Analysis of Accident Statistics

I. BACKGROUND

To ensure that safety objectives are met, a distinction must be made between: (1) locations which are hazardous as identified based on accident experiences, and (2) locations and elements that are potentially hazardous due to their geometrics or physical features. A location can be identified as hazardous by the occurrence of an abnormal number, rate, or severity of accidents over a given period of time.

A. Time Period and Segment Length Considerations

Accident based procedures are used to identify locations defined as hazardous based on past experience. These procedures involve the review and analysis of system wide accident information.

- To compare the accident experience of several locations fairly, the period of time over which accidents are counted and the length of roadway section should ideally be the same at each location.

- If not, an accident rate may be compared between locations, expressed for a common unit of exposure (i.e., accidents per million vehicle miles, or accidents per million entering vehicles).

1. Analysis Period Considerations

- Accident data for the most recent 1 to 3-year period is normally used and is generally sufficient

- 2 or 3 year analysis periods are more appropriate at locations with low traffic volumes, where a 1-year period may not provide sufficient information.

- Accident data should only be used when there are no major changes in facility characteristics or land use.

2. Analysis Roadway Length Considerations

The roadway network can be divided into spots and/or segments. Isolated curves, bridges, and intersections are examples of spot locations. Segments are typically defined by a particular length (e.g., 300 feet, 0.1 mile, 1.0 mile, etc.) or as the section of highway between two defined spots.

When selecting a length for spots or segments, the following points are considered:

- Segment (long roadway) lengths should be no shorter than the minimum distance used by police officers to describe an accident location. For example, if accidents are reported to the nearest 0.1 mile, then the minimum segment length should be 0.1 mile. ODOT's accident database is reported for every 0.01 mile.

- For areas where accident reporting is subject to errors or less accuracy (i.e., rural areas or areas where field reference markers are far apart), longer segment lengths should be used for analysis purposes.

- Spot (short roadway) lengths should include the area of influence around a hazard. For instance, the analysis of intersections should include all accidents that occur within a specified radius, such as 250 feet, from the center of the intersection. Driveway accidents occurring within 250 feet from the center of an intersection should, therefore, be included in the count of accidents for that intersection. Logically, it should be the stopping sight distance, plus the queue length at intersections.

II. Methods for Identifying High Accident Locations

Methods for analyzing the hazardousness of locations include the following:

- Spot map method
- Accident frequency method
- Accident rate method

A. Spot Map Method

The simplest method for identifying hazardous locations is to examine an accident spot map. The map will show the spots or segments having the greatest numbers of accidents. This is an effective way to get a picture of the accident clusters in small areas.

B. Accident Frequency Method

The frequency method ranks locations by the number of accidents. The location with the highest number of accidents is ranked first, followed by the location with the second highest number of accidents, and so on. This method does not take into account the differing amounts of traffic at each location. Therefore, the frequency method tends to rank high volume locations as high-accident locations, even if those locations have a relatively low number of accidents for the traffic volume. Many agencies use the frequency method to select a group of high-accident locations, and then use some other method to rank the locations in order of priority.

C. Accident Rate Method

The accident rate method compares the number of accidents at a location with the number of vehicles or vehicle miles of travel at a location. This comparison results in an accident rate. The rate is stated in terms of “accidents per million vehicles” for intersections (and other spots), and “accidents per million vehicle-miles of travel” for segments. The locations are then ranked in descending order by accident rate.

D. Exposure

The exposure at any location is the number of vehicles that travel over a segment of roadway or through a spot on the roadway, such as, an intersection.

1. Spot Exposure

The exposure at a spot, such as an intersection, is measured by the total number of vehicles entering the intersection for the period.

EXPOSURE (ENTERING VEHICLES) = ADT X 365 X YRS

OR

EXPOSURE (MILLION ENTERING VEHICLES) = ADT X 365 X YRS/1,000,000

2. Section Exposure

The exposure over a roadway section is measured by the total vehicle miles of travel over the section for the period.

EXPOSURE (VEHICLE MILES OF TRAVEL) = ADT X 365 X MI X YRS

OR

EXPOSURE (MILLION VEHICLE MILES) = ADT X 365 X MI X YRS/1,000,000

E. Calculation of Accident Rates

The accident rate for a location is found by dividing the accident experience by the exposure:

Accident Rate = Accidents/Exposure

1. Spot Accident Rate

The equation for computing accident rate for a spot location is as follows:

R_{sp} = A/Exposure [million entering vehicles]

OR

R_{sp} = (A) (1,000,000)/ADT (365)(Yrs)

Where:

R_{sp} = Accident rate at a spot in accidents per million vehicles,

A = Number of accidents for the study period,

Yrs = Period of study (years or fraction of years),

ADT = Average Annual Daily Traffic (AADT) during the study period. For intersections, the sum of the entering volumes on all approach legs.

A spot location is generally defined as a location about 0.3 miles or less in length. For driveways, the spot length should be equal to the stopping sight distance upstream and downstream of the location. A driveway with a low entering volume and low accident experience can achieve a relatively high accident rate.

