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Development of Accident Prediction Model on Horizontal Curves

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Abstract-*Nowadays accidents on horizontal curves are increasing day by day. The speed reduction affect to the safety of the road. To reduce accidents, an accident prediction model has to be developed. Accident Prediction Model is made to take remedial measures in advance by studying future trends, to take mitigation measures to minimize the accident rates to certain extent and to take other safety measures. The main objectives are identify the factors influencing road crashes and to develop a accident prediction model using SPSS software*

Key Words: Accident prediction model, Road stretch. Horizontal curves

1. INTRODUCTION

Every year five lakhs of people are injured and died by road accidents. In 2017 census 4.85 lakh peoples are affected by road accidents. From that 1.5 lakh people were died. Millions of people were seriously injured. Annual GDP loss to India due to road accident is 55,000 crore rupees. Childrens are killed every day. This due to lack of proper education. From a study 50% of deaths are between the age of 15 and 35. In Kerala scenario in 2017, 38.500 road accidents are occurred. Most of the victims of road accidents are two wheelers, pedestrian and vulnerable road users more than twenty million individuals are wounded and over one thousand are killed per annum globally owing to traffic crashes. Highly developing countries account up to eighty fifth of all the facilities.. Driver, vehicle and road conditions are the, major three components relative to the highways. The inconvenience in any part of these components will cause accidents. The vehicle components of road accidents depend to some extent on the design, but it is mainly related to the maintenance aspects. In India the motor vehicle population is growing at a faster the economic and population growth. According to the WHO road traffic injuries are the sixth leading cause of death in India worth a greater share of hospitalization, deaths, disabilities and socio economic losses in the young and the middle aged population. In Kerala road crashes have touched on all time high during the last six years with 39,029 crashes being registered in 2015. It is estimated that more than 50% of the total fatalities on rural highways can be attributed to the crashes that takes place on curved sections. Thus curved sections and the corresponding transition section represents the most critical locations while considering measures for improvement of highway safety. Therefore models have to be develop for predicting accidents or crashes.

2. LITERATURE REVIEW

Harshit Gupta and Dr. Siddhartha Rokade (2017) says the purpose of the study is to develop a model for prediction of crashes in urban medium size cities. In this paper Crash prediction model (CPM) is developed using multiple regression analysis. A model is a simplified representation of a real world process. It should be representative in the sense that it should contain the salient features of the phenomena under study. In general, one of the objectives in modeling is to have a simple model to explain a complex phenomenon**.** Praveen Vayalamkuzhi and Veeraragavan Amirthalingam (2016) says traffic safety is of prime concern worldwide. Highway geometry should be designed for vehicle safety and efficiency. Several researches have been carried out to identify the factors contributing to road crashes and for finding measures to reduce the crash rate. One of the critical gaps in the management of highway safety is the lack of a reliable method for estimating the safety of an existing roadway with, widely varying road geometrics and vehicle mix. The focus of this work is mainly to quantify the relationship between geometric design characteristics and level of safety of intercity highways under heterogeneous traffic conditions. Study was carried out in a four-lane divided rural highway in Tamil Nadu, India and a relationship was established using statistical modeling technique

3. STUDY OBJECTIVE

The main objective of the study is to evaluate the road geometrics that effect the road accidents and develop models to predict safety.

4. METHODOLOGY AND DATA COLLECTION

The data collection basically have 2 components, the geometric data and crash data. Firstly the study stretch was identified and the variables that are to be collected were identified. The stretch having only horizontal curves were taken and another criteria was that the curves in this selected stretch should have a tangent distance of 100m or more

4.1 Study Stretch

The three stretches were selected for the study in the state highway as shown below:

