

**MISSISSIPPI DEPARTMENT OF TRANSPORTATION**

**MATERIALS DIVISION  
INSPECTION, TESTING, AND CERTIFICATION  
MANUAL**

**Approved and Adopted**

**By**

**The Mississippi Transportation Commission**

**June 28, 2005**

**Revised April 1, 2010**

EXCERPT FROM THE MINUTES OF THE MEETING OF THE  
MISSISSIPPI TRANSPORTATION COMMISSION, JUNE 28, 2005

Upon motion duly made with Commissioners Wayne H. Brown and Dick Hall each voting yes, under the authority of the Commission, in conformity with and as spread on its minutes, the Materials Division's Inspection, Testing, and Certification Manual is hereby approved and adopted.

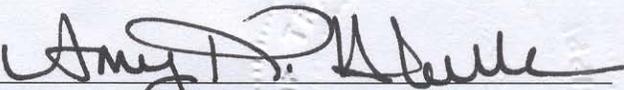
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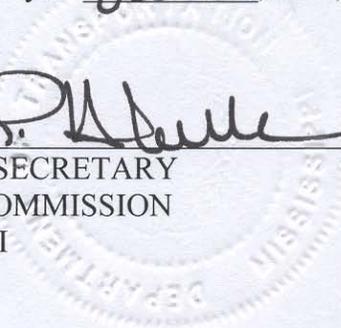
STATE OF MISSISSIPPI

COUNTY OF HINDS

I, Amy K. Hornback, Secretary, Mississippi Transportation Commission, do hereby certify that the above and foregoing is a true and correct copy of an Order of the Mississippi Transportation Commission of record in Minute Book 11, Page 661 of the Official Minutes of said Commission on file in its offices in the City of Jackson, Mississippi, duly adopted on the 28<sup>th</sup> day of June, A.D., 2005.

Witness my hand and official seal this the 30<sup>th</sup> day of June, A.D., 2005.

  
AMY K. HORNBACK, SECRETARY  
TRANSPORTATION COMMISSION  
STATE OF MISSISSIPPI



## **Materials Division Mission Statement**

The Materials Division is responsible for: the sampling, testing, inspection and reporting of materials produced at plants which are assigned to the Central Laboratory; statewide geotechnical operations; testing and reporting of all samples submitted by the Districts; operation of the independent assurance sampling and testing program; publishing information, directives, test procedures, and sampling and materials inspection procedures in order to accomplish statewide uniformity; advising and assisting the Districts in the sampling and testing of materials; and the evaluation of new products and procedures.

One of the other primary functions of the State Materials Engineer is chairman of the Department's Product Evaluation Committee. The Secretary of this committee is the Division's Quality Assurance Engineer. This individual is the Department's liaison between materials suppliers who want to get approval of a new product (for which the Department may or may not have a standard specification) to be incorporated into road construction work. The Quality Assurance Engineer coordinates and assigns the evaluation of these products to the various divisions and districts which could benefit most from a product innovation.

The Materials Division is subdivided into the Field Operations Branch, the Geotechnical Branch, the Independent Assurance Sampling Branch, and the Laboratory Operations Branch.

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# ***Materials Division Inspection, Testing, and Certification Manual***

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## **Section 1 – Certification of Plants, Laboratories, and Testing Personnel**

**1.1 Plants** – Materials Division establishes uniform procedures and guidelines for production plant facilities supplying materials for incorporation into MDOT projects. These procedures and guidelines contained herein are for the purpose of certifying that production plant facilities maintain quality control standards that are acceptable for materials supplied to MDOT.

**1.1.1 Asphalt Distribution Facilities Unit Measurement**—Asphalt Distribution Facilities are to maintain calibration of their distribution and mulch tanks when bituminous material for MDOT projects is being measured for payment by the gallon. Calibration of the distribution tanks shall be conducted accordance with the guidelines set forth herein.

**1.1.1.1 General** – When bituminous material is to be paid by the gallon, the distributor tank(s) or storage tank(s), as applicable, to be used for measurement shall be calibrated in a manner approved by MDOT.

A calibration chart showing the dimensions and volume per inch of depth and measuring gauge calibrated in inches shall be furnished to the Engineer. Each tank shall have an identifying serial number on a steel plate welded or riveted to the tank.

In the event the Contractor does not have the above mentioned calibration chart previously made by an approved agency, MDOT will perform the calibration and furnish the required charts upon written request to the Engineer from the Contractor.

**1.1.1.2 Location of Calibration Stations** – Each District shall establish a calibration station and perform the required calibration of distributors and tanks used to supply MDOT work in the respective District.

**1.1.1.3 Equipment Required to Set Up a Calibration Station** – Following is a list of the required equipment for a calibration station.

Two (2) – 36" pipe wrenches

One (1) – calibration stick, graduated in inches and equipped with a float

One (1) – hose with 2" connections and cut-off valve

Two (2) – 55 gallon drums calibrated in gallons to 50 gallons

One (1) – or two (2) tanks with a total capacity of approximately 500 gallons (see Note)

One (1) – tank with a capacity of 50 gallons or more calibrated in gallons (see Note)

Note: These tanks are to be elevated to allow gravity loading of the equipment being calibrated.

**1.1.1.4 Equipment to be Furnished by the Contractor** – The following items are required by the Contractor at the time a distributor tank is calibrated.

- (1) The Contractor shall furnish a calibration stick, graduated in inches, for measuring depth of liquid in the tank.
- (2) The Contractor shall provide an aluminum or sheet metal plate which shall be riveted or welded to the distributor tank. This plate will bear the Serial Number of the distributor, and a place for capacity, in gallons, which will be stamped in the plate by MDOT personnel after calibration has been made.

**1.1.1.5 Preparation of Distributor or Tank for Calibration** – The equipment to be calibrated must be clean and free of leaks. If the distributor or tank is new, steam cleaning will not be necessary. If the distributor or tank is used, it shall be steam cleaned (inside and out) prior to being delivered for calibration.

**1.1.1.6 Calibration Procedure** – The following procedure shall be followed when calibrating Asphalt distributors or tanks for distribution of asphalt when being paid for by MDOT by the gallon.

- (1) Fill the distributor or tank to capacity from the elevated tanks and record the capacity on Form TMD-132. (See Appendix A)
- (2) Record the distance from the zero point to the water surface.
- (3) Place the calibration stick into the distributor or tank and record the depth of water in the tank.
- (4) Lower the water level in the distributor tank in increments of one (1) inch on the calibration stick by draining the water into the calibrated drums. Record the calibration stick reading and the number of gallons of water in the drums at each increment.

**1.1.1.7 Recalibration** – Any change made in the distributor or tank which alters the calibrated

capacity voids the previous calibration and, the distributor or tank shall be recalibrated prior to further use.

**1.1.2 Inspection of Hot-Mix Asphalt Plants** – Hot-Mix Asphalt Plants must be inspected by MDOT personnel prior to supplying hot-mix asphalt mixes for MDOT projects. Following is the standard procedure for Hot-Mix Asphalt Plant Inspection.

**1.1.2.1 General** – The District Materials Engineer will be responsible for the initial inspection and approval of each plant in the District before hot-mix production begins for a project, and subsequent inspection and approval not to exceed six months. Upon completion of this formal inspection, copies of Form TMD-322 will be completed and distributed. (See Appendix A)

**1.1.2.2 Responsibilities of Plant Management**

- (1) Shall make all parts of the plant and material storage accessible to authorized Department personnel.
- (2) Shall provide adequate and acceptable working facilities for Department personnel.
- (3) Shall supply such materials as necessary for testing purposes, in accordance with the specifications.
- (4) Shall purchase all asphalt cement from MDOT approved suppliers of certified bituminous materials.
  - a. Shall obtain a copy of the refinery test report, the temperature-viscosity curve, Certificate "A" or "B" (as applicable) accompanying each shipment of asphalt cement and make available to Department personnel.
  - b. Shall not use different brands or asphalt cement of the same brand from different refineries without a new or transferred approved mix design.
- (5) Shall assume, in conjunction with the Contractor, responsibility for the quality of the hot-mix produced.
- (6) Shall obtain the services of a reputable scales company as required by the specifications.
- (7) Shall notify Project or District personnel as far in advance as possible of the beginning of production for Department work.

- (8) Shall obtain all aggregates for Department work from sources approved by the Department and shall not change sources without a new or transferred mix design.
- (9) Shall employ knowledgeable and competent personnel to operate the plant. A Level I Certified Asphalt Technician (CAT-I) shall be on location at the plant laboratory to conduct all quality control testing. A Level II Certified Asphalt Technician (CAT-II) shall be on location to make appropriate adjustments to the mix for proper quality control.

### **1.1.2.3 Department Responsibilities**

- (1) Shall perform initial inspection upon request from hot-mix plant (Section 1.1.2). The plant will be approved if it meets all applicable requirements of the specifications. The Department will then perform informal inspections at least every two to four weeks during production, in accordance with the Asphalt Plant Inspection Checklist from the HMA Field Manual.
- (2) Advise plant personnel of specification requirements regarding materials, material storage, and plant and laboratory facilities.
- (3) A qualified inspector will perform an inspection, in accordance with the QMP Inspector's Checklist found in the HMA Field Manual, of the plant's quality control laboratory and their sampling and testing procedures. The plant's designated personnel shall be informed of the results of all inspections.

### 1.1.3 Volume Correction for Bituminous Materials

**1.1.3.1 General** – When bituminous materials are to be paid for by the gallon, the pay quantity will be based on the volume of the material at 60°F. At the time of use, the temperature of the material will be determined by the use of a thermometer. This will be the observed temperature.

#### 1.1.3.2 Use of Tables

- (1) From the observed temperature, the conversion factor can be chosen for emulsions, cutback asphalts, and asphalt cements.
- (2) The correct volume of the material can be calculated by multiplying the conversion factor times the volume of material at the observed temperature.
- (3) **EXAMPLE:** What is the volume of 5,000 gallons of AC-5 at 60°F with an observed temperature of 300°F?

From the table, the conversion factor at 300° F for AC is 0.9187.

5,000 gallons x 0.9187 = 4593.5 gallons

Factor for Reducing Volume to 60°F							
Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.	Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.
50	1.0025			90	0.9925	0.9881	
51	1.0023			91	0.9923	0.9877	
52	1.0020			92	0.9920	0.9873	
53	1.0018			93	0.9918	0.9869	
54	1.0015			94	0.9915	0.9865	
55	1.0013			95	0.9913	0.9861	
56	1.0010			96	0.9910	0.9857	
57	1.0008			97	0.9908	0.9854	
58	1.0005			98	0.9905	0.9850	
59	1.0003			99	0.9903	0.9846	
60	1.0000	1.000		100	0.9900	0.9842	
61	0.9998	0.9996		101	0.9898	0.9838	
62	0.9995	0.9992		102	0.9895	0.9834	
63	0.9993	0.9988		103	0.9993	0.9830	
64	0.9990	0.9984		104	0.9890	0.9826	
65	0.9988	0.9980		105	0.9888	0.9822	
66	0.9985	0.9976		106	0.9885	0.9818	
67	0.9983	0.9972		107	0.9883	0.9814	
68	0.9980	0.9968		108	0.9880	0.9810	
69	0.9978	0.9964		109	0.9878	0.9806	
70	0.9975	0.9960		110	0.9875	0.9803	
71	0.9973	0.9956		111	0.9873	0.9799	
72	0.9970	0.9952		112	0.9870	0.9795	
73	0.9968	0.9948		113	0.9868	0.9791	
74	0.9965	0.9944		114	0.9865	0.9787	
75	0.9963	0.9940		115	0.9863	0.9783	
76	0.9960	0.9936		116	0.9860	0.9779	
77	0.9958	0.9932		117	0.9858	0.9775	
78	0.9955	0.9929		118	0.9855	0.9771	
79	0.9953	0.9925		119	0.9853	0.9767	
80	0.9950	0.9921		120	0.9850	0.9763	
81	0.9948	0.9917		121	0.9848	0.9760	
82	0.9945	0.9913		122	0.9845	0.9756	
83	0.9943	0.9909		123	0.9843	0.9752	
84	0.9940	0.9905		124	0.9840	0.9748	
85	0.9938	0.9901		125	0.9838	0.9744	
86	0.9935	0.9897		126	0.9835	0.9740	
87	0.9933	0.9893		127	0.9833	0.9736	
88	0.9930	0.9889		128	0.9830	0.9732	

Factor for Reducing Volume to 60°F							
Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.	Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.
89	0.9928	0.9885		129	0.9828	0.9728	
130	0.9825	0.9725		170	0.9725	0.9570	0.9621
131	0.9823	0.9721		171	0.9723	0.9566	0.9618
132	0.9820	0.9717		172	0.9720	0.9562	0.9614
133	0.9818	0.9713		173	0.9718	0.9559	0.9611
134	0.9815	0.9709		174	0.9715	0.9555	0.9607
135	0.9813	0.9705		175	0.9713	0.9551	0.9604
136	0.9810	0.9701		176	0.9710	0.9547	0.9601
137	0.9808	0.9697		177	0.9708	0.9543	0.9597
138	0.9805	0.9693		178	0.9705	0.9539	0.9594
139	0.9803	0.9690		179	0.9703	0.9536	0.9590
140	0.9800	0.9686	0.9723	180	0.9700	0.9532	0.9587
141	0.9798	0.9682	0.9720	181	0.9698	0.9528	0.9584
142	0.9795	0.9678	0.9716	182	0.9695	0.9524	0.9580
143	0.9793	0.9674	0.9713	183	0.9693	0.9520	0.9577
144	0.9790	0.9670	0.9710	184	0.9690	0.9517	0.9574
145	0.9788	0.9666	0.9706	185	0.9688	0.9513	0.9570
146	0.9785	0.9662	0.9703	186	0.9685	0.9509	0.9567
147	0.9783	0.9659	0.9699	187	0.9683	0.9505	0.9563
148	0.9780	0.9655	0.9696	188	0.9680	0.9501	0.9560
149	0.9778	0.9651	0.9693	189	0.9678	0.9498	0.9557
150	0.9775	0.9647	0.9689	190	0.9675	0.9494	0.9553
151	0.9773	0.9643	0.9686	191	0.9673	0.9490	0.9550
152	0.9770	0.9639	0.9682	192	0.9670	0.9486	0.9547
153	0.9768	0.9635	0.9679	193	0.9668	0.9482	0.9543
154	0.9765	0.9632	0.9675	194	0.9665	0.9478	0.9540
155	0.9763	0.9628	0.9672	195	0.9663	0.9475	0.9536
156	0.9760	0.9624	0.9669	196	0.9660	0.9471	0.9533
157	0.9758	0.9620	0.9665	197	0.9658	0.9467	0.9530
158	0.9755	0.9616	0.9662	198	0.9655	0.9463	0.9526
159	0.9753	0.9612	0.9658	199	0.9653	0.9460	0.9523
160	0.9750	0.9609	0.9655	200	0.9650	0.9456	0.9520
161	0.9748	0.9605	0.9652	201		0.9452	0.9516
162	0.9745	0.9601	0.9648	202		0.9448	0.9513
163	0.9743	0.9597	0.9645	203		0.9444	0.9509
164	0.9740	0.9593	0.9641	204		0.9441	0.9506
165	0.9738	0.9589	0.9638	205		0.9437	0.9503
166	0.9735	0.9585	0.9635	206		0.9433	0.9499

Factor for Reducing Volume to 60°F							
Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.	Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.
167	0.9733	0.9582	0.9631	207		0.9429	0.9496
168	0.9730	0.9578	0.9628	208		0.9425	0.9493
169	0.9728	0.9574	0.9624	209		0.9422	0.9489
210		0.9418	0.9486	250		0.9268	0.9352
211		0.9414	0.9483	251			0.9349
212		0.9410	0.9479	252			0.9346
213		0.9407	0.9476	253			0.9342
214		0.9403	0.9472	254			0.9339
215		0.9399	0.9469	255			0.9336
216		0.9395	0.9466	256			0.9332
217		0.9391	0.9462	257			0.9329
218		0.9388	0.9459	258			0.9326
219		0.9384	0.9456	259			0.9322
220		0.9380	0.9452	260			0.9319
221		0.9376	0.9449	261			0.9316
222		0.9373	0.9446	262			0.9312
223		0.9369	0.9442	263			0.9309
224		0.9365	0.9439	264			0.9306
225		0.9361	0.9436	265			0.9302
226		0.9358	0.9432	266			0.9299
227		0.9354	0.9429	267			0.9296
228		0.9350	0.9426	268			0.9293
229		0.9346	0.9422	269			0.9289
230		0.9343	0.9419	270			0.9286
231		0.9339	0.9416	271			0.9283
232		0.9335	0.9412	272			0.9279
233		0.9331	0.9409	273			0.9276
234		0.9328	0.9405	274			0.9273
235		0.9324	0.9402	275			0.9269
236		0.9320	0.9399	276			0.9266
237		0.9316	0.9395	277			0.9363
238		0.9313	0.9392	278			0.9259
239		0.9309	0.9389	279			0.9256
240		0.9305	0.9385	280			0.9253
241		0.9301	0.9382	281			0.9250
242		0.9298	0.9379	282			0.9246
243		0.9294	0.9375	283			0.9243
244		0.9290	0.9372	284			0.9240
245		0.9286	0.9369	285			0.9236

Factor for Reducing Volume to 60°F							
Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.	Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.
246		0.9283	0.9365	286			0.9233
247		0.9279	0.9362	287			0.9230
248		0.9275	0.9359	288			0.9227
249		0.9272	0.9356	289			0.9223
290			0.9220	330			0.9089
291			0.9217	331			0.9086
292			0.9213	332			0.9083
293			0.9210	333			0.9079
294			0.9207	334			0.9076
295			0.9204	335			0.9073
296			0.9200	336			0.9070
297			0.9197	337			0.9066
298			0.9194	338			0.9063
299			0.9190	339			0.9060
300			0.9187	340			0.9057
301			0.9184	341			0.9053
302			0.9181	342			0.9050
303			0.9177	343			0.9047
304			0.9174	344			0.9044
305			0.9171	345			0.9040
306			0.9167	346			0.9037
307			0.9164	347			0.9034
308			0.9161	348			0.9031
309			0.9158	349			0.9028
310			0.9154	350			0.9024
311			0.9151	351			0.9021
312			0.9148	352			0.9018
313			0.9145	353			0.9015
314			0.9141	354			0.9011
315			0.9138	355			0.9008
316			0.9135	356			0.9005
317			0.9132	357			0.9002
318			0.9128	358			0.8998
319			0.9125	359			0.8995
320			0.9122	360			0.8992
321			0.9118	361			0.8989
322			0.9115	362			0.8986
323			0.9112	363			0.8982
324			0.9109	364			0.8979

Factor for Reducing Volume to 60°F							
Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.	Observed Temp. °F	Emulsions	Cut Back, RC, MC,SC	A.C.
325			0.9105	365			0.8976
326			0.9102	366			0.8973
327			0.9099	367			0.8969
328			0.6096	368			0.8966
329			0.6092	369			0.8963

Observed Temp. °F	A.C.	Observed Temp. °C	A.C.	Observed Temp. °F	A.C.		
370			0.8960	410			0.8832
371			0.8957	411			0.8829
372			0.8953	412			0.8826
373			0.8950	413			0.8822
374			0.8947	414			0.8819
375			0.8944	415			0.8816
376			0.8941	416			0.8813
377			0.8937	417			0.8810
378			0.8934	418			0.8806
379			0.8931	419			0.8803
380			0.8928	420			0.8800
381			0.8924	421			0.8797
382			0.8921	422			0.8794
383			0.8918	423			0.8791
384			0.8915	424			0.8787
385			0.8912	425			0.8784
386			0.8908	426			0.8781
387			0.8905	427			0.8778
388			0.8902	428			0.8775
389			0.8899	429			0.8772
390			0.8896	430			0.8768
391			0.8892	431			0.8765
392			0.8889	432			0.8762
393			0.8886	433			0.8759
394			0.8883	434			0.8756
395			0.8880	435			0.8753
396			0.8876	436			0.8749
397			0.8873	437			0.8746
398			0.8870	438			0.8743
399			0.8867	439			0.8740
400			0.8864	440			0.8737
401			0.8861	441			0.8734
402			0.8857	442			0.8731
403			0.8854	443			0.8727
404			0.8851	444			0.8724
405			0.8848	445			0.8721
406			0.8845	446			0.8718
407			0.8841	447			0.8715
408			0.8838	448			0.8712

Observed Temp. °F	A.C.	Observed Temp. °C	A.C.	Observed Temp. °F	A.C.		
409			0.8835	449			0.8709
450			0.8705	490			0.8580
451			0.8702	491			0.8577
452			0.8699	492			0.8574
453			0.9696	493			0.8571
454			0.8693	494			0.8568
455			0.8690	495			0.8565
456			0.8687	496			0.8562
457			0.8683	497			0.9559
458			0.8680	498			0.8556
459			0.8677	499			0.8552
460			0.8674	500			0.8549
461			0.8671				
462			0.8668				
463			0.8665				
464			0.8661				
465			0.8658				
466			0.8655				
467			0.8652				
468			0.8649				
469			0.8646				
470			0.8643				
471			0.8640				
472			0.8636				
473			0.8633				
474			0.8630				
475			0.8627				
476			0.8624				
477			0.8621				
478			0.8618				
479			0.8615				
480			0.8611				
481			0.8608				
482			0.8605				
483			0.8602				
484			0.8599				
485			0.8596				
486			0.8593				
487			0.8590				

Observed Temp. °F	A.C.	Observed Temp. °C	A.C.	Observed Temp. °F	A.C.		
488			0.8587				
489			0.8583				

**1.1.4 Certification of Concrete Batch Plants and Scale Calibration** – Certification of Concrete Batch Plants will be in accordance with the requirements in the Department's *Concrete Field Manual*. Concrete Batch Plants must be inspected utilizing the National Ready Mix Concrete Association (NRMCA) QC-3 Checklist prior to supplying concrete to Department projects. The inspection must be performed by an inspector approved by NRMCA and observed by the District Materials Engineer. Calibration of scales at Concrete Plants shall be conducted by a licensed scale repairman in the presence of the District Materials Engineer.

Specific information regarding Concrete Batch Plant Certification and scale calibration can be found in the Department's *Concrete Field Manual*. A copy can be obtained at [www.GoMDOT.com](http://www.GoMDOT.com)

**1.2 Laboratories** – Materials Division establishes methods and procedures for certification of laboratories that test materials to be incorporated into MDOT projects.

**1.2.1 Inspection of Laboratories Used for Testing Concrete** – Laboratories conducting quality control (QC) and quality assurance (QA) testing of concrete for MDOT projects must meet the requirements of Section 804.02-8 and the requirements of the Department's *Concrete Field Manual*.

All laboratories testing structural concrete produced for Department projects must be fully equipped to perform the required tests. Laboratory certification by MDOT shall consist of proof of technician certification and inspection of equipment. All such equipment must meet the requirements of the Department's specified test methods.

MDOT Certification of concrete laboratories shall extend to Contractor, Private, State Aid, City, and any other laboratories doing concrete testing utilizing MDOT Standard Specifications.

Laboratories that are Certified or have been Recertified by MDOT to conduct concrete testing shall be certified for a period of three years. It is the Laboratories responsibility to maintain current certification. The State Materials Engineer should be notified to schedule a laboratory

inspection prior to expiration of the certification.

Specific information regarding Concrete Laboratory Certification can be found in the Department's *Concrete Field Manual*. A copy can be obtained at [www.GoMDOT.com](http://www.GoMDOT.com)

**1.2.2 Inspection of Laboratories Used For Testing Soils and Aggregates** – These provisions establish a procedure for certification of laboratories for testing of soils and aggregates.

**1.2.2.1 Laboratory Certification Requirements**

- (1) All laboratories testing soils and aggregates produced for Department projects must be fully equipped to perform tests for which they are certified. Laboratory certification shall consist of proof of technician certification and inspection of equipment. All such equipment must meet the requirements of the Department's specified test methods.
- (2) This procedure for certification of laboratories is for Contractor, Private, State Aid, City, Department of Transportation, and any other entity's Laboratories(as applicable).
- (3) Certification is good for three years.

**1.2.2.2 Equipment Inspection**

- (1) The laboratory shall be equipped, calibrated, and inspected prior to the testing of soils and aggregates. A request shall be made to the Engineer for inspection of Contractor's laboratory equipment.
- (2) Laboratory inspection will be performed by personnel from the Central Laboratory's Soils and Physical Sections.
- (3) Equipment is to be checked for compliance to AASHTO and MT specifications, as applicable. Inspection of the laboratory is as follows:

- a.** MT 8/AASHTO T 99, Moisture Density Relations of Soils Using a 5.5lb Hammer (12 in.) Drop

Rammer  
Rammer Face  
Sample Extruder or Split Molds  
Balances and Scales  
Drying Oven  
Straightedge  
Sieves  
Mixing Tools  
Moisture Containers

- b.** MT 9, Moisture Density Relations of Treated Soils

Rammer  
Rammer Face  
Sample Extruder or Split Molds  
Balances and Scales  
Drying Oven  
Straightedge  
Sieves  
Mixing Tools  
Moisture Containers

- c.** MT 16, Nuclear Method for Field In-Place Density Determination

Probe  
Scrape Plate  
Guide  
Drill Rod

- d.** MT 22, Sieve Analysis of Granular Material

Oven  
Balance  
Stirring Apparatus

Hydrometer  
Sedimentation Cylinders  
Thermometer  
Sieves  
Water Bath  
Beaker  
Timing Device  
Containers  
Glass Stirring Rod

- e.** AASHTO T 11, Material Finer than No. 200 Sieve in Mineral Aggregate by Washing  
Washing  
Balance  
Sieves  
Containers  
Oven  
Wetting Agent
- f.** AASHTO T 87, Determining Dry Preparation of Disturbed Soil & Soil Aggregate Samples  
Drying Apparatus  
Sieves  
Pulverizing Apparatus  
Sample Splitter
- g.** AASHTO T 88, Particle Size Analysis of Soils  
Oven  
Balance  
Stirring Apparatus  
Hydrometer  
Sedimentation Cylinders  
Thermometer  
Sieves  
Water Bath  
Beaker

Timing Device  
Containers  
Glass Stirring Rod

**h.** AASHTO T 89, Determining Liquid Limit of Soils

Dish  
Spatula  
Liquid Limit Device  
Grooving Tool  
Gage  
Containers  
Balance  
Oven

**i.** AASHTO T 90, Determining the Plastic Limit and Plasticity of Soils

Dish  
Spatula  
Surface for Rolling  
Containers  
Balance  
Oven

**j.** AASHTO T 92, Determining the Shrinkage Factors of Soils

Dishes  
Spatula  
Milk Dish  
Straightedge  
Glass Cup  
Glass Graduate  
Balance  
Mercury  
Oven

**k.** AASHTO T 99, Moisture Density Relations of Soils Using a 5.5lb Hammer

(12 in.) Drop  
Molds

Rammer  
Rammer Face  
Sample Extruder or Split Molds  
Balances and Scales  
Drying Oven  
Straightedge  
Sieves  
Mixing Tools  
Containers

**I. AASHTO T 100, Specific Gravity of Soils**

Pycnometer  
Balance  
Oven  
Thermometer

**m. AASHTO T 180, Moisture Density Relations of Soils Using a 10lb Hammer**

(18 in.) Drop  
Molds  
Rammer  
Rammer Face  
Sample Extruder or Split Molds  
Balances and Scales  
Drying Oven  
Straightedge  
Sieves  
Mixing Tools  
Containers

## 1.3 Testing Personnel

### 1.3.1 Certification of Laboratory Technicians for the Office of State Aid Road Construction

– The following provisions are to establish a procedure for certification of laboratory technicians for the Office of State Aid Road Construction.

**1.3.1.1 General** – It is not the purpose of this manual to set up a training program for laboratory technicians in the Central Laboratory. The applicant for certification must be familiar with all test methods (MT or AASHTO) for which certification is sought, including sample preparation.

#### 1.3.1.2 – Certification Procedure

- (1) The County Engineer shall make a written request to the State Aid Engineer to set a date with the State Materials Engineer for examination of an applicant for certification. This written request shall include the following information with copies to the State Materials Engineer and District Materials Engineer.
  - a. List all tests for which applicant seek certification.
  - b. Certify that applicant can perform all tests in accordance with the appropriate test method (MT or AASHTO).
  - c. Certify that he has copies of current test methods.
  - d. County Engineer shall state that he will pay charges for examination of applicant or attach copy of letter from Board of Supervisors stating same.
- (2) Upon receipt of the request as set out in (1), the State Aid Engineer shall make a written request to the State Materials Engineer to set a date for examination of the applicant.
- (3) Upon receipt of the request from the State Aid Engineer, the State Materials Engineer shall set a date for examination of the applicant and shall give a written notice to all parties concerned.

#### 1.3.1.3 – Equipment

- (1) All equipment for use in testing for Office of State Aid Road Construction work must

be approved by the State Materials Engineer in accordance with Section 1.2 of this manual

- (2) The applicant's laboratory cylinder breaking machine must have a current calibration. This calibration must be renewed annually.

**1.3.1.4 – Cost of Examination** – Cost of examination will be based on a per man-hour actual time spent with the applicant. For equipment that cannot be transported to the Central Laboratory, a charge for this inspection will be made based on travel expense plus man-hour time from Central Laboratory to the County Engineer's Laboratory and return to Central Laboratory.

**1.3.2 Certification of Laboratory Technicians for Local Public Agency (LPA) Projects and other applicable entities** – The following provisions are to establish a procedure for certification of laboratory technicians for Urban Projects.

**1.3.2.1 – General**

- (1) It is not the purpose of this manual to set up a training program for laboratory technicians in the Central Laboratory. The applicant for certification must be familiar with all test methods (MT or AASHTO) for which certification is sought, including sample preparation.
- (2) The LPA Engineer may be a full-time employee or a consultant engaged for a specific project.

**1.3.2.2 Certification Procedure**

- (1) The approved Project Engineer shall make a written request to the District Engineer to set a date with the State Materials Engineer for examination of an applicant for certification. This written request shall include the following information:
  - a. List all tests for which applicant seek certification.
  - b. Certify that applicant can perform all tests in accordance with the appropriate test method (MT or AASHTO).
  - c. Certify that he has copies of current test methods.
  - d. The Project Engineer shall state that he will pay charges for examination of applicant or attach copy of letter from Mayor stating same.
- (2) Upon receipt of the request for technician certification, the District Engineer shall make a written request to the State Materials Engineer to set a date for examination of the applicant.
- (3) Upon receipt of the request from the District Engineer, the State Materials Engineer

shall set a date for examination of the applicant and shall give a written notice to all parties concerned.

### **1.3.2.3 Equipment**

- (1) All equipment for use in testing for Urban work must be approved by the State Materials Engineer in accordance with Section 1.2 of this manual
  
- (2) The applicant's laboratory cylinder breaking machine must have a current calibration. This calibration must be renewed annually.

**1.3.2.4 Cost of Examination** – Cost of examination will be based on a per man-hour actual time spent with the applicant. For equipment that cannot be transported to the Central Laboratory, a charge for this inspection will be made based on travel expense plus man-hour time from Central Laboratory to the LPA Engineer's Laboratory and return to Central Laboratory.

### **1.3.3 MDOT Hot Mix Asphalt Technician Certification Program**

#### **1.3.3.1 Scope**

The goals of this program are to provide a group of experienced technicians to design, test and monitor hot mix asphalt (HMA) mixtures used as part of the Mississippi Quality Management Program (QMP). The intent of this program is to improve the quality and performance of hot mix asphalt pavements through knowledge and understanding of the product. The program will provide for the certification for three levels of technicians. These levels include CAT-I Testing Technician, CAT-II Quality Management Technician and CMDT Mixture Design Technician.

#### **1.3.3.2 Program Administration**

##### **(1) Board of Directors**

The Certification Program will be administered by a board of directors appointed by the Joint MDOT/MAPA Specification Committee. The Board shall consist of four members. At least one member shall be a contractor representative of MAPA and at least one member shall be from the MDOT staff.

##### **(2) Meetings**

The Board shall schedule meetings as required to manage the program. Advanced notice of the meetings, agenda and minutes of previous meetings shall be distributed to the Board members as appropriate. Copies of all meeting minutes shall be provided to the Specification Committee.

##### **(3) Responsibilities**

The Board will be responsible for all operations with regards to the HMA technician certification program to include, but not be limited to, such items as: the establishment and modification of all class, laboratory training and examination programs; selection of the trainers; review of candidates' background; recertification; and to hear and decide on all complaints about the certification program.

### 1.3.3.3 Certification Standards

#### (1) Certified Asphalt Technician - I (CAT-I)

The CAT-I will be responsible for the daily sampling, testing, data calculations, charting and process monitoring at the HMA plant. Prospective candidates will be required to have basic math skills, the ability to use a calculator and meet one of the following experience requirements:

- a. A minimum of six months of hands on experience under the supervision of a current CAT-I.
- b. A minimum of two years of current experience in the HMA industry doing Quality Control testing.

Certification will be based on the successful completion of a written examination and demonstrated competence in the required field sampling and testing program before an approved CMDT proctor. The hands-on demonstration shall be with a proctor who usually works in a district outside the employee's normal working area.

#### (2) Certified Asphalt Technician - II (CAT-II)

The CAT-II will be responsible for the successful operations of the quality control program at the HMA plant and the necessary adjustments to the process to maintain the mixture within the required control limits. Prospective candidates shall have successfully completed the CAT-I program. The training will consist of a 2-4 day program of class sessions. Certification will be based on the successful completion of a written examination taken under the supervision of MDOT and/or MAPA.

#### (3) Certified Mixture Design Technician (CMDT)

The CMDT will be responsible for testing according to MDOT design procedures for the development of a job mix formula for HMA mixtures. Prospective candidates will be required to have basic math skills, the ability to use a calculator and meet one of the

following experience requirements:

- a. A minimum of three months experience as a CAT-I.
- b. A minimum of three months experience under the supervision of a current CMDT.
- c. A minimum of two years of current experience in the HMA industry doing Quality Control or Mixture Design testing

The training will consist of a 4 day program of class and laboratory sessions conducted under directive of MDOT or MAPA. Certification will be based on the successful completion of a written examination and the submittal of a mixture design conducted according to MDOT design procedures. Completion of the CMDT certification process will also satisfy the requirements for CAT-I certification.

#### **1.3.3.4 Certification Process**

Prospective candidates shall submit a request for certification to the HMA Technician Certification Board of Directors in care of the Mississippi Asphalt Pavement Association. The request must contain the certification level sought and information about the successful completion of the required prerequisites for the requested level. Students will be allowed one retest if they do not pass the written examination portion of the certification process. If they do not pass the second examination, they must retake the entire training program. Students not meeting the demonstration requirements for certification will be allowed to retest after further documented experience under the supervision of a certified technician.

#### **1.3.3.5 Recertification**

Certification shall be valid at all levels for a period of five years. Recertification for technicians shall consist of attendance at a one-half day review class and passing a written examination. Mix design submittal will also be required for recertification as a CMDT. Recertification will only be required for the highest level of certification obtained.

#### **1.3.3.6 Certified Technician Responsibilities**

Certified Technicians will be required to sign an acknowledgement form before their certificate will be issued. When the technicians sign the form, they acknowledge that they will conduct themselves, in regards to HMA responsibilities, in a professional and honest manner at all times. This means that they will conduct all sampling and testing according to the procedures required for the materials being tested and the specifications for the specific project being constructed. All test results will be calculated and reported accurately according to the required procedures. Failure to comply with these responsibilities may result in the suspension or revocation of certification.

### **1.3.4 MDOT Concrete Technician Certification Program**

#### **1.3.4.1 Scope**

The MDOT Concrete Technician Certification Program is intended to help assure appropriate minimum training and proficiency qualifications for all personnel, both agency and industry, who are involved with quality control (QC), quality assurance (QA), mixture design, and testing concrete and aggregates for acceptance purposes on MDOT projects. There are four (4) classes of certification, as detailed below, and the appropriate class is required of each individual performing these duties on MDOT projects. Certifications are valid for five (5) years. Retesting is required for certification renewal. Additionally, technicians interpreting and applying maturity information to estimate the in-place strength of concrete require a two hour training class, as detailed below.

#### **1.3.4.2 Program Administration**

The MDOT Concrete Technician Certification Program shall be administered by the Mississippi Concrete Industries Association (MCIA). An Oversight Committee is established, consisting of the MCIA Technical Education Committee members, and MDOT's Assistant Chief Engineer of Operations, State Materials Engineer, and Assistant State Materials Engineer. The MDOT/MCIA Oversight Committee will meet once a year to approve any changes in the certification procedures.

#### **1.3.4.3 Certification Standards**

**(1) MDOT CLASS I** certification covers field testing plastic concrete. The MDOT Class I certification program consists of the nationally recognized ACI Concrete Field Testing Technician Grade I program, and maintaining good standing with MDOT. No substitutions are accepted. The MDOT Class I program includes the following test procedures:

- a. ASTM Designation: C 1064 - Temperature of Freshly Mixed Portland-Cement Concrete
- b. ASTM Designation: C 172 - Sampling Freshly Mixed Concrete
- c. ASTM Designation: C 143 - Slump of Hydraulic Cement Concrete
- d. ASTM Designation: C 138 - Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
- e. ASTM Designation: C 231 - Air Content of Freshly Mixed Concrete by the Pressure Method

- f. ASTM Designation: C 173 - Air Content of Freshly Mixed Concrete by the Volumetric Method
- g. ASTM Designation: C 31 - Making and Curing Concrete Test Specimens in the Field

**(2) MDOT CLASS II** certification is intended for technicians who perform tests on aggregates. The MDOT Class II certification program consists of the nationally recognized ACI Aggregate Testing Technician - Level 1 program, and maintaining good standing with MDOT. The MDOT Class II program requires competency in the following test procedures:

- a. ASTM Designation: D 75 - Sampling Aggregates
- b. ASTM Designation: C 702 - Reducing Field Samples of Aggregate to Testing Size
- c. ASTM Designation: C 117 - Materials finer than 75-  $\mu$ m (No. 200) Sieve for Mineral Aggregates by Washing
- d. ASTM Designation: C 136 - Sieve Analysis of Fine and Coarse Aggregate
- e. ASTM Designation: C 127 - Specific Gravity and Absorption of Coarse Aggregate
- f. ASTM Designation: C 128 - Specific Gravity and Absorption of Fine Aggregate
- g. ASTM Designation: C 566 - Total Moisture Content of Aggregate by Drying
- h. ASTM Designation: C 40 - Organic Impurities in Fine Aggregates for Concrete

**(3) MDOT CLASS III** certification is intended for technicians who design and make field adjustments to concrete mixtures. The MDOT Class III certification program requires that the candidate have valid MDOT Class I, MDOT Class II, and MDOT Strength Testing Technician certifications, and knowledge of the following procedures and specifications:

- a. AASHTO Designation: R 39 - Making and Curing Concrete Test Specimens in the Lab
- b. AASHTO Designation: M 157 - Standard Specifications for Ready Mix Concrete
- c. AASHTO Designation: T 325 – Estimating the Strength of Concrete in Transportation Construction by Maturity Tests.
- d. ASTM Designation: C 1074 – Estimating Concrete Strength by the Maturity Method
- e. Adjustment of Batch Weights for Aggregate Moisture
- f. Concrete Fundamentals (PCA's *Design and Control of Concrete Mixtures*)
- g. Principles of mixture design
  - 1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
  - 2. PCA methods
  - 3. MDOT special requirements
- h. Use of Admixtures

- i. Cementitious Materials
- j. MDOT Specifications, 2004 Edition:
  - 1. Section 501 – Portland Cement Concrete Pavement
  - 2. Section 503 – Replacement of Concrete Pavement
  - 3. Section 504 – Ultra-Thin and Thin Portland Cement Concrete Pavement
  - 4. Section 631 – Flowable Fill
  - 5. Section 803 – Deep Foundations (Drilled Shafts)
  - 6. Section 804 – Concrete for Bridges and Structures
- k. Using Maturity to Estimate In-Place Concrete Strength
- l. Data Management procedures of MDOT's QC/QA Concrete Program

**(4) MDOT Concrete Strength Testing Technician** certification is intended for technicians who performed tests on concrete strength specimens. The MDOT Concrete Strength Testing certification program consists of the nationally recognized ACI Concrete Strength Testing certification program, and maintaining good standing with MDOT. The MDOT Concrete Strength Testing program requires competency in the following test procedures:

- 1. ASTM Designation: C 617 - Capping Cylindrical Concrete Specimens
- 2. ASTM Designation: C 1231 - Unbonded Caps for Concrete Cylinders
- 3. ASTM Designation: C 39 - Compressive Strength of Cylindrical Concrete Specimens
- 4. ASTM Designation: C 78 - Flexural Strength of Concrete

**(5) Maturity Training** is intended for technicians who interpret and apply concrete maturity data in order to estimate the in-place strength of concrete. The two hour training program is facilitated by MCIA. Retraining is not required. The training course reviews the following test procedures:

- 1. AASHTO Designation: T 325 – Estimating the Strength of Concrete in Transportation Construction by Maturity Tests
- 2. ASTM Designation: C1074 – Estimating Concrete Strength by Maturity Method

#### **1.3.4.4 Certification Process**

Each class of certification requires, and is contingent upon, current certification at the preceding class level. Except for MDOT Concrete Strength Testing Technician certification, each certification is valid for five (5) years. MDOT Concrete Strength Testing Technician certification is

valid for six (6) years. Renewal requires reexamination. MDOT Grades I, II, and Concrete Strength Testing certifications require passing a closed-book written examination covering each of the referenced standards, and passing the performance examination by properly demonstrating each ASTM test method. MDOT Class III certifications require passing an open-book written examination covering referenced AASHTO standards and concrete technology material presented in the course.

#### **1.3.4.5 Recertification**

Concrete technician recertification will be the same as the certification process, except that attending the classroom sessions will not be mandatory. When a technician's certification has expired and the technician is enrolled in a recertification class, their certification is automatically extended for an additional 45 days until the results of their recertification test are known.

**Section 2 – Inspection, Sampling, Testing, and Reporting of  
Pre-Tested Materials**

## **2.1 Bituminous Materials: Emulsified Asphalt and Performance Graded Asphalt Binders**

**2.1.1 Bituminous Materials** - The following section establishes uniform policies and procedures for the sampling, testing, inspection, and acceptance of certified bituminous materials including emulsified asphalt and performance graded binders for use in pavement work under the supervision of the Mississippi Department of Transportation.

All bituminous materials furnished for use in MDOT construction or maintenance work shall be shipped under the Mississippi Department of Transportation certification program as established in these provisions. The requirements and procedures shall apply to materials that meet the requirements of AASHTO M 140, M 208, and M 320, Section 5, Materials and Manufacture, and which are manufactured at refineries or mixed at terminals.

**2.1.2 Referenced Documents** – The following is a list of documents referenced in this section:

### **AASHTO STANDARDS:**

M 140—Emulsified Asphalt

M 208—Cationic Emulsified Asphalt

M 320—Specification for performance Graded Asphalt Binders

R 29—Practice for Grading or Verifying the Performance Grade of an Asphalt Binder

T 40—Sampling of Bituminous Materials

### **ASTM STANDARDS:**

D 8—Definitions of Terms Relating to Materials for Road and Pavements

D 3665—Random Sampling of Construction Materials

### **MISSISSIPPI SPECIFICATIONS:**

Mississippi Standard Specifications for Road and Bridge Construction, 2004 Edition

Mississippi Standard Specifications for Road and Bridge Construction, 1990 Edition

Mississippi Standard Specifications for Road and Bridge Construction, 1996 Metric Edition

Applicable Notice to Bidders, Special Provisions and Supplemental Specifications

**2.1.3 Terminology** – The following is a list of terms referenced in this section (2.1):

**AAP**—AASHTO Accreditation Program

**AMRL**—AASHTO Materials Reference Laboratory

**Asphalt Binder**—an asphalt-based cement that is produced from petroleum residue either with or without the addition of non-particulate organic modifiers.

**ASC**—Approved Supplier Certification

**EA**—Emulsified Asphalt

**HMA**—Hot Mix Asphalt

**PGAB**—Performance Graded Asphalt Binder

**MDOT**—Mississippi Department of Transportation

**Supplier**—A Supplier shall be defined as one who produces the final product or who makes the blend or modification that alters the properties of the binder to produce the PGAB as specified in by AASHTO specifications. A Supplier shall be a refinery or a terminal. If no modification is made to either the EA or the PGAB after its initial production at the refinery, the refinery shall be the Supplier and must provide the certification. If any modification is made to the bituminous material at the terminal, the terminal shall be the Supplier and must provide the certification. No modification of the PGAB will be allowed after delivery to the HMA plant.

**Note 1:** Various refining techniques can produce equivalent PGAB; however, these asphalts may be incompatible with each other. Suppliers shall confirm compatibility through testing before combining asphalts from different sources.

**Specification Compliance Testing**—Complete testing in accordance with the applicable AASHTO specification requirements. The procedure for verification of PGAB shall be as described in AASHTO R 29 shall be followed.

**Quality Control Testing**—The quality control testing shall be described in the Supplier's quality control plan. The Supplier's quality control plan shall be approved by MDOT.

**Note 2:** Definitions for many terms common to asphalt binder are found in ASTM D 8.

**2.1.4 Significance and Use** – This standard specifies procedures for determining specification compliance of EA or PGAB by a certification system that evaluates quality control and specification compliance tests performed by the Supplier on samples

obtained prior to shipment, and verification testing performed by MDOT. Following are activities covered within this provision:

- General requirements that the Supplier shall satisfy to be given approved-supplier status.
- Minimum requirements that shall be included in a Supplier's quality control plan.
- General requirements that MDOT shall satisfy before certification.
- Procedure for shipping bituminous materials under an ASC system.
- Procedure for MDOT monitoring of an ASC system at the shipping facility and HMA facility.
- Procedure for field sampling and testing of bituminous materials shipped under an ASC system.

**2.1.5 Supplier Requirements**—Each asphalt refinery or terminal proposing to furnish bituminous materials for MDOT work shall submit a written request to the Materials Division of MDOT for authorization to ship PGAB or EA under the ASC system and shall list the material(s) to which the request applies. The request should certify by letter to the State Materials Engineer agreement with and acceptance of the provisions of Section 2.1 of the Materials Division Inspection, Testing, and Certification Manual and that sampling and testing will be in accordance with the applicable AASHTO or MT Test Methods. This letter shall remain in effect until rescinded in writing. At a mutually convenient time, representatives of the Central Laboratory will visit the production and/or shipping site to observe the Supplier's quality control activities, to inspect the facilities and to obtain samples for test of any applicable material(s) prior to beginning shipments.

**2.1.5.2 Initial Approval Requirements**—The Supplier shall meet the following criteria when applying for approval to supply bituminous materials

- (1) The Supplier shall submit to MDOT for approval a complete quality control plan that complies with the requirements of Section 2.1.5.4. The Supplier shall follow the procedures described in the approved quality control plan.
- (2) The Supplier shall establish a continuing test record for each test required for every EA or PGAB included in the approval request to satisfy the requirements of the quality control plan outlined in Section 2.1.5.4.
- (3) The Supplier shall submit to MDOT all reports required by Section 2.1 in a form

approved by MDOT. A copy of each required report shall be submitted with the Supplier quality control plan for approval.

- (4) For each PGAB included in the written request the Supplier shall forward to MDOT the initial series of test data prepared to satisfy the quality control plan. For all PGAB, the Supplier shall also obtain and provide a split sample for MDOT. For polymer modified PGAB, a written procedure for reheating the sample for testing shall be supplied with the sample.
- (5) The Supplier shall have a satisfactory record of compliance with governing specifications. Judgments by MDOT concerning this requirement shall be based on the test results furnished by the Supplier and satisfactory results when the monitoring and field tests are compared with supplier tests. Following the initial refinery tests on a tank of new material, a check test shall be performed at least each week by the refinery to assure compliance of the material with the specifications.

**2.1.5.2 Sampling** – All test samples shall be obtained in accordance with the applicable AASHTO or ASTM test method for the material to be supplied. The use of a random sampling procedure is mandatory to the establishment of a valid certification program.

**2.1.5.3 Testing Requirements** – All required testing shall be performed by a laboratory currently approved by the Materials Division of MDOT. Inspection by AMRL and participation in an AMRL proficiency samples program shall be used as the basis for approval. AMRL inspection reports along with documentation of resolution of discrepancies in the AMRL report must be provided upon request. In addition, MDOT shall require that the certifying technician participate in a bituminous technician certification program.

#### **2.1.5.4 Supplier Quality Control Plan (Minimum Requirements)**

- (1) Identify the following:
  - Facility type (refinery or terminal);
  - Facility location;
  - Name and telephone number of the person responsible for quality control at the facility;

The quality control tests to be performed on each EA or PGAB;  
Name, address and location of the laboratory performing quality control tests on the EA or PGAB that is shipped.

- (2) The plan must include a declaration stating that if a test result indicates that a shipment of EA or PGAB is not in compliance with the specifications, the Supplier shall:  
Immediately notify MDOT of the shipment in question;  
Identify the material;  
Cease shipment until the material complies with the specifications;  
Notify MDOT when shipment resumes;  
Implement any mutually agreed upon procedures for the disposition of the material.
- (3) List procedures that will be taken in the disposition of any shipment(s) of any EA or PGAB not in compliance with the specifications.
- (4) Describe method and frequency for quality control testing and specification compliance testing.
- (5) The plan shall outline the content of the required quarterly summary reports for all quality control and specification compliance tests performed during that period for submittal to MDOT.
- (6) The plan shall provide an outline of the procedure to be followed for checking transport vehicles before loading to prevent contamination of shipments. The outline shall include a statement that the transport vehicle inspection report, signed by the responsible inspector, shall be maintained in the Supplier's records and shall be made available to MDOT on request.

#### **2.1.5.5 Specification Compliance Testing by the Supplier:**

- 2.1.5.5.1 INITIAL TESTING:** For each PGAB or EA to be supplied, specification compliance testing (*complete AASHTO M 320 or M 140 testing*) shall be performed for at least three consecutive lots. A lot may be a fixed batch of material or a specified

quantity in a continuous operation (see Note 3). The Supplier and MDOT shall agree on a lot size. MDOT must approve any change to a lot size.

**NOTE:** If a batch operation is used to manufacture the PGAB or EA, a tank will be defined as a lot and the lot size will be the amount of material batched into the tank. If a continuous process (in-line blending or shipment from “live” tanks) is used to manufacture the PGAB or EA, the lot size will be obtained at random during the production for continuous operations. Lot size shall depend on the production method used and the quantity produced. High production quantity will generally have larger lot sizes than low production quantity.

**2.1.5.5.2 Reduced Frequency of Testing for Specification Compliance:** If test results show that material consistently meets the minimum AASHTO requirements, the manufacturer may elect to reduce the testing frequency as outlined in their Quality Control Plan. If at any time the manufacturer’s test results show marginal or failing material, testing should be conducted for each lot of material until at least three consecutive lots produce satisfactory material. Any material found by test results not to meet the minimum AASHTO requirements, should be handled in accordance with the manufacturer’s Quality Control Plan. In no instance should material be shipped by the Supplier that has been shown by testing not to meet the minimum AASHTO requirements.

Note, For each lot of PGAB, the Supplier shall develop a temperature-viscosity curve. A copy of the curve shall be distributed with each copy of the bill of lading.

## **2.1.6 Shipping and Certification— Requirements for Shipping and Certification of EA or PGAB by an ASC Supplier**

### **2.1.6.1 General Shipping Requirements**

- (1) The Supplier’s quality control plan as approved by MDOT (see Section 2.1.5.4) shall be implemented.
- (2) The Supplier shall make material shipments covered by the certification as dictated by shipping schedules. A certificate “A” or “B” as detailed herein shall be furnished with each shipment.

- (3) If the specification compliance test results do not conform to PGAB specifications, the Supplier shall remove the noncompliant material from the shipping queue as outlined in Section 2.1.5.4
- (4) Based on MDOT assurance testing or the referee sample testing compromise (see NOTE 4), penalties shall be assessed for material that does not comply with the specified requirements. The penalty shall be determined by MDOT. If problems with the material recur at the HMA plant, MDOT may suspend use of the EA or PGAB until the cause for noncompliance with specifications can be identified and corrected.

#### 2.1.6.2

**Certifications and Shipping Reports**--All bituminous materials accepted by certification will be delivered as set forth in one of the following conditions:

**CASE 1: Bituminous Material Delivered Directly From a Pretested Storage Tank to a Project Site or Maintenance Work Order**

- a. Certified refinery test reports shall be furnished to the State Materials Engineer, including all specified tests made on stored bituminous material. The test reports shall also include the following data:

- Refinery Location
- Test Results
- Storage Tank Number
- Type Bituminous Material
- Refinery Laboratory Number
- Date Sampled
- Number Gallons Represented

- b. The certificate of compliance shall contain the following or similar wording:

"The undersigned certifies that the sample(s) represented by this report was obtained from bituminous material loaded into the storage tank number indicated above; that no additional material has been added since these tests were made; that the tests were made in accordance with the latest AASHTO or MT standard methods; and that the bituminous material complies with the Mississippi Department of Transportation specification for the type shown above."

- c. The format of the test report may be the same as that normally used by the refinery. The above certificate may be printed or stamped on the test report.

- d. For each shipment of bituminous material, a certificate (hereinafter called **Certificate "A"**) shall be furnished with the following data:

Certificate "A" Number  
Refinery Laboratory Number  
Refinery Location  
Date Shipped  
Type of Bituminous Material  
Project or Work Order Number  
Storage Tank Number  
Name of Purchaser  
Destination  
Number of Gallons Shipped

- e. The Certificates "A" shall be numbered consecutively and contain the following or similar wording:

"The undersigned certifies that the transport or railroad car was inspected prior to loading and found to contain no contaminating material. The bituminous material in this shipment was loaded from the pre-tested tank indicated above, and it complies with Mississippi Department of Transportation specifications. No bituminous material not covered by a certified test report has been added to the storage tank."

- f. The Certificates "A" shall be signed by an authorized company representative.
- g. When bituminous material is delivered by truck transport, the certificate shall accompany each transport. It shall be delivered to the appropriate Department representative, and copies shall be mailed to the State Materials Engineer and the District Materials Engineer.

**CASE 2: Bituminous Material Delivered Directly From a Pretested Storage Tank To a Commercial Asphalt Plant Which Produces For Department Work.**

Certified refinery test reports with an attached copy of the temperature-viscosity curve shall be furnished the State Materials Engineer, the asphalt plant and the appropriate Department representative at the asphalt plant. (The test reports are

described under Case 1 above.) A copy of the Certificate "A" will be furnished the State Materials Engineer and two (2) copies will be furnished to the asphalt plant. A copy of the Certificate "A" shall be furnished the appropriate Department representative by the asphalt plant.

**CASE 3: Bituminous Material Delivered From a Pre-tested Storage Tank to an Intermediate Terminal for Trans-shipment to Projects, Work Orders, or Asphalt Plants**

Certified test reports, temperature viscosity curves, and Certificate A's, shall be furnished the State Materials Engineer. (These reports are described under Case 1.) A Certificate "A" as described in Case 1 above, shall be furnished to the State Materials Engineer and to the management of the terminal for each shipment to the terminal.

**CASE 4: Bituminous Material Delivered From an Intermediate Terminal to a Project or Work Order**

- a. For each shipment of bituminous material from an intermediate terminal to a project or work order, a certificate (hereinafter called **Certificate "B"**) shall be furnished with the following data:

Certificate "B" Number  
Type Bituminous Material  
Terminal Location  
Number Gallons Shipped  
Terminal Storage Tank Number  
Project or Work Order Number  
Name of Purchaser  
Date Shipped  
Destination  
Asphalt Refinery Location\*  
\*Location from which bituminous material was obtained

- b. The Certificates "B" shall be numbered consecutively and contain the following or similar wording:

"The undersigned certifies that the transport vehicle was inspected prior to loading and found to contain no contaminating material. The bituminous material in this shipment was loaded from the terminal storage tank indicated above; that it is the same bituminous material covered by Certificate "A" No. (Certificate No.) issued by (asphalt refinery name); that no bituminous material not covered by certified test reports has been

added to the storage tank; and that the bituminous material complies with Mississippi Department of Transportation specification for the type indicated."

- c. The certificate shall be signed by an authorized representative of the terminal. When bituminous material is delivered by truck transport, the certificate shall accompany each transport. It shall be delivered to the appropriate Department representative, and copies shall be mailed to the State Materials Engineer and the District Materials Engineer.

**CASE 5: Bituminous Material Delivered From an Intermediate Terminal to a Commercial Asphalt Plant Which Produces For the Department Work**

A copy of the Certificate "B" as described in Case 4 above will be furnished the State Materials Engineer and two (2) copies to the asphalt plant. A copy of the Certificate "B" shall be furnished the appropriate Department representative by the asphalt plant. A copy of the temperature-viscosity curve shall be attached to each Certificate "B" and copies sent to the asphalt plant.

- 2.1.7 Sampling Bituminous Material at the Refinery or Terminal by MDOT** – All bituminous materials shall be sampled according to the procedure in the following Table.

**Sampling Frequency for Bituminous Materials**

MATERIAL TYPE	TANK CAPACITY (GALLONS)	NUMBER OF SAMPLES	SAMPLING LOCATION
ASPHALT EMULSION	LESS THAN 10,000	ONE (1)	MIDDLE
ASPHALT EMULSION	10,000 TO 50,000	TWO (2)	TOP & MIDDLE
OTHER THAN EMULSION	LESS THAN 50,000	ONE (1)	MIDDLE
ALL TYPES	50,000 TO 150,000	TWO (2)	TOP & BOTTOM
ALL TYPES	MORE THAN 150,000	THREE (3)	TOP, MIDDLE & BOTTOM

NOTE: When storage tanks are equipped to properly circulate the material, the samples may be obtained from any one location of the tank.

- 2.1.7.1** Following approval of a storage tank of bituminous material, stock samples will be obtained at a frequency of one (1) each two weeks from each approved tank when

more than 50,000 gallons are shipped each two weeks. When less than 50,000 gallons are shipped each two weeks, a stock sample will be obtained for each 50,000 gallons shipped. During winter months, asphalt emulsions will be sampled prior to shipment or one (1) sample every two weeks from each approved tank.

**2.1.7.2** In the event a stock sample fails to meet the requirements of the specifications, the Central Laboratory will advise the refinery (or terminal) of the failure and advise that shipments to Department projects be ceased. A stock check sample will be obtained if requested by the refinery.

**2.1.7.3** In the event of noncompliance of a stock check sample, the Central Laboratory will notify the refinery (or terminal) that the material is rejected, and no further testing will be performed until the tank has been reworked and a certified test report has been submitted showing the deficiency has been corrected. The tank may then be resampled and tested.

**2.1.7.4** After the failure of the stock sample and the stock check sample, no further shipments of material, of the same type and grade, will be made until the new material has been sampled, tested and accepted by the Central Laboratory.

**2.1.8 Field Acceptance Sampling Requirements—** Bituminous material used for Department work shall be sampled by a representative of the Department at the frequencies outlined hereinafter. The frequencies shown apply to each source and are the minimum; additional samples shall be obtained if there is a question concerning the quality of the asphalt.

**2.1.8.1** Each sample of asphalt binder will consist of 1 quart; each sample of emulsified asphalt will consist of one (1) gallons. The asphalt binder will be placed in one-quart metal cans, and emulsified asphalt will be placed in one-gallon plastic containers. Extreme care must be taken in sealing the sample containers to prevent contamination and loss of volatiles.

**2.1.8.2** The Department Inspector must pay special attention to the following:

- Use proper sampling procedures;
- Use only clean, dry sample containers;
- Complete the sample information card (TMD-320) or enter the SiteManager Sample Information;

Ship samples to Central Laboratory as soon as possible.

**2.1.8.3** The Central Laboratory will notify the Engineer of failing test results by telephone or e-mail. The Engineer will notify the Contractor of the failure as soon as possible so that corrective actions may take place.

**2.1.8.4** Bituminous material delivered to a project for surface treatment will be sampled at the rate of one (1) sample for each 50,000 gallons or fraction thereof. At least one (1) sample will be obtained for each project.

**2.1.8.5** Emulsified asphalt delivered to a project for prime, curing or erosion control will be sampled at the rate of one (1) sample for each 30,000 gallons or fraction thereof. At least one (1) sample shall be obtained for each project.. Emulsified asphalt stored on the project during periods when the temperature is below freezing shall be re-sampled and submitted to the Central Laboratory. Test results will indicate whether or not this material is acceptable for use in the work.

#### **2.1.8.6 Performance Graded Asphalt Binder Field Sampling Requirements**

- (1)** PGAB delivered to a field facility (HMA Plant) shall be sampled on a random basis for quality assurance at a minimum frequency of one sample per 200,000 gallons of PGAB. Additional samples may be obtained by either MDOT or the HMA producer as deemed necessary.
- (2)** Field samples are taken for several purposes including but not limited to the following: To determine the type and magnitude of any changes in the properties of the PGAB during transportation and storage; to determine that the material received in the field is the material ordered; or to verify that the quality control/quality assurance system is performing as intended.
- (3)** If test results indicate that the PGAB does not meet specifications, MDOT shall immediately notify the HMA producer. An investigation shall be conducted that shall include a review of quality control and sampling and testing procedures for field sampling and split sampling. The purpose of the investigation is to rule out contamination of the PGAB due to sampling technique and sampling location.

- (4) After completion of the investigation, if the PGAB is found to not meet the specifications, the District Materials Engineer and Project Engineer shall be notified immediately. The Project Engineer shall notify the HMA producer to suspend operations immediately. The HMA producer and Supplier shall immediately investigate the possibility of contamination in transport vehicles, field storage tanks, pumps, lines and at handling facilities or other causes, and take appropriate action to correct the problem. When it is determined that the PGAB is back in compliance with specifications, operations may resume. Any mixture placed containing noncompliant PGAB shall be evaluated to determine the effect of the noncompliant material on the service life of the pavement. If it is determined that the mixture can remain in place, an appropriate pay adjustment shall be applied to all the placed mixture represented by the test.
- (5) **Temperature-Viscosity Relation Curves** – The Department representative at the hot-mix asphalt plant will compare the temperature-viscosity curves of the asphalt shipped to the temperature-viscosity curve received with the mix design. If the viscosity of the asphalt shipped changes by a factor of two (2) or more from that used in the mix design, a new design will be required.

### **2.1.9 HMA Producer Responsibilities**

- (1) The HMA producer shall insure that all PGAB incorporated in the work conforms to the requirements of Section 2.1 of this manual, and is purchased from an MDOT Approved Supplier.
- (2) The HMA producer shall insure that the PGAB does not become mixed with other grades of binders or otherwise contaminated after delivery.
- (3) When the HMA producer owns and/or operates the transport vehicles, the HMA producer shall provide the transport vehicle inspection report required in Section 2.1.5.4(6).

### **2.1.10 MDOT Responsibilities**

#### **2.1.10.1 Approval, Sampling, and Reporting Requirements**

- (1) MDOT shall verify that the Supplier's quality control plan is adequate. MDOT representatives may visit the shipping site when necessary.
- (2) When approved, MDOT shall notify the Supplier that the Supplier's application for ASC status has been granted. The notification shall include a list of the materials covered. When an application has been denied, MDOT shall provide such notification to the Supplier with reasons for denial.
- (3) MDOT shall determine approval status of the Supplier's testing laboratory.
- (4) MDOT may perform split sample testing for PGAB in accordance with Section 2.1.10.2.
- (5) MDOT personnel shall perform quality assurance sampling and testing in accordance with Section 2.1.8.
- (6) MDOT shall authorize shipment of each listed material under the ASC system only after all ASC requirements have been satisfied.
- (7) MDOT may inspect the operations of the Supplier's facility related to shipments of bituminous materials when necessary.
- (8) The Central Laboratory shall maintain a file of certified refinery test reports from each asphalt refinery furnishing asphalt under the certification program.
- (9) The Central Laboratory shall work to insure that asphalt refineries abide by the procedures herein stated. Refineries failing to abide by these procedures will not be permitted to ship asphalt for Department work until such time as the State Materials Engineer is satisfied that the refinery will abide by the provisions set forth herein.

#### **2.1.10.2. Split Sample Testing Requirements for PGAB**

MDOT shall test split samples that are obtained at random from the Supplier's

facility at a minimum frequency of one sample each ninety (90) days.

Note—Split samples shall be obtained from the same general points in the Supplier's shipping process that the Supplier's samples are taken; for example, from a storage tank at the refinery, from a holding tank at a terminal, or from a loading line down from the blending operation of an in-line blending process.

If the split sample data and the Supplier test data are not within the test tolerance specified in the applicable test standards, an immediate investigation shall be conducted to determine the reason for the difference between the data. Unless available facts indicate otherwise, the investigation shall include a review of sampling and testing procedures of both Supplier and MDOT. MDOT shall notify the Supplier when either split sample data versus Supplier sample data does not compare within the limits established in Sections 2.1.8 and 2.1.10.2.

The Supplier and/or the HMA producer may take a split sample of the PGAB quality assurance samples for verification of MDOT's results. If a split sample is taken, a third sample shall be taken as a referee. The referee sample shall be retained either by MDOT or by the HMA producer until the quality assurance sample test results are available. If the test results are not disputed, the referee sample may be discarded. However, if the test results are disputed, MDOT shall test the referee sample, and if requested the Supplier shall be allowed to witness the referee testing. The results of the referee sample testing shall be binding.

An MDOT representative at the HMA plant shall develop temperature-viscosity curve on samples taken at random at a minimum frequency of one sample per 100,000 gallons of PGAB incorporated in the work. The temperature-viscosity curve shall be compared to the applicable Supplier's curve for determination of uniformity. If the viscosity range at compaction and/or mixing temperature varies by more than 10°F, a sample shall be submitted to the Materials Division for complete analysis for determination of compliance to specifications.

## **2.1.11 Reporting**

### **2.1.11.1 Supplier Reports** - The Supplier shall prepare the reports as described herein

(Sections 2.1.5 and 2.1.6)

### 2.1.11.2 MDOT Reports

- (1) The Supplier may request copies of the split sample test results and field test data.
  
- (2) MDOT Project Engineers shall maintain a log of Certificates (“A” or “B”) on an Asphalt Certificate Summary. A copy of an example form may be obtained from the MDOT intranet website or the [www.goMDOT.com](http://www.goMDOT.com) website. A SiteManager Sample Record shall be completed with all applicable information and the appropriate template (FFO-617--“Report of Asphalt Shipped by Certificate”). The sample record and template should represent the total amount of certified Asphalt listed on the asphalt summary. A copy of the Summary Log shall be maintained by the project engineer.
  
- (3) County or LPA Project Engineers shall submit a Pretested Materials Shipment Report Request Form to the Central Lab for each project listing each Certificate “A” or Certificate “B” that was received from the Asphalt Binder Source. The form shall include:

The binder’s source name

The terminal location

The type material

The certificate number

The total number of gallons from the certification that were received during the reporting period.

The form may be forwarded as the project progresses, or at the end of construction. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website under the *Business Section*, or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material(s).

## **2.2 Cementitious Materials: Hydraulic Cement, Ground Granulated Blast Furnace Slag, and Fly Ash**

**2.2.1 Hydraulic Cement** – The following section establishes uniform procedures for the sampling, testing, reporting of tests and evaluation of Hydraulic Cement.

**2.2.1.1 General** – Acceptance of hydraulic cement for use in concrete or soil-cement produced for the Mississippi Department of Transportation will usually be based on certification by the producer that the cement complies in all respects with the applicable specifications.

Check samples will be obtained from cement delivered to the concrete plant or project site and submitted to the Central Laboratory for testing in accordance with established sampling frequencies as set forth in this section (Section 2.2.1).

The operating procedure outlined herein is applicable to all hydraulic cement delivered to Mississippi Department of Transportation projects; to ready-mix concrete plants producing concrete for Department work; to plants producing precast units and prestressed or post-tensioned concrete members for Department work; and to districts for maintenance work. Section 2.2.1 is also applicable to cement delivered for work supervised by the Office of State Aid Road Construction.

It shall be the responsibility of the Contractor to ascertain that the cement company for whom he purchases cement complies with provisions of this standard operating procedure.

### **2.2.1.2 Requirements for Sampling, Testing, and Certification by Cement Producers**

**2.2.1.2.1** Each cement company proposing to furnish cement for Department work shall indicate agreement with, and acceptance of, the provisions of this standard operating procedure by a letter addressed to the State Materials Engineer. This letter will remain in effect until rescinded in writing by the cement company. A cement company is required to have a letter as described above, on file with the State Materials Engineer in order to qualify as a source of cement for Department work.

**2.2.1.2.2** Each cement mill proposing to produce cement for Department work shall certify in a letter addressed to the State Materials Engineer that the rate of sampling and testing at the

cement mill is in accordance with the latest revision of AASHTO Designation: T 127 and referenced specifications. This letter will remain in effect until retracted by the cement mill. A cement mill is required to have a letter as described above, on file with the State Materials Engineer in order to qualify as a source of cement for Department work.

Each mill proposing to supply cement for Department work must provide 1 quart sized sample of the proposed cement at the time of application for source approval. Upon source approval an annual sample should be submitted during the first quarter of each year. In addition, if the composition of the cement is altered through the addition of Limestone after receiving notification of approval, then an additional sample is required for laboratory testing.

**2.2.1.2.3** When testing cement for Department work, a cement mill shall comply with the "Normal Testing Rate" outlined in AASHTO Designation: T 127 unless it furnishes documentary evidence of its quality history as required by the reference. If the mill furnishes satisfactory evidence of quality, the mill may use the "Reduced Testing Rate". This evidence shall be furnished to the State Materials Engineer, and should consist of test reports by the mill over a period of approximately two years.

The above AASHTO designation gives the purchaser the option to specify the rate of testing for alkali content of the cement. Mississippi Department of Transportation specifications require low alkali cement, and it is required that each test sample be tested for alkali content.

It is not required that railroad cars or transports of cement be sealed at the mill or the terminal. However, the cement company shipping the cement may elect to seal the car or transport for its own protection.

**2.2.1.2.4** Since there are several conditions under which cement is delivered, procedures for each condition are outlined separately as follows:

**Case 1** – Cement delivered directly from a pretested storage silo to a project site, or a maintenance work order.

- a. Certified mill test reports shall be furnished to the State Materials Engineer, including all tests made on the stored cement. The test reports shall include the following data:

Brand Name	Test Results
Cement Mill Location	Kind and Type of Cement
Silo Number	Number of Barrels Represented
Laboratory Number	Certification of Compliance
Date Sampled	Amount of SO <sub>3</sub> in Cement
Indication of Limestone Content and laboratory data*	

\*When Limestone is present in the cement, the Mill test report should include the amount in percent (%) of Limestone, Carbon Dioxide (CO<sub>2</sub>), and Calcium Carbonate (CaCO<sub>3</sub>).

- b. The certificate of compliance shall contain the following or similar wording:

"The undersigned certifies that the sample (or samples) represented by this report was obtained from cement loaded into the bin (or silo) indicated above, that the tests were made in accordance with the latest AASHTO standard methods (if other methods were used, so designate), and that the cement complies with the MDOT specifications for (kind and type)."

The format of the test report may be the same as that normally used by the mill; the above certificate may be printed or stamped on the test report.

- c. The supplier shall submit Quarterly reports of the amount of SO<sub>3</sub> present in cement to be supplied for use on MDOT projects with a notification of compliance with ASTM C 1038. A copy of the certified test report for ASTM C 1038 should accompany the notification.

d.

- e. For each shipment of cement, a certificate shall be furnished with the following data:

Brand Name	Date Shipped
Cement Mill Location	Project, or Work Order, Number
Kind and Type of Cement	Name of Purchaser
Silo Number	Destination
Number of Barrels Shipped	Indication of Limestone Content

- f. The above certification shall contain the following or similar wording:

"The undersigned certifies that the cement in this shipment was loaded from the pretested bin (or silo) indicated above and it complies with MDOT specifications for (kind and type). The cement was tested under laboratory numbers (Lab ID), and no cement not covered by a certified test report has been added to the silo."

- g. When cement is delivered by truck transport, the certificate shall accompany each transport and shall be delivered to the appropriate MDOT representative,

except that the copies for the State Materials Engineer and the District Materials Engineer shall be mailed.

- h. This shipping certificate shall hereinafter be called "**Certificate A**"

**Case 2** – Cement delivered directly from a pretested storage silo to a recognized commercial ready-mix concrete plant which produces concrete for Mississippi Department of Transportation work.

- a. Certified mill test reports shall be furnished to the ready-mix concrete plant and the State Materials Engineer. The reports are described under Case 1, above.
- b. A Certificate "A" (except the project number or work order number) is to be sent to the ready-mix concrete plant and the State Materials Engineer for each shipment of cement.
- c. A copy of Certificate "A" shall be furnished by the ready-mix concrete plant to the Project Engineer(s), County Engineer(s), or District personnel supervising projects, or work orders being furnished concrete.

**Case 3** – Cement delivered from a pretested silo or by barge to an intermediate terminal for trans-shipments to projects, work orders, or ready-mix concrete plants.

Certified mill test reports shall be furnished to the State Materials Engineer. A Certificate "A," as described in Case 1, above (reworded as necessary) shall be furnished to the State Materials Engineer and the terminal management for each shipment to the terminal.

**Case 4** – Cement delivered from an intermediate terminal to a project or work order.

- a. A certificate, hereafter called "**Certificate B**," shall be furnished for each shipment, with the original to a representative of the Project Engineer, County Engineer, or District Engineer, as applicable, and copies or prints mailed to the District Materials Engineer and to the State Materials Engineer. This certificate shall contain the following data:

Terminal Designation	Kind and Type of Cement
Terminal Silo Number	Number of Barrels Shipped
Brand Name	Project, or Work Order, Number
Name of Purchaser	Date Shipped
Destination	Cement Mill Location*
Indication of Limestone Content	
*(from which cement was obtained)	

- b. The certificate shall contain the following or similar wording:

"The undersigned certifies that the cement in this shipment was loaded from the terminal silo indicated above, that it is the same cement covered by certificate numbers (certificate no) issued by (cement mill), that no cement not covered by certified test reports has been added to the silo, and that the cement complies with MDOT specifications for the kind and type indicated above."

**Case 5** – Cement delivered from an intermediate terminal to a recognized commercial ready-mix concrete plant which produces concrete for Mississippi Department of Transportation work.

A Certificate "B", as described above, reworded as necessary, shall be furnished with each shipment to the ready-mix plant and to the State Materials Engineer. A copy of Certificate "B" shall be furnished by the ready-mix plant to the Project Engineer(s), County Engineer(s) or District personnel supervising projects or work orders being furnished concrete.

**2.2.1.2.5** Each cement mill shall number Certificates "A" consecutively. The certificates shall be signed by an authorized official of the cement company.

**2.2.1.2.6** Each intermediate terminal shall number Certificates "B" consecutively. The certificates shall be signed by an authorized representative of the cement company owning or operating the terminal.

**2.2.1.3 Responsibilities of Commercial Ready-Mix Concrete Plants** – All cement purchased by a ready-mix concrete plant for use in concrete produced for any Mississippi Department of Transportation work shall be covered by certified mill test reports and Certificates "A," or Certificates "B," as applicable, and as described in Sections 2.2.1.2.

#### **2.2.1.4 Responsibilities of Department Supervisor Personnel**

**2.2.1.4.1** Cement delivered to the project or work order site may be used provided a Certificate "A" or a Certificate "B," as applicable, has been received. Concrete produced by an approved commercial ready-mix concrete plant may be accepted, insofar as the cement is concerned, provided the concrete plant has furnished the required data as outlined in Sections 2.2.1.2.

**2.2.1.4.2** In case a shipment is received without the proper certificate, the cement shall not be used until the required certificate has been furnished or until tests indicating compliance have been completed on samples submitted from the shipment.

**2.2.1.4.3** Project Engineers shall enter all applicable information into a SiteManager Sample Record and complete Template CPE-901—"Project Engineer Certification" for all the cement received, prior to close of the project.

**2.2.1.4.4** County or LPA Project Engineers shall retain copies of all applicable certificates for project clearance records.

##### **2.2.1.4.4 Sampling of Cement**

- (1)** Cement used in concrete and in soil-cement produced for Mississippi Department of Transportation work will be sampled by a representative of the Department at the approximate frequencies outlined below (Sections 2.2.1.4.3(4) and (5)). The frequencies shown apply to each source of cement and are the minimum; additional samples will be obtained if there is a question concerning the quality of the cement.
- (2)** Each sample will consist of approximately ten (10) pounds (approximately one gallon) and will be obtained in such a manner, and at such points, that the sample will: (1) be representative, (2) not be contaminated and (3) represent only one source and brand of cement.
- (3)** The samples will be placed in triple-seal metal cans or other moisture-proof containers that will insure the samples against contamination. The samples will be delivered, or will be mailed or shipped, prepaid. Consideration should be given to multiple sample

shipments in order to take advantage of minimum shipping charges, but in no case will a sample be retained for longer than fourteen (14) days before submission to the Central Laboratory, Jackson, Mississippi.

- (4) Cement used by approved commercial ready-mix plants in production of concrete for Mississippi Department of Transportation work will be sampled at the rate of one (1) sample for each five hundred (500) cubic yards used, or a fraction thereof. Insofar as possible, at least one sample shall be obtained for each project except that a sample will not be required if the project contains less than approximately 200 cubic yards of concrete. Minor variations from this may be approved in writing by the State Materials Engineer.
- (5) Cement delivered to a central concrete plant set up for a specific project, to be used in concrete paving will be sampled at the rate of one (1) sample for each one thousand (1000) cubic yards, or fraction thereof, used, except that at least one (1) sample will be obtained each week during which concrete is produced. On a project containing less than approximately 200 cubic yards of concrete, a sample will not be required. Minor variations from this may be approved in writing by the State Materials Engineer.
- (6) Cement delivered to a project site for a specific project, to be used in soil-cement, will be sampled at the rate of one (1) sample for each one thousand (1000) barrels, or fraction thereof, received, except that at least one (1) sample will be obtained each week during which soil-cement is produced. Minor variations from this may be approved in writing by the State Materials Engineer.

**2.2.1.5 Responsibility of Central Laboratory** – The Central Laboratory may composite samples from each project, each source, and each type, forming test samples to be tested by the Central Laboratory, or at the discretion of the State Materials Engineer, a commercial laboratory. The Central Laboratory may composite individual samples from multiple projects provided the individual samples are from the same source and of the same type. Only individual samples having sampling dates from within thirty (30) days of each other will be utilized in a composite. Results of these tests will be reported to the parties concerned. The individual samples from which the composite test sample is obtained will be retained until satisfactory test results on the test samples are received.

If a composite test sample fails to comply with specification requirements, each individual sample represented by the composite test sample shall be tested for the failing requirement(s). Upon receipt of results of these tests, the State Materials Engineer shall evaluate the tests to determine action to be taken under Section 2.2.1.6.

A test sample, composites from individual samples, shall represent not more than four thousand (4000) cubic yards of concrete (or 4000 barrels of cement produced for soil-cement projects), except that the State Materials Engineer may decrease this maximum on any particular project if he deems it necessary or advisable due to lack of uniformity, borderline test results, or for other reasons.

**2.2.1.6 Non-Complying Cement Samples** – When a sample of cement fails to comply with the specification requirements, the State Materials Engineer will evaluate the failure and the probable effect of the failing requirement on the quality of the product produced with the cement.

If the State Materials Engineer deems the failure of sufficient seriousness to warrant such action, he may at his discretion order that the cement thus represented not be used in Department work, or he may proceed with the check tests on individual samples as specified in Section 2.2.1.6 for further evaluation.

In the event the check tests on individual samples confirm the failure, the State Materials Engineer will evaluate the failure and the probable effect on the quality of concrete produced with the cement. If he deems the confirmed failure of sufficient seriousness to warrant such action, the cement mill which produced the cement shall be required to suspend all shipments of cement for Department work until such time as the cause(s) of the failure have been corrected to the satisfaction of the State Materials Engineer.

**2.2.1.7 Storage Capacity** – In order to eliminate any possible delay in production because of nonconforming cement, it shall be the Contractor's responsibility to provide ample storage and shipments of cement to permit identification, sampling and testing, and appropriate actions as indicated above for failing samples.

**2.2.2 Ground Granulated Blast Furnace Slag (GGBFS)** – The following section establishes uniform procedures for the sampling, testing, reporting of tests and evaluation of Ground Granulated Blast Furnace Slag, hereinafter referred to as “GGBFS.”

**2.2.2.1 General** – Acceptance of GGBFS for use in concrete or soil-cement produced for the Mississippi Department of Transportation (MDOT) will usually be based on certification by the producer that the GGBFS complies in all respects with the applicable specifications. Check samples will be obtained from GGBFS delivered to the concrete plant or project site and submitted to the Central Laboratory for testing in accordance with established sampling frequencies as set forth in this section (Section 2.2.2).

These provisions apply to all GGBFS delivered to MDOT projects; to ready-mix concrete plants producing concrete for Department work; to plants producing precast units and prestressed or post-tensioned concrete members for Department work; and to districts for maintenance work. Section 2.2.2 is also applicable to GGBFS delivered for work supervised by the Office of State Aid Road Construction.

It shall be the responsibility of the Contractor to ascertain that the company from whom he purchases GGBFS complies with provisions herein.

**2.2.2.2 Sampling, Testing, and Certification by GGBFS Producers** - Following are MDOT requirements for Producers supplying GGBFS for Department Projects.

**2.2.2.2.1** Each company proposing to furnish GGBFS for Department work shall indicate agreement with, and acceptance of, the provisions of Section 2.2.2 of this manual by letter addressed to the State Materials Engineer. This letter will remain in effect until rescinded in writing by the company furnishing GGBFS. A GGBFS company is required to have a letter, as above described, on file with the State Materials Engineer in order to qualify as a source of GGBFS for Department work.

**2.2.2.2.2** Each GGBFS mill proposing to produce GGBFS for Department work shall certify in a letter addressed to the State Materials Engineer that the minimum rate of sampling and testing at the GGBFS mill, or processing facility, is in accordance with the latest revision of AASHTO Designation: T 127 and referenced specifications. This letter will remain in effect until retracted by the GGBFS mill. A GGBFS mill is required to have a letter, as above described, on file with

the State Materials Engineer in order to qualify as a source of GGBFS for Department work.

**2.2.2.2.3 Testing Laboratories** – Each testing laboratory performing any portion or all of the required tests under this procedure must be approved before a GGBFS mill, or processing facility, can be placed on the approved list. Such approval will be contingent upon the following:

- (1) Each testing laboratory must be regularly inspected by the Cement Concrete Reference Laboratory (CCRL). The testing laboratory shall authorize the Cement Concrete Reference Laboratory to send a copy of each inspection report directly to the State Materials Engineer of the Mississippi Department of Transportation. Frequency of these inspections shall be approximately once each 18 months according to CCRL scheduling.
- (2) Failure to participate in the CCRL inspection program on a regular basis will result in disapproval of the laboratory and removal of the GGBFS mill from the approved list.
- (3) Failure to authorize CCRL to send a copy of the inspection report to the Department will result in disapproval. If a copy of the latest inspection report is not received by the Department within any 24 months period, the laboratory will be disapproved and the GGBFS mill removed from the approved list.
- (4) The laboratory will be expected to correct all deficiencies found during the CCRL inspection. Documentation by the laboratory certifying to the correction of each deficiency on the inspection report must be furnished the State Materials Engineer. Failure to correct deficiencies found by the CCRL inspection will result in disapproval of the laboratory and removal of the GGBFS mill from the approved list.

**2.2.2.2.4 Delivery Procedures** – Since there are several conditions under which GGBFS is delivered, procedures for each condition are outlined separately as follows:

- (1) **Case 1** – GGBFS delivered directly from a pretested storage silo to a project site, or a maintenance work order.
  - a. Certified mill test reports shall be furnished to the State Materials Engineer, including all tests made on the stored GGBFS. The test reports shall include the following data:

Source Name	Test Results
GGBFS Mill Location	Grade of GGBFS
Silo Number	Quantity Represented
Laboratory Number	Date Sampled
Certification of Compliance	

- b. The certification of compliance shall contain the following or similar wording:

"The undersigned certifies that the sample (or samples) represented by this report was obtained from ground granulated blast furnace slag loaded into the bin (or silo) indicated above, that the tests were made in accordance with the latest AASHTO standard methods (if other methods were used, so designate), and that the ground granulated blast furnace slag complies with the Mississippi Department of Transportation specifications for (grade)."

- c. The format of the test report may be the same as that normally used by the mill; the above certificate may be printed or stamped on the test report.

- d. For each shipment of GGBFS, a certificate shall be furnished with the following data:

Source Name	Date Shipped
GGBFS Mill Location	Project or Work Order Number
Grade of GGBFS	Name of Purchaser
Silo Number	Destination
Quantity Shipped	

- e. The above shipping certification shall contain the following or similar wording:

"The undersigned certifies that the ground granulated blast furnace slag in this shipment was loaded from the pretested bin (or silo) indicated above and that it complies with Mississippi Department of Transportation specifications for (grade). The ground granulated blast furnace slag was tested under laboratory numbers (laboratory no.'s), and no ground granulated blast furnace slag not covered by a certified test report has been added to the silo."

- f. When GGBFS is delivered by truck transport, the shipping certificate shall accompany each transport and shall be delivered to the appropriate Mississippi Department of Transportation representative, except that the copies for the State Materials Engineer and the District Materials Engineer shall be mailed.

This shipping certificate shall hereinafter be called "**Certificate A.**"

**(2) Case 2** – GGBFS delivered directly from a pretested storage silo to a recognized commercial ready-mix concrete plant which produces concrete for Mississippi Department of Transportation work.

- a. Certified mill test reports shall be furnished to the ready-mix concrete plant and the State Materials Engineer. The reports are described under **Case 1**.
- b. A Certificate "A" (except the project number or work order number) is to be furnished the ready-mix concrete plant and the State Materials Engineer for each shipment of GGBFS.
- c. A copy of Certificate "A" shall be furnished by the ready-mix concrete plant to the Project Engineer(s), the County Engineer(s) or District personnel supervising projects, or for work orders being furnished concrete.

**(3) Case 3** – GGBFS delivered from a pretested silo to an intermediate terminal for transshipments to projects, work orders, or ready-mix concrete plants.

Certified mill test reports shall be furnished to the State Materials Engineer. A Certificate "A", as described in Case 1 above (reworded as necessary) shall be furnished to the State Materials Engineer and the terminal management for each shipment to the terminal.

**(4) Case 4** – GGBFS delivered from an intermediate terminal to a project or work order.

- a. A certificate, hereafter called "**Certificate B,**" shall be furnished for each shipment, with the original to a representative of the Project Engineer, County Engineer, or District Engineer, as applicable, and copies or prints mailed to the

District Materials Engineer and to the State Materials Engineer. This certificate shall contain the following data:

Terminal Designation	Grade of GGBFS
Terminal Silo Number	Quantity Shipped
Source Name	Project, or Work Order, Number
Name of Purchaser	Destination
Date Shipped	
GGBFS Mill Location (from which GGBFS was obtained)	

- b. The certificate shall contain the following or similar wording:

“The undersigned certifies that the ground granulated blast furnace slag in this shipment was loaded from the terminal silo indicated above, that it is the same ground granulated blast furnace slag covered by certificate numbers (certificate no.’s), issued by (GGBFS mill), that no ground granulated blast furnace slag not covered by certified test reports has been added to the silo, and that the ground granulated blast furnace slag complies with MDOT specifications for the grade indicated above.”

- (5) **Case 5** – GGBFS delivered from an intermediate terminal to a recognized commercial ready-mix concrete plant which produces concrete for Mississippi Department of Transportation work.

A Certificate “B”, as described in Section Case 4 above, reworded as necessary, shall be furnished with each shipment to the ready-mix plant and to the State Materials Engineer. A copy of Certificate “B” shall be furnished by the ready-mix plant to the Project Engineer(s), the County Engineer(s) or District personnel supervising projects, or for work orders being furnished concrete.

**2.2.2.2.5 Certificate “A” Numbering** – Each GGBFS mill shall number Certificates “A” consecutively. The certificates shall be signed by an authorized official of the GGBFS mill.

**2.2.2.2.6 Certificate “B” Numbering** – Each intermediate terminal shall number the Certificates “B” consecutively. The certificates shall be signed by an authorized representative of the GGBFS Company owning or operating the terminal.

**2.2.2.3 Responsibilities of Commercial Ready-Mix Concrete Plants** – All GGBFS purchased

by a ready-mix concrete plant for use in concrete produced for any Mississippi Department of Transportation work shall be covered by certified mill test reports and Certificates “A,” or Certificates “B,” as applicable, and as described in Sections 2.2.2.2.4 above.

