Accident Research – Pilot Study on an Indian Express Highway

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Abstract ***ESAR wants the abstract to be limited to 150 words. Hence the changes.***
It is very important for Automotive OEMs to get feedback on their product performance on real roads for continuous improvement. Every OEM has a way of collecting this feedback for various performance parameters. Systematic Accident Research is a way to generate the information related to Safety Performance of the vehicle.
In India, while there is a large amount of data related to the accidents, it is found this data is aimed at understanding the gross statistics and not directly useful for technology development.

This paper explains learnings from a pilot study carried out in collaboration with an Emergency Medical Services provider on one of the expressways (motorways). This pilot study has resulted in development of working model that could now be scaled up at for wider application . The paper also presents some of the important observations based on the data collected.

Keywords

- TML = Tata Motors Ltd.
- CDC = Collision Deformation Classification established as per guidelines of SAE J224 & SAE J 1301
- AIS = Abbreviated Injury Scale as established as per guidelines of Association for the Advancement of Automotive Medicine.
- EMS = Emergency Medical Services
- LMF = Lokmanya Medical Foundation

INTRODUCTION

TML was pioneer of crash safety in India with having established a crash test facility in 1997. This is the only lab in India which is able to conduct tests as per global crash regulations & has been accredited by VCA, UK and TUV Suddeutschland, Germany. Besides the physical test lab, Tata Motors has also set up a team of CAE analysts to simulate and analyse the crash tests using the most advanced and high speed computational resources. It was therefore natural for Tata Motors to start recording & analyzing the accidents that occur in the fieldto better understand the benefit of safety provisions of the vehicle designs and priorities for the future vehicle designs.

Parameter	1990	2008	% change
Vehicle population (in thousands)	19152	105353	550
Length of roads (km)	1983867	4109592	207
No of accidents	282600	484704	171
No of fatalities	54100	119860	221
No of injuries	244100	523193	214
Ratio of injuries to fatalities	4.51	4.35	97

Table 1 – Accident Data recorded by Ministry of Road Transport & Highways[1]

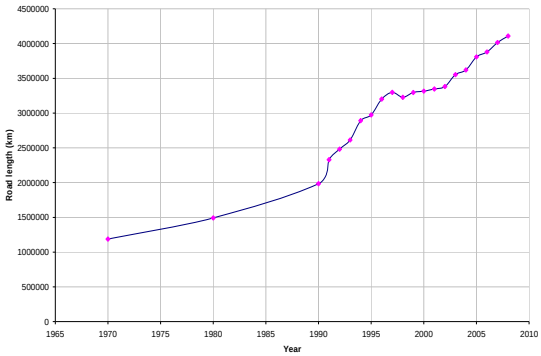


Fig (1) – length of roads in India[1]

In India, Transport Research Wing of Ministry of Road Safety & Highways publishes road accident data every year. The summary of the accidents & injuries, as recorded by police is explained in the table 1 below. The base is compared as 1990 since this was start of widespread motorization in the country after economic liberalization and the road length expansion activity. The data shows not only the accidents have increased manifolds, but also the increase in fatalities & injuries is more than the accidents.

This data has been collected by police department. It includes data about vehicles involved & no of injured persons. However it does not contain engineering data required by vehicle manufacturers.

Ministry of Road Transport & Highways (MORTH) has also decided to take up Accident Research with NATRIP[2] in one of its facilities. However it is expected to take some more time to begin the project & undertake the data collection. in the meanwhile it has become necessary for OEMs to better understand the accident reality & the customer necessities for occupant safety. Therefore TML had decided to take up the initiative for accident study on its own & did not want wait till NATRIP project begins.

As a pilot project, TML decided to collect the accident data on the Mumbai Pune expressway (Fig 2). The reason for selecting of this stretch was –

- It was closer to the engineering centre of TML & therefore it was easy for accident research team for spot visit,
- It has got a divided traffic & there is no mix of vehicles and other road users (as expected on any other road). Therefore the complexities of the accidents & data recording are less so it was appropriate to establish an accident research methodology.

Lokmanya Hospital Nigdi, run by M/s. Lokmanya Medical Foundation (LMF), is a tertiary level trauma centre which provides the Emergency Medical Services (EMS) to this road & treats around 10,000 accident cases annually. TML approached LMF whether it was possible to monitor & record the engineering data from the accident spot by the EMS team. LMF team was quite enthusiastic for this activity. it was decided to initiate the data collection on a stretch of 61km (out of 94 km of Mumbai Pune expressway) which was an operating region for LMF. This stretch is a part of Prime Minister's Golden Quadrilateral programme which aims at building a total of 5846km of roads connecting the North, South, East & West vertices of the country[3].

[1] "Road Accidents in India 2010" published by Transport research Wing of Ministry of road transport & highways, Govt. of India
[2] National Automotive Testing and R&D Infrastructure Project.
[3] Data published on www.nhai.org by Govt of India

