Analysis of Rumble Stripe Safety Effectiveness

Summary

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November 15, 2016

Overview:

This is a comparative analysis of the statewide Rumble Stripe safety program effectiveness on Indiana highways. Analysis of subject projects that included the rumble striping work type was conducted after construction to provide a preliminary assessment of in-service performance for projects with letting date of 7/9/2010 to 4/1/2015. The after construction reported crashes were compared to reported crashes for the same roadway sections using data from January 1, 2008 to each particular contract's letting date. After construction time period was deemed to begin six months after the contract letting date to a date deemed to have complete data entered (3/31/2016). A normalization procedure was used to account for differing durations of Before and After time periods collected for this analysis.

Findings:

The post-construction crash performance values are expressed as a percent reduction in crashes at each severity level. The results have been rounded to nearest 10^{th} of a percent. Two sets of crash reduction factors (CRFs) are presented below: The first based on a relatively broad but still relevant crash types (in relation to rumble stripe countermeasure), and the second based on a highly relevant sub-set of the first (further explained below):

- Fatal crash events showed a reduction of -66.1%
- All Injury crash events showed a reduction of -6.4%
- Combined Fatal/Injury crash events showed a reduction of -10.0%

Findings specific to "RAN OFF ROAD", "OPPOSITE DIRECTION SIDESWIPE", and "HEAD ON BETWEEN TWO MOTOR VEHICLES":

- Fatal crash events showed a reduction of -84.1%
- All Injury crash events showed a reduction of -8.2%
- Combined Fatal/Injury crash events showed a reduction of -14.3%

The last section titled Observations provides more detail on the study's results comparing operating conditions before to those after rumble stripe installation.

Overview of INDOT's Rumble Stripe Projects:

At the time of this review there were 105 projects in the field, and 54 of those projects had enough after-period time and data to be part of this analysis.

Relative to the particular 54 projects studied to gauge before vs. after safety performance, these are the essential stats:

- 572 run-miles or rumble stripe, on 330 road miles
- Of those 572 run-miles, this is the break-down:
    - 255 run-miles of edgeline rumble stripe
    - 317 run-miles of centerline rumble stripe
- Investment value = 572 run-miles x $4,000 per run-mile = $2,288,000 ≈ $2.3 million

Relative to all 105 statewide rumble stripe INDOT projects in 91 contract lettings as of March 2, 2016, construction letting:

- Centerline rumble stripe (CLRS) run length (run-miles), 728
- Edgeline rumble stripe (ELRS) run length (run-miles), 588
- Sum of CLRS & ELRS run length (run-miles), 1,316
- Road miles of CLRS alone (miles measured on center), 456
- Road miles of CLRS + ELRS in combination (miles measured on center), 271
- Road miles of ELRS alone (miles measured on center), 26
- Sum of road ,miles of CLRS and/or ELRS (miles measured on center), 754

Study Procedure - Steps to Create Analysis:

Determine those projects that were appropriate to analyze, create a database for each site, reduce data to specific project area to have comparative data sets, then analyze/compare the before and after data.

The following steps were completed to summarize all the data of general relevance to rumble stripe treatment, then a second iteration to isolate effects of a dataset of types of crashes expected to be affected most directly by rumble stripe, notably the particularly narrow sub-set of these Manner of Collision types: Head On Between Two Motor Vehicles, Opposite Direction Sideswipe, and Ran Off Road. (It's for this reason the final results in terms of crash reduction factors are presented above under two conditions — the 1st based on a more general set of crash types but still relevant to rumble stripe treatment, and the 2nd to a highly relevant sub-set (just three manners of collision).

Step 1: Screen to identify the rumble stripe projects having enough time after construction to allow for comparative analysis (54 out of 105, those built earlier in the program's history since the first project was let July 2010). These projects had the same alignment, and site specific information to analyze.

Step 2: Built 54 databases with crash data from ARIES for January 1, 2008 to March 31, 2016.

Step 3: Reduced out those crash records not with the road section's road name in the Road ID field in the crash record.

Step 4: Reduced out those crash records without latitude/longitude data (as re-populating coordinates for those records missing such was beyond the scope of this before-after study).

