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Analysis of Road Traffic Accidents on NH 45 (Kanchipuram District)

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ABSTRACT

With the support and cooperation of the Kanchipuram district police and Tamil Nadu police, researchers conducted detailed investigations of accidents occurring on the National Highway 45 over a 60 km stretch. The primary objective was to collect and analyze India-based traffic crash data to begin to create a sound basis for decision making for improving safety on India's roadways. A secondary objective was to establish a standardized methodology using economical tools for collecting and analyzing crash data, specific to Indian roads. For the 45 day study period, an accident intimation network was established between researchers and all police stations/highway patrols in the study area. On occurrence of an accident, police called a 24-hour contact number and researchers responded to the scene. On site, researchers used standardized reporting forms, methodologies, and equipment to perform accident scene examinations, accident vehicle examination, and AIS injury coding. The collected accident data was categorized first by single- or multiple-vehicle crash and next by accident type based on the first accident event. The data was then analyzed to identify accident (crash type, location time), vehicle (vehicle type, pre-crash condition), occupant (restraint use, gender, age) and other contributing factors, and environmental factors associated with injury severity. Findings show that front-to-rear collisions, mainly involving trucks and buses, caused due to slowing down, stopping, breaking down or overtaking account for 59% of the accidents. This paper presents the methodology adopted, data analysis, results, conclusions and recommendations to mitigate road accidents and injuries on NH 45 and other similar highways.

INTRODUCTION

In August 2008, the Tamil Nadu (State) Police gave researchers permission to carry out a traffic accident research project on a section of National Highway 45 (NH 45) between Otteri and Acharapakkam in Kanchipuram District, with the help of the Kanchipuram District Police. The project involved collecting in-depth accident data on accidents occurring in the period starting from **1 September 2008** to **15 October 2008**.

The objectives for this real time accident investigation and data collection project were:

1. To initiate in-depth traffic accident data collection with the support of the police.
2. To establish a methodology and develop a framework for a comprehensive accident database for road accidents in India.
3. To understand the nature of accidents and identify causes/problems along NH 45.
4. To provide recommendations based on this study for reducing accidents on NH 45.

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THE AREA OF STUDY

A 60 km stretch of the NH 45 between Otteri and Acharapakkam in Kanchipuram District was selected for the study. Some features of this highway are given below:

- The entire stretch is a 4 lane divided highway.
- Road surface is asphalt.
- The divider is about 5 m in width and is usually planted with large bushes and plants, except at U-turns, intersections and bridges.
- No potholes were observed all along the main highway.
- Speed Limit at some sections is 60 kmph and at other sections is 80 kmph.
- Lighting is provided only at intersections/junctions and some areas such as truck lay bys. Otherwise a good part of the highway is not lit.
- The highway infrastructure also includes:
  a. 1 Toll booth.
  b. 3 Truck Lay-Bys.
  c. 60 bus stops (counting both directions).
  d. 19 petrol pumps.
- Number of police stations: 9
- Number of highway police patrol cars: 3
- EMS is provided by an Emergency Accident Relief Centre (a small station with an ambulance) operated by Parvathy Hospital (private), which is located outside the study area, and Chengalpattu Medical College and Hospital (government) located inside Chengalpattu Town.

METHODOLOGY

ACCIDENT INTIMATION - For the 45-day period of this study, an accident intimation network was established between researchers and all the police stations and highway patrols located in the study area. On occurrence of an accident, the police called a dedicated contact number that was manned 24 hours a day by researchers during the entire project period. As soon as a call was received and details of the accident noted down, researchers travelled to the accident scene from their base camp in Chengalpattu town, which is located midway of the study area. After visiting the accident scene, the researchers collected accident details (police reports, vehicle and driver documents and injury details) from the police station in whose jurisdiction the accident took place. The study being purely scientific, no proprietary information, such as names/addresses of accident victims and vehicle registration numbers, was included in the research. On arrival at the scene, the accident was investigated by our researchers as described below. Data was obtained and recorded using readily available equipment. The aim was also to demonstrate that data capture need not have to be expensive. Of course sophisticated equipment to capture the data will be introduced in future studies.

SCENE EXAMINATION – Scene data is very important for understanding the cause of an accident. Photographs of the point of impact (POI), vehicles, and surroundings are taken from all angles, especially covering the direction of vehicle approach and travel. The notion is to document the accident and all available evidence in photographs, which can be used for future references and analyses. Recording the GPS coordinates and the distance of the point of impact from other specific locations help in identifying the exact accident location for future study and identification of black spots. Scene measurements help identify the final resting positions of the crashed vehicles after a collision, the position of any object that may have been struck by a vehicle, and volatile evidence (such as skid marks, broken parts, etc.) with respect to the road infrastructure and surrounding environment. Infrastructure assessment involves recording the road infrastructure and surrounding environment details such as road type, surface condition, road quality, flow of traffic, presence of a divider or median, junction type, road construction material, weather, lighting, etc. On completion of the above activities and after developing an understanding of the accident events, the entire accident scene is diagrammatically represented to scale in order to give a simple and clear picture of the accident for future reference.

