International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 1, Jan-Feb-2020, ISSN (Online): 2395-566X

A Review on Effect of Highway Geometric Elemnets on Accident Modeling

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***Abstract* - Road safety is an issue of prime importance in all motorized countries. The road accident results a serious social and economic problems. Studies focused on geometric design and safety aim to improve highway design and to eliminate hazardous locations. The effects of design elements such as horizontal and vertical curves, lane width, shoulder width, super elevation, median width, curve radius, sight distance, etc. on safety have been studied. The relationship between geometric design elements and accident rates is complex and not fully understood. Relatively little information is available on relationships between geometric design elements and accident rates. Although it has been clearly shown that very restrictive geometric elements such as very short sight distances or sharp horizontal curve result a considerably higher accident rates and that certain combinations of elements cause an unusually severe accident problem. In this paper, road geometric design elements and characteristics are taken into consideration, and explanations are given on how to which extent they affect highway safety.**

***Keywords*- Accident rate, Geometric Element's, AASHTO, IRC.**

I. INTRODUCTION

Road safety is an issue of prime importance in all motorized countries. The road accident results a serious social and economic problems. Studies focused on geometric design and safety aim to improve highway design and to eliminate hazardous locations. The effects of design elements such as horizontal and vertical curves, lane width, shoulder width, super elevation, median width, curve radius, sight distance, etc. on safety have been studied. The relationship between geometric design elements and accident rates is complex and not fully understood. Relatively little information is available on relationships between geometric design elements and accident rates.

Although it has been clearly shown that very restrictive geometric elements such as very short sight distances or sharp horizontal curve result a considerably higher accident rates and that certain combinations of elements cause an unusually severe accident problem. Geometric design elements play an important role in defining the traffic operational efficiency of any roadway.

Key geometric design elements that influence traffic operations include number and width of lanes, the presence and widths of shoulders and highway medians, and the horizontal and vertical alignment of the highway [1]. Generally speaking, any evaluation of road safety, such as in the driving dynamic field, has been conducted More or less qualitatively. It is safe to say, from a traffic safety point view, that no one is able to say with great certainty, or prove by measure or number, where traffic accidents could occur or where accident black spots could develop. However, everyone agrees that there exists a relationship between traffic safety and geometric design consistency. By all means, alignment consistency represents a key issue in modern highway geometric design.

A consistency alignment would allow most drivers to operate safety at their desired speed along the entire alignment. However, existing design speed-based alignment policies permit the selection of a design speed that is less than the desired speeds of majority of drivers [2]. Much of the research in highway safety has focused on different factors which affect roadway safety. The factors are categorized as traffic characteristics, road geometrics, road surface condition, weather and human factors.

Previous research has shown that geometric design inconsistencies, operations (traffic mix, volume, and speed), environment, and driver behavior are the common causes of accidents. Most of the studies have shown the influence of various geometric design variables on the occurrence of accidents and have concluded that not all variables have the same level of influence in all places [3]. From the relation of factor mentioned above, different researchers have developed the relationship of roadway safety in terms of crash frequency and crash rates, fatality and injury rates and the road elements, traffic

characteristics, and pavement conditions. Many of these previous studies investigated the relationship of crash rates or frequency in terms number of lanes, lane width, presence of median, median width, type of median, shoulder width, access density, speed limit, vertical grade, horizontal curvature, weather condition. The relationship between safety on the highway and factors mentioned above is the primary focus in crash reduction and predictions[3].

II. LITERATURE SURVEY

Rabari et. al. (2018) Everyday, millions of people use roads for travel. A significant amount of travel happens on highways or interstates. On large volume roadways such as interstates, where speeds are high, and problems can occur at locations where there are sharp horizontal curves. At locations such as these the various factors of incline, pavement slope, and friction fully tax the driver's ability to control the vehicle. To make these locations safer study of super-elevation and associated curvature criteria is needed. However, super-elevation and side friction factor are less studied because they are hard to observe or measures. From recorded data we can conclude the safer speed for the motorists and criteria to design higher speed freeways.

For study super-elevation and side friction factor various horizontal curves are selected of State Highway 41 (SH 41) which is from Ahmedabad to Palanpur.Rani and Srikanth (2018) Road safety is an issue of prime importance in all motorized countries. The road accident results a serious social and economic problems. Studies focused on geometric design and safety aim to improve highway design and to eliminate hazardous locations. The effects of design elements such as horizontal and vertical curves, lane width, shoulder width, super elevation, median width, curve radius, sight distance, etc. on safety have been studied.

