Characteristics of Fatal Truck Crashes in the United States

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ABSTRACT

In 2007, one out of nine traffic fatalities resulted from a collision involving a large truck, of which 84% are occupants of other vehicles, even though the trucks accounted for only 3% of all registered vehicles and 7% of total vehicles miles traveled. This contrasting proportion indicates that truck crashes in general tend to be more severe than other crashes and particularly devastating for the occupants of other vehicles. To study this issue, fatal crash data procured from the Fatality Analysis Reporting System (FARS) were used and various conditions that prevail at the time of fatal truck crashes were evaluated. Findings indicate that around 73% of fatal truck crashes occur on rural roadways when compared to urban roadways. About 82% of all the fatal truck crashes occur on two-lane highways, and about 58% occur on two-way trafficways that are not physically divided. Also, almost 68% of the fatal truck collisions involve impacts on the front end of the vehicle, which weakens the argument on poor rear-side visibility being the main reason for truck crashes. Driving under influence was another critical factor, as around 700 drunken drivers are involved in fatal truck crashes every year. Another important observation was that of all the drunken drivers in fatal truck crashes, the non-truck drivers are observed to have greater alcohol involvement (around 62 %) than the truck drivers.

Several other factors have been observed for the better understanding of the fatal truck crash characteristics. By addressing these factors through the implementation of appropriate remedial measures, the overall truck crash rate can be reduced, which can help in improving the overall safety of the transportation system.

Key words: fatal crashes—large trucks—truck crashes—truck safety
INTRODUCTION

Large-truck-related crashes contribute to a significant percentage of motor vehicle crashes in the United States, which involve fatalities and injuries. Of the 41,059 fatalities in motor vehicle crashes in 2007, 12% (4,808) died in crashes that involved a large truck, and 17% of those fatalities in large-truck crashes were occupants of large trucks. Though the large trucks contribute to only 8% of the vehicles involved in fatal crashes for the last 5 years, their impact in terms of severity proves to be a major concern.

Large trucks have different performance characteristics than other smaller vehicles. The physical dimension of the vehicle makes it difficult for drivers to maneuver large trucks smoothly on roadways. They can be 40 or more times heavier than the other vehicles in the traffic stream and have a slower initial pick up and a longer deceleration time. Truck drivers might face many challenges while traversing on Interstate or state highways at high speeds, at intersections, or while taking turns to have control over the vehicle. Also, the element of blind spots, as shown in Figure 1, makes it even more challenging for the truck driver and the surrounding vehicle drivers to avoid the heavy crash risk.

The crash statistics observed from the previous years, as seen in Table 1, show significant consistency in the frequencies of the different categories of large-truck-involved crashes. These trends reflect the need for a more effective analysis, which would provide characteristic facts pertaining to these crashes and help generate productive remedial measures. Achieving effective safety goals to downsize the intensity of the issue will require approaching truck safety aspects from a variety of parameters.

![Figure 1. No zones, or blind spots, around a large truck](image)

The amount of truck travel is dramatically increasing with the growing rate of factors like freight transport, which in turn requires continued attention in order to find ways of reducing truck crash risk.

**Table 1. Large-truck-involved crash statistics**

<table>
<thead>
<tr>
<th>Year</th>
<th>Injury Crashes</th>
<th>Property Damage Only (PDO) Crashes</th>
<th>Fatal Crashes</th>
<th>Single Vehicle Fatalities</th>
<th>Multi Vehicle Crash Fatalities</th>
<th>Total Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>90,000</td>
<td>322,000</td>
<td>4,224</td>
<td>449</td>
<td>4,490</td>
<td>4,939</td>
</tr>
<tr>
<td>2003</td>
<td>85,000</td>
<td>347,000</td>
<td>4,335</td>
<td>457</td>
<td>4,579</td>
<td>5,036</td>
</tr>
<tr>
<td>2004</td>
<td>83,000</td>
<td>312,000</td>
<td>4,478</td>
<td>469</td>
<td>4,766</td>
<td>5,235</td>
</tr>
<tr>
<td>2005</td>
<td>78,000</td>
<td>341,000</td>
<td>4,551</td>
<td>478</td>
<td>4,762</td>
<td>5,240</td>
</tr>
<tr>
<td>2006</td>
<td>77,000</td>
<td>287,000</td>
<td>4,321</td>
<td>499</td>
<td>4,496</td>
<td>4,995</td>
</tr>
</tbody>
</table>

Source: Large Truck Safety Facts 2006

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The Federal Motor Carrier Safety Administration (FMCSA) has set as a goal of “50 by 2010,” a 50% reduction in commercial-truck-related fatalities by the year 2010. Accordingly, it is important for the safety community to identify the characteristics related to large truck involved fatal crashes.