Figure 1A shows the diagram of an accident scene. The truck V2, which had stopped at the petrol station on the other side for refueling, exited the petrol station to join back onto the other side of highway. The car V1, approaching the intersection, braked and skidded for a distance before hitting the rear left wheel of the truck V2. Photographs of the scene showing the direction of approach and travel are given in figures 1B and 1C.

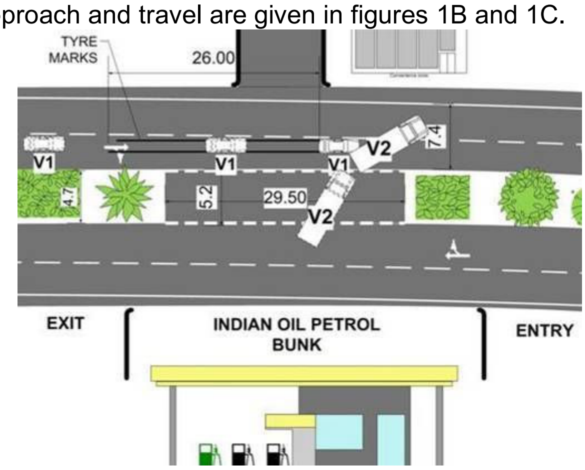

Figure 1A: Accident scene diagram

Figure 1B: Accident spot and direction of approach

Figure 1C: Direction of travel

VEHICLE EXAMINATION – Researchers examined crash vehicles on-scene and/or after it was towed to the side of the road. This examination involved:

- Recording direct and indirect damages.
- Determination of Collision Deformation Classification (CDC) [1] for cars and SUVs or Truck Deformation Classification (TDC) [2] for trucks.
- Measurement of interior intrusions.
- Occupant contact points with vehicle interiors.
- Determination of belt use/airbag deployment.

Based on the type of vehicle involved, researchers scientifically describe impacts on a vehicle by using the seven-character Collision Deformation Classification (CDC) code as per the Society of Automotive Engineers (SAE) standard J224 [1] or the seven-character Truck Deformation Classification (TDC) code as per the Society of Automotive Engineers (SAE) standard J1301 [2]. This internationally accepted standard crosses language barriers and gives a 3-dimensional description and specified magnitude of the impact damage on a vehicle. In addition the CDC/TDC helps in describing, recording and communicating vehicle impact damage very easily in reports and analyses. CDC/TDC retains the damage information for reference should it be required at a future date, especially in the physical absence of the vehicle. An example of CDC is described using the damaged car, shown in figure 2, examined in our study.

Figure 2: Frontal impact damage

For the impact damage shown in figure 2, the CDC obtained is:

0 1 F Z E W 3

01 = Principal Direction of Force (1 o'clock direction)
F = Type of Impact (Frontal)
Z = Location of Damage (Right and centre of frontal
E = area)
W = Vertical Location (Below lower end of windshield)
3 = Type of Damage Distribution (Wide)
Maximum Extent of Crush from front bumper to lower windshield on a scale from 1 to 5

This methodology is developed for passenger cars and SUVs, but researchers used the first four characters to apply CDC to motorcycles and buses as shown in table 1.

Table 1: Case examples of CDC applied to two-wheelers and buses and TDC applied to trucks.

CDC (first 4 characters only)	**TDC**
	
12FD	12FDHR7
	
12FL	12FRAW9

INJURY CODING AND CORRELATION – The Abbreviated Injury Scale (AIS) [3] developed by the Association for the Advancement of Automotive Medicine (AAAM) is used by researchers for injury coding. The code has seven digits in which the first digit represents the affected region of the body, the second digit the type of anatomical structure, the third and fourth the specific anatomical structure and the fifth and sixth the level of injury. Based on the values given to these six digits, the seventh digit is determined which gives the severity of the injury. The severity is indicated by a number ranging from 1 to 6 as shown in the table below:

Table 2: Abbreviated Injury Scale

Scale	Severity	Example
1	Minor	Superficial laceration
2	Moderate	Fractured sternum
3	Serious	Open fracture of the humerus bone
4	Severe	Perforated trachea
5	Critical	Ruptured liver with tissue loss
6	Unsurvivable	Total severance of aorta

An example of injury coding and correlation is described below. Figures 3A, 3B and 3C show the exterior and interior parts of a car involved in a rollover accident examined under this study. Although the driver escaped uninjured, the front left occupant sustained injuries in the accident.


Figure 3A: Rollover accident.

Figure 3B: Roof crush measured is 18 cm and occupant contact identified.


Figure 3C: Occupant contact points.

