

Safety Evaluation of Sinusoidal Centerline Rumble Strips

Task 6: Summary of “Before” Period Data

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BACKGROUND

The objective of the Task 6 deliverable is to summarize the data collection activities and protocols that were used to develop the “before” period data to be used in the safety evaluation of sinusoidal centerline rumble strips. The data collection efforts took place during Tasks 4 and 5 of the project, which involved compiling “before” period crash data, electronic roadway data, and supplemental data for the treatment and reference group sites.

The memorandum summarizes the sources of data, the time periods over which the data were collected, and the protocols used to collect the supplemental data. The technical memorandum is organized by each data element (e.g., roadway inventory, crash, and supplemental data) and then concludes with a summary of the data. The number, type, and severity of crashes at all treatment and reference group sites, as well as those with conventional centerline rumble strips installed, and descriptive statistics (e.g., minimum, maximum, mean, and standard deviation) of all roadway, roadside, traffic, and other site-specific data are also included in this memorandum.

ROADWAY INVENTORY DATA

The Task 4 report includes information about the roadway inventory and crash data sources and data structures for the “before” period of the safety evaluation. The roadway inventory data were collected from the Montana Department of Transportation (MDT) and provided in Geographic Information Systems (GIS) format. Data from state-owned and maintained roadway segments were included in the files. The data included average annual daily traffic (AADT) data, route information, as well as rumble strip data. A detailed summary of the roadway inventory data can be found in the Task 4 project report.

CRASH DATA

The Task 4 report also includes a summary of the electronic crash data from the “before” period. These data were collected for the period between 2016 and 2020, inclusive and include crashes on state-owned roadways in Montana. Data such as the location of the crash, crash type, injury severity, roadway and weather conditions, contributing circumstances, and the first harmful event were included in the files. The process used to merge the electronic crash and roadway inventory files is described in the Task 4 report.

SUPPLEMENTAL DATA ELEMENTS

In addition to the data elements in the roadway inventory geodatabase provided by MDT, the research team collected additional data elements through alternative sources – Google Earth Pro

and MDT's Pathpoints videolog. Specific details regarding the supplemental data collection processes are described in the Task 5 report, with updates included in this section of the Task 6 report.

In order to carry out the supplementary data collection work, roadway segments with lengths greater than one mile were subdivided into segments between 0.1 and 1 mile. These segments were then screened to retain only two-lane undivided roads by eliminating one-way sections, multi-lane segments, segments containing two-way left-turn lanes, and segments with posted speed limits of 45 mph or less. Subsequently, the supplemental data elements were collected for this subset of two-lane undivided segments following the processes described in the Task 5 report.

The roadway data that were collected as part of supplementary data collection are as follows:

- a. Paved shoulder width
- b. Rumble strip presence (shoulder and centerline)
- c. Access points (driveways) per mile
- d. Horizontal curvature data – curve length, radius and degree of curvature
- e. Presence of curve warning signs
- f. Presence of reverse curve (additional data element)
- g. Presence of compound curve (additional data element)
- h. Average gradient (additional data element)

While collecting data on variables such as the presence of rumble strips or curve warning signs, the research team used Google Earth Pro imagery and Pathpoints videologs. It was noted that, for many segments, imagery was either unavailable, or too outdated to verify the presence of rumble strips. Therefore, segments with no available imagery, imagery older than 2017, or route IDs without Pathpoints videologs were omitted from the dataset.

BEFORE PERIOD DATA SUMMARY

The final dataset comprised 10,785 roadway segments totaling 7,565.7 miles, of which 490.4 miles were treated sites with sinusoidal centerline rumble strips, and 7075.3 miles were untreated sites without sinusoidal centerline rumble strips. The crash data was merged with the roadway data based on the location information in the crash data. Table 1 provides descriptive summary statistics for the reported annual crash frequencies for all target crash types. The mean and standard deviation of all crash types and severities is relatively consistent from year-to-year in the before period data, among the entire sample.

Table 1. Summary of reported crash frequencies

Description	Year	Mean	Standard Deviation	Minimum	Maximum
Total Crash Frequency	2016	0.355	0.84	0	14
	2017	0.386	0.898	0	13
	2018	0.387	0.905	0	17
	2019	0.357	0.84	0	13
	2020	0.381	0.877	0	11
Fatal and Injury Crash Frequency	2016	0.097	0.344	0	5
	2017	0.092	0.335	0	5
	2018	0.088	0.332	0	5
	2019	0.084	0.319	0	5
	2020	0.093	0.333	0	4
Head On Crash, Total Frequency	2016	0.005	0.071	0	2
	2017	0.005	0.075	0	2
	2018	0.004	0.068	0	2
	2019	0.004	0.065	0	1
	2020	0.005	0.07	0	1
Head On Crash, Fatal and Injury Frequency	2016	0.004	0.061	0	2
	2017	0.004	0.066	0	2
	2018	0.003	0.06	0	2
	2019	0.004	0.06	0	1
	2020	0.004	0.065	0	1
Opposite Direction Sideswipe, Total Frequency	2016	0.008	0.091	0	1
	2017	0.006	0.078	0	1
	2018	0.006	0.08	0	2
	2019	0.006	0.079	0	1
	2020	0.007	0.084	0	2
Opposite Direction Sideswipe, Fatal and Injury Frequency	2016	0.005	0.067	0	1
	2017	0.002	0.048	0	1
	2018	0.003	0.054	0	2
	2019	0.003	0.053	0	1
	2020	0.002	0.042	0	1
Off Road Left, Total Frequency	2016	0.042	0.22	0	4
	2017	0.05	0.242	0	3
	2018	0.045	0.224	0	3
	2019	0.042	0.217	0	3
	2020	0.045	0.226	0	3

