

Evaluation of “Multiple impacts” Associated with Light Motor Vehicles

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Received October 04, 2014; Revised November 20, 2014; Accepted November 25, 2014

Abstract Most of the vehicles that are involved in accidents suffer from so called second harmful effects rather than the primary collision itself, especially in cases of a shunt or a high speed spin. Secondary harmful, effects not only damage more, they also increase the severity of passenger injuries. The aims and objectives of this study were to evaluate the fatal injuries to the passenger with the initial impact along with the prevalence of multiple impacts. 100 light motor vehicles (LMV) involved in primary collision with other vehicles having clear evidence of multiple impacts and having brought serious injuries to its passengers were selected from a total of 250 crashed vehicles. Criteria for severe injuries caused were, according to AIS or MAIS scale. The study objects were divided into four groups (1 impact, 2 impact, 3 impact and 4 or more impacts) under one class and another 4 groups (frontal, side, rear and multiple) under second class. Results show that 40% of the vehicles had caused serious or fatal injuries with most frequent of impact being side of the vehicle (37%). Besides further research in vehicle safety, the study concludes that present testing of vehicles in laboratories does not comply with actual impacts.

Keywords: collision, rollover, drifting, steering control, car spin and shunt

Cite This Article: Khurshid A Mattoo, and Gurpreet Singh, “Evaluation of “Multiple impacts” Associated with Light Motor Vehicles.” *American Journal of Vehicle Design*, vol. 2, no. 1 (2014): 19-21. doi: 10.12691/ajvd-2-1-3.

1. Introduction

Due to the rapid economic growth in the kingdom of Saudi Arabia (KSA), there has been a drastic rise in the use of motor vehicles. According to previous estimates the number of registered vehicles has increased from 144,768 in 1970 to 5,861,614 in 1994, a forty-fold increase in 24 years. [1,2,3] This in itself has given rise to traffic accidents, especially due to factors like increased size of road network and lack of local public transport system. During the period from 1971 to 1994, the numbers of traffic accidents, injuries, and fatalities have increased by 30 times, 6 times, and 7 times, respectively. [4,5] Road traffic fatalities have been shown to be at the top of the list of the major cause of death in the kingdom. [6] Percentage of injury accidents in KSA are almost double that in USA [7,8].

Injuries sustained in car accidents have been studied and results have shown that a large percentage of injuries (42%) were in crashes that involved more than one harmful effect. [9,10,11,12] Most of the fatal injuries have also been attributed to multiple impact crashes. However, there are few or no studies that show the relation between fatal injuries to the driver and the initial impact direction. This study was therefore undertaken to study the prevalence of multiple impact (secondary harmful effect) with its various types and the relation between the

frequencies of initial impact directions with most harmful sequences in Jazan province of the kingdom of Saudi Arabia.

2. Material and Methods

About two hundred and fifty crashed light motor vehicles (excluding sports utility vehicles) were randomly selected without any preference of the make or year of manufacturing. From these one hundred vehicles were selected which showed confirmed evidence of multiple impacts and had confirmed cases of either fatal or serious injuries to the driver or passengers. Other inclusion criteria's where the vehicles had suffered multiple impact crashes with a evident principal area of impact, crashes with fatalities or severe injuries, according to AIS or MAIS scale, crashes that had evidence of having utilized all safety measures by the driver like seat belt restraint and vehicles who suffered top damage were assumed to be rolled overs.

These multiple impacts crashed vehicles were divided into four groups, namely those with a single impact (n=8) (Figure 1), with two impacts (n=38) (Figure 2), those with three impacts (n=43) (Figure 3) and those with four or more including rollovers (n=11) (Table 1). Another division of the impacted vehicles was done based on the direction of the primary impact. After identifying the primary impact (Front, side, rear and rollover), associated

secondary impacts were grouped and divided according to the amount of impacted vehicles present. The severity of the accidents was then related to either of the groups.



Figure 1. Single primary impact vehicle (Front) with secondary impact on opposite side



Figure 2. Primary impact on same side with secondary impact in front and back



Figure 3. Primary impact on same opposite side with three multiple impact on back, side and front

3. Results

The results showed that out of the total vehicles seen about 40% (n=250) were associated with either fatal or

severe injuries that were classified as vehicles having second harmful effect. Multiple impact crashes represent the largest fraction of injured occupants. Results also show that 82% of vehicles with four or more impacts and 47% of vehicles with three impacts had delivered fatal or severe injuries (Table 1).

Table 1. Distribution of vehicles, according to number of impacts present

Table 1. Shows distribution of impacts in addition to the principal impact in overall selected sample		
	N = 100	
	Total no	Fatal and/ or serious injuries inflicted
One impact	08	13%
Two impact	38	32%
Three impact	43	47%
Four or more with roll over	11	82%

For multiple crashes with serious injuries, the most frequent initial impact was a side (37%) followed by front (32%) (Table 2). The most frequent second impact was a side (23.5%) with same side and (32%) with opposite side, followed by frontal (24%). The most harmful sequences were side-side, front-side and front-front.

Table 2. Distribution of vehicles according to association of principal impact with other impacts

Table 2. Prevalence of different types of multiple impacts along with their relation to each other (n=100)						
Direction of initial impact	Associated types of impacts					
	Top	Same side	Opposite side	Frontal	Rear	Total
Frontal	5.6%	08.7%	19.2%	06.3%	04.2%	44%
Side	2.3%	13.5%	08.7%	11.4%	03.3%	39.2%
Rear	1%	0%	03.3%	03.3%	03%	10.6%
Multiple	1%	1.2	01%	03%		6.2%

4. Discussion

In this study, about 40% of total accidents investigated are exposed to multiple impacts which is more as compared to studies in the United states (24%), Germany (26.5%) or united kingdom (29%). [13] Among different types of multiple impact crashes, the initial impact of front (44%) and side (39.2%) account for a large percentage of multiple impacts that cause fatal or serious injuries. A large fraction of fatal and serious injuries that occur in multiple crashes is a growing concern to safety researchers all over the world. Present safety standards that evaluate safety features in light motor vehicles feature only in relatively simple frontal and side crashes. Testing of the performance of safety systems in the more complex multi-impact modes is virtually non-existent in the public literature [14,15,16,17].

5. Conclusion

A large percentage of the vehicles involved in accidents receive multi directional impacts out of which the side impact and the frontal impacts are most prevalent. Safety measures for new cars should incorporate safety tests in directions other than frontal for safety of passengers. Car

companies should conduct tests other than frontal crashes. Further studies are required to see an evaluation of multiple impacts in one direction.

Acknowledgements

The authors would like to thank all agents of various car companies in jazan who extended their support for conducting this study.

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