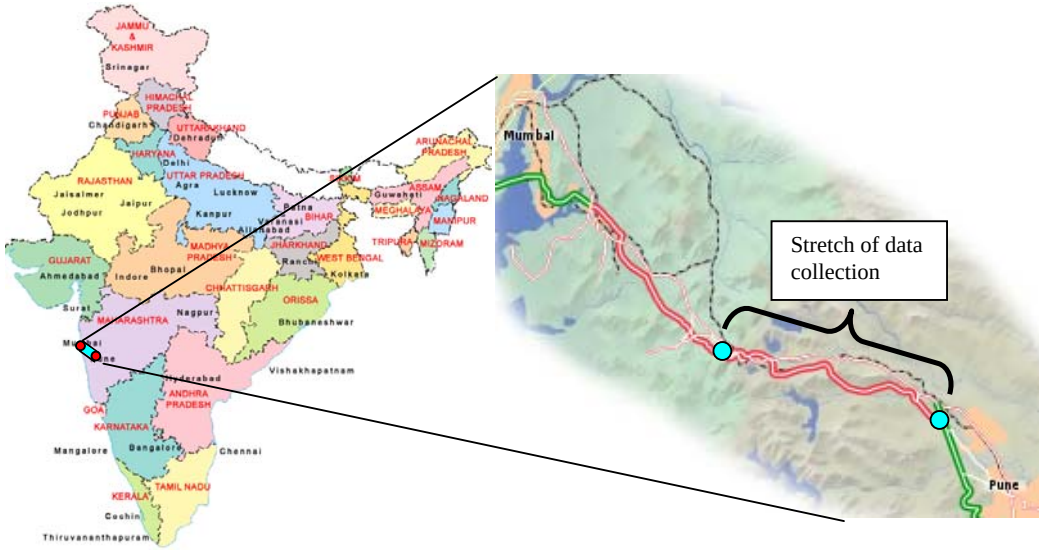


Fig 2 – Map of India & Mumbai-Pune expressway

METHODS

The EMS team had 6 ambulances available on this road & they had decided to include 1 additional person in each ambulance team for the accident data recording purpose.

It was decided to record only those accidents wherein there was an occupant hospitalization or fatality or significant vehicle damages.

TML had developed 8 different formats, checklists & guidelines for the accident data recording. These formats contain the following information :

- Brief description of the accident & the time.
- Description of the vehicle model involved,
- Type of accidents,
- Status of the doors & glazing,
- Evacuation details,
- Evacuation details,
- Details about the Occupant Restraint System - ORS (seat belts, airbags, seats etc.)
- Environmental conditions,
- Guidelines for the various views to be photographed,
- Injury details of the victims,
- measurements for the external deformation of the vehicle,

The accident research team of TML trained the EMS team for collecting the information described above. For about first 3 months, TML team visited accident spots & recorded the accidents in the prescribed manner alongwith the EMS team. Thereafter EMS team started collecting the necessary information independently. TML representatives meet LMF team once in week to collect the data recorded.

The accidents are counted as a part of the accident research database only when there are any hospitalization of the occupants or fatality or if there is an excessive structural deformations seen on the vehicles. Generally 25% of the total accidents get recorded because of these criteria.

RESULTS

In the year 2011, data was collected for 149 recordable accidents. The analysis of the data was as follows :

a. *Accidents distribution* (Ref Fig 1 of appendix 1) - The density of the accident was seen to be higher in the months of May & November. These are the months of festival season with greater road use activity & resultant vehicle movement is seen during this time.

b. *Type of vehicles* (Ref fig 2 of appendix 1) - Majority of the cases involved were passenger carriers. Within passenger carriers, cars account for 55%. There is lot of passenger movement between these Pune & Mumbai (which is financial as well as state capital). People travel by various modes viz. taxis, buses & railways. The most preferred mode is either by personal car or by hired taxi so that the time to reach destination is minimized by at least 30% as both these cities are quite large & use of public transport increases the travel time. Most of the times people like to complete the to & fro journey on the same day.

c. *Time of accident* (Ref fig 3 of appendix 1) – this data shows the popular belief that accidents happen more in night time is not justified. Overall 88 accidents (62%) were recorded in day time (6am to 6 pm). The highest accident occurrence is recorded during early morning (6am to 9 am) followed by late afternoon to early evening (3pm to 6 pm). Early morning accidents could be due to insufficient sleep or rushing to reach the destination in time. There is a lot of traffic between Pune & Mumbai wherein the person has to complete his return trip on the same day. Therefore the persons start early & reach in the late evening. The vehicles are driven at high speeds & that becomes the cause of accident.

d. *Type of accidents* (Ref fig 4 & 5 of appendix 1) - The highest occurence is of rollovers followed by full frontal impacts & frontal underrides. The reasoning recorded for these accidents are –

- Rollovers –
    a. vehicle leaving the track and moving to the road shoulders which has depressions such as drains or open fields (the road is elevated from its surroundings at most of the places). The causes for vehicle becoming off track are loss of control at high speeds, tyre bursting, wheel dislocation, sudden braking, skidding in rainy season, driver drowsiness, brake failures etc.
    b. Negotiating a sharp turns.
    c. Misjudgment while trying to overtake another vehicle & having a low overlap collisions.
    d. Hitting by another vehicle in the rear with narrow overlaps,
    e. Jumping down the bridge,
    f. Angular impact with road structures such as walls, bridge columns, poles etc.
- Full frontal impacts
    a. Vehicle leaving track due to brake failure, tyre bursting, skidding on wet road in rainy season,
    b. Hitting of the vehicle in front due to inadequate judgement of the distance, understeering, sudden stoppage of the front vehicle, loss of vehicle control at high speed, Poor visibility (darkness in the tunnel), drowsiness, failure to assess a standstill vehicle at toll booths etc.
    c. Loss of vehicle control while negotiating turn
    d. Vehicle traveling on wrong side of the traffic,
- Frontal underrides – the reasons for the accident are more or less same as that of full frontal impacts however the severity of the accident is higher when the vehicle in front is not equipped with underrun protection devices (UPD). These accidents are seen when there is a wrong side traveling of good carriers.
- no fire accident has been reported nor any of these crashes indicated a risk of fire .

d. *Injuries* (Ref fig 6, 7, 8 & 9 of appendix 1) – the injuries were recorded using Abbreviated Injury Scale (AIS). (However no injury details could be captured for the fatalities as they are handled by the police department from legal perspective & EMS staff is not allowed to interfere). They were analysed by following considerations :

- Injuries severities (fig 6 of appendix 1) – no or minor injuries dominate the injury data however a 9% rate of fatal injuries on a regulated traffic is a concern to be addressed for. These are mainly on account of high speeds leading to loss of control in emergency.
- Study of type of injuries against the type of crash (fig 6, 7 of appendix 1) –The injury count was further divided by the

accident occurrences to estimate the probability of injuries in a given accident (fig 9 of appendix 1). It shows that rear impact & frontal underride crashes result into excessive injuries.

