ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

# Road Accident Investigation in Highway

Nelaturi.Praneeth,
M.Tech scholar,
Nalanda Institute Of Engineering And Technology

T.Venkateswara Reddy, M.Tech ,
Assistant Professor,
Nalanda Institute Of Engineering And Technology

## Abstract

Accidents are not natural but they are caused is a common saying in the area of traffic safety. Thus, if accidents are caused by some factors, those can be identified and appropriate remedial measures can be developed and implemented to the extent feasible. The spectacular increase in the number of motor vehicles on the road has created a social problem i.e. the loss of human lives through the road accidents. Road accidents have been a major social problem in the developed countries of the world for fifty years. It only the fast 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. In the present study, the accident data of the proposed stretch from the year 2010-2014 has been collected from concerned police stations in prepared data formats. The data sheet covers all the accident details. At each police station First Information Reports were referred to note down the accident particulars. The analysis work was carried out for the proposed stretch and black spots were identified. After this, the main data required is the geometrics of the road.

## 1. INTRODUCTION

People, roads and vehicles form the same important combination all over the world that of being able to transfer themselves or goods from one place to the other. Road accidents became a serious problem throughout the world, in social, health and economic terms. Over twenty million people are injured and over one million are killed every year globally due to road traffic crashes. Developing countries account for up to 85% of all the fatalities. Traffic accidents in developing countries have been increasing rapidly and have in some cases become more deadly than the diseases that historically affected the population.

## ACCIDENT SCENARIO

It has been estimated that every year about 10 lakh people are killed worldwide due to road accidents and another 10-15 million injured. The economical loss due to road accidents has been estimated to be more than 500 billion dollars. The social losses due to these accidents are too many and hard to be substituted or compensated. Among the men aged between 15-44 the road accidents are the main killer elements [Jacobs et al. 2002] .

In India the number of accidents per 1000 vehicles is 2 times than that of UK, 5 times than that of Italy, 10 times as that of Australia. The fatality rate is 15 to 20 times than that of developed countries [Mittal, 2001] . Poor enforcements, lack of awareness and discipline as also the bad road conditions are some of the significant factors contributing to the high accident rates.

## NEED FOR THE STUDY

There are three components in the highway system; the driver, the vehicle and the road environment. Accidents may occur due to the failure on the part of any of these components or a combination of these. Analysis of previous data indicates that 65% of the accidents occur due to human error, 2.5% due to vehicle factors and road environment factors account for about 2.5%. Another 4%of accidents occur due to a combination of vehicle and road user factors and the rest of about 26% is due to a combination of road environment and road user factors [Schelling, 1997] .

India has a road network of 3.3 million km consisting of National Highway (NH), State Highway (SH), Major District Roads (MDR), Other District roads (ODR) and Village roads (VR). National Highways constitute 2% of the total road length and carries more than 40% of passenger traffic and 85% of goods traffic, has registered more accidents accounting for 20%, as compared to other roads.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

## 2. LITERATURE REVIEW

### BLACK SPOT IDENTIFICATION METHODS

Accident prone locations on the roads are those places, where accidents often appear to cluster or concentrate. These stretches are termed as black spots . Studies conducted in the developed countries show that identification and improvement of black spot locations reduces the occurrence of accident significantly. The broad techniques for the identification of black spot may be categorized as [Yulong PEI, Jianmei DING, 2005].

### STATISTICAL METHODS [Yulong PEI, Jianmei DING, 2005]

Accident statistics are intended to provide insight in to the general safety of highway safety and systematic contributing causes of accidents. Although use of statistics and statistical analysis can yield valuable information for the engineer, providing insight that help in the development of corrective measures.

### Crash Frequency Method [Yulong PEI, Jianmei DING, 2005]

The Crash Frequency Method summarizes the number of crashes at location and the stretches having the more number of crashes are taken as accident prone stretches. The main advantage to this method is that it is simple to use and doesn t require additional information beyond number and location of crashes. Locations are ranked by descending crash frequency and those with more than a predetermined number of crashes are classified as high-crash locations to be further scrutinized for statistical significance.

### Crash Density Method [Vivian Robert R, A. Veeraragavan 2004]

The Crash Density Method is closely related to the crash frequency method. The crash density method summarizes the number of crashes per mile of kilometer for highway sections. Sections are defined as a minimum length of roadway with consistent characteristics, with the minimum distance used frequently being one mile or kilometer.

### Crash Rate Method [Yulong PEI, Jianmei DING, 2005]

The crash rate method does account for both exposure and the total number of crashes. For links, crash rate is a function of the number of crashes, traffic volume, and the length of the segment. At nodes, crash rate is a function of the number of crashes and daily entering vehicles. Crash rate is typically expressed as the number of crashes per million vehicle miles traveled for road segments and number of crashes per million daily entering vehicles for intersections.

### Frequency- Rate Method [Vivian Robert R, A. Veeraragavan 2004]

This method is a combination of the Crash Frequency and Crash Rate Methods. Locations are first ranked by Crash Frequency and the worst locations re-ranked using Crash Rate. The rational of combining Crash Frequency and Crash Rate is to eliminate or minimize the bias of the two individual methods. The frequency-rate method is a combination of crash frequency/crash density methods and the crash rate method.

## 3. STUDY METHODOLOGY

### PREPARATION ACCIDENT DATA FORMAT

The First stage of the study includes preparation of accident data format to collect the accident data from the police stations. The forms are prepared as per IRC: 53 1982. These forms if filled properly provide the necessary information about the accidents like date of occurrence, day of occurrence, time of accident, type of area, chainage, weather condition, Classification of the accident, number of deaths, number of injured, nature of accident, accused vehicle driver gender and age, person driving vehicle, type of accused and victim vehicles, type of license, type of maneuver, responsibility of driver, type of junction, type of traffic control, cause of accident, and collision diagram.

### ACCIDENT DATA COLLECTION FROM SECONDARY SOURCES

The accident data of AH45 through Nellore to Kavali for five consecutive years i.e. 2010, 2011, 2012, 2013, and 2014 has to be collected from FIR reports. In the FIR reports the complete details about the accidents

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

will be available, and whatever data is necessary to fill the accident data sheet that has to be noted down for each accident that was recorded in that police station. In the same way in all the police stations covering AH45 through Nellore to Kavali, the accident data has to be collected.

## TABULATION AND GENERAL ANALYSIS OF ACCIDENT DATA

The collected data has to be tabulated in MS-Access and General analysis has to be carried out. General analysis includes finding out total number of accidents in police station regions, Composition of vehicles involved in the accidents, Nature of accidents occurred, based on type of area, type of accused and victim vehicles, type of manoeuvre, responsibility of driver etc. Then cross analysis has to be carried out for relating two or more categories at a time with the number of accidents occurred.

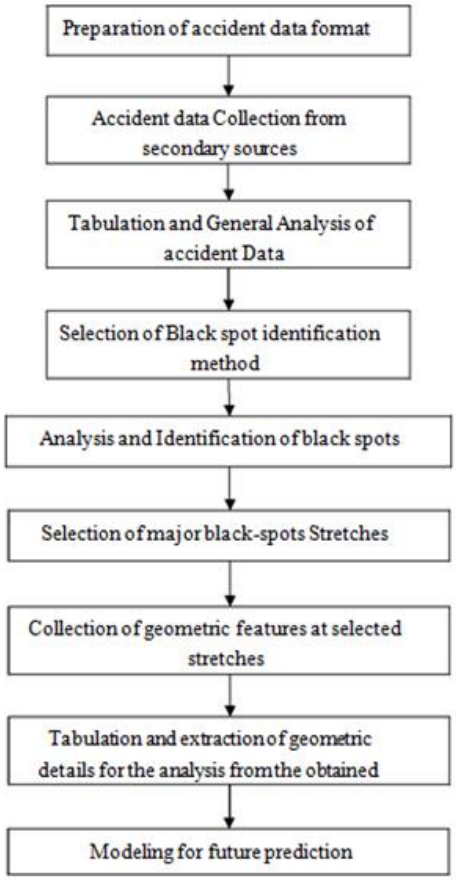



Figure 3.1: Proposed Study Methodology

## SELECTION OF BLACK SPOT IDENTIFICATION METHOD

After the general analysis, depending up on data availability, two or more Black spot identification methods are to be selected for comparison among them. For the present study Crash Density and Crash Frequency methods are considered. From the Crash Density method a stretch (section of road under a police station area) can be selected in which more number of accidents occurred when compared with length of the stretch. From the Crash Frequency method accident prone locations in that stretch can be identified.

