AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
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ERRATA

March 2016

Dear Customer:

Recently, we were made aware of some technical revisions that need to be applied to the *Highway Safety Manual Supplement*.

Changes are reflected by color-coded highlights on individual pages throughout errata file. 2016 changes are highlighted in **green.**

Please scroll down to see the full erratum.

In the event that you need to download this erratum file again, please download from: http://downloads.transportation.org/HSM-1S-Errata.pdf.

In order to see color-coding on a hard copy printout, please select "Document and Markups" in the Print dialog box when selecting your print options so that highlighting will be displayed properly.

Then, please replace the existing pages with the corrected pages to ensure that your edition is both accurate and current.

AASHTO staff sincerely apologizes for any inconvenience.

Errata to the *Highway Safety Manual*, 1st Edition and *Supplement*

• 2016 errata changes in **green (bold)**

Page	Existing Text	Corrected Text

Supplement

Page	Existing Text	Corrected Text
18-42	**In Eq. 18-35:** $CMF_{8,\ fs,ac,sv,z} = \left(1.0 - \sum_{i=1}^{m} P_{c,i} \times f_{c,i}\right) \times \exp\left(a \times [W_s - 10]\right) + \left(\sum_{i=1}^{m} P_{c,i} \times f_{c,i}\right) \times \exp\left(b \times [W_s - 10]\right)$	**Make the following change to the equation:** $CMF_{8,\ fs,ac,sv,z} = \left(1.0 - \sum_{i=1}^{m} P_{c,i}\right) \times \exp\left(a \times [W_s - 10]\right) + \left(\sum_{i=1}^{m} P_{c,i}\right) \times \exp\left(b \times [W_s - 10]\right)$
18-43	**In Eq. 18-36:** $CMF_{9,\ fs,ac,sv,\ fi} = \left(1.0 - \sum_{i=1}^{m} P_{c,i} \times f_{c,i}\right) \times f_{\tan} + \left(\sum_{i=1}^{m} P_{c,i} \times f_{c,i}\right) \times 1.0$	**Make the following change to the equation:** $CMF_{9,\ fs,ac,sv,\ fi} = \left(1.0 - \sum_{i=1}^{m} P_{c,i}\right) \times f_{\tan} + \left(\sum_{i=1}^{m} P_{c,i}\right) \times 1.0$
18-52	**In the first paragraph, last sentence; and the third paragraph, last sentence: "…is less than 0.75 ft, then it should…"**	**Make the following text change: "…is less than 0.75 ft, then W_{icb} should…"**
19-67	**Following Table 19-42**	**Please add the following text: "The curve entry speeds need to be calculated for all curves from milepost 0.0 to the end of the analysis segment. This may include segments of an adjacent ramp that are not included in the current analysis segment. For each curve, record the entry speed, the total length of the curve, and the length of the current analysis segment. Once the procedure on the following pages is completed, return to Equation 19-33. In this equation, the summation term only includes entry speeds and radii that have a length in the current analysis segment. All other curves analyzed should be ignored if they are not part of the current analysis segment."**

Table 18-20. Coefficients for Lane Change CMF–Freeway Segments

Cross Section (x)	Crash Type (y)	Crash Severity (z)	CMF Variable	CMF Coefficients a	b	c	d
Any cross section (ac)	Multiple vehicle (mv)	Fatal and injury (fi)	$CMF_{7, fs, ac, mv, fi}$	0.175	12.56	0.001	–0.272
		Property damage only (pdo)	$CMF_{7, fs, ac, mv, pdo}$	0.123	13.46	0.001	–0.283

If the segment is in a Type B weaving section, then the length of the weaving section is an input to the CMF. The variables for weaving section length (i.e., $L_{wev, inc,}$ $L_{wev, dec}$) in Equation 18-31 and Equation 18-32 are intended to reflect the degree to which the weaving activity is concentrated along the freeway. The sign of the coefficient in these two equations indicates that the lane change CMF value will increase if the segment is in a Type B weaving section. The amount of this increase is inversely related to the length of the weaving section. Guidance for determining if a weaving section is Type B is provided in Section 18.4.

