Does Separating Trucks from Other Traffic Improve Overall Safety?

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March 29th, 2005

Paper submitted for presentation and publication at the 84th Annual Meeting of the Transportation Research Board
ABSTRACT

Decision-makers have long speculated that building separate roads for trucks and passenger cars, or at least separating them on their own lanes would accomplish two major objectives: 1) they would make the roadways safer for passenger cars, and 2) roadways designed specifically for a select class of vehicles rather than for all vehicles might represent overall savings in construction costs. This paper addressed the first objective. Recent studies on the evaluation of safety effects of truck traffic levels on general freeway facilities have not provided a clear understanding on how they affect the number of crashes. In some cases, they have been contradictory. In addition, no studies have specifically compared passenger cars-only with mixed traffic freeway facilities. The original research on which this paper is based is aimed to assess whether or not more homogeneous flows of traffic by vehicle type are safer than the current mixed flow scenario. To accomplish the objective of the study, an exploratory analysis of crash data is conducted on a selected number of freeway sections located on the New Jersey Turnpike for the year 2002. These sections operate as a dual-dual freeway facility: divided inner and outer lanes. At these locations, the inner lanes have the special characteristic of being for passenger cars only (homogeneous traffic). The selected sections, therefore, offer a very good opportunity to compare the crash experience between passenger car-only and mixed traffic rural freeway facilities. The results of the study show that outer lanes experience more crashes, both when raw numbers are used and exposure is included into the analysis. It shows that truck-related crashes contribute significantly to the total number of crashes on the outer lanes. In fact, trucks are over-involved in crashes given the exposure on these sections. Even though the outcome of this study suggests that separating truck traffic from passenger cars for freeway facilities improves safety, further work is needed to understand the contributing factors leading to truck-related crashes in the outer lanes.
INTRODUCTION

Decision-makers have long speculated that building separate roads for trucks and passenger cars, or at least separating them on their own lanes would accomplish two major objectives: 1) they would make the roadways safer for passenger cars, and 2) roadways designed specifically for a select class of vehicles rather than for all vehicles might represent overall savings in construction costs. This paper only addresses the first objective. Given the anticipated growth in truck traffic nationwide due to many factors (NAFTA, etc.), there is an urgent need to evaluate the safety impacts of removing trucks from the general flow of traffic. A study of the I-10 corridor published in 2003 and utilizing the Highway Performance Monitoring System (HPMS) and the Freight Analysis Framework (FAF) found that growth in truck traffic will outpace automobile traffic (1). The study concluded that, by 2025, automobile traffic would grow by 62 percent whereas truck traffic would grow by 118 percent along this corridor.

Recent studies that have evaluated the safety effects of truck traffic levels on freeway facilities have been quite sparse (2, 3, 4, 5). In addition, these studies have not provided clear understanding on how different truck traffic levels affect the number of crashes. Some of the findings have been contradictory. So far, no studies have specifically compared passenger cars-only with mixed traffic freeway facilities. As a result, there is a need to assess whether or not more homogeneous flows of traffic by vehicle type are safer than the current mixed flow scenario.

To accomplish the objective of the study, an exploratory analysis of crash data is conducted on a selected number of freeway sections located on the New Jersey Turnpike for the year 2002. These sections operate as a dual-dual freeway facility: divided inner and outer lanes. This type of geometry offers more flexibility in closing part of the freeway for maintenance activities or incidents. The turnpike’s traffic operations staff can easily shift traffic from one roadway to the other using changeable message signs. In fact, shifting the traffic need not just occur due to incidents or maintenance; it could happen just to balance the flows. Under normal circumstances, the inner lanes have only passenger cars, so the outer lanes serve commercial vehicles (trucks and buses) plus passenger cars. The selected sections, therefore, offer a very good opportunity to compare the crash experience between passenger car-only and mixed traffic rural freeway facilities. Finally, it is important to point out that the dual-dual freeway with exclusive passenger car lanes in New Jersey is the only type of facility of its kind in North America.