- The data (fig 10 of appendix 1) shows that the head is the most injured part followed by the lower extremities. These can be mitigated by providing adequate restraint systems. Though significant injury count is also observed for upper extremities though the injuries are of minor nature (AIS1 or below). However it should be noted that the currently available crash test dummies do not have any injury recording capabilities for upper extremeties.

e. *Age of the occupant* (fig 11 of appendix 1) : the victims of these accidents show that productive manpower (between age 20 to 60) is suffered the most (≅ 81%). This would lead to very high impact on the cost of accident on society. The younger generations (age group 20 to 30) are the most affected age group which is surely on account of higher speeds & lack of traffic discipline.

e. *Seat belt usage* (fig 12, 13 & 14 of appendix 1) : the use of safety belt was recorded for the vehicle occupants. The observations were as follows :

- The belt wearing rate was quite low. Approximately $3/4^{th}$ of the traveling population does not wear safety belts. This stresses a need of education of the vehicle occupants. Focused campaigning will also improve the seat belt wearing rates.
- The injury data was divided by the belt usage volume to establish probability of the injuries. It was observed that the probability of critical injuries is higher in case of unbelted occupants.

DISCUSSION

- The pilot project has established a good model of data recording on roads. With the confidence gained in the data collection, the data collection activity would be expanded on other roads wherein an EMS is ready to participate.
- However this model will not be useful for data collection within city for the following reasons :
  - There is no dedicated EMS within city. The victims are moved to the nearest possible medical centre by other road users or police.
  - The accidents are scattered on a larger scale. It would be more meaningful if such a system is established with help of police staff.

  Similar would be the situation on the non highway traffic as well.
- This data includes an information for a stretch of 61 km. if it is extrapolated for 5846km of golden quadrilateral project, it would be about 95 times of it. The numbers would be –
  - No of accidents = 14662,
  - No of fatalities = 4791,
  - No of injuries = 34405,
- It is expected on non highway roads, wherein a divided traffic is not followed, more vehicle to vehicle accidents would be recorded. Also with intra city data collection, more pedestrian accidents would possibly be recorded.
- Victimization of the productive manpower in the accident is of concern from since it burdens the society financially at large.
- Involvement of younger generation in the accident shows a need to have focus on implementing traffic discipline right from early age groups. Probably higher punishments to this age group would be a need of the hour.
- The data can be extrapolated for other expressways that are coming up in the country however this can not be considered as representative data for total road usage as there is no information about non highway, inter & intra city roads. Therefore there is absence of information 2 wheeler accidents, pedestrian accidents & other type of accidents.
- The next step of this exercise would be take up accident reconstructions so that the EES (Energy Equivalent Speed) of the colliding vehicles can be assessed & energy dissipations can be established.
- It is also worthwhile to study the cost of accidents to understand the monetary impact of the accidents on society.

CONCLUSIONS

- The pilot project has established a good model of data recording on roads. The data collection can be expanded to other expressways wherein a similar structured EMS support exists.
- It would be worthwhile to enforce a speed limit for the driving speeds which would improve better control over the vehicles & also the tyre bursting phenomenon would be reduced.
- The low belt wearing rates show an urgent need for people education about its benefits. Benchmarking of belt promotion campaigns elsewhere would be strongly recommended.

ACKNOWLEDGEMENT

The authors appreciate the efforts put in by 21 member EMS who had worked 24x7 for the data recording. Dr N R Rakshe, VP (EMS) provides guidance & motivation to the EMS team for participation in this project. Dr Shrikhande J K , Dr Patil V V monitored the data collection, AIS scaling & liasioning with TML for data interactions. The authors express their sincere gratitude to this medical professionals. Mr. Pronoy Ghosh & Mr. Dhiraj Borse of TML did a commendable task of developing the data collection formats, training the EMS personnel for data collection & photography. They had worked further for analysis of the data & CDC coding.

The authors are very thankful to the management of TML & LMF who supported for this non profit making activity.

