Truck Accident Models

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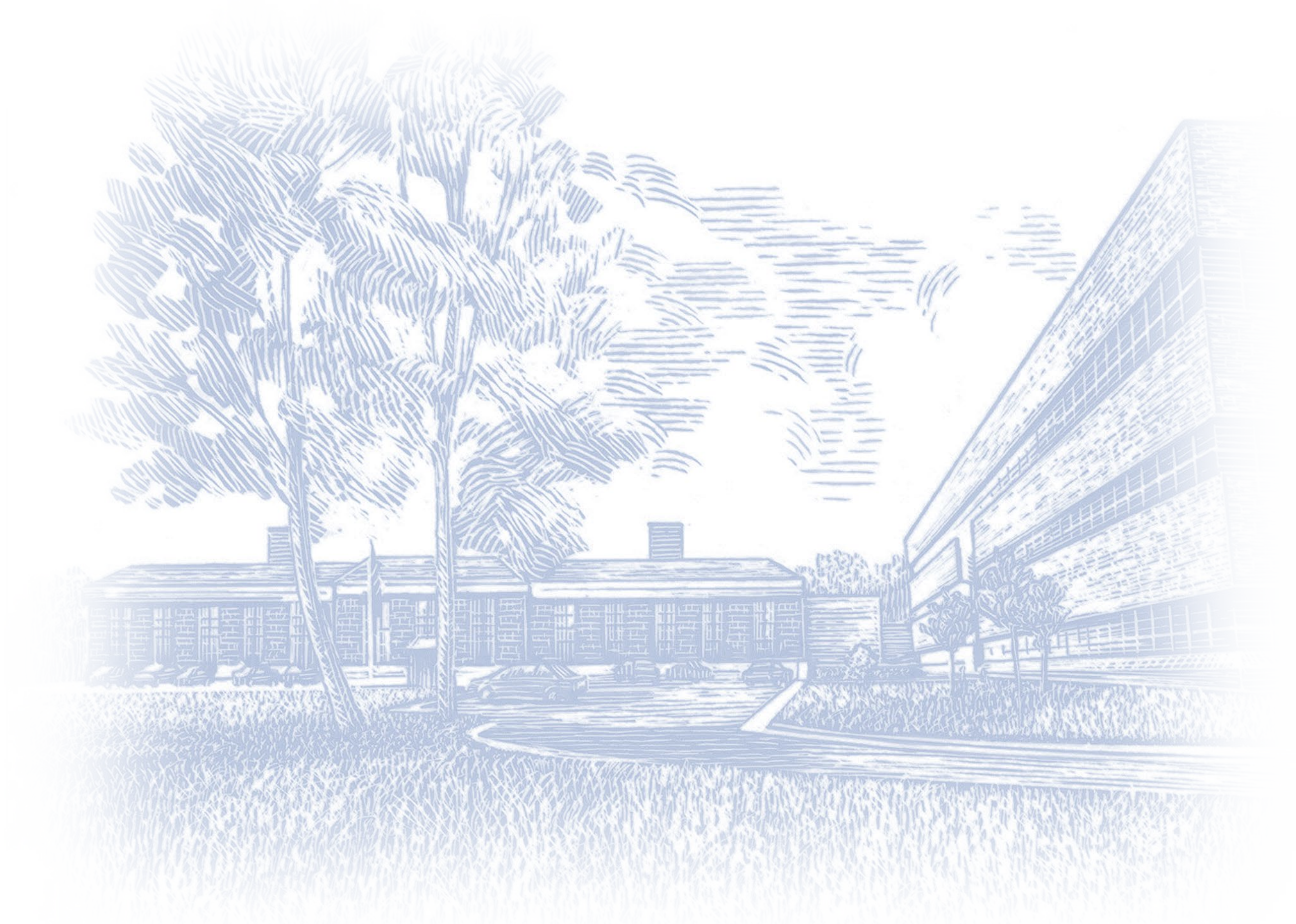

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Foreword

Truck accidents have become an important safety issue in recent years in many parts of the United States. Between 1980 and 1989, truck travel mileage in the United States increased by approximately 50 percent. In addition, the Surface Transportation Assistance Act (STAA) of 1982 allowed longer and wider trucks to travel on the designated national highway network. Major safety questions that still exist include: (1) Are current highway designs adequate to accommodate increased truck travel and larger trucks? and (2) Which highway designs pose the most serious threats to truck safety?