This paper is divided into four sections. The first section presents a review of previous work on exclusive and mixed traffic facilities, and their effects on safety and operations. The next section summarizes the data collection effort and discusses the characteristics of the study sections. The third section describes the results of the exploratory analysis. The last section presents a discussion of important issues and offers avenues for further work on this topic.
PREVIOUS WORK

The earliest attempts at separating cars and trucks were actually car-only facilities called “parkways” in the 1920s and 1930s (6). Moving forward in time to the past 30 years, the earliest mention of exclusive truck facilities (ETF) was in a 1977 ITE paper (7) which describes ways to improve urban goods movement efficiency. The paper did not document practice because none existed and none were pursued in that era.

In the mid-1980s, the Texas Department of Transportation (TxDOT) sponsored research to investigate the feasibility of exclusive truck facilities. In a Texas Transportation Institute (TTI) research performed in 1985, Mason et al. (8) described seven types of truck lane configurations. Construction of all of these treatments could occur within an existing right-of-way, especially if sufficient median width remained unused. In 1986, additional research (9, 10) by TTI examined the feasibility of an exclusive truck facility for a 75-mile segment of I-10 between Houston and Beaumont. The options considered in the study included: the construction of an exclusive truck facility within the existing I-10 right-of-way; construction of an exclusive truck facility immediately adjacent to I-10 outside of the existing right-of-way; or construction of an exclusive facility on, or immediately adjacent to, an existing roadway that parallels I-10 (U.S. 90). The studies concluded that existing and future trends in traffic volumes did not warrant an exclusive facility along the I-10 corridor.

After the passage of ISTEA there was more serious consideration of truck-only lanes in the 1990s. Another approach to separating truck and passenger car traffic is the dual-dual roadway, with the most notable example being the New Jersey Turnpike (the subject of this paper). The initial sections of the turnpike opened to traffic in 1951 (11).

A relatively new idea, which TTI is now evaluating, is called “managed lanes.” A managed lane facility is one that increases freeway efficiency by packaging various operational and design actions. The concept promotes adjustment of lane management operations at any time to better match regional goals. Managed lanes also offer peak period free-flow travel to certain user groups. Managed lane operations for trucks strategies include exclusive use lanes, separation and bypass lanes, dual use lanes, and lane restrictions (12).

In a current research project entitled “Strategies for Separating Trucks from Passenger Vehicle Traffic” (13) TTI is again investigating truck roadways. This research is being conducted in conjunction with one of the most revolutionary ideas for transportation in Texas and the largest engineering project ever proposed, called the Trans Texas Corridor. It is a concept that will connect Texas and other states with a 4000-mile network of corridors up to 1,200 ft wide with separate lanes for passenger vehicles (three in each direction) and trucks (two in each direction). The corridor as currently conceived will also include six rail lines (three in each direction), one for high-speed freight and one for conventional commuter and freight trains. There will also be a 200-ft wide dedicated utility zone. Figure 1 shows a conceptual view of the facility.
In a 1990 FHWA study, Janson and Rathi \((14)\) examined the feasibility of designating exclusive lanes for vehicles by type. This study, which ultimately resulted in a computer program known as exclusive vehicle facilities (EVFS), evaluated exclusive lane use feasibility by utilizing the following lane use possibilities: 1) mixed vehicle lanes, 2) light vehicle lanes (vehicles weighing less than 10,000 pounds), and 3) heavy vehicle lanes. Some 10 years later, Battelle updated the values previously used in the model and evaluated the program code, determining that its continued use was appropriate \((15)\). The program can evaluate the economic feasibility of exclusive lanes for specific sites on high-volume, limited access highways in both urban and rural areas. The Battelle study resulted in some criteria for providing truck facilities based on annual average daily traffic, annual average daily truck traffic, level of service, truck-involved crash rates in million vehicle-miles traveled (MVMT), daily traffic delays, and proximity to freight origin-destination points.

The mechanism for financing truck facilities in upcoming years will be an important topic. A recent study for the Reason Policy Institute by Samuel et al. \((16)\), proposed that self-financing toll truckways consisting of one or two lanes in each direction be built in the existing right-of-way. These truckways would be barrier separated from existing lanes and have their own ramps. The lanes would be designed specifically for trucks and trucks would have exclusive use of the lanes. Financing for the truckways would be from tolls collected from trucks using the facilities. Trucks using the truckways would be rebated federal and state fuel taxes for the mileage traveled on the truckways. Federal truck size and weight regulations would also be eased for truckway users.

