The Relationship between Geometric Design and Safety of Roadways

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Abstract— Geometric design of highway affects very effectively to road safety, it is observed that road accidents are less happens on the road which has good geometric design. Geometric design of highways related to the design of the visible components like cross sections, intersections, horizontal and vertical alignments, and bicycle and pedestrian facilities. The main purpose of geometric design is to produce a highway with safe, efficient, and economic traffic operations. Geometric design is affected by the road user, vehicle user and traffic characteristics. Faulty design of highway results into road accidents, like curve are not design properly, shoulder distance not adequately provided etc these situations increase hazardous conditions for road safety. Hence safety of road user strongly depends upon highway geometric design. This paper presents relationship between geometric design and safety of roadways.

Key words: Road Safety, Intersections, Geometric Design Etc

I. INTRODUCTION

Highway geometric design reflects into design of vertical curve, horizontal curve, intersections, shoulders, lane, speed of vehicle, medians, roadside facility, pedestrian and bicycle services, etc. A road accident is caused because of so many reasons like surface condition of roadway, avoiding rules of traffic, failure of traffic operations, bad weather condition skill of driver and geometric conditions. Geometric condition of highway is essential among all, because if geometric conditions are not as per requirement then the chances of accidents will increase. This study presents relationship between geometric design of roadways and road safety.

II. RELATIONSHIP BETWEEN GEOMETRIC DESIGN AND SAFETY OF ROADWAYS

A. Vehicular Speed

Speed of the vehicle is one of the important parameters in geometric design and road safety is increases with decrease in speed. For example, Finch et al. concluded that a reduction of 1.6 km/hr (1 mph) in the average speed reduces the incidence of injuries by about 5%. Controlling of vehicle is good in lower speed. Sight distance also required less if design speed of roadway is less.

B. Number of Lanes

Most of the studies show that higher the number of lanes increases the probability of road crashes, Abdel-Aty and Radwan stated that more lanes in urban roadway sections are associated with higher collision rates.

C. Gradients

Steep gradients are responsible for higher number of road hazardous prone situations. Hedman Swedish research stated that grades of 2.5% and 4% increase crashes by 10% and 20%, respectively.

D. Sight Distance

Sight distance is that distance which driver can see in both the horizontal and vertical planes to stop vehicle when it is required to apply brake. It is important for traffic accident. It is observed that high accident rates are reported if the sight distance is not enough. In order to ensure road safety, the traveling sight distance should be design enough when design horizontal or vertical alignment. Sight distances include overtaking sight distance, stopping sight distance.

E. Shoulder width

The objectives of providing shoulder along road are including accommodating stopped vehicles so that they do not capture on the travel lane, to make maintenance work. The study of Zegeer has shown that increasing the shoulder width is associated with a decline of accidents. 21% reduction of total accidents was determined on road with shoulders of 0.9m-2.7m compared to road without shoulders.

F. Horizontal Alignmen

Superelevation are provide to overcome the effect of turning on horizontal curve, and it helps to increase driver comfort by counteracting the lateral acceleration experienced as the vehicle traverses the curve. Super elevation is provided for all the horizontal curves with radius less than 2000 m in order to counteract the effect of centrifugal force. As per IRC : 38, superelevation to fully counteract the centrifugal force for 75% of the design speed of 100 kmph neglecting the lateral friction developed will be adopted in design. The super elevation 'e' has been calculated from the formula. Ore = (v)2 / (225 R) where V is the design speed i.e., 100 Kmph and R is the radius of the curve in meters. The maximum super elevation is limited to 7% as per codal requirement.

G. Vertical Alignment

There are criteria thresholds for minimum and maximum grades. The minimum grade is specified to ensure that water will drain off the pavement surface. Minimum grade is usually set at 0.5 to 0.3 percent. Proper drainage improves safety by reducing the the situation of skidding due to water on the pavement. Maximum grades depend on the function of the road. Steep upgrades affect the speed of heavy vehicles. Trucks at very low speeds may lead drivers of faster vehicles to attempt passing maneuvers at undesirable locations. Climbing lanes should be considered on extended steep grades.

III. CONCLUSIONS

Highway geometric design affects the road safety. If roadway is designed as per the code recommended provision then chances of road safety will increase. Road accidents is highly associated with highway geometric design features like, cross sectional elements, sight distances, vertical elements, shoulder width, road median, superelevation and vehicular speed etc. Superelevation is providing to overcome the effect

of turning on horizontal curve. Steep gradients are responsible for higher number of road hazardous prone situations. Sight distance is that distance which driver can see in both the horizontal and vertical planes to stop vehicle when it is required to apply brake. If sight distances are not provided as per requirement of that stretch of road network than chances of road accidents will increase. Hence all the geometric design of road factors strongly relate with the road safety

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