**2.2.2.4 Responsibilities of Department Supervisory Personnel** – Following are procedures for MDOT personnel.

**2.2.2.4.1 Certificates “A” and “B”** – GGBFS delivered to the project or work order site may be used provided a Certificate “A” or a Certificate “B”, as applicable, has been received. Concrete produced by an approved commercial ready-mix concrete plant may be accepted, insofar as the GGBFS is concerned, provided the concrete plant has furnished the required data as outlined in Section 2.2.2.2.

**2.2.2.4.2 Shipments Received Without Proper Documentation** – In case a shipment is received without the proper certificate, the GGBFS shall not be used until the required certificate has been furnished or until tests indicating compliance have been completed on samples submitted from the shipment.

**2.2.2.4.3 Reporting** -- Project Engineers shall enter all applicable information into a SiteManager Sample Record and complete Template CPE-901—“Project Engineer Certification” for all GGBFS received, prior to close of the project.

2.2.2.4.4 County or LPA Project Engineers shall retain copies of all applicable certificates for project clearance records.

**2.2.2.4.4 Sampling** – Following are procedures for sampling GGBFS by MDOT personnel.

- (1) GGBFS used in concrete and in soil-cement produced for Mississippi Department of Transportation work will be sampled by a representative of the Department at the approximate frequencies outlined in paragraphs 2.2.2.4.3(4) and (5) below. The frequencies shown apply to each source of GGBFS and are the minimum; additional samples will be obtained if there is a question concerning the quality of the GGBFS.
- (2) Each sample will consist of approximately ten (10) pounds (approximately one gallon) and will be obtained in such a manner, and at such points, that the sample will: (1) be

representative, (2) not be contaminated and (3) represent only one source of GGBFS.

- (3) The samples will be placed in triple-seal metal cans or other moisture-proof containers that will insure the samples against contamination. The samples will be delivered, or will be mailed or shipped, prepaid. Consideration should be given to multiple sample shipments in order to take advantage of minimum shipping charges, but in no case will a sample be retained for longer than fourteen (14) days before submission to the Central Laboratory, Jackson, Mississippi.
- (4) GGBFS used by approved commercial ready-mix plants in production of concrete for Mississippi Department of Transportation work will be sampled at the rate of one (1) sample for each one thousand (1000) cubic yards of concrete used, or a fraction thereof. Insofar as possible, at least one sample shall be obtained for each project except that a sample will not be required if the project contains less than approximately 200 cubic yards of concrete. Minor variations from this may be approved in writing by the State Materials Engineer.
- (5) GGBFS delivered to a project site, or to a central concrete plant set up for a specific project, to be used in concrete paving will be sampled at the rate of one (1) sample for each two thousand (2000) cubic yards of concrete, or fraction thereof, received, except that at least one (1) sample will be obtained each week during which concrete or soil-cement is produced.
- (6) On a project containing less than approximately 200 cubic yards of concrete, a sample will not be required. Minor variations from this may be approved in writing by the State Materials Engineer.

**2.2.2.5 Responsibility of Central Laboratory** – Following are procedures to be followed by Central Laboratory Personnel when testing GGBFS.

- (1) The Central Laboratory may composite samples from each project, each source, and each grade, forming test samples to be tested by the Central Laboratory, or at the discretion of the State Materials Engineer, a commercial laboratory. Only individual samples having sampling dates from within thirty (30) days of each other will be utilized in a composite. In no case will samples from more than one project, different sources, or

- different grades be used to compile a composite. Results of these tests will be reported to the parties concerned. The individual samples from which the composite test sample is obtained will be retained until satisfactory test results on the test samples are received.
- (2) The same cement will be used in both the control specimen containing only cement and the test specimen containing the GGBFS sample. This cement may be from the project from which the GGBFS sample was received if the cement meets the requirements of this section. The cement used in the control specimen and test specimen for determining the Strength Activity Index with Portland Cement must comply with AASHTO M 302, Subsection 10.1.2.
  - (3) If a test sample fails to comply with specification requirements, each individual sample represented by the composite test sample shall be tested for the failing requirement(s). Upon receipt of results of these tests, the State Materials Engineer shall evaluate the tests to determine action to be taken under Section 2.2.2.6.
  - (4) A test sample, composed from individual samples, shall represent not more than 8000 cubic yards of concrete, except that the State Materials Engineer may decrease this maximum on any particular project if he deems it necessary or advisable due to lack of uniformity, borderline test results, or for other reasons.

**2.2.2.6 Non-Complying GGBFS Samples** – Following are the steps to follow when a GGBFS sample fails to comply with MDOT specifications.

- (1) When a sample of GGBFS fails to comply with the specification requirements, the State Materials Engineer will evaluate the failure and the probable effect of the failing requirement on the quality of the product produced with the GGBFS.
- (2) If the State Materials Engineer deems the failure of sufficient seriousness to warrant such action, he may at his discretion order that the GGBFS thus represented not be used in Department work, or he may proceed with the check tests on individual samples as specified in Section 5 for further evaluation.
- (3) In the event the check tests on individual samples confirm the failure, the State Materials Engineer will evaluate the failure and the probable effect on the quality of concrete

produced with the GGBFS. If he deems the confirmed failure of sufficient seriousness to warrant such action, the GGBFS mill which produced the GGBFS shall be required to suspend all shipments of GGBFS for Department work until such time as the cause(s) of the failure have been corrected to the satisfaction of the State Materials Engineer.

**2.2.2.7 Storage Capacity** – In order to eliminate any possible delay in production because of nonconforming GGBFS, it shall be the Contractor's responsibility to provide ample storage and shipments of GGBFS to permit identification, sampling and testing, and appropriate actions as indicated above for failing samples.

**2.2.3 Fly Ash** – The following section establishes uniform procedures for the sampling, testing, reporting of tests and evaluation of fly ash for use in work under the supervision of the Mississippi Department of Transportation.

**2.2.3.1 General** – Acceptance of fly ash for use in work under the supervision of the Mississippi Department of Transportation will be based on source approval, certification by the fly ash supplier that the fly ash complies in all respects with the applicable specifications, and check samples obtained after delivery by Department representatives and tested by the Central Laboratory.

It shall be the Contractor's responsibility to ascertain that the fly ash supplier from whom he purchases fly ash complies with the provisions of this section.

### **2.2.3.2 Responsibility of Fly Ash Suppliers**

**2.2.3.2.1 Source Approval** – Source approval is based upon fly ash produced by a specific plant utilizing specific equipment, materials, and processes. Any change in equipment, materials and processes, shipment of non-specification fly ash; or violation of any provision of the section will void any source approval and require that a new approval be obtained prior to further shipment(s). Each fly ash supplier proposing to furnish fly ash for Department work shall provide the following:

- (1) A formal request for source approval shall be submitted in writing to the State Materials Engineer containing the following information:
  - a. Name and address of Fly Ash Supplier
  - b. Class of Fly Ash: ***Class F fly ash is designated as material with a calcium oxide (CaO) content of less than 6.0%. Class C fly ash is materials with a CaO content of greater than or equal to 6.0%.***
  - c. Name and location of ash source
  - d. Name and location of coal source
  - e. Number of boilers at plant and tons of fly ash produced per hour by each boiler
  - f. Detailed quality control program. The quality control program must meet the minimum requirements of Section 2.2.3.3.
  - g. **Proof of a Beneficial Use Determination for the ash source as determined by**

**the Mississippi Department of Environmental Quality**

- h. A statement certifying agreement with, and acceptance of, all provisions of Section 2.2.3 on the Materials Manual; certifying that all information and data furnished with this request for source approval is accurate and any change in the information will be reported immediately; and further certifying that upon any change in equipment, materials, and/or processes used in the production of fly ash, shipments of fly ash to Department work will cease until re-approval of the source is obtained.
- (2) Submit test data verifying compliance to the specifications and compliance to the minimum quality control sampling and testing. This test data shall represent the material produced in the last one (1) year period.
- (3) Submit a sample of fly ash along with the complete analysis of the tests required by the specifications to the State Materials Engineer for verification testing. The sample must have been split and analyzed by the laboratory that is performing the quality control testing.
- (4) The fly ash source will be placed on the Department's "Approved Sources of Materials" list of fly ash suppliers, provided that the data submitted with the request and test results verifies that a uniform quality product conforming to the specifications is being produced, and that the fly ash supplier's quality control program provides reasonable assurance that only fly ash meeting the requirements of the specifications will be shipped.

**2.2.3.3 Minimum Quality Control Program**

**2.2.3.3.1** The fly ash supplier shall provide a quality control program meeting at least the minimum sampling and testing frequencies established in ASTM Designation: C 311. The tonnage units expressed in this standard are interpreted to refer to as-marketed material.

**2.2.3.3.2** Each sample representing 400 tons, or the sample representing the quantity sampled when this is less than 400 tons, shall be tested for the following:

- (1) Fineness (No. 325 sieve analysis)
- (2) Moisture Content
- (3) Loss on Ignition

All other physical and chemical tests required by the specifications shall be made on composite samples representing each 3200 tons. The composite sample for this purpose shall be prepared by combining equal parts of eight (8) consecutive samples, each representing 400 tons.

**2.2.3.3.3 Quality Control Program Approval** – The sampling, tests, and testing frequencies required may increase from the minimum depending on the particular production problems of the plant. In all cases the quality control program shall be submitted to the State Materials Engineer for approval.

The quality control program submitted for approval must be detailed and include at least the following:

- (1) Name and location of company or firm performing the quality control sampling.
- (2) Name and location of company or firm performing the quality control testing.
- (3) Name and title of the individual directly responsible for the quality control program at the source.
- (4) Sampling points, sampling frequency, and tests to be performed.
- (5) Procedures and equipment for handling, storage and shipment of fly ash.
- (6) Number of storage silos and capacity of each.
- (7) Action to be taken when quality control testing indicates borderline and non-specification fly ash has been produced.

**2.2.3.3.4 Testing Laboratories** – Each testing laboratory performing any portion or all of the required tests under this procedure must be approved before a fly ash source can be placed on the Department's "Approved Sources of Materials" list. Such approval will be contingent upon the following:

- (1) Each testing laboratory must be regularly inspected by the Cement Concrete Reference Laboratory (CCRL). The testing laboratory shall authorize the Cement Concrete

- Reference Laboratory to send a copy of each inspection report directly to the State Materials Engineer of the Mississippi Department of Transportation. Frequency of these inspections shall be approximately once each 18 months according to CCRL scheduling.
- (2)** Failure to participate in the CCRL inspection program on a regular basis will result in disapproval of the laboratory and removal of the fly ash source from the approved list.
  - (3)** Failure to authorize CCRL to send a copy of the inspection report to the Department will result in disapproval. If a copy of the latest inspection report is not received by the Department within any 24-month period, the laboratory will be disapproved and the fly ash source removed from the approved list.
  - (4)** The laboratory will be expected to correct all deficiencies found during the CCRL inspection. Documentation by the laboratory certifying to the correction of each deficiency on the inspection report must be furnished the State Materials Engineer. Failure to correct deficiencies found by the CCRL inspection will result in disapproval of the laboratory and removal of the fly ash source from the approved list.
  - (5)** Comparison tests will be performed at least once a year and more frequently if deemed necessary by the State Materials Engineer. Continued approval of the laboratory will depend on the comparison of its test results with the Central Laboratory. If major differences are found, an attempt to resolve them will be made as quickly as possible. Continued unresolved differences in test results will result in disapproval of the laboratory and removal of the fly ash source from the approved list.
  - (6)** The fly ash supplier is totally responsible and will be accountable for the utilization of a qualified laboratory in the performance of the quality control program.
  - (7)** All test reports shall be on letterhead paper identifying the laboratory performing the tests and shall contain the following information:
    - a. Date of Report
    - b. Fly Ash Source
    - c. Class of Fly Ash
    - d. Silo Number

- e. Boiler Unit Number(if plant is equipped with more than one boiler)
  - f. Sample Control Number
  - g. Test Report Number
  - h. Date Sampled
  - i. Test Results
  - j. A Statement certifying that the fly ash represented by the test results meets the requirements of the Mississippi Department of Transportation specifications. **NOTE:** If the test results do not meet specifications, in lieu of the certified statement, documentation of the disposition of the fly ash represented by the test report shall be submitted with the test report;
  - k. Signature and title of responsible official.
- (8) Sample test records shall be available for inspection by Department personnel for at least three (3) years after the fly ash has been tested.

#### 2.2.3.4 Certification and Reporting by the Fly Ash Supplier

##### 2.2.3.4.1 Distribution of Test Reports

- (1) After source approval, a copy of all test reports shall be submitted to the Central Laboratory.
- (2) When fly ash is delivered directly to a commercial ready mix concrete plant which produces concrete for Mississippi Department of Transportation work, a copy of the test report(s) covering the material shipped shall be furnished to the ready mix plant.

##### 2.2.3.4.2 Certification of Shipments

- (1) For each shipment of fly ash, a certificate shall be furnished with the following data:

Fly Ash Source	Date Shipped
Class of Fly Ash	Project, or Work Order, Number
Silo Number	Name of Purchaser
Number of Tons Shipped	Destination

- (2) The certificate shall also contain the following or similar wording:

"The undersigned certifies that the fly ash in this shipment was loaded from the pretested

silos indicated above and that it complies with MDOT specifications for (Class Designation). The fly ash was tested under Lab No.'s.: (Laboratory ID Number), and no fly ash not covered by a certified test report has been added to the silos."

**(3) Distribution of the certificate shall be made as follows:**

- a. When fly ash is delivered directly to a project site, or a maintenance work order, the certificate shall accompany each transport and shall be delivered to the appropriate MDOT representative, except that the copies for the Materials Division and the District Materials Engineer shall be mailed.
- b. When fly ash is delivered directly to a commercial ready mix concrete plant which produces concrete for Mississippi Department of Transportation work, the certificate (except the project number or work order number) is to be furnished the ready mix plant with each transport and copy sent to the State Materials Engineer.
- c. A copy of the certificate shall be furnished by the ready mix concrete plant to the Project Engineer(s), County Engineer(s) or District personnel supervising projects or work orders being furnished concrete.

### **2.2.3.5 Responsibilities of MDOT Project Supervisor, Personnel**

**2.2.3.5.1 Certification of Shipment to Project Site** – Fly ash delivered to the project or work order site may be used provided a certification has been received with each shipment. Concrete produced by an approved commercial ready mix concrete plant may be accepted, insofar as the fly ash is concerned, provided the concrete plant has furnished the required data as outlined in Section 2.2.3.4

In case a shipment is received without the proper certificate, the fly ash shall not be used until the required certificate has been furnished or until tests indicating compliance have been completed on samples submitted from the shipment.

#### **2.2.3.5.2 Reporting:**

Project Engineers shall enter all applicable information into a SiteManager Sample Record and complete Template CPE-901—"Project Engineer Certification" for all Fly Ash received, prior to close of the project.

County or LPA Project Engineers shall retain copies of all applicable certificates for project clearance records.

**2.2.3.5.3 Sampling** – Fly ash delivered for use in Department work will be sampled by a representative of the Department at the approximate frequencies outlined below. The frequencies shown apply to each source of fly ash and are the minimum requirements; additional samples will be obtained if there is a question concerning the quality of the fly ash.

- (1)** Each sample will consist of approximately eight (8) pounds (approximately one gallon) and will be obtained in such a manner, and at such points, that the sample will: (1) be representative, (2) not be contaminated, and (3) represent only one source and class of fly ash.

- (2) The samples will be placed in triple-seal metal cans or other moisture-proof containers that will insure the samples against contamination. The samples will be delivered, or will be mailed or shipped, prepaid to the Central Laboratory as soon as possible.
- (3) Fly ash used by approved commercial ready mix plants in production of concrete for Department work will be sampled at the rate of one (1) sample for each 2000 cubic yards of concrete production, or a fraction thereof. Insofar as possible, at least one (1) sample shall be obtained for each project except that a sample will not be required if the project contains less than 200 cubic yards of concrete. Minor variations from this frequency may be approved in writing by the State Materials Engineer.
- (4) When fly ash is delivered to a project site for soil stabilization, or to a central concrete plant set up for a specific project to be used in concrete paving, sampling shall be at the rate of one (1) sample for each 4000 cubic yards of concrete production for concrete paving and structural concrete and 4000 tons for soil stabilization, or fraction thereof, received. On concrete paving and structural concrete projects containing less than 2000 cubic yards or soil stabilization projects containing less than 2000 tons of fly ash, a sample will not be required. Minor variations from this may be approved in writing by the State Materials Engineer.

**2.2.3.4 Responsibility of Central Laboratory** – The Central Laboratory shall follow the procedures outlined below when processing and testing fly ash samples submitted for testing.

- (1) Except for the initial sample required under Section 2.2.3.2.1(4), the Central Laboratory may composite as many as four (4) consecutive samples from each project, forming test samples to be tested by the Central Laboratory. In no case will samples from more than one project, different sources, or different class fly ash be used to compile a composite. Only individual samples having sampling dates from within thirty (30) days of each other will be utilized in a composite. The individual samples from which the composite test sample is obtained will be retained until satisfactory test results on the test samples are obtained.
- (2) The same cement shall be used in both the control specimen containing only cement and the test specimen containing the fly ash sample. This cement may be from the project from which the fly ash sample was received if the cement meets the requirements of this section. The cement used in the control specimen and test specimen for determining the Strength Activity Index with Portland Cement must comply with ASTM C 311, Section 5.3.

- (3) If a composite test sample fails to comply with specification requirements, each individual sample represented by the composite test sample will be tested for the failing requirement(s). Upon receipt of test results on individual samples, the State Materials Engineer will evaluate the tests to determine action to be taken under Section 2.2.3.5.
- (4) Central Laboratory test results will be distributed to all concerned parties.
- (5) The Central Laboratory will maintain the Department's "Approved Sources of Materials" list of fly ash suppliers, and monitor the suppliers' quality control program.

**2.2.3.5 Noncomplying Fly Ash Samples** – When a sample of fly ash fails to comply with the specification requirements, the State Materials Engineer will evaluate the failure and the probable effect of the failing requirement on the quality of the product produced with the fly ash. If the State Materials Engineer deems the failure of sufficient seriousness to warrant such action, he may at his discretion order that the fly ash thus represented not be used in Department work and require the fly ash supplier to suspend all shipments for Department work until such time as the cause(s) of the failure has been corrected to his satisfaction. The shipment of non-specification fly ash will be cause for removal of the source from the Department's "Approved Sources of Materials". In order to eliminate any possible delay in production because of nonconforming fly ash, it shall be the Contractor's responsibility to provide ample moisture-proof storage and shipments of fly ash to permit identification, sampling and testing, and appropriate actions as indicated above for failing samples.

### **2.3 Steel Products: Reinforcing Steel and Steel Wire Fabric**

**2.3.1 Reinforcing Steel** – The following section establishes uniform procedures for the sampling, testing, acceptance and reporting of reinforcing steel for use in Department work.

**2.3.1.1 General** – Reinforcing steel may be shipped to Department projects as pretested or untested materials. It shall be the responsibility of the Project Engineer to ascertain the tested status of each shipment of reinforcing steel.

Hereinafter, when company (or companies) is referred to, it shall be understood to mean the fabricator (or fabricator(s)) who supplies the reinforcing steel to the project. The fabricator may be categorized in one of the following:

- (1) Purchases all steel from various manufacturers of reinforcing steel.
- (2) Purchases part of the steel from other manufacturers and manufactures part of it himself.
- (3) Uses only the steel that he manufactures.

A company is further defined as the one who bends the steel to the shapes as shown on the plans and/or cuts straight steel to the exact length specified on the plans.

**2.3.1.2 Pretested Reinforcing Steel** – Reinforcing Steel shipped as pretested material shall meet all requirements as set forth herein.

**2.3.1.2.1 List of Approved Sources** – A company proposing to furnish pretested reinforcing steel for use in Department work shall have been approved and their name placed on the Department's "Approved Sources of Materials" list by the Central Laboratory.

In order for a company to have its name placed on the approved sources list, the company must state agreement with and acceptance of the provisions of this Section (Section 2.3) by letter addressed to the State Materials Engineer. The company must also certify in this letter that the steel furnished will meet all applicable requirements of the Mississippi Department of Transportation specifications and that only domestic steel will be used. This letter will remain in effect until rescinded in writing.

**2.3.1.2.2 Certification of Domestic Origin** - The Company shall provide a certification of domestic origin annually to the Central Laboratory. Such certification shall contain the following or similar wording:

**(1) Certification from Manufacturers**

"We hereby certify that any and all reinforcing steel supplied by (Name of Steel Mill) for use on Mississippi Department of Transportation projects will be manufactured in our plant located at (City & State) and will be made with domestic steel only."

**(2) Certification from Companies Other Than Manufacturers**

"We hereby certify that any and all reinforcing steel processed and supplied by (Name of Company) located at (City & State) for use on Mississippi Department of Transportation projects will be obtained from (Name & Location of Steel Mill) which is a MDOT approved manufacturer, and we further certify that only reinforcing steel made from domestic steel will be supplied."

**2.3.1.2.3 Quality Control Program** – The Company shall maintain a quality control program to detect and prevent the shipment of reinforcing steel having borderline or nonconforming characteristics.

It shall be understood that representatives of the Mississippi Department of Transportation shall have free entry on the premises to inspect the fabrication of reinforcing steel, to take samples of reinforcing bars in stock and to review records of quality control programs and tests.

The company shall take immediate action to correct irregularities reported by the Department.

**2.3.1.2.4 Sampling of Pretested Reinforcing Steel** – Following are guidelines for sampling of pretested reinforcing steel.

- (1)** Each bar size and grade of each manufacturer of reinforcing steel will be randomly sampled by representatives of the Mississippi Department of Transportation. The frequency of random samples will be at a predetermined rate as established by the State Materials Engineer, based on the quantity produced, quality of the steel, and the

frequency of shipments.

- (2) Representatives of the Central Laboratory will normally perform all sampling, but on occasion, due to the location of the fabrication plant, amount and frequency of shipments, the Districts may be requested to perform this task.
- (3) For manufactured reinforcing steel bars containing a registered mill marking, the sample will be saw cut or sheared to a length of approximately thirty (30) inches from material proposed to be used in Department work. The Mississippi Department of Transportation representative will observe the sample being cut, properly identify the sample, and prepare information card (TMD-320) or SiteManager sample record (as applicable) with all pertinent information. If it is necessary to cut the sample with a torch, the length shall be approximately forty-two (42) inches.
- (4) For manufactured welded fabric (deformed or plain) units the sample shall be one (1) square yard; or in the case of prefabricated bridge rail units, the sample shall be one (1) yard in length.

**2.3.1.2.5 Testing** – All acceptance testing of reinforcing steel will be performed by the Central Laboratory in accordance with established procedures of the specified test methods.

**2.3.1.2.6 Shipping** – It shall be the responsibility of the company to ascertain that the following provisions are complied with:

- (1) With each shipment, the company will furnish a copy of the shipping ticket designated for the Project Engineer. The shipping ticket shall include all pertinent information, such as project number, county, purchaser, number of pounds of each bar size or prefabricated unit, grade and manufacturer (if fabricator is different from manufacturer).
- (2) The shipping ticket shall also include the following statements or similar: "This material was shipped from Mississippi Department of Transportation pretested stock. The steel included on this ticket is of Domestic Origin and compliant with the Buy America Act." In addition, the ticket must be signed by an authorized representative of the company.
- (3) Mill Test Reports representative of the steel being shipped shall be attached to the

- shipping ticket when shipped to an MDOT job site. This includes steel shipped by the manufacturer to vendors, fabricators, and other applicable suppliers. Vendors, fabricators, and suppliers are also required to send copies of the manufacturer's mill test reports along with shipments to an MDOT job site. In any event, the mill test reports should be attached to the shipping ticket and should represent the steel that is being shipped.
- (4) Upon receipt of the company's completed shipping ticket and mill test reports, the Engineer will allow the steel to be used in construction unless visual inspection reveals questionable or inferior steel. If questionable or inferior steel is delivered to the project site, the Engineer shall immediately notify the Central Laboratory in order that corrective action can be taken. Questionable steel must be sampled, tested, and accepted prior to use. Inferior steel will be rejected without further testing.
  - (5) All aforementioned requirements must be fulfilled; otherwise, the steel will be considered untested and will be sampled and tested accordingly (See Section 2.3.1.3).

#### **2.3.1.2.7 Reporting**

- (1) The company shall mail to the Central Laboratory a copy of each shipping ticket and mill test reports at least once each calendar week. The mailing address is:

State Materials Engineer (72-01)  
Mississippi Department of Transportation  
P. O. Box 1850  
Jackson, MS 39215-1850
- (2) MDOT Project Engineers shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO-622--"Shipment of Pretested Reinforcing Steel"), upon receipt of a shipment of steel.
- (3) County or LPA Project Engineers shall submit a "Pretested Materials Shipment Report Request Form" for each project. The form may be forwarded as the project progresses, or at the end of construction. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

#### **2.3.1.3 Untested Reinforcing Steel** – All untested steel shall be tested and accepted by the

Central Laboratory prior to use. If the requirements of Section 2 are not met, the steel will be considered untested. Upon determination that a shipment of steel is untested, the following conditions shall be met:

- (1) The Engineer, or his representative, will obtain one (1) sample in accordance with Section 2.3.1.2.4 for each 10 tons, or fraction thereof, of each size of mill-marked steel. Care must be exercised to insure that the manufacturer's identification markings are contained within the sample length. The steel should be sampled immediately after delivery to the project and submitted to the Central Laboratory without delay.
- (2) Unmarked deformed steel bar units shall be sampled at the rate of one (1) sample for each 10 tons, or fraction thereof, of each size. The grade, size and fabrication dimensions shall be as specified by the project's documents. The grade and size shall be shown on the invoice. Information listed on the identification tags tied on the units shall match the items listed on the shipping invoice.
- (3) Each sample must be accompanied by Form TMD-320 or the SiteManager Sample Identification (as applicable) properly completed.
- (4) As soon as possible after receipt of the samples, the Central Laboratory will test the bars and report the results.

### **2.3.1.4 Responsibilities of Project Engineer**

**2.3.1.4.1 Pretested Reinforcing Steel** – The Project Engineer shall follow these guidelines when pretested reinforcing steel is shipped to a MDOT project.

- (1) Prior to allowing the use of a shipment of pretested reinforcing steel, obtain a copy of the shipping ticket and mill test reports to make sure the ticket meets all requirements set out in this Section (Section 2.3.1). Any irregularities must be corrected prior to allowing the use of the shipment; otherwise, the shipment will be considered as untested steel and its acceptance will be determined in accordance with Section 2.3.1.3 of this section.
- (2) Prior to allowing the use of a shipment of mill-marked pretested reinforcing steel, inspect the shipment, paying particular attention to the mill markings for proper grade, size and

MDOT's approved fabricator and/or manufacturer of the steel. Make sure the shipment is accurately identified on the shipping ticket by grade, size and manufacturer. The shipment will be rejected if it contains the wrong size, grade, or contains foreign steel. Other irregularities found during the inspection must be corrected prior to allowing the use of the shipment; otherwise, the shipment will be considered as untested steel, and its acceptance will be determined in accordance with Section 2.3.1.3 of this section.

**Note:** Most reinforcing steel manufacturers register their identification markings (mill markings) with the Concrete Reinforcing Steel Institute (CRSI) and are displayed in CRSI Manual of Standard Practice. Excerpts from the manual have been provided to each Project Office for use in making proper identification of steel in shipments with respect to manufacturer, grade, and size. Do not rely completely on tags attached to bundles of steel. Additional excerpts from the CRSI Manual are available from the Central Laboratory as needed.

- (3) Prior to allowing the use of a shipment of pretested welded fabric reinforcing steel, inspect the shipping invoice for a statement that the material was shipped from pretested stock. Each prefabricated unit will have a MDOT seal attached to it; otherwise, the shipment will be considered as untested steel and its acceptance will be determined in accordance with Section 2.3.1.3 of this section.
- (4) The Project Engineer shall notify the MDOT Independent Assurance Sampler as soon as possible of the arrival of steel shipments so that Independent Assurance Verification sampling and testing can be initiated at the earliest possible time.
- (5) The Central Laboratory will notify the Project Office immediately by telephone followed by a test report of all failing steel samples.
- (6) Upon receipt of notice of an Independent Assurance Sample failure, the Project Engineer will suspend operations and determine the acceptability of the steel as required in Section 2.3.1.3. The steel is rejected subject to retests in accordance with Section 2.3.1.5.
- (7) The Project Engineer will make a determination of the amount of steel, if any, represented by a failing test report(s) that has been incorporated into the work. The

acceptability of such steel to remain in-place will be determined in accordance with Section 105.03 of the Standard Specifications.

**2.3.1.5 Retests** –Retests for determining the acceptability of reinforcing steel represented by a failing test report will be permitted under the conditions set out in AASHTO M 31.

**2.3.2 Steel Wire Fabric (Wire Mesh)** – The following section establishes uniform procedures for the sampling, testing, acceptance, and reporting of steel wire fabric for use in Department work.

**2.3.2.1 General** – Steel wire fabric may be shipped to Department projects as a pretested or untested material. It shall be the responsibility of the Project Engineer to ascertain the tested status of each shipment of steel wire fabric. Steel wire fabric may be furnished by any supplier (Manufacturer, Wholesale Supplier or Broker) provided the material meets all applicable requirements of the specifications.

**2.3.2.2 Pretested Wire Fabric** – Wire Fabric shipped as pretested material shall meet all requirements as set forth herein.

**2.3.2.2.1 Approved Sources** – A company proposing to furnish pretested steel wire fabric for use in Department work shall have been approved and placed on approved suppliers list by the Central Laboratory. In order for a supplier to have his name placed on this approved list, the supplier must state agreement with and acceptance of the provisions of this Section (Section 2.3.2) by letter addressed to the State Materials Engineer. Also, in this letter, the supplier must certify that the steel wire fabric will meet all applicable requirements of the Mississippi Department of Transportation specifications, and that only domestic steel will be supplied. This letter will remain in effect until rescinded in writing.

**2.3.2.2.2 Certification of Domestic Origin** – The supplier of the wire fabric shall provide a certification of domestic origin at least annually to the Central Laboratory. Such certification shall contain the following or similar wording:

**(1) Certification from Manufacturers**

"We hereby certify that any and all steel wire fabric supplied by (Name of Steel Mill) for use on Mississippi Department of Transportation projects will be manufactured in our plant located at (City & State) and will be made with domestic steel only."

**(2) Certification from Companies Other Than Manufacturers**

"We hereby certify that any and all steel wire fabric supplied by (Name of Company) located at (City & State) for use on Mississippi Department of Transportation

projects will be obtained from     (Name & Location of Steel Mill)     which is a MDOT-approved manufacturer, and we further certify that only reinforcing steel made from domestic steel will be supplied."

**2.3.2.2.3 Quality Control Program** – The Company shall maintain a quality control program to detect and prevent the shipment of steel wire fabric having borderline or nonconforming characteristics.

It shall be understood that Department representatives shall have free entry on the supplier's premises for the purpose of inspection, sampling and tagging the steel wire fabric. It shall be further understood that the supplier will maintain a separate stock of accepted materials for each gauge and spacing, and that stock shall be physically separated from all unapproved stock.

**2.3.2.2.4 Sampling of Pretested Wire Fabric** – Following are guidelines for sampling of pretested wire fabric.

- (1) Prior to sampling, the steel wire fabric in each Lot shall be checked to determine if each roll or sheet has been tagged in accordance with AASHTO M 55.

**NOTE:** It is suggested that Wholesale Suppliers and Brokers specify that the steel wire fabric meet AASHTO M 55 or ASTM A 185 when ordering from the Manufacturer and be tagged accordingly. No lot will be inspected unless properly tagged.

- (2) A Lot shall consist of 40,000 pounds or fraction thereof, of each size and spacing. One sample (approximately 3' x 3'), shall be selected at random from each Lot. The Department Inspector will observe the sample being cut, properly identify the sample, and prepare an Information Card (Form TMD-320) or the SiteManager Identification with all pertinent information included thereon.
- (3) If the initial sample fails to meet the specifications, two (2) check samples will be taken at random from this Lot. The average of the three test results will be used to determine the acceptance of the Lot.

**2.3.2.2.5 Testing and Tagging** – All acceptance testing of steel wire fabric will be performed by the Central Laboratory in accordance with the specified test methods. Each roll or sheet of steel

wire fabric in each approved Lot will be tagged with a MDOT seal.

**2.3.2.2.6 Shipping** – It shall be the responsibility of the supplier to ascertain that the following provisions are complied with:

- (1) With each shipment, the supplier will furnish a copy of the shipping ticket designated for the Project Engineer. The shipping ticket shall include all pertinent information such as project number, county, purchaser, size and spacing, quantity (in pounds), and the MDOT seal number(s).
- (2) The shipping ticket shall include the following statements or similar: "This material was shipped from MDOT Pretested Stock. The steel included on this ticket is of Domestic Origin and compliant with the Buy America Act." In addition, the ticket must be signed by an authorized representative of the supplier.
- (3) Mill Test Reports representative of the steel being shipped shall be attached to the shipping ticket when shipped to an MDOT job site. The mill test reports should represent the steel being shipped.
- (4) All aforementioned requirements must be fulfilled; otherwise, the steel wire fabric will be considered untested and will be sampled and tested according to Section 2.3.2.3.
- (5) Upon receipt of the supplier's completed shipping ticket, mill test reports, and a favorable comparison of the MDOT seal numbers on the shipping ticket with the seals on the rolls, the Engineer will allow the steel wire fabric to be used in construction unless a visual inspection reveals questionable or inferior material. If questionable or inferior material is delivered to the project site, the Engineer shall immediately notify the Central Laboratory in order that corrective action can be taken. Questionable steel wire fabric must be sampled, tested, and accepted prior to use. Obviously inferior fabric will be rejected without further testing.
- (6) The company shall mail to the Central Laboratory a copy of each shipping ticket and mill test reports at least once each calendar week. The mailing address is:

State Materials Engineer (72-01)  
Mississippi Department of Transportation  
P. O. Box 1850

Jackson, MS 39215-1850

#### **2.3.2.2.7 Reporting**

- (1) The MDOT Project Engineer shall verify that the wire contains a MDOT metal seal denoting a seal number. The Project Engineer shall also enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO623 – “Shipment of Pre-Tested Wire Mesh”), upon receipt of a shipment of steel wire mesh.
  
- (2) County or LPA Project Engineers shall submit a “Pretested Materials Shipment Report Request Form” for each project. The request form shall include a listing of each MDOT Seal Number attached to each roll or sheet. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

**2.3.2.3 Untested Steel Wire Fabric** – All untested steel wire fabric shall be tested and accepted by the Central Laboratory prior to use. Failure to meet any of the requirements of Section 2.3.2.2 will require that the wire fabric be considered untested. Upon determination that the shipment of wire fabric is untested, the following conditions shall be met:

**2.3.2.3.1 Identification of Rolls or Sheets**– Each unit of wire fabric shall have attached thereto a suitable tag bearing the name of the manufacturer and description of the material.

**2.3.2.3.2 Sampling of Untested Wire Fabric** – A Lot shall consist of 40,000 pounds of material or fraction thereof of each size and spacing. The Engineer or his representative will obtain one sample (approximately 3' x 3') from a roll or sheet selected at random in each Lot. Samples submitted for State, Federal, or Maintenance projects must have the SiteManager Identification Number affixed to the sample. Samples submitted for State Aid or Urban Projects must be accompanied by Form TMD-320 properly completed.

## 2.4 Aggregates and Stone Rip Rap

**2.4.1 Aggregates** – The following section establishes uniform procedures for the sampling, testing, inspection, and reporting results of tests of all aggregates.

**2.4.1.1 General** – The sources of certain aggregates are required to be approved prior to shipping of the aggregates to a project. Upon source approval, these aggregates, as well as others not requiring source approval, are accepted, or rejected, on the basis of sampling, testing, and inspection procedures described in this section (Section 2.4.1) for the particular type of aggregate.

For Project Engineers, reporting of aggregate samples for Department projects shall be in accordance with this section and the policies and procedures established for entering a SiteManager Sample Record. Samples submitted for State, Federal, or Maintenance projects must have the SiteManager Identification Number and/or a copy of the sample record affixed to the sample. Samples submitted for State Aid or Urban Projects must be accompanied by Form TMD-320 properly completed.

**2.4.1.1.1 Approval of Source** – Following is the general procedure to be followed when an aggregate to be supplied for a MDOT project must be supplied from an approved source.

- (1) A proposed source of an aggregate is inspected by a representative of the Central Laboratory or appropriate District, when required by the specifications, MDOT QC/QA provisions, or as detailed in this section,
- (2) Source Deposits are analyzed for determination of the following:
  - a. the geological formation;
  - b. the extent of the deposit (the extent of the deposit shall be described in the inspection report);
  - c. whether or not the material to be obtained there from will be borderline uniformity of material;
  - d. the presence of strata of undesirable material, if any;
  - e. if considered necessary, a petrographic analysis is made of the deposit.
- (3) Samples of the material are obtained by either the Central Laboratory or District

- personnel. These samples are tested by the Central Laboratory for all quality requirements before approval of the source. In addition, the plant facilities are inspected by either the Central Laboratory or the District Laboratory for adequacy and ability to produce quality materials.
- (4) For Contractor furnished materials involving local material sources, it shall be the responsibility of the Contractor to arrange for sampling and testing necessary for source approval.
  - (5) Upon approval of a source by the State Materials Engineer, materials may be produced for Department projects subject to job control sampling, testing and inspection.
  - (6) Before any aggregates are produced from any source for Department work, it is the responsibility of the Materials Engineer of the District in which the work is located to ascertain that the source has been approved in accordance with all applicable specifications and Section 2.4.1 of this manual.
  - (7) If dredging or mining operations of an approved source are moved to a new location (beyond the limits of the deposit as described in the initial inspection report for source approval), the Central Laboratory shall be notified. A final determination as to whether the new location shall be treated as a new source will be made by the State Materials Engineer.

**2.4.1.1.2 Quality Check Tests** – Samples will be obtained by the District, on either a semiannual, annual, or biannual basis, as determined by the State Materials Engineer and the District Materials Engineer, from each active aggregate source in a District. An active source is defined as one which has produced materials for Department work within the preceding twelve (12) months or which has impending orders for aggregates to be furnished for Department work.

The frequency of quality check tests from any source shall be determined based on the history of the source, including past test results.

The Central Laboratory will advise the District when samples from any source should be obtained, so that samples will be tested within a reasonable period of time. The Central Laboratory and a representative of the District will take the samples for quality tests. The Central Laboratory and each District shall maintain records to insure that each source is sampled for quality check tests at the established frequency.

The Central or District Laboratory will perform required tests on each sample. Results of these tests will be shown on job control and independent assurance sample test reports distributed by the Central Laboratory.

**2.4.1.1.3 Inspection of Aggregates** –Materials are generally sampled and inspected at the job-site, or as directed by the District Materials Engineer. Please note that Rip Rap is inspected in accordance with the provisions of Section 2.4.2. It is the ultimate responsibility of the Project Engineer and the District Materials Engineer to ensure that only aggregates complying with the specifications be incorporated in work, in accordance with the provisions of this manual.

**2.4.1.1.4 Independent Assurance Samples** – Independent assurance samples will be obtained by representatives of the Central Laboratory and tested by the Central Laboratory. The frequencies for sampling are listed Section 5.2 of this manual.

**2.4.1.1.5 Testing Procedures** – Testing of aggregates for approval of a source will be conducted in accordance with the latest version of the applicable AASHTO test method for the specific material sampled, or as outlined individually in this manual. Aggregate Sampling shall be in accordance with AASHTO T2.

Provided the inspector is ACI Level II Certified in sampling and testing procedures, he is to take certain discretionary measures; i.e., if tests indicate a material to be well and uniformly within the specifications on certain sieves or for certain qualities, he may omit testing on such sieves or for such qualities to the extent indicated below.

**EXAMPLE 1:** If several initial tests indicate that a concrete gravel is uniformly well within the specifications for the 1-inch, 3/4-inch, and 1/2-inch sieves but borderline on other required sieves, the routine tests could be made on only the borderline sieve sizes.

**EXAMPLE 2:** If several initial tests and visual inspections indicate that a granular material (Group C) is friable, then Atterberg Limits tests may be waived in routine tests.

The above permissible "shortcuts" must be used with judgment and discretion. Approximately every tenth (10th) sample should be tested on all required sieves and for all required field tests.

## **2.4.1.2 Concrete Aggregates**

**2.4.1.2.1 Source Approval** – Following are procedures to be followed to approve a concrete

aggregate source.

- (1) Each source must be approved by the State Materials Engineer prior to delivery of aggregate for use in Department work.
- (2) Each Approved Source will be assigned a plant number, upon approval, and a base Fineness Modulus will be established. The base F.M. may be subsequently changed by the State or District Materials Engineer if it is determined that an adjustment is required.
- (3) The Central Laboratory will maintain a current list of approved sources. Each District should maintain a current list of approved sources within the District and of out-of-state sources adjacent to the District.

#### **2.4.1.2.2 Inspection of Aggregates for Structural Concrete and Paving Concrete**

- (1) Aggregates from a specific source, or for a specific project, should be tested after delivery. The minimum frequency for testing after delivery shall be in accordance with the Department's QC/QA Provisions as referenced in S.O.P. No. TMD-20-04-00-000 and S.O.P. No. TMD 20-05-00-000. In these cases, the production of concrete should be delayed pending satisfactory test results.
- (2) An initial sample of each type of aggregate shall be submitted to the Central Laboratory for complete tests when shipment is begun to a project. The District representative will obtain the sample. The sample may be taken from the stockpile proposed for use on the project, the conveyer belt used in forming the stockpile. Regardless of the point sampled, it is essential that the sample be representative of the aggregate being shipped since the mix design for the concrete to be produced is usually based on test results of this sample.
- (3) It shall be the responsibility of the District Materials Engineer to have an inspection made of the aggregate stockpiles at least once per week. This inspection shall be made by a certified ACI Level II employee assigned by the District; he may be from either the District Laboratory or selected from project personnel.

- (4) The inspector should observe handling of the aggregates, the condition as to cleanliness, segregation, etc. The inspector should visually check the gradation and if there is a question concerning cleanliness or gradation, he shall obtain a sample(s) for submission to either the District Laboratory or the Central Laboratory. Each inspection should be made a matter of record.
- (5) Samples at concrete plants should be obtained from the conveyer belts feeding the hopper bins or from the bins, as practicable, in order that the samples will represent as nearly as possible the aggregate actually being used in the concrete. If the samples are obtained from stockpiles, particular care shall be exercised to obtain representative samples. Portions should be obtained from various locations in the perimeter of the stockpile and at various elevations. The portions should then be combined and quartered.
- (6) The testing of samples may be performed at the plant or at the District Laboratory as determined by the District Materials Engineer.
- (7) One sample of each kind of aggregate shall be taken at the point of use in accordance with PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI) Quality Control Manual, 4<sup>th</sup> Edition and at least one (1) per project. If the quantity of concrete required on a project is less than thirty (30) cubic yards a sample will not be required for testing unless deemed to be appropriate by the Engineer or Inspector.
- (8) Should a sample fail to meet the specifications, check tests shall be performed in sufficient number to verify or to disprove the failure. The number of check tests required would be dependent on the size of the stockpile, history of previous tests at the plant, and the reliability of the sampling procedure. If the average of the original failing test and all check tests is within the specification range, the aggregate may be considered as acceptable.
- (9) If the above tests indicate that the aggregate does not conform to the specifications, the plant will not be permitted to produce concrete for Department projects until the stockpile (in which the failure occurs) is

removed or reprocessed to the satisfaction of the District Materials Engineer. In addition, the plant shall take necessary steps to correct the causes of the failure prior to resuming production of concrete for Department work.

- (10) If the above noncompliance occurs during a pour, the District Materials Engineer shall determine whether the work shall be suspended or the pour should be completed before suspension. This decision shall be based on the extent of the failure, the amount of concrete involved, and the effect of suspension on the work.
- (11) If a weekly inspection is desired by the Office of State Aid Road Construction, it will be the responsibility of the County Engineer to perform same.

**2.4.1.2.3 Frequencies** – The frequencies of sampling and testing of aggregates outlined above, and as required by the Department’s QC/QA Procedures as referenced in S.O.P. Nos. TMD-20-04-00-000 and TMD-20-05-00-000 may be increased at the discretion of the District Materials Engineer. Increased frequencies may be necessary or desirable due to non-uniformity, borderline materials, substandard methods of production, or for other reasons.

**2.4.1.3 Masonry Sand** – Masonry sand is usually sampled at the job-site after delivery; the sample is submitted to the Central Laboratory for testing if the quantity involved justifies the cost of sampling and testing.

#### **2.4.1.4 Aggregates for Bituminous Mixes**

**2.4.1.4.1 Approved Sources of Aggregates** – Normally, aggregates for bituminous mixes are obtained from sources approved as outlined in the General section of 2.4.1. Aggregates obtained from local sources are sampled and tested prior to being approved for use. If the source has not been tested for abrasion and soundness as specified in Section 2.4.1.1.4 within the preceding twelve (12) months, samples shall be submitted for these tests.

**2.4.1.4.2 Sampling from Contractor Stockpiles** – Samples of each aggregate are obtained from the stockpiles of the Contractor and these samples are submitted to the Central Laboratory for the determination or approval of the job-mix formula.

During the progress of the work if the requirements for the mix are not being obtained or if the aggregate materials change in characteristics, additional samples shall be submitted for determination of a revised job mix formula. A change in the source of an aggregate requires a new job-mix formula.

During the progress of the work, the aggregates should be checked for gradation when it is apparent, or it is indicated, that there has been a change in the gradations. Such samples should be obtained from the cold bins and tested by the plant laboratory personnel. There is no requirement as to frequency of such tests.

**2.4.1.4.3 Testing** – Testing for conformance to crushing requirements will be performed in accordance with S.O.P. No. TMD-20-04-00-000, the Field Manual for Hot Mix Asphalt, and all applicable specifications.

The frequency for checking the characteristics of the mixture will be established in accordance with S.O.P. No. TMD-20-04-00-000 and the specifications.

#### **2.4.1.5 Granular Materials**

**2.4.1.5.1 General** – Granular materials are those materials used in subbases and bases (whether later chemically or mechanically stabilized or not), and in some cases are used as temporary gravel surface course material.

**2.4.1.5.2 Testing and Inspection** – Following are procedures to be followed for testing and inspection of Granular Materials.

**(1) Source Inspection**

- a. It is the Contractor's responsibility to make such investigation necessary to establish to the State's satisfaction that the proposed source(s) will furnish satisfactory material.
- b. Each source of granular material containing coarse aggregate must conform to the specification requirements for abrasion. It shall be the District's responsibility to submit a source sample(s) to the Central Laboratory for abrasion testing, and to insure that the source has been tested within the

past twelve (12) months prior to use. The source shall be retested annually.

**(2) Job Control Acceptance Sampling and Testing**

- a. A minimum of one (1) random sample shall be obtained for each 1000 cubic yards or 1400 tons of material placed for determining acceptance of the material for gradation, liquid limit, and plasticity index. The samples will be taken at the roadway. This frequency should be increased if the material is non-uniform, borderline or deficiencies have occurred.
- b. When a roadway sample fails to meet the requirements of the specifications, additional samples will be taken along the roadway until the limits of the inferior material is located. The Contractor will be required to correct or remove and replace the deficient material at his own expense.
- c. Extreme care must be taken in order to obtain samples representative of the material incorporated into the work. Roadway samples must be taken in such a manner as to avoid contamination with underlying or adjacent materials.
- d. Occasionally, and when requested, a sample shall be submitted to the Central Laboratory for check tests. Such samples should weigh approximately 100 pounds each and shall be accompanied by a Form TMD-320 or the SiteManager Sample Identification Number, as applicable, showing the class and the group the material represents, in addition to the usual information.

**2.4.1.6 Mechanically Stabilized Course** – The granular materials in place prior to stabilizing with stabilizer aggregate will be sampled, tested, and evaluated as outlined above in Section 2.4.1.5.2. The completed base after mechanical stabilization will be sampled, tested, and evaluated as outlined above in Section 2.4.1.5.2 except that the minimum frequency of sampling will be 1000 linear feet of 24-foot roadway.

**2.4.1.7 Aggregate for Bituminous Surface Treatments** – Following are procedures to be

followed for testing and inspection of aggregates for bituminous surface treatments.

### **(1) Approval of Source and Quality Tests**

- a. The source(s) of aggregates for bituminous surface treatment must be approved prior to use as described in Section 2.4.1.1.1.
- b. The quality of the material from the source(s) will be based on the quality tests described in Section 2.4.1.1.2.
- c. If the aggregate for a project is to be obtained from a source not previously approved, approval samples will be required, and the Central Laboratory will make any investigation necessary in order that the State Materials Engineer may formally approve the source.

### **(2) Job Control**

- a. The District Materials Engineer or Project Engineer shall sample and inspect the material after delivery to the project site.
- b. In either case, an initial sample for each type aggregate and from each source shall be submitted to the Central Laboratory accompanied by a Form TMD-320 or the SiteManager Sample Identification Number as applicable.
- c. A job control sample shall be obtained from each 300 cubic yards of each type of material delivered. These samples will be tested by the District Laboratory or the Project Laboratory.

**2.4.1.8 Mineral Filler** – Following are procedures to be followed for testing and inspection of mineral filler.

#### **(1) Approval of Source**

The source(s) of mineral filler shall have been approved by the State Materials Engineer

prior to delivery to a project. If not previously approved, samples from a new source shall be submitted to the Central Laboratory, and any required investigation will be made in order that the State Materials Engineer may approve the source.

## **(2) Job Control**

After delivery to the project site, an initial sample shall be submitted to the Central Laboratory at the same time that samples of aggregates are submitted for determination of the job mix formula for testing. Thereafter, samples will be submitted whenever there is a change in the material, a change in source, or when there is a question as to whether or not the material complies with the specifications.

**2.4.1.9 Bedding, or Filter Material** – The material will be tested and inspected by the District or Project Laboratory, as required. Frequency for sampling and testing shall be in accordance with S.O.P. TMD-20-04-00-000.

**2.4.1.10 Stabilizer Aggregate** – Following are procedures to be followed for testing and inspection of stabilizer aggregate.

### **(1) Approval of Source**

The source(s) of stabilizer aggregate shall have been approved by the State Materials Engineer. If the aggregate is to be obtained from a source not previously approved, samples of each type will be submitted to the Central Laboratory for approval tests. After testing of these samples and after investigation as necessary, the State Materials Engineer will advise whether or not the source is approved.

### **(2) Job Control**

- a. An initial sample of each type aggregate from each source will be submitted to the Central Laboratory by the Plant Inspector from the materials proposed for use on the project.
- b. Job control sampling, testing, and inspection may be performed at the project or at the discretion of the District Materials Engineer.
- c. At least one (1) sample shall be obtained for each 300 cubic yards of each type

delivered, and tested by the District or Project Laboratory.

**2.4.1.11 Borrow Excavation** – This material will be sampled, tested, and inspected by the District or Project Laboratory, as required by the District Materials Engineer and in accordance with S.O.P. TMD-20-04-00-000 or TMD-20-05-00-000.

**2.4.2 Stone Riprap** – The following section establishes uniform procedures for the inspection and acceptance of stone riprap both prior to delivery and/or after delivery to a project.

**2.4.2.1 General** – The following procedures include the inspection of the stone riprap prior to delivery and/or after delivery to the project. Acceptance prior to delivery does not preclude rejection of the riprap at the job site.

In case of a dispute between the Producer (or Contractor) and the Department Inspector concerning the acceptability of the riprap, a sample of the stone shall be selected and each piece in the sample weighed. The provisions for such testing shall be the responsibility of the Producer (or Contractor).

The Department Inspectors shall have familiarized themselves with the appearance of stones of the weights stipulated in the specifications.

All riprap shall have been inspected and accepted prior to placement.

**2.4.2.2 Inspection Prior to Delivery** – If the Producer stockpiles riprap, the Inspector shall visually inspect this material periodically for conformity with the specifications. The Producer shall notify the Inspector when shipments will be made in order that the material may be observed during loading or prior to shipment. If an Inspector is not available, the Producer may ship the material without delay, provided the material is loaded in such a manner as to maintain the required gradation.

If the Producer loads the riprap directly into railroad cars or trucks, without stockpiling, the Inspector shall be present during loading to inspect the material prior to shipment. It shall be the responsibility of the Producer to contact the Inspector in order to establish a mutually convenient time for the inspection.

**2.4.2.3 Inspection After Delivery** – It shall be the responsibility of the Project Engineer to have the riprap visually inspected at the job site if the material has not been pretested. It is recommended that the Central Lab be contacted to perform the inspection.

The Project Engineer shall be responsible for completion of a Sample Record and Template (“Completion of Visual Inspection”) in the SiteManager Information System if the Engineer

performs the inspection at the project site. The source must be on the MDOT “Approved Sources of Materials” list.

State Aid and Private Entity Project Engineers may inspect and accept riprap by forwarding a letter to the State Materials Engineer stating the riprap was inspected and met the specification requirements. The source must be on the MDOT “Approved Sources of Materials” list.

#### **2.4.2.4 Reporting**

##### **(1) Pretested Riprap by the Central Laboratory**

- a. Pretested riprap shipped will be accompanied by the Producer's bill of lading, shipping invoice, etc., which will contain a statement to the effect that the material has been pretested. A copy of the shipping ticket shall be forwarded to the Central Lab by the producer.
- b. The MDOT Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO633 – “Shipment of Pre-Tested Rip Rap”), upon verification that the riprap was shipped from pre-tested stock.
- c. County or LPA Project Engineers shall submit a “Pretested Materials Shipment Report Request Form” for each project, upon verification that the riprap was shipped from pre-tested stock. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

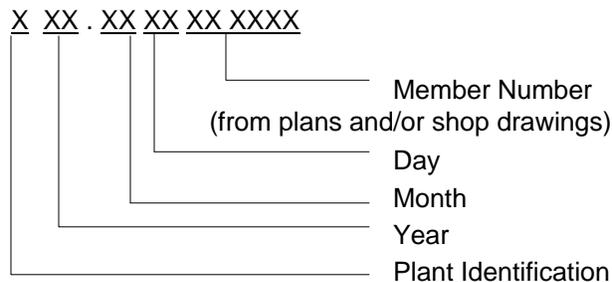
## 2.5 Prefabricated Concrete Products

**2.5.1 Identification of Prestressed or Precast Concrete Bridge Members** – The following section establishes a uniform numbering system for identification of pre-fabricated concrete bridge members and to indicate the location of the member in the structure.

### 2.5.1.1 Responsibility of the Department

**2.5.1.1.1 Identification Numbering System** – The Department shall assign a number to each member described as follows:

**(1) Identification Number Format:**



**(2) Plant Identification** – The plant identification shall be a one character letter. Plant letters shall be assigned by the District or Central Laboratory. The Central Laboratory shall approve and maintain a list of approved plant identification letters.

**(3) Year, Month, Day**

Example: 01.0512

01 is the year 2001

. is to break up the complexity of the number

05 is the month

12 is the day of the month

The date the member was cast is May 12, 2001.

**(4) Member Number** – The number assigned to each prestress or precast member represented on the plans and/or shop drawings.

**2.5.1.1.2 Member Length** – The length of the member shall be inscribed directly under the

member identification number.

**2.5.1.1.3 Reporting** – The member number shall be recorded on Form TMD-895. The member number shall also be recorded in the project field book and on the final plans indicating the exact location of each member.

**2.5.1.2 Responsibility of the Producer** – The producer shall inscribe the member number in the plastic concrete surface. The inscription shall be legible and located as follows:

- (1) **Pile:** Near both ends.
- (2) **Bridge Slab:** Near both ends on top right surface facing the member.
- (3) **Beams:** At both ends on the side, near the top of the beam.
- (4) **Other Members:** As required by the Department's contract documents, or as instructed by the Engineer responsible for production at the plant.

**2.5.2 Inspection of Prestressed Concrete Bridge Members at the Prestressed Plant** – The following section establishes uniform procedures and practices for quality assurance sampling, testing of materials, and auditing of documentation for fabrication of prestressed concrete bridge members.

**2.5.2.1 General** – All facilities involved in the production of prestressed concrete bridge members must be certified by the Precast/Prestressed Concrete Institute (PCI), as stated in the specifications.

These provisions provide instructions and procedures to Department personnel, for inspection and testing of prestressed concrete members under the Department's Quality Control/Quality Assurance (QC/QA) program, as required by the specifications. Sampling procedures and frequencies, tests, and frequencies for documentation review to be performed by the Department for the quality assurance of the members are detailed.

### **2.5.2.2 Testing**

**2.5.2.2.1 Plastic Concrete** – Following are procedures to be followed when testing plastic concrete at the prestressed facility.

- (1) Frequency of sampling and testing of plastic concrete will be conducted as specified in Division VI of the PCI Quality Control Manual, 4<sup>th</sup> Edition.
- (2) The following plastic concrete tests shall be performed by an ACI Grade I or MDOT Class I Concrete Field Testing Technician:
  - a. AASHTO T 23: Making and Curing Concrete Test Specimens in the Field
  - b. AASHTO T 119: Slump of Hydraulic Cement Concrete
  - c. AASHTO T 141: Sampling Freshly Mixed Concrete
  - d. ASTM C 1064: Temperature of Freshly Mixed Portland Cement Concrete
- (3) The following concrete tests shall be performed by a MDOT Class III Concrete QC/QA

Technician, or an ACI Grade I or MDOT Class I Concrete Field Testing Technician under the direct supervision of a MDOT Class III Concrete QC/QA Technician:

- a. AASHTO T 22: Compressive Strength of Cylindrical Concrete Specimens
- b. AASHTO T 231: Capping Cylindrical Concrete Specimens

**2.5.2.2.2 Aggregates** – Following are procedures to be followed when sampling and testing aggregates at the prestressed facility.

- (1) Sampling and testing of aggregates, consisting of fine aggregate gradation, coarse aggregate gradation, and fineness modulus (FM) of both fine and coarse aggregates, will be conducted as specified in Division VI of the PCI Quality Control Manual, 4<sup>th</sup> Edition.
- (2)
- (3) The following aggregate tests shall be performed by a MDOT Class II Concrete QC/QA Technician or a PCI Quality Control Technician/Inspector Level II:
  - a. AASHTO T 2: Sampling Aggregates
  - b. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates
  - c. AASHTO T 248: Reducing Field Samples of Aggregate to Testing Size
  - d. AASHTO T 255: Total Moisture Content of Aggregate by Drying

**2.5.2.2.3 Wire Rope, Cable, Spiral Wire, and Reinforcing Steel** – Frequency of sampling and testing of wire rope or cable, spiral wire and reinforcing steel will be conducted according to Item No. 804 in SOP TMD-20-04-00-000.

**2.5.2.2.4 Elastomeric Bearings** – Frequency of sampling and testing of elastomeric bearings will be according to Item No. 804 in SOP TMD-20-04-00-000.

### **2.5.2.3 Quality Assurance of Concrete and Aggregates**

**2.5.2.3.1 Quality Assurance Testing** – Quality assurance tests will be performed independently

of the samples taken by the Producer.

**2.5.2.3.2 QC-QA Comparison of Aggregate** – The Producer’s quality control and the Department’s quality assurance tests of aggregate gradations shall be in comparison if the results of both QC and QA meet the gradation and fineness modulus (FM) requirements of the specifications.

After it is determined that the Producer’s QC test results of aggregate gradations are comparative to that of the Department’s QA test results, then the Department’s QA testing frequency can be reduced to a frequency of no less than the frequency specified in the Standard Specifications for Road & Bridge Construction Section 804.02.13.

**2.5.2.3.3 QC-QA Comparison of Concrete Compressive Strength** – The quality control and quality assurance tests for compressive strength of cylinders will be compared using the FHWA “Data Test” statistical analysis computer program.

After it is determined that the Producer’s QC test results of concrete compressive strengths are comparative to that of the Department’s QA test results, then the Department’s QA testing frequency can be reduced to a frequency of no less than the frequency specified in the Standard Specifications for Road & Bridge Construction Section 804.02.13.

**2.5.2.3.4 Non-Comparisons** – If the Producer’s QC test results fail to compare to those of the Department’s QA test results, QA testing frequency will increase to the frequency specified in the Standard Specifications for Road & Bridge Construction Section 804.02.13 until the Producer’s and the Department’s test data again compare.

**2.5.2.4 Review of Documentation** – The following documentation shall be reviewed by the appropriate MDOT personnel at the prescribed frequency.

- (1) The documentation generated by the Producer shall meet the requirements necessary to retain PCI certification. The documentation shall be reviewed by the District or Central Laboratory by a PCI Quality Control Technician/Inspector Level I.
- (2) The following reports are to be reviewed, at a minimum, every two months:
  - a. Tensioning Report;

- b. Concrete Test Report;
- c. Inspection Report (Post-Pour & Pre-Pour);
- d. Steam and/or Concrete Maturity Report;
- e. Steel Test Report and/or Manufacturer Certification;
- f. Aggregate Gradation Report;
- g. Elastomeric Bearings Certificate (as applicable).

(3) The Contractor's Daily Steam Report, which shall contain a graphical representation of time versus the temperature of the steam throughout the duration of curing, will be reviewed on a monthly basis.

(4) After the above listed documentation has been verified, the inspector shall issue Form TMD-895 for the prestress members it represents. Form TMD-895 will be delivered along with the prestress member to the bridge construction site as proof of compliance to the specifications.

**2.5.2.3.5 Non-Conforming Documentation** – If the Producer's documentation does not conform to the requirements as stated in the contract specifications at the time of inspection, the District or Central Laboratory will place the Producer on probation until the next scheduled inspection. If the deficiency is not corrected by the time of the next inspection, the Producer will be instructed to halt all production of members intended for Department projects until all deficiencies are resolved.

**2.5.2.5 Reporting** – The following procedures shall be followed to document that Prestressed Concrete Bridge Members at the Prestressed Plant were sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

(1) For QA sampling and testing, the Inspector at the Prestress Plant will enter the applicable information into a SiteManager Sample Record and complete the appropriate template for the material being tested.

(2) For member inspection, the Inspector at the Prestress Plant will enter the applicable information into a SiteManager Sample Record and complete the appropriate template for member inspection (CCL513 - Prestressed Units). These templates are identical to Form TMD-895.

- (3)** The completed Form TMD-895 listing the shipped member will be delivered along with the prestress member to the bridge construction site as proof of compliance to the specifications.
- (4)** When member is shipped, the District or Central Laboratory personnel will enter the applicable information into a SiteManager Sample Record and complete the appropriate template for member shipment (FCL516 - Prestressed Units).

### **2.5.3 Inspection of Prestressed Concrete Bridge Members at the Bridge Construction Site**

– The following section establishes uniform procedures for the inspection of prestressed concrete bridge members at the bridge construction site.

**2.5.3.1 General** – An inspection will be performed on each prestressed concrete bridge member. A representative of the Project Office will perform the inspection.

**2.5.3.2 Documentation** – A completed copy of Form TMD-895 shall accompany the prestressed member when delivered to the bridge construction site, as required by the contract specifications. Refer to Appendix A for a copy of Form TMD-895. This form shall be reviewed upon arrival to the site by a representative of the Project Office.

**2.5.3.3 Inspection** – Upon arrival at the bridge construction site, the prestressed member shall be visually inspected by a representative of the Project Office for the following:

- (1) **Cracks** – Any cracks that may have occurred during transit, mainly near the middle of the member.
- (2) **Broken Corners** – Check for broken corners, on each end, at top and bottom of member that may have occurred during loading and unloading of the member.
- (3) **Identification Numbers** – The identification number should correspond to plans and/or shop drawings, as stated in Section 2.5.1 of this manual.
- (4) **Embedded Items** – Check for damage to inserts. Check for reinforcing steel extended from top and/or end of member. Check for damage to bearing plates.
- (5) **Coating of Strands** – Check for damage to the coating of the strands at beam ends.

**2.5.3.4 Acceptance and Rejection Procedures** – Following are guidelines for acceptance or rejection of a prestressed member upon inspection at the bridge site.

- (1) Prestressed members that have proper documentation and that pass visual inspection requirements may be incorporated into the work.

- (2) Members arriving at the bridge construction site without the proper documentation shall be rejected and not incorporated into the work until the Engineer receives the documentation.
- (3) Members with a visual crack across the width or depth are to be rejected.
- (4) Members with broken corners with exposed reinforcing steel shall be repaired at the expense of the Producer.
- (5) The Engineer may approve repairs of a prestressed member with damage to embedded items, made at the expense of the Producer.
- (6) Damaged prestressed members that cannot be repaired to the satisfaction of the Engineer will be rejected and not used on Department projects.

**2.5.3.5 Reporting** – The following procedures shall be followed to document that Prestressed Concrete Bridge Members at the Bridge Construction Site were sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

For member acceptance at the bridge construction site, the Project Office will enter the applicable information into a SiteManager Sample Record and complete the appropriate template for Project Engineer certification (CPE901 – Engineer Certification).

2.5.3.6 County or LPA Project Engineers shall retain copies of all applicable certificates for project clearance records.

## 2.6 Precast Concrete Products

**2.6.1 Non-Metal Pipe, Flared End Sections, and Cattlepasses** – The following section outlines the standard procedures for the sampling, testing, inspection, and acceptance of non-metal pipe, flared-end sections and cattlepasses for use in Department work. All units must meet the requirements of the applicable AASHTO specifications and Section 708 of Mississippi Standard Specifications for Road and Bridge Construction.

Producers of precast products for use on department projects must be certified by the American Concrete Pipe Association (ACPA), the National Precast Concrete Association (NPCA), or the Prestressed Concrete Institute (PCI). The certification requirement is in addition to our standard specifications and testing requirements. All Precast-Prestressed Concrete Bridge Members must be certified by the Prestressed Concrete Institute (PCI). Suppliers of precast products are only required to be certified by one of the three above listed entities. Approved producers should submit proof of certification from one of the certifying entities annually.

**2.6.1.1 General** – Hereinafter, when “unit” or “units” is used, it shall be understood to mean unit or units of non-metal pipe, flared end sections and cattlepasses.

**2.6.1.2 Notice of Completion of Units for Inspection** – The Producer shall notify the Chief of the Inspection Section or the Field Operations Engineer of the Materials Division as far in advance as possible when the units will be ready for inspection.

All units shall be inspected by lots at the plant at which they were manufactured. A lot of pipe is defined as that portion of a continuous stack of pipe of one size and class which is offered for inspection. Only units which meet all requirements and conditions will be accepted for use in Department work.

**2.6.1.3 Basis of Acceptance** – The basis of acceptance of all units shall be as specified under **Option I (three-edge bearing)** or **Option II (cylinder test)**. The pipe producer shall advise the State Materials Engineer, in writing, the option (I or II) under which the thirty-six (36) inch diameter through sixty (60) inch diameter pipe will be manufactured. The option chosen will remain in effect until rescinded in writing.

**(1) Option I** – Under Option 1, acceptance shall be based on plant load-bearing tests, material tests and inspection of the manufactured units for visual defects and imperfections. Acceptability of the units of the specified size shall be determined by the

results as follows:

- a. The testing of the units by the three-edge bearing method up to the minimum D-load as specified in AASHTO M 170 for the 0.01 inch crack.
- b. The material tests as required on cement, aggregates and reinforcement.
- c. Measurements of the finished units to determine their conformance with the design.
- d. Visual inspection of the finished units to determine their freedom from defects.

**(2) Option II** – Under Option II, acceptance shall be based on compressive strength tests, materials tests, and inspection of the manufactured units for defects and imperfections. Acceptability of the units of the specified size shall be determined by the results as follows:

- a. Compressive strengths of the cured concrete cylinders as specified in the Tables in AASHTO M 170. One test shall be represented by the average of a minimum of two cylinder breaks of the same age cylinder.
- b. Material tests as required on cement, aggregates and reinforcement.
- c. Measurements of the finished units to determine their conformance with the design.
- d. Visual inspection of the finished units to determine their freedom from defects.

**2.6.1.4 Sampling** – Following are sampling procedures for the materials used in the production of precast concrete pipe, flared end sections, and cattlepasses.

#### **2.6.1.4.1 Materials**

**(1) Aggregates** – The aggregates shall be sampled and tested on a monthly basis. The Producer shall use aggregates from MDOT approved aggregate sources only.

**(2) Cement** – The cement shall be sampled and tested on a monthly basis. The Producer

shall use cement from a MDOT approved cement mill only.

**(3) Water** – The water shall be sampled and tested prior to production and as necessary thereafter.

**(4) Reinforcement** – Mesh or single strand rolls of reinforcement shall be sampled per shipment for each size. Bar reinforcement shall be sampled at the rate of one (1) sample for each 10 tons, or fraction thereof, of each size and grade.

**2.6.1.4.2 Acceptance Option I Sampling** – When pipe are to be tested under Option I, the Inspector will select the test specimen from the pipe offered for inspection. One (1) specimen shall be tested for the required minimum D-load for each one hundred (100) sections, or fraction thereof, of each size and class of pipe per one week's production.

**2.6.1.4.3 Acceptance Option II Sampling** – The following sampling procedures shall be followed when the Producer chooses Acceptance Option II.

**(1)** When machine-made or wet cast pipe are to be tested under Option II, a set of cylinders shall be made by the Producer for each compressive strength mix design of concrete used during each calendar day of production. One test shall be represented by the average of at least two cylinder breaks on the same age cylinder. A minimum of six cylinders shall be made per calendar day of production.

**(2)** The Producer shall inscribe into the top of each cylinder the following:

- a. Producer's identification;
- b. Date manufactured;
- c. Compressive strength.
- d. At the option of the Producer, the cylinders may be tested by the Central Laboratory (when shipped prepaid); by an approved commercial laboratory; or by the Producer (under conditions set forth in Section 2.7.1.5).

**2.6.1.5 Testing** – Unless otherwise specified, the applicable specifications shall be those specified in AASHTO M 170, AASHTO M 242, or AASHTO M 206.

**2.6.1.5.1** All pipe, flared-end sections and cattlepasses will be tested under Option I (three-edge

bearing test) or Option II (cylinder test) as specified hereinafter.

**2.6.1.5.2** All pipe having a diameter of thirty (30) inches or less shall be tested under Option I.

**2.6.1.5.3** Pipe having a diameter in excess of thirty (30) inches up to and including sixty (60) inches shall be tested under Option I or Option II as specified in Section 2.6.1.3.

**2.6.1.5.4** Pipe having a diameter in excess of sixty (60) inches, flared-end sections and cattlepasses shall be tested under Option II, unless otherwise authorized by the State Materials Engineer.

**2.6.1.5.5** The testing of cylinders for compressive strength will be performed in accordance with the following procedure:

- (1) A minimum of 2 cylinders will be tested, initially. If the average compressive strength is satisfactory, no further testing is required. In the event the compressive strength is not satisfactory, additional cylinders may be tested, one at a time, until the average compressive strength of three consecutively broken cylinders is satisfactory.
- (2) If the compressive strength(s) of the cylinder(s) is not satisfactory, the Producer may request the pipe be tested by the three-edge bearing test, or cored. If coring is the test option selected, a minimum of two (2) cores averaged shall be used for analysis. The Producer shall make the request in writing to the State Materials Engineer.

**2.6.1.6 Testing of Cylinders by the Producer** – The producer may test their own cylinders under the conditions specified in the following provisions.

- (1) The Producer shall furnish a testing machine conforming to AASHTO T 22 located on the plant yard. The equipment must be calibrated and meet the requirements of all applicable AASHTO specifications. Calibration of the testing machine shall be repeated at intervals deemed necessary by the State Materials Engineer, and such intervals for calibration shall not exceed one (1) year. A copy of each calibration shall be furnished the State Materials Engineer.
- (2) The Producer shall have a qualified technician trained in the applicable procedures for

- testing concrete cylinders (AASHTO T 22).
- (3) The Producer shall furnish a cylinder capping apparatus that meets the requirements of AASHTO T 231 for cylinders and cores, or shall use neoprene caps for cylinders to meet the requirements of AASHTO T22.
  - (4) The Producer shall test the cylinders in the presence of the Laboratory Inspector. Each cylinder to be tested will first be observed by the Central Laboratory Inspector, capped and then tested in his presence.
  - (5) The Producer shall furnish the necessary forms, approved by the State Materials Engineer, and each form shall be signed by an authorized ACI certified technician employed by the Producer.
  - (6) The Producer will give a copy of the completed report to the Inspector, upon completion of the tests, for the Central Laboratory's records.

**2.6.1.7 Inspection** – All materials, process of manufacture, and the finished units shall be subject to inspection and approval by the Inspector. Such specimen(s), as needed, shall be furnished to the Department. The Inspector shall be furnished access to the facility and assistance for performing the tests and inspection.

- (1) The Inspector will visually inspect each unit of pipe, flared-end section and cattlepass for defects, workmanship and markings.
- (2) The Inspector will measure and record all the necessary dimensions to determine if the unit conforms to the design and is within the permissible variation limits.
- (3) If the lot is being tested under Option I, the Inspector will observe and record the results of the three-edge bearing test.
- (4) If the lot is being tested under Option II, the Producer will present to the Inspector a copy of the cylinder test report(s), prior to inspection, covering the lot offered for inspection.
- (5) If more than twenty percent (20%) of the lot is rejected, the entire lot shall be rejected

until the Producer culls and removes the unacceptable units.

**2.6.1.8 Acceptance** – Each acceptable unit will be stamped after all of the required conditions have been satisfied. The Inspector will record the number of units, by size and class. Each accepted and stamped unit will be placed in “**Stock**” for shipment to Department projects.

**2.6.1.9 Reporting** – The following procedures shall be followed to document that non-metal pipe, flared end sections, and cattlepasses were sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

(1) The producer shall identify and mark the units as specified in the applicable AASHTO and MDOT Specifications and below.

- a. The Producer shall be responsible for sending a copy of the shipping invoice with each shipment designated for the Project (or County) Engineer. Each shipping ticket must indicate that the units were shipped from pre-tested stock.
- b. The shipping invoice shall contain all pertinent data; i.e., Purchaser, Project Number, County, Number of Units, Length, Size, Class, and Date of Shipment.
- c. The Producer shall mail to the Central Laboratory a copy of each shipping ticket. The mailing address is:

State Materials Engineer (72-01)  
Mississippi Department of Transportation  
P. O. Box 1850  
Jackson, MS 39215-1850

(2) When a Producer is shipping units which were produced at another plant, the shipping invoice must indicate the plant at which the units were manufactured.

(3) For State, Federal, and Maintenance contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The Project Engineer shall also enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO624—“Shipment of Pre-tested Concrete Pipe”).

- (4) For State Aid and LPA contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The engineer shall submit a “Pretested Materials Shipment Report Request Form” for each project to the Materials Division. The request form shall include the total number of feet used for each type of unit, and the length, size and class of the pipe. The form must also state that the material contained a MDOT inspector’s stamp. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

**2.6.2 Precast Concrete Box Culverts** – The following section outlines the standard procedures for the sampling, testing, inspection and acceptance of precast box culverts for use in Department work. All units shall meet the specification requirements of the applicable AASHTO and MDOT specifications.

Producers of precast products for use on department projects must be certified by the American Concrete Pipe Association (ACPA), the National Precast Concrete Association (NPCA), or the Prestressed Concrete Institute (PCI). The certification requirement is in addition to our standard specifications and testing requirements. All Precast-Prestressed Concrete Bridge Members must be certified by the Prestressed Concrete Institute (PCI). Suppliers of precast products are only required to be certified by one of the three above listed entities. Approved producers should submit proof of certification from one of the certifying entities annually.

**2.6.2.1 General** – A **Group** will consist of the number of box sections produced during one (1) day's production from the same concrete strength mix.

**2.6.2.2 Notice of Completion of Units for Inspection** – The Producer shall notify the Chief of the Inspection Section or the Field Operations Engineer of the Materials Division as far in advance as possible as to when the units will be ready for inspection.

All units shall be inspected at the plant at which they are manufactured. Only units which meet all requirements and conditions will be accepted. Prior acceptance by the Materials Division will not preclude rejection of the units at the project site.

**2.6.2.3 Basis of Acceptance** – Acceptance of the units shall be determined by the results of the following:

- (1) The material tests as required on cement, aggregates and reinforcement.
- (2) Measurements of the finished units to determine conformance with the design dimensions.
- (3) Visual inspection of the finished units to determine freedom from defects.
- (4) Each group's compression tests performed on concrete cores or cylinders that meet the specified average strength requirement. Note, the average of a minimum of two (2)

cylinders will constitute one test. The concrete cylinders averaged must represent breaks on the same age cylinders.

**2.6.2.4 Sampling** – Following are sampling procedures for the materials used in the production of precast box culverts.

#### **2.6.2.4.1 Materials**

- (1) **Aggregates** – The aggregates shall be sampled and tested on a monthly basis. The Producer shall use aggregates from MDOT approved aggregate sources only.
- (2) **Cement** – The cement shall be sampled and tested on a monthly basis. The Producer shall use cement from a MDOT approved cement mill only.
- (3) **Water** – The water shall be sampled and tested prior to production and as necessary thereafter.
- (4) **Reinforcement** – The reinforcement shall be sampled at the rate of one (1) sample for each 75,000 sq. ft., or fraction thereof, of each size and spacing.

#### **2.6.2.4.2 Cylinders**

- (1) The Producer shall inscribe into the top of each cylinder: Producer's identification, plant, date made, and size of unit the cylinder represents.
- (2) At the option of the Producer, the cylinders may be tested by the Central Laboratory (when shipped prepaid); by a commercial laboratory; or, by the Producer (under conditions set forth in Section 2.6.2.6).
- (3) Testing for compressive strength of cylindrical concrete specimens shall be in accordance with AASHTO T 22.

**2.6.2.5 Testing** – Unless otherwise specified, the applicable specifications shall be those

specified in AASHTO M 259 and AASHTO M 273 for this section. All materials including cylinders or cores will be tested and approved prior to acceptance of the box sections.

**Note:** The minimum compressive strength of the concrete shall be 5,000 psi.

**2.6.2.6 Testing Cylinders or Cores by the Producer** – The producer may test their own cylinders or cores under the conditions specified in the following provisions.

- (1) The Producer shall furnish a testing machine conforming to AASHTO T 22 located on the plant yard. The equipment must be calibrated and meet the requirements of all applicable AASHTO specifications. Calibration of the testing machine shall be repeated at intervals deemed necessary by the State Materials Engineer, and such intervals for calibration shall not exceed one (1) year. A copy of each calibration shall be furnished the State Materials Engineer.
- (2) The Producer shall have a qualified technician trained in the applicable procedures for testing concrete cylinders (AASHTO T 22).
- (3) As applicable, the Producer shall furnish a specimen capping apparatus meeting the requirements of AASHTO T 231 for cylinders and cores, or shall use neoprene caps for cylinders meeting the requirements of AASHTO T22. Each specimen to be tested will first be observed by the Central Laboratory Inspector, capped and then tested in the presence of the inspector.
- (4) The Producer shall furnish the necessary forms, approved by the State Materials Engineer, and each form shall be signed by an ACI certified technician employed by the Producer.
- (5) Upon completion of the tests, the Producer will give a copy of the completed report to the Inspector for the Central Laboratory's records.

**2.6.2.7 Inspection** – All materials, process of manufacture, and the finished units shall be subject to inspection and approval of the Inspector. The Inspector shall be given access to the facility and assistance for performing the inspection.

- (1) Prior to inspection, the Producer will present to the Inspector a copy of the cylinder (or core) test report covering the group offered for inspection.
- (2) The Inspector will visually inspect each box section for defects, workmanship and markings.
- (3) The Inspector will measure and record all the necessary dimensions to determine if the unit conforms to the design and is within the permissible variation limits.

**2.6.2.8 Acceptance** – Each acceptable unit will be stamped after all of the required conditions have been satisfied. The Inspector will record the number of units, by size and specification designation, in each group. Each accepted and stamped unit may be placed in “**Stock**” for shipment to Department projects.

**2.6.2.9 Reporting** – The following procedures shall be followed to document that precast box culverts were sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

- (1) The Producer shall identify and mark the units as specified in the applicable AASHTO and MDOT specifications and below.
  - a. The Producer shall be responsible for sending a copy of the shipping invoice with each shipment designated for the Project (or County) Engineer. Each shipping ticket must indicate that the units were shipped from pre-tested stock.
  - b. The shipping invoice shall contain all pertinent data; i.e., Purchaser, Project Number, County, Number of Units, Length, Size, Specification Designation, and Date of Shipment.
  - c. The company shall mail to the Central Laboratory a copy of each shipping ticket. The mailing address is:

State Materials Engineer (72-01)  
Mississippi Department of Transportation  
P. O. Box 1850  
Jackson, MS 39215-1850

- (2) When a Producer is shipping units which were produced at another plant, the shipping ticket must indicate the plant at which the units were manufactured.
- (3) For State, Federal, and Maintenance contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO626—“Shipment of Pre-tested Box Culverts”).
- (4) For State Aid and LPA contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The engineer shall submit a “Pretested Materials Shipment Report Request Form” for each project to the Materials Division. The request form shall list the total number of feet used for each type of unit, the length, the size (including span and rise) and the specification designation(AASHTO M 259 or M 273).The form must also state that the material contained a MDOT inspector’s stamp. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

**2.6.3 Concrete Fence Posts and Right-of-Way Markers** – The following section outlines the standard procedures for the sampling, testing, inspection and acceptance of concrete fence posts and right-of-way markers for use in Department work.

**2.6.3.1 General** – Hereinafter, when "unit" or "units" is used, it shall be understood to mean unit or units of concrete fence posts and right-of-way markers.

**2.6.3.2 Notice of Completion of Units for Inspection** – The Producer shall notify the Chief of the Inspection Section or the Field Operations Engineer of the Materials Division as far in advance as possible when the units will be ready for inspection.

All units shall be inspected at the plant at which they were manufactured. Only units which meet all requirements and conditions will be accepted for use in Department work. Acceptance will be on the basis of plant load-bearing tests, material tests, and inspection of the manufactured units for visual defects and imperfections.

**2.6.3.3. Sampling** – Following are sampling procedures for the materials used in the production of concrete fence posts and right-of-way Markers.

**2.6.3.3.1 Materials**

**Aggregates:** The aggregates shall be sampled and tested on a monthly basis. The Producer shall use aggregates from the Mississippi Department of Transportation's list of approved aggregate sources only.

**Cement:** The cement shall be sampled and tested on a monthly basis. The Producer shall use cement from the Mississippi Department of Transportation's list of approved cement mills only.

**Water:** The water shall be sampled and tested prior to production and as necessary thereafter.

**Reinforcement:** Bar reinforcement shall be sampled at the rate of one (1) sample for each ten (10) tons or fraction thereof.

#### 2.6.3.4 Testing

- (1) The strength of the units shall be determined by the beam method. Under the beam method, a completed unit is loaded at the midpoint of an 18-inch span with three-edge bearing.
- (2) The unit shall develop not less than 6,000 pounds for a 4-inch by 4-inch unit or 12,000 pounds for a 6-inch by 6 inch unit.
- (3) The lot shall be tested at the rate of two (2) units for each 200 units, or increment thereof; one (1) to the ultimate load; and one (1) to destruction. The location, size and number of reinforcing bars will be checked on the unit loaded to destruction. The lot shall be rejected should both units fail.
- (4) Should one unit fail to meet the requirements of the specifications, two (2) additional units shall be tested. If either of the additional units fails to meet the requirements of the specifications, the lot shall be rejected.

**2.6.3.5 Inspection** – All materials, process of manufacture and the finished units shall be subject to inspection and approval by the Inspector. The Inspector shall be furnished with every facility and assistance for performing the tests and inspection. The Inspector will visually inspect each unit for defects in workmanship. The Inspector will measure and record all the necessary dimensions to determine if the unit conforms to the design and is within the permissible variation limits. If more than twenty percent (20%) of the lot is rejected, the entire lot shall be rejected until the Producer culls and removes the unacceptable units.

**2.6.3.6 Acceptance** – When all of the required conditions have been satisfied, each acceptable unit will be stamped. The Inspector will record the number of units, by size and length, in the lot. Each accepted and stamped unit will be placed in "STOCK" for shipment to Department projects.

**2.6.3.7 Reporting** – The following procedures shall be followed to document that concrete fence posts and right-of-way markers were sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

- (1) For State, Federal, and Maintenance contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO618—“Shipment of Pre-tested Concrete Fence Posts or FFO619—“Shipment of Concrete Right-of-Way Markers”).
- (2) For State Aid and LPA contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The engineer shall submit a “Pretested Materials Shipment Report Request Form” for each project to the Materials Division. The request form shall state that the material contained a MDOT inspector’s stamp. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

**2.6.4 Precast Inlets, Junction Boxes, and Manholes** – The following section outlines the standard procedures for the sampling, testing, inspection and acceptance of precast curb inlets, median inlets, junction boxes and manholes for use in Department work.

Producers of precast products for use on department projects must be certified by the American Concrete Pipe Association (ACPA), the National Precast Concrete Association (NPCA), or the Prestressed Concrete Institute (PCI). The certification requirement is in addition to our standard specifications and testing requirements. All Precast-Prestressed Concrete Bridge Members must be certified by the Prestressed Concrete Institute (PCI). Suppliers of precast products are only required to be certified by one of the three above listed entities. Approved producers should submit proof of certification from one of the certifying entities annually.

**2.6.4.1 General** –Precast units may be used in lieu of the cast-in-place inlets and junction boxes that are shown in Department plans and Standard Drawings. The Project Engineer shall decide whether or not precast units will be allowed on a particular project. The Project Engineer may decide to allow precast units for all inlets and junction boxes on a particular project or to require cast-in-place units at specific locations.

The Project Engineer may also allow precast units to be used that require certain segments of the precast units to be cast-in-place (i.e. tops). This condition may occur whenever the plans require the SS-2 curb inlet, for example. The precast units for SS-2 inlets usually come in more than a single segment. The bottom section, riser sections, extensions, wings and top are separate units.

Precast units will also require inspection by the Materials Division. This inspection will follow the procedures established by this section. The Project Engineer, should he allow precast units to be used on the project, should forward a letter of request for inspection to the Materials Division. This letter should include drawings prepared by the contractor of each station's unit stub-out angles and locations above the invert, if the unit is non-standard. (Note: Neither the Project Engineer nor Department Inspectors/personnel shall be responsible for accurate interpretation of the contractor's drawings for construction of the unit(s).)

**2.6.4.2 Notice of Completion of Units for Inspection** – The Producer shall notify the Chief of the Inspection Section or the Field Operations Engineer of the Materials Division as far in

advance as possible as to when the units will be ready for inspection.

All units shall be inspected at the plant at which they are manufactured. Only units which meet all requirements and conditions will be accepted. Prior acceptance by the Materials Division will not preclude rejection of the units at the project site.

In addition, a manufacturer's precast unit(s) must have prior approval from the Roadway Design Division of MDOT before the unit(s) may be used on a MDOT project. If the units are from a supplier that does not have prior approval from Roadway Design, then the appropriate shop drawings should be attached to the Project Engineer's request and a copy should be sent to Roadway Design. Upon approval of the shop drawings, Roadway Design will notify the Materials Division, so that the Materials Division can proceed with arrangements for inspection of the units. Approved shop drawings will be maintained on file in the Roadway Design Division and the Materials Division.

**2.6.4.3 Basis of Acceptance** – Acceptance of the units shall be determined by the results of the following:

- (1) The material tests as required on cement, aggregates and reinforcement.
- (2) Measurements of the finished units to determine conformance with the design dimensions.
- (3) Visual inspection of the finished units to determine freedom from defects.
- (4) Each group's compression tests performed on concrete cores or cylinders that meet the specified average strength requirement. Note, the average of a minimum of two (2) cylinders will constitute one test. The concrete cylinders averaged must represent breaks on the same age cylinders. A minimum of six (6) cylinders should be made.

**2.6.4.4 Sampling** – Following are sampling procedures for the materials used in the production of precast inlets and junction boxes. For this section, a **Group** will consist of the number of units produced during one (1) day's production from the same concrete strength mix.

#### 2.6.4.4.1 Materials

- (1) **Aggregates** – The aggregates shall be sampled and tested on a monthly basis. The Producer shall use aggregates from MDOT approved aggregate sources only.
- (2) **Cement** – The cement shall be sampled and tested on a monthly basis. The Producer shall use cement from a MDOT approved cement mill only.
- (3) **Water** – The water shall be sampled and tested prior to production and as necessary thereafter.
- (4) **Reinforcement** – The reinforcement shall be sampled at the rate of one (1) sample for each 75,000 sq. ft., or fraction thereof, of each size and spacing. Steel may be sampled at the discretion of the inspector and represent a maximum of thirty (30) tons.

#### 2.6.4.4.2 Cylinders

- (1) The Producer shall inscribe into the top of each cylinder: Producer's identification, plant, date made, and mix design identification.
- (2) At the option of the Producer, the cylinders may be tested by the Central Laboratory (when shipped prepaid); by a commercial laboratory; or, by the Producer (under conditions set forth in Section 2.6.4.5).
- (3) Testing for compressive strength of cylindrical concrete specimens shall be in accordance with AASHTO T 22.