The injury report for the front left occupant mentioned a head laceration. The AIS codes obtained for the injuries were as follows:

Injury	AIS code
Head Laceration	110600.1

The occupant contact points in the car interiors, shown in figures 3B and 3C, were examined and then correlated with the injuries of the occupant to determine the cause of each injury. As can be seen the blood marks on the roof indicate injury on the head. On closer inspection of the windshield, blood marks were found giving the indication that the occupant's head hit the windshield, which caused the injury. Hence the source of the head laceration was determined as windshield.

This also indicates that the occupant was not wearing seatbelts, and the same was confirmed on checking the seatbelts as they too had no marks on them to indicate usage. This type of correlation is important for reconstructing the occupant position and occupant kinematics (the manner in which the occupant moves) during an accident. The classification of injuries and determination of their severity helps to identify those specific injuries that cause accidents to be fatal. Based on data collected over a period of time, injuries can be studied and conclusions can be drawn on types of steps that could be taken to prevent such fatal injuries.

During the study, coding of injuries could not be an area of focus due to permissions required to obtain hospital records. Researchers performed injury coding based on injuries mentioned in the police reports. For the analysis, the traditional classification of "Fatal", "Grievous", "Minor" or "No Injury" been used by the police departments in their reports.

PROFILE OF ACCIDENTS INVESTIGATED

Over the 45 days of this project, researchers investigated 32 accidents. The accident data parameters are provided in Appendix A. Figure 4 gives the distribution of accidents by level of injury noted at the time of accident.

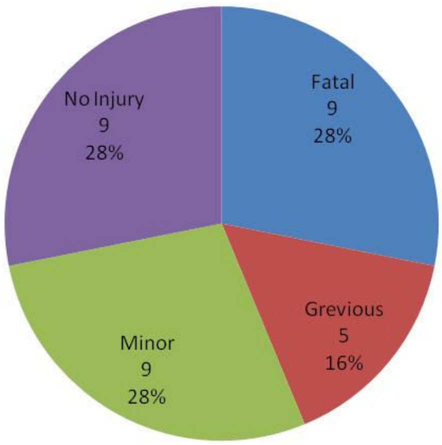

Figure 4: Distribution of accidents by injury level.

The distribution of accidents by time is shown in figure 5. 21 of the 32 accidents (65.6%) took place between 00:00 and 09:00 hours. Maximum number of accidents recorded (10) was between 03:00 to 06:00 hours.

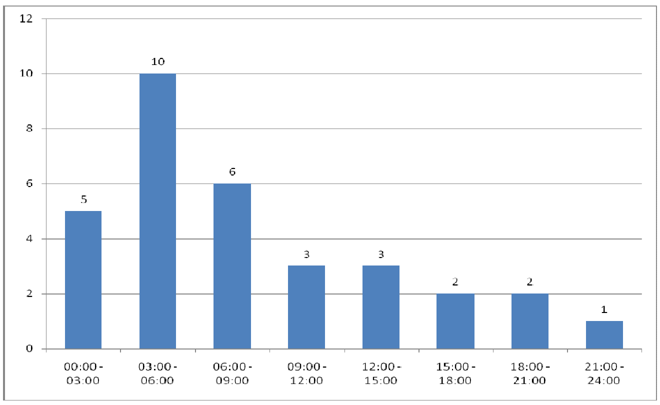

Figure 5: Accident distribution by time

Figure 6 shows the type and number of road users involved in the 32 accidents investigated. Trucks form the majority vehicle type (45.61%) followed by passenger cars (15.79%).

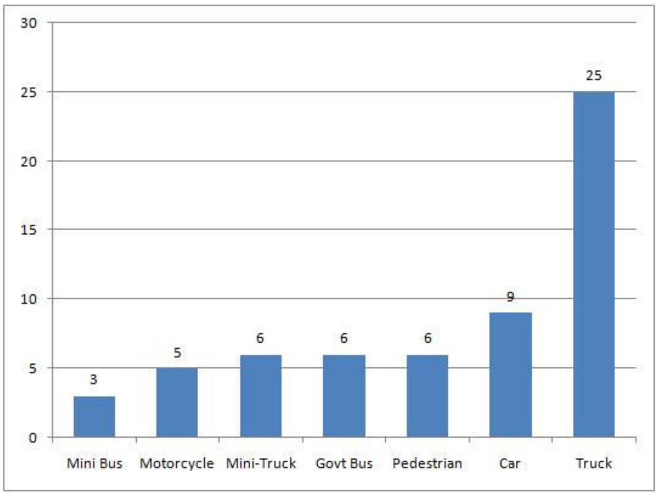

Figure 6: Accident distribution by road user type.

The above graphs broadly indicate that night time accidents, involving trucks, is an area for further research. The general reason for this could be a restriction on entry of trucks into Chennai city limits between 7:00 am and 11:00 pm. This restriction compels truckers, transporting goods and construction material to various parts of the city, to drive only during the night time and make as many trips as possible for monetary gain.

DETAILED ANALYSIS

To get a deeper insight into the accidents, the 32 accidents were categorized for analysis as shown in figure 7. The accidents are first divided into Multiple-Vehicle and Single-Vehicle Accidents. They are then sub-divided as per the type of accident based on the 1st accident event.