The variables $P_{wevB, inc}$ and $P_{wevB, dec}$ in Equation 18-31 and Equation 18-32, respectively, are computed as the ratio of the length of the weaving section in the segment to the length of the freeway segment L_{fs}. If the segment is wholly located in the weaving section, then this variable is equal to 1.0.

The X and $AADT$ variables describe the distance to (and volume of) the four nearest ramps to the subject segment. Two of the ramps of interest are on the side of the freeway with travel in the increasing milepost direction. One ramp on this side of the freeway is upstream of the segment, and one ramp is downstream of the segment. Similarly, one ramp on the other side of the freeway is upstream of the segment and one ramp is downstream. Only those entrance ramps that contribute volume to the subject segment are of interest. Hence, a downstream entrance ramp is not of interest. For similar reasons, an upstream exit ramp is not of interest.

The lane change CMF is applicable to any segment in the vicinity of one or more ramps. It is equally applicable to segments in a weaving section (regardless of the weaving section type) and segments in a non-weaving section (i.e., segments between an entrance ramp and an exit ramp where both ramps have a speed-change lane). If the weaving section is Type B, then an additional adjustment is made using Equation 18-31 and Equation 18-32. The CMF is applicable to weaving section lengths between 0.10 and 0.85 mi. It is applicable to any value for the distance variable X and to the range of ramp AADTs in Table 19-4.

The two SPFs for predicting speed-change-related crash frequency (i.e., Equation 18-20 and Equation 18-22) are not used when evaluating a weaving section because the ramps that form the weaving section do not have a speed-change lane. As a result, the predicted crash frequency for the set of segments that comprise a weaving section will tend to be smaller than that predicted for a similar set of segments located in a non-weaving section but having entrance and exit ramps. This generalization will always be true for weaving sections that are not Type B. It may or may not hold for the Type B weaving section, depending on the length of the weaving section.

$CMF_{8, fs, ac, sv, z}$—Outside Shoulder Width

Two CMFs are used to describe the relationship between average outside shoulder width and predicted crash frequency. The SPFs to which they apply are identified in the following list:

- SPF for fatal-and-injury single-vehicle crashes, specified number of lanes (*fs*, *n*, *sv*, *fi*); and
- SPF for property-damage-only single-vehicle crashes, specified number of lanes (*fs*, *n*, *sv*, *pdo*).

The base condition is a 10-ft outside shoulder width. The CMFs are described using the following equation:

$$CMF_{8,\, fs,\, ac, sv, z} = \left(1.0 - \sum_{i=1}^{m} P_{c,\, i}\right) \times \exp\left(a \times [W_s - 10]\right) + \left(\sum_{i=1}^{m} P_{c,\, i}\right) \times \exp\left(b \times [W_s - 10]\right) \quad (18\text{-}35)$$

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Where:

$CMF_{8,\,fs,\,ac,\,sv,\,z}$ = crash modification factor for outside shoulder width in a freeway segment with any cross section *ac*, single-vehicle crashes *sv*, and severity *z*; and

W_s = paved outside shoulder width (ft).

The coefficients for Equation 18-35 are provided in Table 18-21. The variable $P_{c,i}$ is computed as the ratio of the length of curve *i* in the segment to the effective length of the freeway segment L^*. The CMF is applicable to shoulder widths in the range of 4 to 14 ft. The "length of curve *i* in the segment" is computed as an average of two values: the length of curve *i* between the segment's begin and end mileposts for roadbed 1 and that for roadbed 2, where each value excludes the length of any coincident speed-change lane that may be present and where the value for a given roadbed is zero if that roadbed is not curved.