**2.6.4.5 Testing Cylinders or Cores by the Producer** – The producer may test their own cylinders or cores under the conditions specified in the following provisions.

- (1) The Producer shall furnish a testing machine conforming to AASHTO T 22 located on the plant yard. The equipment must be calibrated and meet the requirements of all applicable AASHTO specifications. Calibration of the testing

machine shall be repeated at intervals deemed necessary by the State Materials Engineer, and such intervals for calibration shall not exceed one (1) year. A copy of each calibration shall be furnished the State Materials Engineer.

- (2) The Producer shall have a qualified technician trained in the applicable procedures for testing concrete cylinders (AASHTO T 22).
- (3) As applicable, the Producer shall furnish a specimen capping apparatus meeting the requirements of AASHTO T 231 for cylinders and cores, or shall use neoprene caps for cylinders meeting the requirements of AASHTO T22. Each specimen to be tested will first be observed by the Central Laboratory Inspector, capped and then tested in the presence of the inspector.
- (4) The Producer shall furnish the necessary forms, approved by the State Materials Engineer, and each form shall be signed by an ACI certified technician employed by the Producer.
- (5) Upon completion of the tests, the Producer will give a copy of the completed report to the Inspector for the Central Laboratory's records.

**2.6.4.6 Inspection** – All materials, process of manufacture, and the finished units shall be subject to inspection and approval of the Inspector. The Inspector shall be given access to the facility and assistance for performing the inspection.

- (1) Prior to inspection, the Producer will present to the Inspector a copy of the cylinder (or core) test report covering the group offered for inspection.
- (2) The Inspector will visually inspect each unit section for defects, workmanship and markings.
- (3) The Inspector will measure and record all the necessary dimensions to determine if the unit conforms to the design and is within the permissible variation limits.

**2.6.4.7 Acceptance** – Each acceptable unit will be stamped after all of the required conditions have been satisfied. The Inspector will record the number of units, by size and specification

designation, in each group. Each accepted and stamped unit may be placed in “**Stock**” for shipment to Department projects or held for supply to a specific project.

**2.6.4.8 Reporting** – The following procedures shall be followed to document that precast curb inlets, median inlets junction boxes and manholes were sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

**2.6.4.8.1—Producer’s Responsibility**

(1) The Producer shall identify and mark the units as specified in the applicable AASHTO and MDOT specifications and below.

- a. The Producer shall be responsible for sending a copy of the shipping invoice with each shipment designated for the Project (or County) Engineer. Each shipping ticket must indicate that the units were shipped from pre-tested stock.
- b. The shipping invoice shall contain all pertinent data; i.e., Purchaser, Project Number, County, Number of Units, Size, and Date of Shipment.
- c. The company shall mail to the Central Laboratory a copy of each shipping ticket. The mailing address is:

State Materials Engineer (72-01)  
Mississippi Department of Transportation  
P. O. Box 1850  
Jackson, MS 39215-1850

(2) When a Producer is shipping units which were produced at another plant, the shipping ticket must indicate the plant at which the units were manufactured.

**2.6.4.8.2—Project Engineer and Department Responsibilities**

(1) For State, Federal, and Maintenance contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The Project Engineer shall enter the applicable

information into a SiteManager Sample Record and complete the appropriate template (FFO632—"Shipment of Pre-tested Inlets and Junction Boxes").

- (2)** For State Aid and LPA contracts, the Project Engineer shall verify the shipping ticket was stamped "Shipped from Pre-tested Stock", and that each unit is stamped with a MDOT Inspector's stamp. The engineer shall also inspect each unit for damage. The engineer shall submit a "Pretested Materials Shipment Report Request Form" for each project to the Materials Division. The form must state that the material contained a MDOT inspector's stamp. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

## 2.7 Metal Pipe

**2.7.1 Corrugated Metal Pipe and Arches** – The following section outlines the uniform procedures for the sampling, testing, acceptance, and reporting of corrugated metal culvert pipe and pipe arches.

**2.7.1.1 General** – All corrugated metal pipe and pipe arches shipped to Department projects shall be pretested. Only material on order for a Department project or on order from other agencies (for which we have been authorized to inspect) will be inspected.

The producer shall notify the Central Laboratory when the pipe is ready for inspection.

**2.7.1.2 Approved Fabricators** – A fabricator proposing to furnish pretested corrugated metal pipe and pipe arches for use in MDOT work shall have been approved and their name placed on the list of approved fabricators by the Central Laboratory. The fabricator must follow the procedures outlined below to be placed on the list of approved fabricators.

(1) In order for a fabricator's name to be placed on the Department's "Approved Sources of Materials" list, the fabricator must state agreement with and acceptance of the provisions of this section (Materials Manual Section 2.7.1) by letter to the State Materials Engineer. In addition he shall certify that only domestic steel will be used in the fabrication of metal pipe, and that the pipe will be fabricated meeting the requirements of Section 709 of the Mississippi Standard Specifications. This letter will remain in effect until rescinded in writing.

(2) The fabricator shall provide a recertification of domestic origin at least annually to the Central Laboratory. Such certification shall contain the following or similar wording:

"We hereby certify that any and all corrugated metal pipe and pipe arches supplied by (Name of Company) for use on Mississippi Department of Transportation projects will be fabricated in our plant(s) located at (City & State) and will be fabricated with domestic steel only."

(3) The sheet metal from which the pipe is fabricated shall be from a MDOT "Approved Sources of Materials" listed source. The fabricator shall obtain copies of the mill test report on each heat of sheet steel purchased from the manufacturer. A copy of the mill

test report will be furnished to the Department upon request.

**2.7.1.3 Sampling and Inspection** – All materials, process of manufacture, and the finished units shall be subject to inspection and approval of the inspector. The inspector shall be given access to the facility and assistance for performing the inspection. Following are procedures to be followed during sampling and inspection of the facilities and materials.

- (1) The Inspector shall check the sheet metal manufacturer to determine if they are on the Department's "Approved Sources of Materials" list.
- (2) The spelter coating weight and metal thickness shall be tested at the fabricator's plant. If it becomes evident that the spelter is borderline, after testing the metal for spelter coating weight, a sample approximately seven inches long by the width of the sheet shall be cut. This sample shall be cut into three (3) equal sections, forming one (1) mid-section and two (2) end sections, and returned to the Central Laboratory for tests.
- (3) The Inspector shall make the necessary measurements and visual inspection of the fabricated pipe, then a metal seal shall be attached to each acceptable pipe.
- (4) If the pipe is to be coated and/or paved, a sample of the bituminous coating material shall be obtained. The metal sample shall be approximately ten inches long and four (4) corrugations wide. It shall be cupped in a half-moon shape, and shall receive the same coating as the fabricated pipe. One (1) sample, approximately 250 g of the coating material, shall be obtained from the coating vat.
- (5) After the pipe has been coated and/or paved, it will be inspected for coating thickness and the width of the paved invert. If all requirements for asphalt-coated pipe have been met, the inspector shall place another seal on each accepted pipe.

**2.7.1.4 Reporting** – The following procedures shall be followed to document that metal pipe is sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

- (1) Pipe shall be inspected on an order basis only. After the pipe has been accepted a seal is placed on each pipe.

- (2)** The Materials Division inspector shall enter the applicable information into a SiteManager Sample Record and complete the applicable template (FFO604—"Inspection of Metal Pipe").
  
- (3)** A copy of SiteManager Report with Template FFO604, or an electronic notification that the report is available in SiteManager, should be received by the Project Engineer within three (3) weeks of the inspection.
  
- (4)** The project engineer is responsible for verification that the pipe contains a MDOT seal(s) and that the pipe has not been damaged.

**2.7.2 Corrugated Metal Pipe for Maintenance** – The following section outlines the uniform procedures for the acceptance of corrugated metal pipe for maintenance work.

**2.7.2.1 General** – All corrugated metal pipe used in maintenance work shall be furnished and accepted in accordance with this section (Materials Manual Section 2.7.2) and Section 709 of the Standard Specifications (also by reference AASHTO Designations: M 36, M 218, ASTM A 525 as well as other applicable specifications). A certification type program is established in this section (Materials Manual Section 2.7.2) for furnishing metal pipe to maintenance work.

Failure to comply with all applicable requirements will be cause to have a company's name removed from the Department's "Approved Sources of Materials" list.

**2.7.2.2 List of Approved Suppliers of Corrugated Metal Pipe for Maintenance Work** – A supplier may be a fabricator of metal pipe or a vendor who purchases metal pipe from a fabricator. The following procedures are to be followed by a vendor or supplier for placement on the Department's "Approved Sources of Materials" list.

**(1) Corrugated Metal Pipe Vendors**

- a. A vendor proposing to furnish corrugated metal pipe for maintenance work shall have been approved by the State Materials Engineer and their name placed on the Department's "Approved Sources of Materials" list.
- b. In order for a vendor to have the company's name placed on the Department's "Approved Sources of Materials" list, an authorized company official must state agreement with and acceptance of the provisions of this section (Materials Manual Section 2.7.2) by letter to the State Materials Engineer. In addition, he shall certify that only domestic steel will be furnished to the Department and that all pipe furnished to the Department will be obtained from an MDOT approved fabricator. This letter will remain in effect until rescinded in writing.
- c. The vendor shall provide a recertification of domestic origin at least annually to the Central Laboratory. Such certification shall contain the following or similar wording:

"We hereby certify that any and all corrugated metal pipe supplied by (Name of Company) located at (City & State) for use on Mississippi Department of

Transportation projects will be obtained from(Name & Location of Fabricating Plant(s)) which is an MDOT approved fabricator, and we further certify that only pipe made from domestic steel will be supplied."

- d. A list of approved fabricators will be maintained by the Central Laboratory and is available upon request.
- e. The vendor's delivery ticket will contain the following information on all metal pipe furnished to the Department: date delivered, size, length, quantity, gauge, purchase order number, the fabricator and a certified statement that the metal pipe meets the requirements of Section 709 of the Standard Specifications. A copy of the Mill Test Report on each Heat will be attached to the delivery ticket furnished to the Department.

## **(2) Corrugated Metal Pipe Fabricators**

- a. In order for a corrugated metal pipe fabricator to have the company's name placed on the Department's "Approved Sources of Materials" list, the fabricator must conform to all requirements for approved fabricators set out in Materials Manual Section 2.7.1.
- b. The fabricator will furnish the vendor such mill test reports on each heat, delivery tickets with all pertinent information including statements certifying the fabrication of the pipe, domestic steel and other information as may be requested by the vendor. This information will be required on all pipe furnished to the Department.
- c. When the fabricator is supplying metal pipe directly to the Department, he will furnish delivery ticket and mill test report as outlined in Section 2.7.2.2(e).

**2.7.2.3 Responsibilities of the Central Laboratory** – The Central Laboratory will initiate and maintain lists of approved vendors, fabricators and sheet metal manufacturers on the Department's "Approved Sources of Materials" list. The list is available at the [www.goMDOT.com](http://www.goMDOT.com) website under the Business Section, or upon request to the Materials Division.

Any questionable pipe will be inspected by Central Laboratory inspectors, upon request by the Maintenance Engineer.

At the discretion of the State Materials Engineer or at the request of the District Maintenance Engineer, an inspection will be made at the vendor's and/or fabricator's premises. The inspection would include all metal pipe on the yard and the appropriate files concerning the pipe furnished to the Department.

**2.7.2.4 Responsibilities of Maintenance Employees** – Maintenance employees receiving the metal pipe will obtain a copy of the delivery ticket, check the ticket against the order, check for statement of certification, observe the pipe for obvious defects, and check the brand on the pipe to ascertain it is on the Department's "Approved Sources of Materials" list of Manufacturers of Sheet Metal for Corrugated Metal Pipe. The heat numbers on the pipe shall be checked against the heat numbers on the mill test report. No pipe will be accepted unless it meets all the above conditions.

## 2.8 Treated Timber Products

The following section outlines the standard procedures for the inspection, sampling, testing, acceptance, identification, and reporting of treated timber products.

**2.8.1 General** – Timber products to be used on MDOT projects shall follow the following procedures and be inspected as detailed below.

- (1) Timber products will not be accepted for use on Department projects unless the material has been inspected by an authorized representative of the Department and found to be satisfactory both before and after treatment. The procedure set out in Section 2.8.2 may, at the discretion of the State Materials Engineer, be performed after treatment, when timber products are to be treated with CCA or Pentachlorophenol preservative.
- (2) When material is manufactured at one plant and shipped to another for treatment, the inspection prior to and after treatment shall be made at the treating plant.
- (3) The treating plant shall notify the Chief of the Inspection Section or the Field Operations Engineer of the Materials Division as far in advance as possible when material will be ready for inspection.
- (4) Treated wood materials inspected for Stock will be inspected according to the current specifications.
- (5) Treated wood materials inspected on an order basis will be inspected under the applicable specifications for that specific order.
- (6) All piling and poles inspected for Department use shall be branded as set out in AWPA Specification M-1.
- (7) Certified guardrail blocks shall be branded as specified in Section 712.0.6.5 the Mississippi Standard Specifications for Road and Bridge Construction.

**2.8.2 Inspection Prior to Treatment** – All treated timber products to be incorporated into work for MDOT projects must be inspected prior to treatment according to the following procedures.

- (1) All materials shall have been processed, graded, and ready for treatment at the time of the inspection.
- (2) Piles, stringers, caps, sway braces and all other lumber which will be used in bridge superstructures shall receive 100% inspection. Poles shall receive 100% inspection.
- (3) Guard posts, guardrail posts, fence posts, sign posts, and all lumber which will not be placed in bridge superstructures shall be inspected as follows:
  - a. As the material is manufactured or received at the treating plant for treatment, it shall be stacked in lots easily accessible to the Inspector. A lot shall represent the amount of guard posts, guardrail posts, fence posts, sign posts, or lumber to be treated in one (1) charge in the treating cylinder.
  - b. The Inspector will select a representative sample from each lot. The sample will consist of twenty percent (20%) or more of the lot for a piece-by-piece inspection. (NOTE: The Department reserves the right to inspect any lot 100 percent.)
  - c. If twenty percent (20%) or less of the pieces in the sample fails to meet the specification requirements, the lot will be accepted subject to the provisions of 2.8.4 herein below.
  - d. If more than twenty percent (20%) of the sample selected by the Engineer or his designated Inspector for piece-by-piece inspection of any lot of material is rejected, the lot shall be rejected until the Producer culls and removes the pieces in the entire lot that do not meet the requirements of the specifications and replaces them with material that will allow the lot to be accepted. The lot may then be offered for re-inspection before treatment, in which case the lot shall be subject to the same sampling and inspection procedures as for the original inspection. Should the lot fail to be accepted on the second inspection, at the discretion of the Engineer or his designated Inspector, the producer may break open the bundles in the rejected lot and form a new lot by selecting the material that meets the requirements of the specifications.
- (4) Prior to acceptance of any lot for treatment, the Inspector will mark any pieces in the lot

which are unacceptable; such pieces shall be removed from the lot by the manufacturer prior to treatment. The Inspector will mark each acceptable piece in each acceptable lot with the hammer stamp prior to treatment, except that guardrail blocks need not be so stamped.

**2.8.3 Preservative** – The preservatives shall meet the applicable requirements of the Mississippi Standard Specifications for Road and Bridge Construction, or as amended by the contract.

**2.8.4 Treatment** – All timber products shall be treated in accordance with AWPA Treating Practices (*The USE CATEGORY SYSTEM for Highway Construction*) unless otherwise specified.

Acceptance of the treated material shall be by assay of the borings in accordance with AWPA. For timber and lumber, the length of the borings is determined by MDOT Standard Specifications for Road and Bridge Construction Section 718.

**2.8.5 Inspection after Treatment** – All treated timber products to be incorporated into work for MDOT projects must be inspected after treatment according to the following procedures.

(1) The Inspector shall be furnished a copy of the treating report on each charge of materials for Mississippi Department of Transportation use.

**(2) Boring Treated Materials**

- a. A borer core shall be taken from at least twenty (20) pieces selected at random in each charge for all materials except piling. Each piling in each charge shall be bored.
- b. The borings shall be made at approximately the midpoint of each piece and directed towards the pith. In the case of lumber, the borings shall be made at approximately the center of the edge and parallel with the face.
- c. In treated timber products, if less than twenty percent (20%) of the borings fail to meet the penetration requirements, the charge will be accepted, but all pieces failing to meet the penetration requirements shall be rejected and may be subjected to re-treatment.

- d. If more than the allowed percentage of the borings fails to meet the penetration requirements, the entire charge shall be rejected and may be subjected to re-treatment. If upon re-treatment the material meets the penetration requirements, it will be accepted. Only one (1) re-treatment will be permitted, and any apparent damage due to re-treatment shall be cause for rejection.
  - e. In addition to boring, each charge shall be inspected for cleanliness, treatment damage and mechanical damage.
- (3) Timber, lumber and piles shall have a one hundred percent (100%) sapwood penetration or a minimum penetration of four inches (4"). Guard posts, guardrail posts, fence posts and braces, and sign posts shall be penetrated according to the requirements of AWPA's **USE CATEGORY SYSTEM FOR HIGHWAY CONSTRUCTION.**
- (4) The amount of preservative retention shall be determined by assay. The borer cores shall be obtained in accordance with AWPA Standard M-2. The borings shall be taken from pieces having a sapwood depth of at least equal to the specified sampling zone. For timber and lumber, refer to MDOT Standard Specifications for Road and Bridge Construction Section 718 for sampling zone.
- (5) After inspection, each acceptable piece shall be hammer-stamped in the end opposite to the end stamped prior to treatment.

**2.8.6 Care and Storage of Treated Material** – Care and storage of treated material shall be in accordance with the current specifications.

**2.8.7 Method of Plant Operation** – The treating plant will operate under one of the methods hereafter described, the Order Basis Method or the Stock Operation Method.

**(1) Order Basis Method—Lumber, Piling(s), Poles, and Structural Members**

- a. Under this method of operation, only materials designated for MDOT Purchase Orders, State Projects, and Office of State Aid Road Construction Projects or other Agencies for which authorization to inspect has been given, will be inspected.

- b. At the beginning of each order, the Producer shall advise the Central Laboratory in accordance with Section 2.8.1. The project number (or purchase order number), the amount and type of materials will be given in the request for an inspection. If the project number can be verified as a current project, an Inspector will be sent to the plant. If the project number is not valid, the plant will be notified and an Inspector will not be sent to the plant.
- c. When emergency situations arise, the State Materials Engineer may give permission for material to be shipped from plant stock. When this permission is granted, the material will be bored as set out in Section 2.8.5(2), above. If requirements for penetration and assay requirements are met, the material will be branded as set out in AWWA Specification M-1. In no case will it be considered an emergency when a buyer fails to place an order in time to meet his production schedule.

**(2) Stock Operations Method—Guardrail post(s)/block(s), guard post(s), and fence post(s), or as otherwise specified**

- a. Under this method of operation, all material inspected and accepted by the Mississippi Department of Transportation will be placed in stock for shipment to Department projects only.
- b. Each Supplier proposing to furnish treated wood products for Department work under the Stock Operation Method must write the State Materials Engineer requesting permission to use this method of operation. A list of the plants approved under the Stock Operation Method will be maintained by the Central Laboratory.
- c. Approved materials in Stock on the plant yard which have received physical damage or otherwise rendered unsuitable for use, will be removed from Stock.
- d. Approved materials in Stock shall be shipped only to MDOT projects, Office of State Aid Road Construction projects or other projects for which authority has been granted.
- e. A treating plant that has received approval of the Stock Operation Method may have

their approval revoked by the State Materials Engineer for failure to abide by the provisions set forth in herein (Materials Manual Section 2.8). The plant may continue to furnish materials under the Order Basis Method. The plant will be considered for reinstatement for Stock when it has been demonstrated that they will abide by the section provisions.

- f. A treating plant that has received approval of the Stock Operation Method may have their approval revoked by the State Materials Engineer for failure to abide by these provisions. The plant may continue to furnish materials under the Order Basis Method. The plant will be considered for reinstatement for Stock when it has been demonstrated that they will abide by the section provisions.
- g. Treating plants may ship Stock materials to approved suppliers as defined in Section 2.8. Upon receipt of the shipping ticket, these materials will be removed from the treating plant's inventory and placed in the Supplier's inventory.

**2.8.8 Department Stock Maintained by a Broker or Wholesale Supplier** – A broker or wholesale supplier desiring to stock treated materials for Department work may request approval as set forth in Subsection 2.8.7(2). When approved, he shall operate under the provisions of Sections 2.8.7(2) and 2.8.9.

**2.8.9 Time Limitation on Treated Material in Department Stock** – Treated material which has been in stock for a period of two (2) years shall be re-treated or removed from the Mississippi Department of Transportation stock.

**2.8.10 Inspection at Project Site** – The Project Engineer or his representatives shall examine treated material shipped to the project. All material shipped shall be identified by an inspector's hammer mark in each end of each piece. Note, certified guardrail blocks are branded, not hammer stamped.

Any material shipped to the project without proper identification shall not be accepted. The Project Engineer will reject any obviously defective material, and any suspected or questionable deficiencies shall be reported to the State Materials Engineer. In the latter case, an Inspector from the Materials Division may re-inspect the material at the project site.

**2.8.11 Reporting** – The following procedures shall be followed to document that treated timber is sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

**2.8.11.1 Order Basis Materials**

- (1) Upon notification of completion of an order, the Central Laboratory will perform an inspection and complete a SiteManager Sample Record and Template (Template FFO607 or FFO608). Shipments to each project will be accumulated and reported semimonthly.
- (2) For State, Federal, and Maintenance contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The Project Engineer should confirm that the material’s inspection records have been entered into SiteManager. If the record is not entered into SiteManager, the Project Engineer should contact the Field Operations Section of the Materials Division for further information.
- (3) For State Aid and LPA contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. State Aid, and Private Entities will receive a report for each inspection conducted.

**2.8.11.2 Stock Operations Materials**

**a. Producer’s Responsibilities**

- (1) With each shipment, the Producer will furnish a copy of the shipping ticket designated for the Project Engineer. The shipping ticket shall include all pertinent information, such as project number, county, purchaser, size, length, quantity, the preservative type and retention.

- (2) At least once each calendar week, the Producer shall mail to the Central Laboratory a copy of each shipping ticket. The mailing address is:

State Materials Engineer (72-01)  
Mississippi Department of Transportation  
P.O. Box 1850  
Jackson, MS 39215-1850

**b. Department Responsibilities**

- (1) For State, Federal, and Maintenance contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO627—Shipment of Pre-tested Wood Posts)
- (2) For State Aid and LPA contracts, the Project Engineer shall verify the shipping ticket was stamped “Shipped from Pre-tested Stock”, and that each unit is stamped with a MDOT Inspector’s stamp. The engineer shall also inspect each unit for damage. The engineer shall submit a “Pretested Materials Shipment Report Request Form” for each project to the Materials Division. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

## 2.9 Traffic Materials

**2.9.1 Thermoplastic Traffic Stripe** – The following section outlines the uniform procedures for the acceptance of thermoplastic traffic striping materials by certification.

**2.9.1.1 General** – Acceptance of thermoplastic traffic striping material produced for use in Department work will be based on certification by the producer.

Upon request of the State Materials Engineer, samples of the material shall be furnished to the Central Laboratory. Each container of thermoplastic material shall bear the following data:

- (1) The manufacturer's name;
- (2) Address of the plant;
- (3) Date of manufacture;
- (4) Batch number;
- (5) Color of the material.

**2.9.1.2 Certification** – A manufacturer's certification shall be issued on each batch of thermoplastic material to be used in Department work.

The certificate shall contain the following information:

- (1) Date of manufacture;
- (2) Batch number;
- (3) Number of pounds in the batch;
- (4) Color of the material;
- (5) Test results on all required tests;  
A statement that the materials meet all applicable specifications (or cite specific specifications) of the Mississippi Department of Transportation;
- (6) Signed by an authorized representative of the company.

**2.9.1.3 Certification Distribution** – The following procedures shall be followed for Certificate Distribution.

- (1) The manufacturer shall furnish the Contractor copies of the certification on each batch of material.
- (2) The Contractor shall furnish the Project Engineer three (3) copies of the certification covering each batch to be used on the project. The certificate must show the project

number and the county in which the material is to be used.

- (3) After the Project Engineer has compared the batch number(s) on the certificate(s) with the batch number(s) on the material, the Contractor may proceed with his work.

**2.9.1.4 Reporting**--Upon completion of the work, the Project Engineer shall adhere to the provisions of Materials Manual Section 2.9.2, Glass Beads for reporting the number of pounds of pretested drop-on glass beads (by lot number) on the project. For State, Federal, and Maintenance contracts, the Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (CPE901—"Project Engineer Certification"). The Project Engineer will distribute copies as needed. For State Aid and LPA contracts, the Project Engineer shall maintain a record of certification in the Project File.

**2.9.2 Glass Beads** – The following section outlines the uniform procedures for the sampling, testing, and acceptance of glass beads used with traffic paint and thermoplastic.

**2.9.2.1 General** – The sampling, testing and acceptance of glass beads are the responsibility of the Central Laboratory; the proper handling and application of the beads after delivery are the responsibility of the Contractor, when applicable, District and/or Project personnel.

**2.9.2.2 Sampling** – The following sampling procedures shall be followed for glass beads to be used on MDOT Construction or Maintenance Projects.

- (1) Beads requiring sampling are Maintenance Beads (application under contract or by the Department) and Construction Beads.
- (2) At the discretion of the State Materials Engineer, all beads proposed for use by the MDOT shall be randomly sampled by personnel of the Central Laboratory at the manufacturer's plant or warehouse, supplier's or contractor's warehouse.
- (3) One (1) random sample for each lot (100,000 pounds maximum) shall be obtained as follows:
  - a. Randomly select the number of 50 pound bags obtained by taking the cube root of the number of 50 pound bags in the lot to be tested.
  - b. Reduce the material by passing each selected 50 pound bag through 16:1 splitter.
  - c. Using a 1:1 splitter, further reduce the material to sample size of one (1) quart minimum.
  - d. Bulk containers shall be sampled as arranged by the Central Laboratory.
- (4) Samples will be tested by the Central Laboratory.
- (5) Each container of accepted beads shall be stamped by the Central Laboratory Inspector. Maintenance beads to be applied by MDOT personnel; that are sampled, tested and accepted after delivery to MDOT facilities will not be stamped.
- (6) The bags of beads shall be palletized so that each bag is accessible for stamping

by the Central Laboratory Inspector.

**2.9.2.3 Reporting** – The following procedures shall be followed to document that glass beads were sampled and tested in accordance with project specifications and the procedures set forth in these provisions.

- (1) For State, Federal, and Maintenance contracts, the Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO628—“Shipment of Glass Beads”).
- (2) For State Aid and LPA contracts, the Project Engineer shall submit a “Pretested Materials Shipment Report Request Form” for each project to the Materials Division. In order to prepare the reports, the following information submitted with the “Pretested Materials Shipment Report Request Form”:
  - a. Project number, when applicable;
  - b. Manufacturer of beads;
  - c. Central Laboratory Inspector's number(s);
  - d. Lot number(s) of Manufacturer;
  - e. Quantity of beads used by lot number(s).

A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

**2.9.2.4 Testing and Acceptance** – Testing of all beads shall be in accordance with Mississippi Test Method, MT-75. Final acceptance of all beads shall be based on results of tests performed by the Central Laboratory.

**2.9.3 Raised Pavement Markers and Adhesive** – The following section outlines the uniform procedures for the sampling and acceptance of raised pavement markers and adhesive.

**2.9.3.1 General**

Raised pavement markers shall be sampled on the project as required by the specifications, or at the Project Engineer's discretion, as applicable. Adhesive may be shipped to the project as pretested or untested materials. It shall be the responsibility of the Project Engineer to ascertain the sampling or testing status of the materials. Raised pavement markers shall be listed on the Department's Approved Sources of Materials List.

For **pretested adhesive**, prior to sampling, the supplier shall physically separate the adhesive to be sampled from other materials in the storage area. The boxes or containers shall be arranged in such a manner that the Inspector will have access to each one. Only boxes or containers that bear the manufacturer's batch number and the vendor's lot number will be considered for pretesting by the Department.

**2.9.3.2 Sampling** – At the time of sampling, the vendor or contractor shall furnish such assistance as necessary for obtaining the samples and shall furnish the Inspector a copy of the manufacturer's certified test results covering each lot of markers and adhesive. The Following are sampling procedures and frequencies for markers and bituminous adhesive. (Note: consult MDOT specifications for the sampling requirements of the various types of markers when necessary.)

**(1) Markers:** Ten (10) markers of each type and class, selected at random will constitute a representative sample for each lot regardless of lot size. A resample will consist of twice as many markers as originally sampled.

**(2) Bituminous Adhesive:** Obtain one (1) 10-lb. sample per lot.

**2.9.3.3 Reporting** – The following procedures shall be followed by vendors and MDOT project engineers to document the sampling and testing of raised pavement markers and bituminous adhesive.

**(1) Vendor:** The vendor shall furnish the required certification(s) and send a copy of the shipping invoice (designated for the Project Engineer) with each shipment. The shipping

invoice shall contain all pertinent data; i.e., purchaser, project number, county, quantities of adhesive identified by lot number, date shipped, and shall contain the statement: "This material was shipped from MDOT pretested stock." Also, a copy of the shipping invoice shall be sent to the Central Laboratory.

**(2) Project Engineer:**

- a. The project engineer shall verify that the markers and adhesive are on the Department's "Approved Sources of Materials" list, sample markers as needed, and get a copy of the proper certification with each lot.
- b. Adhesive materials may be pre-tested. If the adhesive is pre-tested the project engineer shall:

- (1) For state, federal and maintenance contracts, verify that the boxes are stamped with a MDOT Inspector's stamp. In addition, the project engineer shall enter the applicable information into a SiteManager Sample Records and attach the appropriate template (CPE901—"Project Engineer Certification" and/or FFO630—"Shipment of Pre-tested Bituminous Marker Adhesive", as applicable).

- (2) For State Aid and LPA contracts, the Project Engineer shall submit a "Pretested Materials Shipment Report Request Form" for each project to the Materials Division. In order to prepare the reports, the form should include the manufacturer, lot number, and quantity used from each lot of adhesive.

- (3) For materials that have not been pre-tested, and require sampling, the project engineer shall sample the material as specified in Section 2.9.3.2. For state, federal and maintenance contracts, the sample shall be submitted with the applicable SiteManager Identification. For State Aid and Private Entity contracts, the sample shall be submitted with a complete TMD 320 card.

**2.9.3.4 Manufacturer's Certified Test Reports** – The Contractor shall furnish the Project Engineer the original and three (3) copies of the manufacturer's certified test reports covering all pavement markers and adhesive shipped to the project. The certified test reports shall show the results of each test specified in Test Method MT-17 for markers and in the Department's Standard Specifications for adhesive. The certifications shall state that the markers or adhesive

represented by the test results comply with MDOT specifications.

#### **2.9.3.5 Acceptance**

**(1) *Tentative Acceptance:*** The pavement markers and adhesive shall be tentatively accepted on the basis of the manufacturer's certified test reports and may be placed on the roadway at the Contractor's risk, pending results of testing for final acceptance.

**(2) *Final acceptance:*** Final acceptance shall be based on the results of the Project Engineer's check samples. These samples shall be obtained as set forth in Section 2.9.3.2 and submitted to the Central Laboratory for testing.

**Note:** Markers from any lot may be used with adhesive from any approved lot.

**2.9.4 Traffic Paint** – The following section outlines the uniform procedures for the sampling, testing, and acceptance of traffic paint for use in Department work.

**2.9.4.1 General** – The term “purchaser,” as referred to in these provisions, refers to striping contractors who apply traffic paint under contract (construction or maintenance) or the receiving District when traffic paint is purchased and applied by the Department.

**2.9.4.2 Establishment of “List of Approved Traffic Paint Manufacturers”**

- (1) Manufacturers with a proven history (within the past 24 months) of furnishing the Department a quality traffic paint that meets MDOT specifications are placed on the Department’s “Approved Sources of Materials” List.
- (2) For all other manufacturers, an evaluation will be made to determine that the proposed traffic paint consistently meets our specification requirements. For the purpose of this evaluation, manufacturers must submit the following to the State Materials Engineer, P.O. Box 1850, Jackson, MS, 39215-1850:
  - a. The manufacturers’ procedures for in-plant quality control of batch-to-batch production. The procedures must include tests performed, testing frequency, sampling procedures for raw materials and the finished traffic paint, and procedures used to correct deficiencies noted by the quality control testing.
  - b. A List of State DOTs that have approved and used manufacturer's traffic paint in the past twenty-four (24) months.
  - c. The manufacturer shall prepare a laboratory formulated batch of each color of paint meeting MDOT specifications and submit samples of each with a certified laboratory analysis to the MDOT Central Laboratory for a complete laboratory analysis on each batch to determine conformance with Department specifications. Samples shall be packaged in four (4) one (1) quart triple-sealed lined metal cans. Batch Formulation(s) meeting the specifications will be finger printed by X-Ray and infrared for future acceptance and reference. In addition, at the discretion of the State Materials Engineer, the sample may be tested using gas chromatography and/or ultraviolet spectral analysis. The manufacturer shall assign a formulation identification number

or code for each submittal. If the batch is approved, the formulation identification must be used for all shipments and related documents for that paint. Any changes to a formulation must be submitted for approval.

- d. If the evaluation is satisfactory, the paint manufacturer will be added to the Department's "Approved Sources of Materials" list. Such approval will be tentative until a proven history has been established.

- (3)** Furnishing non-specification traffic paint, misrepresentation and/or failure to follow the provisions of this section will be grounds for removal of a manufacturer from the Department's "Approved Sources of Materials" list.

**2.9.4.3 Procedures for Purchase and Acceptance of Traffic Paint** – Traffic paint must be purchased from a manufacturer on the Department's "List of Approved Traffic Paint Manufacturers."

**2.9.4.4 Responsibilities of the Manufacturer** – After receipt and manufacture of an order of traffic paint and the manufacture of the ordered paint, but prior to its delivery, the manufacturer shall furnish the MDOT Central Laboratory and the purchaser a copy of the shipping documents, and a certification that the batch(es) shipped conform to the approved laboratory sample formulation in composition and proportioning of all components. Note: any change in the formulation shall necessitate approval of the re-formulation as outlined in Section 2.9.4.2. The shipping document/certification should also include the following: manufacturer, purchaser, paint type, formulation identification number, destination, batch number(s), quantity in each batch and the date of manufacture and test results.

**2.9.4.5 Responsibility of the Purchaser** – The purchaser must notify the MDOT Central Laboratory upon receipt of a shipment of paint. Prior to placement, the paint will be sampled at random, tested and accepted by the Department at the following minimum frequency for each formulation:

- (1) Manufacturer with a proven history (within the past 24 months):** One (1) sample for every five (5) batches produced for the Department.

- (2) Manufacturer with no proven history:** One (1) sample for each of the first ten (10) batches produced for the Department. If test results for all batches are within (not

borderline) the required formulation, then one (1) sample for every five (5) batches produced thereafter.

Prior to sampling, the purchaser will be responsible for mixing the paint in accordance with the manufacturer's instructions.

#### **2.9.4.6 Responsibilities of the Department**

- (1) The MDOT Central Laboratory will be responsible for sampling and testing of the traffic paint after delivery to the purchaser or as arranged. When paint is sampled at the manufacturers or purchasers facility, the paint shall be stamped with a MDOT inspector's stamp. Stamping of the paint will not be required of paint sampled at a MDOT maintenance facility.
- (2) The random samples obtained from the delivered batches will be finger-printed for comparison with the finger-print from the original laboratory formulated batch. Acceptance or rejection of the paint will be based on an evaluation of the prints. When a comparative match of the print(s) is inconclusive, physical tests will be performed for acceptance or rejection.
- (3) For State, Federal, and Maintenance contracts or purchase orders, the Project Engineer shall verify that the paint is pre-tested. The Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO631—"Shipment of Pre-Tested Traffic Paint").
- (4) For State Aid and LPA contracts, the Project Engineer shall submit a "Pretested Materials Shipment Report Request Form" for each project to the Materials Division. The form should include the following information: Project number, manufacturer, paint type, and the quantity of paint used by batch number(s). A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

**2.9.4.7 Non-Specification Traffic Paint** – Non-specification traffic paint on the roadway shall be removed or accepted for payment in accordance with the 2004 Edition of the Mississippi Standard Specifications for Road and Bridge Construction, Subsection 105.03, Conformity with

Plans and Specifications.

## 2.10 Seeding: Seed for Roadside Development

The following section outlines the standard procedure for acceptance of seed.

**2.10.1 General** – Seed will be sampled and tested for acceptance by the Mississippi Department of Agriculture and Commerce Seed Laboratory at:

The Mississippi State University Seed Laboratory  
P.O. Drawer S  
Mississippi State, MS 39762

Test reports shall be issued prior to planting. Bags of seed not properly labeled or tagged will not be permitted. In addition, seed damaged in storage or from handling will not be permitted.

When more than nine (9) months have elapsed between the germination test data and the time of planting, exclusive of the calendar month in which the test was completed, the seed will be resampled and retested by the Mississippi Department of Transportation.

### 2.10.2 Seed Initially Sampled and Tested by the Mississippi Department of Agriculture and Commerce or other Laboratories

- (1) The Project Engineer shall check the certified label/tag of the seed to see that it meets the requirements of the specifications (Mississippi Standard Specifications for Road and Bridge Construction Section 715.03) and the state seed law prior to granting permission for planting.
- (2) Seed labeled with a total germination of less than 60 percent shall not be used. However, if the label indicates a deficiency in the germination or purity, the Project Engineer may approve increasing the application of seed to address the deficiency at no additional cost to the Department.
- (3) The Project Engineer will indicate acceptance or rejection of the seed and retain at least one (1) label/tag for each lot of seed used on the project.

- (4) The Project Engineer shall sample the seeds in accordance with MDOT specifications and as noted below.

### **2.10.3 Seed Sampled and Tested by the Mississippi Department of Transportation**

#### **2.10.3.1 Sampling Apparatus**

- (1) The sampling apparatus for sampling Bahiagrass, Fescue, and similar or larger size seed shall be either of the following samplers:
  - a. 39-inch trier, double tube, 7/8-inch outside diameter, or
  - b. Fertilizer probe, 24 inches long, 3/4 -inch diameter, single tube
- (2) An 18-inch trier, 1/2 -inch outside diameter, double tube, shall be used for sampling Bermuda grass, Lespedeza, Clovers, Carpet grass, and similar or smaller size seed.

**2.10.3.2 Sample Containers**—Seed Samples shall be stored and shipped to the State Seed Testing Laboratory in TMD-088 (Container for Seed Samples).

**2.10.3.3 Lot Size**—a lot is defined as all the seed of each species (kind and variety) from the same source and with the same lot identification as shown on the tag of each bag of seed in approved storage at the time of sampling. Each subsequent shipment of each species of seed from the same or a different source will constitute a new lot.

#### **2.10.3.4 Sampling Procedure**

- (1) All seed sampling shall be performed by the appropriate District Laboratory. Each District Laboratory shall have at least two (2) properly trained employees to perform all seed sampling in their respective District.
- (2) Each lot of seed as defined in Section 2.10.3.3 will be sampled and tested.
- (3) Tested and approved seed stored for a period longer than nine (9) months,

exclusive of the calendar month in which the test was completed, shall be resampled and retested for the percent germination.

- (4) Samples shall be drawn from unopened bags using the appropriate sampler (trier or probe) specified in Section 2.10.3.1.
- (5) Determine the lot identification and the number of bags in that lot actually in storage.
- (6) For lots of six (6) bags or less, each bag shall be sampled and a total of at least five (5) trierfuls shall be taken.
- (7) For lots of more than six (6) bags, five (5) bags plus ten percent (10%) of the number of bags in the lots shall be sampled at random. Regardless of the lot size, it is not necessary to sample more than thirty (30) bags.
- (8) Check the name of the seed and the lot number on the tag of each bag of seed before sampling to avoid mixing lots.
- (9) The sampler shall be fully inserted into the container so as to obtain a representative cross-section of its contents. Care shall be taken not to unduly tear the container when inserting the sampler. When possible, insert the sampler at a point where the seed exerts the least pressure on the container. Be careful when probing the width of a bag so as not to push the sampler through the opposite side. Holes made by the sampling instrument must be carefully resealed with pressure-sensitive tape to prevent loss and contamination of the seed.
- (10) The double tube trier sampler shall always be inserted in the closed position. After insertion, open the tube and allow seed to completely fill the sampler. Close the tube and extract the sample.
- (11) The open single tube probe sampler shall always be inserted with the slot down. After insertion, turn the slot up and allow seed to completely fill the sampler; then extract the sample.

(12) The seed extracted from each container sampled in the lot shall be combined, thoroughly mixed, and quartered until a test specimen weighing approximately one-quarter (1/4) pound is obtained.

(13) The test specimen shall be placed in the approved sample container (Section 2.10.3.2 above) and shipped immediately to the following address:

State Seed Testing Laboratory  
P. O. Drawer S  
Mississippi State, MS 39762

(14) The following information shall be submitted with each sample: project number, lot number, source, kind and variety, date sampled, place sampled, sampled by, sample number, quantity, test desired, and any other pertinent data.

#### **2.10.3.5 Care of Samples**

- (1) Seed are very sensitive and must be protected from rough handling and damage.
- (2) Seed shall be protected from high temperature, direct sunlight, dampness, and exposure to petroleum products as these factors can very quickly affect germination.
- (3) Samples shall be stored in a cool, dry place.

#### **2.10.4 Acceptance and Reporting of Seed by Certified Test Report**

**2.10.4.1** Seed shipped to a project that is accompanied by a Certified Test Report from the State Seed Laboratory shall be accepted by the Project Engineer. Upon receipt of the Certified Test Report, the Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (CPE 901—“Project Engineer Certification”).

**2.10.4.2** The State Seed Testing Laboratory will submit their test report on each sample of seed

to the Central Laboratory.

**2.10.4.3** The Central Laboratory will check the test results for conformance with the specifications and distribute the test reports as follows:

Original copy: Central Laboratory File;

1 copy: District Materials Engineer;

1 copy: Project Engineer;

1 copy: Contractor (sent to Project Engineer for distribution).

## 2.11 Preformed Joint Filler

The following section establishes uniform policies and procedures for the sampling, inspection, and acceptance of joint materials, bituminous type, used in work under the supervision of the Department.

**2.11.1 General** – All joint material furnished for Department use shall have been sampled by Department personnel, tested by the Central Laboratory, and approved for use prior to shipment. All suppliers proposing to furnish joint material for Department use shall maintain a separate stock of no less than one (1) bundle (approximately 3000 sq. ft.) of each thickness that is proposed to be furnished.

**2.11.2 Sampling Procedure** – One (1) sample shall be taken at random from each bundle (approximately 3000 sq. ft.), and an identifying mark shall be placed on each bundle sampled. The samples shall be submitted to the Central Laboratory for testing. Upon receipt of satisfactory test results, the Inspector will stamp each sheet of the material represented by the test results with his MDOT stamp.

**2.11.3 Non-complying Sample** – When a sample of joint filler fails to comply with the specification requirements, two (2) check samples may be obtained at random from the failing bundle at the discretion of the Engineer. When the test results of these two (2) check samples indicate compliance with specification requirements, the lot will be accepted. When the test results of one (1) or both of the check samples indicate failure to meet specification requirements, the lot shall be rejected.

**2.11.4 Reporting** – The following procedures shall be followed to document the sampling and testing of preformed joint filler.

- (1) The Producer shall be responsible for sending a copy of the shipping ticket, with each shipment, designated for the Project Engineer. Then the Producer shall forward a copy of the shipping ticket to the Central Laboratory as soon as possible after shipment.
- (2) The shipping ticket shall contain all pertinent data; i.e., purchaser, project number, county, number of sheets of each size and thickness, and date of shipment.

- (3)** Upon receipt of the Producer's shipping ticket, the Project Engineer shall enter the applicable information into a SiteManager Sample Record and complete the appropriate template (FFO621—"Expansion Joint Material")
- (4)** For State Aid and LPA contracts, the Project Engineer shall submit a "Pretested Materials Shipment Report Request Form" for each project to the Materials Division. A copy of the form may be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website or by request to the Materials Division. Upon receipt of the form, the Materials Division will issue a SiteManager Report of the applicable material.

## 2.12 Advanced Payment of Materials

### 2.12.1 Identification, Storage, and Inventory Control of Materials for Advanced Payment –

The following section details the procedure for advance payment of material stored or stockpiled for a particular Department project's use.

**2.12.1.1 General** – Only materials which have been inspected and tested in accordance with all applicable specifications and approved by the Mississippi Department of Transportation will be considered for advance payment. When a determination has been made to allow advance payment for materials, the Project Engineer or a verifier representing either the Central Laboratory, District Materials Engineer or an approved Department representative agency acting on behalf of the Project Engineer, shall make an inventory. Upon completion of the inventory, Form TMD 323, Certificate of Storage, shall be completed and distributed in time for an advance payment to be included on the monthly estimate. Refer to Appendix A of this manual to view Form TMD-323.

**2.12.1.2 Responsibility of the Contractor** – The contractor must make a written request for payment and furnish written consent of the Surety to the Project Engineer. The Contractor shall make arrangements through the Project Engineer for the satisfactory storage of materials as stipulated in the standard specifications and/or contract documents, and as addressed in the following provisions.

#### (1) Storage of Materials

- a. Each unit or bundle shall be handled and stored as specified in the Standard Specifications or as approved by the Department's representative if not specified otherwise.
- b. Materials to be inventoried for advance payment shall be physically separated (in a different storage area) from other materials in stock. These materials must be stored in such a manner that they may be easily inventoried. During inventory, a cursory inspection may be performed. While in storage, if the material is damaged, lost, destroyed or becomes unacceptable for any reason, it will be rejected and taken off the inventory until replaced.

- c. Each unit or bundle shall be clearly identified with a tag, Department stamp or other approved method. The method of identification shall designate the identification number of the material and other pertinent information. This method of identification shall be securely affixed on each unit or bundle.
- d. Once a unit or bundle of material has been designated for a specific project and for which advance payment is made, it shall be used on that particular project only, unless transferred by the Project Engineer to another project under contract by the same contractor.

## (2) Invoices

- a. **Storage Invoices** – Each storage invoice shall contain the requirements of the contract and the following information:
  1. Project number and county;
  2. Purchaser;
  3. Date of Purchase;
  4. Number, size and/or length of each material;
  5. Costs or price to contractor at producer's plant or point of storage.
- b. **Shipping Invoices** – Each shipping invoice shall contain the following information:
  1. Project number and county;
  2. Purchaser;
  3. Date of shipment;
  4. Number, size and/or length of each material;
  5. A statement to the effect that this material was shipped from MDOT pretested stock;
  6. If shipped from project stock or general pretested stock, denote on invoice.

One copy of the shipping invoice shall accompany each shipment and be designated for MDOT personnel.

After shipment, the producer will forward a copy of the shipping invoice to the Central Laboratory, District Materials Engineer and designated inspection agency (if applicable).

**2.12.1.3 Responsibility of the Department's Representative Agency** – Inventory of the materials in each Project Stock should be made at the end of each month. Upon completion of the inventory, Form TMD-323 shall be completed and distributed.

## 2.13 Inspector Stamps

**MDOT Inspector Identification** – In order to assist in the identification of inspected and accepted materials that are shipped from producers' plant(s) the following system has been established. A Stamp Number is assigned to MDOT Central Laboratory and District Personnel along with other specified entities for identification when material is inspected. All currently assigned Stamps issued by the Mississippi Department of Transportation are listed below.

MDOT STAMP NUMBER	STAMP ASSIGNMENT
1 DOT	GEORGE R. WHITE
2 DOT	MELTON W. STUART
3 DOT	CARL W. CRAIG
4 DOT	JERRY E. ANDERSON
5 DOT	THOMAS M. SMITH
6 DOT	JAY A. WINDHAM
7 DOT	JAMES R. THORTON
8 DOT	NORTH CAROLINA DEPT. OF TRANSPORTATION
9 DOT	TEXAS STATE DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
10 DOT	ROBERT W. HUNT COMPANY
11 DOT	CHARLES L. CANOY
12 DOT	TENNESSEE DEPT OF TRANSPORTATION
13 DOT	ALBERT G. CALLOWAY
14 DOT	<i>NOT ASSIGNED</i>
15 DOT	EVERETT E. CRAFT
16 DOT	CELINA M. SUMRALL
17 DOT	<i>NOT ASSIGNED</i>
18 DOT	<i>NOT ASSIGNED</i>
19 DOT	<i>NOT ASSIGNED</i>
20 DOT	GEORGIA DEPT. OF TRANSPORTATION
MDOT 1-1	DISTRICT 1
MDOT 1-2	DISTRICT 1
MDOT 2-1	DISTRICT 2
MDOT 2-2	DISTRICT 2

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MDOT 3-1	DISTRICT 3
MDOT 5-1	DISTRICT 5
MDOT 5-2	DISTRICT 5
MDOT 6-1	DISTRICT 6
MDOT 6-2	DISTRICT 6
MDOT 6-3	DISTRICT 6
MDOT 6-4	DISTRICT 6
MDOT 6-5	DISTRICT 6
MDOT 7-1	DISTRICT 7

### **Section 3 – Mix Designs**

## 3.1 Hot Mix Asphalt Mix Design Approval Process

**3.1.1 Hot Mix Asphalt Mix Design Approvals** – All requests for a new hot mix asphalt mix design must be submitted to the State Materials Engineer in writing for review. Requests will be forwarded to the Lab Operations Branch.

After an initial review, the mix parameters will be checked for compliance against the project specifications using the Departments mix design spreadsheet. Once the design parameters have been verified, the mix will be tested in the lab in accordance with MT-78 Volumetric Mix Design of Hot Mix Asphalt Mixtures Using the Superpave Gyratory Compactor.

Upon completion of the laboratory testing, the mix design parameters will be entered into a sample record within SiteManager and a copy of the approved mix design sent to the District Materials Engineer that submitted the mix design request.

**3.1.2 Hot Mix Asphalt Mix Design Transfers** – All requests to transfer a hot mix asphalt design from one project to another must be submitted to the State Materials Engineer in writing for review. Requests will be forwarded to the Lab Operations Branch.

Upon review of the request, a sample record will be entered into SiteManager and the sample record will be linked to the original test data using the “Link To” functionality within SiteManager.

**3.1.3 Termination of a Hot Mix Asphalt Mix Design** – In the event a hot mix asphalt mix design does not perform satisfactorily in the field in accordance with the project specifications, the District Materials Engineer may submit a request to terminate a mix design to the State Materials Engineer for review. If upon review, a mix design is deemed deficient due to field performance, a termination date will be entered into SiteManager and the mix design will not longer be valid.

## **3.2 Portland Cement Concrete Mix Design Approval Process**

**3.2.1 Portland Cement Concrete Mix Design Approvals** – All requests Portland cement concrete mix designs must be submitted to the State Materials Engineer in writing for review. Requests will be forwarded to the Lab Operations Branch.

The mix design parameters will be checked for compliance against the project specifications using the Departments PCC Mix Design Spreadsheet. Once the design parameters have been verified, the mix will be given tentative approval pending field verification. The field verification process validated the producer/supplier's ability to supply the mix within the specified batching and field performance tolerances. Once the field verification of the mix is reviewed and approved by Materials Division, the mix will be given final approval.

Upon completion of the mix design review, the Laboratory Operations Branch will complete a sample record within SiteManager and attach the PCC Mix Design Spreadsheet.

**3.2.2 Portland Cement Concrete Mix Design Transfers** – A Portland cement concrete mix design that has undergone field verification and has final approval may be, upon written request to the State Materials Engineer, transferred to other projects. The District Materials Engineer is to certify that all of the component materials have not changed since the mix design received final approval.

**3.2.2 Termination of a Portland Cement Concrete Mix Design** – In the event Portland cement concrete mix design does not perform satisfactorily in the field in accordance with the project specifications, the Project Engineer or District Materials Engineer may submit a request to terminate a mix design to the State Materials Engineer for review. If upon review, a mix design is deemed deficient due to field performance, a termination date will be entered into SiteManager and the mix design will not longer be valid.

## **Section 4 – Job Control Testing and Acceptance of Materials**

## **4.1 Evaluation, Certification, and Acceptance of Materials**

**4.1.1 Procedures to Certify Materials Used in a Project** – Upon completion of a project, the State Materials Engineer is responsible for certifying that all sampling and testing requirements are satisfied for each material on a project. The following provisions establish a standard procedure for issuing a letter of Certification of Materials and Tests by the State Materials Engineer.

### **4.1.1.2 Guidelines**

- (1)** The letter of Certification of Materials and Tests will be issued for a completed project by the State Materials Engineer upon determination that all construction materials are adequately covered by test reports and/or required certifications. The materials and quantities as submitted by the Project Engineer on Form TMD-725, STATEMENT OF ESTIMATED FINAL QUANTITIES AND CERTIFIED TESTS OF MATERIALS, will be used in this determination.
- (2)** Upon receipt of the Form TMD-725 by Materials Division, the subject project files are removed from the active status. All test reports and certifications are reviewed for compliance with specification requirements and for approximate frequency of sampling in order to determine if materials that were incorporated into the project have been adequately sampled and/or tested in accordance with S.O.P. TMD-20-04-00-000, Approximate Frequencies for Job Control Acceptance Sampling and Testing.
- (3)** If it is found in the above review of the test reports and certifications that there are shortages in test reports or samples that fail to meet specification requirements, then the material shortage or sample failures will be listed on a Materials and Tests Clearance memorandum. Each material deficient in test reports or certifications will be listed, along with the quantity not covered by test reports or certifications, on a Materials and Tests Clearance memorandum. Any acceptance sample failures will be listed on a separate sheet, and attached to the Materials and Tests Clearance memorandum. At the time these reports are issued for a project, a file will be established for all final documents. A flow sheet is then attached to this file showing status of finalization of the project.
- (4)** All sample variations will be documented in writing by the Project Engineer to the District Materials Engineer, listing the variations by type, sample I.D. and deficiencies, and giving the Project Engineer's recommendations as to the disposition of the materials and deficient samples. WHEN POSSIBLE, THE PROJECT ENGINEER, UPON RECEIPT OF TEST

REPORTS OF DEFICIENT MATERIAL, SHOULD PROCEED WITH DOCUMENTATION IMMEDIATELY, **BEFORE COMPLETION OF A PROJECT**. The District Materials Engineer will submit a Laboratory Tolerance letter (including a copy of the Project Engineer's letter of documentation) to the State Materials Engineer documenting his recommendations as to the disposition of the materials and deficient samples. The State Materials Engineer will issue a Laboratory Tolerance Letter with his recommendations for acceptance or rejection of the deficient material, and attach copies of letters of documentation received from the Project Engineer and the District Materials Engineer.

- (5) If a project is found to comply with the requirements as outlined above and upon receipt of documentation from the District Materials Engineer of comparison of Independent Assurance Samples with corresponding split job control samples, the State Materials Engineer will issue a letter of Certification of Materials and Tests, TMD-441 or TMD-442, with attachments TMD-444 and TMD-445. At the discretion of the State Materials Engineer, if after three months from the issuance of the Materials and Tests Clearance Memo, shortage of items, material certifications or samples, etc. exist, each material will be considered an exception. Exceptions will be listed as such on the Certification of Materials and Tests.
- (6) After receipt of the Letter of Final Acceptance, the Materials Division will place the project records in the inactive files for archiving.

**4.1.2 General Procedures for Evaluation of Materials and Work** – The proper evaluation for acceptance of materials or work should be based on the appropriate job control sampling and testing. The following provisions establish a general procedures acceptance or rejection of materials and work.

**4.1.2.1 General** – All rejected materials and work shall be addressed in accordance with the provisions of the Standard Specifications. Complete documentation is to be made as to the disposal, method of correction and later approval or rejection, as applicable, and complete cross-referencing of failing test(s) with acceptance test(s) if applicable. All unacceptable work shall be similarly documented.

- (1) The proper evaluation for acceptance or rejection of any material or work is based on proper sampling, testing and inspection by individual(s) or agency(ies). All of these functions should be performed in such a manner that: (1) no lot will be accepted unless it meets all requirements of the applicable specifications, and (2) no lot will be rejected unless it can be established that it does not comply with one or more contract requirements. As a matter of principle, a material or work should not be accepted or rejected on the basis of a single sample or a single test unless the nature of the material or work and the test is such as to render the test result conclusive. The more samples of a given material or work that are tested, the greater the assurance of the test results. All samples tested must be reported, however, and all results considered in an engineering determination of acceptance or rejection.
- (2) Under conventional testing for acceptance or rejection, the number of samples tested must necessarily be limited by practicality and economics, but regardless of the number tested all must be considered and reported.
- (3) The number of check samples tested before material rejection shall be in accordance with the applicable test method and/or Department standard operating procedures and contract specifications.

### **4.1.3 Acceptance of Materials Used in Certain Maintenance Projects by Certification of the Project Engineer**

**4.1.3.1 General** – To establish a procedure whereby materials used in the construction of project offices, maintenance buildings, shops, and additions and alterations to existing buildings (including District buildings) may be accepted by certification.

#### **4.1.3.2 Acceptance of Materials by Certification**

- (1)** The normal procedures for acceptance of the materials used in the construction of the facilities as set out above may be waived and the materials accepted on the basis of a Letter of Certification stating all materials installed (structural, mechanical, electrical, plumbing, miscellaneous, etc.) had been approved by the Architectural Services Division and met the requirements of the specifications, plans, and shop drawings. The Letter of Certification shall be provided by the Project Engineer with copies to the District Materials Engineer and the State Materials Engineer.
- (2)** Upon receipt of this certification, the State Materials Engineer will issue the Letter of Certification of Materials and Tests (Form TMD 442) to the State Construction Engineer.
- (3)** Concrete aggregates, stabilizer aggregates, cementitious materials, water, and steel reinforcement are subject to normal job control sampling and record sampling testing procedures. However, where applicable, these materials may be accepted under the provisions of S.O.P. No. TMD-20-05-00-000, Sampling and Testing of Small Quantities of Miscellaneous Materials.

## **4.2 Job Control Sampling and Testing**

### **4.2.1 Job Control Sampling and Testing**

**4.2.1.1 General** – To outline uniform procedures for job control of materials and operations.

#### **4.2.1.2 Purpose of Testing Materials**

All testing of materials has several purposes, among which are:

- (1)** To assure that materials comply with specifications.
- (2)** To indicate corrective action necessary.
- (3)** To improve materials and construction control.
- (4)** To provide data for statistical analysis as a basis for revision of the specifications.
- (5)** To promote awareness of the importance of optimum quality materials and proper methods of construction.

Job Control sampling and testing is that performed on a day-to-day basis during construction and after completion of any phase of construction. This sampling and testing may be performed by project personnel, district laboratory personnel, the Central Laboratory, commercial laboratories, and, in some cases, by manufacturers' laboratories.

Whenever a test indicates noncompliance with the specifications, several steps may be taken:

- (1)** Retest the sample or obtain a check sample and test;
- (2)** Notify the Contractor so that corrective action may be taken;
- (3)** Notify the Project Engineer, District Materials Engineer, or State Materials Engineer.

All test results shall be retained. When a test indicates failure, the project records shall indicate the corrective action taken and shall include both the failing test data as well as the complying test data after corrections have been made.

It is required that all basic data, from which test results are computed, be retained in project files. This includes wet and dry weight in moisture determinations, retained weights in gradation tests, and similar data for other tests. It also includes both laboratory and field testing.

Job control sampling and testing is applicable to all materials, processes, construction operations, and includes field determinations of specification requirements, such as in-place densities, depth and width measurements, and other tests which inherently require testing in-place.

These provisions are applicable to all materials on all projects, except that, when the quantity of a material on a given project is insufficient to justify the expense of testing, the District Materials Engineer or the State Materials Engineer may determine that no job control samples will be required for these materials within the guidelines of documents cited in Section 4.2.2.2 of this document.

## **4.2.2 Standard Lot Sizes and Sampling and Testing Frequencies**

**4.2.2.1 General** – Materials Division maintains Standard Operating Procedures (SOPs) that define standard lot sizes to assure conformity with specifications. The applicable materials are then sampled and tested at the required frequencies.

### **4.2.2.2 SOPs Related to Job Control Sampling and Testing of Materials**

**TMD-20-03-00-000 Schedule of Standard Lot Sizes for Conformity Determination**

**TMD-20-04-00-000 Approximate Frequencies for Job Control Acceptance Sampling  
And Testing**

**TMD-20-05-00-000 Sampling and Testing of Small Quantities of Miscellaneous  
Materials**

Copies of these SOPs can be found in **Appendix C**.

## **Section 5 – Independent Assurance Program**

**5.1 General** – The Materials Division is responsible for operation of an independent assurance sampling and testing program meeting the requirement of Federal-Aid Policy Guide, 23 CFR 637B. To accomplish this, the State Materials Engineer maintains a staff of Independent Assurance Samplers. The proper and efficient administration of this program requires cooperation between the Independent Assurance Section, the District Materials Laboratory, and the District Project Office. Independent Assurance sampling and testing will be conducted on all Federal Aid Projects on the National Highway System and any state funded project as directed by the State Materials Engineer.

The staff of the Independent Assurance Section consists of the following: a Chief of the Independent Assurance Sample Section and six Independent Assurance Samplers. One Independent Assurance Sampler will be located in each District.

**5.2 Standard Operating Procedures Related to the Independent Assurance Program** – Specific Policies that establish uniform procedures for the Independent Assurance Sampling and Testing Program are found in the following Department SOPs.

**TMD-06-01-00-000 Independent Assurance Sampling and Testing**

**TMD-06-02-00-000 Approximate Frequencies for Independent Assurance  
Sampling and Testing**

Copies of these SOPs can be found in **Appendix C**.

## **Section 6 – Radiation Safety**

**6.1 Radiation Safety Procedures for Nuclear Gauges** – These procedures establish MDOT’s standards that are established to comply with Federal and State regulations governing the minimum standards for the protection against radiation which apply to nuclear gauges used in testing.

### **6.1.1 Regulations**

The standards for protection against radiation which govern the Department's use of nuclear gauges are set forth by the Mississippi State Board of Health in the publication, “Regulations for Control of Radiation in Mississippi.”

These regulations, with all revisions and additions, form a part of the requirements of this S.O.P. Copies may be obtained from the Central Laboratory.

These standards are enforced by the Mississippi State Board of Health by licensing and inspection. Violations could result in the suspension of licenses and/or a substantial fine.

### **6.1.2 Radioactive Material License**

Each District will operate under the Radioactive Material License issued by the Mississippi State Board of Health to the Mississippi Department of Transportation. The license will state the radioactive material, the chemical and/or physical form, the source strength, manufacturer, and model number of the nuclear gauges that are approved for use. Under no circumstances will unapproved instruments be used on Mississippi Department of Transportation construction projects. Only personnel who have received the proper training may operate these instruments.

### **6.1.3 Procedures for the Use of Nuclear Gauges**

This section provides a guide for personnel using and administering the use of nuclear gauges and regulates the use of these gauges containing radioactive materials. All personnel responsible for radioactive sources shall:

- (1) Be thoroughly familiar with the safe handling techniques for using radioactive materials.
- (2) Be fully informed of the hazards to health that exist near radioactive material.

- (3) Be completely familiar and shall comply with the procedures set forth in this S.O.P., and with the Mississippi State Board of Health "Regulations for Control of Radiation in Mississippi."
- (4) Read the manufacturer's instructions for the instrument being used.

#### 6.1.4 Central Laboratory Responsibilities

**6.1.4.1 MDOT Radiation Administrative Officer** – The State Materials Engineer, as the MDOT Radiation Administrative Officer, has the direct responsibility for administering and controlling the use of radioactive material within the Mississippi Department of Transportation. His duties are as follows:

- (1) License and Inventory: Obtain the Department license and amendments as required. This includes the responsibility for the inventory of sources and to insure that the number, strength, and type of sources do not exceed those for which the Department is licensed.
- (2) Regulations: Insure statewide conformance to the regulations and procedures incorporated into this S.O.P.
- (3) Training: Provide the necessary training to qualify personnel as nuclear gauge operators.
- (4) Emergency Procedures: Assist in implementing any emergency procedures in any situation which could arise endangering the public from the use of radioactive material.
- (5) Appoints the MDOT Radiation Safety Officer and is responsible for his activities.

**6.1.4.2 MDOT Radiation Safety Officer** – The MDOT Radiation Safety Officer has the responsibility for radiation protection program with the Mississippi Department of Transportation. His Duties are as follows:

- (1) Records: Responsible for maintaining and inspection of the following records: (He may delegate the duties of record keeping to subordinates.)

- a. Radiological Exposure Records
- b. Gauge Location Records
- c. Wipe Test Records
- d. Radiation Survey Records
- e. Semiannual Inventory Records
- f. Utilization Logs
- g. All other records as required

(1) Radiation Detection Equipment: Responsible for obtaining and maintaining the following radiation detection equipment:

- a. Survey Equipment
- b. Film Badges

(2) Radiation Surveys: Perform radiation surveys as required.

(3) Wipe Tests: Witness or perform all wipe tests on radioactive sources once every six (6) months.

(4) Emergency Procedures: Responsible for the implementation of emergency procedures for any situation that may arise which endangers the public to exposure to radioactive materials.

(5) Safety Control: When in his judgment a situation exists that cannot be corrected quickly, and is a potential hazard to the operator or those working in the vicinity, the MDOT Radiation Safety Officer shall stop or suspend the operation until corrective action has been taken to eliminate the hazard and the operation complies with the current regulations and the requirements of this S.O.P.

(6) Personnel Monitoring:

- a. Assign all film badges in accordance with the regulations.
- b. See that all film is changed monthly and the old film is forwarded to the MDOT Radiation Safety Officer by those to whom the badge is assigned within two days after receiving the replacement film.

- c. Submit all old badges monthly to a qualified commercial laboratory for monitoring individual dosages.
  - d. See by practical inspection that all operators are properly using the film badges and that the badges are properly stored when not in use.
  - e. Inspect records and verify that radiation exposure records are on file as required.
- (7) Training: Assist the MDOT Radiation Administrative Officer in the training of gauge operators.
- (8) Gauge Repair: Responsible for the repair of only the electronics of all nuclear gauges.
- (9) Responsible for all nuclear gauges located in the Central Laboratory and the application of at least minimum standards for protection of individuals against radiation exposure in accordance with the regulations.

### 6.1.5 District Responsibilities

**6.1.5.1 Application of Minimum Standards** – The District Materials Engineer is responsible for the application of at least minimum standards for protection of individuals against radiation exposure in his District in accordance with the regulations and the requirements of this S.O.P. When in his judgment a situation exists that cannot be corrected quickly and is a potential hazard to the operator or those working in the vicinity, the District Materials Engineer shall stop or suspend the operations and notify the MDOT Radiation Safety Officer immediately for corrective action. The operation shall be permitted to continue after eliminating the hazard and the operation complies with the current regulations and the requirements of this S.O.P.

**6.1.5.2 Inventory of District Nuclear Gauges** – The District Materials Engineer shall keep the MDOT Radiation Safety Officer informed of the location of each nuclear gauge at all times. When a nuclear gauge is transferred from the District Laboratory to a Project Engineer, from one Project Engineer to another, or from a Project Engineer to District Laboratory, the District Materials Engineer shall advise the MDOT Radiation Safety Officer, in writing, of such transfer by gauge number. It is necessary that the MDOT Radiation Safety Officer knows at all times the location of each nuclear gauge.

**6.1.5.3 Storage of Nuclear Gauges in the District Laboratory** – When the nuclear gauge is stored in the District Laboratory and used by District personnel, the following requirements become the direct responsibility of the District Materials Engineer:

- (1) Storage of Nuclear Gauges (Section 8)
- (2) Posting of Regulations and Notices to Employees (Section 11)
- (3) Radiation Protection (Section 10)
- (4) Records and Reports (Section 16.3 and 16.4)
- (5) Transporting Nuclear Gauges (Section 9)
- (6) Emergency Procedures (Section 12)

### **6.1.6 Supervision at Project Level**

All field operations involving the use of radioactive materials shall be under the direct supervision of the Project Engineer. The Project Engineer is directly responsible to the MDOT Radiation Safety Officer for the use of the nuclear gauges in the field. The Project Engineer is responsible for the application of at least the minimum standards for protection of individuals against radiation exposure in accordance with the requirements of the regulations and this S.O.P. His duties include the following:

- (1) Storage of Nuclear Gauges: Provide adequate storage and insure conformance to the minimum requirements set out in Section 8 of this method.
- (2) Transporting Nuclear Gauges: Insure conformance to the minimum requirements set out in Section 9 of this method.
- (3) Radiation Protection: Insure conformance to the minimum requirements for protection against radiation exposure as set out in Section 10 of this method.
- (4) Security Requirements: See that all security measures for storage and transporting nuclear gauges meet the requirements set out in this method.
- (5) Posting of Regulations and Notices to Employees: See that all regulations, notices to employees and this S.O.P are posted in accordance with the requirements of Section 11 of this method.

- (6) Emergency Procedures: Comply with the requirements of Section 12 should such an emergency arise.
- (7) Training: Insure that only trained qualified personnel are permitted to handle or operate nuclear gauges.
- (8) Reports: The law clearly places responsibility for public safety upon the user and the following reports are legal documents for the protection of the Project Engineer and the State. These reports are as follows:
  - a. Utilization Log for Nuclear Gauges (TMD-801): This report is to be filled out daily by the nuclear gauge operator or other responsible person checking the gauge out of storage. The Project Engineer shall see that this report is properly maintained in accordance with Section 16.3 and submit one (1) copy of the complete report monthly to the MDOT Radiation Safety Officer.
  - b. Report of Accumulated Dosage: This report shall be prepared and submitted annually by the MDOT Radiation Safety Officer for each employee assigned a film badge. The Project Engineer shall see that the individual concerned receives a copy of this report.
  - c. The Project Engineer shall notify, in writing, the MDOT Radiation Safety Officer when an employee who is assigned a film badge assumes new duties or leaves the Department. Upon receipt of this notice a report showing the total dosage accumulated during employment with the Department will be sent to the individual for his record.
  - d. Storage Radiation Monitoring Report (TMD-738): See Section 16.4 of this method.

### 6.1.7 Obligations of Test Operator

The test operator on a project must notify the Project Engineer immediately whenever difficulties arise and will be responsible for the following items:

- (1) Shutter Device: The test operator must know how the shutter device for shielding the radioactive material works. He should continuously check the operation of the shutter device and report any malfunction to the MDOT Radiation Safety Officer immediately.
- (2) Storage: When not in use, the shutter device will be locked and the gauge locked in an adequate storage facility.
- (3) Safety: When operating the nuclear gauges (i.e., when the handle is in the "USE" position) unauthorized personnel are to be kept at a distance greater than fifteen feet (15') from the probe. If it becomes necessary to recharge the nuclear gauge batteries when away from the regular storage area, the operator shall be in attendance at all times taking the necessary precautions to prevent access to the nuclear gauge by unauthorized personnel.
- (4) Radiation Signs: The test operator will insure that the proper radiation signs are used in the work area and storage area. (Note: The radiation signs placed on the nuclear gauges by the manufacturer only meet the requirements for the work area.)
- (5) Utilization Log for Nuclear Gauges (TMD-801): The test operator is responsible for making the daily entries on this form in accordance with Section 16.3 of this method.

### 6.1.8 Storage of Nuclear Gauges

**6.1.8.1 General Requirements** – The following requirements must be complied with for all storage facilities used:

- (1) The storage area shall prevent exposure of persons in the immediate vicinity to a radiation field greater than 0.5 mr/hr.
- (2) Notification of the existence of ionizing radiation to the parties responsible for the premises and approval of storage by the parties. (Storage location must be a minimum of fifteen feet (15') from any permanent work station.)
- (3) The premises shall be inspected and the responsible State employee shall satisfy himself that the area has adequate locks. The State employee shall have keys to the locked

area.

- (4) Radiation signs, provided by the Central Laboratory, shall be conspicuously posted on the storage facility so as to notify the public of the existence of ionizing radiation. The signs shall be clearly legible magenta-on-yellow containing the words "CAUTION! RADIOACTIVE MATERIAL."
- (5) When a nuclear gauge is placed in storage, its probe shall be padlock in the safe position. The gauge and case shall then be locked in the storage facility.
- (6) Each time the nuclear gauge is placed in a storage facility, a reading shall be taken with the CD-V-700 Survey Meter immediately outside the storage at the closest point to the nuclear gauge. These readings shall be maintained as a permanent record to insure that no individual in the immediate vicinity is exposed to a radiation field of more than 0.5 mr/hr.

**6.1.8.2 District Office and Central Laboratory Storage** – When the gauges are not in field use, the normal storage will be in the District Office or the Central Laboratory. The District Materials Engineer is responsible for the storage facilities at the District Office.

**6.1.8.3 Field Storage Sites** – The Project Engineer is responsible for storage of nuclear gauges in the field. The nuclear gauges may be stored in the following area provided the facility meets the requirements of Section 6.1.8.1 of this method:

- (1) State Vehicle on State Property Within a Fenced Enclosure or Building with a Locked Gate or Door: The vehicle must be locked and the keys retained by the responsible State employee.
- (2) MDOT Maintenance Yard: A locked room or building not available to the public.
- (3) Resident Engineer's Office: In a closet or special area.
- (4) Other State-owned facilities if required.

**6.1.9 Transportation of Radioactive Materials** – The nuclear gauge shall be transported in the shipping container provided by the manufacturer with the nuclear probe padlocked in the safe position. In addition, the following rules for the various modes of transportation shall be complied with as well as all applicable M.D.O.T. regulations.

**6.1.9.1 Exposure Rate** – The exposure rate on the outside of the vehicle shall not exceed 2 mr/hr.

**6.1.9.2 Placement in Vehicles**

- (1) Passenger Car: The box containing the nuclear gauge shall be kept locked in the trunk and secured in the trunk to prevent damage during transportation.
- (2) Station Wagon or Panel Truck: The nuclear gauge shall be placed at the back of the vehicle in the shipping container and secured to the vehicle in such a manner as to prevent them from sliding around. When the driver is not in attendance, the vehicle shall be locked to prevent access to the gauge.
- (3) Pickup Trucks: When pickup-type vehicles are used, the box containing the nuclear gauge shall be secured to the bed of the vehicle to prevent movement and in such a way as not to be easily removed by a passer-by. In addition, when the driver is not in attendance, the container shall be locked or the gauge shall be placed in the cab of the vehicle with its doors locked.

**6.1.9.3 Overnight Nuclear Gauge Storage** – For enroute overnight storage at a motel, hotel, or other lodging place, the locked gauge may be left in the locked vehicle. In the case of pickup trucks, the locked gauge shall be locked in the cab of the vehicle or locked in a box which is bolted to the truck bed. The vehicle when used as a storage area shall be posted with signs in accordance with [Subsection 8.1.4](#). Permission to have the source on the premises must be obtained from the owner or the manager of the property.

**6.1.9.4 Transporting Vehicle Accident** – In case of collision when transporting the nuclear gauges, which results in radiation danger, notify the local civil authorities and the MDOT Radiation Safety Officer by phone. He will then notify the proper authorities to take action. The emergency procedures set out in Section 12 of this method shall be followed. A copy of this method shall be located in the glove compartment of the vehicle.

**6.1.9.5 Commercial Carriers** – Commercial carriers are to be used only by the Central Laboratory in returning nuclear gauges to the manufacturer for service or repair.

- (1) Carriers: Suggested carriers to be used in order of preference:
  - a. Air Freight
  - b. Truck Freight
  
- (2) Container: Always use the supplied shipping container which shall be sealed with metal shipping bands or equal. The container shall contain all of the required markings to identify the contents as radioactive.
  
- (3) The shipper shall be given two (2) copies of the restricted article statement prepared by the MDOT Radiation Safety Officer and two (2) copies of the latest wipe test results.
  
- (4) Information for Receiver: Notify the receiver of the date shipped, carrier, and when to expect delivery.

#### 6.1.10 Radiation Protection

**6.1.10.1 Personnel Restriction** – Only those employees directly involved in the use of the gauges containing radioactive materials shall be permitted access to radiation of greater intensity than two (2) milliroentgen per hour (mr/hr). **No one under 18 years of age shall be authorized to use nuclear equipment or frequent areas where nuclear equipment is located.**

**6.1.10.2 Occasional Exposure** – Personnel that are within a 2-mr/hr. field two (2) hours or more per day shall wear a film badge. Personnel not regularly within a 2-mr/hr. field will not be required to wear film badges.

**6.1.10.3 Maximum Radiation Dosage** – The maximum allowable radiation dosage to the test operator is established at 50 milliroentgen per week. This dosage shall be calculated from the monthly film-badge reading by dividing the total days represented by the monthly film badge by seven (7), and then by dividing the monthly exposure reading by this quotient.

**6.1.10.4 Restricted Radiation Field** – No one shall be permitted to enter a radiation field of greater than 5 mr/hr.

**6.1.10.5 Use of Radioactive Materials** – The nuclear gauges shall not be used for any other purpose than the determination of soil or aggregate moisture, soil or aggregate density, asphalt cement content, and pavement density.

**6.1.10.6 Film Badges** – Personnel monitoring of radiation received from nuclear gauges is one of the major items in the health safety program. The following items shall be conformed to:

- (1) Any State employee, using or transporting a nuclear gauge, must wear personal dosimeter (film badge).
- (2) When an employee is to be assigned a film badge, the Project Engineer or District Materials Engineer, as applicable, shall obtain a signed statement from the employee stating the total radiation accumulated during previous employment while working with or in the presence of radioactive sources. This statement, along with a written request giving the employee's name and social security number, shall be sent to the MDOT Radiation Safety Officer.

Prior to the assignment of a nuclear gauge to an employee, the Central Laboratory shall train the individual in radiation safety.

**6.1.10.7 Radiation Survey Instrumentation** – A CD-V-700 Survey Meter will be assigned with each nuclear gauge. This meter shall be used as follows:

- (1) Storage Facilities: The Project Engineer or District Materials Engineer, as applicable, shall maintain a permanent record of the daily readings immediately outside the storage facility at the closest point to insure that no individual in the immediate vicinity becomes exposed to a radiation field greater than mr/hr. These readings may be taken by the nuclear gauge operator each day at the time the gauge is placed in storage.
- (2) Transportation Facilities: The survey meter shall be used to insure against a radiation field greater than 520  $\mu\text{C/g/h}$  at the closest point outside the vehicle.
- (3) Emergencies: The survey meter shall be used to isolate a contaminated area due to accident with the nuclear gauge.

**6.1.11 Posting of Regulations, Procedures, and Notices to Employees** – The following documents shall be posted in conspicuous places in the District Laboratory, the Central Laboratory, and Project Offices to permit individuals working in or frequenting any portion of a controlled (radiation) area to observe a copy of the documents.

**6.1.11.1 Regulations and Procedures**

- (1) Mississippi State Board of Public Health Regulations:

Regulations for Control of Radiation in Mississippi

- (2) MDOT Standard Procedures and Test Methods:

MT-6, MT-16, and *Materials Division Inspection, Testing, and Certifications Manual*,  
Section 6

**6.1.11.2 Radioactive Material License** – A copy of the Department’s license or certificate of registration shall be posted in each storage area.

**6.1.11.3 “Notice to Employees” Mississippi State Board of Public Health, Form No. RH-5** – The “Notice to Employees” may be obtained from the Central Laboratory.

**6.1.11.4 “Notice to Employees,” (TMD-523)** – In lieu of posting the lengthy documents set out in Section 6.1.11.2 and 6.1.11.3, this notice shall be posted advising personnel of the location of these documents. A copy of the documents set out in Section 6.1.11.1 shall be located at the District Laboratory, Central Laboratory, and the Project Engineer’s Office and made readily available.

**6.1.12 Emergency Procedures**

**6.1.12.1 Emergency Contact Procedures** – In an emergency where damage or possible damage has occurred to the radioactive source, notify the following immediately:

- (1) The local law enforcement agency and/or Highway Patrol
- (2) Division of Radiological Health, Mississippi State Board of Health

- (3) The manufacturer of the gauge

**6.1.12.2 MDOT Radiation Safety Officer** – The MDOT Radiation Safety Officer will then carry out the requirements of the regulations. All personnel responsible for nuclear gauges are required to have the names, addresses, and telephone numbers of all officials to be notified in an emergency.

#### **6.1.12.3 Action to Take for Different Types of Emergencies**

- (1) In the event of an accident involving the nuclear gauges, the responsible State employee at that time shall rope off an exclusion area with a radius of fifteen feet (15') around the gauge until the civil authorities and/or the MDOT Radiation Safety Officer arrive.
- (2) The area of the collision must be marked and a radiation survey made of this area.
- (3) In case of theft or loss of radioactive material, the responsible person at the time of discovery shall notify the MDOT Radiation Safety Officer or the MDOT Radiation Administrative Officer who will notify the State Board of Health.
- (4) In case the handle which operates the shielding shutter device sticks in the "USE" Position, notify the MDOT Radiation Safety Officer immediately, and:
  - a. Place sacks of wet soil around and above the gauge, and
  - b. Place radiation signs and rope off an area fifteen feet (15') from the gauge.

**6.1.13 Procedure for Wipe Tests** – Wipe tests or leak testing is required by law and is simply a swabbing of the sealed source to ascertain that no radioactive contamination has occurred from the nuclear source.

**6.1.13.1 Wipe Test Frequency** – Each source must be wiped every six (6) months. A label indicating the date of this wipe test is required on each gauge.

**6.1.13.2 Performance of Wipe Test** – The wipe tests are to be performed by personnel from the Central Laboratory. The MDOT Radiation Safety Officer will arrange for these tests and keep the required records on the results. The Central Laboratory will report all wipe tests to the State

Board of Health.

**6.1.14 Maintenance of Nuclear Gauges** – No maintenance will be performed by District or Project personnel. Instruments requiring maintenance will be returned to the Central Laboratory for repair. The MDOT Radiation Administrative Officer will arrange for the manufacturer of the instrument to make any repairs that are needed.

#### **6.1.15 Radiation Safety Training of Gauge Operators**

**6.1.15.1 Frequency of Training** – The MDOT Radiation Safety Officer or his representative will conduct a radiation safety training class on an annual basis at each District Headquarters.

**6.1.15.2 Attendees** – All gauge operators must attend a radiation safety training class annually.

- (1) All new employees (prospective gauge operators) must attend a radiation safety training class prior to receiving instructions for operation of gauges. (Pursuant to certain conditions, arrangements for a special training class may be made by the MDOT Radiation Safety Officer.)
- (2) Employees who previously were gauge operators, but have not attended a radiation safety training class within the last twelve (12) months, must attend such a class before resuming duties as a gauge operator. (Pursuant to certain conditions, arrangements for a special training class may be made by the MDOT Radiation Safety Officer.)

#### **6.1.16 Records and Reports**

**6.1.16.1 Radiation Survey Report** – The MDOT Radiation Safety Officer shall make periodic field inspections to evaluate radiation hazards incident to the production, use, release, or presence of sources of radiation. This valuation includes a physical survey of the location of materials, equipment and facilities, and the measurements of levels of radiation or concentrations of radioactive material present.

A written report of the survey shall be prepared and distributed as follows:

Original to: MDOT Radiation Administrative Officer

Copies to: Deputy Executive Director/Chief Engineer  
District Materials Engineer  
Project Engineer  
File

**6.1.16.2 Semiannual Inventory** – The MDOT Radiation Safety Officer shall conduct a semiannual inventory to account for all sealed sources. A record of this inventory shall be maintained on file in the Central Laboratory.

**6.1.16.3 Utilization Log for Nuclear Gauges (TMD-801)** – This is a monthly report showing the daily usage of the nuclear gauge. The District Materials Engineer or the Project Engineer, as applicable, shall submit this report to the MDOT Radiation Safety Officer at the end of each month. This report is to be submitted even though the nuclear gauge may not have been used during the reporting period. The report shall contain the following information:

- (1) Make and Model Number of nuclear gauge.
- (2) Name of responsible employee to whom the nuclear gauge is assigned.
- (3) Location where used and dates of use. The project number will suffice for location.
- (4) Name of nuclear gauge operator.

**6.1.16.4 Storage Radiation Monitoring Report (TMD-738)** – Each time the nuclear gauge is placed in a storage facility, a reading shall be taken with the CD-V-700 Survey Meter immediately outside the storage area at the closest point to the nuclear gauge. These readings shall be maintained as a permanent record by the District Materials Engineer or the Project Engineer, as applicable, to insure that no individual in the immediate vicinity is exposed to a radiation field of more than 0.5 mar/hr. When a nuclear gauge is in storage for a period of one week or more, readings with a survey meter shall be taken, as set out above, weekly and entered on Form TMD-738. A copy of this report shall be submitted monthly to the MDOT Radiation Safety Officer.

**6.1.16.5 Report of Accumulated Dosage** – Section 801 J 13(b) of the Mississippi State Board of Health Regulations for Control of Radiation requires that each licensee advise each worker annually of the worker's exposure to radiation in writing. The report will contain the following statement followed by a signature-date block.

"This report is furnished to you under the provisions of the Mississippi State Board of Health Regulations for Control of Radiation, Part 801, Section J. You should preserve

this report for further reference.”

In conformance to this regulation, the MDOT Radiation Safety Officer will send the original and one (1) copy of the annual report to the employee’s supervisor (District Materials Engineer or Project Engineer, as applicable). The employee’s supervisor will have each employee complete the signature-block on their respective report, give the original to the employee with instruction to retain the report for his/her future reference, and return the signed copy to the MDOT Radiation Safety Officer.

A report of accumulated dosage of a film badge holder will be sent at any time requested by the employee.

**Section 7 – Producers and Suppliers and List of “Approved Sources of  
Materials**

## 7.1 Organization and Function of the MDOT Product Evaluation Committee

The following section provides guidelines for establishment of, and to outline organization, functions and procedures for a committee to conduct the Department's product evaluation function.

**7.1.1 General** – There shall be established in the Mississippi Department of Transportation a Committee which conducts the product evaluation function. This committee will be a non-policy making body of technical and administrative advisors to the Chief Engineer who will review and evaluate new materials, new products and new procedures proposed to the Department, and make appropriate recommendations.

**7.1.2 Organization of the Committee** – The name of the Committee shall be the Mississippi Department of Transportation Product Evaluation Committee.

***Members of the Committee:***

Assistant Chief Engineer - Operations  
Assistant Chief Engineer - Preconstruction  
Bridge Engineer  
State Construction Engineer  
Roadway Design Engineer  
Support Services Director  
Procurement Director  
State Maintenance Engineer  
Research Engineer  
State Materials Engineer  
State Traffic Engineer  
Planning Engineer  
Information Systems Director  
District Engineer (Yearly Rotation)

***Non-Voting Member(s):***

Planning and Research Engineer  
FHWA Division Office  
State Aid Division Representative

The Chairman of the Committee shall be the State Materials Engineer. The Secretary shall be the person designated by the Chairman. The Secretary shall have no vote.

The District Engineers and other Division Heads shall be called upon for advice as the need arises.

Regular meetings shall be held on the third Thursday of January, April, July, and October. Special meetings may be held as deemed necessary.

The District Engineer shall serve on a rotational basis for an entire calendar year from the January meeting, (third Thursday of January) through the October meeting. The annual District Engineer appointment to the Product Evaluation Committee shall be as listed in Table 7.1.

**TABLE 7.1: Product Evaluation Committee District Engineer Assignments**

NOMINEE	CALENDAR YEAR
DISTRICT ENGINEER 7	2005
DISTRICT ENGINEER 1	2006
DISTRICT ENGINEER 2	2007
DISTRICT ENGINEER 3	2008
DISTRICT ENGINEER 5	2009
DISTRICT ENGINEER 6	2010
DISTRICT ENGINEER 7	2011
DISTRICT ENGINEER 1	2013

Note: The schedule will start repeating in calendar year 2014 and nominees thereafter will be in the sequential numerical order as shown above.

**7.1.3 Duties of the Committee** – Following are the duties assigned to the Product Evaluation Committee.

Review and evaluate new materials, new products, and new procedures that are proposed to the Mississippi Department of Transportation for use in the highway program.

Recommend on the basis of review and evaluation of new items appropriate action to be taken by

the Department, including:(a) immediate adoption;(b) trial usage for further evaluation or trial usage on a project tested basis;(c) additional review, development, or research by the Department;(d) reference back to initiator for additional information; and(e) rejection. The appropriate Assistant Chief Engineer will ultimately determine whether or not an evaluation will be performed on a project tested basis.

It is understood that specifications and/or plan modifications must be developed before some approved products can be incorporated into general use. For this reason, the Committee will, as a part of the product approval process, make a determination as to the necessary documents which must be developed to implement the use of an approved product. A listing of the necessary implementation documents will accompany the approval recommendation submitted to the Deputy Executive Director/Chief Engineer. Upon concurrence of the Committee's recommendation by the Deputy Executive Director/Chief Engineer, the appropriate Assistant Chief Engineer will notify the affected Division(s) by memorandum of the product's approval and will determine the letting date in which the new material, product or procedure is to be incorporated in the contract documents after consulting the applicable Division Head. The Division Head will advise the Committee Chairman of this target date.