## ANALYSIS AND IDENTIFICATION OF BLACK SPOTS

Black spots are to be identified according to crash density and crash frequency methods through the analysis of accident data collected. Critical crash density and critical crash frequency values are to be calculated for all the locations. The locations which are having the more crash frequency or crash density values than their critical values are said to be critical locations i.e, Blackspot locations.

## SELECTION OF MAJOR BLACK SPOTS

From the identified black spots a few major black spots are to be selected which are having the highest crash frequency and crash density for the further continuation of work i.e collection of geometric features.

## COLLECTION OF GEOMETRIC FEATURES AT SELECTED BLACK SPOT

In this section the geometric features of each selected black spot like cross-section details, camber, super elevation, signs and markings, drainage, sight distance, horizontal and vertical profiles and encroachment details will be collected. The total station instrument is going to be used for the present study to collect the geometrical details. From the total station instrument north- east coordinates of different locations has to be recorded.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

## TABULATION AND EXTRACTION OF GEOMETRIC DETAILS FROM THE COLLECTED DATA

The geometric details like camber, super elevation, distances, gradients etc are to be extracted from the data collected in the field and tabulated to proceed for further analysis.

## MODELING FOR ACCIDENT PREDICTION

Statistical model has to be developed from the available data to give the predicted accident count when the geometric details of a particular section were known. For this, MINI TAB software is going to be used. MINI TAB software is statistical software from which all types of statistics can be performed based on the data available. For the present study multiple Regression equation is to be developed for the prediction of accidents for a section with known geometrical details. From the analysis and comparisons, the proposals for the accident reduction measures can be given.

## 4. ANALYSIS OF ACCIDENT DATA

In this Section the data collection and analysis of the accidents on AH45 through Nellore to Kavali will be discussed. The data collected consists of accident details which occurred on the AH45 through Nellore to Kavali during the years 2010 to 2014 that is for 5 years. The details will be like place of occurrence, characteristics of accused and victim vehicles, date and day of occurrence, time of accident, type of area, nature of the accident, cause of the accident, vehicles involved, classification of accident, No. of deaths, No. of injured, Type of manoeuvre, responsibility of the Driver etc.

## STUDY AREA DESCRIPTION

AH 45 is a National Highway passing through the Nellore and Kavali, having a total length of 58 km, all with two lane bitumen surface. Layout of AH 45 is shown in the following figure.

## COLLECTION OF ACCIDENT DATA AND GENERAL ANALYSIS

The accident data was collected from the FIR reports in the police stations covering the AH45 through Nellore to Kavali. For this data recording, an accident data format was prepared and all the data was recorded on those sheets. A total number of 804 accidents were recorded in the entire stretch. Accident data is summarized in Tables 4.1 and 4.8.

Table 4.1 shows the police station wise distribution of accidents throughout the AH45 through Nellore to Kavali. In the total accident data 9% accidents are recorded in Near Eenadu police station, and next 8.3% of accidents are recorded in Gowravaram police station area.

| Name of the Police Station | Total no of accidents in 5 years |
|---|---|
| On AH-45 near Eenadu office Road | 69 |
| On AH-45 near Ayyappagudi Circle | 17 |
| On AH-45 Near Kanuparthipadu | 64 |
| On AH-45 Near Saakshi office | 47 |
| On AH-45 Near Narayana Engineering College | 24 |
| On AH-45 Near Prashanthi nagar | 27 |
| On AH-45 Near Bhagat Singh Colony | 25 |
| On AH-45 Near Simhapuri Hospitals | 41 |
| On AH-45 Near Maipadu Road | 28 |
| On AH-45 Near Penna Bridge | 14 |
| On AH-45 Near Jammipalem Road | 8 |
| On AH-45 Near Inamadugu Road | 23 |
| On AH-45 Near Chowdary Petrol Bunk Near Kovur Main Road | 17 |
| On AH-45 Near Maneguntapadu Road | 19 |
| On AH-45 Near North Rajupalem | 29 |
| On AH-45 Near Yallayapalem, Bucchi Road | 21 |
| On AH-45 Near North Rajupalem | 7 |

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

| | |
|---|---|
| Entrance | |
| On AH-45 Near B.v Palem Road | 13 |
| On AH-45 Near Kothapalle | 15 |
| On AH-45 Near Sunnambathi Village | 31 |
| On AH-45 Near Damavara Main Road | 24 |
| On AH-45 Near Alluru Road | 29 |
| On AH-45 Near Anantharam Road | 9 |
| On AH-45 Near Tellagunta circle | 10 |
| On AH-45 Near Bitragunta Main Road | 8 |
| On AH-45 Near Gowravaram Village | 67 |
| On AH-45 Near Chenchugoddu Palem Road | 24 |
| On AH-45 Near Musunuru Village | 61 |
| On AH-45 Near Thummalapenta Road | 29 |
| On AH-45 Near Bainatipalem Road | 16 |

Table 4.2 briefs the total number of accidents and nature of accident. In this, rear end collisions and head on collisions are more in number with 44% and 29% respectively.

Table 4.2: Accident details based on Nature of accident occurred

| Nature of accident | No of accidents | % of accidents |
|---|---|---|
| Over turning | 56 | 7 |
| Head on collision | 118 | 14.46 |
| Rear end collision | 216 | 26.5 |
| Collision brush / Side swipe | 86 | 10.5 |
| Right angled collision | 54 | 6.25 |
| Skidding | 76 | 9.3 |
| Right turn collision | 125 | 15.31 |
| Others | 85 | 10.41 |

Accidents occurred at different places are categorized into different types of areas. Most of the accidents occurred at Near or inside a village (54%) and at open area (22%). Table 4.3 summarizes the accident details with respect to type of area.

Table 4.3: Accident details based on Type of area

| Type of Area | No of accidents | % of accidents |
|---|---|---|
| Near school or college | 74 | 9.06 |
| Near or inside a village | 85 | 10.4 |
| Near a factory / Industrial area | 126 | 15.4 |
| Near a religious place | 201 | 24.6 |
| In Bazaar | 173 | 21.2 |
| Near office complex | 98 | 12.0 |
| Residential areas | 35 | 4.28 |
| Open area | 24 | 2.9 |

The analysis about type of accused vehicle gives the result of about 44% of accused vehicles are Lorry/DCM/Truck/Tractor and 22% are Car/Van/Jeep. Table 4.4 shows the percentages of different accused vehicles in the total accident data.

Table 4.4: Accident details based on Type of accused vehicle

| Type of accused vehicle | No of accidents | % of accidents |
|---|---|---|
| Unknown | 136 | 16.66 |
| 2W | 124 | 15.19 |
| 3W / AUTO | 100 | 12.25 |
| Lorry / DCM / Tractor / Truck | 239 | 29.28 |
| Car / Van /Jeep | 123 | 15.07 |
| Bus / Ambulance | 94 | 11.51 |

In case of victim vehicles, two wheelers (31%) are the major category in the total accident details. Table 4.5 shows the variation in the accident details for different victim vehicles.

Table 4.5: Accident details based on Type of victim vehicle

| Type of victim vehicle | No of accidents | % of accidents |
|---|---|---|
| Unknown | 77 | 9.43 |
| 2W | 133 | 16.29 |
| 3W / AUTO | 129 | 15.80 |
| Lorry / DCM / Tractor / Truck | 167 | 20.46 |
| Car / Van /Jeep | 94 | 11.5 |
| Bus / Ambulance | 101 | 12.37 |
| Cycle | 49 | 6.00 |
| ADV | 66 | 8.08 |

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Table 4.6 shows the analysis of accident data based on the type of manoeuvre. In this case while crossing a vehicle (50%) majority of accidents are taking place.