1.vazhakode – pazhayanur

2.kulapully – perumpilav

3.pannithadam – ottupara

4.2 Geometric Data Collection

A hanheld GPS MEGALLIAN was used for preliminary data collection and identification of study routes..Global Positioning System (GPS) is a navigation and positioning tool to collect spatial data. The tangent distance was measuring using an instrument called rodometer. The detailed geometric data collection of the identified study stretch was accomplished with the help of total station survey .The geometric data includes the location, road width, shoulder width, existence of any features like electric posts, signboards, culverts, trees etc. Total station is a surveying equipment, combination of electromagnetic distance instrument can be used to measure horizontal and vertical angles as well as sloping distance of the object to the instrument. Roadway details regarding width of carriageway and width of shoulder, and length of tangent to the curve were measured. Other general characteristics of the site like presence of signs and marking, location of bus stops, etc. were noted down separately. The study requires horizontal alignment of the centreline of the highway sections understudy. Hence, a total station survey was deployed in these stage. As it was found difficult to collect data along the centerline of the highway, data of points along the edges of the carriageway were recorded. Logging interval was reduced up to 2 meter, especially near the vicinity of curves. Points along the edges of shoulder were also surveyed in order to understand the variation of shoulder width along the section. Any road side obstruction such as tree, post, culvert or kilometre stone were also logged if they seemed to encroach in to carriageway or shoulder area. Data from total station were later exported to CAD software for generating plan and profile. Details like radius of curve, length of curve, rate of superelevation, gradient and tangent length were extracted from the drawings. Sight distance is measured in the field. For the purpose of measuring the stopping sight distance or visibility a head IRC has suggested to the height of eye level of driver as 1.2 m and the height of the object as 0.15m above the road surface. Hence the stopping sight distance is that minimum distance measured along the centreline of the inner curve at which an object of height 0.15m can be seen by a driver whose eye is at a height of 1.2m above the road surface. Equipment was used for finding sight distance. A rod with a rectangular aluminium sheet is fixed to one end was fabricated. The sheet was having a central hole at a height of1.2m from the bottom of the rod, in order to represent the height of the eye level of the driver. The procedure for measuring sight distance is described below. Let the person standing with the rod be A and the person standing with the object of 1.5m height be B . A was standing on the starting of the curve and B was asked to walk through the centreline of the inner curve till object at B was invisible to A. Then the distance was measured. This was done for every 10m in the curve and the minimum distance was taken as the critical sight distance. Next step was to collect the crash data of last four years that happened in these routes. Crash statistics are generally maintained by police department. For this we identified the police circles in which these routes form part. Crash data were collected from the first investigation sample report(FIR) for the last 4 consecutive years (2014,2015,2016,2017).The police stations coming under the study stretches are Wadakancherry, chalissery, pazhayanur, shornur, cheruthuruthy, pattambi, erumapetty, thrithala,.

5. PRELIMINARY ANALYSIS

A preliminary analysis of data will help to identify the relationship between dependant and independent variables in the data set. the variables are influential on dependant variable can be identified and their logical relationship can be recognized. A. Estimation of equivalent property damage only crashes(EPDO)A property damage crash only crash means that there were no injuries or fatalities. The equivalent property damage only crashes (EPDO) is a way of comparing severity types among each other. Generally ,the crashes are of three types are on injury crash/ property damage only, evident injury crash (major and minor crash) ,fatal injury crash(death causing).These three types of crashes are expressed in terms of severity by a factor termed as equivalent property damage only crashes. The corresponding EPDO values for the crashes are on-injury crash(IPC 279)-1,major/minor injury crash(IPC 337/338)-4fatal injury crash (IPC 304(A))-12. Scatter diagram of parameters is plotted with EPDO value