Table 18-21. Coefficients for Outside Shoulder Width CMF–Freeway Segments

Cross Section (*x*)	Crash Type (*y*)	Crash Severity (*z*)	CMF Variable	CMF Coefficients *a*	CMF Coefficients *b*
Any cross section (*ac*)	Single vehicle (*sv*)	Fatal and injury (*fi*)	$CMF_{8,\,fs,\,ac,\,sv,\,fi}$	–0.0647	–0.0897
		Property damage only (*pdo*)	$CMF_{8,\,fs,\,ac,\,sv,\,pdo}$	0.00	–0.0840

$CMF_{9,\,fs,\,ac,\,sv,\,fi}$—Shoulder Rumble Strips

One CMF is used to describe the relationship between shoulder rumble strip presence and predicted crash frequency. The SPF to which it applies is identified in the following list:

- SPF for fatal-and-injury single-vehicle crashes, specified number of lanes (*fs*, *n*, *sv*, *fi*).

The base condition is no shoulder rumble strips present. The CMF is described using the following equation:

$$CMF_{9,\,fs,ac,sv,\,fi} = \left(1.0 - \sum_{i=1}^{m} P_{c,\,i}\right) \times f_{\tan} + \left(\sum_{i=1}^{m} P_{c,\,i}\right) \times 1.0 \quad (18\text{-}36)$$

$$f_{\tan} = 0.5 \times \left([1.0 - P_{ir}] \times 1.0 + P_{ir} \times 0.811\right) + 0.5 \times \left([1.0 - P_{or}] \times 1.0 + P_{or} \times 0.811\right) \quad (18\text{-}37)$$

Where:

$CMF_{9,\,fs,\,ac,\,sv,\,fi}$ = crash modification factor for shoulder rumble strips in a freeway segment with any cross section *ac* and fatal-and-injury (*fi*) single-vehicle (*sv*) crashes;

f_{tan} = factor for rumble strip presence on tangent portions of the segment;

P_{ir} = proportion of effective segment length with rumble strips present on the inside shoulders; and

P_{or} = proportion of effective segment length with rumble strips present on the outside shoulders.

The proportion P_{ir} represents the proportion of the effective segment length with rumble strips present on the inside shoulders. It is computed by summing the length of roadway with rumble strips on the inside shoulder (excluding the length of any rumble strips adjacent to speed-change lanes) in *both* travel directions and dividing by twice the effective freeway segment length L^*. The proportion P_{or} represents the proportion of the effective segment length with rumble strips present on the outside shoulders. It is computed by summing the length of roadway with rumble strips on the outside shoulder (excluding the length of any rumble strips adjacent to speed-change lanes) in *both* travel directions and dividing by twice the effective freeway segment length L^*.

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The first summation term "∑" in Equation 18-48 applies to short lengths of barrier in the median. It indicates that the ratio of barrier length $L_{ib,i}$ to clearance distance (= $W_{off,in,i} - W_{is}$) should be computed for each individual length of barrier that is found in the median along the segment (e.g., a barrier protecting a sign support). The continuous median barrier is not considered in this summation. Any clearance distance that is less than 0.75 ft should be set to 0.75 ft. Similarly, if the distance "0.5 × (W_m – 2 × W_{is} – W_{ib})" is less than 0.75 ft, then W_{icb} should be set to 0.75 ft.

For segments or speed-change lanes with a continuous barrier adjacent to one roadbed (i.e., asymmetric median barrier), the following equations should be used to estimate W_{icb} and P_{ib}.

$$W_{icb} = \frac{2 \times L}{\frac{L}{W_{near} - W_{is}} + \sum \frac{L_{ib,i}}{W_{off,in,i} - W_{is}} + \frac{L - \sum L_{ib,i}}{W_m - 2 \times W_{is} - W_{ib} - W_{near}}} \quad (18\text{-}50)$$

$$P_{fs+sc,ac,at,K} = \frac{\exp(V_K)}{\frac{1.0}{C_{sdf,fs+sc}} + \exp(V_K) + \exp(V_A) + \exp(V_B)} \quad (18\text{-}51)$$

Where:

W_{near} = "near" horizontal clearance from the edge of the traveled way to the continuous median barrier (measure for both travel directions and use the smaller distance) (ft).