APPENDIX 1

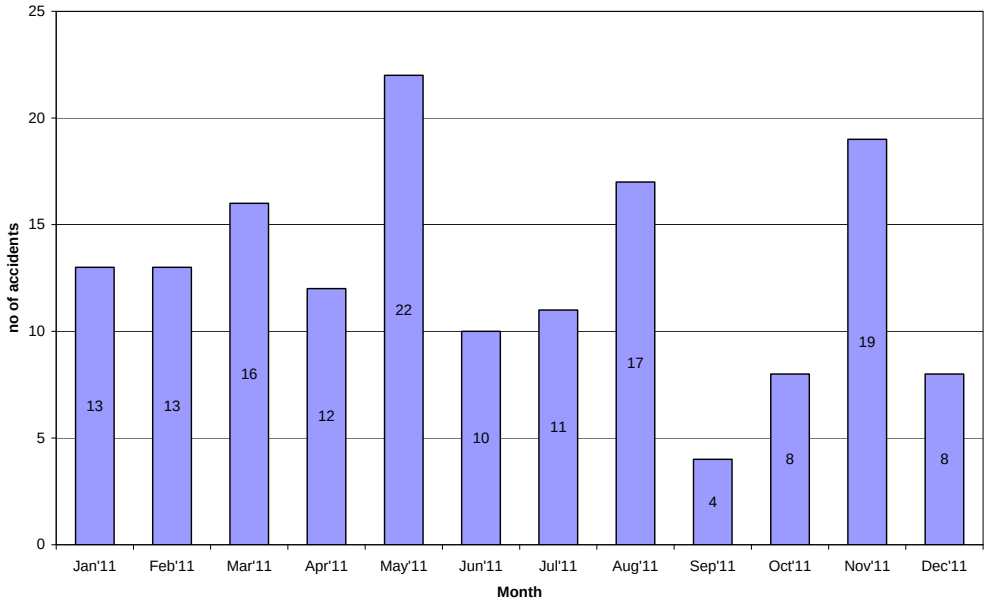


Fig 1 : no of accidents recorded during 2011

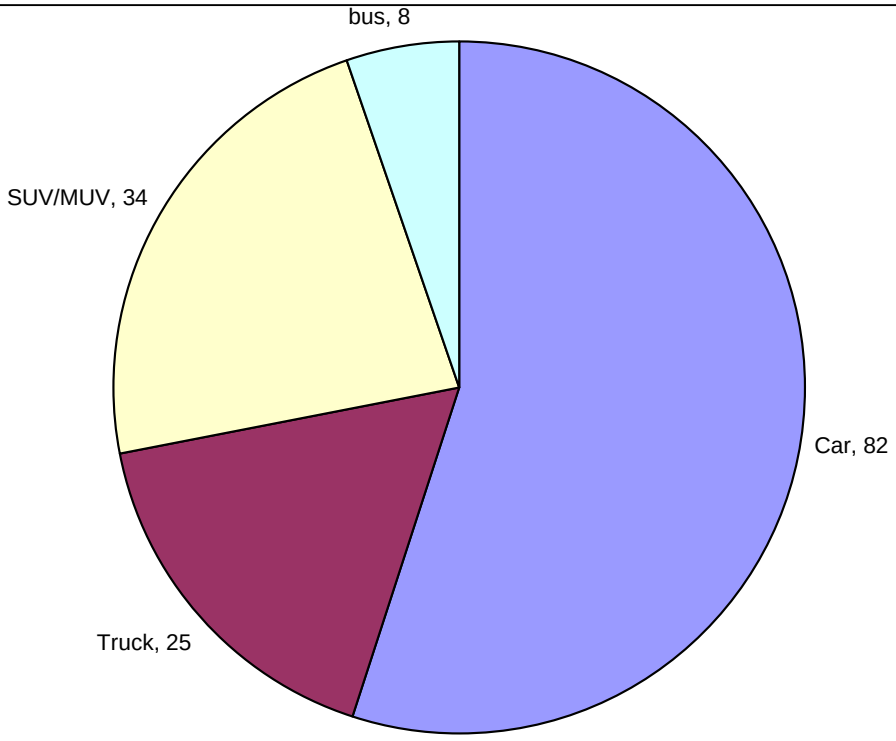


Fig 2 : Type of vehicles involved in the accidents on Mumbai Pune expressway during 2011