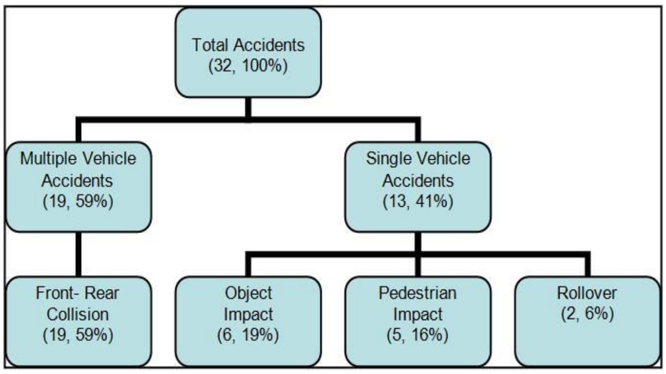

Figure 7: Breakup of accidents for analysis.

Front-Rear collisions account for 59% of the accidents investigated. If pedestrian impacts are excluded then front-rear collisions comprise 70% of accidents investigated. This is the only Multiple-Vehicle type of accident that has been observed by researchers on the NH 45. Head-on collisions were not observed as this 4 lane highway has a wide centre median separating traffic flowing in opposite directions.

A look at the injury severity distribution in figure 8 gives a clearer indication of the injury contribution of each type of accident event. Front-Rear Collisions and Pedestrian Impacts dominate fatal accidents, followed by Object Impacts, while Rollovers involved no injuries in this study.

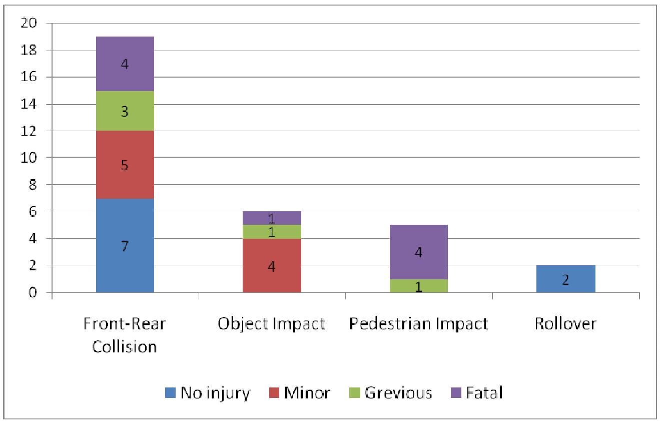

Figure 8: Injury severity distribution by type of accident

The following sections provide insights into each of these types of accident events.

FRONT-REAR COLLISIONS - Based on the study of 19 Front-Rear collisions, the following are some important observations:

1. Of the two vehicles involved, one is a “leading” vehicle while the other is a “following” vehicle.
2. The “leading” vehicle suffers either a rear impact (13 out of 19) or a side impact (6 out of 19), while the “following” vehicle suffers a frontal impact.
3. The “leading” vehicle is usually the initiator (but not necessarily the cause) of the accident, while the “following” vehicle is usually the victim of the accident.

The “leading” and “following” vehicles are studied separately to understand their composition and effects on injury severity.

“Leading” Vehicle Characteristics: Figure 9 describes the types of leading vehicles investigated and their effect on injury severity. From the graph it can be noted that:

1. Trucks (14) form the majority of leading vehicles involved in Front-Rear collisions, while Buses (3) come a distant second.
2. The injury severity distribution clearly indicates that larger vehicles (trucks and buses) inflict serious injuries as leading vehicles to occupants of the following vehicles.
3. In the case involving the passenger car as a leading vehicle, fatal injuries were suffered by the occupants of the car and not the following vehicle.

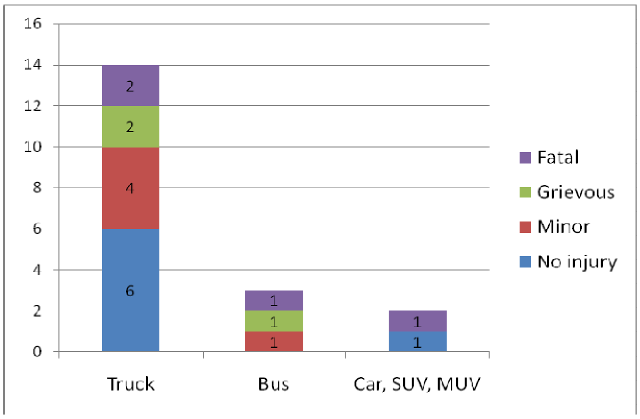

Figure 9: Accident distribution by leading vehicle type and injury severity of the following vehicle.

"Following" Vehicle Characteristics – Figure 10 describes the types of following vehicles and the severity of injury suffered by their occupants.

