

# RESEARCH MEETS

## PRACTICE:

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### IDENTIFYING AND APPLYING CMFs

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# 2-lane, Rural Road Example

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Paving a 2-foot shoulder and adding centerline and edgeline rumble stripes on a 2-lane minor rural road.

What happens to safety when you:

- Pave the shoulder
- Add CL and EL rumble stripes AND...
- Steepen the sideslope????

# What's Different?

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- Made assumptions (volume, lane width, grade, driveway density, etc.), but they are relative.
- Therefore the only the difference between the existing condition and the proposed condition are:
  - Shoulder Type
  - Centerline Rumble Stripes
  - Edgeline Rumble Stripes
  - Sideslope

# Edgeline Rumble CMF

- Source = FHWA Training “HSM Practitioner’s Guide for Two-Lane Rural Highways Workshop”

- CMF = 0.870

Applying CMFs to the SPF Base Prediction Model: Example		
From Example Calculations: Rural Two-Lane Road:  AADT = 3,500 vpd, Length = 5.02 mi, 31 Driveways, RHR = 5, $N_{spf-rs} = 4.69$	Lane Width = 10 ft	CMF <sub>1r</sub> = 1.172
	Shoulder Width = 2 ft gravel	CMF <sub>2r</sub> = 1.180
	Segments on Grade (none)	CMF <sub>5r</sub> = 1.000
	Driveway Density (6.17/mi)	CMF <sub>6r</sub> = 1.029
	Centerline Rumble, None	CMF <sub>7r</sub> = 1.000
	Edgeline Rumble	CMF <sub>7re</sub> = 0.870
	Passing/Climbing Lanes, None	CMF <sub>8r</sub> = 1.000
	TWLTs, None	CMF <sub>9r</sub> = 1.000
	Roadside Design, RHR = 5	CMF <sub>10r</sub> = 1.143
	Lighting, None	CMF <sub>11r</sub> = 1.000
	Automated Enforcement, None	CMF <sub>12r</sub> = 1.000

# Steepening Sideslope CMF

- Source = HSM, Volume 3, Table 13-18 'Potential Crash Effects on Total Crashes of Flattening Sideslopes', page 13-20
- From table, assume 1V:2H to 1V:3H.

**Table 13-18.** Potential Crash Effects on Total Crashes of Flattening Sideslopes (15)

Treatment	Setting (Road Type)	Traffic Volume	Crash Type (Severity)	CMF				
				Sideslope in Before Condition	Sideslope in After Condition			
					1V:4H	1V:5H	1V:6H	1V:7H
Flatten Sideslopes	Rural (Two-lane road)	Unspecified	All types (Unspecified)	1V:2H	0.94	0.91	0.88	0.85
				1V:3H	0.95	0.92	0.89	0.85
				1V:4H		0.97	0.93	0.89
				1V:5H			0.97	0.92
				1V:6H				0.95

Base Condition: Existing sideslope in *before* condition.

NOTE: Standard error of the CMF is unknown.

# Steepening Sideslope CMF

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				1V:4H		0.97	0.93	0.89
				1V:5H			0.97	0.92
				1V:6H				0.95

Base Condition: Existing sideslope in *before* condition.

NOTE: Standard error of the CMF is unknown.

- Take inverse of because we are steepening.
- $CMF = 1 / 0.97 = 1.03$

# Existing Conditions

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	CMF 2r	CMF 3r	CMF 4r	CMF 5r	CMF 6r	CMF 7r	CMF 8r	CMF 9r	CMF 10r	CMF 11r	CMF 12r	CMF comb
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x...x(11)x(12)
1.03	1.19	1.00	1.00	1.00	1.03	1.00	1.00	1.00	1.14	1.00	1.00	1.448

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	N spf rs	Overdispersion Parameter, k	Crash Severity Distribution	N spf rs by Severity Distribution	Combined CMFs	Calibration Factor, Cr	Predicted average crash frequency, N predicted rs (crashes/year)
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	5.343	0.02	1.000	5.343	1.45	1.00	7.736
Fatal and Injury (FI)	--	--	0.321	1.715	1.45	1.00	2.483
Only (PDO)	--	--	0.679	3.628	1.45	1.00	5.253

# Proposed Conditions

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)		
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF	Steeplen Sideslope	Edgeline Rumbles
<i>CMF 1r</i>	<i>CMF 2r</i>	<i>CMF 3r</i>	<i>CMF 4r</i>	<i>CMF 5r</i>	<i>CMF 6r</i>	<i>CMF 7r</i>	<i>CMF 8r</i>	<i>CMF 9r</i>	<i>CMF 10r</i>	<i>CMF 11r</i>	<i>CMF 12r</i>	<i>CMF comb</i>		
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x...x(11)x(12)		
1.03	1.17	1.00	1.00	1.00	1.03	0.94	1.00	1.00	1.14	1.00	1.00	1.197	1.030	0.870

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

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Crash Severity Level	N spf rs	Overdispersion Parameter, k	Crash Severity Distribution	N spf rs by Severity Distribution	Combined CMFs	Calibration Factor, Cr	Predicted average crash frequency,
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	5.343	0.02	1.000	5.343	1.20	1.00	6.394
Fatal and Injury (FI)	--	--	0.321	1.715	1.20	1.00	2.655
Only (PDO)	--	--	0.679	3.628	1.20	1.00	4.342



# Conclusion...

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- Existing Condition:
  - 7.736 crashes/year
- Proposed Condition:
  - 6.394 crashes/year

**Predicted 17.3% reduction in total crashes by paving a 2-foot shoulder and adding CL and EL rumble stripes to a 10-mile segment of a rural, 2-lane road with 2000 veh/day.**

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**Thank You.**