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**Figure 1. Concept Plan View of the Trans Texas Corridor**

In the recent Transportation Research Board *Commercial Truck and Bus Safety Synthesis* 3 on “Highway/Heavy Vehicle Interaction,” the authors include a section on “exclusive lanes or roadways for heavy vehicles.” It includes summary results from a survey of states indicating the states that have considered or implemented measures to separate trucks from passenger vehicles. It states that exclusive lanes for trucks and buses have been considered by 17 percent of the highway agencies, exclusive lanes for buses only by 20 percent of the highway agencies, and exclusive roadways for heavy vehicles only by 3 percent of highway agencies. The Conclusions and Recommendations section of this synthesis includes the point that many highway agencies are facing decisions about whether to reduce traffic congestion by building exclusive truck roadways or exclusive truck lanes. It then makes the following statement: “Research is needed to provide safety performance measures to assist highway agencies in such decisions” (I7). Therefore this paper addresses a critical need in a timely fashion.

As indicated above, very few studies have examined how the level of truck traffic affects safety on freeway facilities. There exist studies that looked at the safety effects of different truck traffic control strategies (e.g., lane restrictions, exclusive truck lanes, etc.) (see I8, I9, 20), but very few addressed regular mixed traffic facilities. For instance, Jovanis and Chang (2) studied the safety effects of traffic exposure by vehicle and collision types on Indiana highways. They found that increased truck traffic is usually associated with an increase in the number of crashes, although the relationship increases at a decreasing rate for all truck-related crashes. On the other hand, Miaou (3) reported that an increase in truck percentages on urban and rural freeways in Utah were associated with a decrease in the number of crashes. He hypothesized that, for a constant vehicle density, as the percent of trucks increases, the frequency of lane change becomes less frequent, hence reducing the number of truck-car collisions. Hiselius (4) also found that increases in the number of trucks resulted in a decrease in the number of crashes on 83 rural highway sections in Sweden. She attributed this effect to the lower average vehicle speed in the traffic stream when the proportion of trucks increases. Nonetheless, she indicated that the low sample size may have affected the conclusions of the study. In summary, there is no clear understanding about the effects of how homogenous and non-homogenous traffic flow affects truck-related crashes on freeway segments.

**DATA COLLECTION**

Two study sections were used in this analysis. They are located on the northern part of the NJ Turnpike, near the Garden State Parkway (see Figure 2). The first study section is situated between interchanges 10 (MP 88.1) and 11 (MP 90.6) for a total length of 2.5 miles. On this section, both inner and outer segments have three lanes in each direction. The second section is located between interchanges 11 and 12 (MP 95.9) for a total of 5.3 miles. The inner segment contains three lanes per direction while the outer segment has 4 lanes per direction. The left lane on the outer segment is used as an HOV lane during the a.m. peak period and no trucks are allowed to use it. Trucks are restricted to the right two lanes in both the four-lane outer roadway and on the inner roadway if they happen to be diverted for some reason. All sections have 12-ft lanes with a 12-ft paved shoulder on the
right side of the traveled-way. The posted speed limit is 65 mph for both study sections, but turnpike personnel can reduce the speeds as needed via dynamic speed limit signs.

Figure 2. Location of Study Sections on the NJ Turnpike

The study period covered crashes that occurred for year 2002. Crash data contained detailed information about the severity, the location, the crash type, the type of vehicle, the day of the week, the direction of travel, and the time of day among others. The data were initially obtained as a printed computer output and were eventually coded into an electronic database. In 2002, there were 298 crashes, of which 78 involved trucks. The seven crashes that occurred on exit or entrance ramps were eventually removed from the analysis to minimize the influence of these ramps on crashes. Thus, all crashes used in this work occurred on the main traveled ways.

