Harry Lee James
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Inter-Departmental Memorandum

Date: April 2, 2008

To: Design Teams

From: Keith Purvis CKP
Roadway Design Division Engineer

Subject: Vertical Curve K-values

Stopping Sight Distances (SSD) and k-values for Vertical Curves were revised in the latest version of the AASHTO Green Book. The Roadway Design Manual will be changed to reflect these changes. In the interim period before the manual is revised, the k-values listed on the attached sheet should be used for all projects to be let beginning with the July 2008 letting.

The procedure used to determine 3R k-values has also been revised. They are now determined using updated stopping sight distances, a 3.5 ft. eye height and a 3.0 ft. object height.

A copy of the FHWA approval letter is also attached.

pc: Roadway Design Section Engineers
Roadway Design Division (S. Reeves)
Roadway Design Division (K. Boteler)
District Engineers
Assistant Chief Engineer, Pre-Construction
Assistant Chief Engineer, Operations
Maintenance Division Engineer
Traffic Division Engineer
State Aid Engineer
Active Consultants
file

Vertical Curve k-values

4/2/2008

V (mph)	SSD (feet)	3R crest k-value	3R sag k-value	New Construction crest k-value	New Construction sag k-values
30	200	16	20	30	37
35	250	24	27	40	49
40	305	36	35	60	64
45	360	50	44	80	79
50	425	70	54	110	96
55	495	95	65	150	115
60	570	125	78	190	136
65	645	160	91	230	157
70	730	206	106	290	181

U.S. Department
of Transportation

**Federal Highway
Administration**

MISSISSIPPI DIVISION

**666 North Street, Suite 105
Jackson, Mississippi 39202-3199**

In Reply Refer To: POST-MS

March 27, 2008

Mr. Larry L. Brown, Executive Director
Mississippi Department of Transportation
Jackson, Mississippi

Dear Mr. Brown:

Subject: 3R k-Values for Crest Vertical Curves
Approved Changes to Current MDOT Design Policy

We have received and reviewed the Department's March 20, 2008 request recommending new 3R k-values for crest vertical curves. As pointed out within the request, the 2004 AASHTO Policy on the Geometric Design of Highways and Streets which changed object height and stopping sight distances has resulted in decreases in k values for new construction and thus now warrants reconsideration for k values for 3R projects. Based on the reasons outlined within the March 20, 2008 request, we agree with the recommended k values based on Option C (3-foot object height).

The Option C crest k values are hereby approved for use on Federal aid 3R projects. The proposed application of these new values for all 3R projects beginning with the July 2008 letting is also approved.

Sincerely yours,

Jeffrey A. Schmidt

Andrew H. Hughes
Division Administrator

cc: Mr. David Foster, 81-01
Mr. Keith Purvis, 83-01
Mr. John Reese, 83-01

MOVING THE
AMERICAN
ECONOMY

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March 20, 2008

Mr. Andrew Hughes
Division Administrator
Federal Highway Administration
666 North Street, Suite 105
Jackson, MS 39202-3199

Re: 3R k-values for crest vertical curves

Dear Mr. Hughes:

MDOT is preparing to update its 2001 Roadway Design Manual that will incorporate design changes to reflect those made in the 2001 and 2004 versions of the AASHTO Policy on the Geometric Design of Highways and Streets (2004 Green Book). One of the changes to be incorporated involves the k-values of crest vertical curves for new construction.

The 1990 version of the AASHTO Policy on the Geometric Design of Highways and Streets (1990 Green Book), on which MDOT's 2001 Roadway Design Manual is based, used a 6-inch object height to determine k-values of crest vertical curves for new construction. The 2004 Green Book now bases the crest k-values for new construction on a 2-foot object height. In addition to increasing the object height, stopping sight distances (SSD) were also increased in the 2004 Green Book. The larger object height and increased stopping sight distances have resulted in decreased k-values for crest vertical curves.

Current MDOT 3R k-values for crest vertical curves are based on the 1990 Green Book SSD values and an 18-inch object height. Since the 2004 Green Book now bases new construction k-values on a 2-foot object height, a new policy is needed to determine 3R k-values for crest vertical curves. As part of its research, MDOT conducted an informal survey of several surrounding states and found that a number of them evaluate vertical curves based on k-values corresponding to design speeds which are 10 or 20 mph below the new construction 2-foot object height criteria. A variation of this information was incorporated into the following options that were considered by MDOT to derive updated 3R crest k-values:

Option A: Increase the object height to 2.0 ft. (same as new construction)
Option B: Increase the object height to 2.5 ft.
Option C: Increase the object height to 3.0 ft.
Option D: Use new construction values 5 mph less than the design speed.
Option E: Use new construction values 10 mph less than the design speed.

The following chart compares MDOT's "Current" crest k-values with the "Considered" k-values resulting from the aforementioned options.