PROBLEM STATEMENT

To attenuate the fatal truck crash frequency in the country and achieve the sustainability of this trend seems difficult with the growing rate of movement of people and goods throughout the country. Hence, it is essential to analyze the situations under which fatal truck crashes are occurring. These factors that prevail at the time of a fatal truck crash and their frequencies/rates can give a picture of the conditions under which a larger proportion of such crashes occur.

This study deals with the identification of these characteristics for all fatal crashes in the country for the period of 2003–2007. Also from these observed characteristics to make reasonable suggestions for the mitigation of the fatal truck crash risk.

LITERATURE REVIEW

Numerous researchers had investigated and analyzed truck crashes using various techniques and sources. Krishnaswami, Blower, Schneider, and Putcha (2005) conducted an elaborate study for nearly a decade in establishing a unique truck-crash characteristic database and analyzed several parameters related to truck crashes. Data for this project was acquired from a number of sources, including Fatality Analysis Reporting System (FARS), Trucks Involved in Fatal Accidents (TIFA), and General Estimates System (GES). This paper analyzed the causes of heavy truck-driver aggressiveness impact in two-vehicle truck/light-vehicle crashes and also derived detailed models that have helped propose countermeasures to mitigate collision severity.

Another analysis conducted using the same data sources on the rear-end fatal truck crashes (Craft 2002) had observed that though trucks initiate a collision by striking the other vehicle, in fatal crashes, trucks are struck by other vehicles more often. Also, the overlapping effect of light condition and the alcohol-involvement level of the drivers were observed, and it was seen that the other-vehicle drivers were more often involved in alcohol consumption under all light conditions.

In a study about (Williams, Allan, and Shabanova 2003) motor vehicle crash rate comparisons made with respect to truck or non-truck drivers, their at-fault status was observed as the chief criterion. Data from FARS were used for the period of 1996–2000. Drivers in fatal, single-vehicle crashes were assumed to have responsibility for the crash. In fatal two-vehicle crashes, driver-operator errors reported by police were used to assign crash responsibility. Tables based on the deaths in crashes involving one or more passenger vehicles for which drivers of various ages were likely to be responsible per 100,000 licensed drivers by occupant type and many other categories were calculated.

Many other projects based on the analysis of driver parameters like age and gender were used to generate models using the driver-behavior factors to have a precise understanding of the driver issues in crashes. Crum and Morrow (2002) investigated the influence of carrier scheduling practices on truck driver fatigue by developing and empirically testing a truck driver fatigue model. Earlier than this, Massie, Green, and Campbell (1997) had developed another model with the four predictor variables of driver age, gender, time of the day, and average annual mileage. The effect of these four variables on crash involvement rate was studied, and their level of significance was obtained.
In order to identify the unsafe driver actions that lead to fatal car-truck crashes, a study analyzed two-vehicle crashes in the 1995–98 FARS database to compare car-car crashes with car-truck crashes (Lidia, Kostyniuk, Fredrick, Streff, and Zakrajsek 2002). In this, the 94 at-fault cases categorized as per the FARS were used to see the predominant faults in both types of crash situations. A key finding of this study is that most of the 94 unsafe driver acts were about as likely in fatal car-truck crashes as in fatal car-car crashes. Therefore, general safe-driving practices are also relevant around large trucks.

United States General Accounting Office (2003) made a report on the “Share the Road Safely” program, whose goal is to educate the public about driving safely around large trucks. This report analyzed the crash risk factors that predominantly arise while driving around large trucks. The program elaborated the necessity of having specific roadway educative measures for the public to mitigate this issue and lower the truck crash rate in general.

OBJECTIVES

The most primary objectives of this study include

- To analyze and evaluate various crash characteristics that prevail at the occurrence of fatal truck crashes
- To observe the trend of the crash occurrence under the overlapping effect of two-crash parameters

DATA AND METHODOLOGY

Data for the study was procured from the National Highway Traffic Safety Administration’s FARS for a period of 2003-2007. The database documents descriptive data on vehicles, drivers, roadways, and environmental conditions collected from police reports, emergency medical service reports, hospital records, and coroner’s reports of all fatal crashes in the country. The data are categorized into accident, person, and vehicle files. The accident file consists of all the general characteristics of the crashes; the person file has the details of every person involved in the fatal crashes, and the vehicle file explains the vehicular details. Every crash is given a unique identification code by which the files were merged using the statistical analysis computing software.

The accident file was primarily merged with the vehicle file to extract all the crashes involving a large truck (body weight >10,000 pounds). The various crash characteristics are recorded by using the filtering techniques in Microsoft Excel and Access. To obtain information about all the people in that crash, this file is in turn merged with the person file.