Step 5: Reduced out those crash records that had "Private" or "DNR" in the Property Type field.

Step 6: Reduced out those crash records that showed 1 or higher in the field for Deer.

Step 7: Reduced out those crash records with Primary Factor that had "Collision with Animal, Object, or Deer."

Step 8: Reduced out those crash records in Manner of Collision that had "Collision with Object."

Step 9: Reduced out those crash records with dates in what was calculated to be the default 6-month construction timeframe.

Step 10: Created a temporary electronic map to see where latitude/longitude data mapped and reduced crash records to those within the project area of the Reference Post (RP) from the project schedule.

Step 11: Created two tables from the remaining crashes for Before and After time periods for each site.

Step 12: Created an Excel sheet for data entry for the summary of the Before and After periods.

Step 13: Calculated the days of service Before and After (i.e., the Before and After time periods containing the subject crash data).

Step 14: Entered raw data for three levels of crash severity: Total Crashes, Fatal Crashes, and Injury Crashes (not counting also Fatal).

Step 15: Used the data sets to calculate a "daily average" for Fatal, Injury, and combined Fatal/Injury crashes (for both Before and After time periods).

Step 16: Calculated an "annualized" number for Before and After Injury and Fatal crashes. For instance, Before Injury divided by Before Days equals Daily Average times 365 = Annualized Before Injury, or as a numerical example, 15 Injury crashes divided by 2,647 days x 365 days per year = 2.06.

Step 17: Added annualized Injury and Fatal crashes to come up with an annualized combined Injury/Fatal total value.

Step 18: By individual project and by all projects combined, compared the two annualized numbers (Before period and After period) for Injury, Fatal, and combined Injury/Fatal, presenting values in form of percent crashes reduced—over each of the two datasets (relevant and highly relevant to rumble stripe treatment). A negative value in this context implies frequency after was lower than before, therefore positive traffic safety benefit, and vice versa. (It's understood that convention for a Crash Reduction Factor, or CRF, is a change in sign from that, meaning, expressed as a positive rather than negative percentage.)

Observations:

The core, essential findings of this check on effectiveness — percent reduction in crashes before vs. after — are presented above in the section titled Findings. Particularly for fatal events, rumble stripe at the program level is shown by this in-service analysis of 54 projects to be significantly effective in improving safety (under select road conditions). The effect was much less favorable but still positive for injury crashes.

Companion (to this documentation) Excel files break down by individual project the aggregate- or program-level findings. While there are dozens of cases where the presence of rumble stripe

brought about exceptional improvement in safety performance, perhaps the best example is US 231 from I-74 on the north side of Crawfordsville to the start of the multi-lane section on the south side of Lafayette. In the 4.6 years prior to the rumble stripe project, 11 fatal crashes took place on that 17-mile stretch of mostly rural, high-speed, high-volume highway. (For purpose of comparison, this study evaluated 8 of those 11, as 3 lacked geo-coordinates in their crash records, and such events were screened.) However, in the 3.1-year evaluation period after installation, no fatal crashes occurred on US 231.

Regarding the initial review on crash types considered generally relevant to rumble stripe treatment, 31 of the 54 sites saw a positive effect on fatal crash frequency, 17 remained unchanged (zero before, zero after), and 6 experienced higher frequency after than before treatment. The projects experiencing a positive benefit for fatal events outnumbered those with a negative outcome by 5 to 1, again, for the set of crashes viewed as relevant but not necessarily highly so. Overall, on an annualized basis, there were 13.3 fatal crashes in the before period, compared to 4.5 after, thus a 66 percent reduction.

The second manner of comparison before vs. after involved a narrow sub-set of crashes considered highly relevant to presence of rumble stripe: ran off road, opposite direction sideswipe, and head on. Nineteen of the 54 projects studied saw an improvement in fatal crash frequency, 34 remained unchanged (zero before, zero after), and 1 experienced higher frequency after than before treatment. Overall, annualized frequency of fatal crashes was 7.1 before, compared to 1.1 after, an 84 percent reduction.