2. Section Accident Rate
For roadway sections, length becomes a consideration, and the equation becomes:

$$Rse = A / Exposure\ (Million\ vehicle\ miles)$$
OR
$$Rse = (A)\ (1{,}000{,}000) / ADT\ (365)\ (MI)\ (Yrs)$$

Where:

R_{se} = Accident rate of the section in accidents per million vehicle miles of travel,

MI = Length of the section (in miles). Roadway segments of less than 0.3 miles should not be considered as sections.

- Since this method takes the location’s traffic “exposure” into account, it is less likely to unfairly favor high-volume locations than the accident frequency method. On the other hand, it tends to unjustly favor low-volume locations with relatively few accidents.

- An accident rate of between 2 to 3 accidents per million vehicle miles (MVM) is considered by some states to be an average rate on rural two-lane roads (excluding intersections). However, a 1-mile section with a traffic volume of only 300 vehicles per day, and only one accident per year would have an accident rate of 9.1 accidents per million vehicle miles (MVM), which would be more than three times higher than an average rate, even though only one accident has occurred. Thus, the simple accident rate method can give misleading results for low-volume locations.

III. Case Study #1: High Accident Location Analysis

Five roadway sections (A through E) were identified as high-accident locations based on the use of several identification methods. All locations are on two-lane county roads with 10 to 11 foot lanes and shoulders less than three feet wide. All sections are on rolling terrain with moderate horizontal curvature. The average accident rate for this class of roadway in Superior County is 3.5 ACCS/MVM. the methods tested included:

- Frequency method
- Accident rate method

The sections had the following information:

Location	Section Length (Miles)	AADT	PDO	No. of Accs. Injury: A	B	C	F	No. Accs.	No. Years
A	0.8	4,200	12	1(1)	1(3)	1(2)	0	15	3
B	1.2	3,500	15	0	2(4)	3(4)	1(1)	21	2
C	3.4	1,750	35	2(2)	4(4)	2(3)	0	43	2.5
D	2.2	2,400	24	0	0	3(3)	0	27	1.5
E	1.6	3,000	12	4(7)	5(7)	4(6)	2(3)	27	3

Note that the number of years of accident data that was used (i.e., 1.5 to 3 years) varies because of some inaccuracies in portions of the accident data base for some previous years. Section lengths vary between 0.8 and 3.4 miles per section, and average annual daily traffic (AADT) ranges from 1,750 to 4,200.

A. Frequency Method

In this example, the measure of accident frequency must account for varying section lengths and time period of accidents. If not, the accident frequencies would not be comparable. For example, 43 accidents occurred at Location C over a 2.5 year period on a 3.4 mile section, while at Location D, 27 accidents occurred on a 2.2 mile section in the most recent 1.5 year period.

Therefore, the analyst must "normalize" the data, or convert the accident frequencies to a common base, in terms of accidents per mile per year. For Location A, this is computed as:

15 accidents ÷ 0.8 miles ÷ 3 years <u>or</u>

15 / (0.8) (3) = 6.25 accs./ mile/ year

Similarly, values for all five sites are given below.

Loc. A: (15) / (0.8) (3) = 6.25 Acc. / mi. / yr.
Loc. B: (21) / (1.2) (2) = 8.75 Acc. / mi. / yr.
Loc. C: (43) / (3.4) (2.5) = 5.06 Acc. / mi. / yr.
Loc. D: (27) / (2.2) (1.5) = 8.18 Acc. / mi. / yr.
Loc. E: (27) / (1.6) (3) = 5.62 Acc. / mi. / yr.

B. Accident Rate Method

The accident rates for the five locations were computed from the standard formula for roadway sections:

$$R_{se} = (A)\ (1{,}000{,}000)\ /\ (365)\ (T)\ (V)\ (L)$$

Where:

- R_{se}= Accident rate of the section in accidents per million vehicle miles of travel (ACC/MVM).
- A = Total number of accidents on the roadway section for the analysis period
- T = Time period of the study (in years or fraction of years).
- V = Average Annual Daily Traffic (AADT) during the study period.
- L = Length of the section in miles.

Location A, has AADT of 4,200 over the 0.8 mile segment with 15 total accidents in a three-year period. Thus, the accident rate (R_{se}) is computed as:

$$R_{se} = (15)\ (1{,}000{,}000)\ /\ (365)\ (3)\ (4200)\ (0.8)$$
$$R_{se} = 4.08 \text{ ACC/MVM}$$

Likewise, accident rates for all five sites were computed as:

Loc. A: (15) (1,000,000) / (365) (3) (4,200) (0.8) = 4.08 ACC/MVM
Loc. B: (21) (1,000,000) / (365) (2) (3,500) (1.2) = 6.85 ACC/MVM
Loc. C: (43) (1,000,000) / (365) (2.5) (1,750) (3.4) = 7.92 ACC/MVM
Loc. D: (27) (1,000,000) / (365) (1.5) (2,400) (2.2) = 9.34 ACC/MVM
Loc. E: (27) (1,000,000) / (365) (3) (3,000) (1.6) = 5.13 ACC/MVM