STUDY OF ROAD GEOMETRY FOR THE IMPROVEMENT OF ROAD ACCIDENT

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Abstract: *The primary objective of this research is to study the road geometry for the improvement of Road accident as well to identify the role of various geometric design elements affecting accident rates. Road safety has become a major concern, with significant consequences for a country's socio-economics. According to the findings, geometric design elements which affects road accidents comprises of (1) road curves radii, (2) road gradients, (3) super elevation, (4) number and density of access and (5) median barriers. It is necessary to quantify the relationship between road geometric elements and road accidents. This research focuses on all of those elements of road geometry in order to give the research foundation for implementation of the gathered information and improvement of road accident.*

Keywords:. *Road Geometry, Geometric design, Road curves radii, Road gradients, Super elevation, Median barrier*

I. Introduction

Road safety has become a key worry that has a negative impact on a country's socio-economics. According to World Health Organization(WHO) figures, road accidents result in around 1.25 million deaths and 20-50 million people being seriously injured and living with long-term disabilities each year around the world. Road accidents are the ninth largest cause of mortality among teenagers, and they are anticipated to rise to the fifth by 2030. The majority of traffic accidents occur in underdeveloped countries, costing the global economy USD $518 billion per year. Road accidents are caused by three major factors: human-related factors, vehicle-related factors, and roadway-related factors (William Haddon, 1970).
Traffic accidents are influenced by elements such as the road, the driver, and the vehicle. The impact of each element on traffic accidents varies depending on the type of accident. The consequences of roadway factors on traffic accidents will be identified, resulting in a safer road design.
Roadway factors, unlike driver or vehicle factors influencing traffic accidents, are modifiable by highway planners and designers, making studies using roadway factors attractive. The relationship between road geometric characteristics, accidentrates, and their prediction is revisited in this paper. Because of its wide range of applications and crucial practical ramifications, road safety modelling has piqued researchers' interest throughout the last four decades. State Departments of Transportation, for example, may be interested in detecting accident-prone locations and promoting safety remedies.
To improve roadway design and offer a safer driving environment, transportation engineers may be interested in determining those aspects (traffic, geometry, etc.) that influence accident frequency and severity. Highway safety enhancement is an important goal of transportation engineering because of the huge cost of highway accidents paid by society all over the world.

II. RELATED STUDY

Rengarasu et al [1] in their research looked at theeffectsofroadgeometryandcross-section variablesonnumbersofaccidents. In addition, they also looked in decision trees which was to build a framework for combining variables. The chi-square automatic interaction detection approach was used to build combination variables for road shape and cross section. The researchers created two negative binomial models, one with homogenous road segments and the other with 1-kilometer road segments.

Karlaftis et al [2] used a rigorous non-parametric statistical methodology known as hierarchical tree-based regression to address the subject of the relationship between rural road physical attributes, accident rates, and their prediction. The study had two objectives: first, to provide a system for statistically assessing the effects of various roadway physical attributes on accident rates, and second, to propose a simple, yet fundamentally and mathematically valid approach of predicting accident rates on rural roads.
To quantify the relationship between road geometric elements and road accidents, several statistical models were developed, including linear regression, Poisson models, Poisson-gamma models, negative binomial models, generalised estimating equation, random-parameters, and bivariate and multivariate models. In previous studies, linear regression models were considered and developed to determine the relationship between road accidents and road geometry elements.

Jovaniset al [3] reported that using traditional linear regression models produced unsatisfactory results because linear regression properties are normally distributed, which can result in negative or non-discrete values of accident rates.

III. GEOMETRIC DESIGN ELEMENTS AFFECTING ACCIDENTS RATES

Improving road geometric design is one technique to improve road safety by reducing the frequency and severity of incidents on highways. It is critical to examine and specify the road design in order to enhance it. There is a link between road geometric design components and traffic collisions.

Yingxue, [4] The study focussed on Radii of road curves.: The radius of a road curve is a major aspect of road geometric design that is involved with horizontal curve design. It is linked to traffic accidents since the smaller the curve radius, the more likely an accident will occur on the road. Vehicle transverse stability, which includes slippage and overturns, influences the curve radius value to be picked while building road horizontal curves, according to vehicle steering theory.

