Characteristics of Passenger Car Rollover accidents on Indian Roads

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I. INTRODUCTION

Rollover accidents are among the most dangerous types of road traffic accidents (RTA). The aim of this study is to identify and understand the factors responsible for rollover accidents involving passenger cars, and their resultant injury severities, on Indian roads. This knowledge of the characteristics of rollover crashes will help to deliver targeted changes and improvements in human, vehicle and infrastructural factors, which will help to prevent and mitigate these types of RTA on roadways in India.

II. METHODS

The Road Accident Sampling System – India (RASSI) database was developed to provide in-depth accident data of real-world crashes in order to help researchers and other stakeholders to analyse and understand Indian road users [1]. This study used data from RASSI about passenger car RTA, between 2011 and 2016, that involved rollover as their primary crash configuration. Crashes involving rollover as a subsequent event or rollover of vehicles other than passenger cars were excluded from the study. A broad cross-section of factors was analysed: distribution of vehicle body types; types of accident; pre-crash and pre-event movement; avoidance manoeuvres; pre-impact stability; type of rollover; interrupted rollovers; distribution of occupant injury severity; restraint use; and ejection during rollover.

III. INITIAL FINDINGS

Passenger cars were selected for analysis because the fatality rate observed in this group (31 fatalities in 64 accidents) is higher than that of both trucks and buses (16 fatalities in 65 accidents). The accident data of 64 rollover crashes were considered for analysis. The body type for passenger vehicles involved were distributed as follows: “sedan”, 12%; “hatchback”, 27%; “SUV”, 23%; “MUV”, 27%; “van”, 11%.

Out of 64 crashes, pre-crash movement was going straight for 37 vehicles (58%), negotiating curve for 11 vehicles (17%), successful avoidance of previous event for nine vehicles (14%), passing or overtaking for six vehicles (9%) and accelerating in traffic lane for one vehicle (2%). We observed three types of accident (pre-crash event) scenario for rollover: “Type 1 - driving accident”, 47%; “Type 7 - Other accident”, 34%; “Type 6 - Accident in lateral traffic”, 19% [2] (Fig. 4).

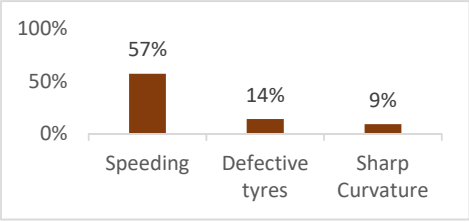

Fig. 1. Major accident contributing factors.

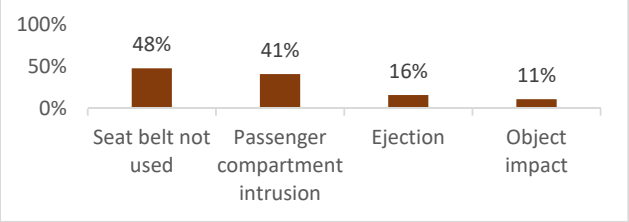

Fig. 2. Major injury contributing factors.

From scene inspection data, it was found that after the critical pre-crash moment, 14 vehicles (22%) showed no avoidance manoeuvre, 23 vehicles (36%) showed avoidance manoeuvre by steering, 20 vehicles (32%) showed avoidance manoeuvre by combination of braking and steering and six vehicles (10%) performed braking as an avoidance manoeuvre. Out of the 64 rollover crashes studied, in 50

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crashes (78%) the rolling vehicles were skidding laterally in clockwise or counter-clockwise before rollover, four vehicles (6%) were skidding longitudinally and 10 vehicles (16%) were tracking before rollover.

Of the 64 vehicles involved, 29 (45%) rolled due to tripping over, 19 (30%) due to turn over, 13 (20%) due to fall over and three (5%) vehicles due to end-over-end.

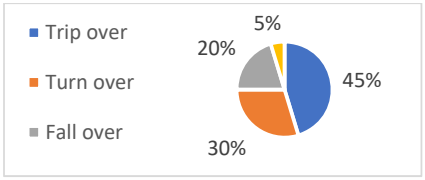

Fig. 3. Rollover initiation types observed.

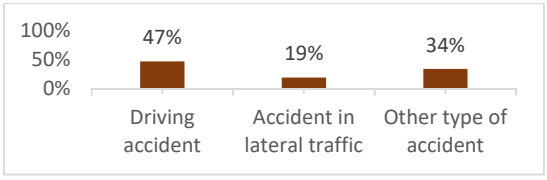

Fig. 4. Types of accident scenario.

In 19 (30%) of the 64 crashes, rollover motion was interrupted by an object, which in turn increased the severity of the accident.

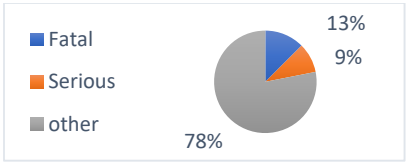

Fig. 3. Injury severity of belted occupants.

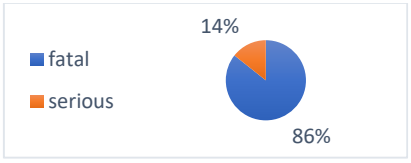

Fig. 4. Injury severity of ejected occupants.

A total of 264 occupants were involved in the 64 crashes. Of these, 31 occupants (12%) were fatal and 74 occupants (28%) were seriously injured. Only 32 occupants (12%) were wearing a seat belt. Of these 32 occupants, four (13%) were fatal and three (9%) were seriously injured due to interrupted rollover or partial/full ejection. The other 25 (78%) belted occupants sustained minor or no injury. Ejection (complete, partial or ejection of unknown degree) was observed for 21 occupants (8%), and of these 18 (86%) were fatal and three (14%) were seriously injured. Only one occupant (5%) of those 21 occupants was wearing a seat belt, and that occupant died due to partial ejection during an interrupted rollover event.

IV. DISCUSSION

The tendency of a vehicle to roll increases with an increase in centre of gravity, steering sensitivity and speed. This tendency can be reduced by lowering the ride height or increasing the wheel track, thereby increasing the static stability factor [3]. In terms of pre-crash movement, avoidance stability, avoidance manoeuvre and rollover initiation type, it is beneficial to employ technologies such as electronic stability control, rollover avoidance system and active roll control suspension system, as these can help to avoid rollovers. Furthermore, the severity of rollover accidents can be reduced if interruption to the rollover event is avoided, which can be achieved using road interventions (22% fatal/serious occupants). The analysis also shows that use of a restraint system reduces the injury severity to occupants in rollover crashes (78%, minor/no injury). In particular, the use of a restraint system helps to reduce the incidence of ejection of the occupants, which is otherwise highly possible in rollover crash scenarios (21 occupants, 8%).

V. REFERENCES

[1] Rameshkrishnan, N., *et al.*, IRCOBI, 2013.
[2] Modified Accident Classification system (GDV) for left-hand traffic, Version 2.1.
[3] Trends in the Static Stability Factor of Passenger Cars, Light Trucks and Vans, NHTSA, 2005.