

Hazard Elimination Project Evaluation

Order # 41000003160

Hazard Elimination Project W-4842

Evaluation of the Rumble Strip Installation on I-40 in Buncombe County

Documents Prepared By:

Safety Evaluation Group
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Principal Investigator



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2/17/2010

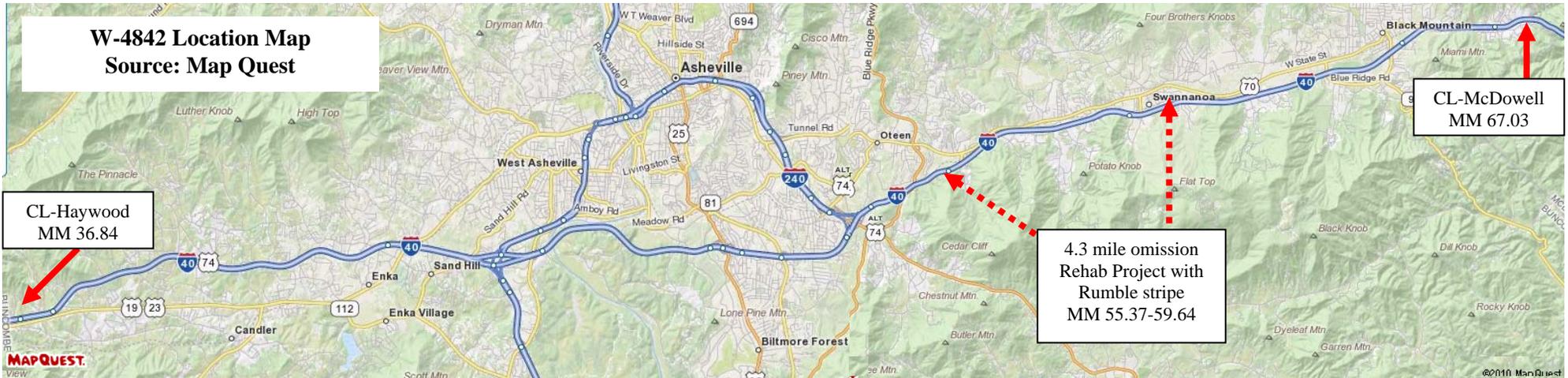
Date

Traffic Safety Project Engineer

Hazard Elimination Project Evaluation Documentation

Subject Location

W-4842 was installed on I-40 from the Haywood County Line to the McDowell County Line. Approximately 4.3 miles were omitted from the project from Exit 55 (SR 2838/Porter Cove Rd) to the overpass at SR 2856/Dennis Rd. Improvements were made to the omitted section under a different funding source, and will be evaluated in this report as well.



Project Information and Background from the Project File Folder

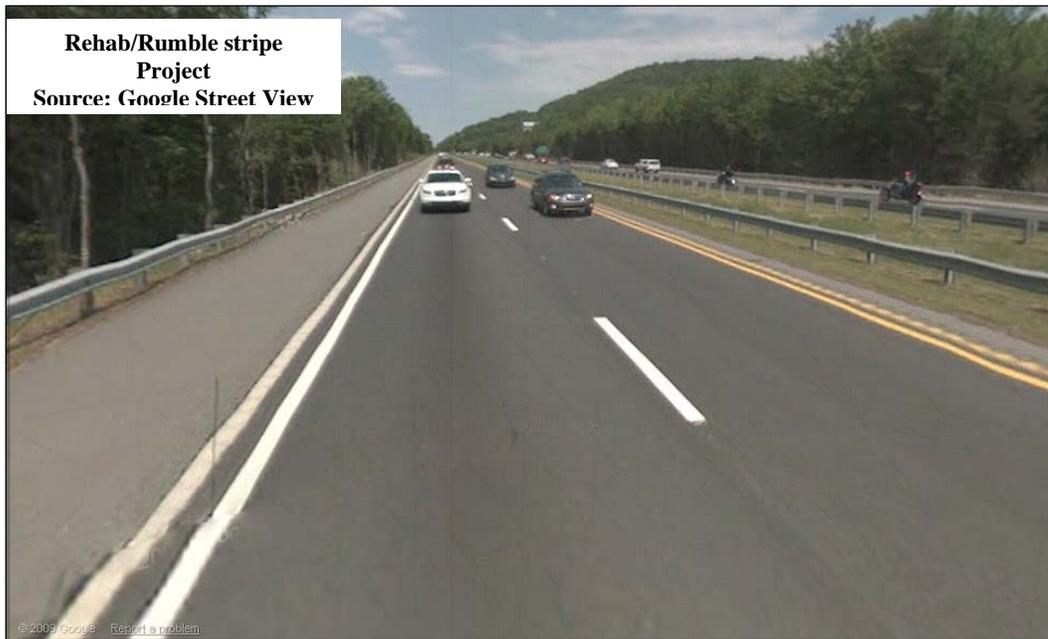
The hazard elimination improvement countermeasure chosen for the subject I-40 interstate segment was the installation of rumble strips on both the median and outside shoulders. The countermeasure was applied to both the eastbound and westbound travel lanes for 25.9 miles of I-40. I-40 along this strip is mostly a four-lane cross-section with 12 foot lanes, 10 foot outside shoulders, and 4 foot median shoulders. Median protection exists along the entire section and varies between three-strand cable, W-beam guardrail or concrete barrier wall. The posted speed limit ranges from 55 to 65 mph. The original statement of problem was that vehicles running off the road were producing crashes resulting in fatalities, serious injury, and property damage. The intended purpose of the improvements was to alleviate the frequency of roadway departure crashes by alerting the motorist of their actions. The initial crash analysis was completed from July 1, 2000 to June 30, 2003 with 975 total reported crashes, 371 of which were deemed correctable Ran Off Road crashes. The improvement was completed in Summer 2006 with a total cost of \$190,000. The projected B/C Ratio was 111.38.