After the Deputy Executive Director/Chief Engineer's approval of the Committee's recommendation, the submitter of the product will be notified by letter from the Committee Chairman that the product has received approval or that final approval would await preparation of the necessary documents. When these documents are completed and approved, the Chairman will be notified and he will in turn issue final approval notice to the submitter.

MDOT correspondence disregarded for at least six months during the product evaluation process will terminate the evaluation. A letter to the supplier will state: (a) MDOT correspondence has not been answered within the last six months; (b) Evaluation has been terminated due to supplier lack of interest; and (c) Two years after the date of this letter is the earliest allowable product resubmission date.

Encourage development and introduction into the highway field of new and improved products, materials, and processes.

Review and evaluate new equipment proposed to be purchased by a Division, when requested.

The Secretary shall screen and furnish the Committee with information on the various proposals received. When deemed desirable by the Committee, representatives of manufacturers or producers may be asked to appear to clarify or amplify their proposals. Outside experts and members of the Mississippi Department of Transportation with first hand knowledge of the proposals being considered may be requested to appear before the Committee.

The Chairman may assign a specific proposal to a member of the Committee who will serve as Chairman of the subcommittee to study the proposal. This member shall report the findings and his Recommendation(s) to the Chairman for further action by the Committee. A written report shall be furnished to the Committee Chairman at each scheduled meeting giving the status of each product and his recommendation for Committee action if needed.

When determination of a proposal is urgent, the Chairman may informally poll the members of the Committee and the result of the poll shall constitute an official vote. Unless there is such urgency, however, final action on a proposal shall await the next regular meeting of the Committee.

**7.1.4 Application Submittal** – The Product Evaluation Committee reviews new materials, new products, and new procedures for which the Department has no standard specification, that are proposed for the Mississippi Department of Transportation for use in the highway program.

Material Suppliers who wish to have a product evaluated by the Committee must complete and submit for review the most current version of Form ADM-361. A copy of Form ADM-361 is available in the appendix of this manual. In addition, a copy can be obtained from the [www.goMDOT.com](http://www.goMDOT.com) website under the *Business Section* or by contacting the Materials Division for more information.

## 7.2 Approved Product and Producer/Supplier Categories on the MDOT “Approved Sources of Materials” List

Listed below is a table of all of the categories for which the Mississippi Department of Transportation currently maintains a list of approved products and/or producers/suppliers. The Department’s “Approved Sources of Materials” list is available at the [www.goMDOT.com](http://www.goMDOT.com) website under the *Business Section, MDOT Approved Sources of Materials*, or by contacting the Materials Division Quality Assurance Engineer. The approved products are also listed in the SiteManager Information System under the Approved Lists Icon in the Producer/Supplier and the Approved Products Sections.

**TABLE 7.2: “Approved Sources of Materials” — Categories & References**

CATEGORY	REFERENCE
Admixtures, Concrete	Standard Specifications for Road & Bridge Construction Section 713.02
Aggregate Sources	Standard Specifications for Road & Bridge Construction Section 703
Asphalt Pavement Restoration Seal	Standard Specifications for Road & Bridge Construction Section 401.02.6.7
Backer Rods (Sec. 707.02.15)	Standard Specifications for Road & Bridge Construction Section 707.02.1.5
Bituminous Material Suppliers—Certified (Also Refer to SHRP)	Standard Specifications for Road & Bridge Construction Section 702
Bituminous Mixtures, Commercial Cold Mix	Standard Specifications for Road & Bridge Construction Section 404.02
Cement Suppliers	Standard Specifications for Road & Bridge Construction Section 701
Coating Systems, Bridge Structural Steel	Standard Specifications for Road & Bridge Construction Section 710.03 and 710.04
Coating Systems, for Upgrading Existing Coatings by Maintenance Forces	Standard Specifications for Road & Bridge Construction Section 710.03 and 710.04
Concrete Pipe Suppliers	Standard Specifications for Road & Bridge Construction Section 708

Concrete Texture Spray Coatings Suppliers	Standard Specifications for Road & Bridge Construction Section 714.12
Corrugated Metal Pipe for Maintenance Work (Vendors)	Standard Specifications for Road & Bridge Construction Section 709
Corrugated Metal Pipe Fabricators	Standard Specifications for Road & Bridge Construction Section 709
Corrugated Metal Pipe, Sheet Steel Manufacturers	Standard Specifications for Road & Bridge Construction Section 709
Dowel Tie Bar Anchor Systems (in Concrete)	Standard Specifications for Road & Bridge Construction Section 714.11.7
Fly Ash, Sulfate and Non-Sulfate Areas	Standard Specifications for Road & Bridge Construction Section 714.05
Geocomposite Edge Drains	Standard Specifications for Road & Bridge Construction Section 605
Geogrids	Standard Specifications for Road & Bridge Construction Section 714.15
Ground Granulated Blast-Furnace Slag, Grade 100 & 120	Standard Specifications for Road & Bridge Construction Section 714.06
Grouts & Patching Compounds (Rapid Setting Commercial)	Standard Specifications for Road & Bridge Construction Section 714.11.6
Guard Rail Suppliers	Standard Specifications for Road & Bridge Construction Section 712
Impact Attenuators	Standard Specifications for Road & Bridge Construction Section 619.02
Joint Repair Materials (Sec. 714.11.8)	Standard Specifications for Road & Bridge Construction Section 714.11.8
Manhole Risers	Standard Specifications for Road & Bridge Construction Section 604
Pavement Marking Materials, Inverted Profile Thermoplastic	Standard Specifications for Road & Bridge Construction Section 626
Prestressed and Precast Plants	Standard Specifications for Road & Bridge Construction Section 804.03.22
Reinforcing Steel Suppliers, Pre-tested	Standard Specifications for Road & Bridge Construction Section 711

Retroreflective Sign Sheeting Material(s)	Standard Specifications for Road & Bridge Construction Section 721.06
SHRP Superpave Performance Graded Asphalt Binder(s)	Standard Specifications for Road & Bridge Construction Section 702
Silicone Joint Sealing Compounds	Standard Specifications for Road & Bridge Construction Section 707.02.1.4
Soil Reinforcing Mats	Standard Specifications for Road & Bridge Construction Section 224
Steel Wire Fabric (Wire Mesh) Suppliers	Standard Specifications for Road & Bridge Construction Section 711.02.3
Substitute Materials	Standard Specifications for Road & Bridge Construction Section 106.12
Traffic Control Devices, Miscellaneous	Standard Specifications for Road & Bridge Construction Section 619.02
Traffic Control Materials	Standard Specifications for Road & Bridge Construction Section 619 and 720
Traffic Paint Manufacturers	Standard Specifications for Road & Bridge Construction Section 710
Treated Wood Products Suppliers	Standard Specifications for Road & Bridge Construction Section 712, 718, 719, and 722

## Appendix A – Materials Division Standard Forms

### Index of Materials Division Standard Forms

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**MISSISSIPPI DEPARTMENT OF TRANSPORTATION**

**QMP HMA**

**Asphalt Paving Inspectors Daily Report**

**TMD-004**

Rev 3/03

Project No.: \_\_\_\_\_ County: \_\_\_\_\_ Contractor: \_\_\_\_\_ Date: \_\_\_\_\_

MDOT JMF No. \_\_\_\_\_ Mix Type: \_\_\_\_\_ Temperature: AM \_\_\_\_\_

PM \_\_\_\_\_

Beginning Station No. / Lane \_\_\_\_\_

Total Tons Today: \_\_\_\_\_

Ending Station No. / Lane \_\_\_\_\_

Theor. Tons Today: \_\_\_\_\_

Total Paving Length, ft. \_\_\_\_\_

Over/Under Today: \_\_\_\_\_

**INSTRUCTIONS:**

Use Table 1 first production day, or bias update day, for density and bias determination.

Req. No. Lots \_\_\_\_\_

Fill in Table 2 on bias update days. Use Table 3 on normal production days.

Lot Length, ft. \_\_\_\_\_

**Table 1**

Lot	1	2	3	4	5	6	7	Average
Beginning Station								
Test Location, Sta.								
Offset to rt., ft.								
Core Density, pcf								
Nuclear Density, pcf								
Gauge Bias, pcf								
Max. Den. (Note 1), pcf								
Compaction (Cores), %								
Pay Factor								

**Table 2**

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	New Gauge Bias
Prev. Gauge Biases:											

**Table 3**

**Lot Compaction**

Lot	1	2	3	4	5	6	7	1	2	3	4	5	6	7
<b>Nuclear Density, pcf</b>							<b>Core Density, pcf</b>							
Location 1														
Location 2														
Location 3														
Location 4														
Location 5														
<b>Average</b>														
Bias														
Corr. Density, pcf														
Max. Den. (Note 1), pcf														
Compaction, %														
Pay Factor (Note 2)														

Note 1: Max. Den. = Average Gmm for the day x 62.24

Note 2: Any pay factor < 1.0 must be verified by core density.

**Average Daily Compaction:** \_\_\_\_\_

REMARKS: \_\_\_\_\_

**DISTRIBUTION:**

- Original to State Materials Engineer
- Copy to State Construction Engineer
- Copy to District Materials Engineer
- Copy to Project Engineer

Signed: \_\_\_\_\_

Paving Inspector

**QMP HOT-MIX ASPHALT**

Q.A. Mixture Report

Project Number \_\_\_\_\_

TMD-005

Day No.	Contractor Report No.'s Test No.	Q.A. No.	M.D.O.T. Dist. Report No.'s Lab No.
MDOT Mix No. _____	Type Mix _____	A.C. Source _____	Placed As _____
Contractor _____	Sub-Contr. _____	Agg. BSG _____	Job Mix AC _____
J. M. VMA _____	J. M. Voids _____	J.M. % Cr. Mat'l. _____	J.M. % L. S. Ret. _____
Producer of Mix _____		% Crush Count _____	% L. S. Ret. _____
Date Produced _____		Date Comparison Made _____	

Extraction					Max. Sp. Gr. (Gmm)	
					# 1	# 2
Sample Mass, g						
Dry Mass, g						
Extr. Mass, g						
Job Mix	Sieve Size	MDOT Mass Ret.	MDOT % Passing	Diff. from Contr. QC	SSD Mass	
	37.5 mm				Dryback Factor	
	25.0 mm				Max Sp. Gr.	
	19.0 mm				MRCF	
	12.5 mm				Corr. Max. SG	
	9.5 mm					
	4.75 mm					
	2.36 mm					
	1.18 mm					
	600 um					
	300 um					
	75 um					
					Avg. MSG.	

AC Content / Moisture Corr.	
% AC	
Sample Mass	
Dry Mass	
% Moisture	
% Corr. AC	

Laboratory Compaction / Void Analysis					
Specimen No.	1	2	3	4	Average
Comp. Temp.					*****
Mass in Air					*****
Mass in Water					*****
Mass SSD					*****
Volume					
Bulk Gr.					
Height (N-MAX)					*****
Height (N-DES)					*****
Bulk Gr.(N-DES)					
EQ. Corr. Factor					*****
BRCF					*****
Corr. Bulk Gr.					
Total Voids %					
VMA %					

DESIGN # GYRATIONS  
 N (ini) = \_\_\_\_\_  
 N(des) = \_\_\_\_\_  
 N(max) = \_\_\_\_\_

Core Density (Evaluation Section or Bias Update)								
Lot No.	1	2	3	4	5	6	7	Average
Station No.								*****
Location								*****
Thickness cm.								*****
Mass in Air								*****
Mass in Water								*****
Mass SSD								*****
Volume								
Bulk Sp. Gr.								
Max. Sp. Gr.								
% Density								
Absorption								

Remarks \_\_\_\_\_

**DISTRIBUTION:**

- Original to State Materials Engineer
- Copy to State Construction Engineer
- Copy to District Testing Engineer
- Copy to Project Engineer
- Copy to Producer Lab File

Signed \_\_\_\_\_

TMD-006

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

QMP HMA

Summary Report of QC Mixture Properties

Project No.: \_\_\_\_\_

Contractor: \_\_\_\_\_

Mix: \_\_\_\_\_

MDOT JMF No. \_\_\_\_\_

ACsg \_\_\_\_\_

Date	Tons	Test	AC	AC AVG-4	Gmm	Gmm AVG-4	Gmb	Gmb AVG-4	VOIDS	Voids AVG-4	VMA	VMA AVG-4	Gsb Blend	Crush
------	------	------	----	-------------	-----	--------------	-----	--------------	-------	----------------	-----	--------------	--------------	-------

Design	<input type="text"/>													
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		1												
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		40												

**MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
QMP HMA  
Summary Report of QC Gradation Properties**

Project No.: \_\_\_\_\_

Contractor: \_\_\_\_\_

Mix: \_\_\_\_\_

MDOT JMF No. \_\_\_\_\_

Date	Tons	Test	1/2"	1/2" AVG-4	3/8"	3/8" AVG-4	No.8	No.8 AVG-4	No.30	No.30 AVG-4	No.200	No.200 AVG-4
		JMF	<input type="text"/>		<input type="text"/>		<input type="text"/>		<input type="text"/>		<input type="text"/>	
		1										
		2										
		3										
		4										
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		39										
		40										

HMA DAILY PLANT SAMPLES RANDOM NUMBERS

TMD-020

DATE \_\_\_\_\_  
PROJECT NO. \_\_\_\_\_  
LOT NO. \_\_\_\_\_  
TYPE OF MIX \_\_\_\_\_

REQUIRED SAMPLE FREQUENCY	
TOTAL ESTIMATED PRODUCTION, tons	NUMBER OF TESTS
50-800	1
801-1700	2
1701-2700	3
2701 +	4

TONNAGE PRODUCED PREVIOUS DAY \_\_\_\_\_  
ESTIMATED TONNAGE FOR DAY (A): \_\_\_\_\_  
NUMBER OF SAMPLES REQUIRED (B): \_\_\_\_\_  
ESTIMATED TONNAGE / SAMPLES (A/B) = C: \_\_\_\_\_

**SELECT 4 RANDOM NUMBERS AND ENTER BELOW (4 random numbers should be selected regardless of the number of tests required. Use additional random numbers if production exceeds the estimated tonnage.**

RANDOM NO. 1 (R1) \_\_\_\_\_ SAMPLE TONS 1 = (C x R1) \_\_\_\_\_  
RANDOM NO. 2 (R2) \_\_\_\_\_ SAMPLE TONS 2 = (C+(C x R2)) \_\_\_\_\_  
RANDOM NO. 3 (R3) \_\_\_\_\_ SAMPLE TONS 3 = (2 x C)+(C x R3) \_\_\_\_\_  
RANDOM NO. 4 (R4) \_\_\_\_\_ SAMPLE TONS 4 = (3 x C)+(C x RS4) \_\_\_\_\_

**COLD FEED RATES (%)**

AGG # 1 \_\_\_\_\_  
AGG # 2 \_\_\_\_\_  
AGG # 3 \_\_\_\_\_  
AGG # 4 \_\_\_\_\_  
AGG # 5 \_\_\_\_\_  
AGG # 6 \_\_\_\_\_  
AGG # 7 \_\_\_\_\_

IF THE COLD FEED RATES ARE CHANGED MORE THAN 5% FROM THE JMF, RECALCULATE THE COMBINED AGGREGATE BSG AND NOTE THAT CHANGE ON YOUR ASPHALT REPORT

SIGNED \_\_\_\_\_

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

Bituminous Mix Design for \_\_\_\_\_ Course

(SIZE - TYPE)

Date: \_\_\_\_\_

Project No. \_\_\_\_\_

County \_\_\_\_\_

Contractor \_\_\_\_\_

Sub-Contr. \_\_\_\_\_

TEST DATA: \_\_\_\_\_ Original Design

\_\_\_\_\_ Revised Design

\_\_\_\_\_ Transfer:

From Proj. No. \_\_\_\_\_

MDOT Lab No. \_\_\_\_\_

Sample No.						Agg. Blend	Job Mix	Spec.
Type Material						% Passing	% Passing	Design Range
Aggregate Source								
Percent of Material Used in Blend								
Sieve Size	Gradation (Percent by Weight Passing)							
1-1/2"								
1"								
3/4"								
1/2"								
3/8"								
No. 4								
No. 8								
No. 16								
No. 30								
No. 50								
No. 100								
No. 200								
% Clay								
						<b>Comb. Aggr. Blend Properties</b>		
PI -40 Material								% Total Clay
% Crushed, + #4								Dust/Binder Ratio
Apparent SG, Gsa								% Crushed, + #4
Bulk SG, Gsb								Apparent SG, Gsa
% Abs. Moisture								Effective SG, Gse
<b>Gyratory Compaction</b>								Bulk SG, Gsb
Revolutions: Nini = _____		Ndes = _____		Nmax = _____				% Abs. Moisture
Compaction Temp. _____ <small>(ATTACH VISCOSITY CHART)</small>		Bulk Spec. Grav. @ Ndes (Gmb) = _____						Thin & Elong. Pcs., %
						<b>Mix Properties @ Ndes</b>		
<b>Analysis of Stripping</b>								Mix Temp.
TSR = _____ %		Visual Stripping = _____ %						Air Voids, Pa, %
Antistrip Addition: _____	Rate = _____	% by wt. of AC		Source: _____				VMA, %
<b>Asphalt Cement</b>								Absorbed AC by wt. of Total Mix, %
Source _____	Grade _____	Spec. Grav. _____						Effective AC, %
AC (RAP) _____ %	AC (New) _____ %	Total AC _____ %						Max. SG, Gmm (Dry Back)
The percentage of Asphalt Cement of the grade specified above to be used with the above blend of mineral aggregates for the _____ Course is _____ % by weight of the total mixture.								

Remarks: \_\_\_\_\_

SIGNATURE

**MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
MATERIALS DIVISION  
JACKSON, MS**

DAILY REPORT FOR PRESSURE GROUTING

1. Report No. \_\_\_\_\_ Date \_\_\_\_\_ MS
2. Project No. \_\_\_\_\_ County \_\_\_\_\_ Route No. \_\_\_\_\_
3. Contractor \_\_\_\_\_ Cement Brand \_\_\_\_\_ Type \_\_\_\_\_
4. Station \_\_\_\_\_ Station \_\_\_\_\_ Weather \_\_\_\_\_

GROUP BATCH QUANTITIES

5. Batch No.	Atmosphere Temperature (°C)	% Calcium Chloride	Calcium Chloride (Lbs.)	Cement Lbs.	Fine Sand (Cu. Yds.)	No. Holes Pumped	Sand Cement Ratio	Flow (Seconds)
6. TOTAL								

7. Remarks \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Submit Copies to: State Materials Engineer (1)  
State Construction Engineer (1)  
District Engineer (1)  
Project File (1)

Certified Correct \_\_\_\_\_ Inspector

Submit original with final estimate



**MISSISSIPPI DEPARTMENT OF TRANSPORTATION**  
**MATERIALS DIVISION**  
**JACKSON, MS**

DAILY REPORT OF LIME STABILIZATION  
REPORT NO. \_\_\_\_\_

Lime: Brand \_\_\_\_\_  
Unit Weight (lbs./cu. ft.) \_\_\_\_\_  
Water: Source \_\_\_\_\_  
Raw Soil: Clay; Silts; Silty Clay (Circle One)  
Std. Dens. (lbs./cu. ft.) \_\_\_\_\_  
Class of Treatment: A; B; C; D; (Circle One)  
Depth of Treatment: Specified \_\_\_\_\_  
Range permitted \_\_\_\_\_  
Method of Mixing \_\_\_\_\_  
Type of Rollers \_\_\_\_\_

Project No. \_\_\_\_\_  
County \_\_\_\_\_  
Contractor \_\_\_\_\_  
Length of Project (Mi.) \_\_\_\_\_  
Progress to Date: (incl. this report) \_\_\_\_\_  
Processed: Lin. Ft. \_\_\_\_\_  
Sq. Yds. \_\_\_\_\_  
Lime Allowed: Lbs. \_\_\_\_\_  
Percent Complete \_\_\_\_\_

SECTIONS PROCESSED

First Application: (A, B, C, D)						
Date	_____					
Lane	_____					
Station	_____					
Station to	_____					
Net Length: Ft.	_____					
Ave. Width: Ft.	_____					
Square Yards	_____					
Lime: % Specified	_____					
Ordered: Lbs.	_____					
Plus 5%: Lbs.	_____					
Spread: Lbs.	_____					
Allowed: Lbs.	_____					
Time:						
Spread Begun:	_____					
Incorp. Complete:	_____					
Temperature: Low (°F)	_____					
High (°F)	_____					
Second Application (Class A); or Compaction after Mellowing Period (Class B)						
Date (A, B) *	_____					
Lane (A, B)	_____					
Station (A, B)	_____					
Station to (A, B)	_____					
Net Length: Ft. (A)	_____					
Ave. Width: Ft. (A)	_____					
Square Yards (A)	_____					
Lime: % Specified: (A)	_____					
Ordered: Lbs. (A)	_____					
Plus 5%: Lbs. (A)	_____					
Spread: Lbs. (A)	_____					
Allowed: Lbs. (A)	_____					
Time:						
Spread Begun: (A)	_____					
Incorp. Complete: (A)	_____					
Temperature: Low (°F) (A)	_____					
High (°F) (A)	_____					
Pulverization: Percent (A, B, C)	_____					
Depth: Actual (A, B, C)	_____					

\* Information to be shown for class(es) of treatment shown in ( ).  
Reports for Classes A and B to be submitted after sections are completed.

**Distribution:**

Original: State Materials Engineer  
cc: Contract Adm. Engineer (To be submitted with final estimate with tickets (pink copies) attached.)  
District Materials Engineer  
Project Engineer

\_\_\_\_\_  
Inspector

\_\_\_\_\_  
Project Engineer



**MISSISSIPPI DEPARTMENT OF TRANSPORTATION**  
**Materials Division**  
**Jackson, Mississippi**

**To: Project Engineers**

**From: State Materials Engineer**  
**Mr. Richard Sheffield**

**Please add the following innage table for the distributor, as listed below, to the calibration charts formerly mailed to you . Any subsequent change or alteration made in the unit described herein which would change the LIQUID LEVEL or CALIBRATED CAPACITY in the tank(s) VOIDS this calibration. when any change is made which alters the calibrations, the unit shall be RECALIBRATED before further use.**

**Make :**  
**Distributor Serial No.**  
**Mounted on:**  
**Owned by:**

**Tire Size:**

**Zero Point to Bottom: {Inches}**  
**Zero Point to Liquid when Full: {Inches}**  
**Total Capacity: {Gallons}**  
**Calibrated at:**

Zero Point	Gallons	Zero Point	Gallons	Zero Point	Gallons
To Liquid	In Tank	To Liquid	In Tank	To Liquid	In Tank

MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
MATERIALS DIVISION  
SAMPLE INFORMATION CARD

1. <b>SAMPLE ID:</b> _____	2. SAMPLE DATE: _____
3. <b>CONTRACT ID:</b> _____	4. <b>PROJECT (FMS) NO.:</b> _____
5. <b>PAY ITEM NO.:</b> _____	6. <b>SAMPLE TYPE:</b> _____
7. <b>MATERIAL:</b> _____	
8. APL PRODUCT NAME (if applicable): _____	
9. <b>PRODUCER/SUPPLIER NAME:</b> _____	
10. PLANT (if applicable): _____	
11. <b>QUANTITY REP.:</b> _____	12. <b>SAMPLE UNIT(S):</b> _____
13. INTENDED USE: _____	14. STATION NO.: _____
15. <b>SAMPLED BY:</b> _____	16. <b>REQUESTED BY:</b> _____
17. SAMPLED FROM: _____	18. LOT/BATCH NO.: _____
19. MIX DESIGN TYPE/CLASS: _____	20. MIX ID: _____
21. TEST(S) DESIRED: _____	
22. REMARKS: _____	
_____	

NOTES: SAMPLE INFORMATION CARD

1. The Sample ID is the ID number used by SiteManager. This number will be assigned by the Materials Division Central Lab for samples submitted by County & Consultant Engineers.
2. The date the sample was taken.
3. This is the SiteManager Contract ID number (as applicable).
4. The Project Number is the FMS 12-Digit Number /Construction Number.
5. The Pay Item Number is the Contract Pay Item associated with the Material Sample (MDOT Projects Only).
6. The Type of Sample Taken. Choose from the following types: Job Control, Information, Mix Design, QA, Stock, State Aid, Source Approval, Research, IAS, and Recheck.
7. Material Name and/or Description.
8. The Brand Name of the Material as listed on the Approved Products List (for applicable materials).
9. The Original manufacturer or approved supplier of the material. (Not the Broker or Vendor)
10. The name of the plant supplying the material, or the Plant Number for Aggregate Sources. List according to the City in which the plant is located. If there are multiple locations within the same city, include a street name for clarification.
11. The quantity of material used on the project represented by the sample, or maximum permitted by SOP No. TMD 20-04-00-000.
12. The unit of measure for the sample (i.e. feet, square feet, pounds, etc.).
13. The intended use of the sample, as applicable.
14. The station number of the sampling location, as applicable.
15. The person's name who took the sample.
16. The project engineer's name or other authorized party that authorized the sample to be tested.
17. The location at which the sample was taken, including but not limited to roadway location, stockpile, etc.
18. The unique identifier that corresponds to the manufacturer's lot and/or batch number, as applicable.
19. The Mix Design type and/or class, as applicable.
20. The ID number assigned to the approved mix design for the sample taken, as applicable.
21. Indicate if the requested testing should include the standard tests run on the sample (to be denoted as "REGULAR") and/or any specific tests that should be run on the sample. For example, "Regular plus soundness and abrasion".
22. Specify anything that might clarify sample information or explain conditions or the circumstances pertaining to the sample.

**The fields appearing in red/bold are required for Sample Testing. Samples submitted without this information will not be tested. Refer to the NOTES Section of this form for further instruction.**

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

INSPECTION OF HOT MIX ASPHALT PLANT

Semi-Annual Inspection

Of The

\_\_\_\_\_  
(Name of Plant)

Location \_\_\_\_\_ County \_\_\_\_\_ State \_\_\_\_\_

Project \_\_\_\_\_ District \_\_\_\_\_

Date of Inspection \_\_\_\_\_ Date of Previous Inspection \_\_\_\_\_

Type of Plant:      Batch                      Drum                      Permanent                      Portable  
   Mixer

Make \_\_\_\_\_ Model or Serial No. \_\_\_\_\_

Maximum Batch \_\_\_\_\_ Lbs.      Rated Tons Per Hour \_\_\_\_\_

Inspected By \_\_\_\_\_ Date \_\_\_\_\_

1. STOCKPILES	YES	NO
a. Are stockpiles properly separated?		
b. Is material segregated?		
c. Has contractor submitted and received approval of his intended material sources and his job mix formula?		
d. Is area clean and properly kept?		
<b>2. GENERAL REQUIREMENTS FOR ALL PLANTS</b>		
a. Are tanks for storage of asphalt cement equipped for heating the material under effective and positive control at all times?		
b. Are tanks or storage material properly heated?		
c. Is a circulating system for the asphalt cement of adequate capacity to provide proper and continuous circulation between storage tank and proportioning units during the entire operating period?		
d. Is the discharge end of the asphalt cement circulation pipe below the surface of the material in the storage tanks?		

	YES	NO
e. Are all pipe links and fittings steamed, oil jacketed or otherwise properly insulated to prevent heat loss?		
f. Is storage tank capacity such as to insure continuous operation of the plant and uniform temperature of the asphalt cement when it is mixed with the aggregate?		
g. Is a sampling outlet provided in the asphalt feed lines?		
h. Is a drainage receptacle provided for flushing the outlet prior to sampling?		
<b>3. ANTI-STRIP AND OTHER ADDITIVE SYSTEMS</b>		
a. Is anti-strip material added at plant site?		
b. If anti-strip material is added at plant site, does the anti-strip system meet specifications?		
c. If other approved additives are used, are they handled in accordance with an established procedure?		
<b>4. COLD FEED SYSTEM</b>		
a. Number of Cold Bins _____		
b. Does plant have mechanical or electrical means for uniformly feeding the aggregates into the drier?		
c. Does cold feed have a synchronized proportioning method when blending aggregates from two or more bins?		
d. If mineral filler is required, is a separate bin provided?		
e. Is the feeder for mineral filler furnished with the feeder drive positively interlocked and synchronized with the aggregates feeds?		
<b>5. DRIER</b>		
a. Number of driers _____		
b. Is drier of satisfactory design provided?		
<b>6. DUST COLLECTORS AND EMISSION CONTROLS</b>		
a. What type dust collector is provided?		
b. Is the material collected in the dust collector wasted?		

	YES	NO
c. Can part or all of the material be returned to the aggregate mixture?		
d. Does the plant meet applicable limitations on emissions?		
e. Has company received permit to operate from EPA?		
<b>7. THERMOMETRIC EQUIPMENT</b>		
a. Is a recording pyrometer or armored thermometer located in the asphalt cement feed line near the discharge end at the mixer unit?		
b. Is the plant equipped with recording pyrometers, or armored thermometers or other approved thermometric instruments at the discharge end of the drier?		
c. Has accuracy of pyrometers or thermometers been checked?		
<b>8. SURGE AND STORAGE BINS</b>		
a. Is plant equipped with surge bin?		
b. Is plant equipped with storage bin?		
c. Is unit enclosed, insulated and weather proof?		
d. Is unit equipped with material level indicator?		
e. Is the indicator visible from plant operator or weigh master's station?		
f. Does unit have approved thermometric instrument so placed to indicate automatically the temperature of mixture at discharge?		
g. Is conveyer system covered and insulated (if necessary) so as to prevent excessive loss of heat during transfer of material from mixing plant to storage bin?		
h. Does storage bin have acceptable heating system?		
i. Has surge or storage bin received prior evaluation and approval before using?		
<b>9. SAFETY AND INSPECTION PROVISIONS</b>		
a. Are gears, pulleys, chains, sprockets and other dangerous moving parts thoroughly protected?		
b. Is an unobstructed and adequately guarded passage provided and maintained in and around the truck loading space for visual inspection purposes?		

	YES	NO
c. Does plant have adequate and safe stairways or guarded ladders to plant units such as, mixer platforms, control platforms, hot storage bins, asphalt storage tanks and etc. where inspections are required?		
d. Is an inspection platform provided with a safe stairways for sampling the asphalt mixture from loaded truck?		
<b>10. TRUCK SALES</b>		
a. Are scales capable of weighing the entire vehicle at one time?		
b. Do scales have a digital printing recorder or automatic weight printer?		
c. Have scales been checked and certified by a reputable scales company in the presence of an authorized representative of the Department?		
<b>11. TRANSPORTATION EQUIPMENT</b>		
a. Are truck bodies clean, tight and in good condition?		
b. Do trucks have covers to protect material from unfavorable weather conditions?		
c. Is soapy water or other approved products available for coating trucks?		
d. Is diesel fuel used to prevent material from sticking to truck bodies?		
e. Type of material used. _____		
<b>12. PROVISIONS FOR TESTING</b>		
a. Does size and location of laboratory comply with specifications?		
b. Is laboratory properly equipped?		
c. Is laboratory acceptable?		
<b><u>SPECIAL REQUIREMENTS FOR BATCH PLANT:</u></b>		
<b>13. WEIGH BOX OR HOPPER</b>		
a. Is weigh box large enough to hold full batch?		
b. Does gate close tightly so that material cannot leak into the mixer while a batch is being weighed?		

	YES	NO
<b>14. AGGREGATE SCALES</b>		
a. Are scales equipped with adjustable pointers or markers for marking the weight of each material to be weighed into the batch?		
b. Are ten 5-lb. weights available for checking scales?		
c. Has accuracy of weights been checked?		
d. Have scales been checked and certified by a reputable scales company in the presence of an authorized representative of the Department?		
e. If the plant is equipped with beam type scales, are the scales equipped with a device to indicate at least the last 10 lbs. of the required load?		
<b>15. ASPHALT CEMENT BUCKET</b>		
a. Is bucket large enough to handle a batch in a single weighing so that the asphalt material will not overflow, splash or spill?		
b. Is the bucket steamed, or oil-jacketed or equipped with properly isolated electric heating units?		
c. Is the bucket equipped to deliver the asphalt material over the full length of the mixer?		
<b>16. ASPHALT CEMENT SCALES</b>		
a. Have scales been checked and certified by a reputable scales company in the presence of an authorized representative of the Department?		
b. Are scales equipped with a device to indicate at least the last 10 lbs. of the approaching total load?		
<b>17. SCREENS</b>		
a. Conditions of screens. Satisfactory _____ Unsatisfactory _____		
b. Do the plant screens have adequate capacity and size range to properly separate all the aggregates into sizes required for proportioning so that they may be recombined consistently?		
<b>18. HOT BINS</b>		
a. Number of bins. _____		

	YES	NO
b. Are bins properly partitioned?		
c. Are bins equipped with overflow pipes?		
d. Will gates cut off quickly and completely?		
e. Can samples be obtained from bins?		
f. Are bins equipped with device to indicate the position of aggregate at the lower quarter point?		
<b>19. ASPHALT CONTROL</b>		
a. Are means provided for checking the quantity or rate of flow of asphalt material?		
b. Time required to add asphalt material into pugmill.		
<b>20. MIXER UNIT FOR BATCH METHOD</b>		
a. Is the plant equipped with an approved twin pugmill batch mixer that will produce a uniform mixture?		
b. Can the mixer blades be adjusted to insure proper and efficient mixing?		
c. Are the mixer blades in satisfactory condition?		
d. Does the mixer gate close tight enough to prevent leakage?		
e. Does the mixer discharge the mixture without appreciable segregation?		
f. Is the mixer equipped with time lock?		
g. Does timer lock the weigh box gate until the mixing cycle is completed?		
h. Will timer control dry and wet mixing time?		
i. Can timer be set in five second intervals throughout the designated mixing cycles?		
j. Can timer be locked to prevent tampering?		
k. Is a mechanical batch counter installed as part of the timing device?		
<b>21. AUTOMATION OF BATCHING</b>		
a. If the plant is fully automated, is an automatic weighing, cycling and monitoring system installed as part of the batching equipment?		
b. Is the automatic proportioning system capable of weighing the materials to within $\pm 0.5$ percent?		

	YES	NO
<b><u>SPECIAL REQUIREMENTS FOR DRUM MIXERS:</u></b>		
<b>22. AGGREGATE DELIVERY SYSTEM</b>		
a. Is number of cold feed bins adequate?		
b. Are cold feed bins equipped with devices to indicate when the level of the aggregate in each bin is below the quarter point?		
c. Does the cold feed have an automatic shut off system that activates when any individual feeder is interrupted?		
d. Are provisions available for conveniently sampling the full flow of material from each cold feed and the total cold feed?		
e. Is the total feed weighed continuously?		
f. Are provisions provided for automatically correcting the wet aggregate weight to dry aggregate weight?		
g. Is the flow of aggregate dry weight displayed digitally in appropriate units of weight and time and totalized?		
h. Are means provided for diverting aggregate delivery into trucks, front-end loggers, or other containers for checking accuracy of aggregate delivery system?		
i. Is plant equipped with a scalping screen for aggregate prior to entering on the conveyer weigh belt?		
<b>23. ASPHALT CEMENT DELIVERY SYSTEM</b>		
a. Are satisfactory means provided to introduce the proper amount of asphalt material into the mix?		
b. Does the delivery system for metering the asphalt material prove accurate within $\pm 1$ percent?		
c. Does the asphalt material delivery interlock with aggregate weight control?		
d. Is the asphalt material flow displayed in appropriate units of volume or weight and time and totalized?		
e. Can the asphalt material be diverted into distributor trucks or other containers for checking accuracy of delivery systems?		
<b>24. DRUM MIXER</b>		
a. Is the drum mixer capable of drying and heating the aggregate to the moisture and temperature requirements set forth in the specifications and capable of producing a uniform mix?		



**MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
Materials Division  
Jackson, Mississippi**

TMD-323  
(Rev. 1-94)

**CERTIFICATE OF STORAGE**

**Project Engineer** \_\_\_\_\_ **Date** \_\_\_\_\_

**Project Number** \_\_\_\_\_ **County** \_\_\_\_\_

**Contractor** \_\_\_\_\_ **Sold to** \_\_\_\_\_

This is to certify that the following items are in storage at :

**Producer** \_\_\_\_\_ **Location** \_\_\_\_\_

MATERIAL	SIZE	LENGTH	TOTAL QUANTITY	UNIT NUMBER	DATE MANUFACTURED
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

**Remarks:** \_\_\_\_\_  
\_\_\_\_\_

The above items have been inspected and found to meet all requirements and are designated for the above-captioned project.

**Signed** \_\_\_\_\_

**Title** \_\_\_\_\_

**PC:** Original and copy to P.E.  
State Construction Division  
District Materials Engineer  
State Materials Engineer

MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
MATERIALS DIVISION  
JACKSON, MISSISSIPPI  
Federal Project  
CERTIFICATION OF MATERIALS AND TESTS

Project Number--

County-----

Contractor-----

Division Administrator  
Federal Highway Administration  
Jackson, Mississippi

Dear Sir:

This is to certify that:

1. The Results of the tests in acceptance samples indicate the materials incorporated in the construction work were in conformity with the approved plans and specifications, and are properly covered by samples and accepted in accordance with State Policy and Procedures. Exceptions, if any, are explained on the attached Form TMD-445.

2. The results of the testing referred to in the above paragraph compare favorably with the results of independent assurance sampling and testing. Exceptions, if any, are explained on the attached Form TMD-444.

Very truly yours,

Richard H. Sheffield, P. E.  
State Materials Engineer

Attachment(s)

- PC:----- Central Records----(via Portera) (71-01, 96-20)
- Asst. Chief Engr-Field Oprs. -Melinda McGrath (91-01)
- Construction Engineer- Brad Lewis (73-01)
- Contract Administration - B. B. House (74-01)
- District Engineer-----
- District Mtls. Engineer-
- Project Engineer-----
- Lab File



MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
MATERIALS DIVISION  
JACKSON, MISSISSIPPI  
State Project  
CERTIFICATION OF MATERIALS AND TESTS

Project Number--

County-----

Contractor-----

Construction Engineer  
Department of Transportation  
Jackson, Mississippi

Dear Sir:

This is to certify that:

1. The Results of the tests in acceptance samples indicate the materials incorporated in the construction work were in conformity with the approved plans and specifications, and are properly covered by samples and accepted in accordance with State Policy and Procedures. Exceptions, if any, are explained on the attached Form TMD-445.

2. The results of the testing referred to in the above paragraph compare favorably with the results of independent assurance sampling and testing. Exceptions, if any, are explained on the attached Form TMD-444.

Very truly yours,

Richard H. Sheffield, P. E.  
State Materials Engineer

Attachment(s)

PC:----- Central Records----(via Portera) (71-01, 96-20)  
Asst. Chief Engr-Field Oprs. -Melinda McGrath (91-01)  
Contract Administration - B. B. House (74-01)  
District Engineer-----  
District Mtls. Engineer-  
Project Engineer-----  
Lab File



Mtls.Div.

MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
MATERIALS DIVISION  
Jackson, Mississippi  
List of Non-favorable Comparisons  
of Independent Assurance Samples With  
Job Control Samples

*Project #-*

*Contr.-----*

*Proj. Engr.-*

*County-----*

*District-----*

*Laboratory Number*

*Material*

*Remarks*

Verification and Acceptance of the TMD-891 and the TMD-890's by I. A. S. Chief :

Signature : \_\_\_\_\_

Date : \_\_\_\_\_

MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
MATERIALS DIVISION  
Jackson, Mississippi  
Listing of Job Control Variations

***Project #-***

***Contr.-----***

***Proj. Engr.-***

***County----***

***District-----***

**Laboratory Number**

***MATERIAL***

**Remarks**

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\*All test values or test results used in determining compliance for clearance of materials, such as bituminous asphalt pavement mix, grass seed, agricultural limestone and concrete pavement thickness, that indicate deficiencies from the contract's specified values and where such materials are allowed to remain in place shall be handled in accordance with applicable project documents and specifications.

**MISSISSIPPI DEPARTMENT OF TRANSPORTATION**  
**MATERIALS DIVISION**  
**JACKSON, MS**  
**FIELD DENSITY REPORT FOR EMBANKMENTS**  
**(MT - 16)**

PROJECT \_\_\_\_\_  
 COUNTY \_\_\_\_\_ CONTRACTOR \_\_\_\_\_ TECHNICIAN \_\_\_\_\_  
 COMPONENT: Basement Soil \_\_\_\_\_ Design Soil \_\_\_\_\_ BORROW MAT'L: Class \_\_\_\_\_  
 TREATMENT: None \_\_\_\_\_ Lime (by Wgt.), 1st Appl. \_\_\_\_\_ % 2nd Appl. \_\_\_\_\_ %  
 DESIGN THICKNESS (Inches) \_\_\_\_\_ LIFT \_\_\_\_\_

1.	Lot No.					
2.	Lot Size					
3.	Date of Test					
4.	Time of Test					
5.	Station Limits of Lot					
6.	Station No. at Test Site					
7.	Location from Left Edge, Ft.					
8.	Depth Below Subgrade, Inches					
9.	Depth of Test, Inches					
S T D  D E N S I T Y	10. Std. Density Curve No.					
	11. Optimum Moisture, %					
	12. Std. Density, PCF					
F I E L D  D E N S I T Y  T E S T	13. Gage Moisture Bias (+) or (-)					
	14. Dry Density, PCF					
	15. Moisture, %					
	16. Density, % of Std.					
<b>VERIFICATION TESTS</b>						
	17. Dry Density, PCF					
	18. Moisture, %					
	19. Density, % of Std.					
	20. Avg. Lot Density % of Std.					
	21. Required Density, % of Standard					

REMARKS: \_\_\_\_\_

**DISTRIBUTION:**  
 Original - Project Engineer  
 State Materials Engineer  
 State Construction Engineer  
 District Materials Engineer

Signed \_\_\_\_\_

Title \_\_\_\_\_

**INSTRUCTIONS FOR COMPLETING FORM TMD - 522**

This form is for use in recording density test data on embankments. The form is to be completed for each density test.

- Line 1:** Number, running in numerical order, assigned to each Lot.
- Line 2:** Size of the Lot, as set out in the specifications, on which acceptance or rejection is based.
- Line 3 & 4:** Date and time each density test performed.
- Line 5 - 9:** Location of each density test.
- Line 10:** Number assigned to the Standard Density Curve to be used in determining the percent of Standard Density and Optimum Moisture at each test site.
- Line 11:** Optimum Moisture from the Standard Density Curve corrected to include the moisture for the amount of material retained on the 1/2 inch sieve at the density test site using the nomograph. When there is no material retained on the 1/2 inch sieve, the Optimum Moisture is taken directly from the Standard Density Curve.
- Line 12:** Standard Density from the Standard Density Curve corrected to include the amount of material retained on the 1/2 inch sieve at the density test site using the nomograph. When there is no material retained on the 1/2 inch sieve, the Standard Density is taken directly from the Standard Density Curve. This Standard Density is programmed into the nuclear gage.
- Line 13:** The nuclear gage measures moisture content based on total hydrogen in the soil. Some soils may contain chemically bound hydrogen which would result in an erroneous moisture content if it is not corrected. This condition may occur in soils or soil-aggregate mixtures containing high gypsum content, lime, cement, high calcium content, etc. Moisture correction factor for such conditions must be determined and applied in accordance with the Nuclear Gage Instruction Manual. The correction factor with a plus (+) or minus (-) sign is to be programmed in the Nuclear Gage.
- Line 14 - 16:** Used for recording the field density test data.
- Line 17 - 20:** If the density on Line 16 does not meet the required density, a verification test must be performed and recorded on Lines 17 - 20. Line 20 equals the average of Lines 16 and 19, and is the Test Value for the Lot. If the density on Line 16 meets, then Lines 17 - 20 will be blank.
- Line 21:** Record the required density for each Lot.

VERIFICATION TESTS


REMARKS

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MISSISSIPPI DEPARTMENT OF TRANSPORTATION

Materials Division

Form for Reviewing Field Verification Testing of Portland Cement Concrete Mixtures

SiteManager #

Field Verification of MDOT Mixture #

DATE: \_\_\_\_\_

PROJECT NO.: \_\_\_\_\_

PCC PRODUCER: \_\_\_\_\_

COUNTY: \_\_\_\_\_

PCC PRODUCER'S MIXTURE NO.: \_\_\_\_\_

CONTRACTOR: \_\_\_\_\_

PLANT LOCATION: \_\_\_\_\_

MIX QUANTITIES

Material	Source	Description	Bulk Specific Gravity	Unit Weight (lb/yd³)	Fineness Modulus	Quantities Oven-Dry (lb/yd³)	Absolute Volume (yd³)
Cement							
Fly Ash							
GGBFS							
Water							
Fine Agg.							
Coarse Agg.							
Air-entraining*							
Admixture*							
Admixture*							
Admixture*							
Admixture*							
<b>Total</b>							

BATCH QUANTITIES

Batch Volume: \_\_\_\_\_ yd³

Material	Target Batch Weight (lb/yd³)	Actual Batch Weight (lb/yd³)	Actual Weight per yd³ (lb/yd³)	Total Moisture (%)	Absorption (%)	Surface Moisture		Actual Dry Weight (lb/yd³)
						(%)	(lb)	
Cement								
Fly Ash								
Slag								
Water								
Fine Agg.								
Coarse Agg.								
Air-entraining*								
Admixture*								
Admixture*								
Admixture*								
Admixture*								
<b>Total</b>							<b>Total</b>	

Water Content \_\_\_\_\_ lb  
 Slump \_\_\_\_\_ \*\*within minus (-) 1-1/2 in. of maximum  
 Air Content \_\_\_\_\_ within minus (-) 1-1/2 percent maximum  
 Temperature \_\_\_\_\_ °F  
 Unit Weight \_\_\_\_\_ lb/yd³  
 Yield \_\_\_\_\_ within ± 2%

FINE AGGREGATE

Initial Weight (g) \_\_\_\_\_

Sieve	Accum. Wt. Retained	Total % Passing	Gradation Requirements
1/2 inch			100
3/8 inch			97-100
No. 4			92-100
No. 8			75-100
No. 16			45-90
No. 30			25-70
No. 50			3-35
No. 100			0-10
Pan			

COARSE AGGREGATE

Initial Weight (g) \_\_\_\_\_ Size: \_\_\_\_\_

Sieve	Accum. Wt. Retained	Total % Passing	Gradation Requirements
2 inch			
1-1/2 inch			
1 inch			
3/4 inch			
1/2 inch			
3/8 inch			
No. 4			
No. 8			
Pan			

Note: \* Weights for admixtures are reported in fluid ounces (fl. oz.).  
 \*\* A minimum of 2.5 in. slump is allowed for mixes containing Type F or G chemical admixture.

Remarks:





**MISSISSIPPI DEPARTMENT OF TRANSPORTATION**  
**INFORMATION FOR PRODUCT EVALUATION COMMITTEE**

DATE: \_\_\_\_\_

**FOR NEW MATERIAL OR NEW PRODUCT**

Trade Name: \_\_\_\_\_

Manufacturer: \_\_\_\_\_

Address: \_\_\_\_\_

Street or P.O. Box                      City                      State      Zip Code

Phone Number: (      )                      -                      \_\_\_\_\_

FAX Number: (      )                      -                      \_\_\_\_\_

Represented by: \_\_\_\_\_

Address: \_\_\_\_\_

Street or P.O. Box                      City                      State      Zip Code

Phone Number: (      )                      -                      \_\_\_\_\_

FAX Number: (      )                      -                      \_\_\_\_\_

**Material/Product Data:**

Patented?      Yes:      \_\_\_\_\_      No:      \_\_\_\_\_      Applied for: \_\_\_\_\_

New to market? Yes:      \_\_\_\_\_      No:      \_\_\_\_\_

Recommended Use: \_\_\_\_\_

\_\_\_\_\_

Use for which the product is to be evaluated: \_\_\_\_\_

\_\_\_\_\_

Outstanding Features or Advantages: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Composition: \_\_\_\_\_

\_\_\_\_\_

Specifications furnished by Manufacturer?      Yes:      \_\_\_\_\_      No:      \_\_\_\_\_

**PRODUCT EVALUATION FORM 3.0**  
**ADM-361**  
**(Revised July 2005)**

Drawing, picture, or sketch furnished by Manufacturer? Yes: \_\_\_\_\_ No: \_\_\_\_\_

Has this product been evaluated by the National Transportation Product Evaluation Program (NTPEP): Yes: \_\_\_\_\_ No: \_\_\_\_\_

If yes, please provide all applicable NTPEP report citation(s), evaluation dates, and information:\_\_\_\_

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**Meets requirements of following specifications:**

MDOT: \_\_\_\_\_; AASHTO: \_\_\_\_\_;

ASTM: \_\_\_\_\_; Federal Specification \_\_\_\_\_;

Others (Please List): \_\_\_\_\_

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**Availability:**

Seasonal? Yes: \_\_\_\_\_ No: \_\_\_\_\_

Are quantities limited? Yes: \_\_\_\_\_ No: \_\_\_\_\_

Will sample be furnished? Yes: \_\_\_\_\_ No: \_\_\_\_\_

Will laboratory analysis be furnished? Yes: \_\_\_\_\_ No: \_\_\_\_\_

Delivery at Site in \_\_\_\_\_ days after receipt of order.

**Product Competitors:**

Alternate for what existing material or product: \_\_\_\_\_

---

Are costs comparable to materials or products now being used in Mississippi? Yes: \_\_\_ No: \_\_\_

If the answer is no, what is difference? \_\_\_\_\_

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**THE FOLLOWING IS APPLICABLE TO:**

**NEW MATERIAL, NEW PRODUCT, OR NEW PROCEDURE**

Approved for use by highway authorities or other agencies in the following states: \_\_\_\_\_

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Being used?    Yes: \_\_\_            No: \_\_\_            On trial basis?            Yes: \_\_\_            No: \_\_\_

Are instructions or directions for installation, application or use available? Yes: \_\_\_            No: \_\_\_

Will demonstration be provided?            Yes:    \_\_\_\_\_            No:    \_\_\_\_\_

Are educational courses or films available?            Yes:    \_\_\_\_\_            No:    \_\_\_\_\_

If proprietary, what are royalty costs and on what basis are they collected?            \_\_\_\_\_

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Background description of company offering this proposal: \_\_\_\_\_

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Whom have you contacted in the Mississippi Department of Transportation? \_\_\_\_\_

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Has this proposal been made previously?            Yes:    \_\_\_\_\_            No:    \_\_\_\_\_

Additional information: \_\_\_\_\_

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**PRODUCT EVALUATION FORM 3.0  
ADM-361  
(Revised July 2005)**

Additional information Continued: \_\_\_\_\_  
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\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Person Completing Form: \_\_\_\_\_  
Title: \_\_\_\_\_  
E-Mail Address: \_\_\_\_\_  
Firm Represented: \_\_\_\_\_

**For consideration by the Mississippi Department of Transportation Product Evaluation Committee, please submit the original of this form plus one copy and duplicate copies of any relative information (such as product brochures) to the following address:**

**STATE MATERIALS ENGINEER  
MISSISSIPPI DEPARTMENT OF TRANSPORTATION  
P.O. BOX 1850  
JACKSON, MISSISSIPPI 39215-1850**

## Appendix B – Mississippi Test Methods

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**MT6- Nuclear Determination of Bitumen Content of Bituminous Paving Mixtures**

**PURPOSE:** To establish a standard procedure for determining the bitumen content of hot bituminous paving mixtures by use of a nuclear bitumen content gauge.

**1. APPARATUS**

- 1.1 Troxler Asphalt Content Gauges, Models 3241-A, 3241-B and 3241-C; CPN Corporation AC-2 Asphalt Content Gauge, or approved equal.
- 1.2 Balance - Mettler PC 16, or approved equal.
- 1.3 Mechanical convection oven capable of maintaining a temperature of 300°F ± 5°F.
- 1.4 Thermometer with a temperature range of 50° to 400°F (10° to 204°C) with sensitivity of 5°F (2.8°C).
- 1.5 Miscellaneous Equipment
  - 1.5.1 3/4-inch board approximately 14 inches square.
  - 1.5.2 Supply of wrapping paper to cover board.
  - 1.5.3 A trowel or small spade for use in filling specimen container.
  - 1.5.4 A supply of rags and solvent for cleaning equipment.

**2. CALIBRATION OF GAUGES**

- 2.1 Troxler Asphalt Content Gauge, Model 3241-A.
    - 2.1.1 Prepare three (3) calibration specimens in accordance with the gauge instruction manual. The specimens must be prepared at the same weight within ±1 gram. The aggregate blend and asphalt cement to be used in the mix must be used to prepare the specimens. Prepare one specimen at 1% higher than the design bitumen content, one specimen at the design bitumen content, and one specimen at 1% lower than the design bitumen content. All calibration specimens shall be prepared and tested at a uniform temperature within ± 10°F (6°C) and as close as possible to the job-mix temperature. (This may necessitate heating the specimens in an oven at a temperature not to exceed the job-mix temperature.)
    - 2.1.2 Using two (2) of the calibration specimens (one at 1% higher than the design bitumen content and one at 1% lower than the design bitumen content), calibrate the gauge in accordance with the gauge instruction manual.
    - 2.1.3 Check the gauge calibration by taking the average of fifteen (15) 4-minute counts using the calibration specimen prepared at the design bitumen content. If the average is ± 0.06% or more from the design bitumen content, check the gauge calibration procedures. If the average is less than ± 0.06% from the design bitumen content, adjust the intercept to make the gauge read the design bitumen content. This adjustment is accomplished by using the calibration offset procedure as set out in the gauge instruction manual.
  - 2.2 Troxler Asphalt Content Gauges, 3241-B and 3241-C; CPN Corporation AC-2 Asphalt Content Gauge.
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- 2.2.1 Prepare three (3) or more calibration specimens in accordance with the gauge instruction manual. The specimens must be prepared at the same weight within  $\pm 1$  gram. The aggregate blend and asphalt cement to be used in the mix must be used to prepare the specimens. The range of bitumen content of the specimens (lowest to the highest) shall not exceed three percent (3%) and shall encompass and be equally distributed above and below the design bitumen content. All calibration specimens shall be prepared and tested at a uniform temperature within  $\pm 10^{\circ}\text{F}$  ( $6^{\circ}\text{C}$ ) and as close as possible to the job-mix temperature. (This may necessitate heating the specimens in an oven at a temperature not to exceed the job -mix temperature.)
  - 2.2.2 Using the three (3) or more calibration specimens prepared as outlined in Subsection 2.2.1, calibrate the gauge in accordance with the gauge instruction manual.
  - 2.2.3 Check gauge calibration (correlation factor, fit coefficient or correlation coefficient; acceptable value is 0.995 or greater) for acceptance in accordance with the gauge instruction manual.
  - 2.3 Record calibration and supporting data (background count; temperature and weight of calibration specimens).
  - 2.4 Gauge must be calibrated for each job-mix formula. A new calibration will be required when there is a change in aggregate or bitumen source. When gauge repairs are made, check calibration.

### 3. PREPARATION OF TEST SPECIMEN

- 3.1 Obtain a representative sample of the mix and reduce to test specimen size in accordance with AASHTO T 248, Method B.
- 3.2 Fill specimen pan with the mix to within  $\pm 1$  gram of the weight of the calibrated specimen.
- 3.3 Measure and record the temperature of the test specimen. All test specimens shall be tested at a temperature within  $\pm 10^{\circ}\text{F}$  ( $6^{\circ}\text{C}$ ) of the calibrated specimens.

### 4. PROCEDURE

- 4.1 With the proper job-mix calibration in the gauge, place the test specimen in the gauge chamber and take a sixteen (16) minute-measure count in accordance with the gauge instruction manual.

NOTE: (FOR CENTRAL LABORATORY USE ONLY) When it is necessary to test a specimen after it cools, heat the test specimen in an oven to  $290^{\circ}\text{F}$  -  $300^{\circ}\text{F}$  for a minimum of three (3) hours before testing.

- 4.2 The sixteen (16) minute-measure count is the bitumen content of the specimen.
- 4.3 Remove specimen from the gauge, empty and clean the specimen pan.

### 5. REPORT

Report the bitumen content to the nearest 0.01 percent.

### 6. CORRECTED BITUMEN CONTENT

The reported bitumen content shall be corrected for moisture as set out in S.O.P. No. TMD-11-31-00-000

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## MT-7 Moisture-Density Relations of Soils Using Family of Curves

**PURPOSE:** To establish a rapid method of test for determining the moisture-density relations of soils.

**SCOPE:**

**1.1** This method of test is intended for determining the relationship between the moisture content and density of a soil utilizing the family of moisture-density curves and a one point proctor, compacted as specified herein. This method is an acceptable alternate to MT-8, Moisture-Density Relations of Soils, under the conditions set forth in these provisions. This method is applicable to embankment soils, design soils, and to untreated subbase and base materials.

**1.2** To obtain maximum utilization of the family of curves, the person using this method of test:

- (1)** Must familiarize himself thoroughly with the materials being tested.
- (2)** Must be experienced in the use of the AASHTO Classification System.
- (3)** Should be familiar with the Unified Classification System to be able to recognize the difference between an SP and SM soil within the A-2 AASHTO Group.

**1.3** When Case 1 or Case 2 is referred to herein, this shall be interpreted to mean:

**Case 1** – When approximately 90 percent or more of the soil or material passes the No. 4 sieve.

**Case 2** – When approximately 10 percent or more of the soil or material is retained on the No. 4 sieve.

**APPARATUS:**

**2.1** Molds

- (1)** 4.0 inch inside diameter mold having a capacity of 0.333 ft<sup>3</sup>
- (2)** 6.0 inch inside diameter mold having a capacity of 0.10 ft<sup>3</sup>

**2.2** Rammer – A metal rammer having a 2 inch diameter circular face, or a segmented face (used with mechanical tampers) having an area equivalent to a 2 inch diameter circle, and weighing 5.5 pounds. (The use of a mechanical tamper with a segmented rammer face is not only permissible but is desirable.) The rammer shall be equipped with a suitable arrangement to control the height of drop to a free fall or twelve inches above the elevation of the soil.

**2.3** Sample Extruder (optional) – A jack, lever, frame, or other device adapted for the purpose of extruding compacted specimens from the mold.

Note: It has been found that an extruder is very useful in breaking up heavy clay specimens, after compaction, by slicing the specimen into very thin layers during extrusion.

**2.4** Balances – A balance of at least 1000 g capacity sensitive to 0.1 g.

**2.5** Drying Apparatus – A thermostatically-controlled drying oven capable of maintaining a temperature of 110±5 C.

**2.6** Straight Edge – A rigid steel straight edge approximately twelve inches in length and having one beveled edge.

**2.7** Sieves – ½ inch and No. 4 (If required)

**2.8** Mixing Tools – Miscellaneous tools such as mixing pan, spoon, trowel, spatula, knife, etc.; a suitable mechanical device for thoroughly mixing the sample of soil with increments of water is desirable.

**SAMPLE:**

**3.1** If a soil sample is damp when received from the field, it shall be dried until it can be easily broken up with a trowel; drying may be in air or by use of drying apparatus such that the temperature of the sample does not exceed 60 C. Then thoroughly break up the aggregations in such a manner as to avoid reducing the natural size of individual particles.

**3.2** Determine by sieving or visual inspection if the soil should be tested under Case 1 or Case 2.

- (1)** For Case 1 – Select a representative sample of the soil prepared as described in 3.1 and weighing approximately 7 pounds.
- (2)** For Case 2 – Determine the moisture content of the soil prepared as described in 3.1. Separate the sample on the ½ inch sieve, determining the percentage of the retained portion. Select a representative sample of the fraction passing the ½ inch sieve and weighing approximately 20 pounds.

**PROCEDURE:**

**4.1** Thoroughly mix the selected representative sample with sufficient water to bring the sample to slightly less than its optimum moisture. (From 1 to 3 percentage points below optimum moisture.)

**4.2** Case 1 – Form a specimen by compacting the prepared soil in the 4 inch mold (with collar attached) in three equal layers to give a total compacted depth sufficient to fill the mold, but not to exceed approximately five inches. Compact each layer by twenty-five uniformly distributed blows from the rammer dropping free from a height of 12 inches above the elevation of the soil. During compaction, the mold shall rest on a solid, rigid foundation. Following compaction, remove the extension collar, carefully trim the compacted soil even with the top of the mold by means of the straight-edge and weigh. Record weight of specimen and mold as “D”; weight of mold as “E”.

**4.3** Case 2 – Form a specimen by compacting the minus ½ inch portion of the prepared soil in the 6 inch mold (with collar attached) in four equal layers to give a total compacted depth of about 6.5 inches. Compact each layer by fifty-six (56) uniformly distributed blows from the rammer, as described in 4.1, and weigh. Record weight of specimen as “D”; weight of mold as “E”.

**4.4** Remove the material from the mold and slice vertically through the center. Take a representative sample of the material, weighing not less than 100 g for fine-grained soils, or not less than 500 g from coarse-grained soils, from the full height of one of the cut faces; weigh immediately; dry to a constant weight and weigh. Determine weight of container.

**CALCULATIONS:**

**5.1** Calculate the moisture content of the soil specimen as follows:

$$w = \frac{A - B}{B - C} \times 100$$

Where, w = percentage of moisture in the specimen, based on oven-dry weight of the soil

A = weight of container and wet soil

B = weight of container and dry soil

C = weight of container

**5.2** Calculate the dry weight per cubic foot of the compacted soil, as follows:

$$\text{(1) Case 1: } W = \frac{(D - E) \times 30}{w + 100} \times 100$$

$$(2) \text{ Case 2: } W = \frac{(D - E) \times 100}{w + 100} \times 100$$

Where,  $W$  = dry weight, in pounds per cubic foot of compacted soil,

$D$  = weight of compacted specimen and mold in pounds

$E$  = weight of mold, in pounds

$w$  = percentage of moisture in the specimen, based on oven-dry weight of the soil.

NOTE: When gram scales are used, the results obtained under 5.2 should be divided by 453.6.

#### MOISTURE-DENSITY RELATIONSHIP AS DETERMINED FROM THE FAMILY OF CURVES:

**6.1** Case 1 – Plot the dry density and moisture content of the compacted specimen on Figure 1 containing Curves B & C. (If the point falls above Curve B, the Family of Curves shall not be used.)

**(1) A1, A4, A6, and A7 Soils** – Project a line parallel with the nearest diagonal line to the intersection of Curve B. The corresponding dry density and moisture content at the intersection of Curve B shall be recorded as the Standard Density and Optimum Moisture of the Sample.

NOTE: For all A1, A4, A6, and A7 Soils, Curve C shall be disregarded, use Curve B. In the event a question should arise as to the classification of the particular soil being tested, the Engineer will require that a second specimen must be compacted at a slightly higher moisture content and plotted to determine whether to use Curve B or Curve C when the density is within the range of Curve C.

**(2) A2 and A3 Soils** – Project a line parallel with the nearest diagonal line to its intersection with the first curve (Curve C or B) crossed. The corresponding dry density and moisture content at the intersection shall be recorded as the Standard Density and Optimum Moisture of the sample.

NOTE: Most A3 soils and some A2 (SP-SM) Soils will fall within the limits of Curve C. In the event a question should arise as to the classification of the particular soil being tested, the Engineer will require that a second specimen must be compacted at a slightly higher moisture content and plotted to determine whether to use Curve B or Curve C when the density is within the range of Curve C.

**6.2** Case 2 – Plot the dry density and moisture content of the compacted specimen on Figure 1 containing Curve A. Project a line parallel with the nearest diagonal line to the intersection of Curve A. The corresponding dry density and moisture content at this intersection shall be recorded as the Standard Density and Optimum Moisture of the – ½ inch material. (If the point falls above Curve A, the Family of Curves shall not be used.)

**(1) Optimum Moisture Content** – The “optimum moisture content” of the whole sample, under Case 2 (when the sample contains + ½ inch material), shall be obtained from the following formula:

$$OM_w = \frac{3}{100} (\% \text{ Retained on } \frac{1}{2} \text{ inch sieve}) + \frac{OM_p}{100} (\% \text{ Passing } \frac{1}{2} \text{ inch sieve})$$

Where,  $OM_w$  = Optimum Moisture of Whole Sample

$OM_p$  = Optimum Moisture of – ½ inch fraction

NOTE: In this formula, the moisture content of the plus ½ inch material is assumed to be 3 percent.

**6.3** Standard Density – The standard density of the whole sample, under Case 2 (when the sample contains + ½ inch material), shall be obtained by applying the percentage of + ½ inch material, as determined above, to the Nomograph (Figure 2). (The Nomograph is available as TMD-520.) In determining the standard density from the Nomograph, the Bulk Specific Gravity of the + ½ inch material, as determined in accordance with AASHTO T 85, will be used. It will not be necessary to determine the specific gravity for each density determination after sufficient experience has been gained so that a value may be assigned to the specific type and source of the material being tested.

Figure 1

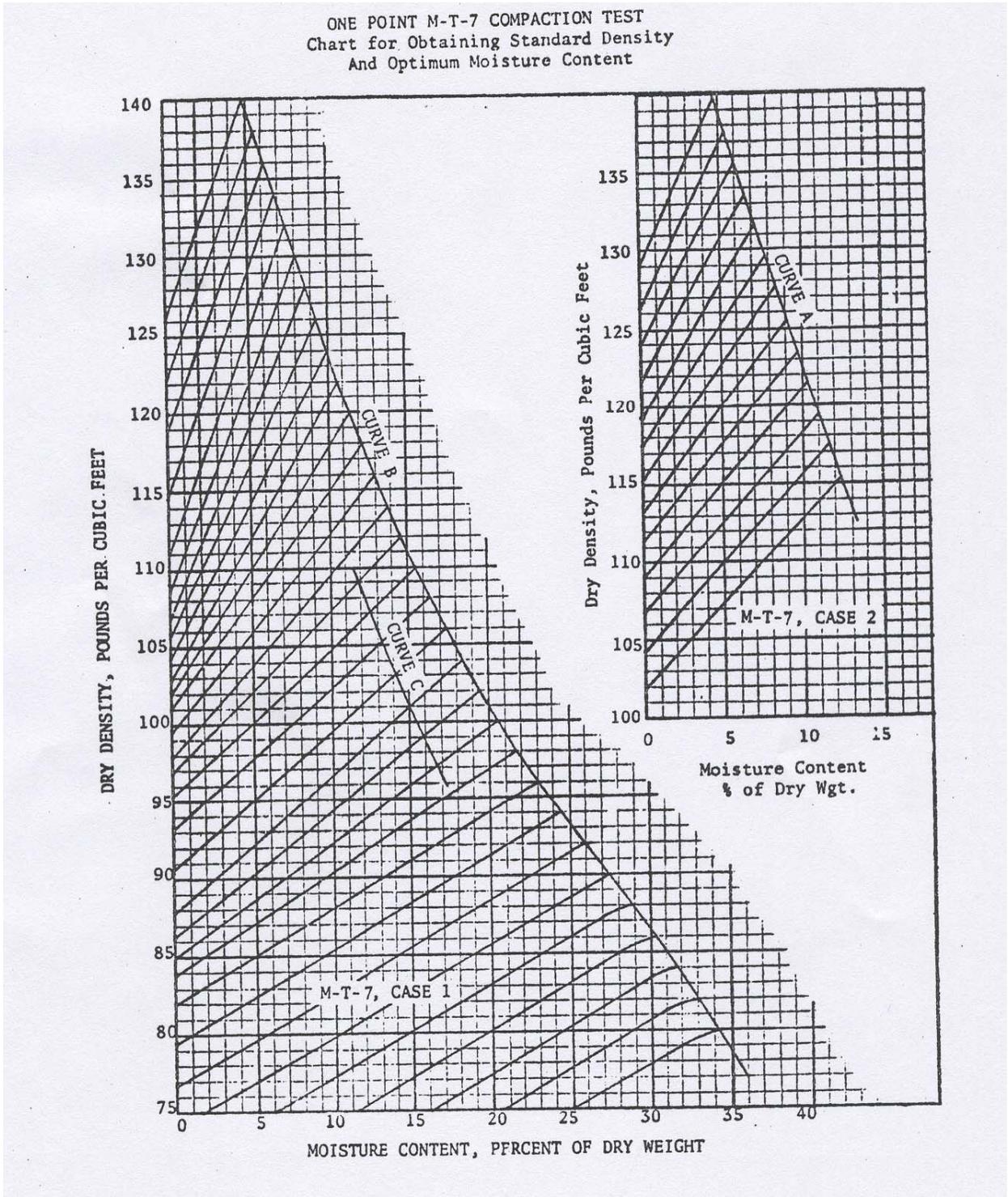
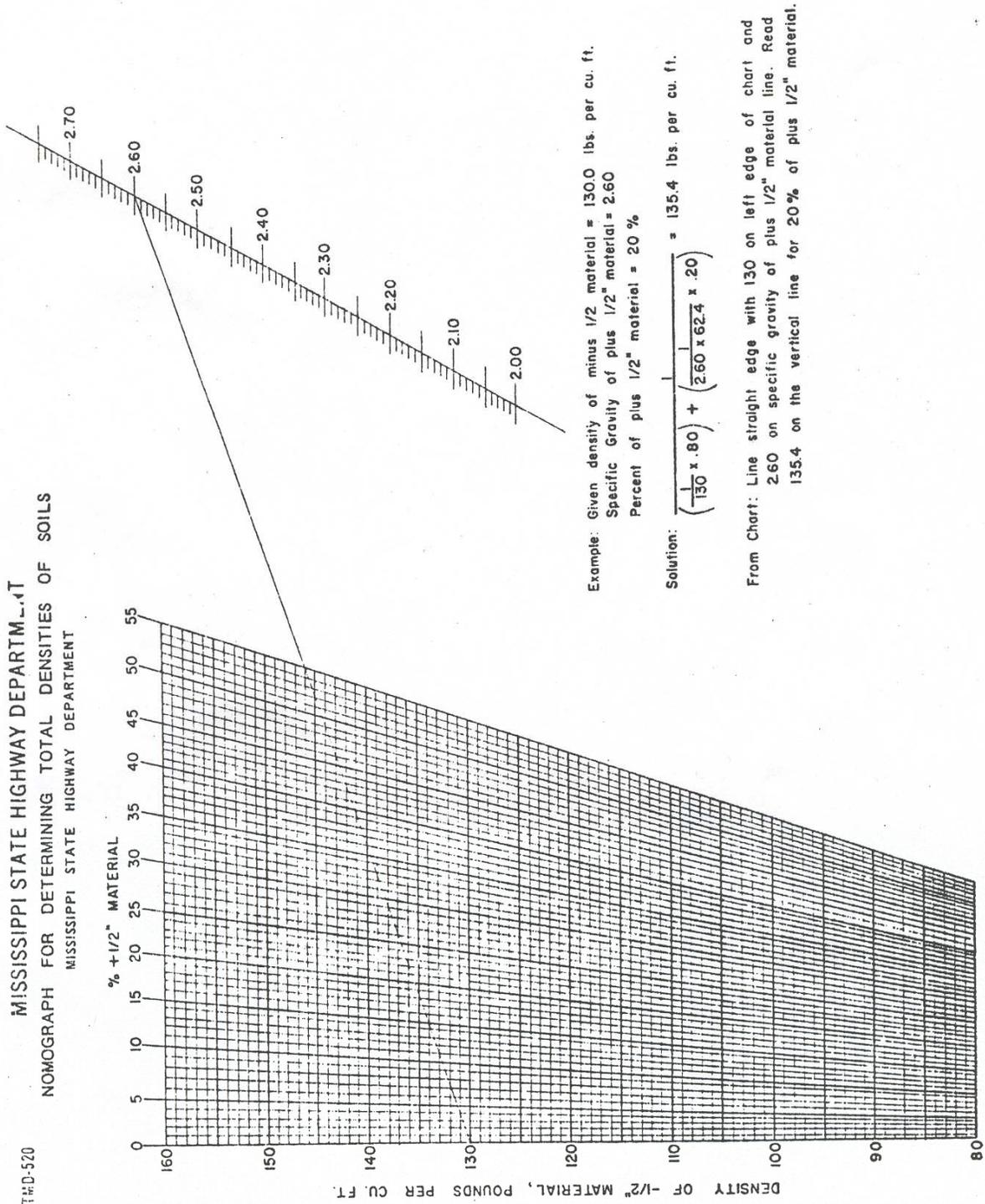


Figure 2



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## MT-8 – Moisture-Density Relations of Soils Using Family of Curves

**PURPOSE:** To establish a method of test for determination of the moisture-density relations of soils.

### 1. SCOPE

1.1 This method of test is intended for determining the relationship between the moisture content and density of a soil compacted in a mold of a given size with a 5.5 lb hammer dropped from a height of 12 in. The method is otherwise known as Method MT-8M and is a modification of AASHTO T 99.

1.2 These methods are applicable to embankment soils, design soils, and untreated subbase and base materials.

1.3 When CASE 1 or CASE 2 is referred to herein, this shall be interpreted to mean:

1.3.1 CASE 1: When approximately 90 percent or more of the soil or material passes the No. 4 sieve.

1.3.2 CASE 2: When approximately 10 percent or more of the soil or material is retained on the No. 4 sieve.

### 2. APPARATUS

#### 2.1 MOLDS

2.1.1 4.0 in. inside diameter mold having a capacity of  $0.000\ 943 \pm 0.000\ 008\ \text{m}^3$ .

2.1.2 6.0 in. inside diameter mold having a capacity of  $0.002\ 124 \pm 0.000\ 021\ \text{m}^3$ .

2.2 RAMMER. A metal rammer having a 2 inch diameter circular face, or a segmented face (used with mechanical tampers) having an area equivalent to a 2 inch diameter circle and a mass of 5.5 pounds. (The use of a mechanical tamper with a segmented rammer face is not only permissible but is desirable.) The rammer shall be equipped with a suitable arrangement to control the height of drop to a free fall of 12 inches above the elevation of the soil.

2.3 SAMPLE EXTRUDER (optional). A jack, lever, frame, or other device adapted for the purpose of extruding compacted specimens from the mold.

2.4 BALANCES. A balance or scale of at least 12 kg (25 lb) capacity sensitive to 5 g (0.01 lb); and a balance of at least 1000-g capacity sensitive to 0.1 g.

2.5 DRYING OVEN. A thermostatically-controlled drying oven capable of maintaining a temperature of  $110 \pm 5^\circ\text{C}$  ( $230 \pm 9^\circ\text{F}$ ), or other suitable means for drying moisture samples.

2.6 STRAIGHTEDGE. A rigid steel straightedge approximately 12 inches in length and having one (1) beveled edge.

2.7 SIEVES. 1/2 inch, and No. 4 (if required, see Subsection 3.3 below)

2.8 MIXING TOOLS. Miscellaneous tools such as mixing pan, spoon, trowel, spatula, knife, etc.; a suitable mechanical device for thoroughly mixing the sample of soil with increments of water is desirable.

### 3. SAMPLE

3.1 If the soil sample is damp when received from the field, it shall be dried until it can be easily broken up with a trowel; drying may be in air or by use of drying apparatus such that the temperature of the sample does not exceed 60°C (140 °F). Then thoroughly break up the aggregations in such a manner as to avoid reducing the natural size of individual particles.

3.2 After the above drying and pulverizing, the moisture content of the soil should be determined. If preferable, the soil may be dried to constant mass (zero moisture content).

3.3 Determine by sieving or visual inspection if the soil should be tested under CASE 1 or CASE 2.

3.3.1 FOR CASE 1, select a representative sample of the soil prepared as described in Subsection 3.1 and with a mass of approximately 7 lb.

3.3.2 FOR CASE 2, separate the sample, prepared as described in Subsection 3.1, on the 1/2 inch sieve, determining the percentage of the retained portion. Select a representative sample of the fraction passing the 1/2 inch sieve and weighing approximately 20 lb.

### 4. PROCEDURE

4.1. Thoroughly mix the selected representative sample with sufficient water to dampen it to approximately four percentage points below the estimated optimum moisture content.

4.2 CASE 1: Form a specimen by compacting the prepared soil in the 4 inch mold (with collar attached) in three (3) equal layers to give a total compacted depth sufficient to fill the mold, but not to exceed approximately 127 mm. Compact each layer by twenty-five (25) uniformly distributed blows from the rammer dropping free from a height of 5 inches above the elevation of the soil. During compaction, the mold shall rest on a solid, rigid foundation. Following compaction, remove the extension collar, carefully trim the compacted soil even with the top of the mold by means of the straightedge, and measure its mass. Record mass of specimen and mold as "D" and mass of mold as "E."

4.3 CASE 2: Form a specimen by compacting the minus 1/2 inch portion of the prepared soil in the 6 inch mold (with collar attached) in four (4) equal layers to give a total compacted depth of about 6.5 inches. Compact each layer by fifty-six (56) uniformly distributed blows from the rammer, as described in Subsection 4.2 above, and determine mass. Record mass of specimen as "D;" and mass of mold as "E."

4.4 Remove the material from the mold and slice vertically through the center. Take a representative sample of the material, with a mass of not less than 100 g for fine-grained soils, or not less than 500 g for coarse-grained soils, from the full height of one of the cut faces; weigh immediately; dry to a constant mass and measure its mass. Determine mass of container.

4.5 Thoroughly break up the remaining portion of the molded specimen and add to the remaining portion of the sample being tested. Add water in sufficient amount to increase the moisture content of the soil sample by one or two percentage points and mix; repeat the procedure described in Subsection 4.2 and Subsection 4.4 for each increment of water added. Continue this series of determinations until there is either a decrease or no change in the wet mass of the compacted soil and mold.

NOTE: This procedure has been found satisfactory in most cases. However, in instances where the soil material is fragile in character and will reduce significantly in grain size due to repeated compaction, and in cases where the soil is a heavy-textured clayey material into which it is difficult to incorporate water, a separate and new sample shall be used in each compaction test. In these cases, separate samples shall be thoroughly mixed with amounts of water sufficient to cause the moisture contents of the samples to vary by approximately one, or two, percentage points. The moisture contents selected shall bracket the estimated optimum moisture content, thus providing samples which, when compacted, will increase in mass to the maximum density and then decrease in mass.

## 5. CALCULATIONS

5.1 Calculate the moisture content of the soil specimen for each trial, as follows:

$$w = \frac{A - B}{B - C} \times 100$$

Where, w = percentage of moisture in the specimen, based on oven-dry mass of the soil,

A = mass of container and wet soil (Subsection 4.4)

B = mass of container and dry soil (Subsection 4.4)

C = mass of container.

5.2 Calculate the dry mass per cubic meter of the soil as compacted, for each trial, as follows:

$$\text{Case 1: } W = \frac{(D - E) \times 1059.43}{w + 100} \times 100$$

$$\text{Case 2: } W = \frac{(D - E) \times 470.74}{w + 100} \times 100$$

Where, W = dry mass, in kilograms per cubic meter of compacted soil,

D = mass of compacted specimen and mold in kilograms (Subsection 4.2),

E = mass of mold, in mass,

w = percentage of moisture in the specimen, based on oven-dry mass of the soil.

## 6. MOISTURE-DENSITY RELATIONSHIP

6.1 The calculations in Section 5 shall be made to determine the moisture content and corresponding oven-dry mass per cubic meter (density) for each of the compacted soil samples. The densities of the soil shall be plotted as ordinates and corresponding moisture contents as abscissa.

- 6.2 OPTIMUM MOISTURE CONTENT. When the densities and corresponding moisture contents for the soil have been determined and plotted as indicated in paragraph (a), it will be found that by connecting the plotted points with a smooth line, a curve is produced. The moisture content corresponding to the peak of the curve shall be termed the "optimum moisture content" of the soil under Case 1, and of the minus 1/2 inch fraction under Case 2. The "optimum moisture content" of the whole sample, under Case 2 (when the sample contains plus 1/2 inch material), shall be obtained from the following formula:

$$OM_w = \frac{3}{100} (\% \text{ retained on 12.5 mm sieve}) + \frac{OM_p}{100} (\% \text{ passing 12.5 mm sieve})$$

where,  $OM_w$  = Optimum Moisture of whole sample,

$OM_p$  = Optimum Moisture of minus 12.5 mm fraction.

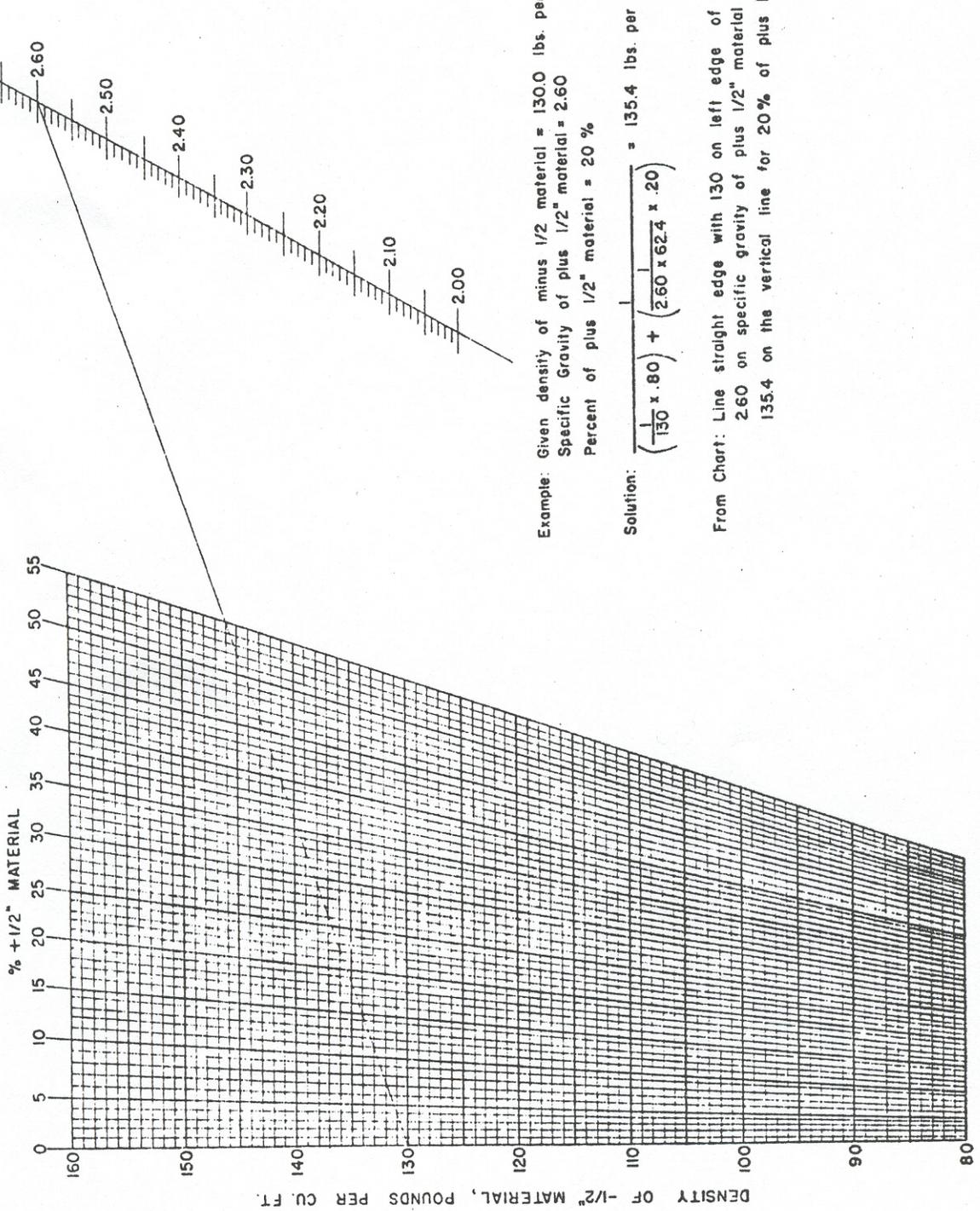
NOTE: In this formula, the moisture content of the plus 12.5 mm material is assumed to be 3 percent.

6.3 STANDARD DENSITY. The oven-dry mass per cubic meter of the soil at optimum moisture content shall be termed "standard density" under the above compaction. The density at optimum moisture is the standard density of the soil under Case 1, and of the minus 1/2 inch fraction under Case 2. The standard density of the whole sample, under Case 2 (when the sample contains plus 1/2 inch material), shall be obtained by applying the percentage of plus 1/2 inch material, as determined above, to the Nomograph shown below. **(The Nomograph is available as Form TMD-520.)** In determining the standard density from the Nomograph, the Bulk Specific Gravity of the plus 1/2 inch material, as determined in accordance with AASHTO T 85, will be used. It will not be necessary to determine the specific gravity for each density determination after sufficient experience has been gained so that a value may be assigned to the specific type and source of the material being tested.

NOTE: Closer determinations may be made by using approximately one percent (1%) increments of moisture which, when plotted, result in at least two points on each side of the optimum moisture.

MISSISSIPPI STATE HIGHWAY DEPARTMENT  
 NOMOGRAPH FOR DETERMINING TOTAL DENSITIES OF SOILS  
 MISSISSIPPI STATE HIGHWAY DEPARTMENT

TMD-520



Example: Given density of minus 1/2 material = 130.0 lbs. per cu. ft.  
 Specific Gravity of plus 1/2" material = 2.60  
 Percent of plus 1/2" material = 20 %

Solution: 
$$\left( \frac{1}{130} \times 80 \right) + \left( \frac{1}{260 \times 62.4} \times 20 \right) = 135.4 \text{ lbs. per cu. ft.}$$

From Chart: Line straight edge with 130 on left edge of chart and  
 260 on specific gravity of plus 1/2" material line. Read  
 135.4 on the vertical line for 20% of plus 1/2" material.

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## MT-9 Moisture-Density Relations of Treated Soils

**PURPOSE:** To establish a method of test for determination of the moisture-density relations of soils treated with Portland cement, hydrated lime, or hydrated lime and fly ash.

### 1. SCOPE

1.1 This method covers procedures for determining the relationship between the moisture content and density of soil-cement, soil-lime, or soil-lime-fly ash mixtures compacted in a mold of a given size with a 5.5 pound rammer dropped from a height of 12 inches. Method A is to be used for design tests and for any preliminary tests made prior to beginning of construction. Method B is to be used after roadway mixing for determination of the standard density of the mixed material. The method, otherwise known as Method MT-9M, is a modification of AASHTO T 134.

1.2 When Case 1 or Case 2 is referred to herein, this shall be interpreted to mean:

1.2.1 CASE 1: When approximately 90 percent or more of the soil or material passes the 4.75 mm sieve.

1.2.2 CASE 2: When approximately 10 percent or more of the soil or material is retained on the 4.75 mm sieve.

### 2. APPARATUS

#### 2.1 MOLDS

2.1.1 4.0 inch inside diameter mold having a capacity of 1/30 ft<sup>3</sup>.

2.1.2 6.0 inch inside diameter mold having a capacity of 1/10 ft<sup>3</sup>.

2.2 RAMMER. A metal rammer having a 2 inch diameter circular face, or a segmented face with an area equivalent to a 2 inch diameter circle, with a mass of 5.5 pounds. (The use of a mechanical tamper with a segmented rammer is not only permissible but is desirable.) The rammer shall be equipped with a suitable arrangement to control the height of drop to a free fall of 12 inches above the elevation of the mixture.

2.3 SAMPLE EXTRUDER. A jack, lever, frame, or other device adapted for the purpose of extruding compacted specimens from the mold.

2.4 BALANCE. A balance or scale of at least 12 kg (25 lb) capacity sensitive to 5 g (0.01 lb); and a balance of at least 1000-g capacity sensitive to 0.1 g

2.5 DRYING OVEN. A thermostatically-controlled drying oven capable of maintaining a temperature of  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ), or other suitable means for drying moisture samples.

2.6 STRAIGHTEDGE. A rigid steel straightedge approximately 12 inches in length and having one (1) beveled edge.

2.7 SIEVES. 1/2 inch and No. 4.

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2.8 MIXING TOOLS. Miscellaneous tools such as mixing pan, spoon, trowel, spatula, knife, etc.; a suitable mechanical device for thoroughly mixing the sample of soil with cement, lime, and/or lime-fly ash, and with increments of water, is desirable.

### METHOD "A"

(For Use In Design And Other Preconstruction Tests)

## 3. SAMPLE

3.1 If the soil sample is damp when received from the field, dry it until it can be broken up easily with a trowel; drying may be in air or by use of drying apparatus such that the temperature of the sample does not exceed 60°C (140 °F). Then thoroughly break up the aggregations in such a manner as to avoid reducing the natural size of individual particles.

3.2 After the above drying and pulverizing, the moisture content of the soil should be determined. If preferable, the soil may be dried to constant mass (zero moisture content).