Similar to the previous guidance, the first summation term "∑" in Equation 18-50 applies to short lengths of barrier in the median. The ratio of barrier length L_{ib} to the clearance distance (= $W_{off,in,i} - W_{is}$) should be computed for each individual length of barrier that is found in the median along the segment. The continuous median barrier is not considered in this summation. Any clearance distance that is less than 0.75 ft should be set to 0.75 ft. Similarly, if the distance "$W_{near} - W_{is}$" or the distance "W_m – 2 × W_{is} – W_{ib} – W_{near}" is less than 0.75 ft, then W_{icb} should be set to 0.75 ft.

For segments or speed-change lanes with a depressed median and some short sections of barrier in the median (e.g., bridge rail), the following equations should be used to estimate W_{icb} and P_{ib}:

$$W_{icb} = \frac{\sum L_{ib,i}}{\sum \frac{L_{ib,i}}{W_{off,in,i} - W_{is}}} \quad (18\text{-}52)$$

$$P_{ib} = \frac{\sum L_{ib,i}}{2 \times L} \quad (18\text{-}53)$$

Any clearance distance (= $W_{off,in,i} - W_{is}$) that is less than 0.75 ft should be set to 0.75 ft. When a freeway segment is being evaluated, the proportion P_{ib} represents the proportion of the effective segment length with barrier present in the median. It is computed by summing the length of roadway with median barrier (excluding the length of any median barrier adjacent to speed-change lanes) in *both* travel directions and dividing by twice the effective freeway segment length L^*.

For segments or speed-change lanes with depressed medians without a continuous barrier or short sections of barrier in the median, the following equation should be used to estimate P_{ib}:

$$P_{ib} = 0.0 \quad (18\text{-}54)$$

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The input data needed for this procedure are identified in Table 19-42. The first three variables listed represent required input data. Default values are provided for the remaining variables.

Table 19-42. Input Data for Ramp Curve Speed Prediction

Variable	Description	Default Value	Applicable Site Type
X_i	Ramp-mile of the point of change from tangent to curve (PC) for curve *i* (mi) [a]	None	All
R_i	Radius of curve *i* (ft) [b]	None	All
$L_{c,i}$	Length of horizontal curve *i* (mi)	None	All
V_{frwy}	Average traffic speed on the freeway during off-peak periods of the typical day (mi/h)	Estimate as equal to the speed limit	All
V_{xroad}	Average speed at the point where the ramp connects to the crossroad (mi/h)	15 – ramps with stop-, yield-, or signal-controlled crossroad ramp terminals 30 – all other ramps at service interchanges	Entrance ramp, exit ramp, connector ramp at service interchange
V_{cdroad}	Average speed on C-D road or connector ramp (measured at the mid-point of the C-D road or ramp) (mi/h)	40	C-D road, connector ramp at system interchange

[a] If the curve is preceded by a spiral transition, then X_i is computed as equal to the average of the TS and SC ramp-mile locations, where TS is the point of change from tangent to spiral and SC is the point of change from spiral to curve.
[b] If the curve has spiral transitions, then R_i is equal to the radius of the central circular portion of the curve.

The curve entry speeds need to be calculated for all curves from milepost 0.0 to the end of the analysis segment. This may include segments of an adjacent ramp that are not included in the current analysis segment. For each curve, record the entry speed, the total length of the curve, and the length of the current analysis segment. Once the procedure on the following pages is completed, return to Equation 19-33. In this equation, the summation term only includes entry speeds and radii that have a length in the current analysis segment. All other curves analyzed should be ignored if they are not part of the current analysis segment.

Entrance Ramp Procedure
This procedure is applicable to entrance ramps and connector ramps at service interchanges that serve motorists traveling from the crossroad to the freeway.

Step 1—Gather Input Data.
The input data needed for this procedure are identified in Table 19-42.

Step 2—Compute Limiting Curve Speed.
The limiting curve speed is computed for each curve on the ramp using the following equation:

$$v_{\max,i} = 3.24 \times \left(32.2 \times R_i\right)^{0.30} \tag{19-59}$$

where $v_{max,\,i}$ is the limiting speed for curve *i* (ft/s).

The analysis proceeds in the direction of travel. The first curve encountered is curve 1 (i =1). The value of v_{max} is computed for all curves prior to, and including, the curve of interest. The value obtained from Equation 19-59 repre-

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