Table 4.6: Accident details based on Type of manoeuvre

| Type of maneuver | No of accidents | % of accidents |
|---|---|---|
| Unknown | 99 | 12.13 |
| Diverging | 127 | 15.56 |
| Merging | 166 | 20.34 |
| Crossing | 146 | 17.89 |
| Stationary | 111 | 13.6 |
| Temporary held up | 100 | 12.25 |
| Parked | 67 | 8.21 |

Table 4.7 shows the variation in accidents based on the responsibility of driver. In this, exceeding lawful speed (88%) is the major factor that can be observed from the table.

Table 4.7: Accident details based on Responsibility of Driver

| Responsibility of Driver | No of accidents | % of accidents |
|---|---|---|
| Consumption of Alcohol or Drugged | 155 | 18.99 |
| Exceeding lawful speed | 96 | 11.76 |
| Did not give right of way to vehicle | 54 | 6.617 |
| Did not give right of way to pedestrian | 66 | 8.08 |
| Improper overtaking | 129 | 15.80 |
| On wrong side of road | 35 | 4.28 |
| Failed to give signal | 33 | 4.04 |
| Gave improper signal | 56 | 6.86 |
| Improper turn | 81 | 9.92 |
| Attention diverted | 74 | 9.06 |
| Others | 37 | 4.53 |

Classification of accident gives the effect of the accident occurred directly for the vehicle, driver and victims such that whether it is a major accident or minor accident. Table 4.8 shows the classification of accidents with respect to the total number of accidents.

Table 4.8: Accident details based on Classification of Accident

| Classification of accident | No of accidents | % of accidents |
|---|---|---|
| Fatal | 303 | 37.13 |
| Grievous injury | 346 | 42.40 |
| Minor injury | 167 | 20.47 |

Table 4.9 was prepared in such a way that in each characteristic which type of characteristic is standing top in total no of accidents was presented. In 5 th town police station area maximum no of accidents were recorded as 69 over a period of 5 years.

Table 4.9: Characteristic wise peak accident records out of 816 accidents

| Characteristic | Type of Characteristic with max number of Accidents | No of accidents |
|---|---|---|
| Nature of accident | Rear end collision | 216 |
| Type of area | Near or inside a village | 85 |
| Type of accused vehicle | Lorry/DCM/Tractor/Truck | 167 |
| Type of victim vehicle | Two wheeler | 133 |
| Type of maneuver | Crossing | 146 |
| Classification of accident | Minor injury | 167 |

From the above table it can be clearly observed that rear end collisions are occurring in maximum amount at near or inside a village. The main accused vehicle is lorry/truck and victim vehicle is two wheeler. The main reason for more number of accidents is exceeding lawful speed while crossing another vehicle.

## CROSS ANALYSIS OF ACCIDENT DATA

In the above section general analysis has been done and each characteristic was compared with the total no of accidents. Where as in this section cross analysis has been done. Cross analysis means comparing one characteristic with another characteristic with total no of accidents. Such that the result of cross analysis will be, total no of accidents for a combination of two characteristics. This cross analysis has been done for Type of accused vehicle Vs Type of victim vehicle , Manoeuvre Vs Classification of accident , etc. Following tables 4.10 to 4.16 briefly summaries the cross analysis.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Table 4.10: Type of accused vehicle Vs Type of victim vehicle

| Type of Accused Vehicle | Type of victim vehicle | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Unknown | 2W | 3W / Auto | Lorry / Tractor | Car / Van | Bus | Cycle | ADV | |
| Unknown | 12 | 21 | 12 | 10 | 15 | 18 | 15 | 9 | 112 |
| 2W | 20 | 23 | 17 | 25 | 22 | 5 | 10 | 11 | 133 |
| 3W/Auto | 9 | 15 | 20 | 45 | 10 | 15 | 5 | 10 | 129 |
| Lorry/Tractor | 67 | 10 | 25 | 12 | 3 | 17 | 13 | 20 | 167 |
| Car/Van | 42 | 10 | 20 | 30 | 23 | 15 | 2 | 3 | 145 |
| Bus | 50 | 5 | 5 | 15 | 13 | 17 | 10 | 14 | 130 |
| Total | 200 | 84 | 100 | 137 | 86 | 87 | 55 | 67 | 816 |

From the Table 4.10 it can be observed that highest accidents were observed when the accused vehicle is a Lorry and the victim vehicle is a Two wheeler (11.5%) or a Lorry (10.5%).

Table 4.11: Type of manoeuvre Vs Classification of accident

| Type of maneuver | Classification of accident | | | Total |
|---|---|---|---|---|
| | Fatal | Grevious | Minor | |
| Diverging | 23 | 24 | 21 | 68 |
| Merging | 22 | 15 | 23 | 60 |
| Crossing | 20 | 28 | 28 | 76 |
| Stationary | 15 | 24 | 29 | 68 |
| Temporary held up | 20 | 21 | 13 | 54 |
| Parked | 22 | 27 | 25 | 74 |
| Stopping | 25 | 25 | 39 | 89 |
| Starting from near side | 20 | 25 | 5 | 50 |
| Starting from off side | 17 | 38 | 15 | 70 |
| Turning right | 18 | 14 | 33 | 65 |
| Going ahead overtaking | 34 | 15 | 24 | 73 |
| Unknown | 34 | 18 | 17 | 69 |
| **Total** | 270 | 274 | 272 | 816 |

From the Table 4.11 it was observed that more number of fatal accidents (15%) and minor accidents (30%) occurred during the crossing type of manoeuvre.

Table 4.12: Type of manoeuvre Vs Type of accused vehicle

| Type of maneuver | Type of accused vehicle | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | Unknown | 2W | 3W / Auto | Lorry / Tractor | Car / Van | Bus | |
| Diverging | 13 | 12 | 15 | 15 | 7 | 6 | 68 |
| Merging | 9 | 8 | 12 | 10 | 11 | 10 | 60 |
| Crossing | 13 | 12 | 9 | 6 | 18 | 18 | 76 |
| Stationary | 12 | 13 | 5 | 10 | 17 | 11 | 68 |
| Temporary held up | 10 | 12 | 18 | 5 | 6 | 3 | 54 |
| Parked | 12 | 15 | 15 | 8 | 16 | 8 | 74 |
| Stopping | 10 | 10 | 10 | 12 | 16 | 31 | 89 |
| Starting from near side | 13 | 9 | 8 | 7 | 7 | 6 | 50 |
| Starting from off side | 8 | 10 | 10 | 13 | 15 | 14 | 70 |
| Turning right | 11 | 15 | 9 | 11 | 10 | 9 | 65 |
| Going ahead overtaking | 9 | 13 | 9 | 18 | 15 | 9 | 73 |
| Unknown | 10 | 13 | 9 | 15 | 12 | 10 | 69 |
| **Total** | 130 | 142 | 129 | 130 | 150 | 135 | 816 |

From the Table 4.12 it can be observed that more no of accidents occurred when a Lorry (22%) / Car (12%) cross another vehicle

Table 4.13: Type of manoeuvre Vs Type of victim vehicle

| Type of Maneuver | Type of victim vehicle | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Unknown | 2W | 3W / Auto | Lorry / Tractor | Car / Van | Bus | Cycle | ADV | Total |
| Diverging | 12 | 4 | 0 | 13 | 21 | 9 | 4 | 5 | 68 |
| Merging | 16 | 3 | 7 | 0 | 4 | 8 | 2 | 6 | 46 |
| Crossing | 19 | 11 | 20 | 23 | 9 | 16 | 2 | 14 | 114 |
| Stationary | 0 | 4 | 2 | 7 | 0 | 3 | 18 | 1 | 36 |
| Temporary held up | 21 | 19 | 17 | 5 | 68 | 4 | 2 | 3 | 139 |
| Parked | 4 | 10 | 11 | 0 | 21 | 7 | 8 | 10 | 73 |
| Stopping | 2 | 4 | 7 | 0 | 9 | 12 | 2 | 5 | 41 |
| Starting from near Side | 0 | 2 | 4 | 7 | 0 | 7 | 5 | 3 | 28 |
| Starting from off Side | 0 | 8 | 34 | 5 | 31 | 36 | 10 | 2 | 102 |
| Turning right | 1 | 2 | 11 | 0 | 17 | 11 | 2 | 3 | 56 |
| Going ahead Overtaking | 8 | 1 | 32 | 7 | 18 | 20 | 2 | 1 | 84 |
| Unknown | 3 | 6 | 6 | 1 | 4 | 3 | 1 | 5 | 29 |
| **Total** | 86 | 74 | 152 | 68 | 202 | 136 | 58 | 40 | 816 |

From the Table 4.13 it was observed that more no of accidents were occurred when a vehicle crosses a two wheeler (10.5%) / Lorry (10%).

