MODELING FOR PREDICTION OF CRASH RATE FOR NAIDUPETA ROAD STRETCH (NH71)

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Abstract

The main objective of the present study was to predict the expected number of crashes in the selected stretch by developing a model. It only the past decade the developing countries like India begun to experience large increase in the number of road accidents taking place and have found it necessary to institute road safety programs. It is strongly felt that most of the accidents, being a multi factor event, are not merely due to drivers fault on account of driver's negligence or ignorance of traffic rules and regulations, but also due to many other related factors such as abrupt changes in road conditions, flow characteristics, road user's behavior, climatic conditions, visibility and absence of traffic guidance, control and management devices. In the present study, the accident data of the proposed stretch from the year 2012-2016 has been collected from concerned police station, by using this data actual crash rate for the respect stretch is found. After this, the main data required is the geometrics of the road way which will be useful for the evaluation of the black spot locations. Crash rate and crash rate per year is find for the each location. After this for the identified black spots the geometrical details were identified and modeling is done to predict the crash rate using linear regression method in MINI TAB software.

Keywords: *Road accidents, Observed crash rate, Predicted crash rate, Linear Regression, Road Stretch, Horizontal alignment and Geometrical details*

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1. INTRODUCTION

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 fatalities. Traffic accidents in highly urbanizing countries are increasing apace and in some cases become more deadly than the diseases that affected the population. 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. He must suit the traffic situation; to overtake, to give way at times, to perform turning maneuver, to contend with pedestrians, slow moving vehicles etc. He must build variety of selections in fraction of seconds. Any call incorrectly taken by the driver during this tiny time-frame might lead to accidents. The vehicle components of road accidents depend to some extent on the design, but it is mainly related to the maintenance aspects.

The design of road has much effect on the accident occurrence. The roads condition may directly or in combination affect the safety aspects. The visibility in horizontal and vertical curves affects the driver very much. Poor visibility and abrupt changes in geometry could compel the driver to require fast decisions which can cause accidents; higher road style, additional widening at curves can have a positive bearing on accidents. Uniformity in design avoiding frequent changes in width, vertical profile on the alignment is to be maintained. Co-ordination of horizontal and vertical alignments will have some effect on accidents. An alignment with common apex point for horizontal and vertical curves will help in reducing accidents. The effect of lane width on accidents is dependent on the traffic volume of the road. Carriageway width can have positive or negative impacts on accidents depending upon the above factor. Roads with reasonable width and normal traffic can have more accidents than a road with same width and congested traffic condition which cause the slower speed of the traffic stream. The pavement condition, lighting, footpath availability, number of junctions etc are some important factors affecting the accidents on urban roads. Whereas on rural roads, pavement condition, radius of the curves, sight distances, horizontal and vertical curvatures, super elevation, etc are the main factors affecting the accidents.

1.1 Objectives of the Study

The objectives of the present study are as follows

- Road geometrics that effect the road accidents
- Developing a model to identify the predicted crash rate

2. DETAILS OF PRESENT INVESTIGATION

For the investigation a road stretch is selected, a small stretch on NH71 which comes under Naidupeta police station. In this the geometric details of road of each identified Blackspot like cross-section details, camber, super elevation, signs and markings, drainage, sight distance,

horizontal and vertical profiles and total rise details will be collected. The Total station instrument is used for the collection of the geometrical details of road. From the total station Northing- Easting of different locations is also noted. The geometrical details of road like camber, super elevation, length, gradients etc are to be calculated using the data collected in the field and tabulated for further analysis.

2.1 Modeling for Accident Prediction

So many authors have worked out to find the effect of geometrics of roads on accidents and developed several models which will give the relationship between geometric features and accidents. A type of traffic and geometric elements of road such as AADT, cross-section design, horizontal alignment, roadside features, access control, pavement conditions, speed limit, lane width, and median width, will be used for the future prediction of crash rates as output.

Statistical model is developed from the data which is available to induce the predicted crash rate when the geometrics of a selected section were identified. For this, MINITAB software package is to be used. MINI TAB software package is statistical software package from that all kinds of statistics is performed based on the information out there. For this study multiple regression equation is to be developed for the prediction of accidents for a section with identified geometrical details .From the analysis and comparisons, the proposals for the accident reduction measures are given.

The road was divided into different sections and components of road such as accident data, length of each section, the average annual daily traffic flow, average road width, number of junctions, average horizontal curvature, and surface irregularity were collected for each section. The model developed.