3.3 Determine by sieving or visual inspection if the soil should be tested under Case 1 or Case 2.

3.3.1 For CASE 1, select a representative sample of the soil prepared as described in Subsection 3.1 and with a mass of approximately 7 lb.

3.3.2 For CASE 2, separate the sample prepared as described in Subsection 3.1, on the 1/2 inch sieve, determining the percentage of the retained portion. Select a representative sample of the fraction passing the 1/2 inch sieve and weighing approximately 20 lb.

## 4. PROCEDURE

### 4.1 MIXING

4.1.1 SOIL-CEMENT. Add to the soil the required amount of cement, computed as shown in Subsection 5.3, and mix thoroughly to a uniform color. When needed, add sufficient water to dampen the mixture to approximately four to six percentage points below the estimated optimum moisture content and mix thoroughly. At this moisture content, plastic soils, tightly squeezed in the palm of the hand, will form a cast that will fracture with only slight pressure applied by the thumb and fingertips; nonplastic soils will bulk noticeably.

4.1.2 SOIL-LIME. Add to the soil the required amount of lime, by mass of dry soil. Add sufficient water to increase the moisture content to approximately ten (10) percentage points above the estimated optimum moisture content, and mix. Allow the mixture to cure for the period of time required by the specifications for the particular type of application being designed; maintain the moisture content, by adding water when necessary, at approximately ten (10) points above the estimated optimum moisture content. In the case of a "Split" application of lime, add the second increment at the end of the curing period. Then allow the mixture to air dry until the moisture content is approximately four (4) to six (6) percentage points below the estimated optimum moisture content. Pulverize the material until it all passes the 1/2 inch sieve and the specified percentage passes the No. 4 sieve, discarding any gravel particles retained on the 1/2 inch sieve.

4.1.3 SOIL-LIME-FLY ASH. Add to the soil the required amount of hydrated lime and fly ash, by mass of dry soil, and mix thoroughly to a uniform color. Add sufficient water to dampen the mixture to approximately four (4) to six (6) percentage points below the estimated optimum moisture content, and mix thoroughly.

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## 4.2 COMPACTION.

4.2.1 CASE 1: Form a specimen by compacting the prepared mixture in the 4 inch mold (with collar attached) in three (3) equal layers to give a total compacted depth sufficient to fill the mold, but not to exceed approximately 5 inches. Compact each layer by twenty-five (25) blows uniformly distributed from the rammer dropping free from a height of 12 inches above the elevation of the mixture. During compaction, the mold shall rest on a solid, rigid foundation. Following compaction, remove the extension collar, carefully trim the compacted mixture even with the top of the mold by means of a knife and straightedge, and determine its mass. Record the mass of specimen and mold as "D;" and mass of mold as "E."

4.2.2 CASE 2: Form a specimen by compacting the minus 1/2 inch portion of the prepared material in the 6 inch mold (with collar attached) in four (4) equal layers to give a total compacted depth of about 6.5 inches. Compact each layer by fifty-six (56) uniformly distributed blows from the rammer, as described in (1) above, and determine its mass. Record the mass of specimen and mold as "D;" mass of mold as "E."

4.2.3 Remove the material from the mold and slice vertically through the center. Take a representative sample of the material, with mass of not less than 100 g for fine-grained soils, or not less than 500 g for coarse-grained soils, from the full height of one of the cut faces; determine its mass immediately; dry to a constant mass and measure its mass. Determine mass of container.

4.2.4 Thoroughly break up the remaining portion of the molded specimen and add to the remaining portion of the sample being tested. Add water in sufficient amount to increase the moisture content of the mixture by one or two percentage points; mix; and repeat the procedure described in Subsections 4.2.2 and 4.2.3 above for each increment of water added. Continue this series of determinations until there is either a decrease or no change in the wet mass of the compacted mixture and mold.

## 5. CALCULATIONS

5.1 Calculate the moisture content of the compacted mixture for each trial, as follows:

$$w = \frac{A - B}{B - C} \times 100$$

Where,  $w$  = percentage of moisture in the specimen, based on oven-dry mass of mixture,

$A$  = mass of container and wet mixture, (Subsection 4.2.3),

$B$  = mass of container and dry mixture, (Subsection 4.2.3),

$C$  = mass of container.

5.2 Calculate the dry mass per cubic meter of the mixture as compacted, for each trial, as follows:

$$5.2.1 \quad \text{CASE 1:} \quad W = \frac{(D - E) \times 1059.43}{w + 100} \times 100$$

$$5.2.2 \quad \text{CASE 2:} \quad W = \frac{(D - E) \times 470.74}{w + 100} \times 100$$

Where,  $W$  = dry mass, in kilograms per cubic meter of compacted mixture,

$D$  = mass of compacted specimen and mold in kilograms (Subsection 4.2.1),

$E$  = mass of mold, in kilograms,

$w$  = percentage of moisture in the specimen, based on oven-dry mass of the mixture.

5.3 The following example will illustrate the method of proportioning cement and soil in the preparation of a sample for the moisture-density test:

GIVEN: 8% cement, by volume, to be incorporated in a soil.

122 lb/ft<sup>3</sup> equals approximate standard density of the soil and cement mixture (determined from previous tests on same type of soil, or may be assumed from tests made in the Jackson Laboratory on same soil).

SOLUTION: 8%  $\times$  94 lb/ft<sup>3</sup> = 7.52 lb cement per ft<sup>3</sup>.

$$122.0 - 7.52 = 114.48 \text{ lb soil in } 1 \text{ ft}^3 \text{ of mixture.}$$

$$(7.52 \div 114.48) \times 100 = 6.57 = \text{required per cent cement by mass of dry soil.}$$

ASSUME: mass of oven-dried soil in sample as 3000 g.

$$(3000 \times 6.57) \div 100 = 197.1 \text{ g cement in sample.}$$

$$\text{Total mass of sample (cement and oven-dried soil)} = 3197.1 \text{ g}$$

If is desired to start with the standard density of the raw soil, proceed as follows:

ASSUME: 115.0 lb/ft<sup>3</sup> as the standard density of the raw soil:

The assumed density of the mixture would be  $115.0 + 7.52 = 122.52 \text{ lb/ft}^3$ ;  
 $(120 \div 1842) \times 100 = 6.51\%$ , per cent cement by mass.

Then the mass of cement in a batch containing 3000 g of soil =  $\frac{6.54}{100} \times 3000 = 196.2\text{g}$ .

$$\text{Total mass of test sample} = 3000 + 196.2 = 3196.2 \text{ g.}$$

NOTE: If the result of the moisture-density test results in a standard density varying from the assumed density by more than 1 lb/ft<sup>3</sup>, repeat the test, using the standard density obtained in the first trial in the calculation.

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## 6. MOISTURE-DENSITY RELATIONSHIP

6.1 The calculations in Subsections 5.1 and 5.2 shall be made to determine the moisture content and corresponding oven-dry mass per cubic feet (density) for each of the compacted soil-cement, soil-lime, or soil-lime-fly ash samples. The densities of the mixture shall be plotted as ordinates and the corresponding moisture contents as abscissa.

6.2 **OPTIMUM MOISTURE CONTENT.** When the densities and corresponding moisture contents for the mixture have been determined and plotted as indicated in Subsection 6.1, it will be found that by connecting the plotted points with a smooth line, a curve is produced. The moisture content corresponding to the peak of the curve shall be termed the "optimum moisture content" of the soil-cement, soil-lime, or soil-lime-fly ash mixture under CASE 1, and of the minus 1/2 inch fraction under CASE 2. The "optimum moisture content" of the whole sample, under CASE 2 (when the sample contains material retained on the 1/2 inch sieve), shall be obtained from the following formula:

$$OM_w = \frac{3}{100} (\% \text{ retained on } 1/2 \text{ inch sieve}) + \frac{OM_p}{100} (\% \text{ passing } 1/2 \text{ inch sieve})$$

Where,  $OM_w$  = Optimum Moisture of Whole Sample,

$OM_p$  = Optimum Moisture of minus 1/2 inch fraction.

NOTE: In this formula, the moisture content of the plus 1/2 inch material is assumed to be 3 percent.

6.3 **STANDARD DENSITY.** The oven-dry mass per cubic meter of the soil-cement, soil-lime, or soil-lime-fly ash mixture at optimum moisture content shall be termed the "standard density" under the above compaction. The density at optimum moisture is the standard density of the mixture under CASE 1, and of the minus 1/2 inch fraction under CASE 2. The standard density of the whole sample, under CASE 2 (when the sample contains material retained on the 1/2 inch sieve), shall be obtained by applying the percentage of plus 1/2 inch material, as determined in Subsection 3.3.2, and the standard density of the minus 1/2 inch fraction, as determined above, to the **Nomograph** (shown below). In determining the standard density from the Nomograph, the Bulk Specific Gravity of the plus 1/2 inch material, as determined in accordance with AASHTO T 85, will be used. It will not be necessary to determine the specific gravity for each density determination after sufficient experience has been gained so that a value may be assigned to the specific type and source of the material being tested.

NOTE: In designing soil-cement mixes with coarse aggregates, the Central Laboratory determines the moisture-density relationship of the minus 1/2 inch fraction, using the 4 inch mold; this is for the purpose of producing specimens suitable for compression tests. The standard densities shown on the design reports may not be the same as those obtained under the above methods, and, therefore, should not be used as the true standard densities.

### METHOD "B"

(For Use In Determining Standard Density Of Materials After Mixing On The Roadbed)

## 7. PROCEDURE

7.1 After the specified pulverization of the material in the base, subbase or treated subgrade has been obtained and prior to beginning of final compaction operations of soil-cement, soil-lime, or soil-lime-fly ash mixtures, a sample of the mixed material shall be obtained, and prepared as outlined in Subsections 3.3 and 3.3.1.

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7.2 The sample shall be dried to about 4% to 6% below the estimated optimum moisture percentage. Preferably, the sample should be air-dried; however, if time does not permit air-drying, a moderate heat (not exceeding 60°C) may be applied while the sample is vigorously stirred; then a specimen shall be compacted as described in Subsection 4.2.1 or 4.2.2. In either case, the procedures described in Subsections 4.2.3, 4.2.4, 5.1, 5.2 and Section 6 are applicable.

NOTE: This procedure has been found satisfactory in most cases. However, in instances where the soil material is fragile in character and will reduce significantly in grain size due to repeated compaction, and in cases where the soil is a heavy-textured clayey material into which it is difficult to incorporate water, a separate and new sample shall be used in each compaction test. Sufficient water should be added to vary the moisture of each sample by approximately two (2) percentage points. Some time should be allowed for the moisture to become thoroughly distributed throughout the sample. The moisture contents selected shall bracket the estimated optimum moisture content, thus providing samples which, when compacted, will increase in weight to the maximum density and then decrease in mass.

The mass of the second specimen compacted as outlined in Subsection 4.2.4 should show an increase over that of the first specimen. If the mass does not increase, the sample contained more than optimum moisture when first compacted and the test should be rerun.

Closer determinations may be made by using approximate one percent (1%) increments of moisture which, when plotted, result in at least two points on each side of the optimum moisture.

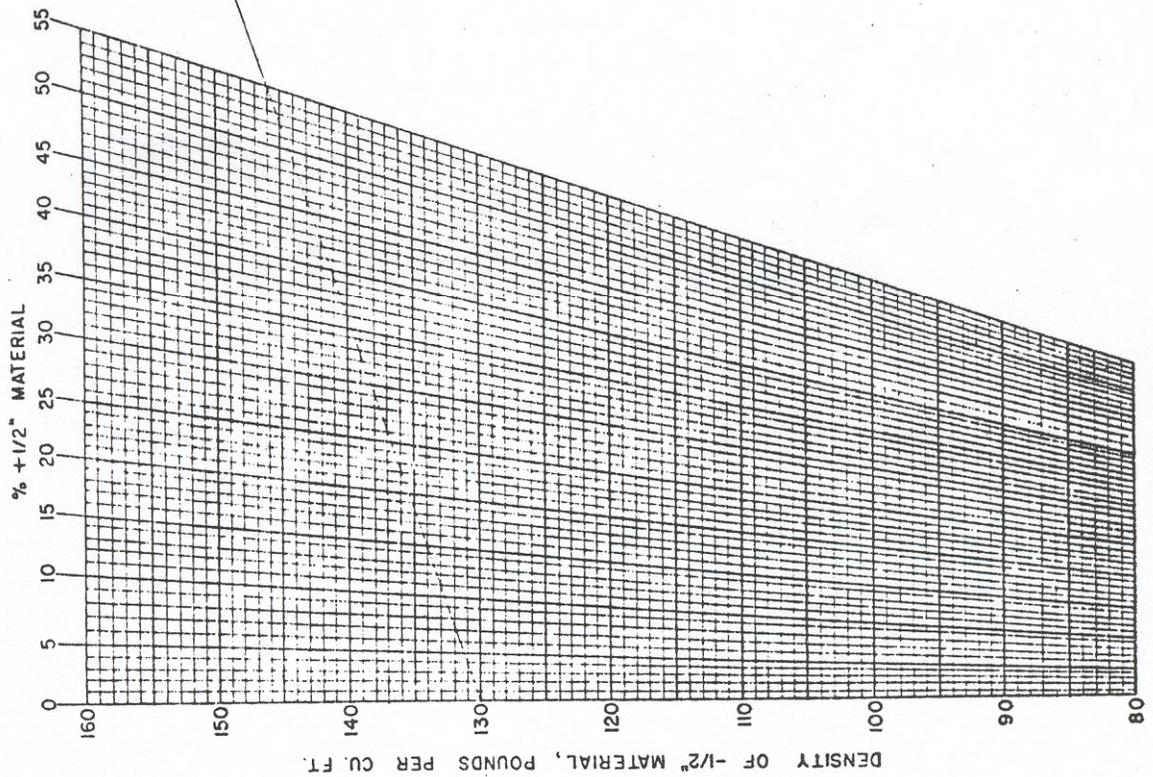
## 8. COMPARISON

8.1 If the moisture-density tests, under Section 7, are made under CASE 1, the standard density and optimum moisture results shall be compared directly with the in-place density and moisture content as determined in MT-10M (TMD-11-10-00-000M).

8.2 If the test sample contains plus No. 4 material and is tested under CASE 2, the standard density and optimum moisture obtained shall be corrected by use of the Nomograph and formula before comparison with in-place densities and moisture contents obtained under MT-10M. The 1/2 inch retainage in the material removed from the test hole shall be used in making such correction.

MISSISSIPPI STATE HIGHWAY DEPARTMENT  
 NOMOGRAPH FOR DETERMINING TOTAL DENSITIES OF SOILS  
 MISSISSIPPI STATE HIGHWAY DEPARTMENT

THD-520



Example: Given density of minus 1/2" material = 130.0 lbs. per cu. ft.  
 Specific Gravity of plus 1/2" material = 2.60  
 Percent of plus 1/2" material = 20 %

Solution: 
$$\frac{130 \times .80}{\left( \frac{130 \times .80}{2.60 \times 62.4} \times .20 \right)} = 135.4 \text{ lbs. per cu. ft.}$$

From Chart: Line straight edge with 130 on left edge of chart and 2.60 on specific gravity of plus 1/2" material line. Read 135.4 on the vertical line for 20% of plus 1/2" material.

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## MT-10 In-Place Density of Soil

**PURPOSE:** To establish approved methods of test for determining the in-place density of embankment design soil, subbase, base, treated or untreated soils, in the natural state or after compaction, and comparing this density with a predetermined standard density and optimum moisture.

### 1. APPROVED METHODS OF TEST

The in-place density shall be determined by one of the following approved methods:

- 1.1 Nuclear Method of Field In-Place Density Determination, MT-16M.
- 1.2 Density of Soil In-Place by the Sand-Cone Method, AASHTO T 191.
- 1.3 Density of Soil In-Place by the Rubber-Balloon Method, AASHTO T 205.
- 1.4 Density of Soil In-Place by the Drive Cylinder Method, AASHTO T 204. This method of test is approved for use only in moist, cohesive, fine-grained materials,
- 1.5 Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester, AASHTO T 217. The Speedy Moisture Tester is an approved alternate for determining moisture content in fine-grained soils only. It should be checked from time to time by the standard method of determining moisture content of a soil by oven-drying. The calibration of the tester is extremely important and must be checked frequently.

### 2. DETERMINATION OF STANDARD DENSITY TO BE COMPARED WITH IN-PLACE DENSITY

- 2.1 **UNTREATED SOILS, SUBBASE OR BASE MATERIALS.** A moisture-density curve shall be developed for each class of material, either prior to construction or as it is encountered during construction. Such curves shall be developed by the method outlined in MT-7M or MT-8M.
  - 2.2 **SOILS TREATED WITH LIME.** A moisture-density curve shall be developed, not earlier than one (1) day prior to beginning of final compaction operations, as described in Section 7 of MT-9M. This test shall be made each time the type of material changes as evidenced by a one-point proctor test varying from the curve, unusual difficulty in attaining required density, or by visual examination. The frequency of making one-point proctor check tests is left to the discretion of the District Materials Engineer. Control of the moisture content of the initial section on the project may be based on design tests made in the Central Laboratory, or on other preliminary tests. Subsequently, optimum moistures will be established as indicated above.
  - 2.3 **SOILS OR MATERIALS TREATED WITH CEMENT.** At the end of mixing of the first section each day, the mixed materials will be tested as outlined in Section 7 of Test MT-9M. The curve thus produced will be used for the other sections mixed during the day unless the type of material changes as evidenced by a one-point proctor test varying from the curve, unusual difficulty in attaining required density, or by visual examination, in which case a new curve will be developed. The frequency of making one-point proctor check tests is left to the discretion of the District Materials Engineer. Control of the moisture content of the initial section on the project may be based on design tests made in the Central Laboratory; or on other preliminary tests. Subsequently, optimum moistures will be established as indicated above.
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2.4 CORRECTION OF STANDARD DENSITY TO THE AMOUNT OF MATERIAL RETAINED ON THE 1/2 INCH SIEVE. In determining the standard density and optimum moisture to be compared with the in-place density and moisture content, the 1/2 inch retainage in the material removed from the test site shall be applied to the Nomograph (MT-7M, MT-8M, or MT-9M) and optimum moisture formula as follows:

2.4.1 STANDARD DENSITY. Enter the Nomograph with the standard density obtained from the proper moisture density curve, the 1/2 inch retainage in the material removed from the test site, and the bulk specific gravity of the plus 1/2 inch material.

2.4.2 OPTIMUM MOISTURE.

$$\text{Use the formula, } OM_w = \frac{3R}{100} + \frac{OM_p}{100} \times P$$

Where,  $OM_w$  = Optimum moisture required,

$R$  = Percent retained on 1/2 inch sieve,

$OM_p$  = Optimum moisture from proper moisture-density curve.

$P$  = Percent passing 1/2 inch sieve.

NOTE: In this formula, the moisture content of the plus 1/2 inch material is assumed to be 3 percent; however, if necessary, the moisture content shall be determined and substituted in the formula.

### 3. DETERMINATION OF PERCENT OF STANDARD DENSITY

3.1 The standard density obtained in Subsection 2.4 shall be compared with the in-place density obtained in Section 1. The specifications will require that a certain minimum percentage of standard density be obtained (with certain tolerances). To determine the percentage obtained, divide the in-place dry density from Section 1 by the standard density from Section 2 and multiply by 100.

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## MT-11 Preparation of Field Specimens of Soil Cement

**PURPOSE:** To establish a uniform method for the preparation of field specimens of mixtures of soil-cement and soil-lime-fly ash. This method covers the frequency, method of preparation, curing and handling, of 4.0 inch diameter cylinders made of soil-cement and soil-lime-fly ash mixtures during construction of soil-cement and soil-lime-fly ash bases and subbases.

### 1. FREQUENCY

At least one (1) specimen, or cylinder, shall be prepared, and submitted to the Central Laboratory, to represent each 8000 yd<sup>2</sup> of soil-cement or soil-lime-fly ash construction, with at least one (1) specimen for each day's operation.

### 2. APPARATUS

2.1 MOLD. A 4.0 inch inside diameter split metal mold having a capacity of 1/30 ft<sup>3</sup> equipped with a detachable base plate and a removable collar.

2.2 STRAIGHTEDGE. A rigid steel straightedge having one (1) beveled edge.

2.3 RAMMER. A metal rammer weighing 5.5 pounds with a 2.0 inch diameter circular face and equipped with a suitable arrangement to control the height of drop to a free fall of 12 inch above the elevation of the mixture.

### 3. PREPARATION

3.1 The cylinder shall be prepared as soon as the Contractor has completed final mixing. Remove any coarse aggregate or lumps of unpulverized material by sieving over a 1/2 inch sieve discarding all particles retained on the sieve. The mixed material passing the 1/2 inch, with no additional water added, shall be compacted in a 4 inch mold (with collar and base plate attached) in three (3) approximately equal layers to give a total compacted height sufficient to slightly over-fill the mold. Compact each layer by twenty-five (25) blows uniformly distributed from the rammer dropping free from a height of 12 inches above the elevation of the mixture. The top surfaces of the first two layers shall be scarified with a screwdriver or similar tool.

3.2 During compaction, the mold shall rest on a solid, firm foundation.

3.3 Following compaction of the third layer, remove the extension collar and carefully trim the specimen even with the top of the mold using the straightedge. Smooth and trim until the specimen presents a plane surface on the end.

3.4 Carefully remove the mold from the base plate and examine the bottom end of the specimen. If necessary in order to obtain a plane surface, the specimen should be patched with fresh mixture, pressing and straightedging the patched areas until a plane surface is obtained.

### 4. CURING AND HANDLING

#### 4.1 SOIL-CEMENT\_

4.1.1 Cover the exposed ends of the specimen with damp cloths and keep moist; or, preferably, place mold and specimen in a moistureproof plastic bag. After not less than twelve (12) hours, carefully remove the mold, taking extreme care to avoid distortion or overstressing of the specimen. The removal shall be performed in the Project Office, Field Laboratory, or District Laboratory.

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4.1.2 Place the specimen in a moistureproof plastic bag or wrap in damp cloth or paper; keep moist. Retain the specimen, preventing loss of moisture, until such time that it can be received by the Central Laboratory on the twelfth (12th) day after preparation. Specimens should be packed in damp sawdust in a container to prevent damage enroute to the Central Laboratory. Each sample shall be accompanied by a fully completed information card, Form TMD-320M, or TMD-321M for independent assurance samples.

#### 4.2 SOIL-LIME-FLY ASH

4.2.1 Place mold and specimen in a moistureproof plastic bag. After not less than twelve (12) hours, carefully remove the specimen from the mold, taking extreme care to avoid distortion or overstressing of the specimen. The removal shall be performed in the Project Office, Field Laboratory, or District Laboratory.

4.2.2 Place the specimen in a moistureproof plastic bag; seal and place in a forced-air oven or temperature-controlled chamber at a constant temperature of 38°C ( $\pm 3^\circ\text{C}$ ) for twenty-eight (28) days. At the completion of this curing period, taking extreme care to prevent damage enroute, ship the sealed bag with the specimen to the Central Laboratory for testing. Each specimen shall be accompanied by a fully completed information card, Form TMD-320M, or TMD-321M for independent assurance samples.

**MT-12 Liquid Curing Compound**

**PURPOSE:** To establish a standard test for determination of the water retention efficiency of liquid membrane-forming compounds for curing concrete.

This method is the same as outlined in AASHTO T-155, with the following alternates:

**1. Section 3.1:** Add as second paragraph:

The molds may be rectangular or circular with such dimensions that the inside area at the top will be between 0.039 m<sup>2</sup> and 0.046 m<sup>2</sup>; the depth shall be 50.8 ± 3 mm. Rectangular molds shall have rounded corners.

**2. Section 8.3:** Add as second paragraph:

The coverage may be determined by weighing, to the nearest 0.1 g, the test specimen and mold before and after application of the curing compound.

**3. Section 10.1:** Add as second paragraph:

A glass plate may be used and the raised edge may be accomplished by forming a bead, using the same material as used in sealing the specimen (Subsection 8.1).

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### MT-15 Calibration of Nuclear Density and Moisture Gauges

**PURPOSE:** To establish procedures for the calibration of surface nuclear density and moisture gauges which are used to determine density and moisture in treated and untreated soils. The calibration will be conducted by Central Laboratory personnel who are properly trained in the use of nuclear density and moisture gauges.

#### 1. APPARATUS

- 1.1 A surface nuclear density and moisture gauge.
- 1.2 A portable scaler or variable time-constant rate meter.
- 1.3 A portable reference standard.
- 1.4 A series of laboratory density standards.
- 1.5 A steel plate, straightedge, probe-hole template and other miscellaneous small tools, such as shovel, tamp hammer, steel probe, etc.
- 1.6 Set of platform scales with a maximum capacity of 500 pounds and a sensitivity of  $\pm 0.5$  pounds.
- 1.7 A soil compaction mold, with a collar attachment, 24 inches by 12 inches by 12 inches construction of 1/2 inch steel plating (volume 2.00 ft<sup>3</sup>).

#### 2. STANDARDIZATION OF EQUIPMENT (STANDARD COUNT)

- 2.1 Warm up the portable scaler or rate meter for the period of time recommended by the manufacturer. Place the gauge on the reference standard and obtain five (5), one (1) minute counts for density and moisture. Record these counts on a work sheet.
- 2.2 Average the five (5) counts for density and moisture. If any one of the five (5) counts used to determine this average fall above or below the average standard count by more than the limit set forth in Table 1, this data will be discarded and a complete new set of standard counts shall be obtained. If a set of standard counts cannot be obtained which meets the criteria of Table 1, the gauge should be returned to the manufacturer for inspection.

TABLE 1

Examples of acceptable range of count variations used for standardizing and calibrating nuclear gauges:

<u>Average Standard Counts</u>	<u>Permissible Variations* (<math>\pm 1.96</math> Avg. Std. CPM)</u>
100 000	620
70 000	520
45 000	420
26 000	320
12 000	220
3500	120

\*These permissible variations are valid only for standard counts and are not applicable to field counts.

### 3. CALIBRATION OF STANDARD GAUGE

- 3.1 Determine and record the mass of the soil container.
- 3.2 Compact a uniformly mixed soil in the container in lifts which will produce a thickness of approximately 2 inches when compacted. Compact enough lifts to produce a thickness in excess of 12 inches. Remove the collar from the container and strike off the excess material to a smooth surface level with the top of the container.
- 3.3 Determine and record the mass of the wet soil and the container.
- 3.4 Determine wet density of the compacted soil.
- 3.5 Verify the operating condition of the gauge by establishing a reference standard count as described in Section 2.
- 3.6 Place the gauge on the surface of the compacted soil. Take and record two (2) one-minute counts. Rotate the gauge 180 degrees and repeat the same procedure. Average the four (4) moisture counts and record the average on line 10 of Form TMD-522.
- 3.7 Place the hole template on the soil and prepare a probe hole at least 8 inches deep, approximately 4 inches from each end of the mold along its longitudinal axis.
- 3.8 Place the gauge on the soil and extend the probe 6 inches into the prepared hole.
- 3.9 Take and record two (2) one-minute density counts. Repeat the same procedure by rotating the gauge 180 degrees and placing the probe in the other hole. Average the four (4) density counts and record the average on line 14 of Form TMD-522.
- 3.10 Repeat Subsection 3.5.
- 3.11 Average the standard counts obtained in Subsections 3.5 and 3.10. Record the average for density and moisture on lines 13 and 9, respectively, of Form TMD-522.
- 3.12 Obtain a moisture sample of the compacted soil from 2 to 5 inches beneath the surface and in the vicinity of the probe hole.
- 3.13 Determine the dry density of the compacted soil:
- $$\text{Dry Density} = \frac{\text{Wet Density}}{1 + \frac{\% \text{ Moisture}}{100}}$$
- 3.14 Determine the kilograms of water per m<sup>3</sup> of soil:
- Kilograms of water = wet density - dry density
- 3.15 Determine and record the moisture- and density-count ratio:
- $$\text{Count Ratio} = \frac{\text{Moisture or density count}}{\text{Standard Count}}$$
- 3.16 Repeat subsections 3.1 thru 3.15 for nine (9) other additional points using at least four (4) different types of soil ranging from heavy clays to heavy granular material.

3.17 Prepare a graph from the ten (10) predetermined points for wet density using a semi-logarithmic plot. Plot the count ratio on the log scale and the wet density on the arithmetic scale. Determine the equation for the line of "best-fit" through these points and prepare a table which shows the count ratio and the corresponding wet density.

3.18 Prepare a graph using the ten (10) predetermined points for pounds of water per ft<sup>3</sup> and the corresponding count ratio. Plot the kilograms of water on the abscissa and the count ratio on the ordinate. Determine an equation for the line of "best-fit" and prepare a table which shows the count ratio and the corresponding mass of water per ft<sup>3</sup>.

3.19 Gauges calibrated by this procedure will be known as standard gauges. Periodic checks on laboratory standards will be conducted to assure the validity of the calibration.

#### 4. CALIBRATION OF FIELD NUCLEAR GAUGES

4.1 Verify the operating conditions of the gauge by establishing a standard count as described in Section 2.

4.2 Using a standard block, obtain five (5) one-minute counts with the probe in the 6 inch direct transmission position. Record these counts on a work sheet.

4.3 Average the five (5) one-minute counts and record the average count on line 14 of FormTMD-522.

4.4 Determine the density count ratio as outlined in Subsection 3.15.

4.5 Repeat Subsections 4.1 thru 4.4 for all laboratory standard density blocks available at the Central Laboratory.

4.6 Prepare a graph, equation, and table with the data collected in Subsections 4.1 thru 4.5 as outlined in Subsection 3.17.

4.7 Select a field site and repeat the calibration procedure outlined in steps 3.5 thru 3.16, with the exception of Subsections 3.12 thru 3.14, using both the standard gauge and the gauge being calibrated. Extreme care should be taken to assure that each gauge occupies the same area when their respective readings are being obtained. At the time a reading for a particular gauge is being obtained, the other gauge must be removed from the test location for a distance of not less than 40 feet.

4.8 Using the predetermined calibration tables for each gauge, determine the field wet density.

4.9 Prepare a data table including the following information obtained in the field:

- a. Moisture and density count ratio from gauge being calibrated.
- b. Wet density from both gauges.
- c. Kilograms of water per ft<sup>3</sup> as determined from standard gauge.

4.10 If the values for wet density in the table prepared in Subsection 4.9 do not vary more than  $\pm 2.0$  lb/ft<sup>3</sup>, the equation derived from the laboratory block standard is valid. If the variance is greater than  $\pm 2.0$  lb/ft<sup>3</sup>, a new equation shall be derived using the count ratio from the gauge being calibrated and the wet density obtained by the standard gauge. Using the new equation, prepare the calibration table for the gauge being calibrated.

4.11 Prepare a graph, equation and table for moisture, using the count ratio from the gauge being calibrated and the corresponding kilometers of water per ft<sup>3</sup> from the standard gauge, as outlined in Subsection 3.18.

4.12 Upon completion of the steps outlined in this section, gauges are considered properly calibrated. Field density gauges shall be brought to the Central Laboratory every six (6) months to be checked for radiation leaks and calibration.

## **5. RADIOLOGICAL HAZARDS**

5.1 Research findings indicate that operators are not exposed to radiological health hazard if appropriate safety precautions are practiced during gauge operations.

5.2 Field and Central Laboratory personnel will be required to wear film badges while operating nuclear gauge equipment.

5.3 Semi-annual leak tests will be performed on all radioactive sources. Leak tests will be required for both licensed and unlicensed radioisotopes.

5.4 It will be the responsibility of the Central Laboratory to assure Mississippi Department of Transportation compliance with all Atomic Energy Commission and Mississippi State Board of Health regulations applying to radiation.

**MT-16 Nuclear Method for Field In-Place Density Determination**

**PURPOSE:** To establish procedures for the use of surface moisture-density nuclear gauges the determination on in-place densities.

**1. SCOPE**

This method of test provides a nondestructive measurement on in-place density and moisture content of various courses (embankment, subbases, bases and pavements).

**2. APPARATUS**

- 2.1 An approved direct read-out surface moisture-density nuclear gauge equipped with a data processor module.
- 2.2 A portable reference standard.
- 2.3 A scraper plate/drill rod guide, drill rod.
- 2.4 Miscellaneous hand tools, such as shovel, hammer, etc.
- 2.5 A supply of fine sand or native fines.

**3. METHOD OF TEST**

- 3.1 **METHOD A.** Method A was for use of the early model nuclear gauges which have been replaced with the direct read-out nuclear gauges covered under Method B. The designation for Method A has been retained to prevent cross-reference problems in the text of other methods and specifications.
- 3.2 **METHOD B.** For determination of in-place density of soil and soil-aggregate mixtures. For this method a coarse grain soil is defined as a soil containing 25% or more retained on the No. 10 sieve. A fine grain soil is defined as a soil containing less than 25% retained on the No. 10 sieve.
  - 3.2.1 **STANDARD COUNT.** Obtain a standard count using the portable reference standard in accordance with the procedure set out in the gauge instruction manual. The standard count should be taken in the vicinity of the test site. A standard count should be taken at least twice a day or more frequently if transporting, background radiation or other conditions necessitate. Record the standard moisture count and the standard density count. If a moisture or density count varies significantly from previous counts, there may be a problem with the nuclear gauge.
  - 3.2.2 **MOISTURE GAUGE BIAS.** The nuclear gauge measures moisture content based on total hydrogen in the soil. Some soils may contain chemically-bound hydrogen which would result in an erroneous moisture content if it is not corrected. This condition may occur in soils or soil-aggregate mixtures containing high gypsum content, lime, cement, high calcium content, etc. A moisture correction factor for such conditions must be determined and applied in accordance with the gauge instruction manual. The correction factor with a plus (+) or minus (-) sign is to be programmed into the nuclear gauge and recorded on the appropriate field density report, TMD-522 or TMD-524.
  - 3.2.3 **PREPARATION OF TEST SITE**
    - 3.2.2.1 For coarse grain soils, prepare test site to a plane surface that extends at least three inches (3") beyond the gauge on all sides after rotating the gauge one hundred eighty degrees (180°). Minor depressions in the test site not exceeding one-eighth inch (1/8") in depth may be filled with native fines or fine sand and struck off to a plane surface.

- 3.2.2.2 For fine grain soils, prepare test site to a plane surface the size of which is at least one gauge length plus six inches (6") by one gauge width plus six inches (6"). Minor depressions may be filled as set out for coarse grain soils.
- 3.2.4 Program proctor density into the gauge as set out in the gauge instruction manual. If the soil contains material coarser than the 1/2-inch sieve, be sure the proctor has been corrected for the plus 1/2-inch material in accordance with MT-10.
- 3.2.5 **MOISTURE AND DENSITY TEST.** Using the scraper plate/drill rod guide, make a hole with the drill rod two inches (2") deeper than the test depth. Place the gauge in position and inset the probe into the hole to the test depth. With operator facing the front of the gauge, pull the gauge toward you to insure that the probe is in contact with the wall of the probe hole.

For coarse grain soils, take one (1) two-minute count. Rotate the gauge one hundred eighty degrees (180°). Take one (1) two-minute count. After each two-minute count, read and record moisture content in percent, dry density in PCF, and the percent of standard density. Average the two readings for moisture content, dry density and percent of standard density, and record on the appropriate field density report, TMD-522 or TMD-524.

For fine grain soils, take one (1) four-minute count. Read the moisture content in percent, dry density in PCF and the percent of Standard Density, and record on the appropriate field density report, TMD-522 or TMD-524.

3.3 **METHOD C:** For determination of in-place density of hot-mix asphalt pavement.

3.3.1 **STANDARD COUNT:** Obtain standard count as set out in Subsection 3.2.1.

3.3.2 **DENSITY TEST:** All density counts are to be taken in the backscatter mode. Small irregularities in test site should be filled with fine sand or native fines. Place the gauge on the test site with sides of gauge parallel to centerline of roadway. Take one (1) four-minute density count and record the wet density in pounds per cubic foot in the space provided on Form TMD-004.

#### **4. TRAINING**

Gauge operators must attend the Mississippi Department of Transportation Training Course for Radiation Safety Procedures for Nuclear Probes and Nuclear Gauge Operation, or other approved course. The gauge operator should be an experienced technician. Upon completion of the training course, the gauge operator will receive a minimum of one week on-the-job training in the principles of nuclear testing and safety procedures.

#### **5. GAUGE PRECISION**

- 5.1 This is a method to determine whether or not the gauge results are valid. This check should be made periodically to insure that the gauge is in proper working order.
- 5.2 Obtain and record ten (10) one-minute standard density and standard moisture counts. No more than three (3) of either of the ten (10) counts should vary more than plus (+) or minus (-) two (2) standard deviations from the average. All counts should fall within the range of plus (+) or minus (-) three (3) standard deviations from the average.
- 5.3 Should a gauge not meet this precision requirement, the gauge is to be delivered to the Central Laboratory for repairs.
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**MT-17 Nonreflective Jiggle and Reflective Pavement Markers**

**SCOPE:** This method describes the testing procedures to be used for determining specification compliance for nonreflective jiggle markers and reflective pavement markers.

**CERAMIC NONREFLECTIVE JIGGLE MARKERS****1. IDENTIFICATION AND WORKMANSHIP**

Use visual inspection and appropriate measurements to determine if the markers are the type and have the color, shape, dimensions, tolerances, characteristic and finish specified.

**2. GLAZE THICKNESS****2.1 APPARATUS AND MATERIALS**

2.1.1 Microscope of at least 25 power with a calibrated reticule.

2.1.2 Hammer.

2.1.3 Power Sander.

2.1.4 Supply of Eriochrome Black T (Black Dye).

2.1.5 Supply of Hydrofluoric Acid.

**2.2 TESTING PROCEDURE**

2.2.1 Use hammer to break pavement marker into fragments small enough to be viewed under a compound microscope and select a fragment, preferably wedge-shaped with a tapered edge, for test. The area selected for measurement must be at least 6.5 mm from edge of marker. Grind the glazed tapered edge smooth and flat using a power sander with fine textured abrasive belt. In most cases, the edges of the glaze will then be clearly delineated when viewed through the microscope, and no further preparation of the specimen will be necessary. When the glaze is not sharply defined or for referee method purposes, use the following procedure to prepare the specimen for test:

2.2.2 Etch the area which has been ground smooth and flat with hydrofluoric acid for approximately thirty (30) seconds. Wash thoroughly and dry. Apply a drop of Eriochrome Black T (black dye) to the etched surface; let stand for ten seconds and wipe off the excess stain. The body of the marker will absorb the dye, leaving glaze unmarked and well defined.

2.2.3 Mount specimen under the microscope and measure glaze thickness with calibrated reticule using a minimum magnification of twenty-five (25). Proper lighting is important.

2.2.4 **PRECAUTIONS FOR HYDROFLUORIC ACID:** Read directions and precautions on bottle before attempting the use of this acid. Keep off skin and clothing.

2.2.5 **TOXICOLOGY.** Hydrofluoric acid is extremely irritating and corrosive to skin and mucous membranes. Inhalation of the vapor may cause ulcers of the upper respiratory tract. Concentrations of 50 to 250 ppm are dangerous, even for brief exposures. Hydrofluoric acid produces severe skin burns which are slow in healing. The subcutaneous tissues may be affected, becoming blanched and bloodless. Gangrene of the affected areas may follow.

2.2.6 Record the glaze thickness to the nearest 25  $\mu\text{m}$ .

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### 3. HARDNESS

#### 3.1 TESTING PROCEDURES

3.1.1 SHORE "D" HARDNESS. Test in accordance with ASTM D 2240: Be careful to prepare a flat, smooth surface on each specimen to be tested. This may be accomplished using a belt sander, surface grinder, vertical mill, or other suitable equipment. Record the initial maximum reading as the hardness.

3.1.2 Moh Hardness. Determine the Moh hardness of the glazed surface of the marker relative to the mineral orthoclase, which has a hardness of 6. Using moderate hand pressure, it must not be possible to scratch the glazed surface of the marker with orthoclase.

### 4. DIRECTIONAL REFLECTANCE

The test for directional reflectance shall be performed in accordance with ASTM E 97.

NOTE: The test on the glazed surface shall be made on the top of the marker. The test on the body of markers shall be made on a clean, flat surface of the marker from which the glaze has been removed.

### 5. YELLOWNESS INDEX

5.1 Test the glazed surface and the body of the marker in accordance with ASTM E 313. Determine the yellowness index for the body of the marker on a smooth, flat, clean surface. The bottom surface of the marker may be used to determine the yellowness index if that surface is smooth, flat and homogeneous in composition with the marker body; if not, prepare a smooth, flat surface of sufficient area by sanding, grinding or milling the marker.

5.2 The test on the glazed surface of markers shall be made on the top of the marker. The test on the body of markers shall be made on a clean, flat surface of the marker from which the glaze has been removed.

### 6. COLOR

TESTING PROCEDURE. Visually compare the marker to FHWA Highway Color Tolerance Chart PR Color #1. The color of the marker must be within the range of the chart.

### 7. AUTOCLAVE

Test in accordance with ASTM C 424 with the following exception: Subject the specimens to only one autoclave cycle at 690 kPa for one (1) hour. Use slow pressure release.

### 8. STRENGTH BY COMPRESSIVE LOADING

#### 8.1 APPARATUS AND MATERIALS

8.1.1 Compression testing machine with a capacity of at least 22kN and a rate capability of 5 mm per minute.

8.1.2 Steel ring 25.4 mm high, 76.2 mm internal diameter and 6.35 mm wall.

8.1.3 Solid metal plug 25.4 mm diameter and 25.4 mm high.

8.1.4 Protective eye glasses or shield.

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**8.2 TESTING PROCEDURE**

8.2.1 Place the metal ring in the testing machine and center the marker base down upon the ring.

8.2.2 Center the solid metal plug on top of the marker.

8.2.3 At a rate of 5 mm per minute, apply the load necessary to break the marker. Use protective eye glasses or shield.

8.2.4 Record the strength by compressive loading in kilonewtons.

**9. WATER ABSORPTION**

Test in accordance with ASTM C 373 with the following exception: Specimens selected for the water absorption test shall be whole markers, and the glaze shall not be removed.

**REFLECTIVE PAVEMENT MARKERS****10. IDENTIFICATION AND WORKMANSHIP**

Use visual inspection and appropriate measurements to determine if the markers are the type and have the color, shape, dimensions, tolerances, characteristics and finish specified. Using a straightedge and a 1.27 mm feeler gauge, determine tile flatness of the base of the markers by locating the largest deviation from the straightedge in all directions across the thermosetting compound.

**11. STRENGTH BY COMPRESSIVE LOADING**

11.1 TESTING PROCEDURE. Same as Section 8, Ceramic Nonreflective Jiggle Markers.

11.2 In addition to the specified 8.9 kN minimum load, failure of a marker shall also consist of one significant deformation of the marker at a load of less than 8.9 kN; (2) significant delamination of the shell and the filler material regardless of the load required to break the marker. (NOTE: Significant deformation or delamination shall normally consist of more than 3 mm.)

**12. COLOR**

Use visual comparison with a previously approved reference marker to determine that the color(s) of the reflectors when illuminated are as specified.

**13. REFLECTANCE**

13.1 APPARATUS AND MATERIAL. Reflex Photometer with power supply, output meter, appropriate color filters, goniometer, pavement marker mount, and miscellaneous fixtures, as needed.

**13.2 TESTING PROCEDURE**

NOTE: See "Calibration Procedure" shown later under Subsections 13.3 and 13.4 for method of determining the specific intensity of "reference reflective pavement marker(s)" referred to in these procedures.

13.2.1 Turn the Photometer "ON" at the power supply. Allow a two (2) or (three (3) minute warm-up period.

13.2.2 Remove the reference marker to be used from its protective storage and place it in the Photometer on the pavement marker fixture at the 1.52 m test distance and 0° entrance angle.

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13.2.3 Set the output meter to the scale that gives the most convenient large scale deflection and response time as dictated by the specific intensity of the reference marker.

13.2.4 Using the rear (nearest to the light source) adjustable iris, set the output meter to the specific intensity of the reference marker. The meter will now indicate the specific intensity of the markers as a direct reading.

13.2.5 In turn, determine at 0° and 20° entrance angles the specific intensity of each marker tested, and record the results.

NOTE: If the specific intensity of any marker is higher than the scale being used, the reference marker must be used to reset the meter to a scale having the required range.

### 13.3 CALIBRATION PROCEDURE (CLEAR REFLECTOR)

13.3.1 Turn the Photometer "ON" at the power supply. Allow a 2 to 3 minute warm-up period.

13.3.2 Place the marker on the marker fixture at the 1.52 m test distance; 0° entrance angle.

13.3.3 Select the meter scale that gives proper response and a convenient large scale deflection, and record the reading. Use the adjustable iris if necessary.

13.3.4 Set the marker and fixture aside. Leaving all settings as is, remove the photocell assembly from its normal position near the lamp end of the photometer and mount it on the goniometer at the 1.52 m test distance, 0° entrance angle, using the fixture supplied for this purpose.

13.3.5 Record the meter reading of the photocell and calculate the specific intensity ( $S_x$ ) of the reflector using the equation:

$$S_x = \frac{R}{C} D^2$$

Where: R = meter reading of the reflector  
C = meter reading of the photocell  
D = test distance

13.3.6 If the photocell reading (C) falls off the scale used in reading the reflector (R), the photocell must be shifted to another test distance at which a usable reading is obtained on the same scale and the specific intensity ( $S_x$ ) of the reflector calculated using the equation:

$$S_x = \frac{R}{C} \frac{D_r^4}{D_c^2}$$

Where:  $D_r$  = test distance of the reflector  
 $D_c$  = test distance of the photocell

13.3.7 On the bottom of the marker identify it as a "Standard" or "Reference" and record the specific intensity ( $S_x$ ) and the most convenient meter scale. Keep the "Standards" in a substantial protective covering or box. Periodically recalibrate all "Standards."

### 13.4 CALIBRATION PROCEDURE (COLORED REFLECTOR)

13.4.1 Follow the same procedure outlined in Calibration Procedure (Clear Reflector) with the following exceptions:

13.4.1.1 In Subsection 13.3.4, place a filter of the proper color in front of the photocell.

13.4.1.2 In Subsection 13.3.5, if the reflector and the photocell are read at the same distance (D), the specific intensity ( $S_x$ ) is calculated using the equation:

$$S_x = \frac{R}{C} D^2 K$$

Where: K = transmission factor of the color filter

If it is necessary to read the reflector and the photocell at different distances, calculate the specific intensity ( $S_x$ ) using the equation:

$$S_x = \frac{R}{C} \frac{D_r^4 K}{D_c^2}$$

Protect the standards as noted under Subsection 13.3.7 of Calibration Procedure (Clear Reflector).

**SPECIAL NOTE:** If it is necessary to determine the reflectance of a single or several markers for which there is no "Standard" available, a "Standard" of approximately the same size and specific intensity can be used in conjunction with the following equation and previously discussed procedures to calculate the specific intensity ( $S_x$ ) of the unknown markers.

$$S_x = S_r \frac{X}{R}$$

Where:  $S_r$  = known specific intensity of the "Standard" reflector  
 $X$  = meter reading of the unknown reflector  
 $R$  = meter reading of the "Standard" reflector

#### **ACRYLONITRILE-BUTADIENE-STYRENE POLYMER NONREFLECTIVE JIGGLE MARKERS**

### **14. GENERAL**

Careful examination of the markers prior to testing must be accomplished to insure accurate reporting. Reject a marker for testing of physical properties on the basis of any break, chip, crack, deformation or other shape, and appearance defects.

### **15. HEAT RESISTANCE**

15.1 APPARATUS. Circulating air oven, capable of maintaining  $60 \pm 3^\circ\text{C}$ .

15.2 PROCEDURE

15.2.1 Place the marker on a horizontal wire rack above the floor of the oven having a temperature of  $60 \pm 3^\circ\text{C}$ .

15.2.2 After an exposure period of four (4) hours, remove the rack on which the marker is resting from the oven. Allow the marker to cool to room temperature.

15.2.3 Examine the marker and compare it to corresponding unexposed marker.

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15.3 REPORT. Indicate conformance or nonconformance to specifications after visual examination.

## 16. IMPACT RESISTANCE

### 16.1 APPARATUS

16.1.1 Steel ball, 47.62 mm in diameter.

16.1.2 Steel base plate, 127 mm x 127 mm x 12.7 mm minimum.

16.1.3 Centering post, to assist in dropping the ball from a height of 610 mm above the marker so as to strike the top center of the marker.

### 16.2 PROCEDURE

16.2.1 Allow the marker to reach room temperature prior to testing.

16.2.2 Position the marker on the steel base plate so that it rests topside up in a position for the steel ball, when dropped, to strike at the approximate center of the marker.

16.2.3 Using the centering post, hold the steel ball 610 mm above the marker. Drop the ball on the marker.

16.2.4 Examine the marker and compare it to corresponding untested marker.

16.3 REPORT. Indicate conformance or nonconformance to specifications after visual examination.

## 17. LOAD RESISTANCE

### 17.1 APPARATUS

17.1.1 Compression testing machine capable of producing a load of 80 kN at a uniformly applied rate of 140 to 340 kPa per second. Compression heads shall be of sufficient area to completely cover the base of the marker.

17.1.2 An elastomeric pad of sufficient area to completely cover the top of the marker and conforming to the following specifications:

17.1.3 Thickness:  $25.4 \pm 3$  mm

Hardness: Type A durometer, ASTM D 2240,  $70 \pm 5$

Tensile Strength: ASTM D 412, 17 MPa minimum

### 17.2 PROCEDURE

17.2.1 Allow the marker to reach room temperature.

17.2.2 Place the marker topside up, on the lower head of the testing machine. Place the elastomeric pad on top of the marker.

17.2.3 Apply a load at 140 to 340 kPa per second until a total load of 80 kN is reached.

17.2.4 Remove the load. Examine the marker and compare it to corresponding untested marker.

17.3 REPORT. Indicate conformance or nonconformance to the specifications after visual examination.

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**18. INFRARED SPECTROMETRY FINGERPRINT**

18.1 Prepare sample from the marker. Run fingerprint scan using the infrared spectrophotometer. Compare the fingerprint of the sample to the fingerprint of the originally approved marker.

18.2 REPORT. Indicate whether the fingerprint of the sample compares favorably or unfavorably to the fingerprint of the originally approved marker. Unfavorable comparison indicates the composition of the marker has been altered.

**19. WORKMANSHIP**

TEST PROCEDURE. Same as Section 1, Ceramic Nonreflective Jiggle Markers.

**HIGH PERFORMANCE REFLECTIVE PAVEMENT MARKERS**

**20. IDENTIFICATION AND WORKMANSHIP**

Use visual inspection and appropriate measurements to determine if the markers are the type and have the color, shape, dimensions, tolerances, characteristics and finish specified.

**21. OPTICAL PERFORMANCE**

21.1 Steel Wool Abrasion Procedure

21.1.1 Form a 25 mm diameter flat pad using #3 coarse steel wool. Place the steel wool pad on the reflector lens. Apply a load of 220 N and rub the entire lens surface 100 times. (Note: On two color units, the red lens may not be covered with glass and if so should not be abraded).

21.2 Optical Testing Procedure

21.2.1 The reflector to be tested shall be located with the center of the reflecting face at a distance of 1.52 m from a uniformly bright light source having an effective diameter of 5.1 mm.

The photocell shall be annular ring 9.4 mm I.D. x 11.9 mm O.D. It shall be shielded to eliminate stray light. The distance from light source center of the photoactive area shall be 5.3 mm. If a test distance of other than 1.52 m is used, the source and receiver dimensions and the distance between source and receiver shall be modified in the same proportion as the test distance.

21.3 Specific Intensity

21.3.1 After abrading the lens surface, using the above steel wool abrasive procedure, the specific intensity of each white reflecting surface at 0.2° observation angle shall not be less than the following when the incident light is parallel to the base of the reflector.

<u>HORIZONTAL ENTRANCE ANGLE</u>	<u>S.I.</u>
0°	3.0
20°	1.2

21.3.2 For yellow reflectors, the specific intensity shall be 60% of the value for white. For red reflectors, the specific intensity shall be 25% of the value for white.

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**22. PHYSICAL PROPERTIES****22.1 Strength Requirement**

22.1.1 Markers shall support a load of 17.8 kN at room temperature as applied in the following manner:

Position marker base down at the center of a flat 12.7 mm thick, 150 mm x 150 mm steel plate. Apply a load on the top center of the marker by means of a 25.4 mm diameter solid steel plug at a rate of 760  $\mu\text{m}$  per minute. Failure shall constitute either breakage or significant deformation of the marker at any load less than 17.8 kN.

**22.2 Impact Testing**

22.2.1 Condition the markers in a convection oven at 55°C for one hour. While at the elevated temperature, impact the reflective face by allowing a 190 g dart fitted with a 6.4 mm radius spherical head to drop 460 mm perpendicularly onto the center of the reflective surface. Cracks in the impact area shall be generally concentric in appearance. There shall be no more than two radial cracks longer than 6.4 mm; there shall be no radial cracks extending to the edge of the glass. (Note: On two color units, the red lens may not be glass covered and if so should not be subjected to impact test).

**22.3 Temperature Cycling**

22.3.1 Subject samples to three (3) cycles of 60°C for four (4) hours followed by -7°C for four (4) hours. There shall be no cracking or delamination following temperature cycling.

**22.4 Tolerances**

22.4.1 In either the impact or temperature cycling test, if 90% or more of the test samples meet the above requirements, the lot shall be acceptable. A lot with failure rate of between 10% and 20% shall be resampled and retested. Failure of more than 10% of the resample shall be cause for rejection of the lot. Failure of 20% or more of the initial sample shall be cause for rejection of the lot.

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**MT-20 Method of Test for Evaluating Color by Means of Chromaticity Coordinates**

**SCOPE:** This method of test is used to determine the spectral characteristics of light-reflecting materials and to designate their color by the Tristimulus Values and Chromaticity Coordinates which are calculated from this measurement.

**1. PROCEDURE**

## 1.1 DESCRIPTION OF TERMS AND SYMBOLS

1.1.1 Tristimulus Values X, Y, Z. The evaluation of color is determined in accordance with this method.

1.1.2 Chromaticity Coordinates x, y, z. Tristimulus values expressed as fractions of their totals, as follows:

$$x = \frac{X}{X + Y + Z} \quad y = \frac{Y}{X + Y + Z} \quad z = \frac{Z}{X + Y + Z}$$

1.1.3 Brightness or Total Luminous Reflectance. Brightness = (Y x 100).

**2. APPARATUS**

2.1 The apparatus shall consist of a Bausch & Lomb Spectronic 505 Spectrophotometer by means of which the spectral characteristics of the test specimen may, within the limits of visible spectrum, (400 to 700 nanometers) be determined. The angular distribution of the light on the test specimen and reference plates shall be 25° to the normal of these plates. The viewing shall be diffuse in that the spectral component shall be trapped out of the measuring sphere.

2.2 Chart paper, for conversion of photometric data to tristimulus values, based on a ten select ordinate system, as referenced to I.C.I. Illuminant "C," is recommended. This chart paper is listed in Bausch and Lomb Catalog, Item No. 33-28-13.

2.3 Chromaticity charts for determinations of purity and dominant wave length. These charts are shown in Chapter VIII of Massachusetts Institute of Technology's Handbook of Colorimetry.

**3. STANDARDS**

3.1 PRIMARY STANDARD. The primary standard for reflectance measurements shall be a layer of freshly prepared magnesium oxide, prepared as described in "Method of Preparation of Magnesium Oxide Standard" in ASTM D 986.

3.2 SECONDARY STANDARD. Secondary Standard shall be a plaque of white structural vitrolite glass identified as "Standard Plaque."

**4. REFERENCE PLAQUE**

The reference plaque shall be of white structural vitrolite glass, identified as "Reference Plaque." The minimum reflectance value of the reference plaque shall be 85% between 400 and 700 nanometers.

## 5. INITIAL CALIBRATION OF APPARATUS

- 5.1 On fabricated blanks, prepare three (3) or more MgO discs following method described in ASTM D 986 "Method of Preparation of MgO Standard."
- 5.2 Compare the reflectance value of these discs in the spectrophotometer by measuring each one, by comparison, with the vitrolite reference plaque in the reference position and a MgO prepared disc in the sample position.
- 5.3 Using the disc that has averaged response in reflectance value, repeat the process for MgO coating in an attempt to bring the values of response equal to, or better than, that of the disc indicating maximum value. Continue to repeat the MgO coating process and evaluation, always recoating the disc with the lower value until the reflectance response is within 1% of each other or until further treatment produces no further change.
- 5.4 With vitrolite reference plaque in reference position, maximum value MgO disc in sample position, set turned on and warm-up time observed, push and hold stop button in and drive pen to the 95% line on the chart by adjusting the optical balance control. Set pen on the chart at this point, release stop and push record button. Allow machine to trace a line across entire chart. Correct for the irregularities of this line as outlined in Bausch and Lomb Reference Manual Catalog No. 33-28-04, Sections 4-7, under the heading "Smoothing the 100% line."
- 5.5 When this correction has been satisfactorily accomplished, using the optical balance control as before, set the pen at the 100% line on the chart.
- 5.6 Make the zero adjustment and record the zero line as outlined in Bausch and Lomb "Reference Manual, Sections 4-8," under the heading "Zero Adjustment."
- 5.7 Place vitrolite secondary standard in sample position and with vitrolite reference plaque in reference position, record the calibration line. This line should be traced as a means of checking the calibration at the beginning of every series of recordings and also at anytime there is reason to believe the setting of the machine has deviated from the original value.

## 6. RECORDING OF REFLECTANCE CURVES

- 6.1 The samples to be measured should be clean and free from oil films or surface dirt. This can be accomplished by careful washing with a soft cloth, warm water and a mild detergent. Thoroughly rinse the sample and blot or shake dry so that no residue or water or detergent remains on the plaque.
- 6.2 Detailed procedure for recording of reflectance curves is given in the Bausch and Lomb Reference Manual, Section 3 "Operation" and Section 7 "Reflectance Accessories."

## 7. CALCULATIONS

- 7.1 Computation of color specifications from spectrophotometric data and a coordinate system for the presentation of color specifications shall be in accordance with A.S.A. method for "determination of color specifications" Z 58.7.2 -- 1951, using the ten select ordinates 1-5-8-11-14-17-20-23-26-29.
- 7.2 Calculations can be given a rough check for errors by use of a light table for comparing the spectral curves by overlaying. Changes in Dominant Wave and Brightness Values are generally made apparent by this method, and some errors are readily detected by an experienced operator.
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**8. PRECAUTIONS**

8.1 Care should be exercised to keep standards and samples clean, free from contact with abrasive materials and from surface damage.

**9. PLOTTING THE VALUE OF THE CHROMATICITY COORDINATES X AND Y**

9.1 Determination of the Dominant Wave and Percentage Purity is made by plotting the values of chromaticity coordinates,  $x$  and  $y$ , of the sample on a chromaticity chart compiled according to the 1931 I.C.I. Standard Observer and Coordinate System. The exact location of the point of intersection is plotted on this chart which contains lines of constant dominant wave length radiating from a point whose coordinates are the trichromatic coefficients of Illuminant C. It also contains contour lines of excitation purity. In this way, the Dominant Wave Length and Excitation Purity may be interpolated directly from the chart.

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**MT-24 Determination of the Specific Gravity of Fine Aggregate Using the LeChatelier Flask**

**SCOPE:** This method sets forth procedures to be followed in determining the specific gravity of fine aggregate using the Le Chatelier flask.

**1. APPARATUS**

1.1 The Standard Le Chatelier Flask. This flask shall conform to the dimensions shown in AASHTO T-133 (Specific Gravity of Hydraulic Cement).

1.2 Balance. A balance having a capacity of one kilogram or more and sensitive to 0.1 g or less.

**2. PREPARATION OF SAMPLE**

Air dry to constant mass approximately 120 g representative of the fine aggregate passing the No. 4 sieve.

**3. PROCEDURE**

3.1 Pour approximately 4000 mL of water into a pan and bring to room temperature.

3.2 Fill the Le Chatelier flask with water or kerosene at room temperature to a point on the stem between the zero and the 1 mL marks. Dry the inside of the flask above the level of the liquid, if necessary, after pouring. Record the reading at this water level on the flask (First Reading).

3.3 Measure the mass of a representative sample of the fine aggregate to between 55 and 60 g.

3.4 Introduce the sample at room temperature in small amounts into the flask, taking care to avoid splashing. The flask may be vibrated to prevent the material from sticking to the side.

3.5 Twirl the flask until no more air bubbles rise to the surface of the liquid.

3.6 Take the final reading with the liquid at a point in the upper series of gradations.

**4. CALCULATION**

The difference between the first and final readings represents the volume of liquid displaced by the fine aggregate used in the test. The specific gravity shall be calculated as follows:

$$\text{Sp. Gr.} = \frac{\text{mass of fine aggregate in g}}{\text{displaced vol. in mL}}$$

**5. REPRODUCIBILITY**

Duplicate determinations of specific gravity by this method should agree within 0.01. At least one (1) duplicate test is usually performed.

**6. REPORT**

Report the specific gravity to the nearest 0.01.

## MT-25 Design of Soil Cement Mixtures

**SCOPE:** This method sets forth the procedures to be followed by the Central Laboratory in the design of soil-cement mixtures. Soil-cement is a mixture of pulverized soil and Portland cement which has been moistened, compacted, and permitted to harden. It is used primarily as a base course under rigid and flexible pavement, and also as a chemical treatment for subgrades with a plasticity index (PI) of less than 15.

### 1. REFERENCE TEST METHODS

Tests required in the design of soil-cement mixtures are as follows:

AASHTO T 87 Dry Preparation of Disturbed Soil Samples for Test

MT-23 Mechanical Analysis of Soils, S.O.P. No. TMD-11-23-00-000

AASHTO T 89 Liquid Limit of Soils

AASHTO T 90 Plastic Limit of Soils

AASHTO T 92 Shrinkage Factors of Soils

AASHTO T 85 Specific Gravity and Absorption of Coarse Aggregate

MT-8 Moisture Density-Relations of Soils, S.O.P. No. TMD-11-08-00-000

MT-9 Moisture Density-Relations of Treated Soils, S.O.P. No. TMD-11-09-00-000

MT-26 Compressive Strength of Soil-Cement Cylinders and Cores, S.O.P. No. TMD-11-26-00-000

### 2. APPARATUS

The apparatus required for the design of soil-cement mixtures are those set out in the required tests listed above.

### 3. SAMPLE

The sample must be representative of the material to be used in the roadway and must meet the requirements of the plans and specifications. For cement treated bases, the class granular material as set out by the plans must be listed on the information card. The minimum weights of total sample (either base or subgrade) required to perform the above tests are as follows:

150 lbs. (dry wgt.) when the sample contains material larger than the 1/2-inch sieve

100 lbs. (dry wgt.) when all the material passes the 1/2-inch sieve

### 4. PREPARATION OF SAMPLE

**4.1** The sample shall be thoroughly mixed and air-dried.

**4.2** By the method of quartering or the use of a sample splitter, select a sample of one of the following approximate weights:

30 lbs. when 10% or more is retained on the No. 10 sieve

7 lbs. when less than 10% is retained on the No. 10 sieve

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Prepare this sample in accordance with AASHTO T 87 (Dry Preparation of Disturbed Soil Samples for Test) and set aside for the following tests:

MT-23 Mechanical Analysis of Soils  
AASHTO T 89 Liquid Limit of Soils  
AASHTO T 90 Plastic Limit of Soils  
AASHTO T 92 Shrinkage Factors of Soils  
AASHTO T 85 Specific Gravity and Absorption of Coarse Aggregate

**4.3** By the method of quartering or the use of a sample splitter, select a sample of one of the following approximate weights:

75 lbs. when the sample contains material larger than the 1/2-inch sieve  
50 lbs. when all of the material passes the 1/2-inch sieve

**4.4** This sample shall be set aside and used in the following tests:

MT-8 Moisture-Density Relations of Soils  
MT-9 Moisture-Density Relations of Treated Soils  
MT-26 Compressive Strength of Soil-Cement Cylinders and Cores

**4.6** The remainder of the original sample shall be set aside and used in check tests if necessary.

## **5. PROCEDURE**

**5.1** Perform the following tests on the sample set aside in Subsection 4.2.

MT-23 Mechanical Analysis of Soils  
T 89 Liquid Limit of Soils  
T 90 Plastic Limit of Soils  
T 92 Shrinkage Factors of Soils  
T 85 Specific Gravity and Absorption of Coarse Aggregate; for the determination of the bulk specific gravity of the plus 1/2-inch material.

**5.2 MOISTURE-DENSITY RELATIONS OF THE RAW SOILS:** Determine the moisture-density relationship of the raw soil in accordance with Method MT-8, using a 4-inch mold for the minus 1/2-inch material.

**5.3 ESTIMATED CEMENT CONTENT:** For base stabilization, estimate the cement content for the mix to be used in performing MT-9 on the basis of the maximum dry density obtained in MT-8 and the Plasticity Index as determined from AASHTO T 90. This will typically be a value between 4% and 8%. For cement treated subgrades, assume an estimated cement content of 4%.

**5.4 MOISTURE-DENSITY RELATION OF THE CEMENT-TREATED MATERIAL:** Determine the moisture-density relationship of the cement-treated material in accordance with MT-9, Method "A."

**5.5 COMPRESSIVE STRENGTH SPECIMENS:** Prepare six (6) cylinders in accordance with MT-9, Method "A," as follows:

5.5.1 Prepare two (2) cylinders at one (1) percentage point below the estimated cement content.

5.5.2 Prepare two (2) cylinders at the estimated cement content.

5.5.3 Prepare two (2) cylinders at one (1) percentage point above the estimated cement content.

5.5.4 Identify one (1) specimen from each cement content for seven (7) day compressive strength tests and one (1) from each cement content for fourteen (14) day compressive strength tests.

**5.6 CURING:** Carefully extrude the samples from the molds and place under damp cloths for four (4) hours. Then place the cylinders in plastic bags and set in the moisture room for curing.

**5.7 COMPRESSIVE STRENGTH TESTS:** At the end of the seven (7) and fourteen (14) day curing periods, the specimens shall be immersed in water for five (5) hours and tested in accordance with MT-26 (Compressive Strength of Soil-Cement Cylinders and Cores).

## 6. DETERMINATION OF DESIGN CEMENT CONTENT

**6.1** Make a graphical plot of the seven (7) and fourteen (14) day compressive strengths, as determined in Subsection 5.7, versus cement contents.

**6.1.1 SUBGRADES.** The 7-day compressive strengths are used to determine the design cement content, but the 14-day compressive strength may be used to verify or confirm any strength gain over time. The design cement content is the minimum amount of cement that will produce a 7-day compressive strength of 200 psi, but in no case shall this value be less than 2% nor exceed 5%. However, if the 200 psi requirement is not met in 7 days with 5% cement content, but is met with the 14-day strength, then the test report can be issued with the caveat that construction traffic cannot be allowed on the treated subgrade for 14 days.

**6.1.2 BASES.** The 14-day compressive strengths are used to determine the design cement content. The design cement content is the minimum cement content that will produce a 14-day compressive strength of 300 psi.

## 7. CORRECTION FACTOR FOR MIXTURES CONTAINING PLUS 1/2-INCH MATERIAL

The correction factor for the reduction of the required percent cement by volume, if the sample contains plus 1/2-inch material, is 0.15 multiplied by the amount of increased density of the raw material determined by the percent and specific gravity of the plus 1/2-inch material obtained from the nomograph (see Fig. 1).

Example:

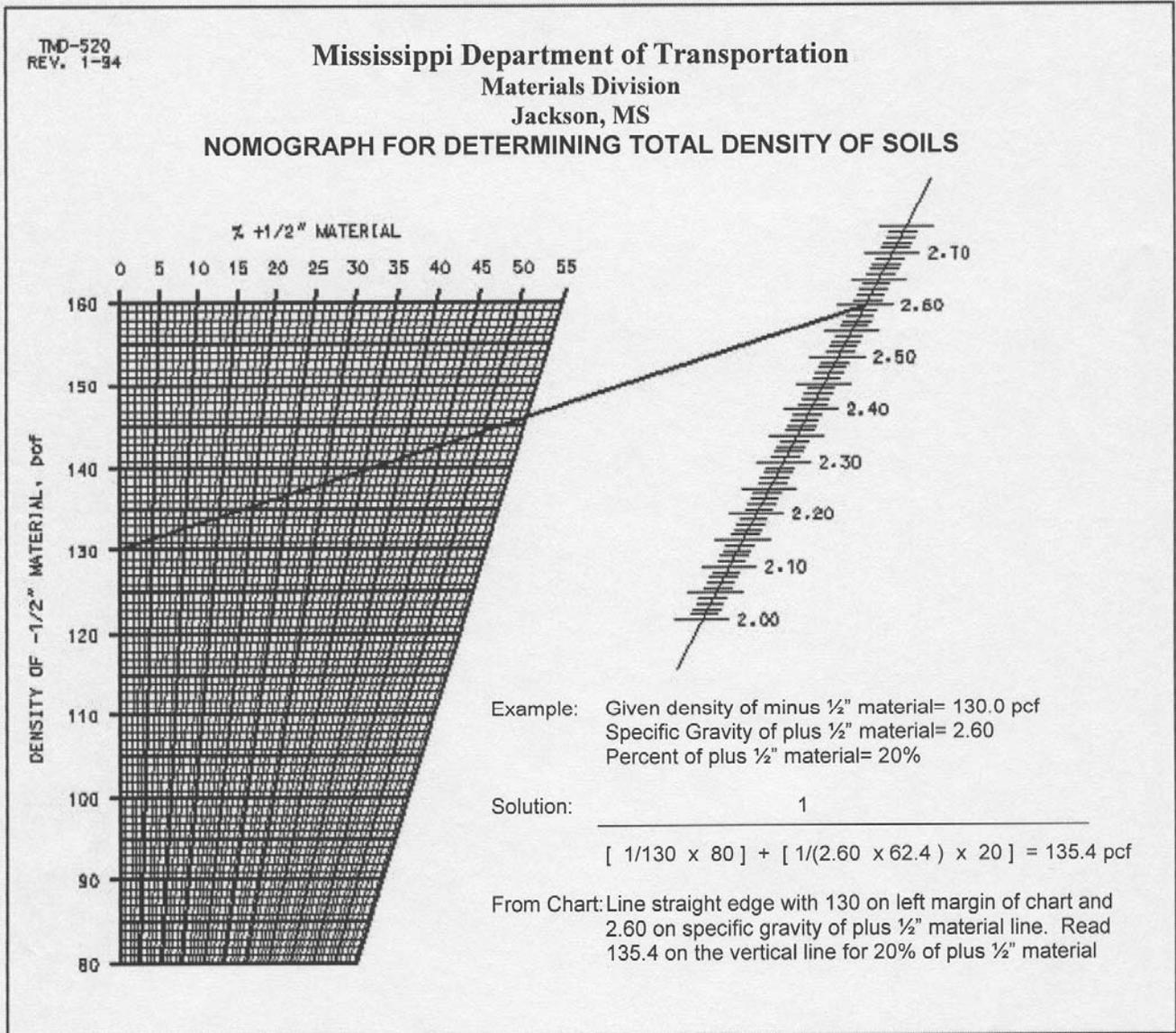
Design cement content based on minus 1/2-inch material = 7% by volume  
 Specific gravity of plus 1/2-inch material = 2.60  
 Maximum dry density of untreated minus 1/2-inch material = 130 PCF  
 Plus 1/2-inch material = 19% of total sample  
 Increase in maximum dry density (from nomograph) = 5 PCF  
 Correction Factor = 0.15

$0.15 \times 5 \text{ PCF} = 0.75\%$   
 $7\% - 0.75 = 6.25\% \text{ Cement by Volume}$

## 8. REPORT

The report shall include the recommended cement content by volume and all supporting test data.

FIGURE NO. 1



**MT-26 Compressive Strength of Soil-Cement Cylinders and Cores**

**SCOPE:** This method sets forth the procedure to be used for determining the compressive strength of 4-inch diameter soil-cement cylinders compacted according to MT-11 (Preparation of Field Specimen of Soil-Cement) and MT-25 (Design of Soil-Cement Mixtures), and the compressive strength of soil-cement cores taken from the roadway.

**1. APPARATUS**

The compression testing machine shall have sufficient capacity and control to adjust the loading at a constant rate of 0.05 in. per minute. It shall be capable of exerting a force of at least 25,000 pounds on an area 4 inches in diameter and capable of recording the total load at failure of the test specimen to the nearest ten (10) pounds.

**2. TEST SPECIMENS**

2.1 The molded test specimens shall have a diameter of 4 in. and a height of 4.59 in.

2.2 The smoothness of the circular faces of the specimens shall be checked with a straightedge. If necessary, the faces shall be capped.

2.3 The diameter of the cored specimens shall be determined to the nearest 0.01 inch.

**3. PROCEDURE**

3.1 At the end of the seven (7) and fourteen (14) day curing periods, immerse the cylinders in water for five (5) hours and the cores for forty-eight (48) hours.

3.2 Place the specimen on the lower bearing block of the compression machine, making certain that the vertical axis of the specimen is aligned with the center of thrust of the spherically-seated block. As this block is brought to bear on the specimen, rotate its movable portion gently by hand so that uniform seating is obtained.

3.3 Apply the load continuously and without shock at a constant rate of 0.05 in. per minute.

3.4 Record the total at failure of the test specimen to the nearest 10 (ten) pounds.

**4. CALCULATION**

Calculate the unit compressive strength of specimen by dividing the maximum load by the circular cross-sectional area.

**5. REPORT**

The report shall include total load, the compressive strength, and the age of the specimen.

**MT-27 Design of Soil-Lime Water Mixtures**

**SCOPE:** This method sets forth the procedures to be followed by the Central Laboratory in the design of lime stabilization mixtures. Lime stabilization is the process of stabilizing soil in which the additive is lime. Hydrated or quick lime is generally added to the more plastic subgrade and design soils to decrease the plasticity and volume change characteristics and to increase workability, strength, and durability. Only hydrated lime is used in this laboratory design procedure.

**1. DEFINITIONS**

- 1.1 CLASS A TREATMENT. This treatment consists of spreading and incorporating the lime in two (2) increments as follows: spreading the predetermined percentage of lime, mixing with liberal amounts of water, sealing, mellowing or curing from five (5) to twenty (20) days, spreading the second increment of lime, mixing, compacting, finishing, and maintaining until covered by a subsequent course.
- 1.2 CLASS B TREATMENT. This treatment consists of spreading and incorporating the predetermined percentage of lime, mixing with liberal amount of water, sealing, mellowing or curing from five (5) to twenty (20) days, mixing, compacting, finishing, and maintaining until covered by a subsequent course.
- 1.3 CLASS C TREATMENT. This treatment consists of spreading and incorporating the predetermined percentage of lime, mixing, compacting, finishing, and maintaining until covered by a subsequent course.

**2. REFERENCE TEST METHODS**

Tests required in the design of lime stabilization mixtures are as follows:

AASHTO T 87 - Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test  
MT-23 - Particle Size Analysis of Soils (S.O.P. No. TMD-11-23-00-000)  
AASHTO T 89 - Liquid Limit of Soils  
AASHTO T 90 - Plastic Limit and Plasticity Index of Soils  
AASHTO T 92 - Shrinkage Factors of Soils  
MT-8 - Moisture-Density Relations of Soils (S.O.P. No. TMD-11-08-00-000)  
MT-9 - Moisture-Density Relations of Treated Soils (S.O.P. No. TMD-11-09-00-000)  
AASHTO T 193 - The California Bearing Ratio

**3. APPARATUS**

The apparatus required for the design of lime stabilization mixtures are those set out in the required tests listed above.

**4. SAMPLE**

The sample must be representative of the material to be used in the lime stabilization mixture. The minimum weight needed to perform the above tests is 150 pounds dry weight.

**5. PREPARATION OF SAMPLE**

Break up the sample so that the material will pass the 3 inch sieve, thoroughly mix, and protect to maintain approximately the same moisture content as when received.

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## PREPARATION AND TESTING OF UNTREATED MATERIAL

### 6. PARTICLE SIZE ANALYSIS AND SOIL CONSTANTS

Select a representative portion from the sample weighing approximately three (3) pounds. Prepare it in accordance with AASHTO T 87 (Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test) and perform the following tests:

MT-23 Particle Size Analysis of Soils  
AASHTO T 89 Liquid Limit of Soils  
AASHTO T 90 Plastic Limit and Plasticity Index of Soils  
AASHTO T 92 Shrinkage Factors of Soils

### 7. MOISTURE-DENSITY OF THE RAW SOIL

Select a representative portion from the material weighing approximately seven (7) pounds. Prepare the sample and determine the moisture-density relationship of the raw soil in accordance with MT-8 (Moisture-Density Relations of Soils).

## PREPARATION AND TESTING OF TREATED MATERIAL

### 8. CLASS TREATMENT AND PERCENT LIME

The class treatment and percent lime to be added for the moisture-density relationship and CBR tests are determined from the particle size analysis, soil constants, soil classification, and past experience.

#### 8.1 CLASS A TREATMENT

8.1.1 Select one (1) sample, weighing approximately fifteen (15) pounds, corrected for hygroscopic moisture for the CBR test (AASHTO T 193).

8.1.2 Select one (1) sample, weighing approximately eight (8) pounds, corrected for hygroscopic moisture for the moisture-density relationship (MT-9).

8.1.3 Add the first increment of lime (usually 4 1/2% by weight of dry soil) to the above samples and thoroughly mix.

8.1.4 Add water to bring the moisture content of the mixture to a saturated condition. Thoroughly mix and maintain the saturated condition by adding water as necessary throughout the curing period of five (5) to twenty (20) days depending upon the soil-lime reaction.

8.1.5 After the curing period, determine the percent pulverization as follows:

8.1.5.1 Spread the sample on a mat and slough off all loose material from the larger pieces.

8.1.5.2 Screen the material over the 1/2-inch sieve and the No. 4 sieve, and weigh the material retained on each sieve.

8.1.5.3 Determine the percentages by weight of the total sample passing the 1/2-inch and the No. 4 sieves.

8.1.6 Continue drying the samples until the moisture content is below optimum.

8.1.7 Pulverize each sample until 100% passes the 1/2-inch sieve and at least 60% passes the No. 4 sieve.

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- 8.1.8 Add the second increment of lime (usually 2 1/2% by weight of the dry soil) to the samples.
  - 8.1.9 Determine the moisture-density relationship of the sample weighing approximately eight (8) pounds in accordance with MT-9.
  - 8.1.10 Determine the California Bearing Ratio of the lime-soil mixture at optimum moisture content (as determined from MT-9) on the sample weighing approximately fifteen (15) pounds in accordance with AASHTO T-193.

**NOTE:** Where Class A treatment is indicated, one or two samples are prepared and tested with Class B treatment to substantiate the class treatment needed.

## 8.2 CLASS B TREATMENT

- 8.2.1 Select three (3) samples, weighing approximately fifteen (15) pounds each, corrected for hygroscopic moisture for the CBR test.
- 8.2.2 Select one (1) sample, weighing approximately eight (8) pounds, corrected for hygroscopic moisture for the moisture-density relationship (MT-9).
- 8.2.3 Add the estimated percent lime by weight of dry soil to the sample weighing approximately eight (8) pounds.
- 8.2.4 Add the estimated percent lime by weight of dry soil to one of the CBR samples weighing approximately fifteen (15) pounds. Add one percent (1%) above the estimated percent lime to one of the remaining CBR samples and one percent (1%) below the estimated percent lime to the other.
- 8.2.5 Add water to bring the moisture content of the mixture to a saturated condition. Thoroughly mix and maintain the saturated condition by adding water as necessary throughout the curing period of five (5) to twenty (20) days depending upon the soil-lime reaction.
- 8.2.6 After the curing period, determine the percent pulverization as follows:
  - 8.2.6.1 Spread the sample on a mat and slough off all loose material from the larger pieces.
  - 8.2.6.2 Screen the material over the 1/2-inch sieve and the No. 4 sieve and weigh the material retained on each sieve.
  - 8.2.6.3 Determine the percentages by weight of the total sample passing the 1/2-inch and the No. 4 sieves.
- 8.2.7 Continue drying the samples until the moisture content is below optimum.
- 8.2.8 Pulverize each sample until 100% passes the 1/2-inch sieve and at least 60% passes the No. 4 sieve.
- 8.2.9 Determine the moisture-density relationship of the sample weighing approximately eight (8) pounds in accordance with MT-9.
- 8.2.10 Determine the California Bearing Ratios of the lime-soil mixtures compacted at optimum moisture content (as determined from MT-9) on the three (3) samples weighing approximately fifteen (15) pounds in accordance with AASHTO T 193.

**NOTE:** For the heavier clays where Class B treatment is indicated, one (1) sample is prepared and tested with Class A treatment in case Class B treatment does not achieve the required CBR.

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**8.3 CLASS C TREATMENT**

- 8.3.1 Air dry approximately sixty (60) pounds of the material until it can be easily broken up with a trowel.
  - 8.3.2 Pulverize until all the material passes the 1/2-inch sieve and at least 60% passes the No. 4 sieve.
  - 8.3.3 Select three (3) samples, weighing approximately fifteen (15) pounds each, corrected for hygroscopic moisture for the CBR test.
  - 8.3.4 Select one (1) sample, weighing approximately eight (8) pounds, corrected for hygroscopic moisture for the moisture-density relationship (MT-9).
  - 8.3.5 Add the estimated percent lime by weight of dry soil to the sample weighing approximately eight (8) pounds.
  - 8.3.6 Add the estimated percent lime by weight of dry soil to one of the CBR samples weighing approximately fifteen (15) pounds. Add one percent (1%) above the estimated percent lime to one of the remaining CBR samples and one percent (1) below the estimated percent lime to the other.
  - 8.3.7 Determine the moisture-density relationship of the sample weighing approximately eight (8) pounds in accordance with MT-9.
  - 8.3.8 Determine the California Bearing Ratios of the lime-soil mixtures compacted at optimum moisture content (as determined from MT-9), on the three (3) samples weighing approximately fifteen (15) pounds in accordance with AASHTO T 193.
- 8.4 Set aside the remainder of the original sample for check tests, if necessary.

**9. DESIGN LIME CONTENT AND CLASS TREATMENT**

The required hydrated lime content and class treatment shall be the least percentage of lime which produces a minimum CBR of 20 and a satisfactory minimum swell. The equivalent quicklime content is calculated at 83% of the required hydrated lime content.

**10. DESIGN REPORT**

The design report shall include the recommended class treatment, hydrated lime and quicklime content expressed as pounds of lime per square yard per inch of thickness, and all supporting test data.

**11. CBR DATA**

The CBR values obtained in this test are for use in the design of soil-lime mixtures only. These values are not indicative of the CBR at standard compaction.

**MT-29 Determination of Organic Content of Soils – Loss by Ignition**

**SCOPE:** This method sets out procedures to be followed in determining the organic content of soils by Ignition Loss. The organic content of topsoil is an indication of its growth potential for grasses and vegetation.

**1. APPARATUS**

- 1.1 Evaporating Dish. A silicon evaporating dish capable of withstanding temperatures of 1100°C.
- 1.2 Bunsen Burner.
- 1.3 Stand. A stand to hold the evaporating dish over the Bunsen burner.
- 1.4 Stirrer. A metal rod to stir sample while burning.
- 1.5 Mortar and Pestle. A device capable of breaking up the aggregations of soil particles without reducing the natural size of the individual grains.
- 1.6 Balance. A balance sensitive to 0.01 g.
- 1.7 Oven. A thermostatically controlled drying oven capable of being heated continuously at a temperature of  $110 \pm 5^\circ\text{C}$ .
- 1.8 Sieve, 2.00 mm.

**2. SAMPLE**

The sample, representative of the material to be used, shall weigh approximately 2 kg.

**3. SAMPLE PREPARATION**

- 3.1 Air-dry or oven-dry the sample at a temperature not to exceed  $110 \pm 5^\circ\text{C}$  to prepare for pulverization.
- 3.2 By the method of quartering, select a representative test sample with a mass of approximately 500 g.
- 3.3 Break up the sample, including all organic matter, to pass the 2.00 mm sieve.
- 3.4 Oven-dry the sample to constant mass in the oven at a temperature of  $110 \pm 5^\circ\text{C}$ .
- 3.5 Mix well and select a representative sample of the material with a mass of at least 20 g.

**4. PROCEDURE**

- 4.1 Place the 20 g ( $\pm$ ) sample in the silicon evaporating dish; measure its mass and record.
  - 4.2 Place dish on stand over Bunsen burner; stir and burn sample to constant mass.
  - 4.3 Cool until dish can be handled; measure its mass and record.
-

**5. CALCULATIONS**

$$\% \text{ Loss by Ignition} = \frac{\text{Oven-Dry Mass} - \text{Burned Mass}}{\text{Burned Mass}}$$

**6. REPORT**

Report the percent Loss by Ignition to the nearest 0.1%.

**MT-30 pH Determination of Soils**

**SCOPE:** This method sets out the procedures to be followed in determining the pH of soils by use of a pH meter. The pH of a soil is indicative of its growth potential for grasses and vegetation and also of its corrosive and leaching characteristics.

**1. APPARATUS**

- 1.1 pH Meter - A pH meter capable of reading the pH of a soil to the nearest 0.01.
- 1.2 Beakers - With a capacity of approximately 100 cc's.
- 1.3 Mortar and Pestle. A device capable of breaking up the aggregations of soil particles without reducing the natural size of the individual grains.
- 1.4 Balance - A balance sensitive to 0.01 gram.
- 1.5 No. 10 Sieve.

**2. SAMPLE**

The sample, representative of the material to be used, shall weigh approximately five (5) pounds.

**3. SAMPLE PREPARATION**

- 3.1 Air dry the sample and by the method of quartering, select a representative portion weighing approximately 500 grams.
- 3.2 Break up the sample to pass the No. 10 sieve.
- 3.3 Thoroughly mix and select a representative portion weighing 35 grams.
- 3.4 Place the 35-gram sample in the beaker and add 70 grams of distilled water.
- 3.5 Thoroughly mix and let soak for approximately one hour.

**4. PROCEDURE**

- 4.1 Calibrate the pH meter according to the manufacturer's instructions
- 4.2 Remix the sample and place the electrode in the beaker for the reading.
- 4.3 Read the pH direct from the meter.

**5. REPORT**

Report the pH to the nearest 0.01.

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**MT-31 Quantitative Analysis of Hot Bituminous Mixtures**

**SCOPE:** This method sets out alternate procedures for determining the percent bitumen and aggregate gradation of bituminous paving mixtures. ALTERNATE METHOD NUMBER I is the cold-solvent extraction procedure which requires determination of ash content. ALTERNATE METHOD NUMBER II, which does not require determination of ash content, utilizes the Nuclear Asphalt Content Gauge for determination of bitumen content. ALTERNATE METHOD NUMBER III utilizes the Nuclear Asphalt Content Gauge for determination of bitumen content and a nonmechanical extraction procedure.

**ALTERNATE METHOD NUMBER I**

This method shall be in accordance with AASHTO T 164, Method A, and AASHTO T 30 except when the Recovery of Asphalt from Solution by Abson Method (AASHTO T 170) is not required, the following solvents may be used:

Biodegradable, Nontoxic Asphalt Extractant: MDOT-Approved

**ALTERNATE METHOD NUMBER II****1. APPARATUS**

- 1.1 Apparatus as required by MT-76.
- 1.2 Pan, flat, approximately 12 in. x 8 in. x 1 in. deep.
- 1.3 Balance, AASHTO M 231.
- 1.4 Extraction Apparatus. Consisting of a bowl with at least 1000-gram capacity and an apparatus in which the bowl may be revolved at controlled variable speeds up to 3600 RPM. The apparatus shall be provided with a container for catching the solvent thrown from the bowl and a drain for removing the solvent. The apparatus shall be installed in a hood to provide proper ventilation.
- 1.5 Filter rings to fit rim of the extraction bowl.
- 1.6 Solvents, as required by Alternate Method Number. 1
- 1.7 Oven, capable of maintaining a uniform temperature of  $230^{\circ}\pm 9^{\circ}\text{F}$ .
- 1.8 Sieves, as required by the gradation specifications and meeting the requirements of AASHTO M 92.
- 1.9 Liquid Detergent (powder detergents are not permitted).
- 1.10 Apparatus required by MT-6.

**2. BITUMEN CONTENT OF PAVING MIXTURE**

Determine the bitumen content in accordance with MT-6.

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### 3. EXTRACTION OF AGGREGATE

#### 3.1 PREPARATION OF SAMPLES

3.1.1 Prepare an extraction test sample of the size as required in Table 1, AASHTO T 164, weighed to the nearest 0.1 gram and a test sample (approximately 500 grams) weighed to the nearest 0.1 gram for moisture determination from the paving mixture used in the Bitumen Content Determination in Section 2.