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Table 4.14: Responsibility of driver Vs Type of accused vehicle

| Responsibility of driver | Type of accused vehicle | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | Unknown | 2W | 3W / Auto | Lorry / Tractor | Car / Van | Bus | |
| Consumption of alcohol | 10 | 15 | 40 | 23 | 22 | 20 | 130 |
| Exceeding lawful speed | 5 | 2 | 10 | 8 | 9 | 16 | 50 |
| Did not give ROW to vehicle | 15 | 35 | 8 | 3 | 3 | 4 | 68 |
| Did not give ROW to pedestrian | 17 | 18 | 5 | 20 | 7 | 7 | 74 |
| Improper overtaking | 5 | 8 | 1 | 10 | 30 | 0 | 54 |
| On wrong side of road | 17 | 2 | 2 | 15 | 22 | 0 | 58 |
| Failed to give signal | 3 | 10 | 37 | 8 | 13 | 3 | 74 |
| Gave improper signal | 9 | 1 | 4 | 27 | 1 | 8 | 50 |
| Improper turn | 2 | 8 | 11 | 4 | 8 | 7 | 40 |
| Attention diverted | 12 | 28 | 4 | 14 | 14 | 27 | 99 |
| Others | 25 | 18 | 8 | 4 | 14 | 50 | 119 |
| Total | 120 | 145 | 130 | 136 | 143 | 142 | 816 |

From the Table 4.14 it was observed that more no of accidents were occurred because of exceeding lawful speed and the major

Table 4.15: Responsibility of driver Vs Type of manoeuvre

| Responsibility of driver | Type of manoeuvre | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unknown | Diverging | Merging | Crossing | Stationary | Improper yielding | Parked | Stopping | Starting from car side | | turning overtake n | | |
| Consumption of alcohol | 13 | 9 | 13 | 12 | 10 | 12 | 10 | 13 | 8 | 11 | 9 | 10 | 130 |
| Exceeding lawful speed | 15 | 7 | 4 | 5 | 1 | 3 | 4 | 2 | 1 | 1 | 4 | 3 | 50 |
| Did not give ROW to vehicle | 13 | 3 | 7 | 10 | 5 | 1 | 18 | 2 | 4 | 2 | 2 | 1 | 68 |
| Did not give ROW to pedestrian | 12 | 11 | 3 | 5 | 4 | 11 | 20 | 3 | 5 | 2 | 1 | 1 | 74 |
| Improper overtaking | 15 | 5 | 1 | 1 | 1 | 12 | 3 | 11 | 2 | 1 | 1 | 1 | 54 |
| On wrong side of road | 14 | 9 | 2 | 15 | 10 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 58 |
| Failed to give signal | 6 | 3 | 4 | 5 | 3 | 1 | 20 | 2 | 4 | 4 | 2 | 1 | 74 |
| Gave improper signal | 7 | 12 | 2 | 1 | 2 | 6 | 2 | 2 | 2 | 5 | 5 | 4 | 50 |
| Improper turn | 11 | 3 | 6 | 2 | 7 | 1 | 1 | 5 | 2 | 4 | 2 | 2 | 40 |
| Attention diverted | 12 | 3 | 2 | 17 | 7 | 10 | 9 | 10 | 9 | 8 | 11 | 1 | 99 |
| Others | 12 | 3 | 6 | 17 | 40 | 6 | 20 | 10 | 2 | 1 | 1 | 1 | 119 |
| Total | 130 | 68 | 50 | 90 | 90 | 54 | 89 | 80 | 40 | 40 | 39 | 26 | 816 |

From Table 4.15 it can be observed that exceeding lawful speed and crossing another vehicle (46%) became major cause for more no of accidents.

## BLACK- SPOT IDENTIFICATION

Accident prone locations on the roads are those places, where accidents often appear to cluster or concentrate. These stretches are termed as “black spots”. Studies conducted in the developed countries show that identification and improvement of black spot locations reduces the occurrence of accident significantly. In chapter 2.3 a brief description of different black-spot identification methods were discussed. In the present analysis “Crash Density” and “Crash Frequency” methods were selected, as further analysis requires finding out the geometric details of the black-spot locations.

### Crash density Method

Crash density is nothing but the average no of accidents per year per km in a stretch. In this crash density method total AH45 through Nellore and Kavali section is divided into stretches based on the number of police stations covering the entire section. Such that each police station covering area is taken as one stretch. In each stretch crash density was calculated based on the length of the stretch and no of accidents occurred on that stretch. Then critical crash density was calculated to identify the black-spot stretches among all the stretches available. Such that those stretches having more crash density value than critical crash density are identified as black-spots.

Critical crash density = Average crash density + Standard deviation of crash density

Table 4.16 summarises crash density analysis results.

Table 4.16: Crash density for AH45 through Nellore and Kavali

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

| Location of Accident | No.of Accidents | Average | Length of stretch(km) | Crash Density |
|---|---|---|---|---|
| On AH-45 near Eenadu office Road | 67 | 13.4 | 0.8 | 16.75 |
| On AH-45 near Ayyappagudi Circle | 17 | 3.4 | 1.2 | 2.83 |
| On AH-45 Near Kanuparthipadu | 64 | 12.8 | 3 | 4.26 |
| On AH-45 Near Saakshi office | 47 | 9.4 | 0.6 | 15.66 |
| On AH-45 Near Narayana Engineering College | 24 | 4.8 | 0.5 | 9.6 |
| On AH-45 Near Prashanthi nagar | 27 | 5.4 | 0.4 | 13.5 |
| On AH-45 Near Bhagat Singh Colony | 25 | 5 | 1.2 | 4.16 |
| On AH-45 Near Simhapuri Hospitals | 41 | 8.2 | 2.1 | 3.90 |
| On AH-45 Near Maipadu Road | 28 | 5.6 | 1.8 | 3.11 |
| On AH-45 Near Penna Bridge | 14 | 2.8 | 1.6 | 1.75 |
| On AH-45 Near Jammipalem Road | 8 | 1.6 | 2.4 | 0.66 |
| On AH-45 Near Inamadugu Road | 23 | 4.6 | 1.6 | 2.87 |
| On AH-45 Near Chowdary Petrol Bunk Near Kovur Main Road | 17 | 3.4 | 1.9 | 1.78 |
| On AH-45 Near Maneguntapadu Road | 19 | 3.8 | 2.8 | 1.35 |
| On AH-45 Near North Rajupalem | 29 | 5.8 | 3.2 | 1.81 |
| On AH-45 Near Yallayapalem, Bucchi Road | 21 | 4.2 | 4 | 1.05 |
| On AH-45 Near North Rajupalem Entrance | 7 | 1.4 | 0.5 | 2.8 |
| On AH-45 Near B.v Palem Road | 13 | 2.6 | 1.8 | 1.44 |
| On AH-45 Near Kothapalle | 15 | 3 | 0.3 | 10 |
| On AH-45 Near Sunnambathi Village | 31 | 6.2 | 3.3 | 1.87 |
| On AH-45 Near Damavara Main Road | 24 | 4.8 | 4 | 1.2 |
| On AH-45 Near Alluru Road | 29 | 5.8 | 1.1 | 5.27 |
| On AH-45 Near Anantharam Road | 9 | 1.8 | 2.8 | 0.64 |
| On AH-45 Near Tellagunta circle | 10 | 2 | 1.7 | 1.17 |
| On AH-45 Near Bitragunta Main Road | 8 | 1.6 | 1.9 | 0.84 |
| On AH-45 Near Gowravaram Village | 69 | 13.8 | 0.8 | 17.25 |
| On AH-45 Near Chenchugoddu Palem Road | 24 | 4.8 | 6.2 | 0.77 |
| On AH-45 Near Musunuru Village | 61 | 12.2 | 1.9 | 6.42 |
| On AH-45 Near Thummalapenta Road | 29 | 5.8 | 1.5 | 3.86 |
| On AH-45 Near Bainatipalem Road | 16 | 3.2 | 1.1 | 2.90 |