Validation of Model

The validation of model is as follows:

- By identifying the Coefficient of Determination (R^2).
- By the comparison of results of total number of crashes find by the model with the data obtained from NHAI.

Coefficient of Determination (R^2)

It is explained as a ratio of the explained variance to the total variance of the independent variable y. The value of R^2 lies between 0 and 1, the closer it is to 1, the better is the model.

3. IDENTIFICATION OF PREDICTED CRASH RATE BY MODEL DEVELOPMENT

Naidupeta police stretch is covering 2.6 km in the NH71. The limits of this stretch are Naidupeta bus station to Gomathi garden hotel center. In crash density method this stretch is identified as a Black-spot. And now the study was taken place for this stretch.

Fig-1: Naidupeta road stretch

3.1 Collection of Geometrical Details of Road Stretch

For gathering of geometric details different instruments are used. Total station is employed to gather the northing and easting of the road which provides the horizontal profile of the road. At a similar time to gather the length of the paved and unpaved shoulders, and sight distances tape is used. In the same approach no of cross roads and also the horizontal curves also are noted in the data sheet. And alternative geometric details like camber, super elevation, Radius of curves, rise and fall were calculated. All the geometric details were shown in the following tables.

Horizontal Profile of Road

In table 5.1 horizontal profile of the Naidupeta stretch is given as northing and easting point.

Table 1: Horizontal profile of Naidupeta road stretch

S.NO	NORTHING	EASTING
1	3.679	1.032
2	9.825	5.601
3	13.516	17.624
4	20.915	29.325
5	36.157	55.002
6	37.830	73.016
7	60.001	91.152
8	81.111	132.604
9	96.313	151.754
10	111.210	190.056
11	150.600	251.804
12	172.015	305.711
13	163.462	362.317
14	181.686	399.015
15	189.62	442.439
16	199.801	479.215
17	210.793	535.172
18	234.712	564.015

19	256.097	591.652
20	275.751	641.735
21	284.152	673.06
22	296.160	685.016
23	311.433	726.153
24	319.267	775.403
25	333.33	798.152
26	344.49	835.061
27	364.177	899.773
28	371.152	956.054
29	392.212	1015.102
30	427.156	1108.635

By using the values of table-1 a graph was drawn for northing and easting points, that gives the horizontal profile of the Naidupeta road stretch.

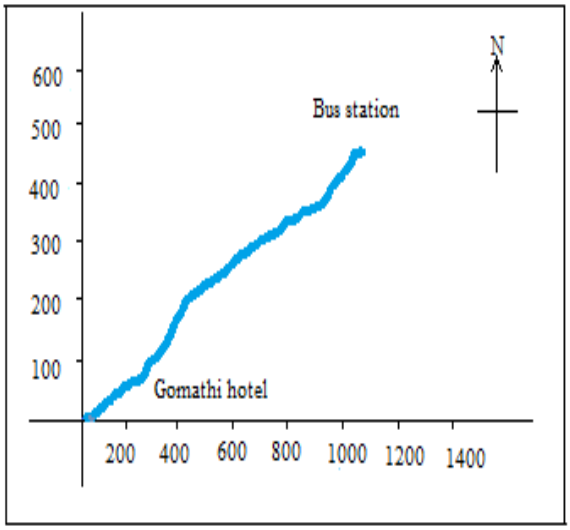

Fig- 2: Graph of Horizontal profile of Naidupeta road stretch

3.2 Model Development

This section deals with the event of model from obtained accident and geometric details to predict the feature accidents. For that the geometric details like camber proportion and super elevation are needed. These are calculated with the help of road breadth and elevations. Radius of curve was calculated by using the horizontal profile in Auto CAD.

Camber (%) = (Elevation difference between Center and one edge of road) / Half width of road * 100

Super elevation (%) = (Elevation difference between two edges of road) / Width of road * 100

For this method the collected information was tabulated as shown in table 2. For every accident location the Camber, Shoulder breadth, Degree of curvature, Minimum sight distance, raise and fall were taken. Length of the every accident zone is taken and all the values are tabulated in table 2. Finally crash rate per year for each accident location was calculated and therefore the crash rate per km is also identified from the available information.

Scatter diagram for each variable is drawn as shown in the figures 3, 4 and 5. The variable degree of curvature per km, sight distance, total rise satisfies the logic with the variable crash rate and the variables, carriage method width, camber, shoulder breadth doesn't satisfies the logic cause they're virtually same throughout the length of the road.