#### 3.2 PROCEDURE

3.2.1 Determine moisture content of the 500-gram sample in accordance with MT-76.

3.2.2 Place the extraction sample in bowl of the centrifuge, distributing it uniformly; cover with solvent and allow sufficient time (30 minutes to 1 hour) for solvent to disintegrate the sample.

3.2.3 Place the bowl containing the sample and solvent in the extracting apparatus.

3.2.4 Fit filter ring to the bowl, clamp cover on the bowl, and place a container under the drain.

3.2.5 Start centrifuge revolving slowly and gradually increase the speed to a maximum of 3600 RPM or until the solvent ceases to flow from drain.

3.2.6 Stop the machine and add approximately 200 ml of solvent and repeat the procedure until the extract is no darker than a light straw color.

3.2.7 Remove filter from bowl and dry in air. Remove the mineral matter adhering to the filter and add to the aggregate bowl.

### 4. MECHANICAL ANALYSIS OF THE EXTRACTED AGGREGATE

#### 4.1 SAMPLE

4.1.1 The sample shall consist of all the extracted material in Section 3.

#### 4.2 PROCEDURE

4.2.1 Shall be in accordance with AASHTO T 30 except that the total extracted weight of mineral aggregate shall be calculated.

#### 4.3 CALCULATIONS

4.3.1 Correct asphalt content for moisture as follows:

$$AC, \% = G - M$$

Where:

AC = percent bitumen corrected for moisture  
G = percent asphalt from gauge as a percent  
M = moisture content as a percent

4.3.2 Calculate dry weight of sample as follows:

$$W_s = W - (W \times (M/100))$$

Where:

$W_s$  = dry sample weight in grams  
 $W$  = weight of sample taken for extraction in grams  
 $M$  = moisture content as a percent

4.3.3 Calculate total extracted weight of mineral aggregate as follows:

$$W_1 = W_s (1 - (AC/100))$$

Where:

$W_1$  = total extracted weight of mineral aggregate in grams  
 $AC$  = percent bitumen corrected for moisture  
 (see Subsection 4.3.1)

4.3.4 Calculate the percent passing each sieve as follows:

$$\% \text{ Passing} = \frac{W_1 - W_2}{W_1} \times 100$$

Where:

$W_1$  = total extracted weight of mineral aggregate in grams  
 (see Subsection 4.3.3)  
 $W_2$  = accumulated weight of material on each sieve in grams

4.4 Report the percent passing each sieve to the nearest 0.1%.

### ALTERNATE METHOD NUMBER III

## 5. APPARATUS

5.1 Apparatus as required by MT-76.

5.2 Pan, bottom diameter of approximately 8 in. and depth of 5 in. (min).

5.3 Balance, AASHTO M 231.

5.4 Solvents, biodegradable, nontoxic extractant, MDOT-approved.

5.5 Oven, capable of maintaining a uniform temperature of  $230^\circ \pm 9^\circ\text{F}$ .

5.6 Sieves, as required by the gradation specifications and meeting the requirements of AASHTO M 92.

5.7 Apparatus required by MT-6.

5.8 Miscellaneous rubber gloves, eye protectors, spatula, trowel and thermometer.

## 6. BITUMEN CONTENT OF PAVING MIXTURE

Determine the bitumen content in accordance with MT-6.

**7. AGGREGATE GRADATION**

## 7.1 PREPARATION OF SAMPLES

7.1.1 Prepare sample from paving mixture used in Bitumen Content Determination in Section 6.

7.1.2 Heat the sample in an oven (or sand bath) to  $230^{\circ} \pm 9^{\circ}\text{F}$  until the sample is soft enough to be separated with a spatula or trowel.

7.1.3 Mix the sample uniformly and quarter in accordance with AASHTO T 248, Method B.

7.1.4 Select an extraction test sample of the size as required in Table 1, AASHTO T 164, weighed to the nearest 0.1 gram and a test sample (approximately 500 grams) weighed to the nearest 0.1 gram for moisture determination.

## 7.2 PROCEDURE

7.2.1 Determine moisture content of the 500-gram sample in accordance with MT-76.

7.2.2 Place the extraction sample in pan and cover with extractant. Gently agitate the sample frequently with a spatula or trowel, allowing sufficient time (20 - 30 min. for virgin mixtures; 45 min. - one hour for recycle mixtures) for the extractant to dissolve the bitumen from the aggregate. Decant extractant, pouring over a No. 8 sieve nested over a No. 200 sieve. Add additional increments of extractant (approx. 500 ml) and agitate for a minimum of two (2) minutes before decanting. Discontinue the extractant rinses when the extractant becomes a straw color. Begin rinsing and decanting with water until the wash water is clear. (NOTE: Care must be taken while agitating and decanting to prevent loss of particles.)

7.2.3 Dry sample to constant weight in an oven (or sand bath) at a temperature of  $230^{\circ} \pm 9^{\circ}\text{F}$ .

7.2.4 Screen the sample over sieves required by the job-mix formula and weigh the material retained on each sieve to the nearest 0.1 gram.

7.3 CALCULATIONS. Conduct the calculations according to the equations given in Section 4.3 of this S.O.P.

7.4 Report the percent passing each sieve to the nearest 0.1%.

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**MT-39 Analysis of Cement, Agricultural Limestone, Fly Ash, and Hydrated Lime**

**SCOPE:** To establish standard procedures for the X-ray analysis of Portland Cement, Agricultural Limestone, Fly Ash, and Hydrated Lime.

**1. SUMMARY OF METHOD**

The specimens are prepared in a 35 mm diameter pellet pressure mold to at least 3 mm thickness and irradiated by an X-ray beam of high energy. The secondary X-rays produced are dispersed by means of a crystal, and the intensities are measured by a detector at selected wavelengths. The output of the in voltage pulses is converted to counts over a fixed time, and the counts are related to an analytical curve.

**2. APPARATUS**

- 2.1 ARL Advant XP. (Automated, computer-assisted X-ray fluorescence spectrometer).
- 2.2 Shatterbox grinder with tool-steel grinding chamber.
- 2.3 Single pan balance (sensitive to 0.001 g).
- 2.4 Pellet mold.
- 2.5 Hydraulic press (3624 B, Spex Industries, 35 Ton).
- 2.6 Cellulose powder (Whatman, CF-1).
- 2.7 Boraxo.
- 2.8 Spectrographic X-ray mix powder (Chemplex).
- 2.9 Sieve, 850  $\mu\text{m}$
- 2.10 Sieve, 300  $\mu\text{m}$
- 2.11 Sample splitter.
- 2.12 Sampling tube.
- 2.13 Standard reference material:
  - a. Cement: All Available NIST Standard Reference Materials
  - b. Fly Ash: All Available NIST Standard Reference Materials
  - c. Agricultural limestone: NIST1b, NIST88a, and at least two other independently analyzed standards of known concentration.
  - d. Hydrated lime: At least four independently analyzed standards of known concentration.

All standards are prepared according to the same procedures as the samples to be tested.

**3. SAMPLE PREPARATION**

- 3.1 Obtaining test specimen from field sample.

3.1.1 CEMENT AND FLY ASH. Pass sample over an No. 20 sieve to remove lumps and foreign material. With sample splitter, or by quartering, reduce sample to a laboratory sample of approximately 50 g. Transfer the material to a clean, dry glass container with airtight lid and further mix the sample thoroughly.

3.1.2 AGRICULTURAL LIMESTONE. With a sample splitter reduce the sample to approximately 25 g. Dry this portion and grind sufficiently to pass a No. 50 sieve. Transfer the material to a clean, dry glass container with airtight lid and further mix the sample thoroughly.

3.1.3 HYDRATED LIME. With sampling tube, obtain test specimen of approximately 25 g. Transfer to a clean, dry glass container with airtight lid and further mix the sample thoroughly.

### 3.2 MIXING.

3.2.1 CEMENT AND AGRICULTURAL LIMESTONE. Measure 4 g of sample into a 90 mL can. Add 0.2 g of spectrographic X-ray mix powder. Shake well until thoroughly mixed.

3.2.2 FLY ASH. Weigh 4 g of sample into a can. Add 0.3 grams of spectrographic X-ray mix powder. Shake well until thoroughly mixed.

3.2.3 HYDRATED LIME. Measure 2 g of sample into a 90 mL can. Add 0.2 g of boraxo/cellulose mix (one part boraxo by mass to two parts cellulose by mass). Shake well until thoroughly mixed.

### 3.3 GRINDING.

3.3.1 CEMENT AND FLY ASH. Place the mixed material into the shatter box grinder and grind for one (1) minute. Transfer to a 3-ounce can using a stiff, short-bristle brush. Mix thoroughly.

3.3.2 AGRICULTURAL LIMESTONE. Place the mixed material into the shatter box grinder and grind for one (1) minute. Transfer to a 3-ounce can using a stiff, short-bristle brush. Mix thoroughly.

3.3.3 HYDRATED LIME. Place the mixed material into the shatter box grinder and grind for one (1) minute. Transfer to a 3-ounce can with a stiff, short-bristle brush. Mix thoroughly.

3.3.4 COMPRESSION OF PELLET. Place the ground material into the pellet mold. Then place approximately 2.5 g of boraxo-cellulose mixture (two parts by mass of cellulose to one part by mass of boraxo) on top of the material to form the backing for the pellet. Place the mold on the ram of the press and pump to a gauge reading of 20 Tons total load on the ram. Hold the gauge reading for ten (10) seconds (two minutes for hydrated lime) and release the pressure slowly. Remove the pellet and brush with a camel's hair brush. Identify the pellet on the backside. Do not touch front of pellet with fingers.

## 4. PROCEDURE

4.1 SETTING-UP PROGRAM. Follow manufacturer's instruction manual procedure for creating program.

4.2 CALIBRATION CURVES. Calibration curves are derived using the multivariable regression calculation procedure. This is an empirical correction procedure used to minimize inter-element interference within a multicomponent matrix. Base curve polynomials and correction coefficients are computed simultaneously using facilities provided in the multiple variable regression (MVR) component of the XRF software. A minimum of four (4) standards is needed for calibration curves.

4.3 DRIFT CORRECTION. Perform drift correction prior to each series of analysis. To accomplish this, place standards furnished by the manufacturer used for drift correction into assigned cassettes. After allowing X-ray tube to stabilize, run drift correction standards. To run drift correction, go to XRF Main Menu Window: one click of mouse on **Analysis**; one click of mouse on **Routine Analysis**; one click of mouse on **Unattended Analysis**. Select **Drift Correction Update** from category list; then select the applicable task from the Analytical Task Block; one click of mouse on **OK**.

4.4 ANALYZING SAMPLES. After drift correction, place samples to be analyzed into the numbered cassettes. Place the cassettes on the 8-position sample tray. To run samples, go to XRF 386 Main Menu Window: one click of mouse on **Analysis**; one click on **Routine Analysis**; one click on **Unattended Analysis**. Select **Concentration of Unknown Samples** from category list. Go to Analytical Program Block: one click of mouse on **Select**. Select applicable program from program block: one click of mouse on **OK**. To enter subsequent samples, double click of mouse on **ICS Operation Manager** that appears on XRF 386 Main Menu Window. Go to insert steps block: one click of mouse on **Analysis**; then proceed as above to enter applicable program and sample identity.

After all sample identities have been entered, click on **Run** to start analyzing samples.

## 5. REPORTING

Report the percent concentrations of the various elements of interest to the degree of accuracy stipulated in the governing specifications.

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**MT-40 Analysis of Hydraulic Cement by Atomic Absorption**

**SCOPE:** This method covers the determination of the aluminum, calcium, iron, magnesium, manganese, potassium, strontium, titanium, and sodium oxides content of a Portland cement by Atomic Absorption Spectrophotometry.

**1. APPARATUS**

- 1.1 Spectrophotometer, Atomic Absorption-Perkin Elmer Model 3110, or equivalent instrument.
- 1.2 Support apparatus for the operations of the above instrument: gas, air, vent, etc.
- 1.3 Heat lamps.
- 1.4 Balance, analytical, capable of weighing to 0.1 mg.
- 1.5 Labware, assorted, to meet requirements as specified in the procedure.

**2. REAGENTS**

- 2.1 Hydrochloric Acid, Reagent Grade.
- 2.2 Lanthanum Solution. (Wet 48.64 g of lanthanum oxide,  $\text{La}_2\text{O}_3$ , with 50 mL distilled water. Slowly and cautiously add 250 mL of HCl to dissolve the  $\text{La}_2\text{O}_3$ . Cool and dilute to 1 L for a 5% lanthanum solution.)
- 2.3 Standard Samples. A supply of the current NBS standard cement samples or other independently analyzed cements.

**3. STANDARD SOLUTIONS**

A minimum of four (4) samples spanning the concentration range of the elements of interest is required to establish linearity either by direct concentration readout or by an absorbance vs. concentration readout or by an absorbance vs. concentration plot. Once linearity has been established, only one standard, preferably one having the highest concentration, and a reagent blank needs to be used, although the linearity of the curve should be checked periodically with intermediate standards.

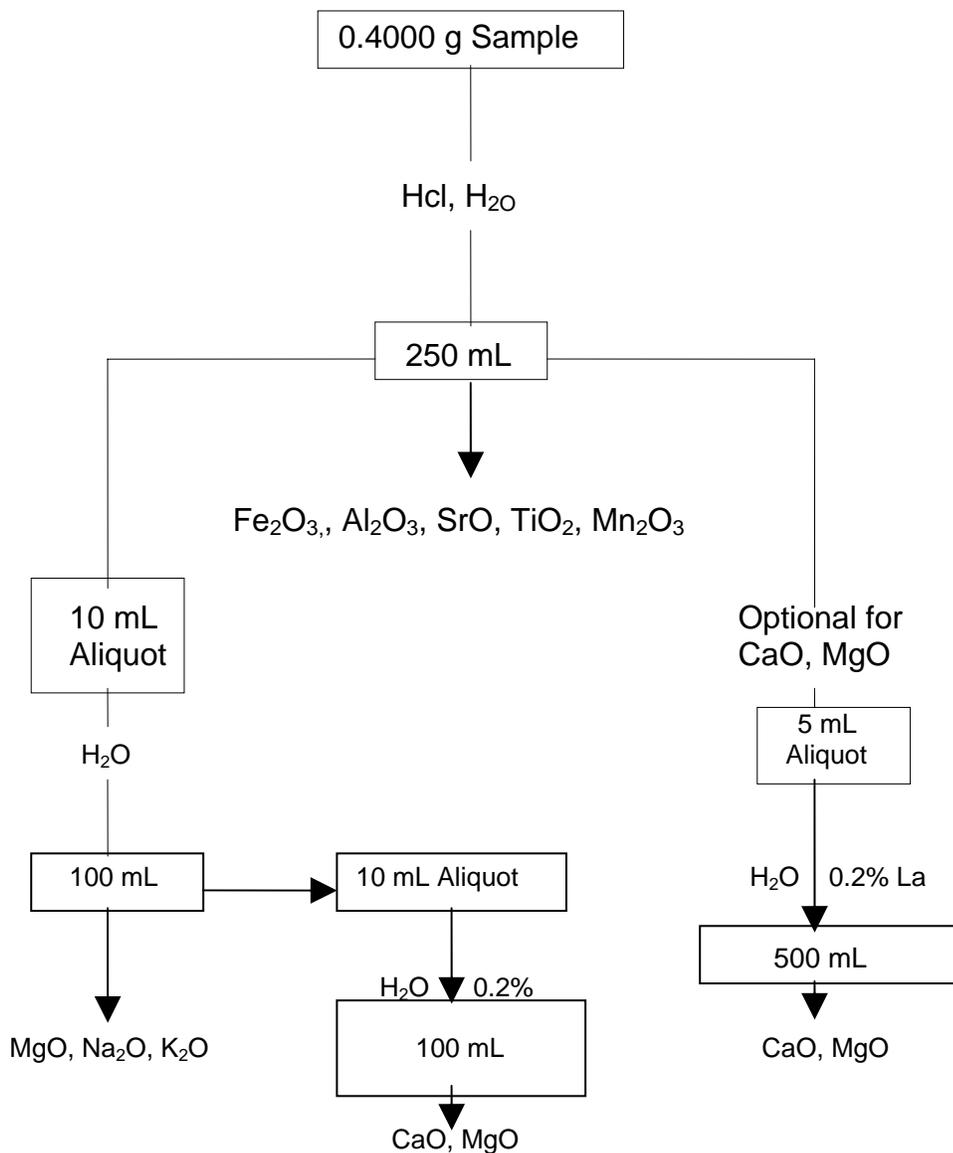
NOTE: In the event nonlinearity is established, a smaller sample mass or a larger dilution step is utilized.

**4. SAMPLE PREPARATION**

- 4.1 Measure  $0.4000 \pm 0.0002$  g of representative blended cement into a plastic beaker of 100-mL capacity. Add 25 mL of distilled water and 5 mL of concentrated hydrochloric acid. Break up all lumps with a plastic policeman.
- 4.2 Heat the samples under infrared lamps for a minimum of fifteen (15) minutes, keeping just below boiling. Filter the solution through No. 41 filter paper into a 250-mL volumetric flask, washing

the beaker, policeman and filter paper thoroughly with hot distilled water. Cool the flask to room temperature and dilute to the mark. For each element of interest, dilute according to the following flow diagram. The dilutions in the following diagram are subject to change at the operator's discretion:

**FLOW DIAGRAM FOR PREPARATION OF SAMPLE SOLUTIONS**



**5. PROCEDURE FOR THE DETERMINATION OF ALUMINUM, IRON, MAGNESIUM, MANGANESE, STRONTIUM, TITANIUM, POTASSIUM, AND SODIUM OXIDES**

5.1 Install the required lamp source and adjust the lamp current to the suggested MA on each lamp.

5.2 Set the **SLIT** and **GRATING RANGE** controls as required, and for measurements above 6000A (potassium) set the **FILTER** switch on **ON**.

- 
- 5.3 Set the analytical wavelength by rotating the coarse and fine dials of the **WAVELENGTH** control to obtain a maximum on the **ENERGY** meter. Keep the ENERGY meter needle near the center of the darker red region by adjusting the **GAIN** control, avoiding excessive gain which could cause possible damage to the photomultiplier tube.
- 5.4 Install and align the appropriate burner head.
- 5.5 Check the waste water receiving tank and make sure that the waste water line from the burner is at least 125 mm under water and that the 150 mm loop in the line is filled with water. This is necessary to avoid a flashback and ruining the burner assembly.
- 5.6 Open gas cylinders and air, adjusting to desired pressures as indicated on each pressure gauge.
- 5.7 Set the fuel and oxidant selector switches as required.
- 5.8 Depress in turn the **FUEL** and **OXIDANT FLOW CHECK** buttons, noting the **PRESSURE** and **FLOW** readings of the respective gauges while the buttons are depressed. If necessary, adjust to obtain recommended settings.
- 5.9 Set the **GASES** switch to **ON**.
- NOTE: When using N<sub>2</sub>O, set the **AIR-OTHER** switch to **AIR** before turning on the gases. After ignition, flip the switch to **OTHER** (N<sub>2</sub>O). An override control inhibits the **IGNITER** control in the **OTHER** setting.
- 5.10 Press and hold the **IGNITE** button to light the flame. Let burner warm up for five (5) minutes and adjust flows and pressure setting if necessary.
- 5.11 Calibration for Concentration Readout. Depress these switches: **CONCENTRATION, REPEAT, 10 AVERAGE**; set both **CURVATURE** controls fully counterclockwise. Press the **READ** switch once after setting the **REPEAT** switch.
- 5.12 Peak the **ENERGY** meter with the **FINE WAVELENGTH** control. Check burner alignment by aspirating a solution of Portland cement and adjusting as to locate the area of the flame where the maximum absorption occurs for the element of interest.
- IMPORTANT: To help avoid contaminating blank, standard or sample solutions, wipe off the end of the tubing with a clean tissue each time before inserting it in the solution. Keep the tubing in solvent between determinations. NEVER ASPIRATE SOLUTIONS WITH THE FLAME OFF.
- 5.13 Aspirate a blank and after three (3) seconds press the **AUTO ZERO** switch. Continue aspiration until the zero function is completed.
- 5.14 While aspirating a standard solution, turn the **CONCENTRATION** control to make the readout display the concentration value of the standard solution. Fine adjustment may be completed with the **CONCENTRATION VERNIER**.
- 5.15 Depress the **MANUAL** switch, **100 AVERAGE** switch and the **READ** switch to check the calibration of the standard solution. After calibration, begin aspirating samples and recording their concentration in percentages by depressing the **READ** switch, checking periodically the zero set and standard concentration, making adjustments when necessary.
- 5.16 Before shutdown, aspirate distilled water for a few minutes; then set the GASES switch to **SHUTDOWN**.
-

**6. CALCIUM OXIDE**

6.1 Prepare instrument as previously outlined in Subsections 5.1 through 5.13; and after the zero function is completed in Subsection 5.13, depress the **ABSORBANCE**, **MANUAL**, **100 AVERAGE**, and **READ** switches.

6.2 Using four (4) standards spanning the concentration range of the unknown, make a minimum of four (4) sets of 100 average readings and average to the fourth decimal place; and make either a plot of concentration vs. absorbance or a least squares calculation and determine the percent of concentration of the unknown.

**MT-41 The Atomic Absorption Method of Analysis of Agricultural Limestone**

**SCOPE:** This method of analysis is intended for the determination by atomic absorption spectrophotometry of the calcium and magnesium carbonate contents of agricultural limestone. A series of solutions prepared from commercial stock standard solutions is utilized for calibration purposes.

**1. APPARATUS**

- 1.1 Perkin-Elmer Model 3110 Atomic Absorption Spectrophotometer and a 50 mm short path acetylene burner head.
- 1.2 Acetylene cylinder and a supply of clean moisture-free compressed air.
- 1.3 A vent for removing toxic fumes and heat.
- 1.4 A 500 watt constant voltage transformer.
- 1.5 A muffle furnace capable of maintaining 1800°F.
- 1.6 Stock solutions of known concentrations of calcium and magnesium.
- 1.7 Mortar and pestle.
- 1.8 No. 100 Sieve.
- 1.9 Platinum crucible.
- 1.10 Balance, analytical, capable of weighing 0.1 mg.
- 1.11 Suitable glassware.

**2. REAGENTS**

- 2.1 Hydrochloric Acid, Reagent Grade.
- 2.2 Lithium Metaborate, Anhydrous, Reagent Grade.
- 2.3 Lanthanum Solution. Wet 58.65 g of  $\text{La}_2\text{O}_3$ , with distilled water. Add 250 mL of concentrated HCl very slowly until the material is dissolved. Dilute to 1000 mL with distilled water; this provides a 5% Lanthanum solution in 3N HCl.

**3. STANDARDS**

A minimum of six (6) samples spanning the concentration range of the element of interest is required to construct calibration curves. These standards of known concentrations of the elements of interest are prepared from stock solutions and are run through the instrument to calibrate the digital readout system at the time the sample is ready to be examined.

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#### 4. SAMPLE PREPARATION

4.1 By use of appropriate sizes of sample splitters, take an aliquot of approximately 25 g. Grind this sample in a mortar so that it will all pass a 100-mesh sieve. Mix well by shaking in a 250 mL can. Place a portion of this ground and mixed material in a bottle and oven-dry at 105 - 110°C for at least two (2) hours. Now, place the bottle and sample in a desiccator and allow to cool to room temperature.

4.2 Measure approximately 0.1 g of the dried sample to the nearest 0.0001 g into a platinum crucible. Add approximately 0.6 g of lithium metaborate to the crucible and fuse the mixture in the muffle furnace at 1800°F for fifteen (15) minutes; remove and allow to cool.

4.3 Place a small Teflon stirring bar in the crucible and fill approximately three-fourths full with hot distilled water and 5 mL of concentrated hydrochloric acid. Place the crucible on a magnetic stirrer-hot plate which is set at low heat and low speed. When solution is complete, proceed to Subsection 4.4.

4.4 Transfer the solution to a 250 mL volumetric flask through a funnel, washing crucible lid, stirring bar and funnel with hot distilled water. Allow to cool to room temperature and dilute to the mark.

4.5 Pipette 10 mL of the solution into another 250 mL volumetric flask containing 20 mL of 5% lanthanum solution, and dilute to the mark.

#### 5. PREPARATION OF STANDARDS

5.1 Fuse approximately 0.6 g lithium metaborate in a platinum crucible as described in Subsection 4.2. Dilute as described in Subsections 4.3 and 4.4.

5.2 Add 4 mL of the above lithium metaborate solution and 8 mL of the 5% lanthanum solution to each of six 100 mL volumetric flasks. From stock standard solutions, add to each of the flasks enough magnesium and calcium to produce the following concentrations after dilution to the mark:

	<u>No. 1</u>	<u>No. 2</u>	<u>No. 3</u>	<u>No. 4</u>	<u>No. 5</u>	<u>No. 6</u>
PPM Mg	0.00	0.5	1.00	1.50	2.00	2.50
PPM Ca	6.00	5.00	4.00	3.00	2.00	0.00

#### 6. PROCEDURE

6.1 Set the acetylene line pressure at 8 psi and the air pressure at 30 psi.

6.2 Set the instrumental parameters for the spectrophotometer for the element of interest according to the manufacturer's recommendations. These parameters are subject to change at the operator's discretion.

6.3 Adjust the monochromator to isolate the desired resonance line of the element to be determined and peak the resulting signal while keeping the energy meter inside the red zone by use of the gain control.

6.4 Check the waste receiving tank and make certain that the waste line from the burner is at least 6 inches under water and that the 6 inch loop in the line is filled with water. This is necessary to avoid a flash-back, which may ruin the burner assembly.

6.5 Adjust the flow of gases and light the burner. Let the burner warm up five (5) minutes and readjust gas flow if necessary.

6.6 Check the resonance line signal for fading and readjust the wavelength control if necessary.

6.7 Aspirate the solution containing the highest concentration of the element of interest and adjust the burner height so as to locate the area of the flame where the maximum absorption occurs for the element of interest.

6.8 If absorption exceeds 70%, rotate the burner head to a degree that will bring the percent absorption within a usable range.

6.9 Either or both of the following methods of data readout may be used at the operator's discretion.

#### 6.9.1 ABSORBANCE METHOD

6.9.1.1 While aspirating the blank solution, press the, **ABSORBANCE, AUTO ZERO, 100 AVERAGE, MANUAL** and **READ** switches.

6.9.1.2 Aspirate the blank and standards and record the absorbance of each. Aspirate the unknown and record the absorbance of each. Aspirate the standards again, the unknowns again, and then the standards for the third time. Average the three absorbance values of each of the standards and the two values for each of the unknowns.

6.9.1.3 Plot on a graph the concentration of the standards versus the absorbance values of the standards. Determine the PPM concentration of the unknowns from the graph using the absorbance values.

#### 6.9.2 DIRECT CONCENTRATION

6.9.2.1 By using the concentration mode and the curvature correction, concentrations may be displayed directly to the one hundredth of a PPM of the element of interest.

6.9.2.2 Refer to Instructions Manual, Section 2B, 3-5, for concentration readout and curvature correction.

## 7. CALCULATIONS

For the determination of the percent concentration, use the following formula:

$$\% \text{ Concentration} = \frac{\text{PPM} \times \text{Gravimetric Factor} \times \text{Dilution Factor}}{\text{Mass of Sample} \times 10\,000}$$

$$\text{For Calcium, } \% \text{ CaCO}_3 = \frac{\text{PPM} \times 2.4973 \times 6250}{\text{Mass} \times 10\,000}$$

$$\text{Magnesium, } \% \text{ MgCO}_3 = \frac{\text{PPM} \times 3.4676 \times 6250}{\text{Mass} \times 10\,000}$$

Convert the element concentration to the equivalent carbonate value.

Convert the MgCO<sub>3</sub> concentration to its equivalent CaCO<sub>3</sub> concentration, and add these two values of CaCO<sub>3</sub> concentration.

## 8. REPORT

Report the percent concentration of CaCO<sub>3</sub> to the nearest 0.1%.

**MT-53 Standard Method of Test for Barbed Wire**

**PURPOSE:** To establish a standard method of test for barbed wire.

**1. GENERAL**

This standard operating procedure sets out a test method to determine the requirements of barbed wire as specified in Subsections 6.2 and 7.3 of ASTM A 121. All other tests will be performed in accordance with the methods set out in ASTM A 121.

**2. APPARATUS**

- 2.1 Spring scales graduated to 200 pounds.
- 2.2 A device to hold a length of 25 feet of wire.

**3. TEST PROCEDURE**

- 3.1 Place 25 ft of wire in the device noted in Subsection 2.2 and apply a tension load of 200 lbs.
- 3.2 Count the number of barbs in the 25 ft length of wire and record as **A**.
- 3.3 Count the number of barbs that will spin out of place by twisting the barbs by hand or that will move laterally more than 3/4 inch and record as **B**.
- 3.4 Measure the distance between each of the barbs in the 8 m length of wire and compute the average spacing of the barbs.
- 3.5 Count the number of bent barbs and record as **C**. A bent barb is defined as a barb that is bent so that the point will not stick.
- 3.6 Count the number of barbs that do not have sharp points and record as **D**.

**4. COMPUTATIONS**

4.1 Percent of Defective Barbs =  $\frac{B+C+D}{A} \times 100$

4.2 The average spacing of the barbs is equal to the sum of the individual spacing divided by the total number of spaces measured.

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**MT-58 Soluable Sulfate Ion in Soils and Water**

**SCOPE:** This test method establishes a standard of procedure and equipment for use in determining the water soluble sulfate ion ( $\text{SO}_4^{=}$ ) in soils and in water.

**1. SUMMARY OF METHOD**

This method describes the indirect determination of water-soluble sulfate by precipitation with standard barium chloride solution and subsequent atomic absorption measurement of the excess barium.

**2. APPARATUS**

- 2.1 Spectrophotometer. Atomic Absorption--Perkin-Elmer Model 3110, or equivalent instrument.
- 2.2 Support apparatus for the operations of the above instrument, gas, air, vent, etc.
- 2.3 Hot plate.
- 2.4 Shaker or some other means of agitating the soil sample.
- 2.5 Centrifuge, high speed.
- 2.6 Tubes, centrifuge, capable of holding in excess of 25 mL and withstanding 10 000 RPM.
- 2.7 Balance, analytical, capable of measuring mass within 0.1 mg.
- 2.8 Oven, drying, capable of maintaining  $105 \pm 5^\circ\text{C}$ .
- 2.9 Mortar and pestle or some other means for grinding the soil sample.
- 2.10 No. 50 Sieve.
- 2.11 Glassware, assorted, to meet requirements as specified in procedure.

**3. REAGENTS**

- 3.1 Barium Chloride Stock Solution. Dissolve 8.8960 g of reagent-grade barium chloride dihydrate,  $\text{BaCl}_2 \cdot 2 \text{H}_2\text{O}$ , in dionized water and dilute to 1 L. This solution contains 5000 ppm barium.
- 3.2 Sulfate Stock Solution. Dissolve 1.4798 g of dried anhydrous sodium sulfate,  $\text{Na}_2 \text{SO}_4$ , in deionized water and dilute to 1 L. This solution contains 1000 ppm sulfate ( $\text{SO}_4^{=}$ )
- 3.3 Hydrochloric Acid, concentrated reagent grade.
- 3.4 Methyl Red. 2g methyl red per 1 L of 95% ethyl alcohol.

#### 4. STANDARD SOLUTIONS.

Standard solutions are prepared either by dilution of the barium stock solution, or by dilutions of the sulfate stock solution and treating the sulfate standard solutions as described under Sample Preparation. Once linearity of the concentration range is established as few as one standard and blank may be used for direct readout.

#### 5. SAMPLE PREPARATION

5.1 If the soil sample as received has not previously been prepared for analysis, a representative portion of the sample is dried at  $105 \pm 5^\circ\text{C}$  and ground to pass the No. 50 sieve.

5.2 To 10 g of the prepared soil in a clean plastic bottle, add 100 mL of deionized water and agitate for fifteen (15) minutes on the small paint shaker. If a less vigorous means of agitation is used, a longer period of time is necessary.

5.3 Centrifuge a portion of the liquid at approximately 10 000 RPM for ten (10) to fifteen (15) minutes and then pipette a 25 mL aliquot into a 50 mL volumetric flask. To the sample and standard solutions, add concentrated hydrochloric acid until the solution is acid to methyl red and then add one (1) drop in excess. Heat to just below boiling and pipette 4 mL of barium chloride stock solution. Digest a minimum of two (2) hours before cooling. Dilute to volume; mix thoroughly; and allow to settle, preferably overnight.

5.4 Water samples are treated as outlined in the previous subsection, usually without centrifuging.

#### 6. ANALYSIS

Determine the barium concentration in the supernatants from the sample and standard solutions using the standard condition for barium except that a 4-inch single slot burner head with air-acetylene flame should be used for reduced sensitivity.

#### 7. CALCULATION

$$\begin{aligned} \text{Soils} & \quad \frac{(400 \text{ ppm Ba} - \text{ppm Ba in diluted samples}) \times 0.6994}{500} \\ & \quad = \% \text{ Soluble SO}_4 \end{aligned}$$

$$\begin{aligned} \text{Water} & \quad (400 \text{ ppm Ba} - \text{ppm in diluted samples}) \times 2 \times 0.6994 \\ & \quad = \text{ppm Soluble SO}_4 \end{aligned}$$

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**MT-59 Determination of Loss of Coating of HMA (Boiling Water Test)**

**PURPOSE:** This method is intended to provide a rapid test that will give an indication of the resistance of a bituminous paving mixture to stripping with or without an antistripping additive. The bituminous paving mixture may be either plant-mixed or laboratory-mixed. This test may be performed in the field, District or Central Laboratories. The loss of adhesion of asphalt from the aggregate particles, if any, is determined subjectively by visually examining the proportion of stripped aggregate particles.

**1. APPARATUS**

- 1.1 Oven. Capable of maintaining constant temperatures with  $\pm 5^{\circ}\text{F}$ .
- 1.2 Balance. Capacity of approximately 2 kilograms or more and sensitive to 1 g or less.
- 1.3 Burner or Hot Plate. A burner shall be equipped with a ring-stand and a ceramic-centered iron wire gauze to prevent localized over heating of the beaker. A hot plate shall be properly shielded to uniformly distribute the heat across the surface.
- 1.4 Beaker. Stainless steel or Pyrex at least 1000 mL capacity.
- 1.5 Thermometers. Armored glass or dial-type with metal stem, having a temperature range of 50 to 400°F, sensitive to  $\pm 5^{\circ}\text{C}$ .
- 1.6 Stirring Rods. Glass or stainless steel.
- 1.7 Miscellaneous. Asbestos gloves, pans, beaker tongs, spatula, etc.
- 1.8 Distilled or deionized water.

**2. PREPARATION OF LABORATORY MIXTURES**

2.1 PREPARATION OF ANTISTRIPPING ADDITIVE. When the bituminous paving mixture requires the use of an antistripping additive to prevent stripping, the additive shall be prepared, as follows, depending on the type to be used:

2.1.1 LIQUID ANTISTRIPPING ADDITIVE. When a liquid antistripping additive is to be used, the asphalt cement in sufficient quantity for the test shall be heated to 149°C in an oven. The selected quantity of additive shall be added based, on percent by mass of the asphalt cement. Immediately mix the contents thoroughly for two (2) minutes using a stainless steel or glass stirring rod. Maintain the treated asphalt cement at 149°C until it is used. If the treated asphalt cement is not used on the same day in which it is prepared, or if it is allowed to cool so that it would require reheating, it shall be discarded.

2.1.2 POWDERED SOLID ANTISTRIPPING ADDITIVE. When a powdered solid antistripping additive is to be used, the batch of mineral aggregate shall be dried, composited, and heated to 149°C. The selected quantity of additive shall be added to the aggregate based on percent by mass of total aggregate, and the entire mass shall be thoroughly mixed until a uniform distribution of additive has been achieved. Care shall be taken to minimize loss of additive to the atmosphere in the form of dust. After mixing, maintain the treated aggregate at the temperature required for mixing until it is used.

2.2 PREPARATION OF BITUMINOUS PAVING MIXTURE. Prepare approximately 1000 g of the mixture in accordance with the job-mix formula using the procedure set out in MT-34M. Spread the mixture in a pan and allow to cool completely to room temperature no longer than twenty-four (24) hours.

**3. PREPARATION OF SAMPLES OF PLANT-PRODUCED MIXTURE**

3.1 Obtain a sample of the mixture from a truck using standard sampling techniques. Using a sample splitter or the quartering method, select approximately 1000 grams of the mixture. If the test sample is not to be tested in the field laboratory, place in a sealed container and transport to the laboratory.

3.2 Allow the sample to cool completely to room temperature.

**4. PROCEDURE**

4.1 Fill the beaker with distilled or deionized water and bring to a boil on the properly adjusted burner or hot plate.

4.2 Transfer approximately 200 g of the sample into the boiling water and boil for a period of ten (10) minutes.

4.3 Remove from heat, drain off water, empty the contents onto a white paper towel, and allow to dry.

**5. DETERMINATION OF STRIPPING**

5.1 The extent of stripping is indicated by visually examining the portion of stripped aggregate particles. The stripping is rated subjectively and shall be no more than 5%.

5.2 If the stripping exceeds 5%, a new dosage rate of antistripping additive shall be established using MT-63. If the mixture did not contain an antistripping additive, an additive shall be incorporated in accordance with MT-63.

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**MT-61 Method of Test for Determining Soil Resistivity**

**PURPOSE:** To establish a standard procedure for determining the minimum resistivity of soil samples.

**1. GENERAL**

The minimum resistivity is defined as the lowest resistivity obtained when running a series of tests on a particular sample.

**2. APPARATUS**

- 2.1 Resistivity meter capable of measuring the resistivity from 0-10,000 ohms to within 2% accuracy.
- 2.2 Soil box calibrated for use with resistivity meter. (See attached drawing)
- 2.3 Sieve, No. 8 sieve.
- 2.4 Drying pans.
- 2.5 Oven, 200° F.
- 2.6 Balance, 7 kg capacity, sensitive to within 0.1% of sample mass.
- 2.7 Pulverizing apparatus (mortar and rubber-covered pestle).
- 2.8 Sample splitter.

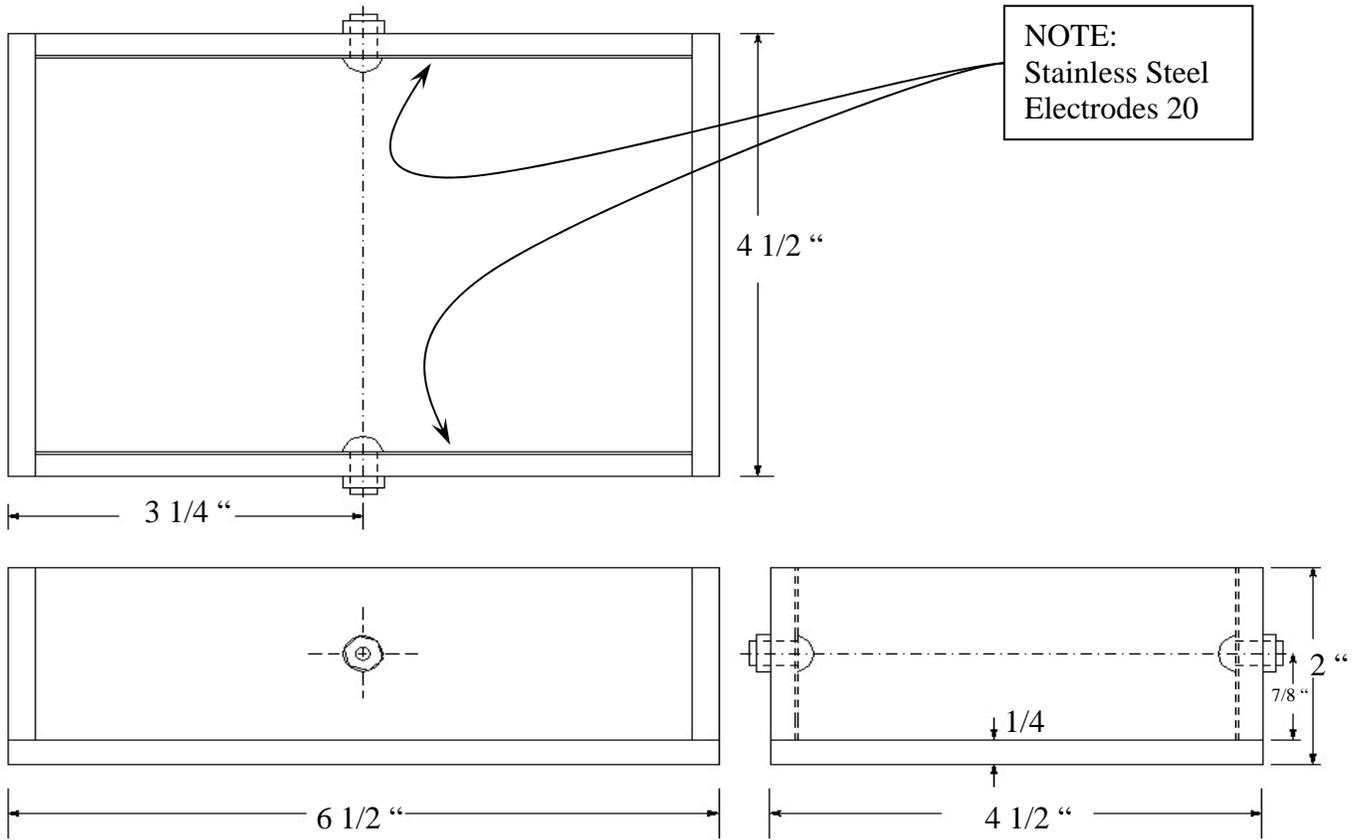
**3. SAMPLE**

Soil sample should contain at least 6000 g.

**4. PROCEDURE**

- 4.1 The soil sample as received from the field shall be dried thoroughly in the drying apparatus at a temperature not exceeding 60°C. The aggregations of soil particles shall then be broken up in the pulverizing apparatus in such a way as to avoid reducing the natural size of individual particles.
  - 4.2 Screen thoroughly mixed sample through a No. 8 sieve. Only the natural material passing the No. 8 sieve is to be used for the test.
  - 4.3 Quarter or split 1300 g of material passing a No. 8 sieve.
  - 4.4 Add 150 mL (cc) of distilled water to the 1300 g of soil and thoroughly mix.
  - 4.5 Place the thoroughly mixed soil in the soil box and compact. (Moderate compaction with the fingers is sufficient.)
  - 4.6 Measure the resistivity of the soil in accordance with the instructions furnished with the meter.
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- 4.7 Remove the soil from the soil box and add 100 additional mL (cc) of distilled water and thoroughly mix.
- 4.8 Place and compact the remixed soil in the soil box and measure its resistivity.
- 4.9 Repeat Subsections 4.7 and 4.8 once more.
- 4.10 If the resistivity of the soil has not followed a trend of high resistivity, low resistivity, and then an increase in resistivity for the preceding additions of distilled water, continue to add water in 50 mL increments to the soil, mixing, placing, compacting, and measuring resistivity for each increment until the minimum resistivity is obtained.
- 4.11 Record the test value that is the minimum value of soil resistivity regardless of the moisture content.



- Material – 1/4 " Plastic
- Bottom - 1 Pc. 6 1/2 " x 4 1/2 " x 1/4 "**
  - Ends – 2 Pcs. 4 1/2 " x 1 3/4 " x 1/4 "**
  - Sides – 2 Pcs. 6 " x 1 3/4 " x 1/4 "**
  - Electrodes – 2 Pcs. 20 Ga. Stainless Steel 6 " x 1 3/4 "**
  - 2 Ea. No. 8-32 = 3/4 " Round Head Stainless Steel Machine Screw With**

TYPICAL

**SOIL BOX FOR LABORATORY RESISTIVITY DETERMINATION**

**MT-63 Resistance of Bituminous Paving Mixtures to Stripping (Vacuum Saturation Method)**

**PURPOSE:** To establish a standard procedure for determining the need for antistripping additives, the effectiveness of antistripping additives, and for establishing dosage rates in bituminous paving mixtures.

**1. APPLICABLE TEST METHODS**

- 1.1 AASHTO T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures.
- 1.2 AASHTO T 209, Maximum Specific Gravity of Bituminous Paving Mixtures.
- 1.3 MT-78, Volumetric Design of Hot Bituminous Paving Mixtures Using the SUPERPAVE Gyrotory Compactor.

**2. APPARATUS**

- 2.1 In addition to the apparatus set out in the above "Applicable Test Methods," the following apparatus is required:
  - 2.1.1 Steel Loading Strips for 6-Inch Diameter Test Specimens. Steel loading strips, 0.75 inch wide, with a concave surface having a radius of curvature equal to the nominal radius of the 6-inch diameter test specimen. The length of the loading strip shall exceed the thickness of the test specimen. The edges of the strips shall be rounded by grinding.
  - 2.1.2 Vacuum chamber, equipped with gauge, capable of withstanding 30 inches of mercury. The chamber shall be large enough to hold at least two (2) 6-inch specimens submerged in water with space on all sides.
  - 2.1.3 Vacuum pump capable of pulling twenty-nine (29) inches of mercury or more.
  - 2.1.4 Constant temperature water bath at least 8 inches deep and thermostatically controlled so as to maintain the bath at  $77 \pm 1.8^{\circ}\text{F}$ . The tank shall have a false bottom or a shelf for supporting the immersed specimen.
  - 2.1.5 Distilled or deionized water.

**3. PREPARATION OF ANTISTRIPPING ADDITIVE**

- 3.1 When the bituminous mixture requires the use of an antistripping additive to prevent stripping, as determined by this test method, the additive shall be prepared as follows, depending on the type to be used:
  - 3.1.1 LIQUID ANTISTRIPPING ADDITIVE. When a liquid antistripping additive is to be used, the asphalt binder in sufficient quantity for the test shall be heated to 300°F in an oven. The selected quantity of additive shall be added based on percent by mass of the asphalt binder. Immediately mix the contents thoroughly for two minutes using a stainless steel or glass stirring rod. Maintain the treated asphalt binder at 300°F until it is used. If the treated asphalt binder is not used on the same day in which it is prepared, or if it is allowed to cool so that it would require reheating, it shall be discarded.

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**4. PROPORTIONING BITUMINOUS MIXTURES**

- .4.1** The bituminous mixture shall be proportioned in accordance with the job-mix formula from samples of the actual component materials to be incorporated in the work. The mixture shall be proportioned in batches as follows:
- 4.1.2** Dry each batch of blended mineral aggregate to a constant weight. Add  $2.5 \pm 0.5$  percent water plus the percent of water absorption for the blend as determined by AASHTO T84 and T85 to each aggregate batch. Mix the batch so that the water is uniformly distributed. The damp aggregate should be allowed to sit for approximately four hours prior to introducing the hydrated lime. Add 1 % hydrated lime to the aggregate as a percent by dry weight of total aggregate. Mix the combined materials until a uniform distribution of lime has been achieved. Care shall be taken to minimize the loss of lime to the atmosphere in the form of dust.
- 4.1.3** One batch shall be prepared for the determination of maximum specific gravity in accordance with AASHTO T 209. If the maximum gravity test was previously performed during the development of the job-mix formula using the same material samples, this step may be omitted.
- 4.1.4** One batch for each laboratory compaction operation. Approximately 3800 grams are required for each compacted 6-inch diameter by 3.75-inch high test specimen. A minimum of four(4) 6-inch diameter test specimens is required for performance of this test.

**5. PREPARATION OF LABORATORY COMPACTED SPECIMEN**

- 5.1** Preparation of 6-Inch Diameter Test Specimens.
- 5.1.1** Mixing and compaction shall be performed in accordance with MT-78 with the following exceptions:
- 5.1.1.1** Compact four(4) specimens to  $7.0 \pm 1$  percent air voids or other void level expected in the field. This level of voids can be obtained by adjusting the number of gyrations of the Gyratory Compactor or by setting the compactor to produce 3.75-inch high specimens and adjusting the mix weight to get the proper air void level. The exact procedure must be determined experimentally for each mixture.
- 5.1.1.2** Cool specimens in the mold for approximately 15 minutes in front of a fan blowing room temperature air, extract the samples from molds, and continue curing at room temperature at least overnight not to exceed twenty-four (24) hours.

**6. DENSITY AND VOID DETERMINATION**

- 6.1** Determine the maximum specific gravity in accordance with AASHTO T 209.
- 6.2** Determine the bulk specific gravity of each of the compacted specimens in accordance with AASHTO T 166, Method A. Record the volume of the specimens in cubic centimeters. The term (B-C) in T 166 Method A is the volume of the specimen in cubic centimeters.

- 6.3** Calculate the percent air voids in each of the compacted specimens by the following formula:

$$\% \text{ Air Voids} = 100 \left[ 1 - \frac{G_{mb}}{G_{mm}} \right]$$

Where:  $G_{mb}$  = Bulk Specific Gravity  
 $G_{mm}$  = Maximum Specific Gravity

- 6.4** Calculate the volume of air voids ( $V_a$ ) in cubic centimeters for each of the compacted specimens according to the following formula:

$$V_a = \frac{\text{Volume of Specimen, cc} \times \% \text{ Air Voids}}{100}$$

## 7. CONDITIONING OF COMPACTED SPECIMENS

- 7.1** Sort the specimens into two subsets (2 - 6 inch diameter specimens per subset) so that the average air voids of the two subsets are approximately equal. One subset is to be stored at room temperature until the indirect tensile strength is to be determined. The other subset is to be subjected to moisture-conditioning in an attempt to induce moisture-related damage (stripping).
- 7.2** Place the subset to be moisture-conditioned in the vacuum chamber, fill with distilled or deionized water at room temperature until the specimens are completely submerged, and saturate under vacuum until the voids are 55 to 80 percent filled as follows:
- 7.2.1** Saturate by applying a partial vacuum such as 20 inches of mercury for five (5) minutes. NOTE: Experience with partial vacuum at room temperature indicates that the degree of saturation is very sensitive to the magnitude of the vacuum and practically independent of the duration. The level of vacuum needed appears to be different for different mixtures.
- 7.2.2** Remove the specimens from the vacuum chamber and determine the saturated surface dry mass in air in accordance with AASHTO T 166, Method A.
- 7.2.3** Calculate the volume of absorbed water ( $V_{ws}$ ) in cubic centimeters by subtracting the mass in air of the specimen determined in Subsection 6.2 from the saturated surface-dried mass in air determined in Subsection 7.2.2.
- 7.2.4** Calculate the degree of saturation ( $W_s$ ) from the following formula.

$$W_s = \frac{V_{ws}}{V_a} \times 100$$

Where,  $W_s$  = Degree of saturation after vacuum, percent  
 $V_{ws}$  = Volume of absorbed water after vacuum, cc  
 $V_a$  = Volume of air voids from Subsection 6.4, cc.

If the degree of saturation is between 55% and 80%, proceed to Subsection 7.3.

If the degree of saturation is less than 55%, place the specimen back in the vacuum chamber and repeat the procedure beginning with Subsection 7.2, but at a slightly higher vacuum. Repeat the procedure until the required degree of saturation is obtained. If the

degree of saturation is more than 80%, the specimen has been damaged and must be discarded, in which case a new specimen must be molded and the process repeated.

- 7.3** Place the vacuum saturated specimens in a distilled or deionized water bath (unagitated) at 140°F and moisture condition for twenty-four (24) hours.
- 7.4** Remove the specimens from the 140°F water bath and place them in the 77°F water bath for two (2) hours  $\pm$  30 minutes.
- 7.5** Remove the moisture-conditioned specimens from the 77°F water bath and determine the bulk specific gravity in accordance with AASHTO T 166, Method A. Record the volume of the specimens in cubic centimeters. The term (B-C) in T 166, Method A, is the volume of the specimens in cubic centimeters.
- 7.6** Calculate the volume of absorbed water ( $V_{wm}$ ) in cubic centimeters by subtracting the mass in air of the specimen determined in Subsection 6.2 from the saturated surface dried mass in air determined in Subsection 7.5.
- 7.7** Calculate the degree of saturation ( $W_m$ ) of the moisture-conditioned specimens from the following formula.

$$W_m = \frac{W_{wm}}{V_a} \times 100$$

Where,  $W_m$  = degree of saturation following moisture conditioning, percent  
 $V_{wm}$  = volume of absorbed water following moisture conditioning, cc  
 $V_a$  = volume of air voids from Subsection 6.4, cc

NOTE: Degree of saturation exceeding 80 percent is acceptable in this step.

- 7.8** Measure the diameter of the moisture-conditioned specimens to the nearest 0.01-inch using calipers.
- 7.9** Adjust the temperature of the unconditioned specimens in the subset which has been curing at room temperature by placing them in the 77°F water bath for thirty (30) minutes  $\pm$  5 minutes.

## **8. INDIRECT TENSILE STRENGTH**

- 8.1** Determine the indirect tensile strength of each specimen at 77°F from both the unconditioned subset and the conditioned subset.
- 8.1.1** Place the specimen on edge and centered with the breaking head of the testing machine. Center the loading strip on top of the specimen so that the concave surface fits the curvature of the specimen circumference.
- 8.1.2** Apply diametrical load at the rate of 2 inches per minute until the maximum load is reached. Record the maximum load (P) in pounds (the Marshall breaking press has a loading rate of 2 inches per minute).
- 8.1.3** Continue loading until specimen can be separated at the failure plane for visual examination of the degree of particle stripping.
- 8.1.4** Calculate the indirect tensile strength from the following formula:

$$S_t = \frac{8.1935PD}{V}$$

Where,  $S_t$  = Indirect tensile strength, psi

$P$  = Maximum load at failure, pounds

$D$  = Diameter of specimen in inches. The diameter of the unconditioned specimen equals the inside diameter of the mold in which the specimen was compacted. The diameter of the moisture-conditioned specimen was determined by measurement in Subsection 7.8.

$V$  = Volume of specimen as tested in tension in cubic centimeters. See Subsection 6.2 for volume of unconditioned specimen and Subsection 7.5 for the volume of the moisture-conditioned specimen.

## 9. TENSILE STRENGTH RATIO

- 9.1 Calculate the average indirect tensile strength of the unconditioned subset ( $S_{tu}$ ).
- 9.2 Calculate the average indirect tensile strength of the moisture-conditioned subset ( $S_{tm}$ ).
- 9.3 Determine the tensile strength ratio from the following formula:

$$TSR = \frac{S_{tm}}{S_{tu}} \times 100$$

Where: TSR = Tensile strength ratio, percent

$S_{tm}$  = Average indirect tensile strength of the moisture-conditioned specimens, psi.

$S_{tu}$  = Average indirect tensile strength of the unconditioned specimens, psi.

## 10. DEGREE OF PARTICLE STRIPPING

- 10.1 After testing under Subsection 8.1.3, separate each moisture-conditioned specimen at the failure plane. Examine each exposed face for loss of asphalt from the aggregate surfaces.
- 10.2 Estimate subjectively the proportion of stripped aggregate particles and record in percent.

## 11. DETERMINING THE NEED FOR ANTISTRIPPING ADDITIVE

- 11.1 If the results of this test on the bituminous paving mixtures without antistripping additive meets all of the specification requirements, the mixture is considered to be sufficiently resistant to stripping; therefore, it will not require the use of an antistripping additive.

## 12. DETERMINING THE EFFECTIVENESS OF ANTISTRIPPING ADDITIVE AND ESTABLISHING DOSAGE RATES

- 12.1 In order to determine the effectiveness of the antistripping additive and determine the dosage rate, the bituminous paving mixture must be tested with and without the additive proposed for use in the mixture.

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- 12.2 To be approved, the type additive proposed for use must result in the bituminous paving mixture's conformance to all of the specification requirements. Also, the dosage rate shall be the lowest necessary (Manufacturer's Recommended Rate or higher) to result in the bituminous paving mixtures conformance to all of the specification requirements.
  - 12.3 The average indirect tensile strength of the moisture-conditioned specimens containing the additive must be greater than the average indirect tensile strength of the moisture-conditioned specimens without the additive.
  - 12.4 The dosage rate selected in the laboratory shall be tentative until tests have been performed on the plant-produced mixture.

### 13. REPORT

- 13.1 Average degree of saturation after application of vacuum.
- 13.2 Average degree of saturation after moisture-conditioning.
- 13.3 Average indirect tensile strength without antistripping additive of unconditioned specimens and of moisture-conditioned specimens.
- 13.4 Average indirect tensile strength with antistripping additive of unconditioned specimens and of moisture-conditioned specimens.
- 13.5 Tensile Strength Ratio (TSR) with and without antistripping additive.
- 13.6 Results of estimated stripping observed when specimen fractures.
- 13.7 Type antistripping additive and dosage rate required. If no additive is required, so indicate.

### 14. JOB CONTROL ACCEPTANCE TESTING

- 14.1 Job control acceptance testing for resistance of plant-produced mixtures to stripping will be performed in accordance with Sections 1 through 13 of this S.O.P. except for the following modifications:
  - 14.1.1 Subsection 5.2.1.2. Curing will not be required overnight. Cool in front of a fan at room temperature a minimum of three (3) hours  $\pm$  30 minutes.
  - 14.1.2 Subsections 7.2 and 7.3. Drinking water may be used.

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**MT-64 Asphalt Retention and Change in Area of Geotextile Pavement Fabric**

**PURPOSE:** To establish a standard method of test for asphalt retention and change in area of geotextile pavement fabric.

**1. APPARATUS**

- 1.1 Die, 100 mm by 200 mm.
- 1.2 Oven capable of maintaining a temperature of  $135 \pm 2^\circ\text{C}$ .
- 1.3 Balance meeting requirements of AASHTO Designation: M 231, Class D.
- 1.4 Rack for hanging test specimens.
- 1.5 Hot plate or oil bath for heating mineral spirits.
- 1.6 Pans suitable for use in submerging the test specimens in asphalt and washing the test specimens.

**2. SAMPLE PREPARATION**

- 2.1 Cut three (3) test specimens at random using the 100 mm by 200 mm die. Test specimens shall be free of defects which are obviously caused by handling of the test sample.

**3. PROCEDURE**

- 3.1 Determine mass of the test specimens to nearest 0.1 g.
  - 3.2 Submerge test specimens in asphalt cement at a temperature of  $135 \pm 2^\circ\text{C}$ . Asphalt cement shall be of same grade that will be used with the fabric on the roadway.
  - 3.3 Maintain submerged test specimens at a temperature of  $135 \pm 2^\circ\text{C}$  for thirty (30) minutes in oven.
  - 3.4 Remove test specimens from asphalt cement, hang on rack and drain at a temperature of  $135 \pm 2^\circ\text{C}$  for thirty (30) minutes.
  - 3.5 Remove the test specimens from the oven and allow to drain at a temperature of  $24 \pm 3^\circ\text{C}$  for one (1) hour.
  - 3.6 Determine mass of the coated test specimens to nearest 0.1 g and determine the mass of asphalt cement retained.
  - 3.7 Submerge test specimens in mineral spirits at a temperature of  $43 \pm 3^\circ\text{C}$  for thirty (30) minutes. Fresh containers of mineral spirits may be alternated as necessary to effect the removal of the asphalt cement. Maintain temperature of mineral spirits with hot plate.
  - 3.8 Remove test specimens from mineral spirits, blot with paper towels, and air dry to constant mass.
  - 3.9 Measure test specimens to nearest 0.000 25 m and compute area in square meters.
-

**4. CALCULATION**

## 4.1 Asphalt Retention

$$R = \frac{W}{A}$$

R = Asphalt cement retention in grams per square meter

W = Mass in grams of asphalt retained in specimen (Subsection 3.6)

A = Area of test specimen in square meters (Subsection 3.9)

## 4.2 Percent Change in Area

$$C = 100 - 5000 A$$

C = Change in area in percent

A = Area of tested specimen in square meters (Subsection 3.9)

NOTE: Based on test specimen of 100 mm. x 200 mm.

**5. REPORT**

5.1 Report the average asphalt retention to the nearest 3 g. per m<sup>2</sup>.

5.2 Report the average change in area to the nearest percent.

**MT-70 Reflective Intensity of Highway Traffic Striping Materials Using a Mirolux 12 Reflectometer**

**SCOPE:** This method covers the measurement of the retroreflective properties of traffic-striping systems using a Mirolux 12 Retroreflectometer.

**1. APPARATUS**

- 1.1 Mirolux 12 Retroreflectometer.
- 1.2 Ambient Light Shield. A strip of cloth or other suitable shield.

**2. CALIBRATION**

- 2.1 Calibrate the Mirolux 12 in accordance with manufacturer's instructions.

**3. PROCEDURE**

- 3.1 Position the Mirolux 12 on the surface to be read, making sure that all three (3) supports are in contact with surface.
- 3.2 Position the light shield around the front half of the Mirolux12, blocking out all outside light.
- 3.3 With digital display reading zeroed, turn on light and allow the reading to stabilize. (Reading must be manufacturer's assigned calibration number.) Gently pull out the calibration plate knob to open the shutter. Record the reading for the selected spot as indicated. Turn light off and close shutter by returning knob to original position. To check reading, repeat procedure before changing position of Mirolux 12.
- 3.4 Take readings at three (3) selected locations on the 5-foot test sample. No reading is to be taken within 6 inches of either end or on an obviously damaged part of the sample. Average the three (3) readings. The resulting average value is the reflective intensity for the particular lot of material represented by the sample.

**4. REPORTING**

- 4.1 Report the reflective intensity in millicandcllas per square meter per meter candela at an illumination angle of  $86\ 1/2^\circ$  and an observation angle of  $1\ 1/2^\circ$ .

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**MT-71 Cross-Calibration of Troxler Asphalt Content Gauges, Model 3241**

**PURPOSE:** To establish a standard procedure for cross-calibration of Troxler Asphalt Content Gauges, Model 3241, by use of Standard and Background Counts of a Master Gauge and Field Gauges. (This procedure does not replace the initial field calibration (MT-6M) of Asphalt Content Gauges.)

**1. SIGNIFICANCE OF USE**

- 1.1 Reduce the time delay problems encountered in the replacement of malfunctioning asphalt content field gauges by eliminating, in most cases, the necessity of field calibration (MT-6) of replacement gauges for the particular job-mix formula being used.
- 1.2 Provide the Department with the means of checking the asphalt content of a particular job-mix through the District and/or Central Laboratory.

**2. PREPARATION OF CROSS-CALIBRATION SPECIMENS**

- 2.1 Prepare six (6) specimens in accordance with the gauge instruction manual. The specimens must be prepared from the same aggregate blend and asphalt cement and at the same mass within  $\pm 1$  g. Starting slightly below the minimum of 4.0%, vary the bitumen content of the specimens at intervals of 1%.
- 2.2 Seal the specimens with a suitable moisture resistance material such as fiber glass cloth and epoxy.

**3. READING OF MASTER AND FIELD GAUGES**

- 3.1 GENERAL
    - 3.1.1 The asphalt content gauge in the Central Laboratory will be the Master Gauge. However, when a field gauge must be replaced, this particular field gauge will be the master gauge for the purpose of cross-calibrating the replacement gauge.
    - 3.1.2 All gauges are to be read in the location of intended use if possible.
    - 3.1.3 All gauges are to be read every twenty-four (24) months with freshly prepared cross-calibration specimens.
    - 3.1.4 Clean inside of gauge and remove all objects that may interfere with readings, such as another nuclear gauge, asphalt, etc., from the general vicinity of the gauge before taking readings.
  - 3.2 Procedure for reading gauges using cross-calibration specimens.
    - 3.2.1 Perform Statistical Stability Test (STAT) in accordance with the gauge instruction manual.
    - 3.2.2 Take a sixteen (16) minute background count in accordance with the gauge instruction manual, and record result.
    - 3.2.3 Using the six (6) prepared cross-calibration specimens, take a sixteen (16) minute standard count of each specimen in accordance with the gauge instruction manual, and record results.
    - 3.2.4 Record data for each gauge: Model; Serial Number; Contractor; Location; Date; any pertinent remarks.
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**4. PROCEDURE FOR CROSS-CALIBRATION OF REPLACEMENT GAUGE**

- 4.1 Replacement gauge and the gauge to be replaced must have current record of background and standard counts as set out in Subsection 3.2.
- 4.2 Provide the Central Laboratory with the following information: serial number of the replacement gauge; serial number and background count at time of calibration of the gauge to be replaced; project number, MDOT lab number and calibration slope and intercept for the particular mix design being used.
- 4.3 By use of Troxler's 3241 Model Transfer Program VI. 0011989, determine new calibration slope and intercept values for replacement gauge.

**5. REPORT**

Report new calibration slope and intercept values for replacement gauge.

**6. COST OF CROSS-CALIBRATION SERVICE**

Cost of cross-calibration service per gauge per mix design will be in accordance with the unit price set forth in S.O.P. No. TMD-20-09-00-000. This service is available to contractors performing work on MDOT projects at the current unit price upon request from the contractor.

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**MT-73 Method of Tests for Bituminous Adhesives (Standard Type)**

**PURPOSE:** To establish standard methods of tests for the various required characteristics for bituminous adhesives used in bonding pavement markers to the roadway surface.

**1. BITUMINOUS ADHESIVE PROPERTIES**

Tests for determining the properties of bituminous adhesive shall be performed in accordance with the following methods:

- 1.1 SOFTENING POINT. ASTM D 36.
- 1.2 PENETRATION AT 25°C. ASTM D 5.
- 1.3 FLOW. Determine the flow in accordance with ASTM D 3407, except that the oven temperature shall be  $158 \pm 2^\circ\text{F}$  and sample preparation shall be according to Subsection 7.1 of ASTM D 5.
- 1.4 HEAT STABILITY FLOW. Determine the heat stability flow in accordance with Subsection 1.3 of this test method, except that 1000 g of adhesive shall be placed in a covered liter can, heated to  $425^\circ\text{F}$  and maintained at this temperature for four (4) hours prior to preparing the sample panel.
- 1.5 VISCOSITY,  $400^\circ\text{F}$ , POISES. Determine the viscosity in accordance with ASTM D 3236 using a spindle speed of 10 rpm. The adhesive shall be heated to approximately  $410^\circ\text{C}$  and allowed to cool. The viscosity shall be determined at  $400 \pm 1^\circ\text{F}$ .
- 1.6 FLASH POINT, C.O.C.,  $^\circ\text{F}$ , ASTM D 92.

**2. ASPHALT PROPERTIES**

Determine the properties of the base asphalt on the filler-free material obtained from the extraction and Abson recovery process, as follows:

- 2.1 EXTRACTION AND ABSON RECOVERY
  - 2.1.1 Heat the adhesive just to the point where it will easily flow and then transfer 125 to 150 g into 400 mL of trichloroethylene having a temperature of 125 to  $150^\circ\text{F}$ . Thoroughly stir the mixture to dissolve the asphalt. Decant the trichloroethylene-asphalt solution.
  - 2.1.2 Recover the asphalt from the decanted solution in accordance with ASTM D 1856, modified as follows:
    - 2.1.2.1 The extraction method of ASTM D 2712 shall not apply, and there shall be no filtration of the solvent-asphalt mixture.
    - 2.1.2.2 Centrifuge the solution for at least thirty (30) minutes at 770 times gravity in a batch centrifuge. Decant this solution into the distillation flask, taking care not to include any filler sediment.
    - 2.1.2.3 Apply heat and bubble carbon dioxide slowly to bring the solution temperature to  $300^\circ\text{F}$ . At this point, increase the carbon dioxide flow to a rate of 800 to 900 mL per minute. Maintain the solution temperature at 320 to  $325^\circ\text{F}$  with this carbon dioxide flow rate for at least twenty (20) minutes and until the trichloroethylene vapors have been completely removed from the distillation flask.

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- 2.1.2.4 Repeat the above extraction-recovery process until sufficient asphalt is obtained for performance of all test properties. The recovered asphalt shall be used to determine penetration, viscosity and viscosity ratio as set out in Subsections 2.2, 2.3 and 2.4 of this test method.
- 2.2 PENETRATION, 100 G, 5 SEC, 77°F, ASTM D 5.
- 2.3 VISCOSITY, 275°F, POISES, ASTM D 2171.
- 2.4 VISCOSITY RATIO, 275°F. Determine the 275°F viscosity ratio by comparing the 275°F viscosity of the asphalt before and after the Thin-Film Oven Test, ASTM D 1754. Determine the specific gravity by the pycnometer method as set out in ASTM D 70 for use in the Thin-Film Oven Test. Calculate the 275°F viscosity ratio by dividing the viscosity at 275°F after the Thin-Film Oven Test by the viscosity at 275°F prior to the Thin-Film Oven Test.

### 3. FILLER PROPERTIES

Determine the properties of the filler obtained from the filler separation technique as follows:

- 3.1 FILLER SEPARATION TECHNIQUE.
- 3.1.1 Measure 10.00 ± 0.01 g of the solid bituminous adhesive into a centrifuge flask having a volume of approximately 100 mL such as that specified in ASTM D 1796. Add 50 mL of 1,1,1-trichloroethane to the adhesive, which should be broken up into small pieces in order to speed the dissolution process. Swirl or stir with a fine rod, taking care not to lose any solids. Place the sample flask in a balanced centrifuge and spin for ten (10) minutes using a minimum relative centrifugal force of 150 (as determined in Section 6 of ASTM D 1796). Remove the sample flask and decant the solvent, taking care not to lose any solids. Repeat the application of solvent and centrifuging until the solvent becomes clear and the filler is visually free of asphalt. Filtration of the decanted solvent may be performed to verify there is no loss of filler. Dry the filler at 160 ± 5°F to remove solvent and determine the mass of the resulting filler.
- 3.1.2 Determine the filler content and the filler fineness in accordance with Subsections 3.2 and 3.3 of this test method.
- 3.2. FILLER CONTENT. From the masses obtained in Subsection 3.1.1, calculate the filler content as follows:
- $$\text{Filler Content, \% by mass} = \frac{(\text{Mass of Dried Filler, g}) * (100)}{\text{Original Adhesive Mass, g}}$$
- 3.3. FILLER FINENESS. The dried filler obtained from separation in Subsection 3.1.1 shall be used in determining the filler fineness. Determine filler fineness in accordance with ASTM C 430 using sieve numbers 100, 200, and 325. This method is to be modified by the use of a water-soluble non-ionic wetting agent, such as Triton X-100, to aid the wetting action. Concentration of the surfactant solution shall be approximately 1% by mass. The 1 g dry sample shall be thoroughly wetted in the surfactant solution and allowed to soak for thirty (30) minutes. The filler shall be transferred completely into the sieve cup and water-spray applied for two (2) minutes. Surfactant solution may be added as needed and physical means used to disperse any clumped particles. The sample shall then be dried and handled as directed in ASTM C 430.
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**MT-74 Determination of Pavement Smoothness Using a Profilograph**

**PURPOSE:** To establish a standard procedure for determining pavement smoothness by use of a Profilograph.

**1. APPARATUS**

- 1.1 **PROFILOGRAPH.** Shall consist of a frame at least 7.5 m in length supported upon multiple wheels having no common axle. The profilograph must have at least twelve (12) reference platform wheels. The axes of these wheels shall not be uniformly spaced but be at least 0.3 m apart so no two wheels cross the same bump at the same time. The sensing mechanism located at the mid-frame may consist of a single bicycle-type wheel or a dual-wheel assembly consisting of either a bicycle-type (pneumatic tire) or solid rubber tire vertical sensing wheel and a separate bicycle-type (pneumatic tire) longitudinal sensing wheel. The wheel(s) shall be of such circumference(s) to produce a profilogram recorded on a scale of 1 (one) meter equal to 300 meters longitudinally and one (1) millimeter equal to one (1) millimeter, or full scale, vertically. Motive power is to be provided manually or by the use of propulsion unit attached to the center assembly.
- 1.2 **BLANKING BAND.** A plastic scale 40 mm wide and 500 mm long representing a pavement length of 150 m at a scale of 1 to 300. Near the center of the scale is an opaque band 5 mm wide extending the entire length of the scale. On either side of the band are parallel scribed lines 2.5 mm apart. These lines serve as a convenient scale to measure scallops, deviations or excursion, of the graph above or below the blanking band.
- 1.3 **BUMP TEMPLATE.** A thin strip of plastic having a line 25 mm long scribed on one face with a small hole or scribed mark at both ends of the line. The template shall have a slot parallel to the scribed line located at a distance equal to the limiting value for acceptance smoothness (7.5 mm for concrete and 10.0 mm for asphalt when measured from a chord length of 7.5 m or less - see Figure 1).

**2. OPERATION OF PROFILOGRAPH**

- 2.1 **OPERATIONS.** The profilograph shall be moved at a speed no greater than 5 km per hour so as to eliminate as much bounce as possible. Check tire roundness to eliminate repetitive errors. Surface irregularities in new tires and those that develop through wear shall be removed by grinding. Air pressure in the tires shall be maintained at a constant level and shall be checked daily.
- 2.2 **CALIBRATION.** Calibration of the profilograph shall be checked monthly. The horizontal scale can be checked by running a known distance and scaling the result on the profilogram. If the scale is off more than 0.5%, the manufacturer's adjustment procedure shall be followed to correct the scaling. The vertical scale is checked by putting a board of known thickness under the profile wheel and again scaling the result on the profilogram. If the scale is off, the cause of the incorrect height shall be determined and corrected.

**3. RUNNING PROFILES**

- 3.1 The profile is recorded from the vertical movement of a sensing wheel attached at the mid-point of the profilograph and is in reference to the mean elevation of the points of contact with the road surface established by the support wheels.
  - 3.2 A profilogram is recorded on a scale of one meter equal to 300 meters longitudinally and one (1) mm equal to one (1) mm, or full scale, vertically.
-

- 3.3 All profilograms will be made in accordance with contract specifications.
- 3.4 The profiles for each section of pavement shall be positioned on the profilogram so that the stationing is coincidental. This will help determine if the high points and depressions extend across the entire pavement width and will permit profile index comparison of adjacent lanes.
- 3.5 The following information shall be marked and/or labeled on the profilogram during testing for ease in evaluation.
  - 3.5.1 Location (which traffic lane and wheel path).
  - 3.5.2 Beginning and ending station of the profile.
  - 3.5.3 Station numbers and other road items of known location.
  - 3.5.4 Construction joints, significant cracks, damaged areas, etc.

**4. DETERMINATION OF PROFILE INDEX**

- 4.1 METHOD OF COUNTING
  - 4.1.1 Place the blanking band over the profile in such a way as to "blank out" as much of the profile as possible. When this is done, scallops above and below the blanking band usually will be approximately balanced. (See Figure 2)
  - 4.1.2 The profile trace will move from a generally horizontal position when going around super-elevated curves making it impossible to blank out the central portion of the trace without shifting the scale. When such conditions occur, the profile will be broken into short sections and the blanking band repositioned on each section while counting as shown in the upper part of Figure 1.
  - 4.1.3 Starting at the right end of the scale, measure and total the height of all the scallops appearing both above and below the blanking band, measuring each scallop to the nearest 1.25 mm or half the distance between the parallel scribed lines on the blanking band scale. Write this total on the profile sheet near the left end of the scale together with a small mark to align the scale when moving to the next section. Short portions of the profile line may be visible outside the blanking band but unless they project 0.75 mm or more and extend longitudinally for 0.60 m or more, they are not to be included in the count. (See Figure 2 for illustration of these special conditions.)
  - 4.1.4 When scallops occurring in the first 0.15 km are totaled, slide the scale of the left, aligning the right end of the scale with the small mark previously made, and proceed with the counting in the same manner. The last section counted may or may not be an even 0.15 km. If not, its length should be scaled to determine its length in kilometers. An example follows:

Section Length (km)	Counts (Number of Lines from Blanking Band)
0.15	5.0
0.15	4.0

	0.15	3.5
(110 m)	<u>0.11</u>	<u>2.0</u>
Total	0.56	14.5

4.1.5 The profile index is determined as millimeters per kilometer in excess of the 5 mm blanking band but is simply called the profile index. The procedure for converting counts of profile index is as set out below.

4.1.6 Using the figures from the above example:

Length = 0.56 km, total count = 14.5 counts  
 Profile Index = (1 km/length of profiles in km) X total counts X 2.5  
 Profile Index = (1/0.56) X 14.5 X 2.5 = 64.7

(NOTE: The formula uses the count as the unit of measurement and then converts it to millimeters.)

4.1.7 The profile index is thus determined for the profile of any line called for in the specifications.

4.2 DAILY AVERAGE PROFILE INDEX. The pavement surface is to be divided into sections that represent continuous placement. A section is to terminate at a day's work joint, a bridge or other interruption. Long sections placed without interruption are to be separated arbitrarily into segments of 0.15 km, with the remaining shorter section also considered a segment. The last 5 m of a segment ending at the day's work joint cannot be profiled until the adjoining pavement is placed. Therefore, the 5 m portion is to be included in the profilogram of the subsequent day's production. Said portion is to be included in the profilogram only when the Contractor is responsible for the adjoining surface. A profilogram is to be made for each continuous section of 15 m or more.

4.2.1 When averaging profile indexes to obtain an average for the day, the average of each section must be "weighted" according to its length.

## 5. DETERMINATION OF HIGH POINTS OR DIPS

5.1 To locate the bumps or dips requiring corrective action, place the bump template at each prominent peak or high point on the profile so that the small holes or scribe marks at each end of the scribed line intersect the profile to form a chord across the base of the peak or high point. The line of the template need not be horizontal. With a sharp pencil draw a line using the narrow slot in the template as a guide. Any portion of the profile extending above this line will indicate the approximate length and height of the deviation in excess of the specified value.

5.2 There may be instances where the base of the high point is less than 25 mm (7.5 m). In such cases, a shorter chord length must be used in making the scribed line on the template tangent to the profile at the low points. When the distance between prominent low points is greater than 7.5 m (25 mm), make the ends of the scribed line intersect the profile with the template in horizontal position. The baseline for measuring the height of bumps should be as near 7.5 m (25 mm) as possible, but in no case shall it exceed this value. A few examples of the procedure are shown in the lower portion of Figure 1.

## 6. REPORT

6.1 Profile Index to the nearest mm/km.

6.2 Daily Average Profile Index to the nearest mm/km when applicable.

6.3 Location of high points or dips that require corrective action.

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### MT-75 Testing of Glass Beads

**PURPOSE:** This method sets out procedures for the testing of glass beads.

1. **CLASS A (STANDARD).** Tests shall be in accordance with requirements of AASHTO M 247.
2. **CLASS B (HIGH-VISIBILITY).** Tests for gradation, refractive index, embedment coating, and roundness and angular particle concentrations shall be as follows:
  - 2.1 Gradation. In accordance with ASTM D 1214.
  - 2.2 Refractive Index. By the liquid immersion method (Becke Line Method or equal) at a temperature of  $25 \pm 5^{\circ}\text{C}$  ( $77^{\circ} \pm 9^{\circ}\text{F}$ ).
  - 2.3 Embedment Coating. In accordance with following procedure:
    - 2.3.1 Apparatus and Reagents:
      - Graduate Cylinder (50 mL)
      - Acetone - Reagent Grade
      - Dansyl Chloride - 98%
      - Scale - Analytical balance (4 place)
      - Darkened Glass Container (that can be sealed tightly)
      - Rubber Gloves (long sleeves)
      - Safety Glasses or Goggles
      - Medicine Dropper
      - Glass Filter Paper (4 inch diameter)
      - Small Aluminum Dishes for measuring mass
      - 2-inch Buchner Funnel and Suction Flasks
      - 2-inch diameter Filter Paper (Whatman # 1)
      - Vacuum Pump
      - Ultraviolet Light Source - Intensity 7 000 uw/cm<sup>2</sup>
    - (CAUTION: Dansyl Chloride is a hazardous compound. Do not handle without protective gloves and safety glasses or goggles. Do not get onto skin.)
    - 2.3.2 PREPARATION OF DANSYL CHLORIDE SOLUTION

Prepare a solution by weighing 0.2 g of Dansyl Chloride and dissolving it in 25 mL of acetone. This solution can be used for several tests during the day but must be kept refrigerated in a dark, tightly closed container between uses. Make a fresh solution daily.
    - 2.3.3 PROCEDURE
      - 2.3.3.1 Set drying oven to 60°C. Turn on the ultraviolet light.
      - 2.3.3.2 Measure two (2) samples of beads of 10 g each. Place the sample to be evaluated in an aluminum dish. Retain the other sample for a fluorescence observation comparison.
      - 2.3.3.3 Place a 2-inch diameter filter paper into the Buchner funnel and attach to the suction flask.
      - 2.3.3.4 Put the beads in the Buchner funnel and saturate the sample with the Dansyl Chloride solution using a medicine dropper. Let solution and sample stand for thirty (30) seconds.

- 2.3.3.5 Place the saturated beads into an aluminum dish and dry in oven at 60°C for 15-20 minutes. Beads will be yellow and agglomerated. Do not let the Dansyl Chloride solution char. (Properly discard the used filter paper because of the toxicity of the Dansyl Chloride.)
- 2.3.3.6 Remove sample from the oven and place the glass beads in the Buchner funnel with new filter paper. Rinse the beads with 100 mL of acetone. Use the suction during this step. All yellow must be removed from the beads.
- 2.3.3.7 Remove the beads from the funnel and place into a new aluminum tray. Allow the beads to dry in the oven for five (5) to ten (10) minutes until free flowing.
- 2.3.3.8 Remove the beads from the oven and place on glass filter paper. If beads are agglomerated, break them up with a spatula.
- 2.3.3.9 Inspect the treated sample under the ultraviolet light, in a darkened room.

#### 2.3.4 OBSERVATIONS

- 2.3.4.1 Embedment-coated beads will emit a yellow-green fluorescence.
- 2.3.4.2 If additional fluorescence is observed when compared with the original untreated sample, the lot is accepted. If no additional fluorescence is observed, the test should be rerun using a new 10 g sample of beads and a fresh solution of Dansyl Chloride.
- 2.3.4.3 If no additional fluorescence is observed on the new sample of beads, the material is not properly coated and the lot is rejected. If additional fluorescence is observed, the lot is accepted.

#### 2.4 ROUNDNESS AND ANGULAR PARTICLE CONCENTRATIONS. (A round particle is defined as a spherical or fundamentally oval bead with an aspect ration of 1.2:1 or less and having no other particles adhered to the parent bead.) in accordance with the following procedure:

##### 2.4.1 APPARATUS

Bell & Howell Microfiche Reader, Model R905, or equivalent, with 20 mm lens  
Transparencies for +14, +16, +18, +20, and +35 mesh spheres defining a 1.2:1 aspect ration  
1/1 mini-splitter  
Clear, transparent tape  
Syringe (3 CC) with a 23-gauge needle  
Microscope slide  
Cooking oil - Wesson Oil, or equivalent, with an approximate 1.5 refractive index. (A standard 1.5 refractive index liquid can also be used.)

##### 2.4.2 PROCEDURE

- 2.4.2.1 All testing is to be performed on properly split samples.
- 2.4.2.2 During the gradation portion of testing, retain separately those fractions that contain the two largest quantities of particles. This will usually be at least 75-80% of the material.
- 2.4.2.3 Using the 1/1 mini-splitter, reduce each fraction to just enough beads to cover a microscope slide when they are adhered to the clear tape. Retain each reduced specimen separately.
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- 2.4.2.4 Place a piece of clear transparent tape, adhesive side up, over the open side of an empty mini-splitter pan (lengthwise).
- 2.4.2.5 Carefully pour one of the specimens over the tape to adhere the beads to the tape. Any particles that fall into the pan should be recovered and again poured onto the tape until all particles have adhered to the tape.
- 2.4.2.6 A microscope slide is then placed on top of the beads and the tape secured to the slide by bringing the ends of the tape over the top of the slide. The beads are now sandwiched between the slide and the tape. This is repeated for the other mesh size retained.
- 2.4.2.7 The beads are next slightly wet with the Wesson Oil or 1.5 refractive index liquid by injecting a few drops onto the beads (under the tape) using the 3 CC syringe and needle. Use only a few drops to avoid excess from running off the slide.
- 2.4.2.8 Place the slide (beads up) between the two glass plates on the sample tray of the Microfiche reader.
- 2.4.2.9 Turn on the light and move the sample tray so that the beads are visible on the screen. Focus in on the beads and count:
- the number of round spheres (less than 1.2:1 aspect ration)
  - the total number of non-round beads in the field (aspect ration greater than 1.2:1, twins, satellites, agglomerates, angular or fire polished particles). Keep track of the number of angular particles in order to determine their concentration.
- 2.4.2.10 Use the transparencies in determining whether sphere has an aspect ration greater than 1.2:1. Depending on the mesh size being examined, select the proper transparency and determine which of the inner circles best matches the width of the sphere in question (match up at the center of the particle); then slide the overlay so that the end of the bead lines up with the outer circle. If the other end of the bead protrudes beyond the opposite edge of the outer circle, the particle's aspect ration is greater than 1.2:1 and the particle is counted as non-round. (Regardless of aspect ration, twins, satellites, angular and fire-polished particles are counted as non-round.) If the edge of the particle does not protrude beyond the opposite edge of the outer circle, and its shape is either spherical or slightly oval, it is to be counted as a round particle.
- 2.4.2.11 A total of at least 200 beads should be counted on each slide. More than one field should be used on a slide to make up the 200 count in order to help ensure that the count is representative of the entire specimen.
- 2.4.2.12 CALCULATIONS
- Calculate the percentage of round beads in each sieve fraction as follows:  
$$\% \text{ ROUNDS} = \frac{\text{Total Number of Round Beads} \times 100}{\text{Total Number of Particles Counted}}$$
  - Calculate the percentage of angular particles at each sieve fraction as follows:  
$$\% \text{ ANGULAR PARTICLE CONTENT} = \frac{\text{Total Number of Angular Particles} \times 100}{\text{Total Number of Particles Counted}}$$
-

2.4.2.13 ACCEPTANCE. If the percentages of round sphere for any of the sieve fractions are lower than the minimum specified or if the angular content is greater than 3% for any screen fraction, a second sample from the same lot is to be analyzed. If any of the fractions again fall outside the specification limits for rounds or angular content, the lot is rejected. If the second sample is found to be within specification limits, the lot is accepted.

### 3. REPORT

- 3.1 Gradation
- 3.2 Refractive Index
- 3.3 Moisture Resistance, Class A Beads only
- 3.4 Embedment Coating, Class B Beads only
- 3.5 Percent Rounds
- 3.6 Percent Angular Particle Content

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**MT-76 Microwave Method for Determining the Moisture Content of Hot Bituminous Mixtures**

**PURPOSE:** To establish an optional test procedure for determining the moisture content of a hot bituminous mixture by utilizing a microwave oven. (For mixtures containing slag, use AASHTO T 110.).

**1. APPLICABLE TEST METHODS**

- 1.1 AASHTO T 110, Moisture or Volatile Distillates in Bituminous Paving Mixtures.
- 1.2 AASHTO T 164, Quantitative Extraction of Bitumen from Bituminous Paving Mixtures.
- 1.3 AASHTO T 168, Sampling Bituminous Paving Mixtures.
- 1.4 MT-6, Nuclear Determination of Bitumen Content of Bituminous Paving Mixtures.
- 1.5 MT-31, Quantitative Analysis of Hot Bituminous Mixtures.

**2. APPARATUS**

- 2.1 Balance. Minimum capacity of 2 000 g, readable to 0.1 g
- 2.2 Microwave Oven (800 cooking watts). Minimum capacity of 0. 028 cubic meters with variable power control.
- 2.3 Pyrex beaker capable of holding 500 g minimum of tap water.
- 2.4 Pyrex container (pie plate type) capable of holding 500 g minimum sample.
- 2.5 Thermometer capable of measuring to 180°C, readable to 2°C.
- 2.6 Scoop, sample container and heat resistant gloves.

**3. PROCEDURE**

- 3.1 Set microwave oven variable power control to 50% power.
- 3.2 Place 500 g of tap water in a Pyrex beaker. Record temperature of water (T1). Set the microwave oven timer for five (5) minutes and heat the 500 g of water. Record the water temperature (T2). The difference between temperatures T1 and T2 should be 20 to 30°C. If the difference is too low (or high), increase (or decrease) the variable power control and repeat applicable part of procedure until the proper power control is established. Verify or establish power control setting for each day of testing by repeating the above steps.
- 3.3 Place the bituminous mixture test specimen (not less than 500 g) in the tared Pyrex container and determine the wet mass to the nearest 0.1 g.
- 3.4 Dry the sample in the microwave oven (check mass at 15-minute intervals) using the power control setting established in Subsection 3.2. Continue to dry the test specimen (usually 30 to 45 minutes) until it has reached a constant mass and determine the dry mass to the nearest 0.1 g.

(Avoid overheating the test specimen, an indication of which is a large amount of blue smoke; in which case, discard test specimen and rerun.)

3.5 Determine the percent moisture as follows:

$$\text{Percent Moisture} = \frac{(A - B)}{A} \times 100$$

Where:        A = Wet mass of test specimen  
                  B = Dry mass of test specimen

#### 4. REPORT

Report the moisture content to the nearest 0.01 percent.