Average crash density = 4.71
Standard deviation of crash density = 2.41
Critical Crash Density = 4.71+2.41 = 7.12

From the above crash density analysis the stretches under Gowravaram police station (Crash Density 17.25) and 5th town police station(On AH-45 near Eenadu office Road) (Crash Density 16.75) were identified as highest accident prone locations. So in those two, Gowravaram stretch was taken for the further work i.e., to collect the geometric details.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

### Crash frequency Method

Crash frequency is nothing but the average number of accidents per year in a location. In this crash frequency method at each location of accident data available crash frequency will be calculated and compared with critical crash frequency, such that those locations having crash frequency more than critical crash frequency are identified as black-spot locations.

Critical crash frequency =Average crash frequency + Standard deviation of crash frequency

For the crash frequency analysis a total no of 30 locations are there. In the following table 4.18 those locations having crash frequency more than critical crash frequency are only given such that 25 black-spots were identified.

Table 4.17: Crash frequency of black-spots on AH45 through Nellore to Kavali

| Location of Accident | No.of Accidents | Acc per year |
|---|---|---|
| On AH-45 near Eenadu office Road | 67 | 13.4 |
| On AH-45 Near Kanuparthipadu | 64 | 12.8 |
| On AH-45 Near Saakshi office | 47 | 9.4 |
| On AH-45 Near Gowravaram Village | 69 | 13.8 |
| On AH-45 Near Musunuru Village | 61 | 12.2 |

Average Crash Frequency = 5.44

Standard Deviation of Crash Frequency = 3.51

Critical Crash Frequency = 5.44+3.51 = 8.95

From the above table, for the present study of geometric details only five locations having more crash frequency than critical crash frequency.

### 5.ACCIDENT PREDICTION MODEL

In this Section the collection of basic geometric details and extraction of all other geometric details from collected data and developing a model for accident prediction will be discussed. These geometric details were collected in the stretch covered under Gowravaram Rural police station which was standing first in crash density method of identifying black-spots.

### DESCRIPTION OF GOWRAVARAM STRETCH

Gowravaram rural police station covers around 6km stretch in which maximum number of accidents were recorded .

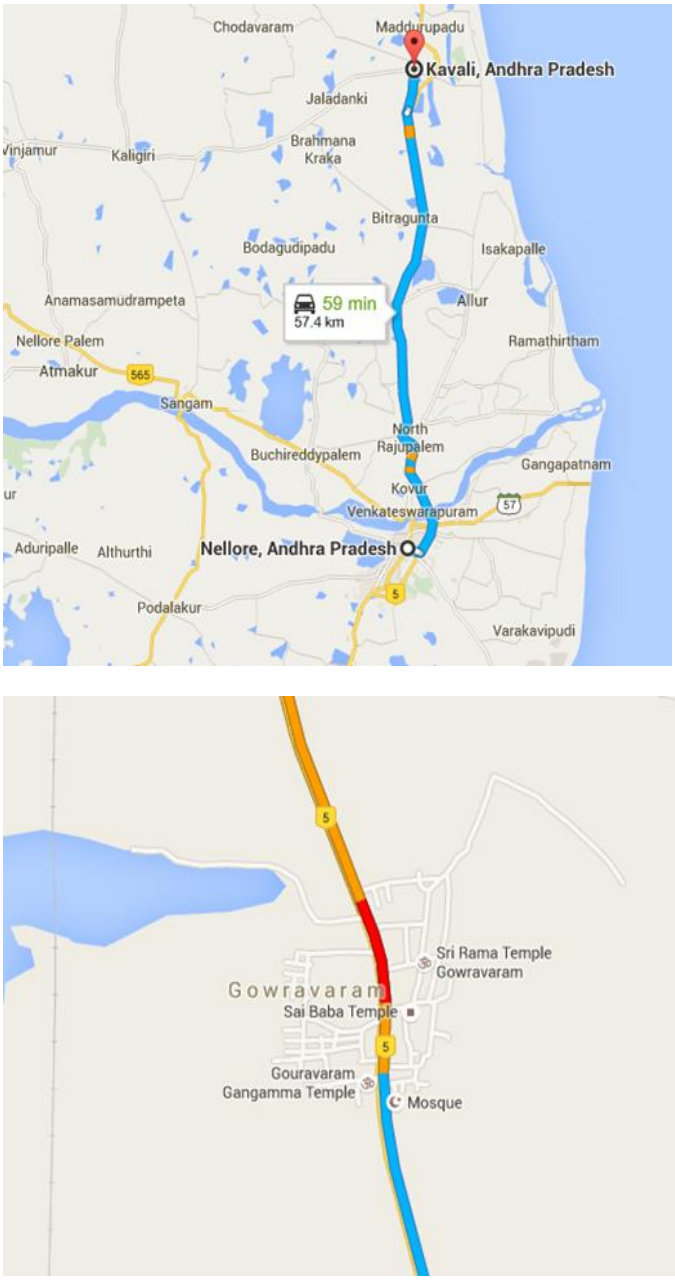



Figure 5.1: Gowravaram Ruralstretch map

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

## GEOMETRIC DETAILS

To collect the geometric details of the road section, Total Station instrument was used, such that it directly stores the northing, easting, and elevation of prism station with respect to the instrument station. Throughout the stretch north, east, and elevations were stored in the instrument, such that at each section readings were taken at three locations as left edge, center, and right edge of the road. At straight sections less no of sections were taken and at curves more no of sections data was taken.

At the same time the data regarding unpaved shoulder width, paved shoulder width, horizontal sight distance, vertical sight distance were measured using a tape. In the same way number of culverts, number of cross roads or junctions, and number of horizontal curves were also noted down in the data sheet.

From the obtained north, east, and elevation values horizontal profile and vertical profile were drawn for the entire stretch. And other geometrics like camber, super elevation, radius of curves, gradients, and rise and fall were calculated.

The following tables show the data regarding different geometric details.

### Horizontal Profile

To get the horizontal profile, the data points were first separated into three sets such as right edge, center, and left edge. Those values were shown in Table 5.1.