Traffic flows in annual average daily traffic (AADT) were obtained from the NJ Turnpike Authority. The data were available for each section and separated by vehicle class and by direction. The data are collected for nine different vehicle classes (e.g.,
passenger cars, two-axle trucks, tractor-trailers, two- and three-axle buses, etc.). As stated above, only passenger cars (class 1) are allowed in the inner lanes (again, except for incidents, maintenance, and lane balancing). The split for passenger car traffic between the inner and outer lanes is about 65% and 35% respectively. Table 1 summarizes the AADT traffic by vehicle class (1 = passenger cars; 2 to 9 = trucks and buses). This table shows that about 30% of the vehicular traffic on outer lanes are heavy vehicles.

<table>
<thead>
<tr>
<th>Interchanges</th>
<th>Inner Lanes Total</th>
<th>Outer Lanes Passenger Cars</th>
<th>Outer Lanes Trucks &amp; buses</th>
<th>Outer Lanes Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southbound</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 11</td>
<td>54,280</td>
<td>29,228</td>
<td>12,953^a</td>
<td>42,181</td>
</tr>
<tr>
<td>11 to 12</td>
<td>64,424</td>
<td>34,690</td>
<td>15,498^b</td>
<td>50,188</td>
</tr>
<tr>
<td>Northbound</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 11</td>
<td>57,587</td>
<td>31,008</td>
<td>14,431^c</td>
<td>45,439</td>
</tr>
<tr>
<td>11 to 12</td>
<td>66,260</td>
<td>35,679</td>
<td>16,810^d</td>
<td>52,489</td>
</tr>
</tbody>
</table>

Buses = ^a4.7%, ^b7.9%, ^c4.4%, ^d7.5%

CRASH DATA ANALYSIS

This section describes the characteristics of crashes that occurred between mile markers 88.1 to 95.9 on the NJ Turnpike in 2002. It first presents information on the general characteristics of crashes occurring on selected sections. Then, it summarizes passenger car and truck-related crashes between the inner lanes (passenger car-only) and outer lanes (mixed traffic).

GENERAL CHARACTERISTICS

As reported above, a total of 298 crashes occurred on the New Jersey Turnpike in 2002. Table 2 depicts the number of crashes by collision type and whether the crash occurred in the outer or inner lanes. This table shows that sideswipe collisions occur more frequently than any other type of crashes in both the inner and outer lanes. Table 2 also illustrates that more crashes per mile occur in the outer lanes than in the inner lanes. Also, total rear-end collisions occur more frequently in the outer lanes than inner lanes, which may suggest that traffic flow is subjected to more unstable traffic conditions (or non-homogeneous flow). Similarly, sideswipe collisions occur more frequently in outer lanes. Interestingly, collisions with an object happen more frequently in the inner lanes. This finding may suggest that the lower undercarriage clearance of cars is a contributing factor in object collisions. In fact, the data show that very few heavy vehicles hit an object on the road.
Table 2. Crashes by Accident Type and Lane Designation

<table>
<thead>
<tr>
<th>Accident Type</th>
<th>Outer Lanes</th>
<th>Inner Lanes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ran-off-road</td>
<td>11</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Collision with an object</td>
<td>22</td>
<td>31</td>
<td>53</td>
</tr>
<tr>
<td>Collision with a guardrail</td>
<td>29</td>
<td>24</td>
<td>53</td>
</tr>
<tr>
<td>Rear-end</td>
<td>43</td>
<td>31</td>
<td>74</td>
</tr>
<tr>
<td>Sideswipe</td>
<td>50</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>Others</td>
<td>20</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>175</strong></td>
<td><strong>123</strong></td>
<td><strong>298</strong></td>
</tr>
<tr>
<td><strong>Miles</strong></td>
<td><strong>7.8</strong></td>
<td><strong>7.8</strong></td>
<td><strong>7.8</strong></td>
</tr>
<tr>
<td><strong>Crashes/mile</strong></td>
<td><strong>22.44</strong></td>
<td><strong>15.77</strong></td>
<td><strong>38.21</strong></td>
</tr>
</tbody>
</table>

Figure 3 shows the number of crashes by severity and excludes the cross-median collisions (8) and the uncategorized or unknown crashes (3); these crashes could not be assigned using the criteria defined in this figure. This figure shows the data by direction of traffic, i.e. northbound and southbound, as well as by lane designation, i.e. inner and outer lanes. Figure 3 shows that property damage only (PDO) crashes account for about 75% of all crashes; there were no fatal crashes in 2002 on these two sections. Interestingly, there are proportionally more PDO crashes on outer lanes than inner lanes. This indicates that the speed of traffic is probably lower in outer lanes than inner lanes. Higher vehicle speed is associated with higher occupant severity (21). Finally, the northbound and southbound lanes experience similar numbers of crashes in both outer lanes.