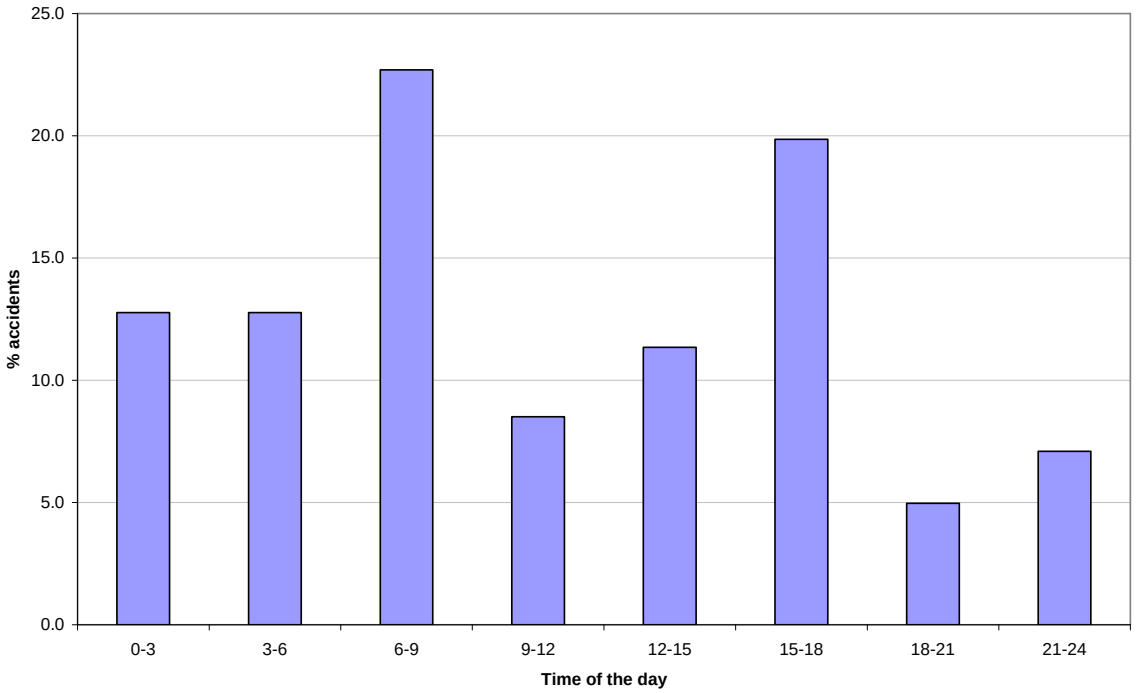


Fig 3 – Time of accidents in a day

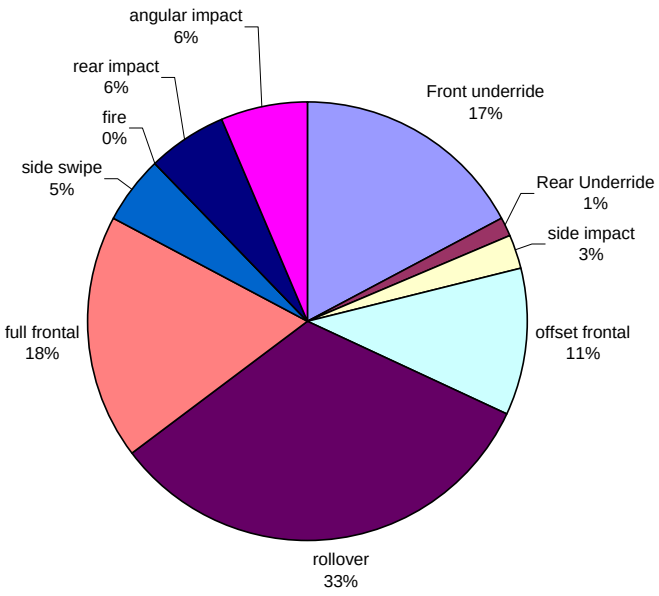


Fig 4 : Type of accidents, Mumbai Pune expressway, recorded during 2011

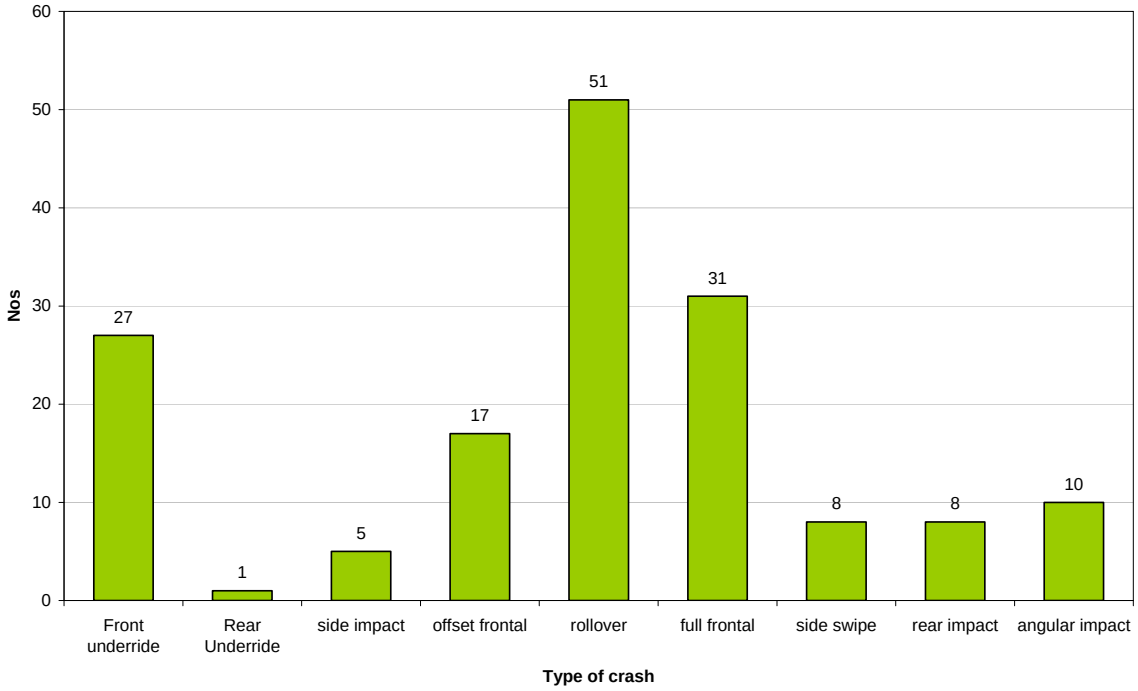


Fig 5 : Distribution of the accidents recorded on Mumbai Pune expressway in 2011

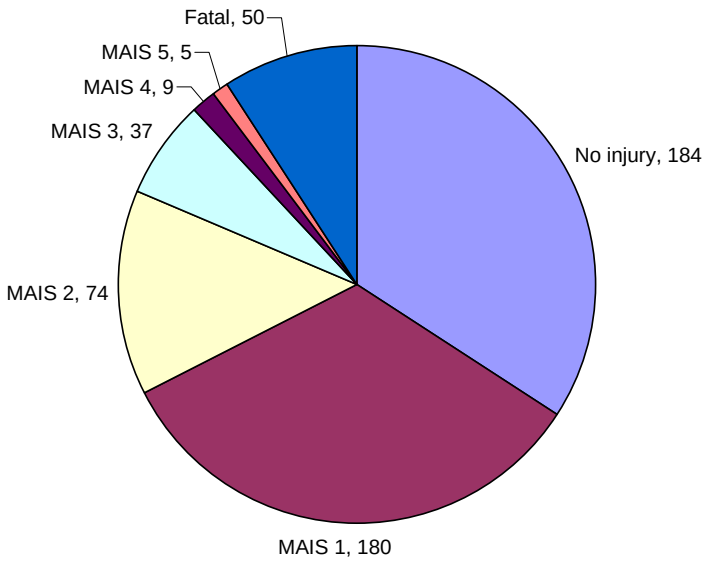


Fig 6 : Distribution of injuries, Mumbai Pune expressway, recorded during 2011