Table 5.1: Horizontal profile of Gowravaram Rural stretch

| Sig no | Northing | Easting | Sig no | Northing | Easting | Sig no | Northing | Easting |
|---|---|---|---|---|---|---|---|---|
| | Right edge | | | Center | | | Left edge | |
| 1 | 4.597 | 2.055 | 2 | 2.888 | 6.848 | 3 | 0.581 | 11.091 |
| 4 | -133.51 | -76.347 | 5 | -39.813 | -17.11 | 6 | -42.683 | -12.696 |
| 7 | -193.465 | -110.393 | 8 | -195.924 | -106.215 | 9 | -198.29 | -101.692 |
| 10 | -224.133 | -128.07 | 11 | -226.866 | -123.752 | 12 | -229.85 | -119.802 |
| 14 | -257.107 | -125.952 | 17 | -279.213 | -124.837 | 13 | -229.85 | -119.802 |
| 16 | -278.912 | -128.181 | 20 | -300.459 | -125.686 | 15 | -257.942 | -119.468 |
| 19 | -299.831 | -130.315 | 23 | -325.52 | -127.673 | 18 | -279.85 | -119.894 |
| 22 | -324.488 | -132.571 | 26 | -353.401 | -130.794 | 21 | -300.757 | -120.649 |
| 25 | -352.58 | -135.866 | 29 | -393.655 | -136.433 | 24 | -326.379 | -122.62 |
| 28 | -392.531 | -141.381 | 32 | -459.512 | -146.73 | 27 | -354.265 | -125.877 |
| 31 | -458.269 | -151.436 | 35 | -555.104 | -161.137 | 30 | -394.52 | -131.412 |
| 34 | -554.885 | -166.265 | 38 | -600.381 | -167.351 | 33 | -460.357 | -141.432 |
| 37 | -599.963 | -172.302 | 41 | -653.987 | -171.73 | 36 | -555.734 | -156.192 |
| 40 | -654.343 | -176.631 | 44 | -695.511 | -172.138 | 39 | -600.342 | -162.159 |
| 43 | -696.139 | -176.968 | 45 | -695.511 | -172.138 | 42 | -654.313 | -166.628 |
| 47 | -770.085 | -212.646 | 48 | -772.351 | -209.022 | 46 | -698.174 | -168.421 |
| 50 | -800.494 | -226.019 | 51 | -803.112 | -222.738 | 49 | -775.403 | -204.766 |
| 53 | -829.034 | -239.103 | 54 | -831.708 | -235.605 | 52 | -805.916 | -218.433 |
| 56 | -898.773 | -270.888 | 57 | -901.115 | -266.474 | 55 | -835.062 | -231.456 |
| 59 | -979.649 | -306.812 | 60 | -981.548 | -302.267 | 58 | -903.679 | -261.965 |
| 62 | -1071.6 | -347.696 | 65 | -1143.29 | -374.49 | 61 | -983.568 | -297.637 |
| 64 | -1141.98 | -379.029 | 68 | -1217.69 | -407.564 | 63 | -1076.64 | -338.94 |
| 67 | -1215.89 | -412.335 | 71 | -1311.24 | -448.709 | 66 | -1145.94 | -369.84 |
| 70 | -1310.1 | -453.661 | 79 | -1446.08 | -469.335 | 69 | -1219.7 | -402.945 |
| 74 | -1394.1 | -466.944 | 82 | -1489.8 | -472.246 | 72 | -1313.24 | -444.335 |
| 76 | -1422.53 | -470.967 | 87 | -1555.76 | -467.597 | 73 | -1313.24 | -444.335 |
| 78 | -1445.35 | -473.871 | 90 | -1580.5 | -462.93 | 75 | -1395.66 | -456.945 |
| 81 | -1488.49 | -476.888 | 93 | -1654.72 | -442.68 | 77 | -1423.85 | -461.202 |
| 84 | -1526.23 | -475.773 | 109 | -2326.71 | -232.613 | 80 | -1446.79 | -464.108 |

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

| Sig no | Northing | Easting | Sig no | Northing | Easting | Sig no | Northing | Easting |
|---|---|---|---|---|---|---|---|---|
| | Right edge | | | Center | | | Left edge | |
| 86 | -1557.62 | -472.269 | 112 | -2422.17 | -199.25 | 83 | -1490.14 | -467.2 |
| 89 | -1580.73 | -467.871 | 115 | -2581.85 | -143.811 | 85 | -1525.31 | -466.33 |
| 92 | -1657.34 | -446.886 | 132 | -3731.02 | 271.039 | 88 | -1554.93 | -462.738 |
| 95 | -1715.75 | -428.629 | 136 | -3954.9 | 369.438 | 91 | -1580.07 | -457.95 |
| 97 | -1851.42 | -389.743 | 138 | -4015.61 | 395.976 | 94 | -1653.28 | -437.675 |
| 99 | -1974.44 | -353.155 | | | | 96 | -1713.59 | -420.378 |
| 101 | -2023.32 | -339.703 | | | | 98 | -1849.31 | -381.997 |
| 103 | -2201.36 | -287.425 | | | | 100 | -1971.95 | -346.287 |
| 105 | -2289.19 | -261.684 | | | | 102 | -2020.7 | -331.254 |
| 110 | -2328.02 | -237.377 | | | | 104 | -2198.19 | -278.314 |
| 113 | -2424.21 | -203.877 | | | | 106 | -2286.88 | -251.752 |
| 116 | -2583.65 | -148.456 | | | | 107 | -2286.88 | -251.752 |
| 118 | -2900.13 | -38.032 | | | | 108 | -2323.57 | -228.313 |
| 120 | -3137.54 | 44.68 | | | | 111 | -2421.05 | -194.394 |
| 122 | -3306.22 | 103.192 | | | | 114 | -2580.08 | -139.192 |
| 124 | -3357.92 | 118.157 | | | | 117 | -2898.23 | -28.767 |
| 127 | -3431.73 | 133.897 | | | | 119 | -3134.6 | 53.934 |
| 129 | -3491.52 | 160.363 | | | | 121 | -3303.57 | 112.372 |
| 131 | -3585.04 | 201.394 | | | | 123 | -3355.8 | 127.792 |
| 133 | -3732.61 | 266.427 | | | | 125 | -3427.36 | 142.676 |
| 137 | -3957.05 | 365.148 | | | | 126 | -3427.36 | 142.676 |
| 139 | -4017.3 | 391.746 | | | | 128 | -3486.58 | 169.144 |
| | | | | | | 130 | -3580.74 | 210.486 |
| | | | | | | 134 | -3729.55 | 275.88 |
| | | | | | | 135 | -3953.46 | 374.227 |
| | | | | | | 140 | -4013.33 | 400.606 |

From the values in the table 5.1, a graph was drawn for the northing and easting values which give the horizontal profile of the stretch and was shown in Figure 5.1.

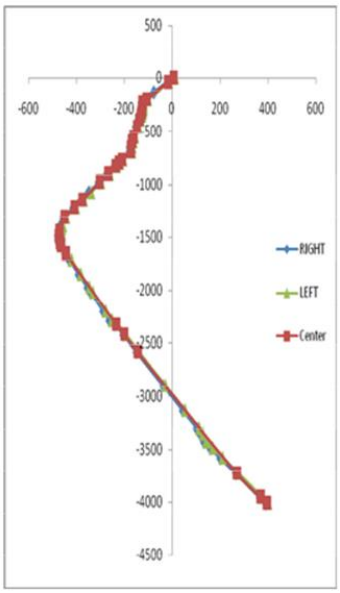



Figure 5.2: Gowravaram Rural stretch horizontal profile

## Vertical Profile

To determine the vertical profile, north and east values were used to find out the distances of signal locations and for each section, elevations are stored in it. By using those distances and elevations, gradients of each signal locations were found out.

Gradient = Distance between two locations / Elevation difference of two locations Vertical profile details are presented in Table 5.2.