The relationship between geometric design elements and accident rates is complex and not fully understood. Relatively little information is available on relationships between geometric design elements and accident rates. Although it has been clearly shown that very restrictive geometric elements such as very short sight distances or sharp horizontal curve result a considerably higher accident rates and that certain combinations of elements cause an unusually severe accident problem. In this paper, road geometric design elements and characteristics are taken into consideration, and explanations are given on how to which extent they affect highway safety.Veer et. al. (2018) Geometric design of highway deals with designing of physical visible features of highway those comprise of crosssectional elements, sight distances, alignment, curves, super-elevation, and other allied features. India is one of the country having population increases progressively causes traffic volume more. In addition to that sanctioning of funds from government for transportation infrastructure development is not satisfactory. So that it is preferable to plan and design the geometric elements of the road during the initial alignment stage itself by considering future traffic growth. And it is very difficult to improve geometric elements after construction and cause to unwanted capital investment.

This paper presents review on past work done on geometric design of highway and emphasizes planning and designing of geometric features. Although there are number of factors influences on design of highway, but suitable geometric design having objective of giving optimum efficiency in traffic operation with contentment safety measures at reasonable cost.Bajaru et. al. (2018)Road safety is an issue of prime importance in all motorized countries. The road accident results a serious social and economic problems. Studies focused on geometric design and safety aim to improve highway design and to eliminate hazardous locations. The effects of design elements such as horizontal and vertical curves, lane width, shoulder width, super elevation, median width, curve radius, sight distance, etc. on safety have been studied. The relationship between geometric design elements and accident rates is complex and not fully understood. Relatively little information is available on relationships between geometric design elements and accident rates.

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The primary data have mainly covered the geometry of the road which was measured during the site survey, road safety audit using the checklist, interview, and questionnaire survey. On the other hand, the secondary data collected from the traffic management office in the district offices. On this, the results presented in the form of line graphs, pie charts, figures for road traffic accident and sketch for the suggested improvement in the road design problem. Based on the results of the study in the year 2010 to the year 2015, it found out that there were 866 Road Traffic Accidents have been occurring in the

vicinity of the survey road sections. From this figure, the road traffic accident and damaged to properties expressed as an equivalent amount of about 33,565,122.00 Birr. It revealed that the primary cause of road traffic accidents in the study area emanated from the road design elements due to some geometric deficiencies at the traffic accident prone areas.

Therefore, this study concluded that the frequency of occurrence of road traffic accidents and the figure of casualties is significantly increasing. This road accident would persist if the concerned agencies do not adequately address the malady.Divya et. al. (2016) Road safety is an issue of prime importance in all motorized countries. The road accident results a serious social and economic problems. Studies focused on geometric design and safety aim to improve highway design and to eliminate hazardous locations. The effects of design elements such as horizontal and vertical curves, lane width, shoulder width, super-elevation, median width, curve radius, sight distance, etc. on safety have been studied. The relationship between geometric design elements and accident rates is complex and not fully understood. Relatively little information is available on relationships between geometric design elements and accident rates.

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The study aims to find the impact of factors like extra widening, horizontal radius, sight distance, K-value, super elevation, horizontal arc length, vertical arc length, vertical gradient on the accident rate and aims to study the significant factors causing accidents and to find the values for future design of roads.Hassan et al. (2014)they got three approaches to relate accident rate to geometric characteristics and traffic related explanatory variables: Multiple Linear regression, Poisson regression and Negative Binomial regression. Various models have been intensively tested and validated. The adjustment of the models is based on historical accident data and on the characteristics of experimental sections selected from the road network. For example, Multiple linear and Poisson regression were used. In order to estimate accident rates using traffic and geometric independent variables. Moreover, developed a model to identify the most significant traffic and geometric elements in predicting accident frequency. They used both the Poisson and negative binomial regression models. It should be pointed that, in using such models for future forecast one has to be careful as this entails extrapolating outside the range where the real observations were made.

These models can be used for short-term forecast of 1–3 years. It is advisable that whenever data is available, these models should be updated through recalibration.Driss et al. (2013) studied on traffic accident prediction system based on fuzzy logic which allows to identify “the degree of exposure to road accidents’ risk”, and to analyze the level of complexity of the factors involved. A Geographic Information System (GIS) was integrated into the analysis process to enable a spatial visualization of the degrees of exposure to road accidents’ risk, provided a cartographically measurable solution to establish and attenuate accident risk. The developed system can be effectively applied to identifying risk factors related to the characteristics of the road.