Glennon et al. [5] examined the findings of various studies conducted in the United States and concluded that highways designed with grade parts have a greater rate of traffic accidents than roads designed with level sections. They also discovered that steep gradient roads had greater accident rates than mild gradient roads, as well as that down-grade roads have higher potential accident rates than up-grade roads. In conclusion, road gradient has a substantial relationship with road accident rates, since higher road gradients result in higher road accident rates.

ZhangYingxue [6]states that the super elevation traverse slope should be between 2.0 and 3.0 percent and also road horizontal alignments, design speed, natural conditions, and curve radius all influence super elevation. He also said that using the right super elevation value will help to reduce events that may add to the severity of an accident. According to several research, super elevation and horizontal alignment have an impact on road traffic safety.

Abdel-Aty et al., [7] concluded in their study that increasing the number of lanes on metropolitan roadways increases the number of accidents Several other studies conducted by researchers have found that the number of lanes is related to the frequency of accidents on the road.
The adoption of an optimal lane width value of 3.5 m to 3.6 m was recommended by the majority of studies. More cross-sectional elements relating to traffic flow rates should be considered as part of a more trustworthy strategy. Other research has found that a wider lane can help in some cases.
Road accidents are somewhat more likely to occur Hearne [8]. Another study, on the other hand, suggests a significant change.

K. Hedman [9]reported that in comparison to broader lanes of 4.0-7.0 metres or greater, there is a decrease in traffic accidents. Several studies, however, have found that there are far fewer accidents corresponding lane widths ranging from 3.4 to 3.7 metres.

Martin R., [10] states one of the most important aspects that can lead to traffic accidents is sight distance. The carriageway viewable distance is the distance that vehicle drivers can see and recognise on both vertical and horizontal planes.

Srinivasan [11]discovered that alterations in vertical alignment might result in shorter sight distances at vertical crest curves, which has been shown to affect the incidence of accidents.

Mouskos et al.[12] conducted research in New Jersey on the impact of access points on multilane highway accident rates. They discovered that roughly 30% of multilane highway accidents occur in the mid-block sections, which can explain the main reason, which is the presence of access points. It was also shown that around 25% of merging and diverging traffic at access points had an impact on multilane highway traffic flow, which could lead to accidents.

Zegeer et al[13] states shoulders are utilised as a free space on roadways to allow cars to halt out of the main flow of traffic, whether for vehicle breakdowns, emergencies, or as a part of road right of way. Wider shoulders result in lower accident rates, with shoulder widths of 0.9 m – 2.7 m causing a drop of up to 20% of incident occurrence, and they advised that the optimal road shoulder width be 1.5 m.

Hadi et al[14] reported that the road medians can be used to separate traffic in both directions, as well as to avoid incorrect manoeuvres, enable left-turn movement, and give a recovery area in the event of an emergency stop.
Raised curbs, crossover resistance, and stripped medians all contribute to a reduction in road safety. Furthermore, physical tight medians have a lower impact than broad medians if just vehicles collide with them.

Nikiforos et al[15] states barriers can reduce accidents caused by erroneous manoeuvres, but they can also increase the amount of incidents involving medians because medians might be utilised as a stopping space. To summarise, barriers can reduce severe crossover collisions; therefore, both the kind and severity of collisions should be considered with and without barriers.

IV. FINDINGS

The following findings can be made based on the review literature that has been done thus far.-

1. Some of these elements are more important than others. While lane width was found to be more important to crash rates than shoulder width, some types of crashes, such as opposite direction and run-off-road crashes, were reduced by increasing both lanes and shoulders widths, but only to a limited extent.
2. The number of accidents decreases when additional lanes are added; nevertheless, road curves cause approximately four times the number of crashes as road tangents. Although a shoulder width of up to 2.5 metres has been shown to be safe, a broader shoulder may increase crash rates. For homogeneous traffic conditions, horizontal curvature is more successful than straight portions in reducing accident rates, particularly at radii less than 200 m, which correspond to a 90 km/h average operating speed.
3. Graded horizontal curves, in particular, have a substantially greater impact on crash rates.
4. Furthermore, it has been found that downgrades have a substantially greater impact on accident rates than upgrades. Because steep grades are more often than not short, their impact on the occurrence of accidents is less effective than mild grades. Mountainous topography, on the other hand, causes 30% more accidents than flat terrain. Head-on collisions are reduced by medians, whereas accident severity is reduced by median barriers. Studies on sight distance have found that distances less than 0 m have a beneficial impact on crash rates but have a negligible effect on safety.