Table 5.2: Vertical profile of Gowravaram Rural stretch

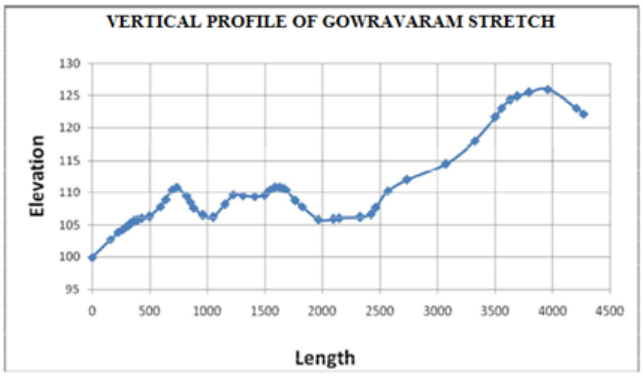
| P.No | Distance | Elevation | Gradient |
|---|---|---|---|
| 1 | 0 | 99.897 | |
| 6 | 158.8254 | 102.714 | 1.773646 |
| 7 | 227.7804 | 103.926 | 1.757668 |
| 10 | 263.1754 | 104.335 | 1.15553 |
| 14 | 292.0684 | 104.735 | 1.384418 |
| 16 | 313.9794 | 104.928 | 0.880836 |
| 19 | 334.9954 | 105.258 | 1.570232 |
| 22 | 359.7274 | 105.585 | 1.322174 |
| 25 | 388.0014 | 105.696 | 0.392587 |
| 28 | 428.3284 | 106.012 | 0.783594 |
| 31 | 494.8314 | 106.265 | 0.380434 |
| 34 | 592.5774 | 107.737 | 1.505944 |
| 37 | 638.0534 | 108.829 | 2.401267 |
| 40 | 692.5244 | 110.38 | 2.847387 |
| 43 | 734.0904 | 110.857 | 1.147573 |
| 47 | 818.7504 | 109.407 | -1.71273 |
| 50 | 851.9724 | 108.441 | -2.90771 |
| 53 | 882.3674 | 107.523 | -3.02023 |
| 56 | 960.0064 | 106.462 | -1.36658 |
| 59 | 1048.51 | 106.16 | -0.34123 |
| 62 | 1149.126 | 108.109 | 1.937068 |
| 64 | 1226.17 | 109.577 | 1.905405 |
| 67 | 1307.22 | 109.456 | -0.14929 |
| 70 | 1410.11 | 109.286 | -0.16522 |
| 74 | 1493.193 | 109.499 | 0.25637 |
| 76 | 1521.859 | 110.118 | 2.159353 |

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

| P.No | Distance | Elevation | Gradient |
|---|---|---|---|
| 78 | 1544.823 | 110.458 | 1.480578 |
| 81 | 1588.079 | 110.824 | 0.846125 |
| 84 | 1624.734 | 110.785 | -0.1064 |
| 86 | 1658.089 | 110.63 | -0.4647 |
| 89 | 1681.599 | 110.452 | -0.75712 |
| 92 | 1760.989 | 108.719 | -2.18289 |
| 95 | 1822.126 | 107.74 | -1.60132 |
| 97 | 1963.249 | 105.833 | -1.3513 |
| 99 | 2091.588 | 105.865 | 0.024934 |
| 101 | 2142.279 | 106.022 | 0.30972 |
| 103 | 2327.819 | 106.173 | 0.081384 |
| 105 | 2419.358 | 106.592 | 0.457728 |
| 108 | 2462.394 | 107.579 | 2.293429 |
| 111 | 2565.603 | 110.194 | 2.533694 |
| 114 | 2733.946 | 111.984 | 1.063305 |
| 117 | 3070.719 | 114.525 | 0.754514 |
| 119 | 3321.136 | 117.981 | 1.380098 |
| 121 | 3499.921 | 121.766 | 2.117068 |
| 123 | 3554.324 | 123.105 | 2.461261 |
| 126 | 3626.885 | 124.352 | 1.718554 |
| 128 | 3691.795 | 124.871 | 0.799569 |
| 130 | 3794.637 | 125.488 | 0.599949 |
| 134 | 3957.172 | 125.913 | 0.261482 |
| 135 | 4201.735 | 123.102 | -1.1494 |
| 140 | 4267.157 | 122.196 | -1.38486 |
| | | | |

In the above table 5.2, continuous right edge points at each section were considered to obtain the lengths and elevations continuously.

From that distances and elevations available vertical profile was drawn as follows.




Geometrical details of the stretch are summarised in Table 5.3.

Table 5.3: Camber, Super elevation, and Radius of curves for Gowravaram Rural stretch

| Sig Loc | Points (R,C,L) | CW | Camber | Super Elevation | RAD | Sig Loc | Points (R,C,L) | CW | Camber | Super Elevation | Radius |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,2,3 | 10.3 | 0.981 | | | 26 | 74,0,75 | 10.4 | | 1.183 | |
| 2 | 0,4,5 | 10.2 | 0.598 | | | 27 | 76,0,77 | 10.4 | | 4.606 | |
| 3 | 6 | 10.2 | 0.813 | | | 28 | 78,79,80 | 10.4 | | 5.663 | |
| 4 | 7,8,9 | 10.2 | 0.578 | | | 29 | 81,82,83 | 10.4 | | 5.673 | |
| 5 | 10,11,12 / 13 | 10.2 | 0.564 | | | 30 | 84,0,85 | 10.4 | | 5.538 | 463.44 |
| 6 | 14,0,15 | 10.2 | | 1.696 | | 31 | 86,87,88 | 10.4 | | 5.635 | |
| 7 | 16,17,18 | 10.2 | | 3.588 | | 32 | 89,90,91 | 10.4 | | 5.337 | |
| 8 | 19,20,21 | 10.2 | | 3.922 | 186.55 | 33 | 92,93,94 | 10.15 | 0.714 | | |
| 9 | 22,23,24 | 10.2 | | 3.441 | | 34 | 95,0,96 | 10.2 | 0.854 | | |
| 10 | 25,26,27 | 10.2 | | 3.441 | | 35 | 97,0,98 | 10.2 | 0.83 | | |
| 11 | 28,29,30 | 10.2 | | 1.186 | | 36 | 99,0,100 | 10.2 | 0.835 | | |
| 12 | 31,32,33 | 10.2 | 0.603 | | | 37 | 101,0,102 | 10.2 | 0.852 | | |
| 13 | 34,35,36 | 10.2 | 0.691 | | | 38 | 103,0,104 | 10.4 | | 0.567 | |
| 14 | 37,38,39 | 10.2 | | 4.48 | | 39 | 105,0,106/ 107 | 10.4 | | 0.452 | 160.63 |
| 15 | 40,41,42 | 10.2 | | 5.098 | 184.18 | 40 | 108,109,110 | 10.2 | 1.025 | | |
| 16 | 43,44/45, 46 | 10.2 | | 3.922 | | 41 | 111,112,113 | 10.2 | 0.613 | | |
| 17 | 47,48,49 | 10.2 | 0.235 | | | 42 | 114,115,116 | 10.2 | 0.637 | | |
| 18 | 50,51,52 | 10.3 | 0.325 | | | 43 | 117,0,118 | 10.2 | 0.867 | | |
| 19 | 53,54,55 | 10.25 | 0.502 | | | 44 | 119,0,120 | 10.2 | 0.867 | | |
| 20 | 56,57,58 | 10.2 | 0.627 | | | 45 | 121,0,122 | 10.2 | | 3.853 | |
| 21 | 59,60,61 | 10.15 | 0.517 | | | 46 | 123,0,124 | 10.2 | | 6.098 | 185.54 |
| 22 | 62,0,63 | 10.2 | 0.68 | | | 47 | 125/126,0,1 27 | 10.2 | | 3.539 | |
| 23 | 64,65,66 | 10.2 | 0.48 | | | 48 | 128,0,129 | 10.2 | 0.65 | | |
| 24 | 67,68,69 | 10.2 | 0.549 | | | 49 | 130,0,131 | 10.2 | 0.67 | | |
| 25 | 70,71,72/ 73 | 10.4 | 0.437 | | | 50 | 134,132,133 | 10.2 | 0.505 | | |
| | | | | | | 51 | 135,136,137 | 10.2 | 0.588 | | |
| | | | | | | 52 | 140,138,139 | 10.2 | 0.534 | | |

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

In the above table at each stretch of signal location, camber values, super elevations and radius of curves where ever those are present were found out.

## MODEL DEVELOPMENT

This section deals with the development of an equation from the available accident details and geometric details to predict the future accidents when a set of geometric details are given. For this process the collected data was tabulated in such a way that entire data is consolidated for each accident location. Each accident location has covered a number of signal locations and those were consolidated as shown in Table 5.4.