Figure 3. Number of Crashes by Direction, Lane Designation, and Severity
Figure 4 shows the number of vehicles involved in a crash. The figure reveals that more single vehicle crashes occur on inner lanes than outer lanes, with about 30% and 50% of all crashes respectively.

![Figure 4. Number of Vehicles Involved in a Crash](image)

Figure 5 illustrates the number of crashes by weather conditions. This figure shows that more than 80% of crashes occurred during clear conditions. The outer lanes experienced more crashes than the inner lanes for all types of weather conditions.
Figure 5. Number of crashes by weather conditions

Figure 6 shows the number of crashes by day of the week. This figure shows that outer lanes have a higher percentage of crashes occurring during a week day than inner lanes. On weekends, the inner lanes experience more crashes than week days. As shown in the next section, the higher percentage of crashes in the outer lanes on week days may be attributed to truck traffic.

Figure 6. Number of Crashes by Day of the Week
TRUCK-RELATED CRASHES

Figure 7 illustrates the types of crashes for passenger cars and trucks. As this figure indicates, about 45% of all truck-related crashes are categorized as sideswipe collisions. This finding is similar to previous work on this subject (5). However, trucks are not over-involved in rear-end collisions and run-off-the-road crashes, as reported in Golob and Regan (5). As indicated above, passenger cars collide more frequently with an object on the pavement than trucks. Finally, passenger cars hit guardrails more frequently than trucks do.

![Figure 7. Percentage of Crashes by Collision Type for Trucks and Passenger Cars](image)

Figure 8 illustrates the severity of the crashes as well as lanes where they occurred. A few truck crashes occurred on the inner lanes when the outer lanes were closed. The severity pattern for passenger cars is very similar between inner and outer lanes.
Figure 8. Number of Crashes by Type of Vehicle, Lane Designation, and Severity

Figure 9 shows the number of crashes by day of the week for trucks and cars respectively, as well as inner and outer lanes. As illustrated in Figure 8 and initially shown in Figure 6, the outer lanes experience a large number of truck-related crashes. If truck-related crashes were removed from the inner lanes, the outer lanes would roughly experience the same amount of crashes during the week days. Very few truck crashes occurred during the weekend because trucks travel less frequently during this period.

Figure 9. Number of Crashes by Day of the Week, Location and Vehicle Type
Figure 10 illustrates the severity of the crash by type of vehicles involved in the collision. This figure shows that the proportion of severe injury car–truck collisions is about the same as severe injury collisions involving two cars. Very few single-truck or truck versus truck crashes caused an injury.

![Figure 10. Number of Crashes by Vehicle and Severity Types](image)

Table 3 summarizes the crash rate (in $10^6$ vehicle-miles) by direction of travel and mile markers. This table shows the rates (all crashes) as a function of the combined passenger car, bus and truck exposure (all vehicles). It is important to point out that the relationship between crashes and exposure has usually been found to be non-linear (22, 23). There were not enough observations, in this study, to properly test this assumption. Thus, a simplification (i.e., using crash rates) had to be made for this part of the analysis. Table 3 suggests that the crash rate in the outer lanes is almost double that in the inner lanes, given the same exposure. This outcome may indicate that truck traffic had an influence on crashes. Finally, the rates for the northbound and southbound traffic provide similar values, similar to what was reported above.