Aswadet. al. (2013) considered road geometric design elements and explanations are given on how to which extent they affect highway safety. The relationship between safety and road geometric design are examined through results of studies mad in different countries and it compares the results of studies in different countries and summarizes current international knowledge of relationship between safety and the principal non-intersection geometric design parameters. In general, there is broad international agreement on these relationships.

Chang et al. (2012) were developed model for identifying accident-prone spots based on the total number of accidents. They considered a mixture of the zero-inflated Poisson and the Poisson regression models to analyze zero-inflated data sets drawn from traffic accident studies.

Kanellaidis et al. (2011) studied highway geometric design from the perspective of recent safety developments and suggested emphasis on concerns of three-dimensional (3D) highway design to achieve a “safe-by-design”.

Choi et al. (2011) studied on the safety effects of highway terrain types in a crash model and suggested that when the design speed is changed, the terrain types will have some safety effects using regression analysis. The statistical analysis was performed with an ordinal logistic regression model in order to relate several independent variables of highway geometric elements such as terrain type, tangent length, curve length, radius of curvature and vertical

grade to actual crash occurrences. Through this investigation, terrain type was found to be a significant independent variable that explains crash occurrences for rural arterial roads in South Korea.

III. ACCIDENT STATISTICS

1. Cost of Road Accident

Road accidents carry high economic and social costs, which are not easy to measure. The cost of road related injuries and accidents can be viewed in terms of (a) medical costs (b) other cost related to administrative legal and police expenditure (c) collateral damage in terms of damage to property and motor vehicle and (d) loss due to income. In addition, accident survivors often live a poor quality of life and have to live with pain and suffering which are difficult to estimate. In economic terms, the cost of road crash injuries creates direct impact to gross domestic product (GDP) of the country.

2. Profile of Road Accident

The total numbers of accidents reported by all the States/ Union Territories (UTs) in the year 2012 were 4.90 lakhs of which 1.38 lakh people were killed and more than 5 lakh personsinjured, many of whom are disabled for rest of their lives (Source: Ministry of Road Transport & Highways). These numbers translate into one road accident every minute, and one road accident death in less than four minutes. Occurrence of accidents is an outcome of factors which include type of road users, colliding vehicles, environmental/road related factors (road geometry, design, visibility etc), vehicle related, nature of traffic management, composition and flow of road traffic and adherence/enforcement of road safety regulations. The main thrust of accident prevention and control across the world has been on Education, Enforcement, Engineering and Environment & Emergency care of accident victims.

3. Spatial Distribution of Road Accidents (Urban vis-à-vis Rural)

In 2012, the total number of accidents that occurred in rural areas was at 54.3 per cent while the rest occurred in urban areas. The number of persons injured in rural areas was also higher at 60.2 per cent as compared to urban areas.

4. Time of Occurrence of Road Accidents

For framing strategies for prevention and organization of care of accident victims, information on timing of accidents is a prerequisite. During 2012, high rates of road accidents were observed between 3pm–6pm, 9am–12am and 6pm–9pm. The distribution of the total accidents during night time (6pm to 6am) and day time (6am to 6pm) is approximately in the ratio of 2:3 i.e. about 40 per cent during night time and 60 per cent during daytime. Motor vehicle population has recorded significant growth over the year. The motor vehicle growth is higher than the rate of road network developed in India. Different elements of highway geometric as well as surface condition of highway have great influence in occurrence of traffic accidents. To minimize traffic accidents, great attention has to be paid inachieving consistency in highway design, minimize the frequency and extent of violations of driver expectancy and emphasis on concerns of three-dimensional (3D) highway design to achieve a "safe-by-design" (George Kanellaidis et al.,2011).

IV. CONCLUSION

After reviewing on the many studies which are related the safety of cross-section and alignment elements can be concluded the following: The presence of a median has the effect of reducing specific types of accidents, such as head-on collisions. Medians, particularly with barriers, reduce the severity of accidents Fixing the cameras everywhere and if the reaction of the traffic police works accordingly may create fear in the drivers then they also follow the rules it leads to decrease in the accident rate.

Providing underground transportation facilities in the highly traffic areas decreases the waiting time and the transportation time. On multilane roads, the more lanes that are provided in the traveled way, the lower the accident rates. Shoulder wider than 2.5m give little additional safety. As the median shoulder width increase, accidents increase. From the limited information available, it appears that climbing lanes can significantly reduce accident rates. Lane width has a greater effect on accident rates than shoulder width. Horizontal curves are more dangerous when combined with gradients and surfaces with low coefficients of friction. Horizontal curves have higher crash rates than straight sections of similar length and traffic composition; this difference becomes apparent at radii less than 1000 m.

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