## MT-78 Volumetric Mix Design of Hot Bituminous Paving Mixtures Using the Superpave Gyratory Compactor

**SCOPE:** This method sets out the procedure to be followed in the volumetric design of hot mix asphalt mixtures using the SUPERPAVE Gyratory Compactor. This procedure determines the proper proportioning of component aggregates and asphalt binder content that conforms to specification requirements when blended together in the laboratory. **NOTE: This procedure shall be used for volumetric design of Warm Mix Asphalt Mixtures. Laboratory mixing and compaction design temperatures for Warm Mix Asphalt shall be the same as those specified for Hot Mix Asphalt.**

### 1. DEFINITIONS

- 1.1 **OPTIMUM ASPHALT BINDER CONTENT.** The asphalt binder content of a paving mixture that satisfies the applicable volumetric design criteria as determined when utilizing the SUPERPAVE Gyratory Compactor.
- 1.2 **VOIDS IN THE MINERAL AGGREGATE, VMA.** The volume of intergranular void space between the aggregate particles of a compacted mixture that includes the air voids and the effective asphalt binder content, expressed as a percent of the total volume of the sample.
- 1.3 **EFFECTIVE ASPHALT BINDER CONTENT.** The total asphalt binder content of a mixture minus the portion of asphalt binder that is absorbed into the aggregate particles.
- 1.4 **AIR VOIDS.** The total volume of the small pockets of air between the coated aggregate particles throughout a compacted mixture.
- 1.5 **VOIDS FILLED WITH ASPHALT, VFA.** The portion of the volume of intergranular void space between the aggregate particles (VMA) that is occupied by the effective asphalt binder.
- 1.6  **$N_{ini}$ .** The number of required revolutions of the Gyratory compactor representing the compactibility of the mixture received from the asphalt spreader.  $N_{ini}$  revolutions shall be specified in the contract.
- 1.7  **$N_{des}$ .** The number of revolutions of the Gyratory compactor required for design characteristics of the job-mix formula.  $N_{des}$  revolutions, specified in the contract, shall produce a density meeting the mixture volumetric requirements of the specifications.
- 1.8  **$N_{max}$ .** The number of required revolutions of the Gyratory compactor representing the density of the pavement layer at the end of design life.  $N_{max}$  revolutions shall be specified in the contract.

### 2. REFERENCE TEST METHODS

Tests required in the design of hot mix asphalt mixtures are as follows:

AASHTO T 11	Materials Finer than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T 27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T 37	Sieve Analysis of Mineral Filler for Bituminous Paving Materials
AASHTO T 84	Specific Gravity and Absorption of Fine Aggregate
AASHTO T 85	Specific Gravity and Absorption of Coarse Aggregate
AASHTO T 166	Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
AASHTO T 209	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
AASHTO T 269	Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
AASHTO T 308	Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method

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AASHTO T 312	Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
ASTM C 604	True Specific Gravity of Refractory Materials by Gas Comparison Pycnometer
ASTM D 3289	Specific Gravity or Density of Semi-Solid and Solid Bituminous Materials by Nickel Crucible
MT-24	Determination of the Specific Gravity of Fine Aggregates Using the Le Chatelier Flask (formerly S.O.P TMD-11-24-00-000)
MT-31	Quantitative Analysis of Hot Bituminous Mixtures (formerly S.O.P. TMD-11-31-00-000)

### 3. APPARATUS

The apparatus required for the design of hot mix asphalt mixtures are those set out in the standards listed in Section 2 of this test method.

### 4. PROCEDURES

**4.1 GRADATIONS.** Perform sieve analysis for the coarse and fine aggregate component sizes according to AASHTO T 27 and T 11 and on mineral filler, according to AASHTO T 37.

**4.2 AGGREGATE SPECIFIC GRAVITIES.** Perform a minimum of two specific gravity tests on each aggregate according to AASHTO T 84 and T 85, on the hydrated lime according to MT-24 or ASTM C 604, and the asphalt binder according to ASTM D 3289 (77/77°F). If an aggregate has greater than 25 percent passing the No. 4 sieve and greater than 25 percent retained on the No. 4 sieve, conduct both a coarse and fine aggregate specific gravity on the material and combine the results according to equation in Section 5.1. Modify AASHTO T 84 as follows:

- a. Conduct tests on washed material passing the No. 4 sieve.
- b. Conduct the drying for the SSD determination in a flat bottom pan in which moisture is easily visible on the bottom.
- c. Define the SSD point at the time when moisture is no longer visible in the bottom of the pan when the material is moved across the bottom, the material is free flowing during this movement, and the surface of the aggregate does not change color with stirring.

#### 4.3 RAP MATERIALS

4.3.1 Gradation. Determine the gradation on representative samples of the processed RAP materials after extraction of the asphalt binder according MT-31.

4.3.2 Asphalt Content. Determine the asphalt binder content of the RAP using a standard asphalt extraction procedure. If the incinerator oven is used, estimate the appropriate correction factor based upon previous testing of mixtures with similar aggregate. See Section 8.10 for further requirements.

4.3.3 Aggregate Specific Gravities. Test extracted RAP aggregate for specific gravity according to the procedures in Section 4.2 of this S.O.P. Aggregate obtained from the incinerator oven extraction procedure may not be used for aggregate specific gravity testing.

**4.4 REQUIRED AGGREGATE BLEND.** Determine by trial and error method, the percentages of each aggregate necessary to produce a blended material meeting the gradation requirements of the specifications.

#### 4.5 PREPARATION OF GYRATORY TEST SPECIMENS.

4.5.1 General. Prepare a minimum of four (4) sets of Gyratory specimens with asphalt binder content at 0.5 percent intervals. Prepare the sets such that at least one set is above the optimum asphalt content and one set is below the optimum asphalt content. Each set shall consist of a minimum of two (2) specimens.

- 4.5.2 Preparation of Aggregates. Dry each aggregate component to be used in the mixture to constant mass in an oven at a temperature of  $230 \pm 9^\circ\text{F}$ .

Estimate the mass of each aggregate component required to produce a batch that will result in a compacted specimen 150 mm in diameter and approximately 115 mm in height. This will normally require approximately 4500 g of mixture. (**Note:** It is generally desirable to prepare a trial specimen prior to preparing all the aggregate batches. If the trial specimen does not meet the height requirement, adjust the amount of material used for the specimens accordingly).

Separate each individual aggregate into the appropriate sizes as follows:

- Plus 1"
- 1" to 3/4"
- 3/4" to 1/2"
- 1/2" to 3/8"
- 3/8" to No. 4
- No. 4 to No. 8
- Passing No. 8

If any of the size fractions represent less than 5 percent of the individual aggregate, they may be combined with the next smaller size fraction.

Weigh cumulatively into a separate pan for each test specimen the required quantity of each aggregate component.

A minimum of eight (8) pans of the batched aggregates will be needed for the Gyratory test specimens. Additionally, two (2) pans will be required for the maximum specific gravity ( $G_{mm}$ ) samples, and two (2) pans for testing at  $N_{max}$ .

Place the asphalt binder to be used in an oven and heat to mixing temperature. The temperature to which the asphalt binder must be heated to produce a kinematic viscosity of  $170 \pm 20 \text{ mm}^2/\text{s}$  shall be the mixing temperature. This temperature will be determined from a current temperature-viscosity curve for the particular source of asphalt binder being used. (**Note:** For polymer modified asphalt binders use the manufacturer's recommended mixing temperature.)

Place the pans of batched aggregates in the oven and heat to mixing temperature, but not to exceed  $50^\circ\text{F}$  above the required mixing temperature.

Charge the mixing bowl with the heated aggregate in one pan and dry mix thoroughly. Form a crater in the dry blended aggregate and weigh the required amount of the heated asphalt binder into the mixture. Mechanically mix the aggregate and asphalt binder as quickly and thoroughly as possible to yield a paving mix having a uniform distribution of asphalt binder.

After completion of mixing, place the mix in a curing oven at  $5^\circ\text{F}$  to  $10^\circ\text{F}$  above compaction temperature for approximately 1-1/2 hours in a round (6.5" to 7.5" in diameter) covered container to allow for absorption. A 10# ink can from Inmark Inc. (205-856-9077) or a paint can without a top lip has been found suitable for aging the mixture. The compaction temperature shall be the temperature to which the asphalt binder must be heated to produce a kinematic viscosity of  $280 \pm 30 \text{ mm}^2/\text{s}$ . This temperature will be determined from a current temperature-viscosity curve for the particular asphalt binder being used. (**Note:** For polymer modified asphalt binder use the manufacturer's recommended compaction temperature).

- 4.5.3 Compaction of Gyratory Test Specimens. Check calibration of Gyratory compactor in accordance with Operations Manual. (It is recommended that this be performed on at least a monthly basis.) Maintain records of calibration results and adjustments to the equipment. Verify  $600 \text{ kPa} \pm 18 \text{ kPa}$  ram pressure with load cell. Verify  $1.25 \pm 0.02^\circ$  angle tilt setting. Verify height calibration using

spacer provided by manufacturer. Set number of gyrations to  $N_{des}$ . Set dwell at the appropriate number of gyrations or dwell time, according to manufacturer's instructions. This is typically 5 gyrations for most Troxler compactors, or 5 seconds for most Pine compactors. Other manufacturers are similar.

Place a compaction mold and base plate in curing oven for 30 to 60 minutes prior to the estimated beginning of compaction (during the absorption period).

After completion of absorption period, remove the heated mold and base plate from the oven and place a paper disc on the bottom of the mold.

Check the compaction temperature of the mix by means of a calibrated probe, prior to removal from the oven. Remove a container of mixture from the oven and place the mixture into the mold in one lift by pouring uniformly through a funnel, taking care to avoid segregation in the mold. After all the mix is in the mold, level the mix. If no calibrated probe was available for the mix in the oven, check for compaction temperature with a calibrated dial thermometer and place another paper disc on top of the leveled material. Load the specimen mold with the paving mix into the compactor and center the mold under the loading ram.

Lower the ram until the pressure on the specimen reaches  $600 \text{ kPa} \pm 18 \text{ kPa}$ . Begin compaction.

Record specimen height after each revolution to the nearest 0.1 mm. Continue compaction until  $N_{des}$  gyrations are reached and the gyratory mechanism shuts off.

Remove the angle from the mold assembly, apply dwell gyrations, raise the loading ram, remove mold from the compactor, provide a cooling period of  $10 \pm 2$  minutes for the mold and specimen in front of a fan, extrude the specimen from the mold and immediately remove the paper discs from top and bottom of the specimen.

After specimen cools to room temperature (usually overnight), weigh and record the mass of the extruded specimen,  $W_m$ , to the nearest gram.

Determine the required characteristics of the compacted mixture at  $N_{ini}$  and  $N_{des}$  levels of compaction.

Repeat procedures in Subsection 4.5.3 for each Gyratory test specimen.

- 4.5.4 Specific Gravity of Compacted Specimens ( $G_{mb}$ ). Determine the specific gravity of the compacted specimens according to AASHTO T 166.
- 4.5.5 Maximum Specific Gravity of Bituminous Mixture ( $G_{mm}$ ). Determine the maximum specific gravity according to AASHTO T 209 in duplicate at an asphalt content near the expected optimum level and average the results. Perform this test on samples which have completed the absorption period. (See Subsection 4.5.2)

## 5. COMPUTATIONS

**5.1 BULK SPECIFIC GRAVITIES OF BLENDED AGGREGATE.** When the total aggregate consists of separate fractions of coarse aggregate, fine aggregate, hydrated lime, and mineral filler (when used), all having different specific gravities, the bulk specific gravity ( $G_{sb}$ ) for the total blended aggregate is calculated as follows:

$$G_{sb} = \frac{P_1 + P_2 + \dots + P_n}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \dots + \frac{P_n}{G_n}}$$

Where:  $G_{sb}$  = bulk specific gravity of the total aggregate  
 $P_1, P_2, P_n$  = percentages by mass of aggregates 1, 2, n; and  
 $G_1, G_2, G_n$  = bulk specific gravities of aggregates 1, 2, n  
 (Note: The apparent specific gravity of hydrated lime and mineral filler shall be used in lieu of the bulk specific gravity.)

**5.2 EFFECTIVE SPECIFIC GRAVITY OF AGGREGATE.** The effective specific gravity of the aggregate,  $G_{se}$ , is determined as follows:

$$G_{se} = \frac{100 - P_b}{\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)}$$

Where:  $G_{se}$  = effective specific gravity of aggregate  
 $P_b$  = asphalt binder, percent by mass of mixture  
 $G_{mm}$  = maximum specific gravity of paving mixture  
 $G_b$  = specific gravity of asphalt binder at 25°C

**Note:** The volume of asphalt binder absorbed by an aggregate is almost invariably less than the volume of water absorbed. Consequently, the value for the effective specific gravity of an aggregate should be between its bulk and apparent specific gravities. When the effective specific gravity falls outside these limits, its value must be assumed to be incorrect. The calculations, the maximum specific gravity of the total mix by AASHTO T 209, and the composition of the mix in terms of aggregate and total asphalt binder content, should then be rechecked for the source of the error.

**5.3 MAXIMUM SPECIFIC GRAVITY OF MIXTURES WITH DIFFERENT ASPHALT BINDER CONTENT.** In designing a paving mixture with a given aggregate, the maximum specific gravities,  $G_{mm}$ , at different asphalt binder contents are needed to calculate the percentage of air voids for each asphalt binder content. After calculating the effective specific gravity of the aggregate, the maximum specific gravity for any other asphalt binder content can be obtained as shown below. For all practical purposes, the effective specific gravity of the aggregate is constant because the asphalt binder absorption does not vary appreciably with variations in asphalt binder content.

$$G_{mm} = \frac{100}{\left(\frac{P_s}{G_{se}}\right) + \left(\frac{P_b}{G_b}\right)}$$

Where:  $G_{mm}$  = maximum specific gravity of paving mixture (no air voids)  
 $P_s$  = aggregate, percent by total mass of mixture = (100 -  $P_b$ )  
 $P_b$  = asphalt binder, percent by total mass of mixture  
 $G_{se}$  = effective specific gravity of aggregate  
 $G_b$  = specific gravity of asphalt binder

- 5.4 ASPHALT BINDER ABSORPTION.** Asphalt binder absorption,  $P_{ba}$ , expressed as a percentage by mass of aggregate is determined as follows:

$$P_{ba} = 100 \left( \frac{G_{se} - G_{sb}}{G_{sb} G_{se}} \right) G_b$$

Where:  $P_{ba}$  = absorbed asphalt binder, percent by mass of aggregate  
 $G_{se}$  = effective specific gravity of aggregate  
 $G_{sb}$  = bulk specific gravity of aggregate  
 $G_b$  = specific gravity of asphalt binder

- 5.5 EFFECTIVE ASPHALT BINDER CONTENT OF A PAVING MIXTURE.** The effective asphalt binder content,  $P_{be}$ , of a paving mixture is determined as follows:

$$P_{be} = P_b - \left( \frac{P_{ba}}{100} \right) P_s$$

Where:  $P_{be}$  = effective asphalt binder content, percent by mass of mixture  
 $P_b$  = total asphalt binder content, percent by mass of mixture  
 $P_{ba}$  = absorbed asphalt binder, percent by mass of aggregate  
 $P_s$  = aggregate, percent by mass of mixture, = (100 -  $P_b$ )

- 5.6 PERCENT VMA IN COMPACTED PAVING MIXTURE.** The voids in the mineral aggregate, VMA, is determined as follows:

$$VMA = 100 - \left( \frac{G_{mb} P_s}{G_{sb}} \right)$$

Where: VMA = voids in mineral aggregate (percent of bulk volume)  
 $G_{sb}$  = bulk specific gravity of aggregate  
 $G_{mb}$  = bulk specific gravity of compacted mixture (AASHTO T 166)  
 $P_s$  = aggregate, percent by total mass of mixture, = (100 -  $P_b$ )

- 5.7 CALCULATION OF PERCENT AIR VOIDS IN COMPACTED MIXTURE.** The air voids,  $P_a$ , in a compacted paving mixture is determined as follows:

$$P_a = 100 \left( \frac{G_{mm} - G_{mb}}{G_{mm}} \right), \quad \text{or} \quad P_a = 100 \left[ 1 - \left( \frac{G_{mb}}{G_{mm}} \right) \right]$$

Where:  $P_a$  = air voids in compacted mixture, percent of total volume  
 $G_{mm}$  = maximum specific gravity of paving mixture (or as determined directly for a paving mixture by AASHTO T 209)  
 $G_{mb}$  = bulk specific gravity of compacted mixture

- 5.8 VOIDS FILLED WITH ASPHALT.** The percent voids filled with asphalt, VFA, is determined for 4.75 mm mixtures as follows:

$$VFA = 100 \frac{(VMA - P_a)}{VMA}$$

Where: VFA = voids filled with asphalt, percent of VMA  
 VMA = voids in mineral aggregate, percent of bulk volume  
 P<sub>a</sub> = air voids in compacted mixture, percent of total volume

- 5.9 SPECIFIC GRAVITY OF COMPACTED SPECIMENS AT N<sub>ini</sub>.** The bulk specific gravity (G<sub>mb</sub>) at N<sub>ini</sub> is calculated as follows:

$$G_{mb} \text{ (at } N_{ini}) = \frac{h_{des}}{h_{ini}} ( G_{mb} \text{ (at } N_{des}) )$$

Where: G<sub>mb</sub> = Bulk specific gravity of the specimen at "x" gyrations  
 H<sub>des</sub> = Height in millimeters of specimen at N<sub>des</sub>  
 h<sub>ini</sub> = Height in millimeters of specimen at N<sub>ini</sub>

- 5.10 PERCENT COMPACTION OF GYRATORY SPECIMEN.** Determine percent compaction, C<sub>x</sub>, as follows:

$$C_x = \frac{G_{mb}}{G_{mm}} 100$$

Where: C<sub>x</sub> = Corrected relative density expressed as a percentage of maximum specific gravity after "x" gyrations  
 G<sub>mb</sub> = Bulk specific gravity of the specimen at "x" gyrations  
 G<sub>mm</sub> = Maximum specific gravity of the mix

## 6. DETERMINATION OF OPTIMUM ASPHALT BINDER CONTENT

- 6.1 GRAPHICAL PLOT.** Prepare a graphical plot for the following values at the various percentages of asphalt binder:

Air Voids vs. Asphalt Binder Content  
 VMA vs. Asphalt Binder Content  
 VFA vs. Asphalt Binder Content (4.75 mm mixtures only)  
 % Density @ N<sub>ini</sub> vs. Asphalt Binder Content

- 6.2 DESIGN CRITERIA.** The designed mixture shall at optimum asphalt binder content conform to all the required design criteria set out in the current version of Section 907-401 of the Specifications.

**6.3 PROCEDURE FOR DETERMINING OPTIMUM ASPHALT BINDER CONTENT.**

- 6.3.1 From the graphical plot of the air voids vs. asphalt binder content curve, select the asphalt binder content corresponding to 4.0 percent air voids.

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- 6.3.2 Determine if the selected asphalt binder content meets all the required design criteria in the current version of Section 907-401 of the Specifications and that the selected asphalt binder content does not exceed the asphalt binder content at the lowest point of the VMA vs. Asphalt Binder content curve. The mix should be redesigned if these criteria cannot be met.
  - 6.3.3 Prepare two additional gyratory specimens compacted to  $N_{max}$  at the optimum asphalt content. Determine the average  $G_{mb}$  value for the specimens according to AASHTO T 166. Calculate the percent compaction according to equation 5.10. Compare the percent compaction at  $N_{max}$  to the maximum limit allowed in the specifications. If the mixture does not meet this requirement, the design fails and a new design is required.

## 7. RESISTANCE TO STRIPPING

- 7.1 Check the designed mixture in accordance with MT-63 and MT-59 to determine if an antistripping additive will be required.
- 7.2 If an antistripping additive is required, establish the dosage rate in accordance with MT-63 using samples of the additive to be used on the project.
- 7.3 Final determination of the requirement for antistripping additive and dosage rate will be established by field testing in accordance with MT-63 and MT-59.

## 8. REPORT

Submit the mixture design report on Form TMD-042 (or similar type document), and include as a minimum:

- 8.1 Project Identification Information
  - 8.2 Name of Contractor(s)
  - 8.3 Type and Source of Component Materials
  - 8.4 Job-Mix Formula With All Supporting Test Data (laboratory worksheets).
  - 8.5 Optimum Asphalt Binder Content.
  - 8.6 % Density @  $N_{max}$  at Optimum Binder Content
  - 8.7 Plant Mixing Temperature. Specify the mixture temperature at the discharge from the mixer. The temperature specified shall provide an asphalt binder viscosity of between 150 and 300  $mm^2/sec$ . (Note: For polymer modified asphalt binders, use the plant mixing temperature recommended by the binder manufacturer. Provide a copy of the manufacturer's recommendation.)
  - 8.8 Type, Brand Name, and Dosage Rate of Antistripping Additive. If no additive is required, so state.
  - 8.9 Seven (7) preblended batches of the virgin aggregate (batch weights should be such that the proper height specimen is produced in the gyratory compactor and also allow for the incorporation of RAP if it is used).
  - 8.10 A 20,000 gm batch of the proposed RAP material. If the incinerator oven was used for determining asphalt content of RAP for the mix design, the correction factor used for the determination must be provided with the RAP sample.
  - 8.11 Two (2) liters of the asphalt binder required for the design.
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- 8.12** If Warm Mix Asphalt Technology is to be used during production the following additional information will be required:
- 8.12.1** Warm Mix Process/Product to be used during production
  - 8.12.2** Anticipated Water Dosage Rate, By Percent of Asphalt Binder. If no water is required, so state.
  - 8.12.3** Anticipated Additive Dosage Rate. If no additive is required, so state.
  - 8.12.4** Anticipated Plant Production Temperature

## MT-79 Design of Soil-Lime-Fly Ash Mixtures

**PURPOSE:** This method sets forth the procedures to be followed by the Central Laboratory in the design of soil-lime-fly ash (LFA) mixtures. Soil-lime-fly ash is a mixture of pulverized soil, hydrated lime, and fly ash, which has been moistened, compacted, and permitted to harden. It is used primarily as a base course under rigid and flexible pavements, and also as a chemical stabilization technique for underlying subgrades.

### 1. REFERENCE TEST METHODS

Tests required in the design of LFA mixtures are as follows:

Miss. Test Method MT-9, Moisture-Density Relations of Treated Soils  
 Miss. Test Method MT-23, Methods of Testing Soils  
 Miss. Test Method MT-26, Compressive Strength of Soil-Cement Cylinders and Cores  
 AASHTO T 85, Specific Gravity and Absorption of Coarse Aggregate  
 AASHTO T 87, Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test  
 AASHTO T 89, Determining the Liquid Limit of Soils  
 AASHTO T 90, Determining the Plastic Limit and Plasticity Index of Soils  
 AASHTO T 92, Determining the Shrinkage Factors of Soils  
 AASHTO T 99, The Moisture-Density Relations of Soils Using a 5.5-lb Rammer and a 12-

in Drop

AASHTO T 100, Specific Gravity of Soils

### 2. APPARATUS

The apparatus required for the design of LFA mixtures are those set out in the required tests listed above.

### 3. SAMPLE

The samples submitted by the District must be representative of the materials (both soil and fly ash) to be used in the roadway. For bases, the soil must also meet the requirements of the plans and specifications for the class granular material designated by the plans. The minimum weights of total sample required to perform the above listed tests are as follows:

300 lbs (dry weight) when the sample contains material larger than the ½ inch sieve

200 lbs (dry weight) when all the material passes the ½ inch sieve.

### 4. PREPARATION OF SAMPLE

4.1 The sample shall be thoroughly mixed and air dried.

4.2 By the method of quartering or the use of a sample splitter, select a sample of one of the following approximate weights and prepare in accordance with AASHTO T 87:

20 lbs –	when 10% by weight of sample or more is retained on the No. 10 sieve
10 lbs –	when less than 10% by weight of sample is retained on the No. 10 sieve

4.3 By the method of quartering or the use of a sample splitter, select another sample of one of the following approximate weights:

150 lbs –	when the sample contains material larger than the ½ inch sieve
100 lbs –	when all of the material passes the ½ inch sieve

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This sample shall be set aside for use in the tests listed in Section 5.2 below.

4.4 The remainder of the original sample shall be set aside and used in check tests, if necessary.

## 5. PROCEDURE

5.1 Perform the following tests on the sample prepared in Section 4.2:

Miss. Test Method MT-23  
AASHTO T 85 (For the determination of the bulk specific gravity of the + $\frac{1}{2}$  inch material)  
AASHTO T 89  
AASHTO T 90  
AASHTO T 92  
AASHTO T 100

5.2 Perform the following tests on the sample prepared in Section 4.3:

5.2.1 Moisture-Density Relationship of the Raw Soil: Determine the moisture-density relationship of the raw soil sample in accordance with AASHTO T 99.

5.2.2 Moisture-Density Relationship of the LFA Treated Soil: Determine the moisture-density relationships of the LFA treated soil in accordance with MT-9, Method A, using a trial design blend of 3% hydrated lime/12% fly ash (by dry weight) as a starting point blend.

**Note:** Experience with different classes of granular material, plasticity indices, and also fly ash sources, may require different blends of LFA in addition to (or in lieu of) the 3%/12% blend.

5.2.3 Compressive Strength Specimens: Prepare cylinders in accordance with MT-9, Method A. Four (4) cylinders for each trial design blend shall be made – two (2) for 14-day curing, and two (2) for 28-day curing.

5.2.4 Curing: Carefully extrude the specimens from the molds and place in plastic bags. Immediately seal the plastic bags and place in triple-sealed cans. Place the sealed cans in a forced-air oven or temperature controlled chamber at a constant temperature of 100°F for the specified 14-day and 28-day curing periods.

5.2.5 Compressive Strength Tests: At the end of the above specified curing periods, the specimens shall be removed from the plastic bags and immersed in water for five (5) hours, then tested in accordance with MT-26.

## 6. DETERMINATION OF THE DESIGN LIME AND FLY ASH CONTENT

The 14-day compressive strength results are used only as an early indicator to evaluate the trial design percentages. Generally, Class “C” fly ashes will achieve early strengths faster than the Class “F” fly ashes, yet may not reach the peak strength that a Class “F” fly ash will achieve at 28 days. The **design** lime and fly ash content is that blend that will produce a 28-day compressive strength of 500 psi for bases, and 400 psi for treated subgrade material.

## 7. REPORT

The report shall include the recommended hydrated lime and fly ash percentages, based on the dry weight of the soil, and all supporting test data.

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## MT-80 Volumetric Mix Design Procedure for Stone Matrix Asphalt (SMA)

**SCOPE:** This method establishes the procedure for the volumetric mix design of Stone Matrix Asphalt (SMA) mixtures. The design is based on the volumetric properties of the SMA including air voids, voids in the mineral aggregate, voids in the coarse aggregate, draindown, and mortar properties.

### 1. DEFINITIONS

**1.1 STONE MATRIX ASPHALT (SMA).** SMA is type of hot mix asphalt comprised of a high percent of coarse aggregate, a high content of mineral filler, and a polymer modified asphalt binder, along with stabilizing fibers.

**1.2 SMA MORTAR.** The mixture of polymerized liquid asphalt binder, mineral filler, and stabilizing fiber.

**1.3 VOIDS IN THE COARSE AGGREGATE (VCA).** The volume between the coarse aggregate particles, including the mineral filler, the fine aggregate, air voids, polymerized liquid asphalt binder, and fiber.

### 2. REFERENCED TEST METHODS

#### AASHTO Standards

T 11	Amount of Material Finer than 0.075 mm (No. 200) Sieve
T 19	Unit Weight and Voids in Aggregate
T 27	Sieve Analysis of Fine and Coarse Aggregates
T 37	Sieve Analysis of Mineral Filler for Road and Paving Materials
T 84	Specific Gravity and Absorption of Fine Aggregate
T 85	Specific Gravity and Absorption of Coarse Aggregate
T 166	Bulk Specific Gravity of Bituminous Paving Mixtures
T 209	Maximum Specific Gravity of Bituminous Paving Mixtures
T 269	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
T 312	Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyrotory Compactor
MP1	Specification for Performance Graded Asphalt Binder
TP1	Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
TP5	Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)

#### Mississippi Test Methods

MT-81	Preparation and Testing of Stone Matrix Asphalt (SMA) Mortars
MT-82	Draindown Testing of Stone Matrix Asphalt (SMA) Mixtures

### 3. APPARATUS

The apparatus required for the design of Stone Matrix Asphalt (SMA) mixtures are those set out in the standards listed in Section 2 of this S.O.P.

### 4. PROCEDURE

**4.1 GRADATIONS.** Perform sieve analysis for the coarse and fine aggregate component sizes according to AASHTO T 27 and T 11 and on mineral filler, according to AASHTO T 37.

**4.2 AGGREGATE SPECIFIC GRAVITIES.** Perform a minimum of two specific gravity tests on each aggregate according to AASHTO T 84 and T 85, on the hydrated lime according to MT-24 or ASTM C 604, and the asphalt binder according to ASTM D 3289 (77/77°F). If an aggregate has greater than 25 percent passing

the No. 4 sieve and greater than 25 percent retained on the No. 4 sieve, conduct both a coarse and fine aggregate specific gravity on the material and combine the results according to equation in Section 5.1. Modify AASHTO T 84 as follows:

- a. Conduct tests on washed material passing the No. 4 sieve.
- b. Conduct the drying for the SSD determination in a flat bottom pan in which moisture is easily visible on the bottom.
- c. Define the SSD point at the time when moisture is no longer visible in the bottom of the pan when the material is moved across the bottom, the material is free flowing during this movement, and the surface of the aggregate does not change color with stirring.

**4.3 REQUIRED AGGREGATE BLEND.** Determine by trial and error method, the percentages of each aggregate necessary to produce a blended material meeting the gradation requirements of the specifications. The specification ranges for SMA mixtures are based on percent passing by volume. These volume-based gradations are converted to weight (mass) for mixture design and control. An example of a gradation by volume is given in Section 11 of this S.O.P.

In preparation for mortar testing as outlined in Section 8 of this S.O.P., obtain at least 200 grams of the filler (passing the No. 200 sieve) in a separate container.

Determine the dry rodded unit weight of the coarse aggregate fraction of the aggregate blend in accordance with AASHTO T-19. This value will be designated  $VCA_{dr}$ . The coarse aggregate fraction consists of all aggregate retained on the break point sieve in the aggregate blend. The following table indicates the break point sieves for various nominal maximum size SMA mixes.

<u>Mixture Size (NMS)</u>	<u>Break Point Sieve</u>
1 in (25 mm)	No. 4 (4.75 mm)
¾ in (19 mm)	No. 4 (4.75 mm)
½ in (12.5 mm)	No. 4 (4.75 mm)
3/8 in (9.5 mm)	No. 8 (2.36 mm)

The calculation of the  $VCA_{dr}$  for the blend is given as follows:

$$VCA_{dr} = \left( \frac{G_{ca}\gamma_w - \gamma_s}{G_{ca}\gamma_w} \right) 100$$

Where:

- $VCA_{dr}$  = voids in coarse aggregate in a dry rodded condition
- $G_{ca}$  = bulk specific gravity of coarse aggregate (aggregate retained on the break point sieve)
- $\gamma_w$  = unit weight of water (998 kg/m<sup>3</sup>)
- $\gamma_s$  = unit weight of the coarse aggregate fraction in the dry-rodded condition (kg/m<sup>3</sup>)

#### 4.4 PREPARATION OF GYRATORY TEST SPECIMENS.

4.4.1 General. Prepare a minimum of four (4) sets of Gyratory specimens with asphalt binder content at 0.5 percent intervals. Prepare the sets such that at least one set is above the optimum asphalt content and one set is below the optimum asphalt content. Each set shall consist of a minimum of three (3) specimens.

4.4.2 Preparation of Aggregates. Dry each aggregate component to be used in the mixture to constant mass in an oven at a temperature of 230 ± 9°F.

Estimate the mass of each aggregate component required to produce a batch that will result in a compacted specimen of correct size. For gyratory compacted specimens the correct size is 150 mm in diameter and approximately 115 mm in height and normally requires approximately 4500 grams of mixture.

(Note: It is generally desirable to prepare a trial specimen prior to preparing all the aggregate batches. If the trial specimen does not meet the height requirement, adjust the amount of material used for the specimens accordingly).

Separate each individual aggregate into the appropriate sizes as follows:

Plus 1"  
1" to 3/4"  
3/4" to 1/2"  
1/2" to 3/8"  
3/8" to No. 4  
No. 4 to No. 8  
Passing No. 8

If any of the size fractions represent less than 5 percent of the individual aggregate, they may be combined with the next smaller size fraction.

Weigh cumulatively into a separate pan for each test specimen the required quantity of each aggregate component.

A minimum of eight (8) pans of the batched aggregates will be needed for the test specimens. Additionally, two (2) pans will be required for the maximum specific gravity ( $G_{mm}$ ) samples.

Place the asphalt binder to be used in an oven and heat to mixing temperature. Since polymer modified asphalt binders will be used, use the manufacturer's recommended mixing temperature.

Place the pans of batched aggregates in the oven and heat to mixing temperature, but not to exceed 50°F above the required mixing temperature. Stabilizing fiber is added to the aggregate blend at the time of mixing. Do not add the fiber to the aggregate prior to heating.

Charge the mixing bowl with the heated aggregate in one pan and dry mix thoroughly. Add the required amount of the stabilizing fiber and mix thoroughly. If the fiber is not thoroughly mixed with the aggregate prior to the addition of the liquid asphalt binder, the fiber will clump and the results will be invalid. Once the aggregate and fiber are thoroughly mixed, form a crater in the aggregate/fiber blend and weigh the required amount of heated asphalt binder into the mixture. Mechanically mix the aggregate, asphalt binder, and stabilizing fiber as quickly and thoroughly as possible to yield a paving mix having a uniform distribution of asphalt binder and fiber.

After completion of mixing, place the mix in a curing oven at 5°F to 10°F above compaction temperature for approximately 1-1/2 hours in a round (6.5" to 7.5" in diameter) covered container to allow for absorption. A 10# ink can from Inmark Inc. (205-856-9077) or a paint can without a top lip has been found suitable for aging the mixture. Use the binder manufacturer's recommended compaction temperature.

4.5.3 Compaction of Gyratory Test Specimens. Check the calibration of the Gyratory compactor in accordance with Operations Manual. (It is recommended that this be performed on at least a monthly basis.) Maintain records of calibration results and adjustments to the equipment. Verify 600 kPa  $\pm$  18 kPa ram pressure with load cell. Verify 1.25  $\pm$  0.02° angle tilt setting. Verify height calibration using spacer provided by manufacturer. Set number of gyrations to  $N_{design}$ . Set dwell at the appropriate number of gyrations or dwell time, according to manufacturer's instructions. This is typically 5 gyrations for most Troxler compactors, or 5 seconds for most Pine compactors. Other manufacturers are similar.

Place a compaction mold and base plate in curing oven for 30 to 60 minutes prior to the estimated beginning of compaction (during the absorption period).

After completion of absorption period, remove the heated mold and base plate from the oven and place a paper disc on the bottom of the mold.

Remove a container of mixture from the oven and place the mixture into the mold in one lift by pouring uniformly through a funnel, taking care to avoid segregation in the mold. After all the mix is in the mold, level the mix, check for compaction temperature and place another paper disc on top of the leveled material. Load the specimen mold with the paving mix into the compactor and center the mold under the loading ram.

Lower the ram until the pressure on the specimen reaches  $600 \text{ kPa} \pm 18 \text{ kPa}$ . Begin compaction.

Record specimen height after each revolution to the nearest 0.1 mm. Continue compaction until  $N_{\text{design}}$  gyrations are reached and the gyratory mechanism shuts off.

Remove the angle from the mold assembly, apply dwell gyrations, raise the loading ram, remove mold from the compactor, provide a cooling period of  $10 \pm 2$  minutes for the mold and specimen in front of a fan, extrude the specimen from the mold and immediately remove the paper discs from top and bottom of the specimen.

After specimen cools to room temperature, weigh and record the mass of the extruded specimen,  $W_m$ , to the nearest gram.

Determine the required characteristics of the compacted mixture at  $N_{\text{design}}$ .

Repeat procedures in Subsection 4.5.3 for each Gyratory test specimen.

4.5.4 Specific Gravity of Compacted Specimens ( $G_{mb}$ ). Determine the specific gravity of the compacted specimens according to AASHTO T 166.

4.5.5 Maximum Specific Gravity of Bituminous Mixture ( $G_{mm}$ ). Determine the maximum specific gravity according to AASHTO T 209, in duplicate, at an asphalt content near the expected optimum level, and average the results. Perform this test on samples that have completed the absorption period. (See Subsection 4.5.2).

## 5. COMPUTATIONS

**5.1 BULK SPECIFIC GRAVITIES OF BLENDED AGGREGATE.** When the total aggregate consists of separate fractions of coarse aggregate, fine aggregate, hydrated lime, and mineral filler (when used), all having different specific gravities, the bulk specific gravity ( $G_{sb}$ ) for the total blended aggregate is calculated as follows:

$$G_{sb} = \frac{P_1 + P_2 + \dots + P_n}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \dots + \frac{P_n}{G_n}}$$

Where:

- $G_{sb}$  = bulk specific gravity of the total aggregate
- $P_1, P_2, P_n$  = percentages by mass of aggregates 1, 2, n
- $G_1, G_2, G_n$  = bulk specific gravities of aggregates 1, 2, n

(Note: The apparent specific gravity of hydrated lime and mineral filler shall be used in lieu of the bulk specific gravity.)

**5.2 EFFECTIVE SPECIFIC GRAVITY OF AGGREGATE.** The effective specific gravity of the aggregate,  $G_{se}$ , is determined as follows:

$$G_{se} = \frac{100 - P_b}{\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)}$$

Where:

$G_{se}$	= effective specific gravity of aggregate
$P_b$	= asphalt binder, percent by mass of mixture
$G_{mm}$	= maximum specific gravity of paving mixture
$G_b$	= specific gravity of asphalt binder at 25°C

**Note:** The volume of asphalt binder absorbed by an aggregate is almost invariably less than the volume of water absorbed. Consequently, the value for the effective specific gravity of an aggregate should be between its bulk and apparent specific gravities. When the effective specific gravity falls outside these limits, its value must be assumed to be incorrect. The calculations, the maximum specific gravity of the total mix by AASHTO T 209, and the composition of the mix in terms of aggregate and total asphalt binder content, should then be rechecked for the source of the error.

**5.3 MAXIMUM SPECIFIC GRAVITY OF MIXTURES WITH DIFFERENT ASPHALT BINDER CONTENT.** In designing a paving mixture with a given aggregate, the maximum specific gravities,  $G_{mm}$ , at different asphalt binder contents are needed to calculate the percentage of air voids for each asphalt binder content. After calculating the effective specific gravity of the aggregate, the maximum specific gravity for any other asphalt binder content can be obtained as shown below. For all practical purposes, the effective specific gravity of the aggregate is constant because the asphalt binder absorption does not vary appreciably with variations in asphalt binder content.

$$G_{mm} = \frac{100}{\left(\frac{P_s}{G_{se}}\right) + \left(\frac{P_b}{G_b}\right)}$$

Where:

$G_{mm}$	= maximum specific gravity of paving mixture (no air voids)
$P_s$	= aggregate, percent by total mass of mixture = (100 - $P_b$ )
$P_b$	= asphalt binder, percent by total mass of mixture
$G_{se}$	= effective specific gravity of aggregate
$G_b$	= specific gravity of asphalt binder

**5.4 ASPHALT BINDER ABSORPTION.** Asphalt binder absorption,  $P_{ba}$ , expressed as a percentage by mass of aggregate is determined as follows:

$$P_{ba} = 100 \left( \frac{G_{se} - G_{sb}}{G_{sb} G_{se}} \right) G_b$$

Where:

$P_{ba}$	= absorbed asphalt binder, percent by mass of aggregate
$G_{se}$	= effective specific gravity of aggregate
$G_{sb}$	= bulk specific gravity of aggregate
$G_b$	= specific gravity of asphalt binder

**5.5 EFFECTIVE ASPHALT BINDER CONTENT OF A PAVING MIXTURE.** The effective asphalt binder content,  $P_{be}$ , of a paving mixture is determined as follows:

$$P_{be} = P_b - \left( \frac{P_{ba}}{100} \right) P_s$$

Where:  $P_{be}$  = effective asphalt binder content, percent by mass of mixture  
 $P_b$  = total asphalt binder content, percent by mass of mixture  
 $P_{ba}$  = absorbed asphalt binder, percent by mass of aggregate  
 $P_s$  = aggregate, percent by mass of mixture, = (100 -  $P_b$ )

**5.6 PERCENT VMA IN COMPACTED PAVING MIXTURE.** The voids in the mineral aggregate, VMA, is determined as follows:

$$VMA = 100 - \left( \frac{G_{mb} P_s}{G_{sb}} \right)$$

Where: VMA = voids in mineral aggregate (percent of bulk volume)  
 $G_{sb}$  = bulk specific gravity of aggregate  
 $G_{mb}$  = bulk specific gravity of compacted mixture (AASHTO T 166)  
 $P_s$  = aggregate, percent by total mass of mixture, = (100 -  $P_b$ )

**5.7 PERCENT VCA IN COMPACTED PAVING MIXTURE ( $VCA_{mix}$ ).** The voids in the coarse aggregate,  $VCA_{mix}$ , is determined as follows:

$$VCA_{mix} = 100 - \left( \frac{G_{mb}}{G_{ca}} \right) P_{ca}$$

Where:  $VCA_{mix}$  = voids in coarse aggregate of the mixture  
 $G_{ca}$  = bulk specific gravity of coarse aggregate  
 $G_{mb}$  = bulk specific gravity of compacted mixture (AASHTO T 166)  
 $P_{ca}$  = percent coarse aggregate in mix by weight of total mix

**5.8 CALCULATION OF PERCENT AIR VOIDS IN COMPACTED MIXTURE.** The air voids,  $P_a$ , in a compacted paving mixture is determined as follows:

$$P_a = 100 \left( \frac{G_{mm} - G_{mb}}{G_{mm}} \right), \quad \text{or} \quad P_a = 100 \left[ 1 - \left( \frac{G_{mb}}{G_{mm}} \right) \right]$$

Where:  $P_a$  = air voids in compacted mixture, percent of total volume  
 $G_{mm}$  = maximum specific gravity of paving mixture (or as determined directly for a paving mixture by AASHTO T 209)  
 $G_{mb}$  = bulk specific gravity of compacted mixture

**5.9 PERCENT COMPACTION OF GYRATORY SPECIMEN.** Determine percent compaction,  $C_x$ , as follows:

$$C_x = \frac{G_{mb}}{G_{mm}} 100$$

Where:  $C_x$  = Relative density expressed as a percentage of maximum specific gravity at  $N_{design}$  gyrations.  
 $G_{mb}$  = Bulk specific gravity of the specimen at  $N_{design}$  gyrations  
 $G_{mm}$  = Maximum specific gravity of the mix

## 6. DETERMINATION OF OPTIMUM ASPHALT BINDER CONTENT

**6.1 GRAPHICAL PLOT.** Prepare a graphical plot for the following values at the various percentages of asphalt binder:

Air Void vs. Asphalt Binder Content  
 VMA vs. Asphalt Binder Content  
 VCA vs. Asphalt Binder Content

### 6.2 PROCEDURE FOR DETERMINING OPTIMUM ASPHALT BINDER CONTENT.

6.2.1 From the graphical plot of the air voids vs. asphalt binder content curve, select the asphalt binder content corresponding to 4.0 percent air voids.

6.2.2 Determine if the selected asphalt binder content meets all the required design criteria in the specifications and that the selected asphalt binder content does not exceed the asphalt binder content at the lowest point of the VMA vs. Asphalt Binder content curve. The mix should be redesigned if these criteria cannot be met.

6.2.3 The  $VCA_{mix}$  must be less than the  $VCA_{dr}$  at the selected asphalt binder content.

## 7. RESISTANCE TO STRIPPING

**7.1** Check the designed mixture in accordance with MT-63 and MT-59 to determine if an antistripping additive will be required.

**7.2** If an antistripping additive is required, establish the dosage rate in accordance with MT-63 using samples of the additive to be used on the project.

**7.3** Final determination of the requirement for antistripping additive and dosage rate will be established by field testing in accordance with MT-63 and MT-59.

## 8. RESISTANCE TO DRAINDOWN

**8.1** Evaluate the designed mixture's resistance to draindown in accordance with MT- 82. The draindown value must be less than 0.30 percent as established in the specifications.

## 9. MORTAR EVALUATION

**9.1** Evaluate the designed mixture's mortar properties in accordance with MT- 81. The mortar must meet the properties set out in the specifications.

**10. REPORT**

Submit the mixture design report on Form TMD-042 (or similar type document), and include as a minimum:

- 10.1** Project Identification Information
- 10.2** Name of Contractor(s)
- 10.3** Type and Source of Component Materials
- 10.4** Job-Mix Formula With All Supporting Test Data (laboratory worksheets).
- 10.5** Optimum Asphalt Binder Content.
- 10.6** **PLANT MIXING TEMPERATURE.** Specify the mixture temperature at the discharge from the mixer. State the plant mixing temperature recommended by the polymer modified binder manufacturer, and provide a copy of the manufacturer's recommendation.
- 10.7** Type, Brand Name, and Dosage Rate of Antistripping Additive. If no additive is required, so state.
- 10.8** Five (5) preblended batches of the virgin aggregate (batch weights should be such that the proper height specimen is produced in the gyratory compactor).
- 10.9** One thousand (1000) grams of the stabilizing fiber.
- 10.10** Two (2) liters of the asphalt binder required for the design.

**11. BLENDING BY VOLUME EXAMPLE**

With SMA the specific gravities of different aggregate components are not always similar enough to blend based upon weight (mass); this is especially true when comparing mineral fillers to the other aggregates. Therefore, SMA gradation bands are based upon percent passing by volume. An example of blending of three aggregates and a mineral filler is provided. The first step is to determine the aggregate stockpile gradations and specific gravities. This is provided in Table 1:

**Table 1**

Sieve	Percent Passing (Based on Mass)			
	Aggregate A	Aggregate B	Aggregate C	Mineral Filler
1 in (25 mm)	100.0	100.0	100.0	100.0
¾ in (19 mm)	95.0	100.0	100.0	100.0
½ in (12.5 mm)	66.0	71.1	97.4	100.0
3/8 in (9.5 mm)	43.0	46.0	84.6	100.0
No. 4 (4.75 mm)	9.0	6.0	48.9	100.0
No. 8 (2.36 mm)	5.0	4.5	27.8	100.0
No. 16 (1.18 mm)	2.9	4.0	16.6	100.0
No. 30 (0.6 mm)	2.5	3.4	10.7	100.0
No. 50 (0.3 mm)	2.0	3.0	7.6	96.0
No. 100 (0.15 mm)	1.5	2.5	6.5	83.0
No. 200 (0.075 mm)	1.0	1.5	4.6	72.5
G <sub>sb</sub>	2.616	2.734	2.736	2.401

The second step is to determine the percent by weight (mass) retained on each individual sieve. For a given sieve this is calculated by subtracting the percent passing the given sieve from the percent passing the next larger sieve. For example, the percent retained on the No. 4 (4.75 mm) sieve for aggregate A is  $43 - 9 = 34$ . This is not a cumulative weight (mass) retained, it is the weight (mass) retained on the individual sieve. Table 2 shows the percent by weight (mass) retained for each individual sieve. The calculations may be checked by totaling each column to 100.

**Table 2**

Sieve Size	Percent Retained for Individual Sieves (Based on Mass)			
	Aggregate A	Aggregate B	Aggregate C	Mineral Filler
1 in (25 mm)	0.0	0.0	0.0	0.0
3/4 in (19 mm)	5.0	0.0	0.0	0.0
1/2 in (12.5 mm)	29.0	28.9	2.6	0.0
3/8 in (9.5 mm)	23.0	25.1	12.8	0.0
No. 4 (4.75 mm)	34.0	40.0	35.7	0.0
No. 8 (2.36 mm)	4.0	1.5	21.1	0.0
No. 16 (1.18 mm)	2.1	0.5	11.2	0.0
No. 30 (0.6 mm)	0.4	0.6	5.9	0.0
No. 50 (0.3 mm)	0.5	0.4	3.1	4.0
No. 100 (0.15 mm)	0.5	0.5	1.1	13.0
No. 200 (0.075 mm)	0.5	1.0	1.9	10.5
Pan (-0.075 mm)	1.0	1.5	4.6	72.5
TOTAL (S)	100.0	100.0	100.0	100.0

Because each column totals to 100 percent, we can assume 100 g of each aggregate source and know that the amount in grams retained on each individual sieve is equal to the percent retained on each individual sieve. Using this information and the aggregate's bulk specific gravity we can calculate the volume of aggregate on each individual sieve.

Where  $\gamma_w$  is the unit weight of water (in  $\text{g/cm}^3$ ), the volume of aggregate retained on each individual sieve can be determined from the following equation:

$$V_{\text{agg retained}} = M_{\text{agg retained}} / (G_{\text{sb}} * \gamma_w)$$

Where:  $V_{\text{agg retained}}$  = Aggregate Volume retained on an individual sieve ( $\text{cm}^3$ )

$M_{\text{agg retained}}$  = Aggregate Mass retained on an individual sieve (g)

$G_{\text{sb}}$  = Aggregate bulk specific gravity

$\gamma_w$  = Unit weight of water ( $\text{g/cm}^3$ )

The following shows how the volume is calculated for the aggregate retained on the No. 4 (4.75 mm) sieve for aggregate C.

$$\text{Volume} = 35.7 \text{ g} / (2.736 * 1 \text{ g/cm}^3) = 13.05 \text{ cm}^3$$

The volume for all sieves is shown in Table 3.

**Table 3**

Sieve Size	Volume Retained for Individual Sieves			
	Aggregate A	Aggregate B	Aggregate C	Mineral Filler
1 in (25 mm)	0.00	0.00	0.00	0.00
3/4 in (19 mm)	1.91	0.00	0.00	0.00
1/2 in (12.5 mm)	11.09	10.57	0.95	0.00
3/8 in (9.5 mm)	8.79	9.18	4.68	0.00
No. 4 (4.75 mm)	13.00	14.63	13.05	0.00
No. 8 (2.36 mm)	1.53	0.55	7.71	0.00
No. 16 (1.18 mm)	0.80	0.18	4.09	0.00
No. 30 (0.6 mm)	0.15	0.22	2.16	0.00
No. 50 (0.3 mm)	0.19	0.15	1.13	1.67
No. 100 (0.15 mm)	0.19	0.18	0.40	5.41
No. 200 (0.075 mm)	0.19	0.37	0.69	4.37
Pan (-0.075 mm)	0.38	0.55	1.68	30.20
<b>TOTAL</b>	38.23	36.58	36.55	41.65
<b>G<sub>sb</sub></b>	2.616	2.734	2.736	2.401
<b>Blend Percentage</b>	30	30	30	10

The values provided in Table 3 are used to blend the different stockpiles to meet the desired gradation based on volumes. In this procedure the aggregate is blended by weight (mass), then the gradation based on volume is determined. This is a trial and error process. To perform the blending, select the estimated percentages by weight (mass) of the different stockpiles to be used.

The blend percentages in Table 3 are based on weight (mass). This indicates that the volume represented by 30 percent by weight (mass) of aggregate A will be used in blending the stockpiles based on volume. The percent of each stockpile in the blend is multiplied by the volume retained on a given sieve for each stockpile to determine the total volume retained on that sieve. For the No. 4 (4.75 mm) sieve, using the volumes and the blend percentages from Table 3, the total volume retained on the No. 4 (4.75 mm) sieve is calculated as follows:

$$\text{Total Volume Retained} = (0.3 \times 13.00) + (0.3 \times 14.63) + (0.3 \times 13.05) + (0.1 \times 0.0) = 12.20 \text{ cm}^3$$

This calculation is performed for each sieve in the gradation. Table 4 shows the volume retained for each sieve in the gradation.

**Table 4**

Sieve Size	Volume Retained per Sieve, cm <sup>3</sup>
1 in (25 mm)	0
3/4 in (19 mm)	0.57
1/2 in (12.5 mm)	6.78
3/8 in (9.5 mm)	6.80
No. 4 (4.75 mm)	12.20
No. 8 (2.36 mm)	2.94
No. 16 (1.18 mm)	1.52
No. 30 (0.6 mm)	0.76
No. 50 (0.3 mm)	0.61
No. 100 (0.15 mm)	0.77
No. 200 (0.075 mm)	0.81
Pan (-0.075 mm)	3.80
<b>TOTAL (S)</b>	<b>37.57</b>

Now, based on the total volume retained per sieve and the summed total volume of the blended aggregates, the percent retained per sieve by volume can be determined for the blend. This is accomplished for a given sieve by dividing the volume retained on that sieve by the total volume of the blend. The following equation illustrates this calculation for the No. 4 (4.75 mm) sieve:

$$\% \text{ Volume Retained on the No. 4 (4.75 mm) sieve} = 12.20 / 37.57 = 32.48 \%$$

Table 5 shows the percent retained by volume for each individual sieve and converts this to percent passing by volume. Percent passing by volume is calculated by subtracting the cumulative percent retained from 100.

**Table 5**

Sieve Size	Volume Retained per Sieve, cm <sup>3</sup>	Percent Retained Per sieve	Cumulative Percent Retained	Percent Passing By Volume
1 in (25 mm)	0	0.00	0.00	100.0
3/4 in (19 mm)	0.57	1.53	1.53	98.5
1/2 in (12.5 mm)	6.78	18.05	19.58	80.4
3/8 in (9.5 mm)	6.80	18.09	37.66	62.3
No. 4 (4.75 mm)	12.20	32.48	70.14	29.9
No. 8 (2.36 mm)	2.94	7.82	77.96	22.0
No. 16 (1.18 mm)	1.52	4.06	82.02	18.0
No. 30 (0.6 mm)	0.76	2.02	84.04	16.0
No. 50 (0.3 mm)	0.61	1.62	85.65	14.3
No. 100 (0.15 mm)	0.77	2.06	87.71	12.3
No. 200 (0.075 mm)	0.81	2.16	89.88	10.1
Pan (-0.075 mm)	3.80	10.12	100.00	0.0
<b>TOTAL (S)</b>	<b>37.57</b>	<b>100.00</b>		

Next, compare the blend's percent passing by volume to the specifications and adjust the blend percentages to best meet the specification gradation specification values. In Table 6, a typical 3/4 in (19 mm) nominal maximum aggregate size gradation is used.

**Table 6**

Sieve Size	19.0 mm NMS Gradation Band		Percent Passing By Volume
	Lower	Upper	
1 in (25 mm)	100	100	100.0
3/4 in (19 mm)	90	100	98.5
1/2 in (12.5 mm)	50	74	80.4 *
3/8 in (9.5 mm)	25	60	62.3 *
No. 4 (4.75 mm)	20	28	29.9 *
No. 8 (2.36 mm)	16	24	22.0
No. 16 (1.18 mm)	13	21	18.0
No. 30 (0.6 mm)	12	18	16.0
No. 50 (0.3 mm)	12	15	14.3
No. 100 (0.15 mm)	-	-	12.3
No. 200 (0.075 mm)	8.0	10.0	10.1 *
Pan (-0.075 mm)			0.0

The asterisks show the blend is too fine on four sieves. To correct this, remove 1 ½ percent of the mineral filler and 20 percent of the fine aggregate (aggregate C), add 6 percent of the coarse aggregate (aggregate B) and 15 1/2 percent of the most coarse aggregate (aggregate A). The revised stockpile percentages are as follows: Aggregate A: 45.5 percent, Aggregate B: 36 percent, Aggregate C: 10 percent and Mineral Filler: 8.5 percent. The revised percent passing by volume is shown in Table 7.

**Table 7**

Sieve Size	Volume Retained per Sieve, cm <sup>3</sup>	Percent Retained Per sieve	Cumulative Percent Retained	Percent Passing By Volume
1 in (25 mm)	0	0.00	0.00	100.0
3/4 in (19 mm)	0.87	2.30	2.30	97.7
1/2 in (12.5 mm)	8.94	23.69	25.99	74.0
3/8 in (9.5 mm)	7.77	20.59	46.58	53.4
No. 4 (4.75 mm)	12.49	33.07	79.65	20.3
No. 8 (2.36 mm)	1.66	4.41	84.06	15.9
No. 16 (1.18 mm)	0.84	2.23	86.29	13.7
No. 30 (0.6 mm)	0.36	0.96	87.25	12.7
No. 50 (0.3 mm)	0.39	1.05	88.30	11.7
No. 100 (0.15 mm)	0.65	1.73	90.03	10.0
No. 200 (0.075 mm)	0.66	1.75	91.77	8.2
Pan (-0.075 mm)	3.11	8.23	100.00	0.0
TOTAL (S)	37.76	100.00		

Table 8 shows the job mix formula by volume and weight (mass) compared to the specification gradation band.

**Table 8**

Sieve Size	19.0 mm NMS Gradation Band		Percent Passing By Volume	Percent Passing By Weight (Mass)
	Lower	Upper		
1 in (25 mm)	100	100	100.0	100.0
3/4 in (19 mm)	90	100	98	98
1/2 in (12.5 mm)	50	74	74	74
3/8 in (9.5 mm)	25	60	53	53
No. 4 (4.75 mm)	20	28	20	20
No. 8 (2.36 mm)	16	24	16	15*
No. 16 (1.18 mm)	13	21	14	13
No. 30 (0.6 mm)	12	18	13	12
No. 50 (0.3 mm)	12	15	12	11*
No. 100 (0.15 mm)	-	-	10	9
No. 200 (0.075 mm)	8.0	10.0	8.2	7.6*

The percent passing by weight (mass) is used for mix design and job control. The asterisks show why computing percent passing by volume is needed for SMA mixes.

For the final developed aggregate blend determine the  $VCA_{dr}$  of the coarse aggregate fraction of the mix according to AASHTO T-19.

Voids in the Coarse Aggregate - Dry-Rodded Condition ( $VCA_{dr}$ ):

Since the gradation is a 1 in. (25 mm) maximum (3/4 in. or 19 mm nominal maximum), the  $VCA_{dr}$  was determined for aggregate retained on the No. 4 (4.75 mm) sieve. The sieve to use as the break point sieve is shown in Section 4.3 of this S.O.P.

The calculation for  $VCA_{dr}$  for the blend is shown below:

$$VCA_{dr} = 100 * (G_{ca} * \gamma_w - \gamma_s) / (G_{ca} * \gamma_w)$$

$$VCA_{dr} = 100 * (2.616 * 998 - 1610) / (2.616 * 998) = 38.33 \%$$

Where,

$\gamma_s$  = unit weight of the dry rodded coarse aggregate fraction ( $kg/m^3$ )

$\gamma_w$  = unit weight of water ( $998 kg/m^3$ )

$G_{ca}$  = bulk specific gravity of the coarse aggregate

Next, the percent VCA of the compacted mix ( $VCA_{mix}$ ) is calculated. The calculation for the percent  $VCA_{mix}$  is shown below. A liquid asphalt binder content of 6.5 percent and a bulk specific gravity of 2.168 for the compacted specimens are used in this example.

$$P_{ca} = P_s * P_{abp}$$
$$P_{ca} = 93.5 * 0.80 = 74.8 \%$$

$$VCA_{mix} = 100 - (G_{mb} / G_{ca}) * P_{ca}$$
$$VCA_{mix} = 100 - (2.168 / 2.616) * 74.8 = 38.01 \text{ percent}$$

Where,

- $P_{ca}$  = percent (by weight [mass] total mix) coarse aggregate retained on break point sieve.  
 $P_s$  = percent (by weight [mass] total mix) aggregate in the mix  
 $P_{abp}$  = percent (by weight [mass] total aggregate) aggregate retained on the break point sieve, expressed as a decimal  
 $G_{mb}$  = bulk specific gravity of the compacted specimen  
 $G_{ca}$  = bulk specific gravity of the coarse aggregate

The  $VCA_{mix}$  is compared to the  $VCA_{dr}$ . The  $VCA_{mix}$  is less than  $VCA_{dr}$ , so this meets specification.

$$VCA_{mix} = 38.01 < 38.33 = VCA_{dr}$$

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## MT-81 Preparation and Testing of Stone Matrix Asphalt (SMA) Mortars

**SCOPE:** This method establishes the procedure for the preparation and testing of Stone Matrix Asphalt (SMA) mortars. A properly blended mortar is important for inhibiting draindown within SMA mixtures.

### 1. DEFINITIONS

**1.1 DRAINDOWN.** Draining of the asphalt binder from the aggregate particles.

**1.2 STONE MATRIX ASPHALT (SMA).** SMA is type of hot mix asphalt comprised of a high percent of coarse aggregate, a high content of mineral filler, and a polymer modified asphalt binder, along with stabilizing fibers.

**1.2 SMA MORTAR.** The mixture of polymerized liquid asphalt binder, mineral filler, and stabilizing fiber.

**1.3 STABILIZING FIBER.** Cellulose, mineral fiber, or other approved material added to the SMA mixture to reduce draindown.

### 2. REFERENCE STANDARDS

#### AASHTO STANDARDS

M 231	Weighing Devices used in the Testing of Materials
R 28	Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
T 240	Effect of Heat and Air on a Moving Film of Asphalt (RTFO)
T 313	Determining the Flexural Creep Stiffness of an Asphalt Binder Using the Bending Beam Rheometer (BBR)
T 315	Determining the Rheological Properties of an Asphalt Binder Using the Dynamic Shear Rheometer (DSR)

#### ASTM STANDARDS

D4402	Viscosity Determinations of Unfilled Asphalts Using the Brookfield Thermosel Apparatus
E11	Wire-Cloth Sieves for Testing Purposes

#### MISSISSIPPI TEST METHODS

MT-80	Volumetric Mix Design Procedure for Stone Matrix Asphalt (SMA)
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### 3. APPARATUS

**3.1 BALANCE,** 2-kg capacity, sensitive to 0.1 g. The balance shall conform to the requirement of M 231, class G2.

**3.2 OVEN,** capable of maintaining the needed temperature within  $\pm 10^{\circ}\text{F}$  ( $5^{\circ}\text{C}$ ).

**3.3 HOT PLATE,** at least 700-W capacity with adjustable temperature control.

**3.4 SAMPLE CONTAINERS,** capable of holding at least 100 g of filler and 200 g of liquid asphalt binder. A 6 oz. (0.18 L) seamless ointment tin is recommended.

**3.5 MIXING TOOLS,** wooden tongue depressors, spatulas, and spoons.

**3.6 INSULATED GLOVES,** for handling hot samples and equipment.

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#### 4. PROCEDURES

- 4.1 Dry respective aggregate fractions containing material passing the No. 200 (0.075 mm) sieve (as per ASTM E11) to constant weight (mass) at  $230 \pm 10^\circ\text{F}$  ( $110 \pm 5^\circ\text{C}$ ). Dry sieve these aggregates and collect the dust from each aggregate. Blend the fillers to meet the percent by volume on the job-mix-formula. An example of how to blend by volume can be found in Section 11 of MT-80.
- 4.2 Obtain one quart can of unaged, RTFO, and RTFO + PAV aged asphalt binder (see section 5.1).
- 4.3 Place a quart of unaged, RTFO, or RTFO + PAV liquid asphalt binder into an oven set at  $330 \pm 10^\circ\text{F}$  ( $165 \pm 5^\circ\text{C}$ ).
- 4.4 Weigh  $100 \pm 0.1$  g of minus No. 200 (0.075 mm) blended filler into the 6 oz. (0.18 L) seamless ointment tin and place into a  $350 \pm 10^\circ\text{F}$  ( $175 \pm 5^\circ\text{C}$ ) oven. The material should remain in the oven for at least 30 minutes.
- 4.5 Weigh into the filler the proper amount of liquid asphalt binder to the nearest 0.1 g.
- 4.6 Place the tin on the hot plate and hand mix with a spatula. Slowly add the proper amount of fiber (weighed to the nearest 0.1 g) and continue mixing until the mortar is homogeneous.
- 4.7 When asphalt-fiber pellets are used, either use loose fiber of the same type to create the mortar or use a high-shear mixer. Asphalt-pellet fibers will not blend into the filler under low-shear mixing conditions.

#### 5. TESTING OF MORTARS

- 5.1 When performing Superpave Liquid Asphalt Binder testing of the mortar to evaluate unaged DSR criteria, the fillers and fibers should be added directly to the unaged asphalt binder. When evaluating the RTFO aged DSR and/or the PAV aged BBR stiffness criteria, the liquid asphalt binder should be aged following T 240 and/or R 28 prior to blending with fillers and fibers.
- 5.2 Perform Brookfield Viscometer testing according to ASTM D4402; except that readings should be taken as soon as the temperature stabilizes because the fillers will sink to the bottom over time.
- 5.3 Perform BBR testing according to T 313; except use a higher preheat temperature of  $136^\circ\text{F}$  ( $58^\circ\text{C}$ ). This is to insure that the specimen will adhere strongly to both plates.
- 5.4 Perform DSR testing according to T 315; except, using aluminum molds.
  - 5.4.1 Place the mold over the corner of the warm hot plate so that the mold is on the hot plate and the rubber O-rings are not.
  - 5.4.2 Using a wooden tongue depressor, gently tamp the mortar into the mold. A light coating of release agent (glycerin and talc) will assist in this procedure.
  - 5.4.3 Repeat step 5.4.2 until the mold is full of mortar.
  - 5.4.4 Continue DSR testing according to T 315.

#### 6. REPORTING

- 6.1 Project Identification Information
  - 6.2 Name of Contractor(s)
  - 6.3 Type and Source of Component Materials
-

**6.4** Unaged DSR  $G^*/\sin\delta$ , in kPa

**6.5** RTFO DSR  $G^*/\sin\delta$ , in kPa

**6.6** PAV BBR stiffness (s), in MPa

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**MT-82 Draindown Testing of Stone Matrix Asphalt Mixtures**

**SCOPE:** This test method covers the determination of the amount of draindown in an uncompacted Stone Matrix Asphalt (SMA) sample when the sample is held at elevated temperatures comparable to those encountered during the production, storage, transport, and placement of the mixture.

**1. DEFINITIONS**

**1.1 STONE MATRIX ASPHALT (SMA).** SMA is a type of hot mix asphalt comprised of a high percentage of coarse aggregate, a high content of mineral filler, and a polymer modified asphalt binder, along with stabilizing fibers.

**1.2 DRAINDOWN.** For the purpose of this test method, draindown is considered to be that portion of material, which separates itself from the sample as a whole and is deposited outside the wire basket during the test.

**2. REFERENCED TEST METHODS**AASHTO Standards

M 92 Wire-Cloth Sieves for Testing Purposes.

Mississippi Test Methods

MT-80 Volumetric Mix Design Procedure for Stone Matrix Asphalt (SMA)

**3. APPARATUS**

**3.1** Oven, capable of maintaining the temperature in a range from 250 to 350°F (120 to 175°C). The oven should maintain the set temperature to within  $\pm 4^\circ\text{F}$  ( $2^\circ\text{C}$ ).

**3.2** Plates of appropriate size. The plates used should be of appropriate durability to withstand the oven temperatures. Paper or metal plates (disposable or otherwise) are acceptable.

**3.3** Standard cylindrical shaped basket meeting the dimensions shown in Figure 1. The basket shall be constructed using standard  $\frac{1}{4}$  in (6.3mm) square openings. Standard sieve cloth, as specified in AASHTO M 92, works best.

**3.4** Spatulas, trowels, mixer, and bowls as needed.

**3.5** Balance accurate to 0.1 gram.

**4. SAMPLE PREPARATION****4.1 LABORATORY PREPARED SAMPLES.**

4.1.1. For each mixture tested, the draindown characteristics shall be determined at three different temperatures. The three temperatures are the anticipated plant production temperature and 27°F (15°C) above and below. For each temperature, duplicate samples should be tested. Thus, for one bituminous mixture, a minimum of six samples will be tested.

4.1.2. Dry the aggregate to constant mass and sieve it into appropriate size fractions as indicated in MT-80, section 4.4.2.

4.1.3. Determine the anticipated plant production temperature or select a mixing temperature in accordance with MT-80, section 3.3.1.

4.1.4. Weigh into separate pans for each test sample the amount of each size fraction required to produce completed mixture samples having a mass of 1200 grams. The aggregate fractions shall be combined such that the resulting aggregate blend has the same gradations as the job-mix-formula. Place the samples in an oven and heat to a temperature not to exceed the mixing temperature established in MT-80, Section 4.4.2 by more than approximately 50°F (28°C).

4.1.5. Heat the asphalt cement to the temperature established in MT-80, Section 4.4.2.

4.1.6. Place the heated aggregate in the mixing bowl. Add fiber stabilizers and thoroughly mix the dry components. Form a crater in the aggregate blend and add the required amount of asphalt. The amount of asphalt shall be that established in the job-mix-formula. At this point, the temperature of the aggregate and asphalt cement shall be within the limits of the mixing temperature established in 4.1.3. Mix the aggregate, stabilizer, and asphalt cement quickly until the aggregate is thoroughly coated.

#### **4.2 PLANT PRODUCED SAMPLES.**

4.2.1. For plant produced samples, duplicate samples should be tested at the plant production temperature. Samples may be obtained during plant production by sampling the mixture at any appropriate location such as the trucks prior to the mixture leaving the plant.

4.2.2. Samples obtained during actual production should be reduced to the proper test sample size by the quartering method.

### **5. PROCEDURE**

**5.1** Transfer the laboratory produced or plant produced uncompacted mixture sample to a tared wire basket described in 3.3. Any aggregate that falls through the basket and onto the plate during the transfer should be removed and wasted. Place the entire sample in the wire basket. Do not consolidate or otherwise disturb the sample after transfer to the basket. Determine the mass of the sample to the nearest 0.1 gram.

**5.2** Dry a plate, at the temperature determined in 4.1.3, for a minimum of 10 minutes. Immediately determine and record the mass of the plate to the nearest 0.1-gram. Place the basket on the plate and place the assembly into the oven at the temperature as determined in 4.1.1 or 4.2.1 for 1 hour ± 1 minute.

**5.3** After the sample has been in the oven for 1 hour, remove the basket and paper plate. Remove any pieces of aggregate, which may have passed through the sieve and onto the plate. Determine and record the mass of the plate plus drained asphalt cement to the nearest 0.1 gram.

### **6. CALCULATIONS**

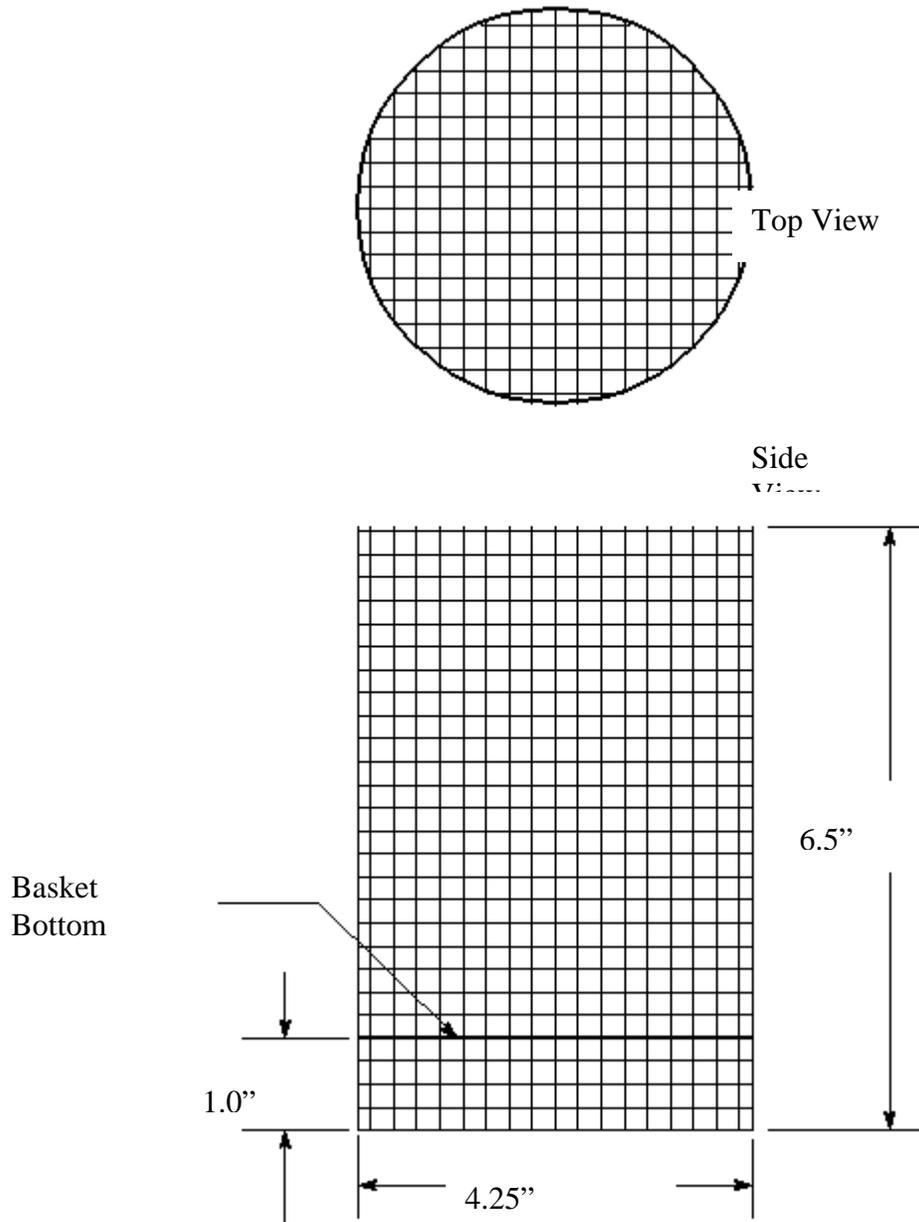
**6.1** Calculate the percent of mixture which drained by subtracting the initial paper plate mass from the final paper plate mass and divide this by the initial total sample mass. Multiply the result by 100 to obtain a percentage.

### **7. REPORTING**

**7.1** Report the average percent draindown at each of the test temperatures.

FIGURE 1

WIRE BASKET ASSEMBLY



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### MT-83 Mix Design of Open Graded Friction Course Hot Mix Asphalt

**SCOPE:** This method establishes the procedure for the volumetric mix design of Open Graded Friction Course (OGFC) asphalt mixtures. The design is based on the volumetric properties of the OGFC including air voids, permeability, voids in the coarse aggregate, and draindown.

#### 1. DEFINITIONS

**1.1 OPEN GRADED FRICTION COURSE (OGFC).** OGFC is type of hot mix asphalt comprised of a high percent of coarse aggregate and a polymer modified asphalt binder, along with stabilizing fibers.

**1.2 VOIDS IN THE COARSE AGGREGATE (VCA).** The volume between the coarse aggregate particles, including the fine aggregate, air voids, polymerized liquid asphalt binder, and fiber.

#### 2. REFERENCED TEST METHODS

##### AASHTO Standards

T 11	Amount of Material Finer than 0.075 mm (No. 200) Sieve
T 19	Unit Weight and Voids in Aggregate
T 27	Sieve Analysis of Fine and Coarse Aggregates
T 84	Specific Gravity and Absorption of Fine Aggregate
T 85	Specific Gravity and Absorption of Coarse Aggregate
T 209	Maximum Specific Gravity of Bituminous Paving Mixtures
T 269	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
T 312	Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyrotory Compactor
T313	Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
T315	Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
M320	Specification for Performance Graded Asphalt Binder

##### ASTM Standards

D 6752	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
D 3289	Standard Test Method for Density of Semi-Solid and Solid Bituminous Materials (Nickel Crucible Method)

##### Mississippi Test Methods

MT-24	Determination of the Specific Gravity of Fine Aggregate Using the Le Chatelier Flask
MT-59	Determination of Loss of Coating of HMA (Boiling Water Test)
MT-63	Resistance of Paving Mixtures to Stripping (Vacuum Saturation Method)
MT-82	Draindown Testing of Stone Matrix Asphalt (SMA) Mixtures
MT-84	Permeability of Open Graded Friction Course Asphalt Mixtures
MT-85	Abrasion Testing of Open Graded Friction Course Asphalt Mixtures

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### 3. APPARATUS

The apparatus required for the design of Open Graded Friction Course (OGFC) mixtures are those set out in the standards listed in Section 2 of this S.O.P.

### 4. PROCEDURE

**4.1 GRADATIONS.** Perform sieve analysis for the coarse and fine aggregate component sizes according to AASHTO T 27 and T 11.

**4.2 AGGREGATE SPECIFIC GRAVITIES.** Perform a minimum of two specific gravity tests on each aggregate according to AASHTO T 84 and T 85, on the hydrated lime according to MT-24 or ASTM C 604, and the asphalt binder according to ASTM D 3289 (77/77°F). If an aggregate has greater than 25 percent passing the No. 4 sieve and greater than 25 percent retained on the No. 4 sieve, conduct both a coarse and fine aggregate specific gravity on the material and combine the results according to equation in Section 5.1. Modify AASHTO T 84 as follows:

- a. Conduct tests on washed material passing the break point sieve. (See 4.3)
- b. Conduct the drying for the SSD determination in a flat bottom pan in which moisture is easily visible on the bottom.
- c. Define the SSD point at the time when moisture is no longer visible in the bottom of the pan when the material is moved across the bottom, the material is free flowing during this movement, and the surface of the aggregate does not change color with stirring.

**4.3 REQUIRED AGGREGATE BLEND.** Determine by trial and error method, the percentages of each aggregate necessary to produce a blended material meeting the gradation requirements of the specifications.

Determine the dry rodded unit weight of the coarse aggregate fraction of the aggregate blend in accordance with AASHTO T 19. This value will be used to calculate  $VCA_{dr}$ . The coarse aggregate fraction consists of all aggregate retained on the break point sieve in the aggregate blend. The following table indicates the break point sieves for various nominal maximum size OGFC mixes.

<u>Mixture Size (NMS)</u>	<u>Break Point Sieve</u>
½ in (12.5 mm)	No. 4 (4.75 mm)
3/8 in (9.5 mm)	No. 8 (2.36 mm)

The calculation of the  $VCA_{dr}$  for the blend is given as follows:

$$VCA_{dr} = \left( \frac{G_{ca}\gamma_w - \gamma_s}{G_{ca}\gamma_w} \right) 100$$

Where:

- $VCA_{dr}$  = voids in coarse aggregate in a dry rodded condition
- $G_{ca}$  = bulk specific gravity of coarse aggregate (aggregate retained on the break point sieve)
- $\gamma_w$  = unit weight of water (62.4 lbs/ft<sup>3</sup>)
- $\gamma_s$  = unit weight of the coarse aggregate fraction in the dry-rodded condition (lbs/ft<sup>3</sup>)

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#### 4.4 PREPARATION OF GYRATORY TEST SPECIMENS.

4.4.1 General. Prepare a minimum of four (4) sets of Gyratory specimens with asphalt binder content at 0.5 percent intervals. Prepare the sets such that at least one set is above the optimum asphalt content and one set is below the optimum asphalt content. Each set shall consist of a minimum of three (3) specimens.

4.4.2 Preparation of Aggregates. Dry each aggregate component to be used in the mixture to constant mass in an oven at a temperature of  $230 \pm 9^{\circ}\text{F}$ .

Estimate the mass of each aggregate component required to produce a batch that will result in a compacted specimen of correct size. For gyratory compacted specimens the correct size is 150 mm in diameter and approximately 115 mm in height. **(Note:** It is generally desirable to prepare a trial specimen prior to preparing all the aggregate batches. If the trial specimen does not meet the height requirement, adjust the amount of material used for the specimens accordingly).

Separate each individual aggregate into the appropriate sizes as follows:

3/4" to 1/2"  
1/2" to 3/8"  
3/8" to No. 4  
No. 4 to No. 8  
Passing No. 8

If any of the size fractions represent less than 5 percent of the individual aggregate, they may be combined with the next smaller size fraction.

Weigh cumulatively into a separate pan for each test specimen the required quantity of each aggregate component.

A minimum of eight (8) pans of the batched aggregates will be needed for the test specimens. Additionally, two (2) pans will be required for the maximum specific gravity ( $G_{mm}$ ) samples.

Place the asphalt binder to be used in an oven and heat to mixing temperature. Since polymer modified asphalt binders will be used, use the manufacturer's recommended mixing temperature.

Place the pans of batched aggregates in the oven and heat to mixing temperature, but not to exceed  $50^{\circ}\text{F}$  above the required mixing temperature. Stabilizing fiber is added to the aggregate blend at the time of mixing. Do not add the fiber to the aggregate prior to heating.

Charge the mixing bowl with the heated aggregate in one pan and dry mix thoroughly. Add the required amount of the stabilizing fiber and mix thoroughly. If the fiber is not thoroughly mixed with the aggregate prior to the addition of the liquid asphalt binder, the fiber will clump and the results will be invalid. Once the aggregate and fiber are thoroughly mixed, form a crater in the aggregate/fiber blend and weigh the required amount of heated asphalt binder into the mixture. Mechanically mix the aggregate, asphalt binder, and stabilizing fiber as quickly and thoroughly as possible to yield a paving mix having a uniform distribution of asphalt binder and fiber.

After completion of mixing, place the mix in a curing oven at  $5^{\circ}\text{F}$  to  $10^{\circ}\text{F}$  above compaction temperature for approximately 1-1/2 hours in a round (6.5" to 7.5" in diameter) covered container to allow for absorption. A 10# ink can from Inmark Inc. (205-856-9077) or a paint can without a top lip has been found suitable for aging the mixture. Use the binder manufacturer's recommended compaction temperature.

4.4.3 Compaction of Gyratory Test Specimens. Check the calibration of the Gyratory compactor in accordance with Operations Manual. (It is recommended that this be performed on at least a

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monthly basis.) Maintain records of calibration results and adjustments to the equipment. Verify  $600 \text{ kPa} \pm 18 \text{ kPa}$  ram pressure with load cell. Verify  $1.25 \pm 0.02^\circ$  angle tilt setting. Verify height calibration using spacer provided by manufacturer. Set number of gyrations to  $N_{\text{design}}$  (50 gyrations). Set dwell at the appropriate number of gyrations or dwell time, according to manufacturer's instructions. This is typically 5 gyrations for most Troxler compactors, or 5 seconds for most Pine compactors. Other manufacturers are similar.

Place a compaction mold and base plate in curing oven for 30 to 60 minutes prior to the estimated beginning of compaction (during the absorption period).

After completion of absorption period, remove the heated mold and base plate from the oven and place a paper disc on the bottom of the mold.

Remove a container of mixture from the oven and place the mixture into the mold in one lift by pouring uniformly through a funnel, taking care to avoid segregation in the mold. After all the mix is in the mold, level the mix, check for compaction temperature and place another paper disc on top of the leveled material. Load the specimen mold with the paving mix into the compactor and center the mold under the loading ram.

Lower the ram until the pressure on the specimen reaches  $600 \text{ kPa} \pm 18 \text{ kPa}$ . Begin compaction.

Record specimen height after each revolution to the nearest 0.1 mm. Continue compaction until  $N_{\text{design}}$  gyrations are reached and the gyratory mechanism shuts off.

Remove the angle from the mold assembly, apply dwell gyrations, raise the loading ram, remove mold from the compactor, provide a cooling period of  $10 \pm 2$  minutes for the mold and specimen in front of a fan, extrude the specimen from the mold and immediately remove the paper discs from top and bottom of the specimen.

After specimen cools to room temperature, weigh and record the mass of the extruded specimen,  $W_m$ , to the nearest gram.

Determine the required characteristics of the compacted mixture at  $N_{\text{design}}$  including but not limited to bulk specific gravity, permeability, and abrasion loss.

Repeat procedures in Subsection 4.4.3 for each Gyratory test specimen.

4.4.4 Specific Gravity of Compacted Specimens ( $G_{mb}$ ). Determine the specific gravity of the compacted specimens according to ASTM D 6752-02a.

4.4.5 Maximum Specific Gravity of Bituminous Mixture ( $G_{mm}$ ). Determine the maximum specific gravity according to AASHTO T 209, in duplicate, at an asphalt content near the expected optimum level, and average the results. Perform this test on samples that have completed the absorption period. (See Subsection 4.4.2).

## 5. COMPUTATIONS

**5.1 BULK SPECIFIC GRAVITIES OF BLENDED AGGREGATE.** When the total aggregate consists of separate fractions of coarse aggregate, fine aggregate, and hydrated lime, all having different specific gravities, the bulk specific gravity ( $G_{sb}$ ) for the total blended aggregate is calculated as follows:

$$G_{sb} = \frac{P_1 + P_2 + \dots + P_n}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \dots + \frac{P_n}{G_n}}$$

Where:  $G_{sb}$  = bulk specific gravity of the total aggregate  
 $P_1, P_2, P_n$  = percentages by mass of aggregates 1, 2, n  
 $G_1, G_2, G_n$  = bulk specific gravities of aggregates 1, 2, n  
**(Note:** The apparent specific gravity of hydrated lime shall be used in lieu of the bulk specific gravity)

**5.2 EFFECTIVE SPECIFIC GRAVITY OF AGGREGATE.** The effective specific gravity of the aggregate,  $G_{se}$ , is determined as follows:

$$G_{se} = \frac{100 - P_b}{\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)}$$

Where:  $G_{se}$  = effective specific gravity of aggregate  
 $P_b$  = asphalt binder, percent by mass of mixture  
 $G_{mm}$  = maximum specific gravity of paving mixture  
 $G_b$  = specific gravity of asphalt binder at 25°C

**Note:** The volume of asphalt binder absorbed by an aggregate is almost invariably less than the volume of water absorbed. Consequently, the value for the effective specific gravity of an aggregate should be between its bulk and apparent specific gravities. When the effective specific gravity falls outside these limits, its value must be assumed to be incorrect. The calculations, the maximum specific gravity of the total mix by AASHTO T 209, and the composition of the mix in terms of aggregate and total asphalt binder content, should then be rechecked for the source of the error.

**5.3 MAXIMUM SPECIFIC GRAVITY OF MIXTURES WITH DIFFERENT ASPHALT BINDER CONTENT.** In designing a paving mixture with a given aggregate, the maximum specific gravities,  $G_{mm}$ , at different asphalt binder contents are needed to calculate the percentage of air voids for each asphalt binder content. After calculating the effective specific gravity of the aggregate, the maximum specific gravity for any other asphalt binder content can be obtained as shown below. For all practical purposes, the effective specific gravity of the aggregate is constant because the asphalt binder absorption does not vary appreciably with variations in asphalt binder content.

$$G_{mm} = \frac{100}{\left(\frac{P_s}{G_{se}}\right) + \left(\frac{P_b}{G_b}\right)}$$

Where:	$G_{mm}$	= maximum specific gravity of paving mixture (no air voids)
	$P_s$	= aggregate, percent by total mass of mixture = (100 - $P_b$ )
	$P_b$	= asphalt binder, percent by total mass of mixture
	$G_{se}$	= effective specific gravity of aggregate
	$G_b$	= specific gravity of asphalt binder

**5.4 ASPHALT BINDER ABSORPTION.** Asphalt binder absorption,  $P_{ba}$ , expressed as a percentage by mass of aggregate is determined as follows:

$$P_{ba} = 100 \left( \frac{G_{se} - G_{sb}}{G_{sb} G_{se}} \right) G_b$$

Where:	$P_{ba}$	= absorbed asphalt binder, percent by mass of aggregate
	$G_{se}$	= effective specific gravity of aggregate
	$G_{sb}$	= bulk specific gravity of aggregate
	$G_b$	= specific gravity of asphalt binder

**5.5 EFFECTIVE ASPHALT BINDER CONTENT OF A PAVING MIXTURE.** The effective asphalt binder content,  $P_{be}$ , of a paving mixture is determined as follows:

$$P_{be} = P_b - \left( \frac{P_{ba}}{100} \right) P_s$$

Where:	$P_{be}$	= effective asphalt binder content, percent by mass of mixture
	$P_b$	= total asphalt binder content, percent by mass of mixture
	$P_{ba}$	= absorbed asphalt binder, percent by mass of aggregate
	$P_s$	= aggregate, percent by mass of mixture, = (100 - $P_b$ )

**5.6 PERCENT VCA IN COMPACTED PAVING MIXTURE ( $VCA_{mix}$ ).** The voids in the coarse aggregate,  $VCA_{mix}$ , is determined as follows:

$$VCA_{mix} = 100 - \left( \frac{G_{mb}}{G_{ca}} \right) P_{ca}$$

Where:	$VCA_{mix}$	= voids in coarse aggregate of the mixture
	$G_{ca}$	= bulk specific gravity of coarse aggregate (aggregate retained on the break point sieve)
	$G_{mb}$	= bulk specific gravity of compacted mixture (ASTM D 6752)
	$P_{ca}$	= percent coarse aggregate in mix by weight of total mix

**5.7 CALCULATION OF PERCENT AIR VOIDS IN COMPACTED MIXTURE.** The air voids,  $P_a$ , in a compacted paving mixture is determined as follows:

$$P_a = 100 \left( \frac{G_{mm} - G_{mb}}{G_{mm}} \right), \quad \text{or} \quad P_a = 100 \left[ 1 - \left( \frac{G_{mb}}{G_{mm}} \right) \right]$$

Where:

- $P_a$  = air voids in compacted mixture, percent of total volume  
 $G_{mm}$  = maximum specific gravity of paving mixture (or as determined directly for a paving mixture by AASHTO T 209)  
 $G_{mb}$  = bulk specific gravity of compacted mixture (ASTM D 6752)

## 6. DETERMINATION OF OPTIMUM ASPHALT BINDER CONTENT

### 6.1 PROCEDURE FOR DETERMINING MINIMUM ASPHALT BINDER CONTENT.

6.1.1 Asphalt content must meet minimum specification requirements as determined by the bulk specific gravity of the combined aggregate blend.