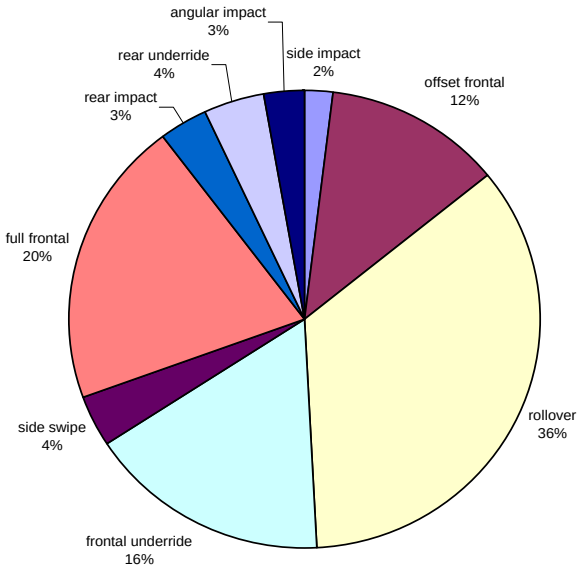


Fig 7 : Distribution of the injuries against the type of accidents recorded on Mumbai Pune expressway in 2011

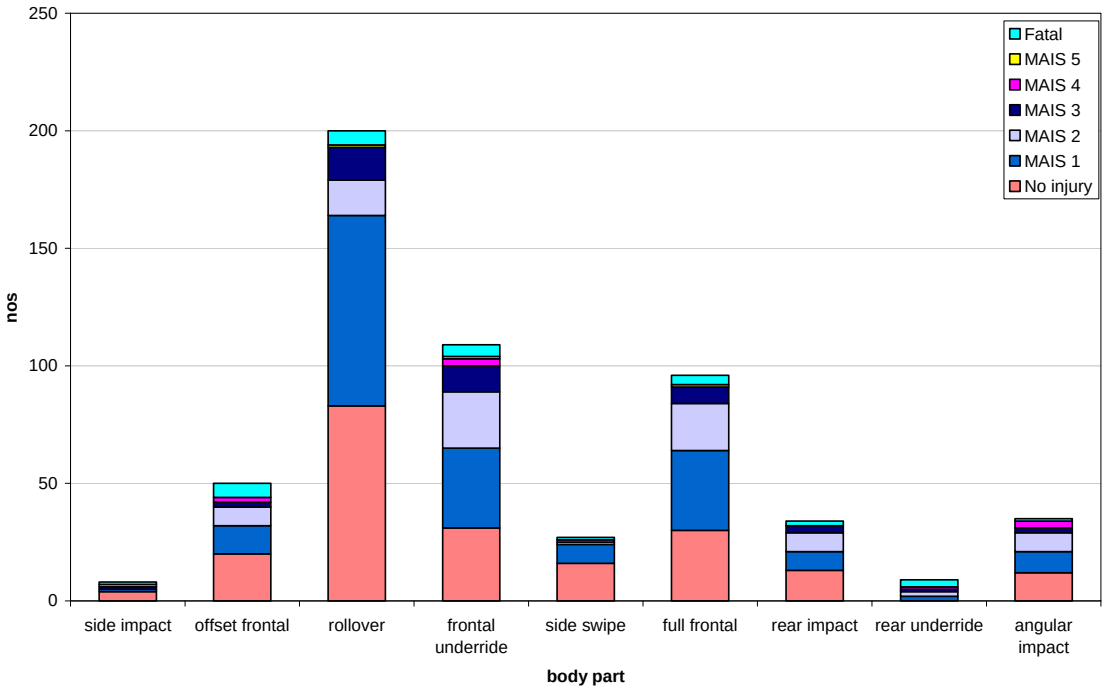


Fig 8 : Type of injuries recorded in the accidents on Mumbai Pune expressway during 2011

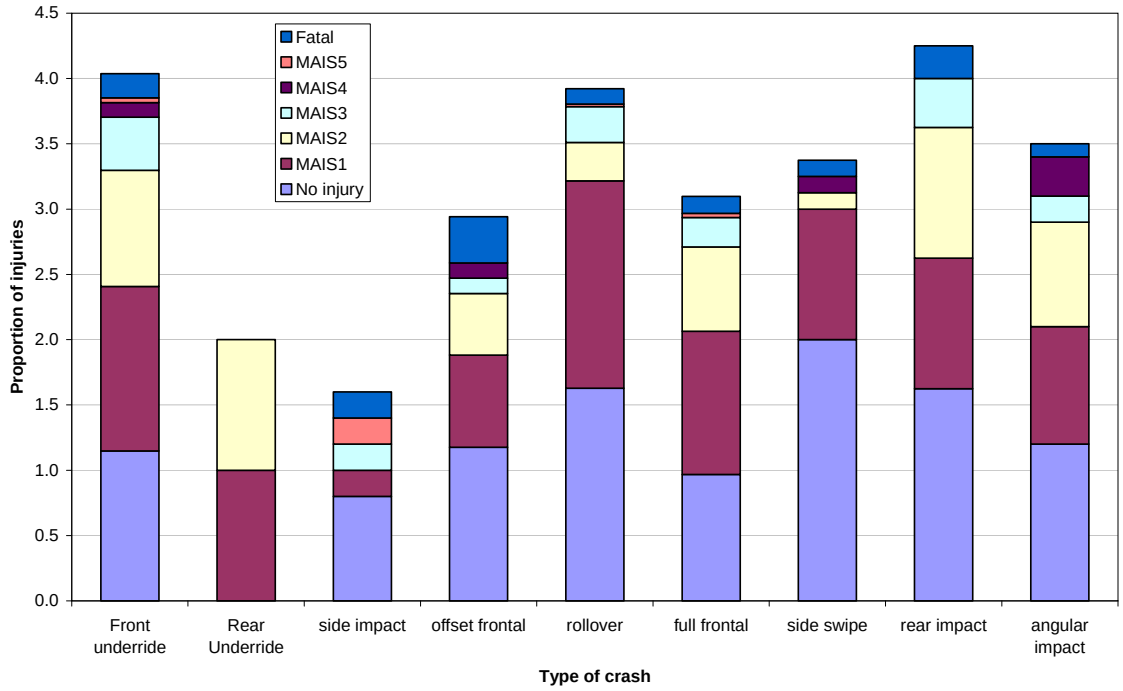


Fig 9 : Probability of the injuries against the type of accidents recorded on Mumbai Pune expressway in 2011

