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Influence of geometric design characteristics on safety under heterogeneous traffic flow



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ABSTRACT

This paper focuses on analysing the influence of geometric design characteristics on traffic safety using bi-directional data on a divided roadway operated under heterogeneous traffic conditions in India. The study was carried out on a four lane divided inter-city highway in plain and rolling terrain. Statistical modelling approach by Poisson regression and Negative binomial regression were used to assess the safety performance as occurrence of crashes are random events and to identify the influence of the geometric design variables on the crash frequency. Negative binomial regression model was found to be more suitable to identify the variables contributing to road crashes. The study enabled better understanding of the factors related to road geometrics that influence road crash frequency. The study also established that operating speed has a significant contribution to the total number of crashes. Negative binomial models are found to be appropriate to predict road crashes on divided roadways under heterogeneous traffic conditions.

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1. Introduction

Traffic safety is of major concern in a developing country. Researches on traffic safety have been widely reported since 1960s, Solomon (1964) relating road crashes in rural highways to speed, vehicle and driver. Several studies have been carried out to identify the factors contributing to road crashes and measures to reduce the crash rate. Several reported studies relate geometric design consistency to road crashes are under homogeneous traffic conditions (Aljanahi et al., 1999; Aram, 2010; Cafiso et al., 2010; Hadayeghi et al., 2003; Kang et al., 2005; Lee et al., 2011; Naderan and Babaei, 2011;

Persaud, 1994, 2000). Road crashes are complex events and are influenced by many factors such as road geometric design, traffic volume and composition, speed differentials between vehicles of the same class and different classes, weather, motivation for travelling, driver's physical and mental conditions and so on (Aljanahi et al., 1999).

In India, as per the recent statistics, around 0.14 million people die and 0.4 million people get injured due to road crashes every year, with a fatality rate of 11.8 (MORTH, 2015). Approximately half of road crash victims are vulnerable road user's viz. motorcyclists, pedestrians and cyclists (WHO, 2009). The traffic conditions are highly heterogeneous in India,

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where the traffic comprises vehicles with diverse static and dynamic characteristics and all such vehicles use the same right-of-way without any physical segregation. Thus, the vehicles of the said heterogeneous traffic, under high-volume conditions, move on Indian roads by sharing the available road space without sufficient lateral as well as longitudinal clearances. The lane-less movement further add to the complexity of analysing/modelling heterogeneous traffic. Under heterogeneous traffic, the effect of speed reduction on vehicles of the same class and vehicles of different classes and their speed differentials along curves on road safety needs an investigation.

Research works were conducted to evaluate the influence of speed on the safety of roadways. According to AASHTO – geometric design of highways and streets (2001), “the safest speed for any highway depends on design features, road conditions, traffic volumes, weather conditions, roadside development, spacing of intersecting roads, cross-traffic volumes, and other factors”. Most of the studies considered the operating speed as the 85th percentile speed of those vehicles travelling on the roadway and found speed-related

crashes are more likely to occur at mid-blocks than at intersections (Lamm et al., 1990; Liu and Chen, 2009; Lu, 2006). Models were also developed to study the dependence of crash rates on speed and geometric characteristics, which showed that they are not linearly related (Garber and Ehrhart, 2000). Vehicle speed could be related to traffic safety in two ways: (a) greater a vehicle's velocity, lesser the time available for the driver to react to a hazard in the presence of other motorists, bicyclists, or pedestrians. If this relationship exists, it would be expressed in relative incidence of crashes at different speeds and (b) due to the physical relationship of mass and speed to energy, it would be possible to express the relative severity of crashes at different speeds (FHWA, 1998). Most of the studies were carried out on undivided rural highways and a few on divided highways.

Research related to geometric characteristics showed that few variables have significant effect on the safety of roadways. Radius of curves was identified as one of the significant variables while defining the effect of horizontal and vertical curves on road crashes and also while estimating the speeds



Fig. 1 – Layout of the study stretch.

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