After suitably merging and filtering these files, the fatal truck crash data for the 5-year time period of 2003–2007 were combined to obtain more consolidated results with respect to several parameters and their frequencies. Further, the values obtained were compared at various levels to analyze the trends and patterns of a specific crash parameter with respect to time or type of crash or the extent of fault of the drivers involved. Eventually, certain pairs of parameters were overlapped to observe the contrasts in the combination of conditions prevailing during higher crash occurrence level. These trends are used to make critical inferences by interpreting them in the most pragmatic conventions.

RESULTS AND FINDINGS

The present study has shown that large trucks contribute to more fatalities in other (non-truck) vehicles than in trucks themselves. On an average, 84% of the fatalities occurring in large-truck crashes in the
country are not the occupants of trucks. This reinforces the threat large trucks impose on other motor vehicles, pedestrians, and pedal cyclists.

**Initial Point of Impact**

One of the primary observations made on the data was to obtain the direction of impact, which is the initial point on the truck where the other vehicle collides. As already shown in Figure 1, trucks have blind spots in all directions; this parameter helps show which zone is more crucial for a higher crash risk. By observing the initial point of impact on the truck, the position of the colliding vehicle with respect to the truck was estimated. From that, the blind spot, which results in a higher crash rate, was interpreted. From the Figure 2 is seen that the almost 62.5% of the cases resulted with the trucks having the initial impact on their front side. This might weaken the argument that poor visibility range for trucks on their rear side leads to majority of rear-end crashes in trucks. From this, it was also inferred that other vehicle drivers should be more vigilant when driving in front of a truck rather than the rear. The figure also shows around 15.5% of the crashes on the left-hand side of the driver. This can be considered significant because from Figure 1, it is observed that the left-hand side of the truck driver has the smallest blind spot zone when compared to all the other directions.

![Figure 2. Point of impact for trucks in fatal crashes for the period of 2003–2007](image)

**Alcohol Involvement**

Alcohol involvement of drivers has the potential to be one of the most significant contributing factors to result in crashes, which could also be the case in truck crashes. Analysis of this factor shows that of all the drunken drivers involved in fatal truck crashes, only 12.7% are truck drivers, and the rest of the 87.3% are non-truck drivers with blood alcohol levels higher than the permissible 0.8 mg/ml. This clears the misconception that a larger percentage of truck drivers are under influence of alcohol/drugs. Hence, it can be deduced that in fatal truck crashes with alcohol involvement, the non-truck drivers are largely at fault.
Manner of Collision

The manner of collision of the trucks in fatal collisions was observed for the all crashes from the combined dataset for the period of 2003–2007, as shown in Figure 3. Angle crashes have the highest proportion of 34.2%, followed by 23.7% of cases where the vehicles collide with a fixed object like a tree or a guardrail, etc. Head-on and rear-end crashes also form a significant portion of crashes, resulting in more fatalities.

![Figure 3. Manner of collision of fatal truck crashes](image)

Speed Limit

Trucks are difficult to maneuver smoothly, and when at higher speeds, they have a risk of losing control. This can also be one of the primary factors contributing to higher crash risk. The speed limit of the roadway where the truck is traversing before succumbing to fatal crash can approximately show the speed of the truck. As seen in Figure 4, the percentage of fatal crashes increases with increase in speed limit up to 60mph. The range of 51–60 mph has the highest number (an average of 5,280 crashes per year) of fatal truck crashes in the past five years. The sudden drop in the number of crashes from 51–60 mph to 61–70 mph can be because of the smaller number of roadways with the later speed range.
Figure 4. Fatal truck crashes in different speed limit ranges

Truck Driver Age Group

A number of driver-related parameters can be responsible for influencing the crash risk factor, especially for trucks that travel on a commercial basis for longer and more strenuous hours. In a study made by Crum and Morrow (2005), they explain that truck driver fatigue plays a major role in the occurrence of a crash. They have investigated and established a driver fatigue model to test various carrier scheduling practices with other driver parameters. Another important study was done by Williams, Allan, and Shabanova (2003) to scale the amount of responsibility in drivers by age and gender for all motor vehicle crashes. Here, they compared the number of drivers at fault in different age groups and gender. From their analysis, they proved that the element of “responsibility” declined with age until about age 63 then increased as a function of age.

From Figure 5, it is seen that the number of drivers involved in fatal truck crashes is higher in the age range of 41–50 yrs than other groups. The age group of 41–50 yrs has the highest percentage (29%) of fatal truck crashes, which may be the effect of driver fatigue factor having a larger impact on this age group.
Types of Traffic Ways

Truck maneuverability becomes more challenging with different kind of roadways, and even actions like lane changing and lane merging can sometimes become critical factors in leading to a crash. Also, the presence of dividers also affects the number of fatal crashes because they have the potential to reduce the severity of an occurred crash and sometimes even prevent fatality.