Table 2: Geometrical details of the each accident location under Naidupeta police station stretch

Location	Length (m)	No.of Junctions	CW Width (m)	Camber %	Paved shoulder width	Degree of curvature/ Km	Sight distance	Total rise	No.of Crashs	Crash rate /yr	CR per year per km
Bus station	0.31	1	7.5	0.8416	1.53	126.4	210	3.89	20	4	12.903
Naidup-eta hp petrol bunk	0.23	1	7.5	0.5811	1.35	81.89	189	5.10	6	1.2	5.217
Saptha-giri oil mill	0.41	1	7.5	0.6423	1.35	64.18	155	1.67	17	3.4	8.292
New kalyana manda-pam	0.24	0	7.5	0.8434	1.46	74.38	250	5.23	3	0.6	2.5
Ragave-ndra Compl-ex	0.26	1	7.5	0.7115	1.45	72.78	195	2.16	2	0.4	1.538
Gomathi center	0.53	1	7.5	0.5622	1.35	59.12	120	3.14	25	5	9.433

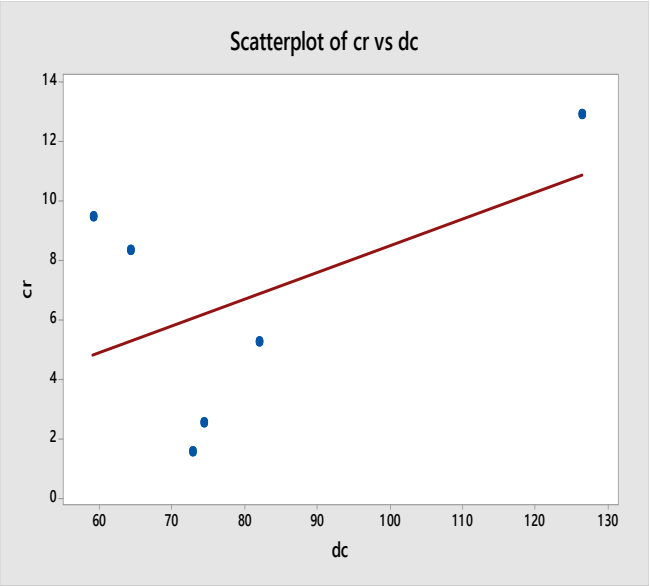

Fig-3: Scatter diagram of crash rate Vs degree of curvature

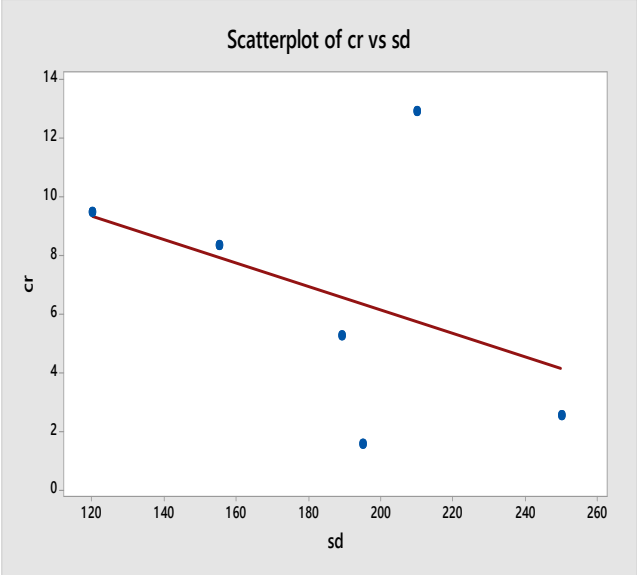

Fig-4: Scatter diagram of crash rate Vs Sight sidtance

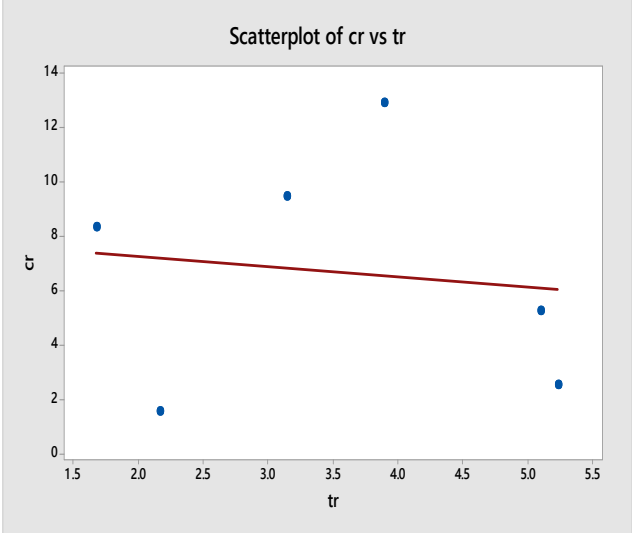

Fig-5: Scatter diagram of crash rate Vs Total rise

From the scatter diagrams the trend lines of every variable may be ascertained. The relation between crash rate and degree of curvature is positive, the relation between crash rate and sight distance is negative and crash rate and total rise is negative.