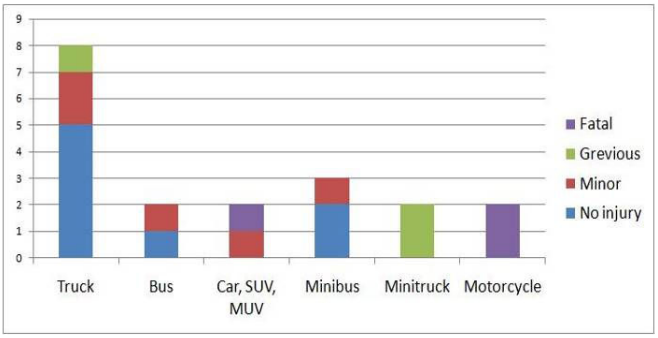

Figure 10: Accident distribution by following vehicle type and injury severity.

From the above graph it can be summarized that:

1. Following vehicles have a larger distribution of vehicle types. Again trucks (8) form the majority of following vehicles.
2. The injury severity distribution clearly indicates that smaller vehicles usually suffer fatal or grievous injuries as following vehicles, while larger vehicles usually suffer only minor or no injuries.

Based on the analysis of "leading" and "following" vehicle characteristics, it can be stated that trucks were the "leading vehicles" in 74% of the front-rear collisions. A deeper understanding is required as to why the accidents are initiated in the first place. The pre-accident conditions in each case of front-rear collision were determined and analyzed.

Pre-Accident Condition of "Leading Vehicle": On studying the 19 Front-Rear collisions, all the 19 accidents could be categorized into the following pre-impact conditions of the leading vehicle.

a. Slowdown: Leading vehicle slows down and following vehicle crashes into it. Slowing down was observed to occur at or near U-turns, gas stations, restaurants or traffic jams (caused by other accidents). In all these cases, there is decision making involved on the part of the driver. Drivers get to know about these locations/situations only when they get very close, hence they slow down to decide whether they want to make a stop or not. If information for each of these locations is provided well in advance through proper sign boards/indications, the driver will be aided to make decisions in advance and prevent sudden slowing down.

b. Stopped: Leading vehicle has stopped/parked for a reason and following vehicle crashes into it. Stopping usually occurs due to the driver/occupants deciding to take a nap or to relieve themselves during a long drive. A facility or area developed to help bus passengers and truck drivers to rest, and information regarding these areas provided well in advance to road users, can help in reducing these accidents.

c. Breakdown: Leading vehicle is broken down/being repaired when the following vehicle crashes into it. Usually tyre punctures are observed and occasionally engine problems. This condition is very dangerous, as occupants are standing outside and close to the vehicle. Breakdown of trucks (need for repairs) was usually due to tyre punctures. Trucks may stop alongside the road for this, but there were instances when trucks were observed being repaired in the middle of the road without proper indications or warning signals.

d. Overtaking: While overtaking the following vehicle, the leading vehicle immediately gets in the path of the following vehicle or slows down in front of it, and the following vehicle crashes into the leading vehicle. The small sample of overtaking accidents does not provide enough information to analyze overtaking conditions in detail. In general it was observed that lack of lane disciple, no signalling by drivers, overtaking from the left side and high speeds caused these accidents. Fatal accidents occurred when there was a large difference in the size of the vehicles involved. In case of motorcycles, helmet usage would seem critical to avoid fatal accidents due to head injuries; however, as noted, more overtaking accidents need to be studied, and in greater detail, to allow conclusions as to the exact conditions and nature of these accidents.

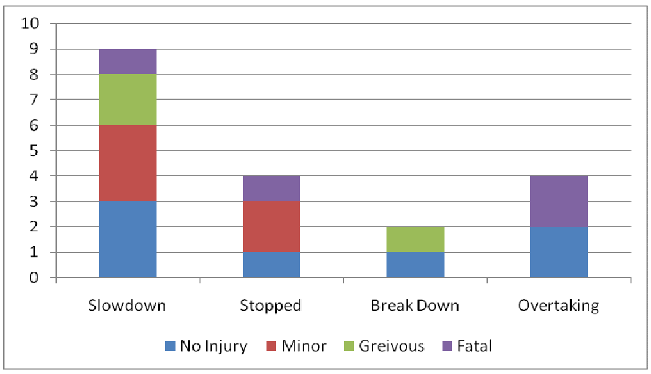

Figure 11: Accident distribution by pre-accident condition of leading vehicle and injury severity of the accident.

Figure 11 shows the leading vehicle condition and the corresponding injury severity of the accident observed. “Slowdown” condition has the maximum contribution to injuries, followed by “overtaking”, “stopped” and “breakdown” conditions. The vehicle types involved in each pre-accident condition is shown in Figure 12. Trucks form the majority and slowdown condition is highest compared to other pre-accident conditions.