Average of camber percentages, Maximum of shoulder widths, Degrees of curvature per kilometer and Maximum of super elevations, Minimum sight distances, Total rise and Total fall in the sections were taken and tabulated for each accident location. Length of each accident location can be obtained from the vertical profile table by knowing the starting and ending point of each location.

Finally the crash rate for each location is converted into crash rate per kilometer to normalize the data for all the sections. Table 5.4 presents consolidated data of geometrical details and accident details for each accident location. Then for each variable, scatter diagrams are drawn as shown in Figures 5.4 to 5.7. In those variables Degrees of Curvature per kilometer, Super Elevation, Sight Distance, Total Rise satisfied the logic with the variable and crash rate. And other variables like camber, shoulder widths didn t satisfy the logic as those are almost same throughout the section and not influencing the crash rate for a small change in those variables.

**Table 5.4** Geometrical details of all the accident locations under Gowravaram Rural stretch

| Location of Accident | Length of stretch (km) | No.of culverts | No.of CR/jun | No.of HC | CW WIDTH (m) | Camber (%) | SW unpaved (m) | SW paved (m) | Degrees of curvature per Km | S.E (%) | Sight distance (m) | Total Rise (m) | Crashes | CR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| On AH-45 near Eenadu office Road | 165 | 0 | 1 | 0 | 7.5 | 1.7 | 1.6 | 2.3 | 0 | 2.9 | 130 | 2.3 | 11 | 1.5 |
| On AH-45 Near Kanuparthipadu | 690 | 0 | 1 | 0 | 7.5 | 1.8 | 1.3 | 1.6 | 0 | 3.2 | 125 | 5.6 | 2 | 1.7 |
| On AH-45 Near Saakshi office | 419 | 1 | 1 | 0 | 7.5 | 2 | 0.9 | 1.8 | 0 | 3.4 | 145 | 3.8 | 4 | 0.8 |
| On AH-45 Near Gowravaram Village | 1052.2 | 1 | 1 | 1 | 7.5 | 1.8 | 1.1 | 2.26 | 62.56 | 6.9 | 70 | 4.6 | 16 | 3.3 |
| On AH-45 Near Musunuru Village | 525 | 0 | 1 | 1 | 7.5 | 1.9 | 0.9 | 1.96 | 9.33 | 6.8 | 75 | 4.2 | 8 | 1.4 |

For the model development, general linear regression has been done for the four independent variables and one dependent variable using MINI TAB software. The following equation 5.1 was obtained from the MINI TAB software package.

$$CR = 0.006979X1 - 0.0892\ X2 + 0.011731\ X3 + 0.3783\ X4 - 5.3888 \quad \text{---------- (5.2)}$$

R square value = 1,

Where

X1 = Length of the curve

X2 = Degree of Curvature

X3 = Sight Distance

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

X4 = Number of Crashes

Using the equation 5.2, crash rates are predicted for the same data from which the equation was developed. Those actual and predicted crash rates were given in table 5.5.

**Table 5.5:** Actual and Predicted crash rates

| Location of Accident | Actual CR | Predicted CR |
|---|---|---|
| On AH-45 near Eenadu office Road | 1.5 | 1.449865 |
| On AH-45 Near Kanuparthipadu | 1.7 | 1.650485 |
| On AH-45 Near Saakshi office | 0.8 | 0.750396 |
| On AH-45 Near Gowravaram Village | 3.3 | 3.248922 |
| On AH-45 Near Musunuru Village | 1.4 | 1.349964 |

## 6.SUMMARY AND CONCLUSIONS

### SUMMARY

Road safety as a problem has been analysed in many ways, prominent amongst them are the four basic elements viz., the vehicle, the driver, road way, and the environment in which the accident takes place.

The present study is mainly intended to determine the causes for accidents in view of geometrics of the road and to develop an equation to predict the crash rate based on the existing field conditions.

For the present study, initially five years accident details were collected and general analysis has been done for the accidents. In the general analysis, for each characteristic the major type of characteristic which is having maximum number of accidents record are observed. And the cross analysis between different characteristics has been done such that in which combination of characteristics more number of accidents are occurring are observed. After that accident prone stretches were identified using Crash Density Method and Crash Frequency Method . In those identified stretches one stretch (Gowravaram Rural stretch) was selected for finding out the geometrical details. All the geometrical details were collected by using a Total Station instrument. Finally multiple regression model was developed to predict the future accidents when a set of geometrical details were given.

### CONCLUSIONS

The following conclusions are drawn from the present study.

1. From the analysis of the accident data it is clear that rear end collisions are occurring more (44%), accidents are occurring at near or inside a village (54%), while the major accused vehicle is a lorry (44%) and major victim is vehicle (31%) is two wheeler. Crossing is the major type of maneuver (50%), and exceeding lawful speed (88%) is the major characteristic when responsibility of driver is considered.
2. From the cross analysis of accident data it was observed that when the accused vehicle is a lorry and victim vehicle is a two wheeler (12%) more number of accidents have been taken place. In the same way, while crossing type of maneuver fatal accidents are recorded as 15% and minor accidents are recorded as 30%. And when lorry crosses any other vehicle, 22% of accidents were taken place. 10% of accidents occurred while some vehicle crosses two wheeler. While considering responsibility of driver, exceeding lawful speed is the major reason for which type of accused vehicle is lorry (38%), victim vehicle is two wheeler (28%), and type of maneuver is crossing (46%).
3. From the crash density method Gowravaram Ruralpolice station stretch was selected for analysis as its crash density is 17.25.
4. From the model developed it was observed that the relation between crash rate with degrees of curvature and total rise is positive and with super elevation and sight distance is negative.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

5. From the field observation it was observed that at cross roads or junctions the chances of occurrence of an accident is more.

## LIMITATIONS

Geometric details like camber, shoulder widths, carriage way width etc were not considered in the equation development since those parameters are almost same throughout the selected stretch.

## REFERENCES

1. Khanna S.K., Justo C.E.G. "Highway Engineering", (1994), Nem Chand & Bros, Roorkee, 7th Edition.
2. Environmental Systems Research Institute (ESRI) Inc. "ArcView GIS, version 3.1", 1996, New York Street, Redlands, California, USA.
3. Baguley Chris, McDonald Mike, et al, "Towards Safer Roads in Developing Countries, A Guide for Planners and Engineers", Transport Research Laboratory, 1994, pp 1-60
4. Kalga R.R, Silanda S.N, "Accident Rate Prediction on Arterial Roads of Durban, South Africa", Indian Highways Journal, July 2002.
5. Bobkov, V.F., "Road condition and traffic safety". Mir Publications, Moscow,1975.
6. I.V.R.L Narasimha Rao, Madhavi Latha Kaithapalli & Raghava Rao Gundala., "Safety Scenario on National Highways – A Case study of NH-5 passing through Visakhapatnam Metropolitan Region", Indian Journal of Transport Management, Vol 27, No.4, October – 2003.
7. K.K.Saija, C.D.Patel & V.J.Upadhyay., " Micro level study of accidents on NH – 8 passing through Valsad District", Indian Highways, Vol 30, No 8, August 2002.
8. Dinesh Mohan, "Traffic Injuries and Fatalities in India", Transportation Research & Injury Prevention Programme, Indian Institute of Technology Delhi, April-2004
9. Dr. S.B. Baviskar, "Analysis of road accidents on National Highways in Nashik District", Indian Highways, Vol. 26, No. 10, October-1998
10. Dr. S.M. Sarin, Faqir Chand & V.D. Rama Rao, "Minor improvements of highways for better road safety", Indian Highways, Vol. 33, No. 9, September-2005.
11. "Geometric Design Standards for the Urban Roads", IRC:86-1983
12. Transport Research Board, "Accident Black spot investigation", December-1994
13. Arapahoe Community College Academy "Accident Investigation manual", June-2002.
14. L.R. Kadiyali, "Traffic Engineering and Transport Planning", Khanna Publishers, Sixth Edition, 2004