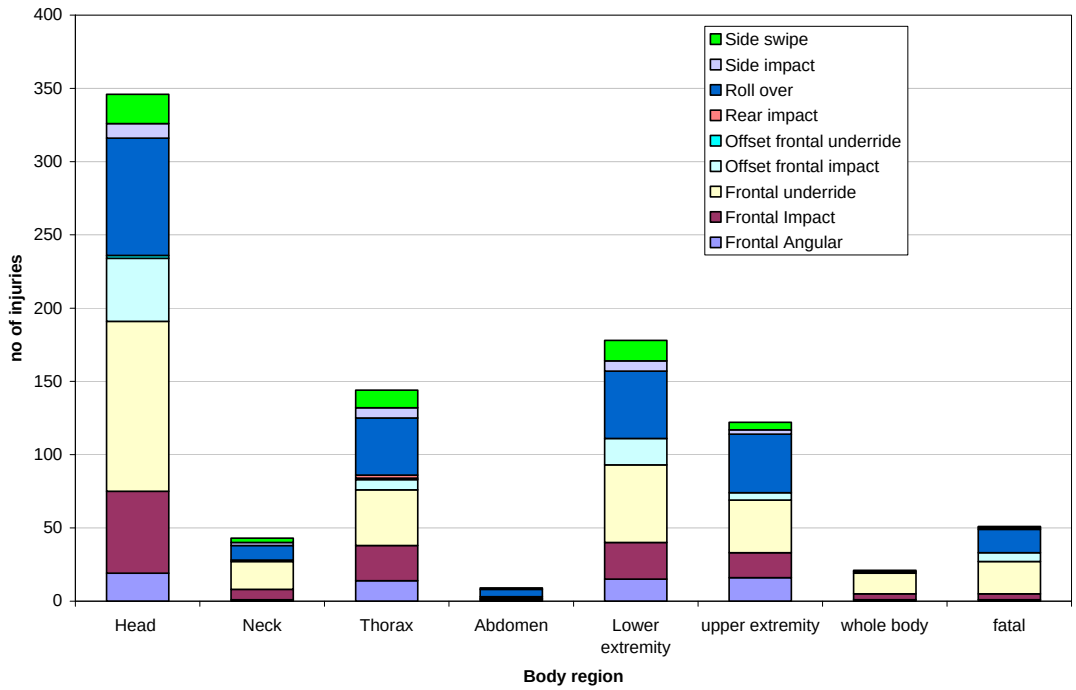


Fig 10 : Body parts injured in accidents on Mumbai Pune expressway in 2011

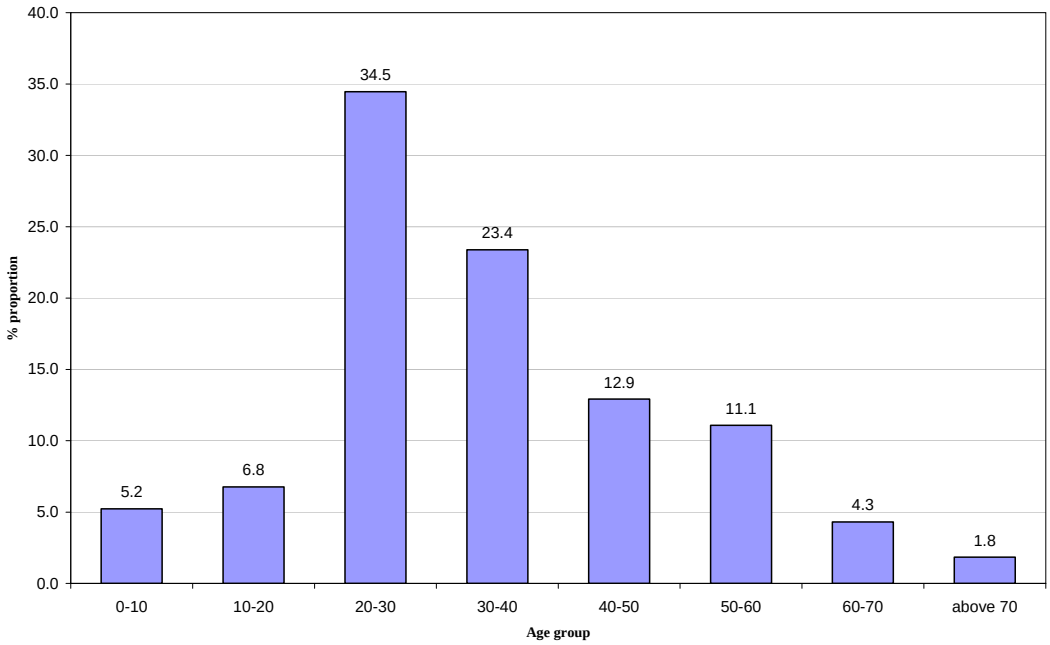


Fig 11 : Age of the victims

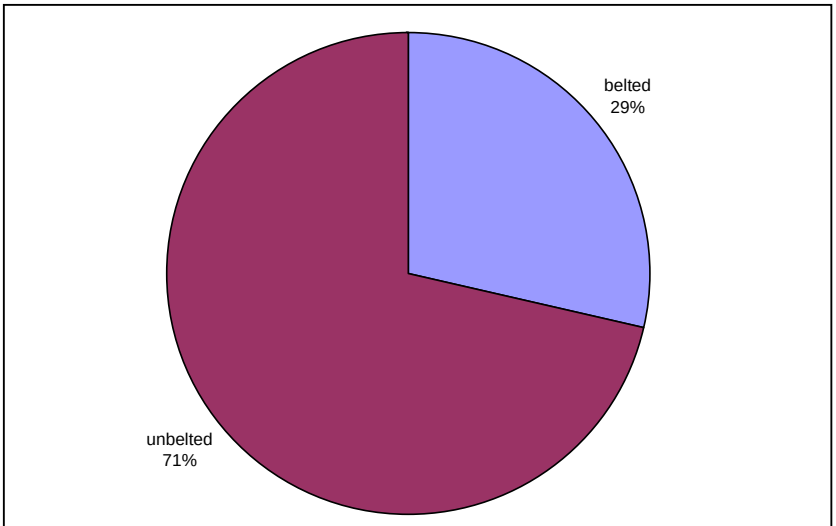
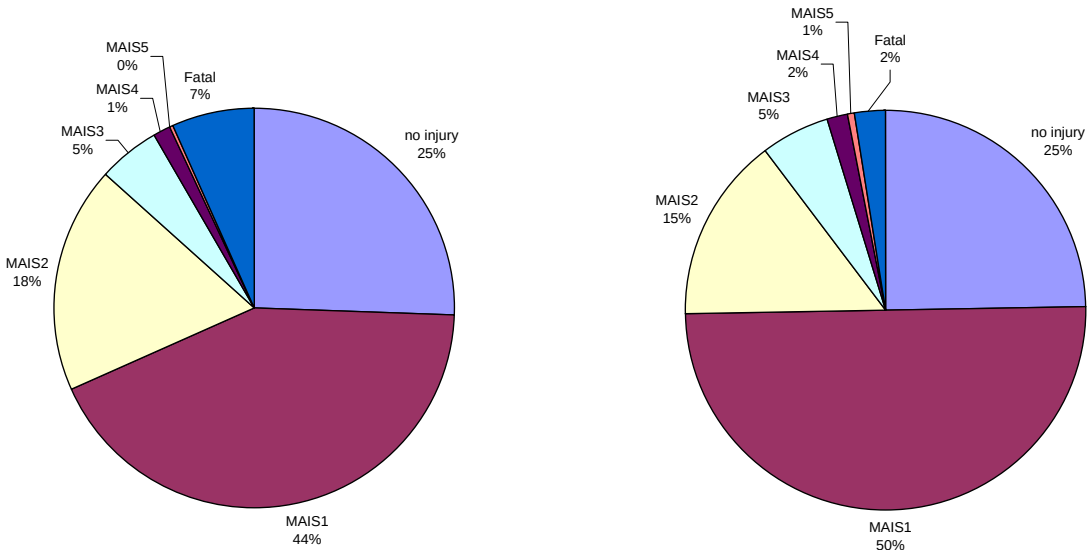