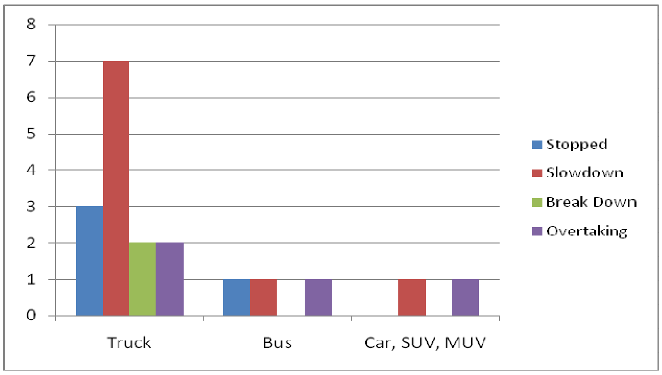

Figure 12: Leading vehicle type and pre-accident condition.

Vehicle Lighting and Visibility: The time of occurrence (day or night) shows that accidents due to breakdown, stopped and slowing down vehicles occurred mostly at night, indicating the significance of vehicle lighting and visibility.

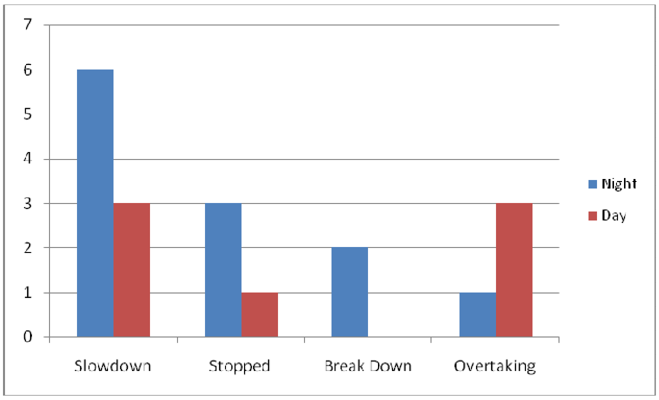

Figure 13: Pre-accident condition and lighting conditions.

Of the 19 front-rear collisions investigated, 12 occurred at night. In all 12 cases, the accident scene had no lighting. Also during the study it was observed that many trucks and buses did not have operational tail lamps and also lacked prominent reflective strips.

Hence, we see that Front-Rear collisions usually involve:

1. Heavy vehicles, majority trucks.
2. Poor vehicle lighting and visibility due to non-operational tail lamps and lack of reflective markings.
3. Last minute decision making by the driver due to insufficient information signboards.
4. Incorrect parking/standing of vehicles alongside or on road.
5. Poor intersection, entry/exit design.

OBJECT IMPACTS - 6 object-impact accidents were examined. These were initiated due to driver’s loss of vehicle control caused by either a sudden steering movement or sleep/fatigue. Due to the small number of object-impact accidents, results are presented for man-made road side constructions only. Although these constructions are created with the sole purpose of warning or alerting drivers, this study showed evidence that they fail to protect vehicle occupants in the event of a crash.

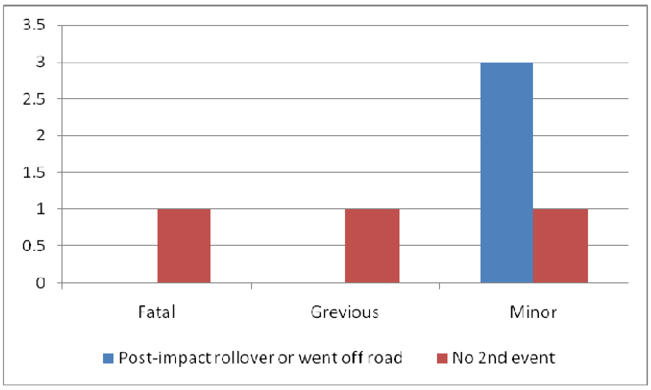

Figure 14: Effect of 2nd accident event on injury severity

As represented in figure 14, it is observed that for vehicles that have a second accident event (i.e., after the object impact) where the vehicle has rolled over or left the road, the injury severity is less when compared to injury severity for vehicles that do ***not*** have a second accident event (i.e., vehicle is stopped abruptly).

Hence, objects that deflect the vehicle from its path result in minor or no injuries compared to objects that bring the vehicle to a stop abruptly. This corroborates the fact that roadside barriers and walls should be designed to deflect the vehicle and provide some crash protection in the event of a vehicle crashing into them. Infrastructure design needs to be more forgiving.

PEDESTRIAN IMPACTS - 5 pedestrian-impact cases were investigated to gain some insight into these accidents. Figure 15 shows the number of vehicles (by type) and severity of the injuries sustained by the pedestrians.