Using data from the FHWA's Highway Safety Information System (HSIS), two recent studies have attempted to address the safety questions of larger trucks. A Federal Highway Administration (FHWA) study at Oak Ridge National Laboratory developed preliminary statistical models relating the truck accident involvement rates for three roadway types and for various geometric and traffic variables.(1) Research as part of a Grants for Research Fellowships Program (GRF) study developed truck accident models for Interstates and two-lane rural roads as a function of relevant geometric features.(2) The following is a discussion of the results of the two studies.

State Data Bases Used

Both studies relied upon data from the Highway Safety Information System (HSIS) data base for developing relationships between truck accidents and highway design variables. Because truck exposure data in HSIS are not currently given by truck type, the Oak Ridge study employed the Highway Performance Monitoring System (HPMS) as a supplementary data source whenever exposure data by truck type were needed.(1)

For the Oak Ridge study, HSIS data from Utah and Illinois were selected for analysis. According to the authors, these States had the most complete information on highway geometric design, especially on horizontal curvature and vertical grade. For both States, accident-related files (i.e., accident, vehicle, and occupant) were available annually from 1985 to 1987. The Utah roadlog file containing roadway cross-section data was available from the years 1985, 1986, and 1987, while the horizontal curvature and vertical grade files were only available from 1987.

Since horizontal curvature and vertical grade usually change very little over the years, the authors used the 1987 curvature and grade data for all 3 years of road sections under the roadlog file. The Illinois roadlog file for 1987 was used. Both Utah and Illinois have the variables required for this study. The authors found the curvature and gradient variables to be more complete for Utah, so the study used only Utah data.

Analysis Methods

In the Oak Ridge study, the authors developed a Poisson regression model to establish relationships between truck accidents and geometric design variables. For a particular roadway type, the number of trucks involved in accidents on each road section over a period of time was assumed to be Poisson distributed.

The authors then presented a "negative binomial regression" model to address the uncertainties associated with the Poisson regression model. In the (GRF) study, a linear model and two non-linear regression models were tested. A stepwise SAS procedure was used to determine which variables were significant at the 0.05 level of confidence. The values obtained from the regression coefficients were then used in a non-linear equation fitting procedure.

Results

A. Oak Ridge Study

In the 3-year period encompassing the Oak Ridge study (1985 through 1987), there were 933 large trucks involved in accidents on rural Interstates in Utah; 1,177 on urban Interstates and freeways; and 685 on rural two-lane undivided arterials.(1) These values translate into 0.88, 1.86, and 1.45 truck accident involvements per million truck miles (0.55, 1.16, and 0.90 truck accident involvements per million truck kilometers), respectively. For Illinois, the truck accident involvement rates per million truck miles (and kilometers) were 0.46 (0.29) on rural Interstates, 5.82 (9.37) on urban Interstates and freeways, and 3.13 (5.04) on rural two-lane undivided arterials.

The number of trucks involved in accidents and the associated involvement rates are shown in Table 1 by truck configuration and by accident severity for Utah. For most categories specified in Table 1, combination trucks had higher accident involvement rates than single-unit trucks. Under dark conditions, a higher proportion of accidents involved combination trucks rather than single-unit trucks (48.8 percent vs. 28.4 percent, respectively, on rural Interstates).

The authors derived a Poisson regression model for each of the three roadway types. Overall, Average Annual Daily Traffic (AADT) per lane and horizontal curvature were found to be significant for all three roadway types at the 5-percent level of confidence. Vertical grade was significant only for rural Interstates. Shoulder width was significant for urban Interstates and rural two-lane undivided arterials.