Fig 12 : data on the seat belt usage in the accident vehicles on Mumbai Pune expressway in 2011



Unbelted occupants

Belted occupants

Fig 13 : Injury distribution for belt usage

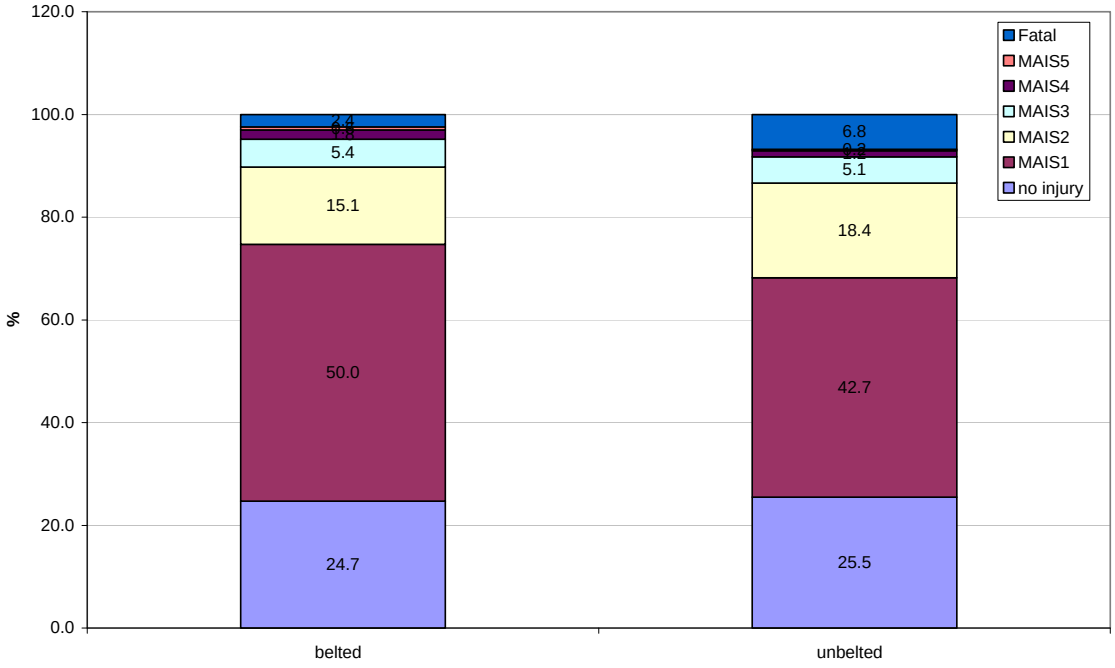


Fig 14 : Probability of the injuries based on belt usage