From Figure 6, it is seen that a majority of almost 23,968 crashes have occurred on two-way trafficways with no physical division in the past ten years. This shows that this kind of roadway has a greater tendency in promoting the occurrence of fatal crashes. Traffic flowing in opposite directions with no physical division in between can be one of the most suitable situations where the smallest of human errors can result in highly severe crash scenarios. Roadways of this type should be improved by providing the necessary divisions so as to minimize the frequency of fatal truck crashes.

The number of lanes on the roadways with these 23,968 crashes was analyzed, and it has been observed that almost 20,848 of those crashes occurred on two-lane, two-way roadways. The difficulty in controlling the large size of the vehicle in narrow or small roadways can be the reason for this high frequency. Two-lane roadways are often congested and cannot be easily traversed. This situation, in conjunction with the two-way trafficway without any physical division, can be the scene causing the occurrence of a fatal truck crash.
Level of Deformation on Urban and Rural Roadways

As seen in Figure 7, the level of deformation of the vehicles involved in fatal truck crashes is severely disabling in most cases. This trend remains consistent in both urban and rural roadways. As large trucks are heavy in weight and volume and also as it was observed in Figure 4 that majority of fatal truck crashes occur at high-speed levels, it is therefore evident that the consequences of such conditions result in severe impact on the collided vehicles. However, the percent of severely disabled vehicles is proportionally smaller in the urban sector when compared to the rural sector. The availability of more space for maneuvering on urban roads could probably be the reason for this observation.
Figure 7. Level of deformation of all vehicles involved in fatal truck crashes

Truck Driver At-fault Factors

Figure 8 explains the various types of truck driver-related factors that may have contributed to the fatal crash. Around 28.1% of the truck drivers are observed to have contributed to fatal truck crashes due to non-compliance to traffic regulations. Improper driving is another factor, which in 24.6% of cases, has contributed to fatal truck crashes. These categories will include factors like running off the road, erratic lane change, following improperly, failure to keep in lane properly, etc. Also, the figure shows that 15.8% of truck drivers involved in fatal truck crashes have an improper mental condition, such as fatigue, drowsiness, inattentiveness, drugs, etc. Such factors can contribute heavily to the occurrence of a crash.
Figure 8. Truck driver-related contributing factors in a fatal crash

Truck Striking/Struck on Different Roadways

Ralph Craft (2002) studied the rear-end truck crashes by comparing those where the truck was the striking vehicle and those where the truck was the struck vehicle. A similar framework was adapted to the current dataset, as shown in Figure 9, to observe the crashes on different types of roadways in the past five years.

It was observed from this that the “truck striking” and “truck struck” categories have a high number of crashes on state highways, contrasting the “other crashes” category, which have a high number of crashes on Interstates rather than other types of roadways. Truck striking another vehicle results in higher number of crashes than being struck on both Interstates and state highways, but this comparison has equal proportion in case of U.S. highways.
Figure 9. Fatal truck crashes by roadway type

Truck Striking/Struck in Different Light Conditions

When a similar criterion is used for different types of light conditions as shown in Figure 10, it was observed that the proportion of cases where trucks are struck has a lesser value than cases where the truck strikes other vehicles. In contrast, the percentage of trucks struck is higher in “dark/dark but lightened conditions” when compared to cases where the trucks are striking other vehicles.
CONCLUSIONS

Certain significant characteristics of fatal truck crashes have been observed from this analysis. The fatal crash frequency was observed to be greater with vehicle in front of the truck rather than anywhere else. In case of alcohol involvement, non-truck drivers seem to have indulged themselves in almost 87% of cases, proven by the high rate of blood alcohol level. Trucks seem to suffer majority of the fatal crashes at higher speed levels like 51–60 mph. Fatigue factor can be a leading characteristic that increases the number of fatal truck crashes with increase in age of the truck driver. Two-way, two-lane traffic flow ways with no physical division are leading to higher crash risk and fatalities. Such roadways should be altered by providing the necessary equipment. Improper driving and non-compliance to traffic regulations have also been observed to be the chief driver-related contributing factor in the case of fatal truck crashes.

By comparing the simultaneous effect of two-truck fatal crash characteristics, “truck striking” and “truck being struck” seemed to have similar proportions on all roadway types. Also, this proportion remained consistent, even under different light conditions. In general, several other factors can be critically observed later in a comparative study to see the at-fault criteria of truck and non-truck drivers can be analyzed to obtain a more detailed picture of this present analysis.
ACKNOWLEDGMENTS

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