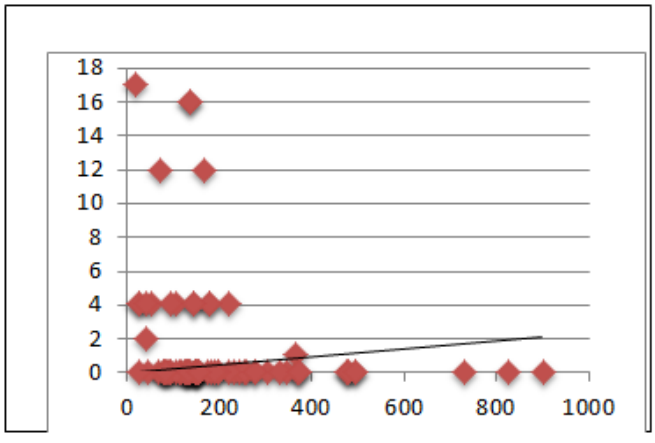

Chart 1.Scatter plot of EPDO and radius of curvature

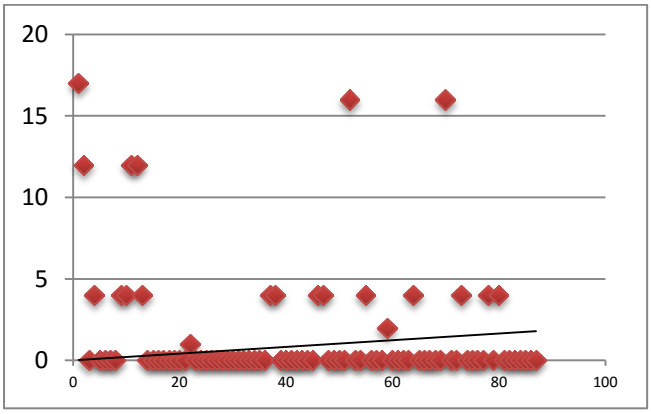

Chart 2.Scatter plot of EPDO and Tangent length

6. DEVELOPMENT OF CRASH PREDICTION MODEL

6.1. Regression Modelling

The basic idea of regression modelling is to estimate the outcome of the event on the basis of some or all casual variables. Thus the analysis involves finding the effect of independent variables on dependant variables. Equivalent property damage is dependant variable and geometric, crash data are the independent variables. For that the assistance of SPSS software was taken. linear regression analysis helps to predict the value of a variable based on the value of two or more other variables. This variable to be predicted is called dependent variable and the various geometric features of the selected two lane rural highways are taken as independent variables. Some of the key features of regression analysis are that it can use unlimited number of independent variables for a single dependent variable. It is the best analysis for predicting the future demand and the optimization of the obtained sample. Data about 60 horizontal curves was collected among them 40 curves are randomly chosen for calibration which is known as the calibration data. And the remaining 20 are taken for checking the validation of the predicted models, and they are known as the validation data. Several trails were performed and the most significant one is only presented. For the better models several conditions were adopted in the analysis,

a. The coefficient of determination (R2) must be significant.

b. The 't' statistic value should be significant. It must have a value of at least '2' for significance to be established

Table -1: Model And Rmse Values

Type of vehicles	Model	R^2Value	Rmse Value
Two wheeler	EPDO=1.773+65.79Ld2 –0.343Se	0.840	4.95
LCV	EPDO =-33.368+5.272 Wr +0.409 Ld +0.026 Dc	0.772	3.81
LMV	EPDO=2.6880.112Da+51.696Ld +3.330Se+0.002Dc2	0.820	2.33
MCV	EPDO =-2.566+0.216Dc-4.275Se+66.197Ld0.210Da+0.043Cl	0.813	4.03

For the purpose of evaluation the actual spot of accidents on each curve was found out. The Equal property damage only (EPDO) values for each curve were found out. Weightage is given to the accident data which were comes in the selected curves. One weightage is given to accidents under IPC 279 (Property Damage only accidents), IPC 337 (minor accidents), four weightage is given to accidents under IPC 338 (major accidents), and 12 weightage is given to accidents under IPC 304(A) (fatal injury-death).

6.2 Validation of models

From the 60 data collected and analysis is performed by taking 40 samples and remaining 20 are taken for validation. Thevalues at each curve was calculated.The difference between the predicted and observed were calculated at each curve.

- Error = observed value – predicted value

The square sum of errors (MSE) were calculated using

- MSE = SSE/n

n= no: of samples

The root mean squared of error (RMSE) werecalculated

- RMSE = √MSE

Table -2: . Model And T Values

Type of vehicles	Model	T value
Two wheeler	EPDO=1.773+65.79Ld2 – 0.343Se	2.031,10.445,-4.379
LCV	EPDO =-33.368+5.272 Wr + 0.409 Ld +0.026 Dc	1.964,1.944,1.826,2.016
LMV	EPDO=2.6880.112Da+51.696Ld-3.330Se+0.002Dc2	1.811,-1.286,2.785,-
MCV	EPDO =-2.566+0.216Dc-4.275Se+66.197Ld0.210Da+0.043Cl	1.707,-3.437,3.945,1.838,1.967

7. CONCLUSIONS

The following general conclusions were developed based on the findings of the study:

- It is identified that accidents have more influence on geometric parameters.
- Models to predict accident based on geometry is developed.In this analysis the geometric details of the chosen road stretch are collected. The geometrical details like horizontal profile of stretch, length of the stretch, degree of curvature, sight distance and level difference. Actual accident for every accident location is calculated using the available crashes. To find out the predicted crash rate a model equation is developed through regression. The equation is developed using accident as dependent variable and degreeof curvature, sight distance, level difference, radius of curvature, curve length as independent variables The model developed is also used for the highways having conditions rather like the study and should facilitate to take right decision in the direction of accidents management i.e. to decide out and implement remedial measures in the view of traffic safety.
- For safety designation and specially, identification of dangerous zones in network by ranking the sites by their accident rates, the model is also very helpful.

It can be observed from the model developed for the geometrical details of the road to predict future crash. Curvature, sight distance, curve length, radius of curvature, traffic volume, level difference all are positive.

- From the observed and predicted accident it is observed that some of them are over predicted and some of them are under predicted.

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