<table>
<thead>
<tr>
<th>Mile Marker</th>
<th>OUTER LANES</th>
<th>INNER LANES</th>
<th>NORTHBOUND</th>
<th>INNER LANES</th>
<th>OUTER LANES</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=88.1 &gt;90.6</td>
<td>0.052</td>
<td>0.442</td>
<td>0.494</td>
<td>0.081</td>
<td>0.162</td>
</tr>
<tr>
<td>&lt;=90.6 &gt;95.9</td>
<td>0.165</td>
<td>0.546</td>
<td>0.711</td>
<td>0.120</td>
<td>0.241</td>
</tr>
</tbody>
</table>
Table 4 shows the crash rates by isolating the passenger car and truck traffic exposure (no bus exposure). In this table, for three out of four sections, truck-related crashes occur more frequently than passenger car only crashes given the same exposure. In other words, the number of truck crashes per truck is higher than the number of passenger car crashes per passenger vehicle, ceteris paribus. Similar numbers were reported by Miaou (3).

Table 4. Crash Rates for Trucks and Passenger Cars Disaggregated by Exposure

<table>
<thead>
<tr>
<th>Mile Marker</th>
<th>SOUTHBOUND</th>
<th>NORTHBOUND</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OUTER LANES</td>
<td>INNER LANES</td>
</tr>
<tr>
<td>&lt;=88.1 &gt;90.6</td>
<td>ALL Injury PDO</td>
<td>ALL Injury PDO</td>
</tr>
<tr>
<td>Trucks &lt;=90.6 &gt;95.9</td>
<td>0.000 0.444</td>
<td>0.904</td>
</tr>
<tr>
<td>Cars &lt;=88.1 &gt;90.6</td>
<td>0.075 0.450</td>
<td>0.162 0.242</td>
</tr>
<tr>
<td>&lt;=90.6 &gt;95.9</td>
<td>0.164 0.492</td>
<td>0.112 0.223</td>
</tr>
</tbody>
</table>

Figure 11 shows the crash rates separated by passenger cars and truck-related crashes. This figure offers a clearer picture about the magnitude of truck-related crashes to the overall crash rate. On two of the four sections, truck-involved crashes are the majority, and on the other two trucks are significant contributors to the overall crash rate. Most of the truck-related rates involve a truck and a passenger car.
a) Mile Markers: 88.1 to 90.6

b) Mile Markers: 90.6 to 95.9

Figure 11. Crash Rates for Trucks and Passenger Cars by Lane Designation
DISCUSSION

The results of the exploratory analysis show that the outer lanes experience more crashes than the inner lanes, both when raw numbers are used and when exposure is incorporated into the analysis. Given the outcome of the analysis, there is a need to determine the potential factors that could explain this difference. Possible hypotheses on this question follow.

The analysis performed in this work seems to indicate that trucks have a strong influence on the safety of outer lanes. As a matter of fact, truck-related crashes account for more than 40% of all crashes occurring on the outer lanes, yet trucks account for only 30% of the vehicles traveling on the outer lanes. This means that truck-related crashes are over-represented in outer lanes. Garber and Joshua (24) noted the same outcome in their study of large-truck crashes in Virginia. It is unclear whether truck traffic levels, highway geometrics, traffic flow states or a combination of all these factors play a role in truck-related crashes.

As indicated above, the safety effects of truck levels, defined as homogeneous and non-homogeneous traffic flows, is currently not well understood (2, 3, 4). The two seminal studies arrive at opposite conclusions. Jovani and Chang found that an increase in truck traffic increases truck-related crashes, whereas Hiselius established no such relationship. Thus, the jury is still out on this effect. If one makes abstraction of vehicle performance and its effects on traffic flow states (addressed below), the exploratory analysis shows that trucks are often involved in sideswipe collisions. It is a known fact that trucks have significant blind spots. Thus, it may be reasonable to assume that increased truck traffic may lead to more sideswipe collisions compared to a similar facility with passenger cars only (though other types of crashes are expected to increase as well, such as run-off-the-road crashes).