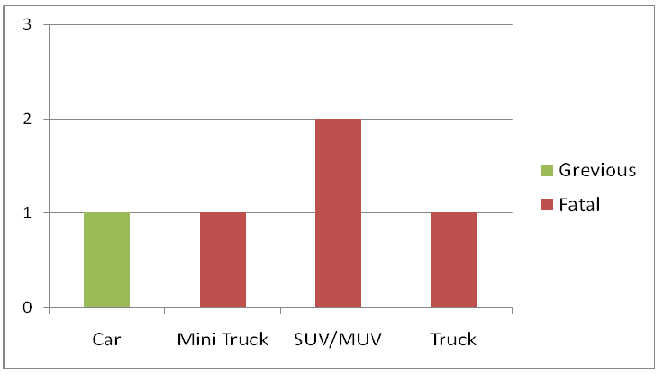

Figure 15: Pedestrian-Impact vehicle type and corresponding injury severity

Some important observations are:

1. 4 of the 5 cases involved high speeds in excess of 50 kmph.
2. None of the accident scenes had pedestrian warning signals or pedestrian crossings.
3. All the vehicles had drivers who were not the owners of the vehicle, and the vehicles were being used on commercial purpose (taxi/hire).
4. 3 of the accidents occurred in broad daylight.

ROLLOVERS - Researchers found only two cases in which a rollover was the first accident event. The vehicles could not be thoroughly examined as they were not in upright position and were later towed away by the owners, which thereafter could not be tracked. However, in both cases:

1. No injuries were reported.
2. There was no second accident event.
3. Both rollovers occurred in the night during rains.
4. Drivers lost control.
5. Roads were wet and tyre tread depths were poor.

ROAD USER ISSUES

In addition to the above, lack of enforcement and education among motorists is also observed. It appears that little regard is shown for safety and road rules. Some of the observations are:

1. Seatbelt use is poor. Passenger cars, buses and trucks investigated showed no positive indication of seatbelt use by drivers or occupants.
2. 2-wheeler accidents (3 accidents) investigated show no helmet use and also one of the accidents involved 4 riders (2 adults and 2 children) and none of them were wearing helmets.
3. Trucks and buses were observed not having functioning tail lamps or reflective strips to provide visibility at night.
4. Many trucks on the highways do not have underride protection.
5. Usage of indicators, hazard warning lamps and tail lamps is poor. Training in this area is essential.
6. Cars, especially commercial taxis, exceed speed limits very often.

CONCLUSION

The study clearly indicates that in-depth accident data collection with police support is very much possible. Researchers have also developed a methodology to work alongside the police, and to conduct in-depth accident investigations. This also provides a framework that can be used to collect in-depth traffic accident data across India. It is also further demonstrated that data can be captured using readily available tools. Therefore data collection studies need not be financially prohibitive.

Based on the above analysis, the following conclusions can be made:

1. Front-Rear Collisions are the biggest contributors to road accidents and injuries on the NH 45. They amount to 59% of the accidents investigated, which occur due to vehicles, especially trucks, slowing down, stopping, breaking down or overtaking.
2. Poor highway design at intersections, entries and exits, lack of good facilities for service and towing, and lack of information to highway users contributes to this problem.
3. Heavy vehicles running on the highway do not have adequate lighting and visibility, and also suffer from poor maintenance.
4. Availability and usage of safety features such as underrun protections, seatbelts and helmets is very low.

RECOMMENDATIONS

The following is a list of recommendations that consider each of the three main elements of an accident: infrastructure, vehicle and human.

INFRASTRUCTURE

Driver Information and Communication:

1. Information concerning U-turns, petrol pumps and restaurants should be provided well in advance to drivers through large, clear signboards mentioning distance to the next opportunity as well as warning of crossing and slowing traffic.
2. Repair shops and off-road areas for performing repairs play critical roles during breakdown. Hence, information on locations of repair shops and lay-bys along the highway should be provided.
3. Truck lay-bys can also be developed into effective information and communication centres for all road users.

Highway Facilities:

1. The Padalam Truck Lay-By was found to lack facilities like drinking water and lighting. The facilities should be improved and the area should be well-maintained. Trucks and buses should be encouraged to use this facility for taking breaks on long drives.
2. Towing service for vehicles should be improved so that breakdown/accident vehicles can be moved away from the road to a safer place, with minimal towing damage.
3. Highway lighting should be regularly checked and these lights should not be affected by power cuts, especially during the night.
4. Pedestrian facilities, for walking alongside and crossing, need to be improved, especially at highway sections close to a city/town.

Highway Design:

1. Shoulder width alongside the road should be increased to a minimum of 3 metres so that vehicles can be parked well inside the shoulder, in case of vehicle problems/breakdowns.

2. U-turn designs need to be re-examined as trucks and buses find it difficult to turn within a safe space.
3. Entrances/exits for fuelling stations, restaurants, factories/industries/warehouses should be well laid out so that vehicles which use them need not have to block/slowdown the traffic immediately behind them.

VEHICLE

Vehicle Maintenance:

1. Proper/functioning headlamps and tail lamps for trucks and buses should be made mandatory.
2. Proper/functioning wipers for both driver and cleaner side should be made mandatory.
3. Tyre depths should be checked regularly.
4. Prominent reflective signs/markings should be used on the backside of vehicles.