B. Graduate Research Fellowship Study

This study found that trucks are more involved than other vehicle classes in property damage accidents and serious accidents, as well as in four accident types (run-off-road, overturning, sideswipe, and single vehicle).[2] Variables found to be significantly related to truck crash involvement rates on Interstate routes included AADT, truck volume, horizontal alignment, and vertical alignment. On rural, two-lane roads, variables significantly related to truck crash rates included AADT, truck volume, shoulder width, and horizontal alignment. All variables in the models are significant at the 0.05 level.

Study Implications

Accurate estimates of truck accident rates for different truck configurations under varying geometric conditions are needed to understand the relationship between highway design and truck safety. In these two studies, preliminary models were developed to explain the relationship.

The two studies collectively revealed that a number of traffic and roadway features can result in increased safety problems for large trucks, as summarized as follows:

Rural Interstates

- AADT per lane
- truck ADT
- horizontal curvature
- vertical grade

Urban Interstates and Freeways

- AADT per lane
- truck ADT
- horizontal curvature
- vertical grade
- shoulder width

Rural, Two-Lane Undivided Arterials

- AADT per lane
- truck ADT
- horizontal curvature
- shoulder width

Note that truck average daily traffic (ADT), total traffic AADT, and horizontal curvature were significant variables for all three types of roadway classes. Vertical grade was also a factor for rural and urban Interstates, while shoulder width was a factor on rural two-lane roads and urban Interstates and freeways.

Based on this type of information, sites could be identified with severe horizontal and vertical alignment, narrow shoulders, high volumes of truck traffic, and/or other factors (as given above) as candidates for high truck crash experience. Such information can be used by highway designers and safety engineers to make appropriate roadway improvements and thus reduce the potential for truck accidents on selected roadway sections. These models could be improved if more complete truck volume and truck accident data (e.g., truck width, length of trailer, and overall truck length) were to become available.

Table 1. Number of large trucks involved in accidents andaccident-involvement rates per million truck kilometers for four roadway types in Utah: 1985-1987.

Truck Type	Single Unit Trucks				Combination Trucks				All Trucks
Severity Type	K&A	B&C	PDO	Total	K&A	B&C	PDO	Total	Total
Rural Interstate									
No. of Accidents	15	26	68	109	147	197	480	824	933
Involvement Rates	0.04	0.06	0.17	0.27	0.11	0.15	0.37	0.63	0.55
Urban Interstate & Freeway									
No. of Accidents	25	91	247	363	79	155	580	814	1177
Involvement Rates	0.07	0.27	0.73	1.07	0.12	0.23	0.86	1.20	1.16
Urban Multilane Divided Arterial									
No. of Accidents	47	114	388	549	39	65	385	489	1038
Involvement Rates	0.69	1.67	5.69	8.07	0.71	1.17	6.96	8.82	8.39
Rural Two-Lane Undivided Arterial									
No. of Accidents	27	37	112	176	111	82	316	509	685
Involvement Rates	0.11	0.15	0.45	0.70	0.22	0.16	0.62	0.99	0.90
Notes:	Accident severity type: K = Fatal, A = Incapacitating Injury, B = Non-Incapacitating Injury, C = Possible Injury, PDO = Property Damage Only. Bobtails (tractors with no trailers) were not included in the table. Multiply by 0.621 to obtain measurements per million truck miles.								

For More Information

To obtain more information on either study or on the HSIS, contact Jeffrey F. Paniati, HSIS Program Manager, at (703) 285-2568.

References

[1] Miaou, S.; Hu, P.; Wright, T.; Davis, S.; and Rathi, A. "Development of the Relationship Between Truck Accidents and Geometric Design," Federal Highway Administration, August 1991.
[2] Mohamedshah, Y.; Paniati, J.; and Hobeika, A. "Truck Accident Models for Interstates and Two-Lane Rural Roads," Federal Highway Administration, January 1992.