	"Current"		"Considered"					
	crest k-values		New Const	3R crest k-values (% of new construction value)				
V	New	3R	crest					
mph	Const		k-values	Option A	Option B	Option C	Option D	Option E
30	30	18 (60%)	19	19 (100%)	17 (89%)	16 (84%)	12 (63%)	7 (37%)
35	40	26 (65%)	29	29 (100%)	27 (93%)	24 (83%)	19 (66%)	12 (41%)
40	60	40 (67%)	44	44 (100%)	40 (91%)	36 (82%)	29 (66%)	19 (43%)
45	80	55 (69%)	61	61 (100%)	55 (90%)	50 (82%)	44 (72%)	29 (48%)
50	110	76 (69%)	84	84 (100%)	76 (90%)	70 (83%)	61 (73%)	44 (52%)
55	150	99 (66%)	114	114 (100%)	103 (90%)	95 (83%)	84 (74%)	61 (53%)
60	190	133 (70%)	151	151 (100%)	137 (90%)	125 (83%)	114 (76%)	84 (56%)
65	230	158 (69%)	193	193 (100%)	175 (91%)	160 (83%)	151 (78%)	114 (59%)
70	290	198 (68%)	247	247 (100%)	224 (91%)	206 (83%)	193 (78%)	151 (61%)

For the following reasons, MDOT recommends Option C (3-foot object height) to determine new 3R k-values:

- The proposed procedure is similar to the current procedure, in that it uses an object height 1 foot greater than the object height for new construction.

- The proposed k-values are very close to the current 3R k-values. For speeds 65 mph and greater, the proposed k-values are greater than the current 3R k-values.

- Option C uses a 3-foot object height. All vehicles are greater than 3 feet in height. The tail lights of many vehicles (large sedans, pickups, SUV's, and vans) are at least 3 feet above the pavement. The center brake light on the vast majority of vehicles is at least 3 feet above the pavement.

- The proposed 3R k-values are approximately 83% of the new construction k-values. The current procedure uses k-values approximately 70% of the new construction k-values.

- Option C results in more conservative K-values than those used by a number of surrounding states.

K-values derived using a 3-foot object height are more conservative than those derived from a lesser design speed. Many of the K-values used by other states will be based on design speeds which are less than the posted speed. MDOT is of the opinion that the use of a 3-foot object height exercises better engineering judgment than the use of an arbitrary design speed. A copy of the results of the survey of other states' 3R procedures is attached.

In the interim before the Design Manual is updated, MDOT is using the more conservative of the values for crest and sag vertical curves. After the Design Manual is updated, MDOT intends on using the values in the 2004 Green Book.

3R k-values for sag vertical curves are based on driver comfort, therefore these values are unaffected by the change in object height and SSD values.

Your concurrence with this policy change for 3R crest k-values is requested.

Pending FHWA concurrence, this new policy will be applied to all projects let to contract beginning in July, 2008.

Sincerely,

Harry Lee James

Harry Lee James, PE, PLS
Deputy Executive Director/Chief Engineer

pc: file

Attachment

3R Criteria for Crest Verticals – Other States' Policies

Alabama – Evaluate curves if they are 20 mph less than posted speed. Re-grade to new construction criteria if possible. Sometimes corrections are limited to what is practical.

Georgia – If a curve is 10 mph below the posted speed, and it has a low crash history, retain the curve. If a curve is 10 mph below the posted speed, and there is a directly related crash history, then re-grade to new criteria, or the highest design speed practicable (w/ a design exception). If a curve is greater than 10 mph below the posted speed, re-grade to new construction criteria, or to the highest design speed practicable (w/ a design exception).

Tennessee – At one time they had separate 3R k-values, but they are not used anymore. They aren't sure what they were based on. Currently, TDOT does not make changes in vertical alignment on 3R projects (as per their agreement with their FWHA Division office). They look at more cost effective safety improvements such as widening shoulders, guardrail, rumble strips, etc.

Louisiana – LDOTD does not have a 3R program.

South Carolina – SCDOT does not have 3R k-values. In the absence of an adverse crash history, it is unlikely to be cost effective to improve vertical geometry on 3R projects. If a vertical curve is improved on a 3R project, it is re-graded to the posted speed. If it is not possible to re-grade to the posted speed, use the highest speed possible, and add appropriate signage.

Kentucky and Arkansas – did not respond.

The following was found on the Texas and North Carolina web sites:

Texas – Typically, 3R projects will involve minor or no changes to either the vertical or horizontal alignment. However, flattening of curves or other improvements may be considered where suggested by crash history. Substantial changes in alignment are considered reconstruction and plans should be developed to new/reconstruction standards. Reconstruction of vertical curves should be considered if the following minimum design speeds are not met:

Rural multilane	50 mph
High volume rural 2 lane	40 mph
High volume rural frontage roads	40 mph
Low volume rural 2 lane	30 mph
Low volume rural frontage roads	30 mph
Urban streets	30 mph
Urban frontage roads	30 mph

North Carolina – On 2-lane roads, if ADT is less than 1500 and curve is within 20 mph of posted, retain the curve. If curve is within 10 mph, and has a low crash rate, retain the curve. Curves on 4 lane roads may be retained if they meet posted speed.