Driver Convenience:

1. Proper driver visibility should be ensured through large rear view mirrors and good wipers.
2. Proper seating should be provided for drivers to avoid tiredness and fatigue.

Vehicle Safety Devices and Markings:

1. Side and rear under ride protection devices should be made mandatory for all trucks.
2. Information about an accident ahead should be provided to other vehicles through proper hazard signs and diversions so that other vehicles can be alerted well in time to slow down and drive carefully.

HUMAN

Enforcement and Traffic Management:

1. Overloading and speeding above the vehicle speed limit should be strictly prohibited.
2. Seatbelt/helmet use should be enforced, especially in smaller vehicles.
3. Turn signal and tail lamp usage should be enforced.
4. In the event of an accident, traffic should not be diverted to the oncoming lanes.
5. Periodic vehicle checks for lighting, driver visibility and tyres should be conducted regularly.

Training:

1. Trucks and buses should be warned to stop only at designated areas where road shoulder width is adequate.
2. Training should be provided on proper marking of accident/breakdown vehicles to avoid front-rear collisions.
3. Existing truck lay-bys may provide a good location to carry out training and information activities, especially for trucks that pass by.
4. Highway workers should be well-equipped with safety equipment and must be educated about its importance and use.

Safety:

1. Highway workers should be provided safety jackets and proper safety equipment so that they can carry out their work safely.
2. A single emergency assistance number should be well known to all road users along the entire stretch of the highway.

FUTURE WORK

1. Heavy trucks account for the largest number of vehicles involved in the highway accidents investigated. More in-depth data studies are required to understand the causes of heavy truck accidents on highways.

2. Networking with accident hospitals is essential to obtain injury data for coding injuries and for detailed injury analysis.

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DEFINITIONS

Front-Rear Collision: Two-vehicle accident in which one vehicle impacts another vehicle from the rear.

Object Impact: Single-vehicle accident in which the vehicle impacts another object such as a tree, barrier, pole, etc.

Rollover: Single-vehicle accident in which the vehicle goes off the road and rolls onto one or more of its sides before coming to rest.

Pedestrian Impact: Single-vehicle accident in which the vehicle impacts a pedestrian.

REFERENCES

1. Collision Deformation Classification, Society of Automotive Engineers, J224 MAR 80, 1980
2. Truck Deformation Classification, Society of Automotive Engineers, J1301, 1994
3. AIS. Arlington Heights. American Association for Automotive Medicine; ILL 1990. The Abbreviated Injury Scale

APPENDIX A: LIST OF VARIABLES

Accident Details Variables

1. Accident Case Number
2. Date and time of accident
3. Accident location and the area
4. Police Station
5. Record number
6. Number of entities/events involved
7. Type striking
8. Type struck
9. GAD (general area of damage) striking
10. GAD (general area of damage) struck

Infrastructure Variables

11. Date and time of accident scene inspection
12. GPS coordinates
13. Accident scene diagramming
14. Road type
15. Traffic-way Flow
16. Road structure
17. Number of lanes
18. Roadway Alignment
19. Roadway Profile
20. Roadway Surface Type
21. Roadway Surface Condition
22. Light Conditions
23. Atmospheric Conditions
24. Road Speed Limit
25. Traffic Control Device
26. Traffic Control Device Functioning
27. Warning signs
28. Pictures taken

Vehicle General Variables

29. Vehicle make
30. Vehicle model
31. Chassis number
32. Engine number
33. RTO
34. Driver age and sex
35. Driver license effectiveness and type
36. Vehicle insurance effectiveness and type
37. Class of vehicle
38. Body type of vehicle
39. Vehicle Special Use
40. Vehicle transmission type
41. Fuel type
42. Number of Occupants
43. Occupants injured?
44. Injury details
45. Injury coding and scaling

Vehicle Inspection Variables

46. Manufacturer's specifications
47. Vehicle damage measurements and sketch
48. Vehicle interior/intrusion sketches
49. Collision Deformation Classification (CDC)/Truck Deformation Classification (TDC)
50. Tire wheel damage
51. Tire tread depth
52. Seatbelt availability and use
53. Odometer reading

Truck/bus

54. Power steering available
55. Steering disabled due to accident
56. Underrun protection
57. Type of load
58. Rear view mirror availability
59. Rear view mirror dimensions
60. Driver seat construction
61. Tail lamps availability and functioning
62. Windshield type
63. Wipers

Car/SUV

64. Occupant seating positions
65. Location of direct damage
66. Location of direct and induced damage
67. Location of maximum crush
68. Direct and induced damage width
69. Direct damage width
70. Crush profile measurements (C1 to C6)
71. Delta v / ETS
72. Occupant area Intrusion Details
73. Occupant Contact Details

Two Wheelers

74. Front and rear brake type
75. Leg guard availability
76. Rear view mirror availability
77. Tail lamp functioning
78. Front and rear side indicators
79. Number of pillion riders and position
80. Helmet use
81. Helmet manufacturer/ISI mark
82. Luggage carried type/location