The 4.3 mile omission from the project was an interstate rehab project (also completed in 2006) that included adding two sets of edgelines, with one edgeline painted in the milled rumble strips on both median and outside shoulders in both directions of travel.

Location Photograph (Near Winery Rd at MM 48.5)



Location Photograph (Near Buckeye Cove Rd at MM 57)



Naive Before and After Analysis

After reviewing the project file folder along with all the crashes at the subject location, the crash data omitted from this analysis to consider for an adequate construction period were from January 1, 2006 through December 31, 2006. The before period consisted of reported crashes from January 1, 2003 through December 31, 2005 (3 years); and the after period consisted of reported crashes from January 1, 2007 through December 31, 2009 (3 years). The ending date for this analysis was determined by the date of available crash data at the time of analysis. The before period ADT year was 2004 and the after period ADT year was 2008.

For W-4842, with the rumble strip installation, the treatment data consisted of all mainline crashes on I-40 in Buncombe County, with the omission of MM 55.37-59.64. For the rehab project, with the rumble stripe application, the treatment data consisted of all crashes on I-40 from MM 55.37-59.64. The analysis was completed with a zero (0) foot y-line. Target crashes are lane departure crash types.

Naive Before and After Analysis for W-4842

<u>W-4842 Treatment Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	866	672	-22.4%
Total Severity Index	4.94	4.62	-6.5%
Lane Departure Crashes – Both Directions	578	420	-27.3%
Lane Departure Severity Index	5.14	4.23	-17.7%
Volume	43,200	43,800	1.4%

The following tables divide the W-4842 crash data by direction of travel:

<u>W-4842 Eastbound Treatment Info</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	470	342	-27.2%
Total Severity Index	4.31	5.15	19.5%
Lane Departure Crashes	308	221	-28.2%

<u>W-4842 Eastbound Crash Details</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Segment Crashes – Injuries			
Fatal Injury Crashes	2	4	100.0%
Non-Fatal Injury Crashes	153	114	-25.5%
Property Damage Only Crashes	315	224	-28.9%
Crashes - Contributing Factors			
Night Crashes	120	71	-40.8%
Wet Road Crashes	118	76	-35.6%
Alcohol Related	14	11	-21.4%
Lane Departure Crash Types			
Angle	13	7	-46.2%
Fixed Object	146	114	-21.9%
Head On	0	1	N/A
Jackknife	2	1	-50.0%
Movable Object	25	10	-60.0%
Overturn / Rollover	9	5	-44.4%
Parked Motor Vehicle	4	2	-50.0%
Ran Off Road (Right & Left)	21	26	23.8%
Sideswipe, Same Direction	88	55	-37.5%

<u>W-4842 Westbound Treatment Info</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	396	330	-16.7%
Total Severity Index	5.69	4.07	-28.5%
Lane Departure Crashes	270	199	-26.3%