6.1.2 The  $VCA_{mix}$  must be less than the  $VCA_{dr}$  at the selected asphalt binder content.

### 6.2 Procedure For Determining Optimum Asphalt Binder Content

6.2.1. The asphalt content that meets the following criteria shall be selected as optimum asphalt content:

1. Air voids shall be a minimum of 15 percent as determined by ASTM D 6752.
2. The minimum laboratory permeability shall be 30 meters per day as determined by MT-84.
3. Asphalt binder draindown shall not exceed 0.3 percent tested in accordance with MT-82.
4. Aged abrasion loss shall not exceed 40 percent and unaged abrasion loss shall not exceed 30 percent as determined by MT-85.

## 7. RESISTANCE TO STRIPPING

**7.1** Check the designed mixture in accordance with MT-63 and MT-59 to determine if an antistripping additive will be required.

**7.2** If an antistripping additive is required, establish the dosage rate in accordance with MT-63 using samples of the additive to be used on the project.

**7.3** Final determination of the requirement for antistripping additive and dosage rate will be established by field testing in accordance with MT-63 and MT-59.

**8. RESISTANCE TO DRAINDOWN**

**8.1** Evaluate the designed mixture's resistance to draindown in accordance with MT- 82. The draindown value must be less than 0.30 percent as established in the specifications.

**9. PERMEABILITY**

**9.1** Evaluate the designed mixtures permeability in accordance with MT-84. Permeability must meet the minimum requirements of 30 m/day.

**10. REPORT**

Submit the mixture design report on Form TMD-042 (or similar type document), and include as a minimum:

- 10.1** Project Identification Information
  - 10.2** Name of Contractor(s)
  - 10.3** Type and Source of Component Materials
  - 10.4** Job-Mix Formula With All Supporting Test Data (laboratory worksheets).
  - 10.5** Design Asphalt Binder Content.
  - 10.6** **PLANT MIXING TEMPERATURE.** Specify the mixture temperature at the discharge from the mixer. State the plant mixing temperature recommended by the polymer modified binder manufacturer, and provide a copy of the manufacturer's recommendation.
  - 10.7** Type, Brand Name, and Dosage Rate of Antistripping Additive. If no additive is required, so state.
  - 10.8** Seven (7) preblended batches of the virgin aggregate (batch weights should be such that the proper height specimen is produced in the gyratory compactor).
  - 10.9** One thousand (1000) grams of the stabilizing fiber.
  - 10.10** Two (2) liters of the asphalt binder required for the design.
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**MT-84 Permeability of Open Graded Friction Course Asphalt Mixtures**

**SCOPE:** This test method covers the determination of the water conductivity of laboratory compacted open graded friction course (OGFC) asphalt mixtures.

**1. DEFINITIONS**

**1.1 OPEN GRADED FRICTION COURSE (OGFC).** OGFC is a type of hot mix asphalt comprised of a high percentage of coarse aggregate and a polymer modified asphalt binder, along with stabilizing fibers.

**1.2 PERMEABILITY.** Indication of the water conductivity of compacted asphalt paving mixtures.

**2. REFERENCED TEST METHODS**

FM 5-565            Measurement of Water Permeability of Compacted Asphalt Paving Mixtures

**3. APPARATUS**

**3.1** Permeameter-See Figure 1. The device shall meet the following requirements:

- a) A calibrated cylinder of  $31.75 \pm 0.5$  mm ( $1.25 \pm 0.02$  in.) inner diameter graduated in millimeters capable of dispensing 500 mL of water.
- b) A tube using a flexible latex membrane 0.635 mm (0.025 in.) thick and capable of confining asphalt specimens up to 152.4 mm (6.0 in) in diameter and 115 mm (4.5 in) in height.
- c) An upper cap assembly for supporting the graduated cylinder and expanding an o-ring against the tube. The opening in the upper cap shall have the same diameter as the inner diameter of the calibrated cylinder. The underside of the upper cap assembly shall be tapered at an angle of  $10 \pm 1^\circ$ .
- d) A lower plate for supporting the asphalt specimen. The opening in the plate should have a minimum diameter of 18 mm (0.71 in). The topside of the lower plate shall be tapered at an angle of  $10 \pm 1^\circ$ .
- e) O-rings shall be of a sufficient diameter and thickness for maintaining a proper seal against the tube.
- f) A frame and clamp assembly for supplying a force to the upper and lower plate necessary to expand the o-rings
- g) An air pump capable of applying 103.42 kPa (15 psi) pressure and capable of applying vacuum to evacuate air from the sealing tube.
- h) A pressure gauge with a range of 0 to 103.42 kPa (0 to 15 psi) with  $\pm 2$  percent accuracy.
- i) Quick connects and pressure line for inflating and evacuating the membrane.
- j) An outlet pipe with a minimum inside diameter of 18 mm (0.71 in) with shutoff valve for draining water.

**3.2** Thermometer, capable of measuring the temperature of water to the nearest  $0.1^\circ$  C ( $0.2^\circ$ F)

**3.3** Timer, such as a stopwatch, graduated in divisions of 0.1 s or less and accurate to within 0.05 percent when tested over intervals of not less than 15 min.

**3.4** Caliper, capable of measuring to the nearest 0.5 mm or better, used to measure the height of the specimen

**3.5** Sealing agent (petroleum jelly)

**3.6** Spatula

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#### 4. PROCEDURE

**4.1** Measure and record to the nearest 0.5 mm (0.02 in.) the height and diameter of the specimen at three locations. The three height measurements shall not vary by more than 5 mm (0.2 in).

**4.2** Apply a thin layer of petroleum jelly to sides of the specimen. This will fill the large voids on the outside of the specimen not representative of the internal compaction level. Use a spatula or similar device to apply the petroleum jelly, taking care not to press petroleum jelly into internal voids and provide erroneous results.

**4.3** Evacuate the air from the sealing tube.

**4.4** Center the specimen on top of the lower plate.

**4.5** Place the sealing tube over the specimen and lower plate.

**4.6** Insert the upper cap assembly into the sealing tube and allow it to rest on top of the asphalt specimen.

**4.7** Install the clamp assembly onto the permeameter frame and evenly tighten, applying a moderate pressure and thus sealing the o-rings against the membrane and sealing tube.

**4.8** Inflate the membrane to  $68.9 \pm 3.4$  kPa ( $10 \pm 0.5$  psi). Maintain this pressure throughout the test.

**4.9** Fill the graduated cylinder approximately halfway with water and rock the entire apparatus to evacuate any remaining air voids.

**4.10** Fill the graduated cylinder to a level above the 500 mL mark. Start timing when the bottom of the meniscus reaches the 500 mL and stop timing when the bottom of the meniscus reaches the 0 mL mark. Record the time to the nearest 0.1 seconds. Perform this test three times to check for saturation.

A specimen will be considered saturated when the difference between the first and third test is  $\leq 4$  percent of the first test. This shall be calculated as follows:

$$\frac{t_1 - t_3}{t_1} * 100$$

Where:

$t_1$ =time for first test, sec;

$t_3$ =time for third test, sec;

**4.11** Record the temperature of the water used in the test to the nearest 0.1°C (0.2°F).

**4.12** After saturation has been achieved and the final time recorded, release the pressure and evacuate the sealing tube. Remove the clamp assembly, upper cap, and specimen. Wipe excess petroleum jelly left on the latex membrane.

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## 5. CALCULATIONS

5.1 The coefficient of permeability,  $k$ , is calculated using the following equation:

$$k = \frac{aL}{At} \ln(h_1 / h_2) * t_c$$

Where:

$k$ =coefficient of permeability, cm/s;

$a$ =inside cross-sectional area of the buret, cm<sup>2</sup>;

$L$ =average height of the test specimen, cm;

$A$ =average cross-sectional area of the test specimen, cm<sup>2</sup>;

$t$ =time elapsed between  $h_1$  and  $h_2$ , sec;

$h_1$ =initial head across the test specimen, cm;

$h_2$ =final head across the test specimen, cm;

$t_c$ =temperature correction for the viscosity of water (Table 1 and 2)

5.2  $h_1$  and  $h_2$  are the dimensions shown in Figure 1.

**Note:** It is recommended to determine a set of dimensional constants for a particular permeameter. The dimensions from the underside of the top assembly to the lower timing mark and from the underside of the top assembly to the upper timing mark are constant. Add the average specimen thickness to these two dimensions and  $h_1$  and  $h_2$  are determined. It is helpful to create a spreadsheet that will calculate these values and permeability automatically.

## 6. REPORTING

6.1 Report the average permeability in whole units x 10<sup>-5</sup> cm/sec and in meters per day.

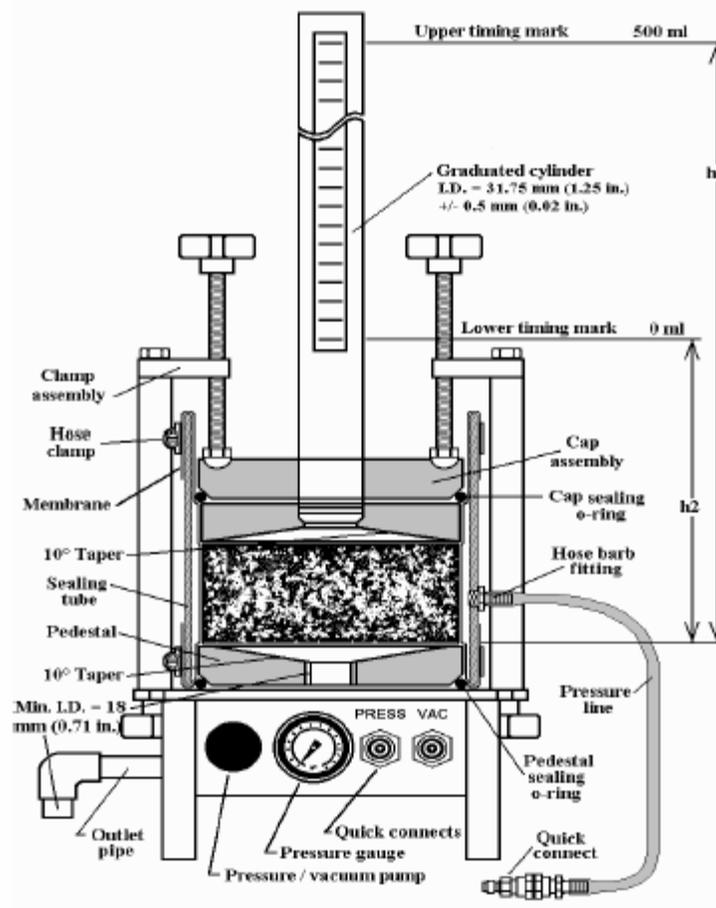


Figure 1 - Water Permeability Testing Apparatus (not to scale).

Table 1 - Temperature Correction for Viscosity of Water, Celsius

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
10	1.30	1.30	1.29	1.29	1.29	1.28	1.28	1.27	1.27	1.27
11	1.26	1.26	1.26	1.25	1.25	1.25	1.24	1.24	1.24	1.23
12	1.23	1.23	1.22	1.22	1.22	1.21	1.21	1.21	1.20	1.20
13	1.20	1.19	1.19	1.19	1.18	1.18	1.18	1.17	1.17	1.17
14	1.16	1.16	1.16	1.16	1.15	1.15	1.15	1.14	1.14	1.14
15	1.13	1.13	1.13	1.13	1.12	1.12	1.12	1.11	1.11	1.11
16	1.10	1.10	1.10	1.10	1.09	1.09	1.09	1.09	1.08	1.08
17	1.08	1.07	1.07	1.07	1.07	1.06	1.06	1.06	1.06	1.05
18	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03
19	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.00	1.00
20	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98
21	0.98	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.96
22	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.94	0.93
23	0.93	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.91	0.91
24	0.91	0.91	0.91	0.90	0.90	0.90	0.90	0.90	0.89	0.89
25	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.87	0.87
26	0.87	0.87	0.87	0.87	0.86	0.86	0.86	0.86	0.86	0.85
27	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84	0.84	0.84
28	0.83	0.83	0.83	0.83	0.83	0.83	0.82	0.82	0.82	0.82
29	0.82	0.81	0.81	0.81	0.81	0.81	0.81	0.80	0.80	0.80
30	0.80	0.80	0.80	0.79	0.79	0.79	0.79	0.79	0.79	0.78
31	0.78	0.78	0.78	0.78	0.78	0.78	0.77	0.77	0.77	0.77
32	0.77	0.77	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.75
33	0.75	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74	0.74
34	0.74	0.74	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.72
35	0.72	0.72	0.72	0.72	0.72	0.72	0.71	0.71	0.71	0.71

Table 2 - Temperature Correction for Viscosity of Water, Fahrenheit

°F	0.0	0.2	0.4	0.6	0.8
50	1.30	1.30	1.29	1.29	1.28
51	1.28	1.28	1.27	1.27	1.26
52	1.26	1.26	1.25	1.25	1.24
53	1.24	1.24	1.23	1.23	1.23
54	1.22	1.22	1.21	1.21	1.21
55	1.20	1.20	1.20	1.19	1.19
56	1.19	1.18	1.18	1.17	1.17
57	1.17	1.16	1.16	1.16	1.15
58	1.15	1.15	1.14	1.14	1.14
59	1.13	1.13	1.13	1.12	1.12
60	1.12	1.11	1.11	1.11	1.10
61	1.10	1.10	1.10	1.09	1.09
62	1.09	1.08	1.08	1.08	1.07
63	1.07	1.07	1.06	1.06	1.06
64	1.05	1.05	1.05	1.05	1.04
65	1.04	1.04	1.04	1.03	1.03
66	1.03	1.02	1.02	1.02	1.02
67	1.01	1.01	1.01	1.01	1.00
68	1.00	1.00	0.99	0.99	0.99
69	0.99	0.98	0.98	0.98	0.98
70	0.97	0.97	0.97	0.97	0.96
71	0.95	0.95	0.95	0.95	0.95
72	0.95	0.95	0.94	0.94	0.94
73	0.94	0.93	0.93	0.93	0.93
74	0.92	0.92	0.92	0.92	0.92
75	0.91	0.91	0.91	0.91	0.90
76	0.90	0.90	0.90	0.89	0.89
77	0.89	0.89	0.89	0.88	0.88
78	0.88	0.88	0.88	0.87	0.87
79	0.87	0.87	0.86	0.86	0.86
80	0.86	0.86	0.85	0.85	0.85
81	0.85	0.85	0.84	0.84	0.84
82	0.84	0.84	0.83	0.83	0.83
83	0.83	0.83	0.82	0.82	0.82
84	0.82	0.82	0.81	0.81	0.81
85	0.81	0.81	0.81	0.80	0.80
86	0.80	0.80	0.80	0.79	0.79
87	0.79	0.79	0.79	0.79	0.78
88	0.78	0.78	0.78	0.78	0.77
89	0.77	0.77	0.77	0.77	0.77
90	0.76	0.76	0.76	0.76	0.76
91	0.76	0.75	0.75	0.75	0.75
92	0.75	0.75	0.74	0.74	0.74
93	0.74	0.74	0.74	0.73	0.73
94	0.73	0.73	0.73	0.73	0.72
95	0.72	0.72	0.72	0.72	0.72

## MT-85 Abrasion Testing of Open Graded Friction Course Asphalt Mixtures

**SCOPE:** This test method covers the determination of the percent abrasion loss of laboratory compacted open graded friction course (OGFC) asphalt mixtures.

### 1. DEFINITIONS

**1.1 OPEN GRADED FRICTION COURSE (OGFC).** OGFC is a type of hot mix asphalt comprised of a high percentage of coarse aggregate and a polymer modified asphalt binder, along with stabilizing fibers.

**1.2 ABRASION LOSS.** Indication of the physical loss occurring in laboratory prepared OGFC specimens expressed as a percentage of the initial mass.

### 2. REFERENCED TEST METHODS

AASHTO T 96 Resistance to Degradation of Small-Size Coarse Aggregate by  
Abrasion and Impact in the Los Angeles Machine  
MT-83 Mix Design of Open Graded Friction Course Hot Mix Asphalt

### 3. APPARATUS

**3.1** Balance, capable of measuring to 0.1 grams

**3.2** Los Angeles abrasion drum, as per AASHTO T 96.

### 4. PROCEDURE

**4.1** Prepare four specimens as described in MT-83 (Mix Design of Open Graded Friction Course Hot Mix Asphalt)

**4.2** Two specimens shall be tested immediately after the cooling period (unaged specimens). Two specimens shall be placed in a forced draft oven at 64°C (147°F) for seven days and then tested (aged specimens).

#### Unaged Specimen

**4.3** Determine the weight of the specimen prior to testing ( $M_1$ ).

**4.4** Place unaged specimen in Los Angeles abrasion drum without the charge of steel balls.

**4.5** Conduct test for 300 revolutions at a rate of 30 revolutions per minute.

**4.6** After the test cycle is complete, remove the specimen from the drum and obtain the final weight ( $M_2$ ).

#### Aged Specimen

**4.7** After the seven day aging process is complete, remove specimens from oven and allow to cool for approximately four hours.

**4.8** Repeat steps 4.5 through 4.7 for aged specimens.

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**5. CALCULATIONS**

**5.1** The percent loss, L, is calculated using the following equation:

$$L = \frac{(M_1 - M_2)}{M_1} * 100$$

Where:

L=percent loss, %;  
M<sub>1</sub>=initial mass, grams;  
M<sub>2</sub>=final mass, grams

**6. REPORTING**

**6.1** Report the average unaged and aged abrasion loss in percent.

## Appendix C – Materials Division Standard Operating Procedures

**Note:** The Standard Operating Procedures listed below were referenced in this manual and are included for convenience. To review additional Materials Division SOPs or check for the latest version, please see the Official Standard Operating Procedures section of MDOT@Work (MDOT's Intranet Site).

### Index of Materials Division Standard Operating Procedures

<u>Form Number</u>	<u>Description</u>	<u>Page Number</u>
TMD-20-03-00-000	Schedule of Standard Lot Sizes for Conformity Determination	C-1
TMD-20-04-00-000	Approximate Frequencies for Job Control Acceptance Sampling and Testing	C-3
TMD-20-05-00-000	Sampling and Testing of Small Quantities of Miscellaneous Materials	C-34
TMD-06-01-00-000	Independent Assurance Sampling and Testing	C-36
TMD-06-02-00-000	Approximate Frequencies for Independent Assurance Sampling and Testing	C-44

**S.O.P. No.:** TMD-20-03-00-000

Mississippi Department of Transportation - Standard Operating Procedures

**Subject:** SCHEDULE OF STANDARD LOT SIZES FOR CONFORMITY DETERMINATION

**Effective Date:** August 01, 2005  
**Issued Date:** September 01, 2003

<b>Supersedes S.O.P.</b>	<b>Dated</b>
TMD-20-03-00-000	May 01, 1995

**PURPOSE:** To establish a schedule of lot sizes to be used in the determination of conformity with the specifications for various operations.

1. Deviation from the standard lot sizes shown may be made by the Engineer under the conditions set forth in the Contract Specifications.
2. The Standard Lot Size is to be followed within reasonable limits when the daily production is near normal or average for that particular type construction. When the daily production is extremely high or extremely low, then the Standard Lot Size may be varied with the judgment and consent of the District Materials Engineer. In cases where pay quantity is subject to adjustment as provided for in Contract Specifications, the Standard Lot Size will be followed as closely as possible.

**SCHEDULE OF STANDARD LOT SIZES FOR CONFORMITY DETERMINATION**

<u><b>TYPE OF CONSTRUCTION</b></u>	<u><b>OPERATION</b></u>	<u><b>STANDARD LOT SIZE</b></u>
Embankments:		
Basement Soils	Density	Note (1)
Design Soils	Density	Note (1)
Structure Backfill	Density	Each 4-ft. depth, Note (3)
Granular Courses	Density	2500 L. F. (each layer)
In-Grade Modification	Density	2500 L. F.
Lime-Treated Courses (Classes A, B, C)	Density	2500 L. F. (each layer) Note (2)
Portland Cement-Treated Courses	Density	2500 L. F. (each layer) Note (2)
Mechanically Stabilized Courses	Density	2500 L. F. (each layer)
Lime-Fly Ash Treated Courses	Density	2500 L. F. (each layer) Note (2)
Shoulders (all types)	Density	Day's Production (10,000 L.F. max.)
Hot Mix Asphalt	Density	Note (4)
Hot Mix Asphalt	Laboratory Testing	Note (5)
In-Grade Modification	Width	1,000 L. F.
Lime-Fly Ash Treated Courses	Width	1,000 L. F. (each layer)
Portland Cement Treated Courses	Width	1,000 L. F. (each layer)
Mechanically Stabilized Courses	Width	1,000 L. F. (each layer)
In-Grade Preparation - Top of Design Soil	Density	1,000 L. F.

**Annotations:**  
**Commission Order:**

**Note (1) Determination of Lot Sizes**

<u>More Than</u>	<u>To and Including</u>
0	250 cu yds. per hour, a lot equals 6 hrs. production
251	500 cu. yds. per hour, a lot equals 5 hrs. production
501	750 cu. yds. per hour, a lot equals 4 hrs. production
751	1,000 cu. yds. per hour, a lot equals 3 hrs. production
1,001	or more cu. yds. per hour, a lot equals 2 hrs. production

**Note (2)** At the discretion of the Project Engineer, a residual portion of a lot completed during a day's operation may be considered as a separate lot or may be included in the previous or the subsequent lot, except that any day's operation of less than one full lot shall be considered a lot.

**Note (3)** Structure backfill is to be considered a separate frame of work. The backfill at each structure up to a depth of four feet will be considered a lot. For long structures, the Engineer may specify that the backfill be divided into smaller lots.

**Note (4)** Each completed lift will be accepted with respect to compaction on a lot to lot basis. For normal production days, divide the production into approximately equal lots as shown in the following table. Obtain two random readings with the nuclear density gauge from each lot and average the results (see Chapter 7 of the latest edition of MDOT's Field Manual for HMA). Additional tests may be required by the Engineer to determine acceptance of work appearing deficient.

**Lot Determination**

Daily Production — Tons	Number of Lots
0-300	1
301-600	2
601-1000	3
1001-1500	4
1501-2100	5
2101-2800	6
2801+	7

**Note (5)** Quality Assurance (QA) testing shall be at a minimum frequency of 10% of the Contractor's Quality Control (QC) testing. Refer to 907-401 specifications and Chapters 5 and 6 of the latest edition of MDOT's Field Manual for HMA to determine lot sizes and required tests.

S.O.P. No.: **TMD-20-04-00-000** Mississippi Department of Transportation - Standard Operating Procedures

Subject: **APPROXIMATE FREQUENCIES FOR JOB CONTROL ACCEPTANCE SAMPLING AND TESTING**

Effective Date: **August 28, 2007**  
Issued Date: **August 28, 2007**

Supersedes S.O.P. TMD-20-04-00-000	Dated May 01, 2005
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**PURPOSE:** To establish a complete schedule for uniform job control acceptance sampling and testing.

The following schedule sets forth the sample size, frequency of sampling and designates the responsibility for sampling and testing. Any sampling and/or testing not performed by the Central Laboratory will be the responsibility of the District. The District may perform these operations or assign them to the Project Engineer as desired.

The frequencies in this schedule will be used by the Central Laboratory to ascertain the quantities of tested materials, unless otherwise stipulated in the Proposal. The responsibility for compliance with this schedule rests with the District and/or Project Engineer; however, additional sampling and testing may be performed as deemed necessary.

At the discretion of the Project Engineer, a residual portion of a lot completed during a day's operation may be considered as a separate lot or may be included in the previous or subsequent lot.

When samples are designated to be obtained by the District, these materials are normally located on or near the project site.

Pretested materials are normally sampled at the producer's plant or at a broker's warehouse.

The Office of State Aid Road Construction will be responsible for administering the frequencies of sampling and testing, at their discretion.

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
203	Borrow Excavation	Quality	Source Approval	District	District
	Excavation & Embankment	Density	See Note (1)	District	District
204	Geogrid Reinforcement of Embankment Slopes & Subgrades	Geogrids	Manufacturer's Certification, Certified Test Report Each Lot & 5 S.Y. Sample Each Shipment, Each Type; MDOT APL	District	Jackson
206	Structure Excavation (Backfill)	Density	Within the upper one-half of each 4' depth of back-fill See Note (6)	District	District
209	Geotextile Stabilization	Geotextile	Mfgr's Certification & 5 S.Y. Sample Each Lot, Each Shipment, Each Type	District	Jackson
211	Topsoiling	Topsoil for Slope Treatment	Source Approval	District	District
		Topsoil for Plant Holes or Pits	Source Approval	District	Jackson
212	Ground Preparation	Depth	As Required	District	District
		Pulverization	As Required	District	District
213	Fertilizing	Commercial Fertilizer	Guaranteed Analysis		
		Agricultural Limestone	1 Gal. Sample each 50 tons	District	Jackson

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
214	Seeding	Seed	Certified Analysis on Each Bag (Germination Report Required)		
			If not Pretested, 1/4 lb. Sample for each Lot	District	State Seed Testing Lab
215	Vegetative Material for Mulch	Mulch	Visual Inspection	District	District
		Asphalt	Manufacturer's Certification each Shipment		
216	Solid Sodding	Sod	Visual Inspection; If kind of sod is specified it must be nursery grown	District	District
217	Ditch Liner	Blanket, Fabric, Jute Mesh & Staples	Manufacturer's Certification each Shipment		
218	Bituminous Treated Roving	Roving	Manufacturer's Certification each Shipment		
		Emulsified Asphalt	See Note (2)	District	Jackson
219	Watering	Water	1 1/2 Pint Sample each Source	District	Jackson
221	Paved Ditches	Concrete, Etc.	See Item No. 601		
		Bituminous Materials	See Item No. 403		

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
224	Soil Reinforcing Mat	Mat	Manufacturer's Certification; MDOT APL		
		Pins, Staples	Manufacturer's Certification		
225	Grassing	Fertilizer	Guaranteed Analysis		
		Seeds	Certified Analysis on Each Bag (Germination Report Required)		
			If not Pretested, 1/4 lb. Sample for each Lot	District	State Seed Testing Lab
		Agricultural Limestone	1 Gallon sample per 50 tons	District	Jackson
		Mulch	Visual Inspection	District	District
	Emulsified Asphalt	See Note (2)	District	Jackson	
230	Tree and Shrub Planting	Plants	Certification of Inspection from Nursery & Visual Inspection by Authorized MDOT Representative		
		Water	1-1/2 Pint Sample each Source	District	Jackson
		Topsoil for Plant Holes	Source Approval	District	Jackson
		Fertilizer	See Item No. 232		

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Mulch	See Item No. 233		
231	Tree Seeding Planting	Plants	Certificate of Inspection from Nursery & Visual Inspection by Authorized MDOT Representative		
		Fertilizer	See Item Nos. 213 or 232 as Specified		
232	Fertilizer for Woody Plant Material	Fertilizer (Packet or Tablet)	Guaranteed Analysis		
233	Mulch for Woody Plant Material	Tree Bark	Guaranteed Analysis		
		Aggregate	Source Approval	District	District
		Straw	Visual Inspection	District	District
234	Silt Fence	Fabric	Manufacturer's Certification & Supplier's Material Conformance Statement, Each Lot		
		Posts, Wire Backing, Staples	Visual Inspection	District	District
235	Temporary Erosion Checks	Baled Hay or Straw	Visual Inspection	District	District
		Stakes	Visual Inspection	District	District
304	Granular Material	Abrasion Test (Class 1-6)	75# Source Sample	District	Jackson

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Grad., P.I.	1 each 1000 C.Y. or 1 each 1400 Tons from Roadway	District	District
		Density	Lot Size is 2500 L.F. each Layer (5 Tests per Lot)	District	District
305	In-Grade Modification	Stabilizer Aggregate	See Item No. 310		
		Density	See Item No. 310		
306	Asphalt Drainage Course	Gradation (belt sample), AC Content	1 per 1000 tons	District	District
		Lime	½ Gal. Initial Sample	District	Jackson
		Asphalt Cement (PG Binder Tests)	1 Qt. per 200,000 gallons; Cert. A	District	Jackson
307	Lime Treated Course	Mix Design	150# Sample for each Type Soil	District	Jackson
		Lime	1 Gal. each 1000 Tons	District	Jackson
		Water	1-1/2 Pint each Source	District	Jackson
		Density	Lot Size is 2500 L.F. each Layer (5 Tests per Lot)	District	District
		Pulverization	As Required	District	District
		Soil-Lime Mixture (Dry Quicklime only)	% Hydration (Cert. Test Report) from test strip	District	Contractor (Independent Lab)

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Curing Seal (Prime)	See Note (2)	District	Jackson
308	Portland Cement Treated Courses	Mix Design	150 lb. Sample for each Type Soil	District	Jackson
		Water	1-1/2 Pint each Source	District	Jackson
		Cement	Cert. A or B & 1 Gal. Sample each 1000 Bbls.; MDOT APL	District	Jackson
	After Mixing	Curing Seal (Prime)	See Note (2)	District	Jackson
		Pulverization	As Required	District	District
		Density	Lot Size is 2500 L.F. each Layer (5 Tests per Lot)	District	District
309	Crushed Stone Drainage Layer	Aggregate	75 lb. Initial Sample; MDOT APL	District	Jackson
		Gradation	1 per 1000 C.Y., or 1 per 1400 tons, or 1 per 9000 S.Y.	District	District
310	Mechanically Stabilized Courses	Aggregates	75 lb. Initial Sample	District	Jackson
		Grad. of Agg.	1 each 300 C.Y. or 400 tons; Project Site	District	District
	After Mixing	Grad. & P.I.	1 each 1000 L.F.	District	District
		Density	Lot Size is 2500 L.F. each Layer (5 Tests per Lot)	District	District

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
311	Lime-Fly Ash Treated Course	Mix Design	300 lb. Sample for each Type Soil, 50 lb. Fly Ash	District	Jackson
		Lime	1 Gal. each 1000 Tons	District	Jackson
		Fly Ash	Certification & 1 Gal. each 4000 Tons; MDOT APL	District	Jackson
		Water	1-1/2 Pint each Source	District	Jackson
		Density	Lot Size is 2500 L.F. each Layer (5 Tests per Lot)	District	District
		Pulverization	As Required	District	District
		Curing Seal (Prime)	See Note (2)	District	Jackson
320	Shoulders	Abrasion Test Class (1-6)	75 lb. Source Sample, Annually	District	Jackson
		Grad., P.I.	1 each 1000 C.Y. or 1 each 1400 Tons from Roadway	District	District
		Density	See Note (4)	District	District
321	In-Grade Preparation	Density (Top of Design Soil)	1 each 1000 L.F.	District	District
		Density (Other Courses)	See Item No. for Applicable Course	District	District

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
403	Hot Mix Asphalt	Mix Design	Each mix; as Req'd by Section 401 of Standard Specifications & MITCM; See Note (13)	Contractor	Contractor; verified by Jackson
		Hydrated Lime	1/2 Gal. Initial Sample, per source	District	Jackson
		Aggregates	MDOT APL or Source Approval	District or Contractor	Jackson
		Crushing Requirements (fractured face count)	One per Day/Production	Contractor	Contractor
		Asphalt Cement (temp., viscosity)	One qt. per 100,000 gal.	District	District
		Asphalt Cement (PG binder tests)	One qt. per 200,000 gal.; Certificate A or B	District	Jackson
		Tack Coat	See Note (2)	District	Jackson
		Gradation of Mineral Aggregates, Stockpiles	See Note (3)	Contractor	Contractor
		Gradation of Mixture, extraction	See Note (3)	Contractor	Contractor; District
		VMA & Total Voids	See Note (3)	Contractor	Contractor; District
		Road Density, HMA Field Manual Chapter 7	See Note (10)	District	District
% Asphalt	See Note (3)	Contractor	Contractor; District		

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Stripping Test (MT-59 and MT-63)	Initial; then One per Two Weeks Production	Contractor	Contractor
		Surface Checks	As Required	District	District
404	Cold Bituminous Pavements	Extraction	1 each 400 Tons If Not Pretested; MDOT APL	District	District
407	Tack Coat	Asphalt	See Note (2)	District	Jackson
408	Prime Coat	Asphalt	See Note (2)	District	Jackson
409	Geotextile for Underseal	Asphalt	See Note (2)	District	Jackson
		Geotextile	Manufacturer's Certification & 5 S.Y. Sample, Each Lot, Each Shipment	District	Jackson
410	Bituminous Surface Treatment	Asphalt	See Note (2)	District	Jackson
		Aggregate	75 lb. Initial Sample each Aggregate; MDOT APL	District	Jackson
		Gradation	1 each 300 C.Y.	District	District
413	Cleaning and Sealing Joints and Cracks	Bituminous Material	See Note (2)	District	Jackson
		Hot-Poured Elastic Type	Manufacturer's Certified Test Report each Lot		
		Silicone	Manufacturer's Certified Test Report each Lot & MDOT APL		

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Backer Rod	3 L.F. Sample each Shipment & MDOT APL	District	Jackson
		Aggregate (Gradation)	75 lb. Initial Sample; MDOT APL	District	District
501	Portland Cement Concrete Pavement				
		Mix Design	Approval	Contractor	Jackson
		Aggregate	75 lb. Sample each Aggregate; MDOT APL	District	Jackson
		Gradation	See Note (5)	District	District
		Cement	Cert. A or B & 1 Gal. each 1000 C.Y. Concrete Production; MDOT APL	District	Jackson
		Water	1-1/2 Pint Sample each Source	District	Jackson
		Admixtures	MDOT APL & Notarized Certificate from Producer for each Batch		
		Joint Filler	Pretested		
		Curing Material	Pretested		
		Fly Ash	Certification & 1 Gal. each 4000 C.Y. Concrete Production; MDOT APL	District	Jackson

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Ground Granulated Blast Furnace Slag	Cert. A or B; MDOT APL and 1 gal. Sample each 1000 C.Y. Concrete Production	District	Jackson
		Reinforcing Steel & Dowels	Pretested, See Note (7); Domestic Origin		
		Bar, Mats or Steel Wire Fabric (Wire Mesh)	Pretested or 3' x 3' Sample each 40,000 lbs; Domestic Origin	District	Jackson
		Cylinders	1 each 2000 S.Y.	District	District or Jackson
		Slump, % Air	Each Cylinder as Applicable	District	District
		Dowel Assemblies	One 5' Section per Project	District	Jackson
		Silicone Sealed Joints		District	Jackson
		Backer Rod:	3 L.F. Sample Each Shipment; MDOT APL		
		Joint Sealant:	Certified Test Reports for each Lot & MDOT APL		
		Dowel or Tie Bars Anchoring to Existing Pavement	See Item No. 503		
		Cores	1 per 1000 L.F. of 12' lane	Jackson	Jackson
502	Cement Concrete Bridge End Pavement	Concrete Items	See Item No. 804		

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Joint Filler	Pretested or Certificate		
		Curing Material	Pretested		
		Reinforcing Steel	Pretested See Note (7); Domestic Origin		
503	Replacement of Concrete Pavement	Concrete and Related Materials	A minimum of one set (two cylinders) per mix, per production day and strength tested at three (3) days. Slump, temperature, and total air content with each set of cylinders	District	District
		Joint Sealant	See Item 413		
		Epoxy or Chemical Anchor System for Dowels/Tie Bars	Manufacturer's Certification each Shipment; MDOT APL		
			Tension Test One per Day at Random In-Place	District	District
504	Cleaning and Patching Concrete Spalls	Patching Material	MDOT APL & Manufacturer's Certification; or 1 Bag each Component Including Mixing Instructions (Approved prior to use)	District	Jackson
508	Silicone Sealed Joints	Silicone	Cert. Test Report Each lot; MDOT APL		

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Backer Rod	3' Sample Each Shipment; MDOT APL	District	Jackson
510	Repair of Concrete Pavement	Polymer Concrete	MDOT APL		
512	Pressure Grouting Concrete Pavement	Cement	Cert. A or B & 1 Gal. Sample each 1000 Bags	District	Jackson
		Fly Ash	Certification & 1 Gal. Sample each 200 Tons; MDOT APL	District	Jackson
		Calcium Chloride	1 Qt. Sample	District	Jackson
		Fine Aggregate	Source Approval	District	District
		Limestone Dust	Source Approval	District	District
		Water	1-1/2 Pint Sample from each Source	District	Jackson
		Consistency	Each Batch	District	District
601	Structural Concrete	Plastic Concrete	A minimum of one set (two cylinders) for each 50 C.Y. placed from a single supplier. Slump, temperature, and total air content with each set of cylinders	District	District
		Mix Design and Component Materials	See 804		

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Precast Units	Roadway Design Division Approval of Shop Drawings; then Pretested	Jackson	Jackson
602	Reinforcement	Reinforcing Steel	Pretested See Note (7); Domestic Origin		
603	Culverts and Storm Drains	Pipe (Concrete, Metal)	Pretested	Jackson	Jackson
		Bituminous Plastic Sealer	Pretested	Jackson	Jackson
		Preformed Joint Material (Flex. Plastic Gaskets)	Manufacturer's Certified Test Report		
		Extruded Pipe (HDPE, PVC)	Manufacturer's Certification; MDOT APL		
		Rubber Gaskets	Manufacturer's Certified Test Report		
604	Manholes, Inlets, and Catch Basins	Brick	10 Brick Samples per 50,000 Bricks used. 5 each Additional 50,000	District	Jackson
		Concrete	See Item No. 601		
		Reinforcing Steel	See Item No. 602		
		Gratings	Pretested		
		Castings	Pretested		
	Precast Items:	Manholes	Pretested		

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Inlets and Catch Basins	Roadway Design Division Approval of Shop Drawings; then Pretested		
605	Underdrains	Pipe: (Concrete, Metal)	Pretested		
		PVC, ABS, and HDPE	Certified Test Report & Manufacturer's Certification		
		Filter Material Gradation	1 each 300 C.Y.	District	District
		Geotextile	Manufacturer's Certification, Each Lot, Each Type	District	Jackson
606	Guard Rail	Metal Rail	Certified Test Reports; MDOT APL		
		Anchorage & Fittings	Mill Test Reports		
		Hardware	Manufacturer's Certification		
		Post, Wood	Pretested		
		Post, Metal	Certified Test Reports; Domestic Origin		
607	Fences and Cattle Guards	Woven Wire	3' Sample each 50 Rolls; Domestic Origin	District	Jackson
		Barbed Wire	25' Sample each 50 Rolls; Domestic Origin	District	Jackson

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Staples	1# Sample	District	Jackson
		Tension Wire	6' Sample; Domestic Origin	District	Jackson
		Tie Wire	6' Sample; Domestic Origin	District	Jackson
		Chain Link	Certified Test Report and 3' Sample; Domestic Origin	District	Jackson
		Non-Metal Post & Lumber	Pretested		
		Gates, Aluminum Slatted	Manufacturer's Certification Dimensions to be checked in field prior to erection		
		Gates, Fabric Filled	Manufacturer's Certification		
		Steel Posts	Certified Test Report and 1 Post each Size; Domestic Origin	District	Jackson
		Hardware	Manufacturer's Certification		
608	Sidewalks	Plastic Concrete	A minimum of one set (two cylinders) for each 500 S.Y. placed from a single supplier. Slump, temperature, and total air content with each set of cylinders	District	District

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Mix Design and Component Materials	See 804		
609	Concrete Curb, Gutter and Combination	Plastic Concrete	A minimum of one set (two cylinders) for each 900 L.F. placed from a single supplier. Slump, temperature, and total air content with each set of cylinders	District	District
		Concrete Mix Design and Component Materials	See 804		
		Bituminous Curb	See Item No. 403		
		Paint	See Item No. 625		
610	Drainage Wicks	Wicks	Certified Test Reports; One 25 L.F. sample	District	Jackson
611	Brick Masonry	Brick	10 Brick Samples per 50,000 Bricks, 5 Bricks each Additional 50,000	District	Jackson
		Masonry Cement	1 Gal. each 200 Bags	District	Jackson
		Water	1-1/2 Pint Sample each Source	District	Jackson
		Mortar Sand	50 lb. Sample	District	Jackson

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Hydrated Lime	1 Gal. Sample per 200 Bags	District	Jackson
613	Adjustment of Castings, Gratings & Utility Appurtenances	Manhole Risers	MDOT APL		
		All Other Materials	See Item No. 604		
614	Concrete Driveways	Plastic Concrete	A minimum of one set (two cylinders) for each 300 S.Y. placed from a single supplier. Slump, temperature, and total air content with each set of cylinders	District	District
		Mix Design and Component Materials	See 804		
615	Concrete Barrier	Plastic Concrete	A minimum of one set (two cylinders) for each 400 L.F. placed from a single supplier. Slump, temperature, and total air content with each set of cylinders	District	District
		Mix Design and Component Materials	See 804		

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
616	Median and Island Pavement	Plastic Concrete	A minimum of one set (two cylinders) for each 200 S.Y. placed from a single supplier. Slump, temperature, and total air content with each set of cylinders	District	District
		Concrete Mix Design and Component Materials	See 804		
		Hot Mix Asphalt	See Item No. 403		
		Joint Filler	Pretested		
617	ROW Markers	Marker	Pretested		
618	Maintenance of Traffic	All Materials	See Specific Item Involved		
619	Traffic Control for Construction Zones	Paint for Traffic Stripe	Pretested		
		Glass Beads	Pretested		
		Reflective Pavement Markers & Adhesive	See Item No. 627		
		Pavement Marking Tape	Manufacturer's Certification; MDOT APL		
		New Construction Signs	Manufacturer's Certification or Certified Test Report		

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Used Construction Signs	Visual Inspection & Certification by Project Engineer	District	District
		Concrete Median Barrier	See Item No. 615		
		Impact Attenuators	MDOT APL		
		Guardrail	See Item No. 606		
		Snap-Back Delineators	MDOT APL		
		All Other Materials	Manufacturer's Certification		
625	Painted Traffic Markings	Paint	Pretested		
		Beads	Pretested		
626	Thermoplastic Traffic Markings	Thermoplastic	Manufacturer's Certified Test Report; MDOT APL		
		Drop-on Glass Beads	Pretested		
627	Raised Pavement Markings	Markers	See Note (8); MDOT APL		
		Bituminous Adhesive	Pretested or Certified test Report, 10 lb. Sample each Lot; MDOT APL	District	Jackson

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

<b>ITEM NO.</b>	<b>ITEM</b>	<b>MATERIAL OR TEST</b>	<b>FREQUENCY</b>	<b>SAMPLED BY</b>	<b>TESTED BY</b>
628	High Performance Cold Plastic Pavement Markings	Cold Plastic Pavement Marking	5' sample and Manufacturer's Certification each Lot; MDOT APL	District	Jackson
629	Vehicular Impact Attenuators	Attenuators	Manufacturer's Certification; MDOT APL		
630	Traffic Signs & Delineators	Concrete, Etc.  Wood Posts  All Metals, Etc.  Reflectorized Materials	See Item No. 601  Pretested  Manufacturer's Certified Test Report; Domestic Origin  Manufacturer's Certification; MDOT APL		
631	Flowable Fill	Mix Design  Cement  Water  Fly Ash  Aggregate	Each  Cert. A or B; 1 gallon sample each 500 C.Y.; MDOT APL  1-1/2 pint sample each source  Cert. And 1 gallon sample each 2000 C.Y.  1 per 500 C.Y.; MDOT APL	Contractor  District  District  District  District	Jackson  Jackson  Jackson  Jackson  District
634-686	Traffic Signal and Illumination Systems-General	Concrete	See Item No. 601		

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Treated Wood	Pretested		
		Other Materials	As Required		
801	Excavation and Fill	Density	See Note (6)	District	District
802	Sheet Piling	Concrete	Pretested		
		Steel	Mill Test Report; Domestic Origin		
803	Bearing Piles	Concrete:			
		(1) Precast	See Item No. 804		
		(2) Drilled Shafts	See Item No. 804		
		Steel	Mill Test Report; Domestic Origin		
804	Concrete Bridge Structures				
		Mix Design	Each	Contractor	Jackson
		Cement	Cert. A or B & 1 gal. Sample each 500 C.Y. Concrete Production; MDOT APL	District	Jackson
		Water	1½ Pint Each Source	District	Jackson
		Fly Ash	Certification & 1 gal. each 2000 C.Y. Concrete Production; MDOT APL	District	Jackson

**Annotations:**

**Commission Order:** 121633

Mississippi Department of Transportation S.O.P. No. **TMD-20-04-00-000**

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Ground Granulated Blast Furnace Slag	Cert. A or B; MDOT APL, and 1 gal. Sample each 1000 C.Y. Concrete Production	District	Jackson
		Metakaolin	Manufacturer's Certification, MDOT APL, and 1 gal. Sample for each 2000 C.Y. Concrete Production	District	Jackson
		Silica Fume	Manufacturer's Certification, MDOT APL, and 1 gal. Sample for each 2000 C.Y. Concrete Production	District	Jackson
		Aggregates	See Note (11) 75 lb. Each Aggregate Initial Sample; MDOT APL	Contractor	Contractor; Jackson
		Curing Material	Pretested		
		Wire Rope or Cable	Certificate and 5' Sample each 100,000 L.F.; Domestic Origin	District	Jackson
		Spiral Wire	4' Sample each Shipment; Domestic Origin	District	Jackson
		Admixtures	MDOT APL & Notarized Certificate from Producer for each Batch		

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Prestressed Concrete Beams & Piles	Pretested & Certified by Producer; See Note (11)	Producer (PCI Certified/MDOT Approved)	Producer (PCI Certified/MDOT Approved)
		Structural Steel (Joints and Bearings)	Mill Test Report; Domestic Origin		
		Reinforcing Steel	Pretested; Domestic Origin  See Note (7)		
		Plastic Concrete Testing	See Note (11)	Contractor; District	Contractor; District
		Neoprene Bearing Pads	Certificate & 1 Pad per Lot  See Note (9)	District	District
		Grout, Epoxy, & Patching Material	MDOT APL, or 1 Bag each Component including Mixing Instructions (Approved prior to use)	District	Jackson
		Joint Repair & Silicone Sealant	Manufacturer's Certification; MDOT APL  See Item No. 413 and 808		
		Poured Joint Sealant	See Item No. 501		
		Concrete Texture Spray Coating	MDOT APL & Manufacturer's Certification		
805	Reinforcement Steel		Pretested; Domestic Origin See Note (7)		

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
806	Precast (All Units) Concrete Bridge Caps, Spans and Wings		Pretested		
808	Joint Repair	Epoxy Joint Repair System	MDOT APL & Manufacturer's Certification each Shipment; OR A Sample of each Component for Approval & then Certification each Shipment	District	Jackson
809	Retaining Walls				
	<b>Conventional:</b>	Concrete Items	See Item No. 804		
		Backfill	75 lb. Initial Sample; Source Approval; Density (Ea. Lift)	District	District
	<b>MSE:</b>	Precast Concrete Panels	Cert. Test Reports (compressive strength)		
		Modular Blocks: - Materials	Manufacturer's Certification on all constituents		
		- Compressive Strengths	Cert. Test Reports		
		Leveling Pads	A minimum of one set (two cylinders) per 200 L.F.	District	District
		Drainage Fill	75 lb. Initial Sample; Source Approval	District	District

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
		Reinforced Backfill	Source Approval	District	Jackson
		- Density	2 per lift	District	District
		Metallic Backfill Reinforcement	Manufacturer's Certification		
		Geogrids	Manufacturer's Certification; 5 S.Y. sample per lot, per shipment	District	Jackson
	<b>Gravity:</b>	Leveling Pad	A minimum of one set (two cylinders) per 200 L.F.	District	District
		Prefab Modular Units	Manufacturer's Certification		
		Backfill	75 lb. Initial Sample; Source Approval	District	District
		- Density	As required (see specifications)	District	District
810	Steel Structures	Steel	Mill Test Reports		
		Paint (Prime, Intermediate & Top Coats)	MDOT APL, Certification & 1 qt. Sample	District	Jackson
		Bolts, Nuts, Washers & DTI's	See Note (12)	District	Jackson
811	Bronze & Copper-Alloy Bearing and Extension Plates	Metals	Certified Test Reports		
812	Steel Grid Flooring	Steel	Mill Test Reports; Domestic Origin		

ITEM NO.	ITEM	MATERIAL OR TEST	FREQUENCY	SAMPLED BY	TESTED BY
813	Railing	Materials	See Applicable Items in 804		
814	Paint Metal Structures	Paint (Prime, Intermediate & Top Coat)	MDOT APL, Certification & 1 qt. Sample	District	Jackson
815	Riprap and Slope Paving	Concrete Items	See Item No. 804		
		Geotextile	Manufacturer's Certification & 5 S.Y. Sample Each Lot, Each Shipment	District	Jackson
		Cloth or Jute Bags	Approval	District	District
		Riprap	Pretested or Visual Inspection; MDOT APL	Jackson or District	
		Sediment Control Stone	75 lb. Initial Sample (Gradation) ; MDOT APL	District	District
816	Maintenance Painting of Metal Structures	Paint (Prime, Intermediate & Top Coat)	MDOT APL, Certification & 1 qt. Sample	District	Jackson
820	Timber Structures	Treated Timbers (Piling, Lumber)	Pretested	Jackson	Jackson
		Hardware	Manufacturer's Certification		
822	Neoprene Expansion Joints	Joints	Manufacturer's Certification		

**REFERENCED NOTES IN SCHEDULE FOR JOB CONTROL SAMPLING AND TESTING**

(1) Determination of Lot Sizes

**Annotations:**  
**Commission Order:** 121633

<u>More than</u>	<u>To and Including</u>
0	500 cu. yds. per hour, a lot equals 6 hours production
501	600 cu. yds. per hour, a lot equals 5 hours production
601	750 cu. yds. per hour, a lot equals 4 hours production
751	1000 cu. yds. per hour, a lot equals 3 hours production
1001	1500 or more cu. yds. per hour, a lot equals 2 hours production
1501	or more cu. yds. per hour, a lot equals 1 hour production
	Maximum thickness of a lot tested cannot exceed 2 feet, regardless of volume of material placed

- (2) All bituminous materials shall be shipped under Certificate "A" or "B" (Certification by refinery) and job control sampling shall be performed at the following rate:
- (A) Asphalt for Plant Mixes and Fabric Undersealing. One sample for each week during continuous production and one sample each 50,000 gallons received during period of intermittent operation. For projects with less than 250 tons of mix, see S.O.P. No. TMD-20-05-00-000.
  - (B) Asphalt for Surface Treatment. One sample for each 50,000 gallons or fraction thereof. For projects with less than 1000 gallons, see S.O.P. No. TMD-20-05-00-000.
  - (C) Asphalt for prime, curing, tack coat, joint sealing and crack filling. One sample for each 30,000 gallons or fraction thereof. For projects with less than 6000 gallons, see S.O.P. No. TMD-20-05-00-000.
- (3) Sampling Frequency. Contractor is to conduct those quality control (QC) tests as required at the following frequency for each mixture produced based on the estimated plant tonnage at the beginning of the day. District is to conduct those quality assurance (QA) tests at a minimum frequency of 10% of the QC tests.

<u>TOTAL ESTIMATED PRODUCTION, tons</u>	<u>NUMBER OF TESTS</u>
50-800	1
801-1700	2
1701-2700	3
2701+	4

The above testing frequencies are for the estimated plant production for the day. If production is discontinued or interrupted, the tests will be conducted at the previously established sample tonnage points for the materials that are actually produced. If the production exceeds the estimated tonnage, sampling and testing will continue at the testing increments previously established for the day. A testing increment is defined as the estimated daily tonnage divided by the required number of tests from the table above.

In addition to the above program, the following tests shall be conducted on the first day of production and once for every eight production samples thereafter, with a minimum of one test per production week.

- Aggregate Stockpile Gradations  
(sample from cold feed bins or stockpile) (AASHTO T-11 and T-27)
- Reclaimed Asphalt Pavement (RAP) Gradation  
(sample from cold feed bin or stockpile) (Mississippi Test Method MT-31)

Fine Aggregate Angularity for all 9.5 mm mixtures and all MT and HT mixtures designed above the maximum density line. (ASTMC 1252 Method A)

At least one stripping test (MT-63) will be performed at the beginning of each job-mix production and thereafter, at least once every two weeks of production. If a stripping test fails, a new antistriper rate shall be established or other changes made immediately that will result in a mixture which conforms to the specifications; otherwise, production shall be suspended until corrections are made.

- (4) Densities shall be taken as required by specifications. Each lot will consist of each day's operation per layer placed, with a maximum lot length of 10,000 linear feet. The lot will be divided into five approximately equal sublots. One density test will be taken at random in each of the sublots. Average of the five (5) tests will be the lot density.
- (5) Job control acceptance sampling shall be performed as follows:
  - (A) Normally, one sample for each 500 cubic yards of concrete produced.
  - (B) A minimum of one sample for each half-day's operation.
- (6) Structure backfill is to be considered a separate frame of work. The backfill at each structure up to a depth of four feet will be considered a lot, except that for very long or very large structures, the Engineer may specify that the backfill be divided into more than one lot.
- (7) All pretested reinforcing steel should have the following, or similar wording on the Project Engineer's copy of the shipping invoice: "This material was shipped from MDOT Pretested Stock." If the steel has not been pretested, the following shall apply:
  - (A) Submit one (1) thirty (30) inch sample for each bar size for each ten (10) tons or fraction thereof to the Central Laboratory for testing. If the sample is cut with a torch, the sample length shall be forty-two (42) inches.
- (8) Types A, H, and I markers: Three (3) copies of manufacturer's certification PLUS 10 markers each type and class per lot.  
  
Types B – G markers: Three (3) copies of manufacturer's certification. Sample markers at the Engineer's discretion.
- (9) The Contractor shall furnish the manufacturer's certified test reports and certification covering each manufacturer's lot in a shipment. Dimensions are to be checked in the field prior to placement.  
  
Department representative from the District or Project Office will sample the bearing pads at the rate of one (1) plain pad per manufacturer's lot, and in the case of reinforced bearings one (1) pad per thickness per project. Samples obtained by the Department will be retained in the District or Project Office until final acceptance of the project. The pads will be tested as deemed necessary by the Department.
- (10) Each completed lift will be accepted with respect to compaction on a lot to lot basis from density tests performed by the Department. For normal production days, divide the production into approximately equal lots as shown in the following table. When cores are being used for the compaction evaluation, randomly obtain one core from each lot. When the nuclear density gauge is being used for compaction evaluation, obtain two random readings from each lot and average the results for the lot density (see Chapter 7 of the latest edition of MDOT's Field Manual for HMA). Additional tests may be required by the Engineer to determine acceptance of work appearing deficient. The Contractor shall furnish and maintain traffic control for all compaction evaluations required in satisfying specified density requirements.

**Lot Determination**

Daily Production — Tons	Number of Lots
0-300	1
301-600	2
601-1000	3
1001-1500	4
1501-2100	5
2101-2800	6
2801+	7

(11) For information regarding the Structural Concrete Quality Control/Quality Assurance (QC/QA) Program see Section 804 of the Standard Specifications and Section 2.5 in the MITCM (See Note 13).

(12) Mill test reports (MTR) required on steel used in manufacture of bolts, nuts, washers and direct tension indicators. Manufacturer's certified test report (MCTR) required for each lot of bolts, nuts, washers, and direct tension indicators. Distributor certified test reports (DCTR) required on each lot of bolts, nuts, washers and direct tension indicators.

Job Control acceptance samples shall be obtained at the rate of one (1) sample per shipment per manufacturer's lot for each size bolts, nuts, washers and direct tension indicators. The size of each sample of these materials shall be as specified in Section 717.02.7 of the Standard Specifications.

(13) MITCM – *Materials Division Inspection, Testing, and Certification Manual*. The latest version can be found on the Materials Division intranet webpage at MDOT@Work or by contacting Materials Division.

S.O.P. No.: TMD-20-05-00-000

Mississippi Department of Transportation - Standard Operating Procedures

Subject: SAMPLING AND TESTING OF SMALL QUANTITIES OF MISCELLANEOUS MATERIALS

Effective Date: April 01, 2003  
Issued Date: April 01, 2003

Supersedes S.O.P. TMD-20-05-00-000  
Dated May 01, 1995

**PURPOSE:** To establish a standard procedure for sampling and testing small quantities of materials for contracts such as Topics, Safety, Control of Junk Yards, Rest Areas, Maintenance Repair, and other projects.

**1. GENERAL**

It is intended that the reduced sampling and testing procedures be permitted for small quantities of materials that will not adversely affect the traffic-carrying capacity of a completed facility. Such procedures will not be permitted for concrete in major structures or other structurally critical items.

**2. SAMPLING AND TESTING OF SMALL QUANTITIES OF MISCELLANEOUS MATERIALS**

2.1 Sampling and testing of small quantities of miscellaneous materials may be waived by the State on the basis of one of the two following methods:

2.1.1 Acceptance on the basis of visual examination provided the source has recently furnished similar material found to be satisfactory under the normal sampling and testing procedures of the Department.

2.1.2 Acceptance on the basis of certification by the producer or supplier that the material complies with the specification requirements.

2.2 Under either of these two methods, the primary documentation of acceptance (certificate from Project Engineer or certification from Producer) shall be provided by the Project Engineer with copies to the District Materials Engineer, State Materials Engineer, and State Construction Engineer. This documentation shall include the material and quantity covered by the acceptance.

2.3 The following are maximum quantities of material that may be accepted as set out in Sections 2.1.1 and 2.1.2:

- (1) Aggregate for Surface Treatment .....100 cu. yds.
- (2) Granular Material .....1,000 cu. yds.
- (3) Bituminous Mixtures..... 250 tons
- (4) Liquid Asphalt..... 6,000 gals.
- (5) Paint & Epoxy Systems..... 55 gals.
- (6) Lumber ..... Recognized commercial grades only to be used
- (7) Treated Lumber (not used in bridge superstructures) ..... 2 M Bd. Ft.
- (8) Masonry Items.....500 pieces
- (9) Pipe, Diameter Less than 30-inch diameter (Concrete and Metal)..... 100 L. F.
- (10) Grass Seed ..... Quantity for 3 acres
- (11) Agricultural Limestone..... 15 tons
- (12) Fence (all types).....500 L. F.
- (13) Fence Posts & Anchors..... Quantity for 500 L. F. of fence
- (14) Staples, Tie Wire, etc. .... Quantity for 500 L. F. of fence
- (15) Gates..... 2 each

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(16)	Reinforcing Steel.....	1,000 lbs.
(17)	Grates or Castings .....	5 each
(18)	Nails .....	Recognized commercial grade to be used
(19)	Wire Mesh .....	10 rolls
(20)	Portland Cement Concrete .....	200 cu. yds.
(21)	Geotextile Fabric *.....	2 rolls
(22)	Bituminous Adhesive.....	100 lbs.
(23)	Expansion Joint Material (Fiber) .....	100 sq. ft.
(24)	Glass Beads.....	100 lbs.
(25)	Raised Pavement Markers.....	50 each type
(26)	Filter Material (A or B).....	100 cu. yds.
(27)	Cold Plastic Tape .....	100 L. F.
(28)	Backer Rod .....	120 L. F.
(29)	Dowel Assembly.....	10 units
(30)	Guardrail Wood Post.....	25 units
(31)	ROW Markers .....	5 each
(32)	Poured Joint Sealant.....	20 gals.

\* Does not apply to any geotextile used under rip rap. These must be tested per TMD-20-04-00-000.

**NOTE:** Cement and aggregates for concrete items shall be from approved sources. Concrete shall be produced from a concrete batch plant which has a current plant calibration. The Project Engineer shall furnish plant inspection as deemed necessary for control. The producer shall furnish with each load of concrete a delivery ticket containing the following information:

- (1) Project Number
- (2) Class Concrete
- (4) Weight of Cement
- (3) Free Water in Aggregate (gallons)
- (5) Weight of Fine Aggregate
- (6) Weight of Coarse Aggregate
- (7) Water in Mix (gallons)
- (8) Number of Revolutions Mixed
- (9) Time of Batching

An occasional test cylinder, slump test, and air content, when specified, shall be performed and no less than one (1) shall be performed for each project.

S.O.P. No.: **TMD-06-01-00-000**

Mississippi Department of Transportation - Standard Operating Procedures

Subject: **INDEPENDENT ASSURANCE SAMPLING AND TESTING**

Effective Date: **November 10, 2009**  
Issued Date: **November 10, 2009**

Supersedes S.O.P. **INITIAL DISTRIBUTION** Dated

**PURPOSE:** To establish uniform procedures for the Independent Assurance Sampling and Testing Program as required in Federal-Aid Policy Guide 23 CFR 637B.

## 1. General

The Materials Division is responsible for operation of an independent assurance sampling and testing program meeting the requirements of Federal-Aid Policy Guide, 23 CFR 637B. To accomplish this, the State Materials Engineer maintains a staff of Independent Assurance Samplers. The proper and efficient administration of this program requires cooperation between the Independent Assurance Section, the District Materials Laboratory, and the District Project Office. Independent Assurance sampling and testing will be conducted on all Federal Aid Projects on the National Highway System and any state funded project as directed by the State Materials Engineer.

## 2. Organization and Personnel

The Independent Assurance (IA) Sampling and Testing Program is the direct responsibility of the State Materials Engineer. The Central Laboratory will maintain a staff of Independent Assurance Samplers: a Chief of the Independent Assurance Sample Section, who is selected by the State Materials Engineer, and six (6) Independent Assurance Samplers. One Independent Assurance Sampler will be located in each District. These employees must have the following qualifications:

- 1) Fully trained and experienced in the proper standard methods of sampling materials.
- 2) Maintain the appropriate Concrete and Hot Mix Asphalt Technician Certifications.
- 3) Fully trained and experienced in standard field test methods.
- 4) Of unquestioned integrity and character.

Vacancies will be refilled in accordance with current state policies in cooperation with the District in which they work.

The Chief of the Independent Assurance Sample Section will supervise and coordinate the work of the Independent Assurance Samplers, will furnish necessary information and assistance, and will supplement the work of the Independent Assurance Samplers when necessary.

All testing supplies and equipment required by the Independent Assurance Sampler will be furnished by the Central Laboratory.

The District shall provide adequate office and laboratory space for the Independent Assurance Sampler, including required office furniture, filing cabinet(s), and office supplies, as necessary for the efficient accomplishment of required duties.

## 3. Sampling Procedures

**3.1 General** – Independent Assurance Sampling and Testing will be conducted on the materials and at the minimum frequency outlined in TMD-06-02-00-000 – Approximate Frequencies for Independent Assurance Sampling and Testing. The sampling and testing frequencies are considered to be the minimum. The IA Sampler may obtain additional samples as considered necessary. Additional samples may be called for by the State Materials Engineer, Chief of the Independent Assurance Section, District Personnel, or FHWA Representatives. All sampling and testing shall be conducted according to the appropriate AASHTO or Mississippi Test Method.

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The IA Sampler shall be certified and experienced in the proper methods of field sampling and testing. As part of their duties, the IA Sampler will observe methods of sampling and testing by Project Office or District Office technicians. Observed variations from standard procedures should be pointed out to the technician and if necessary to the Project Engineer, the District Materials Engineer, and/or the State Materials Engineer.

**3.2 Equipment** – The IA Sampler will be furnished the following equipment to carry out sampling and testing duties.

- 1) Materials Splitter and sample mat
- 2) Electronic Thermometer
- 3) Slump Cone and rod
- 4) Concrete air meter
- 5) Pan and bucket
- 6) Nuclear Density Gauge

**3.3 Independent Assurance Sampling Checklist** – The Chief of the Independent Assurance Section will supervise and coordinate the work of the IA Samplers, will furnish necessary information and assistance, and will supplement the work of IA Samplers when necessary.

Upon generation of a contract in SiteManager, an e-mail notification is sent by Contract Administration Division notifying District Office and Central Office personnel that a new contract is loaded into SiteManager. At this point, the District Materials Engineer is able to generate the materials for the contract. Once the materials have been generated, the IA Section Chief is responsible for running within SiteManager the Independent Assurance Sampling Checklist.

The Independent Assurance Sampling Checklist will be given to the IA Sampler as soon as possible after materials have been generated in SiteManager. The IA Sampler will use the checklist as a guide to assure that the minimum sampling and testing frequencies outlined in TMD-06-02-00-000 are met. The checklist can be run by the IA Section Chief or the IA Sampler as many times as necessary through the life of the project to check the progress of the IA sampling program.

Upon receipt of the IA Sampling Checklist, the IA Sampler will contact the District Materials Engineer and the Project Engineer. Open communication between the IA Sampler and project personnel is essential. The Project Engineer should be made aware of the types of IA samples which will be required for the project. As work on the project progresses, regular communication between the Project Engineer and the IA Sampler is required to assure necessary IA sampling and testing is conducted.

Upon approval of a Supplemental Agreement Contract Administration makes the appropriate changes to SiteManager. Changes can include quantity adjustments to existing line items or addition of line items that could require adjustment of the IA Sampling Checklist. Materials Division receives written notification when a Supplemental Agreement is approved. Upon receipt, the Chief of the Independent Assurance Section is routed a copy of the Supplement Agreement. If the Supplemental Agreement affects the IA Sampling, a new IA Sampling Checklist shall be generated and a copy distributed to the IA Sampler responsible for the project.

**3.4 Documentation of Sample, Test, and Observation Information in SiteManager** – Documentation of samples, test results, and observations by the IA Sampler will be within SiteManager. Detailed instruction on how to enter sample data, complete test templates, and run process reports is found within current SiteManager documentation.

**3.5 Split Sampling** – As many of the IA samples as possible shall be the result of splitting a job control acceptance sample with the appropriate Quality Control, Quality Assurance, or Construction, Engineering, and Inspection (CE&I) Technician. Such sampling and splitting shall be performed by

the technician on the project under the observation of the IA Sampler. Personnel from the project shall retain half of the sample which may be used for job acceptance. The IA Sampler shall retain the other half of the sample to be tested in the Central Lab. In the case of Hot Mix Asphalt, the sample shall be split in accordance with these provisions and the *MDOT Field Manual for Hot Mix Asphalt*.

The IA Sampler will generate the SiteManager ID Number for both the project Job Control Sample and the IA Sample and give the number to the project personnel at the time the sample is taken. Identification of both parts of the split sample is essential to the comparison process. Care should be taken by both the IA Sampler and the project personnel to assure that the correct sample ID is included in SiteManger.

On projects in which the Construction, Engineering, and Inspection (CE&I) is contracted to an outside firm, IA samples shall be split with the CE&I Firm. Such sampling and splitting shall be performed by the technician on the project under the observation of the IA Sampler. The IA Sampler will give the CE&I technician the appropriate sample ID number to identify the sample as one for future comparison. If the project is being managed by the CE&I firm within SiteManager, then they will be responsible for entering the appropriate sample record within SiteManager utilizing the sample ID generated by the IA Sampler. In the event the CE&I firm does not have access to SiteManager, the CE&I firm shall submit the completed job control test data to the District Materials Engineer as soon as possible after completion of the test. Upon receipt of the test data, the District Materials Engineer will complete the comparison between the job control sample and the IA sample.

### **3.6 IA Sampling of Materials Tested in Accordance with QC/QA Specifications –**

**3.6.1** Concrete Specified by Section 804 of the Standard Specifications is sampled, tested, and ultimately accepted by a process of Quality Control (QC) Testing conducted by the Contractor and Quality Assurance (QA) Testing conducted by MDOT. The independent QA sampling and testing serves as verification of the Contractor's test results. Sampling by the Independent Assurance Section of Materials Division provides a check on equipment and testing procedures used in the acceptance of materials.

Involvement by the IA Sampler on jobs containing concrete tested in accordance with QC/QA Specifications falls into the following categories:

1. split sampling of concrete with QC and QA
2. laboratory equipment calibration checks of the QC Laboratory
3. observation of QC tests

At the required frequency, the IA Sampler shall obtain plastic concrete samples from the job site in accordance with the *MDOT Concrete Field Manual* utilizing the appropriate AASHTO Sampling Methods. The sample may be split with the QC Technician or with the District (QA). At a minimum, IA samples shall be obtained at the frequencies outlined in TMD-SOP-06-02-00-000. In addition, at least one sample shall be split with both QC and QA for each concrete mixture type on the project.

**When the purpose of the concrete split sample is to compare to the QC**, the IA Sampler shall either obtain and split or observe the QC Technician obtain and split a sample in accordance with the *MDOT Concrete Field Manual*. The QC portion of the split sample may be used for job control acceptance and values from the testing of the sample used for acceptance and pay. The IA Sampler shall instruct the QC Technician to fax or e-mail the split sample test results to the Central Laboratory to the attention of the IA Section Chief upon completion of testing. After the initial curing period, the IA Sampler shall transport the IA portion of the split sample to the Central Laboratory for strength testing.

Comparison of test results by the Central Laboratory to the QC are to be completed by the IA Section Chief in accordance with the allowable variations established in Section 6. Unfavorable comparisons shall be evaluated by the IA Section Chief, District Materials

Engineer, and the Concrete Field Engineer. Results of the evaluation along with any corrective actions taken as a result of the evaluation shall be documented on the appropriate Form TMD-890.

**When the purpose of the concrete split sample is to compare to the QA**, the IA Sampler shall either obtain and split or observe the QA Technician obtain and split a sample in accordance with the *MDOT Concrete Field Manual*. After the initial curing period, the QA portion of the split sample shall be transported to the District Laboratory for testing. Samples split with QA may not be used to verify the Contractor's test results. Separate, independent samples must be used for that purpose. The IA Sampler shall give the QA Technician the SiteManager Sample ID to use for the sample record. Upon completion of the strength testing, the District Lab will enter the test data into the sample record. The IA Sampler shall transport the IA portion of the split sample to the Central Laboratory for testing.

Upon completion of testing by the District and Central Lab, the District Materials Engineer or their representative shall complete the comparison of the test results in accordance with the allowable variations established in Section 6. Unfavorable comparisons shall be evaluated by the District Materials Engineer, the IA Section Chief, and the Concrete Field Engineer. Results of the evaluation shall be documented on the appropriate Form TMD-890.

- 3.6.2** Hot Mix Asphalt (HMA) Specified in Sections 401 and 403 of the Standard Specifications is sampled, tested, and ultimately accepted by a process of Quality Control (QC) Testing conducted by the Contractor and Quality Assurance (QA) Testing conducted by MDOT. The independent QA sampling and testing serves as verification of the Contractor's test results. Sampling by the Independent Assurance Section of Materials Division provides a check on equipment and testing procedures used in the acceptance of materials.

Involvement by the IA Sampler on jobs containing Hot Mix Asphalt falls into three categories:

1. split sampling of the plant produced HMA with QC and QA
2. laboratory equipment calibration checks of the QC Laboratory
3. observation of QC tests

At the required frequency, the IA Sampler shall obtain HMA samples from the plant in accordance with the *MDOT Field Manual for Hot Mix Asphalt*. The sample may be split with the QC Technician or split and transported to the District Lab for the purpose of comparison with the District (QA). At a minimum, at least one sample shall be split with both QC and QA for each mixture type on the project.

**When the purpose of the HMA split sample is to compare to the QC**, the IA Sampler shall either obtain and split or observe the QC Technician obtain and split a sample in accordance with the *MDOT Field Manual for Hot Mix Asphalt*. The QC portion of the split may be used for job control acceptance and values from the testing of the sample used for acceptance and pay. The split sample shall be taken at the next QC sample tonnage as determined by the random number chart. For this reason coordination between the QC technician and the IA Sampler is essential. The IA Sampler shall instruct the QC Technician to fax or e-mail the split sample test results to the Central Laboratory to the attention of the IA Section Chief upon completion of testing. The IA Sampler shall transport the IA portion of the split sample to the Central Laboratory for testing.

**When the purpose of the HMA split sample is to compare to the QA**, the IA Sampler shall either obtain and split or observe the QA Technician obtain and split a sample in accordance with the *MDOT Field Manual for Hot Mix Asphalt*. Both halves of the split sample shall be retained by the IA Sampler. The QA portion of the split sample shall be transported to the

District Laboratory for testing. Samples split with QA may not be used to verify the Contractor's test results. Separate, independent samples must be used for that purpose. The IA Sampler shall instruct the QA Technician to fax or e-mail the split sample test results to the Central Laboratory to the attention of the IA Section Chief upon completion of the testing. The IA Sampler shall transport the IA portion of the split sample to the Central Laboratory for testing.

Comparison of test results by the Central Laboratory to QC or QA Laboratory results are to be completed by the IA Section Chief in accordance with the allowable variations established in Section 6. Unfavorable comparisons shall be evaluated by the IA Section Chief, District Materials Engineer, and the Hot Mix Asphalt Engineer. Results of the evaluation along with any corrective actions taken as a result of the evaluation shall be documented on the appropriate Form TMD-890.

In addition to obtaining split samples of the HMA, the IA Sampler is also responsible for observing normal job control sampling and testing procedures in the laboratory and on the roadway. Observations of job control testing are documented in SiteManager.

#### **4. Testing Procedures**

Field testing shall be conducted according to the specified AASHTO or Mississippi Test Method and at or above the frequency outlined in TMD-06-02-00-000 – Approximate Frequencies for Independent Assurance Sampling and Testing. It is the responsibility of the IA Sampler to be well versed in each test procedure. The IA sampler will maintain MDOT field testing certifications in the areas of concrete and hot-mix asphalt. The required certifications are MDOT Class I Concrete Technician and Certified Asphalt Technician-I (CAT-I).

#### **5. Quality Control Laboratory Checks**

The IA Sampler will check the condition and/or calibration of testing equipment used in the field or in quality control laboratories involved in acceptance of materials.

**5.1 Field Testing Equipment** – Periodically through the duration of a project the IA Sampler shall check the following field testing equipment used in the acceptance of materials for any given project: concrete air meters, slump cones, nuclear density devices, and other equipment to assure that it is in proper working condition. Any equipment found to be in disrepair shall be reported to the Project Engineer or District Materials Engineer.

**5.2 Concrete Quality Control Laboratories** – Concrete QC Laboratories shall be checked by the IA Sampler at least once during production of concrete for a given project. The IA Sampler shall check the condition and calibration of the concrete breaking machine. If the breaking machine is found to be in disrepair or does not have a current calibration certificate, the IA Sampler should immediately notify the strength testing technician. The IA Sampler should conduct a follow-up inspection approximately one week after the initial inspection to insure that the noted deficiencies have been corrected. If after the second inspection, all deficiencies have not been addressed, the IA Sampler shall document in writing the deficiency and provide documentation to the IA Section Chief, District Materials Engineer, and the State Materials Engineer.

**5.3 Hot Mix Asphalt Quality Control Laboratories** – Hot Mix Asphalt QC Laboratories shall be checked by the IA Sampler at least once during the production of HMA for a given project. The IA Sampler shall check the condition and calibration of equipment as outlined in the Hot Mix Asphalt Field Manual and document the results within SiteManager. If equipment is found to be in disrepair or does not have a current calibration certificate, the IA Sampler should immediately notify the QC Manager and the District QA Technician. The IA Sampler should conduct a follow-up inspection approximately one week after the initial inspection to insure that the noted deficiencies have been corrected. If after the second inspection, all deficiencies have not been addressed, the IA Sampler shall document in writing the deficiency and provide documentation to the IA Section Chief, District Materials Engineer, and the

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State Materials Engineer.

**5.4 Accuracy Check of Balances by IA Samplers** – Each Independent Assurance Sampler will be furnished the necessary test weights with which to spot check balances used in Quality Control Laboratories. The IA Sampler shall check balances in QC Laboratories in connection with tests and observations reported within SiteManager. Results of the IA balance checks will be reported in SiteManager by the IA Sampler.

**6. Comparison of Job Control and Independent Assurance Sample Test Results**

**6.1 General** – With the exception of HMA, comparison of job control acceptance test results with independent assurance sample test results is the direct responsibility of the District Materials Engineer. The District Materials Engineer shall furnish completed copies of Form TMD-890 for each comparison of job control acceptance test results with independent assurance test results to the State Materials Engineer immediately upon completion of all testing included on the appropriate TMD-890. Form TMD-890 shall show the results of the comparison, the cause of any unfavorable comparison, and, when unfavorable, the corrective action taken. Upon completion of the project, the District Materials Engineer shall submit Form TMD-891 to the State Materials Engineer listing and certifying that a comparison of independent assurance sample test results with job control acceptance sample results was performed.

Comparisons made on HMA are the direct responsibility of the IA Section Chief. The IA Section Chief shall furnish completed copies of Form TMD-890 for each comparison made on HMA to the State Materials Engineer with a copy to the District Materials Engineer immediately upon completion of all tests. Results of HMA comparisons will be included on Form TMD-891 submitted by the District Materials Engineer upon completion of the project.

Forms TMD-890 and TMD-891 are generated by running the appropriate process within SiteManager. The comparison of materials within SiteManager is made utilizing the maximum variation for favorable comparison values that follow. The values are valid only on single test results performed by two technicians on a split sample.

**6.2 Allowable Variations for Comparison of Split Samples**

<u>Material and Characteristic</u>	<u>Maximum Variation for Favorable Comparison</u>
<b>I. <u>Soils and Granular Materials</u></b>	
A. Gradation plus No. 10 Material	
1. Passing No. 10 and larger sieves	5%
B. Material finer than No. 10 sieve (100% basis)	
1. Percent Passing No. 40	4%
2. Percent Passing No. 60	4%
3. Percent Passing No. 200	5%
C. Liquid Limit	8%
D. Plastic Limit	5%
E. Optimum Moisture	3%
F. Standard Density (pounds per cubic foot)	5
<b>II. <u>Gradation of Fine Aggregate</u></b>	

A.	Percent Passing 3/8-inch	2%
B.	Percent Passing No. 4	3%
C.	Percent Passing No. 8	3%
D.	Percent Passing No. 16	3%
E.	Percent Passing No. 30	6%
F.	Percent Passing No. 50	5%
G.	Percent Passing No. 100	2%

**III. Gradation of Coarse Aggregate**

A.	Percent Passing 1 1/2-inch	4%
B.	Percent Passing 1-inch	6%
C.	Percent Passing 3/4-inch	7%
D.	Percent Passing 1/2-inch	6%
E.	Percent Passing 3/8-inch	5%
F.	Percent Passing No. 4	2%
G.	Percent Passing No. 8	2%

**IV. Crushed Stone Bases**

A.	Size 610:	
	Percent Passing 1-inch	6%
	Percent Passing 3/4-inch	7%
	Percent Passing 1/2-inch	6%
	Percent Passing 3/8-inch	5%
	Percent Passing No. 4	3%
	Percent Passing No. 40	4%
	Percent Passing No. 200	5%

B. Size 825

Passing 1 1/2-inch	4%	Percent
Percent Passing 1-inch	6%	
Percent Passing 1/2-inch	5%	
Percent Passing No. 4	3%	
Percent Passing No. 8	3%	
Percent Passing No. 16	6%	
Percent Passing No. 50	4%	
Percent Passing No. 200	5%	

C. Size 3/4-inch and Down

Percent Passing 3/8-inch	5%
Percent Passing No. 4	3%
Percent Passing No. 10	4%
Percent Passing No. 40	4%
Percent Passing No. 200	5%

**V. Hot Mix Asphalt Paving Mixtures**

A.	Asphalt Cement Content	0.4%
B.	Maximum Specific Gravity	0.020
C.	Bulk Specific Gravity	0.030
D.	Gradation of Extracted Mineral Aggregates	

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Percent Passing 3/8 inch and larger	6.0%
Percent Passing No. 4	5.0%
Percent Passing No. 8	5.0%
Percent Passing No. 16 (For 4.75 mm mixtures only)	4.0%
Percent Passing No. 30	4.0%
Percent Passing No. 200	3.0%

**VI. Asphalt Drainage Course**

A. Asphalt Cement Content	0.4%
B. Gradation of Extracted Mineral Aggregate	
Percent Passing 1/2-inch and larger	6.0%
Percent Passing No. 4	5.0%
Percent Passing No. 8	5.0%
Percent Passing No. 200	3.0%

**VII. Concrete** – Allowable variations for concrete specified in Sections 601 or 804 of the Standard Specifications.

A. Concrete cylinder breaks	990 psi
B. Slump	1 inch
C. Air content	1%

S.O.P. No.: **TMD-06-02-00-000** Mississippi Department of Transportation - Standard Operating Procedures

Subject: **APPROXIMATE FREQUENCIES FOR INDEPENDENT ASSURANCE SAMPLING AND TESTING**

Effective Date: **November 24, 2009**  
Issued Date: **November 24, 2009**

<b>Supersedes S.O.P.</b>	<b>Dated</b>
<b>INITIAL DISTRIBUTION</b>	

**PURPOSE:** To establish a schedule for determining the approximate number of Independent Assurance Samples to be obtained on Federally funded projects on the National Highway System in compliance with Federal-Aid Policy Guide, 23 CFR 637B.

**1. General**

The guidance provided herein is for determining the minimum sampling and testing required on projects to be sampled and tested by the Independent Assurance Section of Materials Division. At the State Materials Engineer's discretion, the schedule of frequencies for sampling and testing may be adjusted or adapted to specific project needs. It is the responsibility of the State Materials Engineer and the Independent Assurance Section Chief to assure compliance with these guidelines.

**2. Sampling and Testing**

**2.1 Independent Assurance Sampling Checklist** – Shortly after a contract is generated within SiteManager, the IA Section Chief will generate an IA Sampling Checklist in accordance with TMD-06-01-00-000. This checklist shall be used by the IA Sampler to estimate the minimum number and type of samples required for the project. Under certain circumstances, the State Materials Engineer may modify the IA Sampling Checklist to assure proper coverage of the overall Independent Assurance Program. Supplemental Agreements may require that an updated IA Sampling Checklist be generated by the IA Section Chief.

The IA Sampler shall make every effort to obtain the required samples and perform the required tests according to the IA Sampling Checklist. To accomplish the goals of the Independent Assurance Program, communication between the IA Section Chief, IA Sampler, and MDOT District Personnel is critical.

**2.2 Split Samples** – Split Samples shall be obtained and documented in accordance with TMD-06-01-00-000. Samples of material shall be split with the appropriate Quality Control (QC), Quality Assurance (QA), or Construction Engineering and Inspection (CE&I) Technician. When practical, the IA Sampler and the technician conducting job control sampling and testing may jointly obtain samples of material for testing. The material should be split in accordance with applicable AASHTO and Mississippi Test Methods. Once split, the sample shall be documented in SiteManager.

With the exception of samples split with QA Technicians, test results from split samples may be used for job acceptance. Samples split with QA may not be used to verify the Contractor's test results. Separate, independent samples must be used for that purpose. All other split samples may be used by project personnel for the purpose of acceptance and pay.

**2.3 Field Testing** – The IA Sampler is responsible for field testing materials as required in Section 3.2. Field Tests conducted by the IA Sampler should be performed as close as possible to tests conducted for job control acceptance. At his discretion, the IA Sampler may observe the District of Project Office technician conducting job control field testing. Each observation of field testing shall be documented within SiteManager. The IA Sampler is required to personally conduct at least one test of each type or a minimum of 10% of the required number on the IA Sample Checklist.

**3. Schedule of Independent Assurance Section Sampling Frequencies**

**3.1 General** – Independent Assurance Samples and Field Testing of materials shall be sampled and tested according to the following minimum frequencies. The required frequencies are considered to be the minimum coverage needed to meet the goals of the Independent Assurance Program. Samples of material shall be split with the appropriate Quality Control, Quality Assurance, or CE&I Technician in accordance with TMD-06-01-00-000.

Special conditions that require modification of the required minimum frequencies are as follows:

- 1) No IA density samples are required for layers scheduled for chemical treatment prior to the chemical treatment.
- 2) No IA samples are required for granular material used for shoulder leveling on overlay projects.
- 3) No IA samples are required for Pay Items covered under TMD-20-05-00-000, *Sampling and Testing of Small Quantities of Miscellaneous Materials*.

**3.2 Independent Assurance Sampling Frequency Table**

<u>MATERIAL OR OPERATION</u>	<u>TESTS REQUIRED</u>	<u>FREQUENCY</u>	<u>WHEN OR WHERE</u>
Embankments & Design Soil	Gradation	3 per class borrow	In Place
	Density Note (1)	1 per 100,000 cy, min. 2 per project	In Place
	Proctor	1 per class of borrow	In Place
	LL, PI	3 per class borrow	In Place
<hr/>			
Subgrades: Chemically-Treated Soils	Density Note (1)	1 per 50,000 sy, min. 2 per project	In place
<hr/>			
Base: Untreated Granular Materials	Density, Gradation, PI Note (1)	1 each 10,000 cy or 14,000 tons, min. 2 per project	In place
	Mechanically-Stabilized Base		
	Density Note (1)	1 per 50,000 sy, min. 2 per project	In place, After mixing
	Composite Gradation, PI	1 each 10,000 cy or 14,000 tons, min. 2 per project	In place, After mixing
Chemically Treated Bases	Density Note (1)	1 per 50,000 sy, min. 2 per project	In place After mixing

Concrete, Structural: Aggregates	Gradation and Cleanliness	1 each aggregate per 1000 cu. yds concrete or min. 1 per project	At Concrete Plant
Field Tests	Comp. Strength Slump, % Air (if used)	1 cylinder each 1000 cy concrete, min. 1 split with QC and 1 split with QA per project, per Class (Note 2)	Before placing
Reinforcing Steel:	Physical Tests (structures)	1 each 50 tons, min. 1 per bar size	Project Site
Concrete, Paving: Aggregates	Gradation and Cleanliness	1 per 70,000 sy	At Concrete Plant
Field Tests	Compressive Strength, Slump % Air (if used)	1 per 70,000 sy Note (2)	Before placing
<hr/>			
Surface Treatments: Aggregates	Quality Tests	1 each 3,000 cy or 4,200 tons; min. 1 each per project	Stockpile at Project Site
<hr/>			
Hot Mix Asphalt: Mixture	AC, VMA, Total Voids Extraction, Gradation	1 each 10,000 tons for each mix type. Minimum of 1 split with QC and 1 split with QA per project per mix type (minimum of 1 sample per mix type regardless of tonnage).	Asphalt Plant
	Note (1)		
Roadway	Density Note (1)	1 each 10,000 tons for each mix type (excluding irregular areas and volumes under 2,000 tons)	In place
<hr/>			

Asphalt Drainage Course: Aggregate	Gradation	1 per 45,000 sy	Asphalt Plant (Belt Sample)
Mixture	AC Content	1 per 45,000 sy	Asphalt Plant (Truck Sample)

Prestressed Concrete (Excluding Piles) (Note 3):

Aggregates	Gradation and Cleanliness	1 every 3 months	At Concrete Batch Plant
Field Tests	Compressive Strength and Slump Note (2)	1 every 3 months	At Prestress Plant
Reinforcement	Prestress Strand Spiral Wire Reinforcing Steel	1 every 3 months	At Prestress Plant

**SPECIFIC NOTES REFERENCED IN SCHEDULE FOR  
INDEPENDENT ASSURANCE SAMPLING AND TESTING**

- (1) Observation of HMA testing conducted by QC, QA, or CE&I Technicians for density, AC Content, total voids, and VMA tests shall be completed by the IA Sampler. Tests observed by the IA Sampler shall be documented within SiteManager. Observation of acceptance testing shall be done in addition to split sampling of HMA mixture.
- (2) IA concrete cylinders samples may be split with QC, QA, or CE&I Technicians. If concrete cylinders made for IA Comparison are not made by the IA Sampler, sampling procedures shall be observed by the IA Sampler; likewise, the slump and air content tests may be performed by project personnel, but observed by the IA Sampler. Observation of tests conducted by QC, QA, or CE&I technicians conducting acceptance testing shall be included within the IA Sampler's documentation. All split samples and observations of test procedures shall be documented within SiteManager. Observation of acceptance testing shall be done in addition to split sampling and testing of concrete cylinders.
- (3) IA samples taken at prestressed concrete plants shall show the project number for which the units are being cast. When practical, the Independent Assurance Sampler and Prestress Inspector will jointly obtain a sample of material; the sample will be "split" with one (1) part tested as an independent assurance sample, the other as a quality assurance sample. Samples shall be obtained only when production is for Department projects.