For the model development MINITAB software package is employed. General linear regression is employed for 3 independent variables and one dependent variable quantity the subsequent equation is developed from the MINITAB software package.

$$CR=8.91 + 0.1596\ dc - 0.0860\ sd + 0.29\ tr$$

The coefficient of determination R^2 value = 0.7927

T Test values DC = 2.24, SD = -2.08, TR = 0.25

Where DC= Degree of curvature
SD = Sight distance
TR = Total rise

Using the above equation predicted crash rate is obtained. These predicted and observed crash rates are tabulated in the table 5.3.

Table-3: Observed and predicted crash rate for each accident location

Location	Observed crash rate	Predicted crash rate
Bus station	12.903	12.1481
Naidupeta hp petrol bunk	5.217	7.204
Sapthagiri oil mill	8.292	6.307
New kalyana mandapam	2.5	0.7977
Ragavendra Complex	1.538	4.3764
Gomathi center	9.433	8.9306

4. DISCUSSION OF RESULTS

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, length of every accident location camber, carriage manner dimension, dimension of sealed shoulder, degree of curvature, sight distance and total rise. Actual Crash rate 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 crash rate as variable quantity and degree of curvature, sight distance and total rise as freelance variables.

Table-4: Comparison of Observed and Predicted Crash Rate

Location	**Observed crash rate**	**Predicted crash rate**	**Error %**
Bus station	12.903	12.148	0.0585
Naidupeta hp petrol bunk	5.217	7.204	0.3808
Sapthagiri oil	8.292	6.307	0.2393

mill			
New kalyana mandapam	2.5	0.798	0.6808
Ragavendra Complex	1.538	4.376	1.8452
Gomathi center	9.433	8.931	0.0532

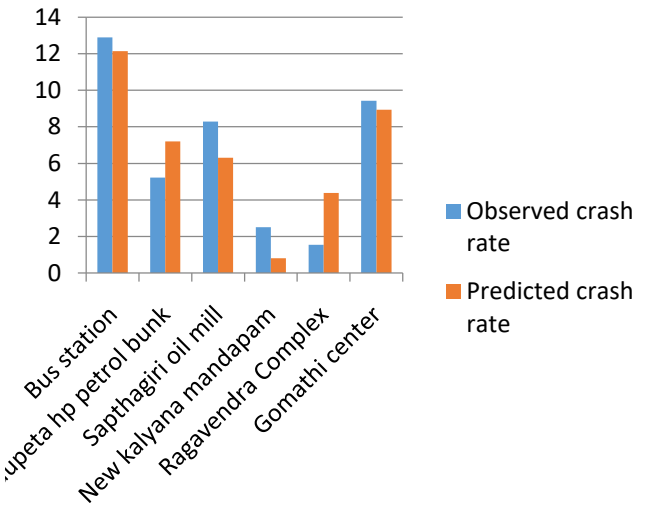

Fig 6: Bar chart comparison of observed and predicted crash rate

- 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.
- The model is also used for analysis of the effectiveness of a security live by examination the accident rates of 2 compatible samples of websites before and after the implementation and to predict accidents, their nature, causes and pattern.
- Also, the result of varied parameters like carriageway dimension, shoulder dimension, number of minor roads, no of curves etc; on the road traffic accidents can be studied with the help of model.

5. CONCLUSION

The following conclusions are drawn from the present study.

- It can be observed from the model developed for the geometrical details of the road to predict future crash rate that the relation between crash rate and degree of curvature per km is positive and therefore the relation between crash rate and sight distance, total rise is negative.
- From the final table the observed and predicted crash rate will be ascertained. Where predicted crash rate is found exploiting the geometrics of the road. It will be used for the additional development of roads.
- From the field observation it is ascertained that it's a 2 lane road and it's having a significant traffic density. Due to heavy traffic and exceeding lawful speed accidents are occurring.

To control the accident rate there in road stretch four lane road is needed because the traffic density is very heavy in that road.

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