<u>W-4842 Westbound Crash Details</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Segment Crashes – Injuries			
Fatal Injury Crashes	5	2	-60.0%
Non-Fatal Injury Crashes	135	107	-20.7%
Property Damage Only Crashes	256	221	-13.7%
Crashes - Contributing Factors			
Night Crashes	118	74	-37.3%
Wet Road Crashes	76	56	-26.3%
Alcohol Related	23	12	-47.8%
Lane Departure Crash Types			
Angle	11	2	-81.8%
Fixed Object	142	82	-42.3%
Head On	1	1	0.0%
Jackknife	3	0	-100.0%
Movable Object	12	10	-16.7%
Overturn / Rollover	15	6	-60.0%
Parked Motor Vehicle	7	5	-28.6%
Ran Off Road (Right & Left)	19	27	42.1%
Sideswipe, Same Direction	60	66	10.0%

The naive before and after analysis for the W-4842 project resulted in an overall 22 percent decrease in Total Crashes and a 7 percent decrease in the Total Severity Index. There was also a 27 percent decrease in Target Crashes and an 18 percent decrease in the Target Severity Index.

Naive Before and After Analysis for Rehab Project with Rumble Stripe

Note that the rumble stripe was not installed using a “conventional” application. The rumble stripe was paint rather than thermoplastic, which may not have provided the anticipated life expectancy for the marking.

<u>Rumble stripe Treatment Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	115	100	-13.0%
Total Severity Index	6.02	5.35	-11.1%
Lane Departure Crashes – Both Directions	84	71	-15.5%
Lane Departure Severity Index	6.26	6.29	0.5%
Volume	43,000	45,000	4.7%

The following tables divide the rehab project with rumble stripe crash data by direction of travel:

<u>Rumble stripe Eastbound Treatment Info</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	42	42	0.0%
Total Severity Index	2.94	5.10	73.5%
Lane Departure Crashes	30	28	-6.7%

<u>Rumble stripe Eastbound Crash Details</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Segment Crashes – Injuries			
Fatal Injury Crashes	0	0	N/A
Non-Fatal Injury Crashes	11	14	27.3%
Property Damage Only Crashes	31	28	-9.7%
Crashes - Contributing Factors			
Night Crashes	12	14	16.7%
Wet Road Crashes	10	9	-10.0%
Alcohol Related	2	1	-50.0%
Lane Departure Crash Types			
Angle	0	0	N/A
Fixed Object	20	19	-5.0%
Head On	0	0	N/A
Jackknife	0	1	N/A
Movable Object	3	1	-66.7%
Overturn / Rollover	0	0	N/A
Parked Motor Vehicle	0	0	N/A
Ran Off Road (Right & Left)	0	0	N/A
Sideswipe, Same Direction	7	7	0.0%

<u>Rumble stripe Westbound Treatment Info</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	73	58	-20.5%
Total Severity Index	7.79	5.53	-29.0%
Lane Departure Crashes	54	43	-20.4%

<u>Rumble stripe Westbound Crash Details</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Segment Crashes – Injuries			
Fatal Injury Crashes	2	1	-50.0%
Non-Fatal Injury Crashes	28	16	-42.9%
Property Damage Only Crashes	43	41	-4.7%

Crashes - Contributing Factors			
Night Crashes	19	6	-68.4%
Wet Road Crashes	27	20	-25.9%
Alcohol Related	7	1	-85.7%
Lane Departure Crash Types			
Angle	2	0	-100.0%
Fixed Object	33	24	-27.3%
Head On	0	0	N/A
Jackknife	1	1	0.0%
Movable Object	1	5	400.0%
Overturn / Rollover	2	3	50.0%
Parked Motor Vehicle	2	1	-50.0%
Ran Off Road (Right & Left)	2	1	-50.0%
Sideswipe, Same Direction	11	8	-27.3%

The naïve before and after analysis for the rehab project with rumble stripe resulted in an overall 13 percent decrease in Total Crashes and an 11 percent decrease in the Total Severity Index. There was also a 16 percent decrease in Target Crashes and a 1 percent increase in the Target Severity Index.

Results and Discussion

W-4842

Using naïve before and after analysis, the number and severity of Total and Target Crashes decreased on the section of I-40 installed with rumble strips under project W-4842. After the installation of the rumble strips in both the eastbound and westbound directions, the occurrence of Lane Departure Crashes by 28 and 26 percent, respectively. Overall, the number of Night and Wet Road Crashes decreased by 39 and 32 percent, respectively.