V. CONCLUSION

Because of the inter-relationships between the geometric design elements and other accident-related factors, it is difficult to understand the relationship between road geometric design elements and road accident rates. However, it is clear that some geometric design elements, such as short sight distance and small curve radius, can significantly increase the rate and severity of road accidents. Furthermore, the occurrence of major accidents might be caused by the combination of specific geometric design features.

It was also shown that assessing the trustworthiness of existing studies is difficult due to differences in parameter definition and selection utilised in the studies, traffic volume and composition, and a lack of control over statistical data and models. Furthermore, because of differences in traffic flow conditions, driver behaviour, environmental factors, actual road conditions, and road enforcement policies and practises, the results of studies conducted in different countries may not necessarily be the same, applicable in other countries, and should not be generalised.

On the impact of road geometric design components on traffic accidents, however, there is widespread international consensus.

When it comes to statistical modelling of accident analysis and prediction, road safety researchers have the ability to produce more reliable models by putting in more study timeand applying new statistical methodology and approaches.

REFERENCES

[1] Rengarasu, T. M., Hagiwara, T., & Hirasawa, M. (2009). Effects of road geometry and cross-section variables on traffic accidents: study using homogeneous road segments. Transportation research record, 2102(1), 34-42.

[2] Jovanis, P., &Chang,H. (1989). Disaggregate model of highway accident occurrence using survival theory. Accident Analysis and Prevention 21(5),445–458.

[3] Karlaftis, M. G., &Golias, I. (2002). Effects of road geometry and traffic volumes on rural roadway accident rates. Accident Analysis & Prevention, 34(3), 357-365.

[4] Glennon, J. (1985). Effect of alignment on highway safety, relationship between safety and key highway features. SAR6, TRB Ltd., Washington, D.C., P.P 48-63.

[5] Zhang Yingxue. (2009) "Analysis of the relation between highway horizontal curve and traffic safety. International Conference on Measuring Technology and Mechatronics Automation, China.

[6] Abdel-Aty, M.A., &Radwan, A.E. (2000). Modeling traffic accident occurrence and Involvement. Accident Analysis and Prevention 34, P.P 633-642

[7] Hearne, R. (1976). Selected geometric elements and accident densities on the network. Environmental Research Unit, Dublin.

[8] Hedman, K.o. (1990). Road design and safety. Proceedings of Strategic Highway Research Program and Traffic Safety on Two continents, Gothenburg, VTI Report 315 A.

[9] Martin R. (2003). Highway Engineering. First Edition, Ireland.

[10] Karlaftis, M.G., Tarko, A., 1998. Heterogeneity considerations in accident modeling. Accident Analysis and Prevention 30 (4), 425–433.

[11] Srinivasan, S. (1982). Effect of roadway elements and environment on road safety. Institution of Engineers, Vol.63.

[12] Mouskos, K.C., Sun, W., % Qu.T. (1999). Impact of access driveways on accident rates at multilanehighways.National Center for Transportation and Industrial Productivity, New Jersey Institute of Technology.

[13] Zegeer, Deen, & Mayes. (1981). Effect of lane and shoulder widths on accident reduction on rural two-lane roads, Transportation Research Board 806, P.P 33-34, Washington, D.C. USA.Hadi, M.A., Aruldhas, J., Chow, L.F., &Wattleworth, J.A.(1995). Estimating safety effects of cross-section design for various highway types using negative binomial regression.

[14] Nikiforos S., Dominique L., Jerry P., John S., & Wendel R. (20). Safety impacts of design element trade-off for multilane rural highways. ASCE Journal of Transportation Engineering.