Description	Year	Mean	Standard Deviation	Minimum	Maximum
Off Road Left, Fatal and Injury Frequency	2016	0.019	0.142	0	2
	2017	0.02	0.148	0	2
	2018	0.014	0.12	0	2
	2019	0.015	0.127	0	2
	2020	0.018	0.136	0	2
Single Vehicle Run Off Road, Total Frequency	2016	0.104	0.363	0	4
	2017	0.123	0.422	0	8
	2018	0.124	0.411	0	8
	2019	0.111	0.383	0	5
	2020	0.117	0.392	0	6
Single Vehicle Run Off Road, Fatal and Injury Frequency	2016	0.045	0.221	0	4
	2017	0.045	0.223	0	4
	2018	0.039	0.207	0	3
	2019	0.039	0.207	0	4
	2020	0.046	0.225	0	3

Tables 2 and 3 provide descriptive summaries of the continuous variables included in the analysis database. Table 2 shows the average annual daily traffic for the years 2016 to 2022 (inclusive), across the entire sample. Table 3 includes data associated with roadway features, such as cross-section widths, segment length, access and intersection density, posted speed limit, horizontal curve, and vertical gradient information. In Table 3, the features represent data from the year 2022.

Table 4 presents a summary of the categorical variables for the most recent year of data. Based on the 2022 data, all segments with a posted speed limit of 45 mph or lower were omitted. Where discrepancies in speed limits were found for the same segments across different years in the database, they were manually corrected by verifying the posted speed limit in the Pathpoints videolog.

Table 2. Summary of AADT in the database

Description	Year	Mean	Standard Deviation	Minimum	Maximum
Average Annual Daily Traffic (AADT)	2016	1272.824	1516.047	21	29017
	2017	1270.116	1563.256	21	30978
	2018	1285.397	1553.347	14	31412
	2019	1311.337	1608.791	14	30509
	2020	1242.112	1537.79	1	13837
	2021	1367.449	1725.51	1	15996
	2022	1342.56	1696.133	1	14969

Table 3. Summary of continuous variables in the dataset (year 2022)

Description	Mean	Standard Deviation	Minimum	Maximum
Surface Width, ft	29.53	5.72	19	74
Segment Length, mi	0.70	0.29	0.1	1
Paved shoulder width, ft	2.68	2.53	0	17
Posted speed limit (mph)	68.09	4.84	50	70
No. of access points per mile	3.86	4.85	0	80
No. of intersections per mile	0.53	1.53	0	40
No. of horizontal curves per mile	1.02	1.91	0	20
Percentage of curve length	12.82	22.3	0	100
Degree of curvature per mile	3.59	10.08	0	256.06
Average gradient (%)	0.60	0.50	0	6.56

Table 4. Summary of categorical variables in the dataset (year 2022)

Category	Mileage	Percentage
Functional classification		
3 - Principal Arterial - Other	2437.5	32.22%
4 - Minor Arterial	2604.9	34.43%
5 - Major Collector	2516	33.26%
7 - Local	7.3	0.10%
Surface type		
Asphalt	7565.7	100%
Concrete	0	0%
Shoulder rumble strips		
No Rumble Strip	5250	69.39%
Shoulder RS	2315.7	30.61%
Centerline rumble strips		
No centerline rumble strips	4138.6	54.70%
Centerline RS	3427.1	45.30%
Presence of sinusoidal centerline rumble strips in the roadway segment		
No Sinusoidal Rumble Strips	7075.3	93.52%
Sinusoidal RS	490.4	6.48%
Presence of reverse curve in the roadway segment		
No Reverse Curve	7197.7	95.14%
Reverse Curve	368	4.86%
Presence of compound curve in the roadway segment		
No Compound Curve	7428.3	98.18%
Compound Curve	137.4	1.82%
Presence of curve warning sign in the roadway segment		
No curve warning sign	7266.8	96.05%
Curve warning sign	298.9	3.95%
Posted speed limit (mph)		
50	96.3	1.27%
55	367.9	4.86%
60	342	4.52%
65	357.5	4.73%
70	6402	84.62%