Another hypothesis could be related to differences in highway geometrics. For instance, controlling criteria governing relevant highway design elements, such as grades, lane widths, lateral sight distances or horizontal curves, could affect the vehicle performance of trucks, thus negatively influencing the safety of the facility. At the study locations however, the roadway geometry between inner and outer lanes is very similar. For instance, the typical cross-section, including the lane width, is essentially the same between both sets of roadways. Similarly, the selected study sections do not have any steep grades that would affect the performance of trucks. Perhaps the location of ramps could potentially explain the difference, especially since a large proportion of trucks are involved in sideswipe collisions (e.g., trucks that change lanes near entrance ramps). However, with the current database, it not possible to investigate whether or not crashes occurred near an exit or entrance ramp (i.e., the data do not indicate the lane in which the crash occurred).

It is possible that a portion of the difference for the crash rates between inner and outer lanes could be attributed to the fact that PDO crashes involving a heavy vehicle is more likely to be reported than a PDO involving a single or two passenger vehicles. Although
possible, one would not expect the driver of a heavy vehicle fleeing the scene of a crash. Unfortunately, with the data at hand, the research team was unable to examine the issue of reportable crashes as a function of the vehicle type. Further work is needed on this topic.

The last hypothesis is related to the traffic flow states. There has been a significant amount of research conducted over the last two or three years on the safety effects of traffic flow states on urban and rural freeways (25, 26, 27). The recent work has shown that vehicle density and volume-to-capacity (V/C) ratios have a great impact on freeway safety, although the effects are more significant for urban freeways. Some have argued that a greater variance in the speed distribution of vehicles on a freeway segment increases the risk of collisions (28, 29); however, not everybody agrees with this argument (30). It is a well-known fact that increased truck traffic can have a significant impact on freeway operations (31). It is impossible with the current data to evaluate this hypothesis.

Some of the hypotheses discussed above could potentially be answered through more sophisticated statistical analyses, combined with the use of disaggregated data (e.g., hourly flows, crashes per lane, etc.). For instance, incorporating V/C ratio or vehicle density would certainly help determine the safety effects of traffic flow states as a function of truck traffic levels (see 27). Thus, the authors suggest additional work using disaggregated data in order to understand the characteristics of the differences in safety between outer and inner lanes.

The results of the exploratory analysis seem to suggest that truck-free freeway facilities would have a better safety record than mixed traffic facilities. This outcome is consistent with other work on this subject. Using simulation tools, others have suggested that removing trucks from mixed traffic lanes and building exclusive truck facilities would significantly improve operations, which should result in important safety gains (14, 15). In conclusion, it is advised that additional work be conducted on this subject before implementing passenger car only freeway facilities.

SUMMARY AND CONCLUSIONS

The objective of this study consisted of assessing whether or not more homogeneous flows of traffic by vehicle type are safer than the current mixed flow scenario. To accomplish this objective, an exploratory analysis of crash data was conducted on a selected number of freeway sections of the New Jersey Turnpike for the year 2002. These sections operate as a dual-dual freeway facility: divided inner and outer lanes. At these locations, the inner lanes have the special characteristic of being for passenger cars only (homogeneous traffic) with some exceptions. The selected sections, therefore, offered a very good opportunity to compare the crash experience between passenger car-only and mixed traffic rural freeway facilities.
The results of the study showed that the outer roadway experiences more crashes, both when raw numbers are used and exposure is included into the analysis. The results also show that truck-related crashes contribute significantly to the total number of crashes on the outer lanes. In fact, trucks are over-involved in crashes given the exposure on these sections. Even though the outcome of this study suggests that separating truck traffic from passenger cars for freeway facilities improves safety, further work is needed to understand the contributing factors leading to truck-related crashes in the outer lanes.

There is also a need to compare the cost of truck roadways versus no truck roadways, given the difference in crashes. The sponsored research will investigate costs, but until then, the authors suggest the use of a computer program (15) which can evaluate the economic feasibility of exclusive lanes for specific sites on high-volume, limited access highways in both urban and rural areas.

ACKNOWLEDGMENTS

The authors would like to acknowledge Mr. Robert Dale and Mr. Jerry Kraft from the New Jersey Turnpike Authority for providing data and other relevant information about the selected freeway sections. They also thank Ms. Amanda Anderle for providing assistance during the data reduction process. Finally, this paper benefited from the input of TRB reviewers.

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