The calculated benefit to cost ratio for W-4842 is **72.5** considering Total Crashes. The benefit to cost ratio considering only Target Crashes is **83.0**. The benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related to the project are not considered in this analysis. The costs of the project include the actual construction costs as well as the increase in annual maintenance costs when applicable.

Rehab Project with Rumble Stripe

Using naïve before and after analysis, the number Total and Target Crashes decreased on the section of I-40 installed with rumble stripes under the rehab project. The crash severity of Total Crashes decreased and the crash severity of Target Crashes remained about the same. After the pavement resurfacing and installation of the rumble stripes in both the eastbound and westbound directions, the occurrence of Lane Departure Crashes by 7 and 20 percent, respectively. Overall, the number of Night and Wet Road Crashes decreased by 35 and 22 percent, respectively.

Unlike W-4842, the rehab project included pavement resurfacing, which may explain the higher number of crashes in the initial year after the project was constructed and a decrease in crashes in subsequent years. Motorists may have felt more comfortable traveling faster on the newly paved section, creating an increase in Total and Lane Departure Crashes. See the following table for more information.

Rehab Project with Rumble Stripe - After Period Crashes Per Year

Year	Total Crashes	Target Crashes
2007	42	26
2008	28	23
2009	30	22
Total	100	71

Below is a table comparing the crashes per mile in both of the treatment sections. Although both sections have a similar average AADT, the generally higher crash rate in the W-4842 section may be explained by the greater number of ramps and merge sections, particularly in the more urban section surrounding Asheville. It appears that the rumble strip and rumble stripe applications produced the same outcomes for target crashes, bringing both sections down to approximately the same number of lane departure crashes per mile in the after period.

<u>Comparison of Crashes Per Mile in Both Sections</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes/Mile			
W-4842 Section	33.4	25.9	-22%
Rehab Project w/Rumble Stripe Section	26.7	23.3	-13%
Target Crashes/Mile			
W-4842 Section	22.3	16.2	-27%
Rehab Project w/Rumble Stripe Section	19.5	16.5	-15%

As the Safety Evaluation Group completes additional spot safety reviews for this type of countermeasure, we will be able to provide objective and definite information regarding actual crash reduction factors for this type of intersection.

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: I-40 CountyWide (exclude MM55.37-59.64)
 COUNTY: Buncombe
 FILE NO.: W-4842
 TOTAL CRASHES

BY: CLS
 DATE: 2/12/2010

DETAILED COST: TYPE IMPROVEMENT - Rumblestrips

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$190,000	10	0.149	\$28,316
		0	0.000	\$0
		0	0.000	\$0
TOTALS	\$190,000	10	0.149	\$28,316

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$0
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$28,316
 TOTAL COST OF PROJECT= \$190,000

COMPREHENSIVE COST REDUCTION:

TIME PERIOD	YEARS	ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES						ANNUAL COSTS
		K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	
BEFORE	3.00	18	6.00	277	92.33	571	190.33	\$6,426,067
AFTER	3.00	11	3.67	216	72.00	445	148.33	\$4,373,000

Annual Benefits from Crash Cost Savings \$2,053,067

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$2,024,751
 BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 72.51

TOTAL COST OF PROJECT - \$190,000 COMPREHENSIVE B/C RATIO - 72.51

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: I-40 CountyWide (exclude MM55.37-59.64)
 COUNTY: Buncombe
 FILE NO.: W-4842
 TARGET CRASHES

BY: CLS
 DATE: 2/12/2010

DETAILED COST: TYPE IMPROVEMENT - Rumblestrips

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$190,000	10	0.149	\$28,316
		0	0.000	\$0
		0	0.000	\$0
TOTALS	\$190,000	10	0.149	\$28,316

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$0
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$28,316
 TOTAL COST OF PROJECT= \$190,000

COMPREHENSIVE COST REDUCTION:

ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	3.00	15	5.00	170	56.67	393	131.00	\$4,833,533
AFTER	3.00	6	2.00	122	40.67	292	97.33	\$2,482,133

Annual Benefits from Crash Cost Savings \$2,351,400

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$2,323,084
 BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 83.04

TOTAL COST OF PROJECT - \$190,000 COMPREHENSIVE B/C RATIO - 83.04