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

Usarthi Murali
Department of Civil Engineering,
St. Ann's College of Engineering and Technology,
Chirala, Andhra Pradesh 523187, India.

Chevuri Pavan Kumar
Department of Civil Engineering,
St. Ann's College of Engineering and Technology,
Chirala, Andhra Pradesh 523187, India.

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.

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 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[1-3], [7].

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].

Around 2,38,000 people die in road crashes every year in South Asian countries. Road fatalities now leads the list of accidental deaths in India much more than any other such as by drowning, fire, rail or air mishaps etc.

Driving or riding a vehicle in India is by large becoming a dangerous experience, and Indian roads like those of other Asian countries are becoming virtual death traps.

Cite this article as: Usarthi Murali & Chevuri Pavan Kumar, "Road Accident Investigation in Highway", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 6 Issue 11, 2019, Page 1-9.

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

The magnitude of road accidents in India is increasing at an alarming rate p[5]. The latest annual statistics indicate that over 80,000 people are killed on Indian roads and top the world in the number of road fatalities. National level of fatalities per kilometers is 0.025. Lack of awareness of road safety issues amongst the masses, apathy of the policy makers and implementers etc add to the increasing problem of road safety [Arvind Kumar Mavoori, 2005].

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.

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. The formats of the forms have been designed to facilitate computer processing such that each data [9] is divided into different sub categories and all those categories are given coding. For example type of area is divided into ten sub categories and given coding like near school or college, near a bus stop, near a temple, at pedestrian crossing etc. These forms are given in Appendix A.

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 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 [11].

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. In the cross analysis important categories like type of accused vehicle, type of victim vehicle, type of manoeuvre, responsibility of driver and compared in combinations [13].

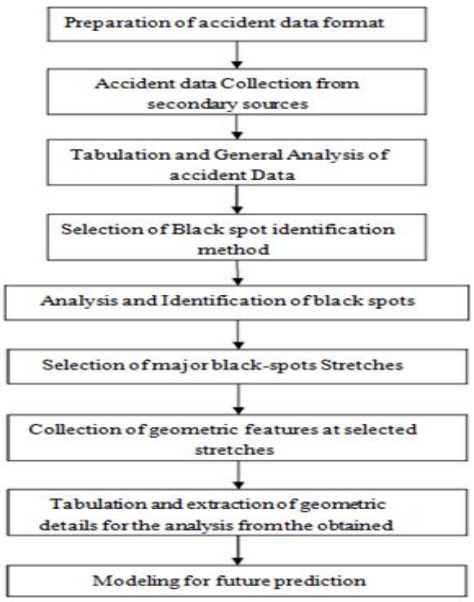

Figure 3.1: Proposed Study Methodology

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

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 [2] 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 [8].

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.

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 [6].

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.

ANALYSIS OF ACCIDENT DATA

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 [4].

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. A sample of the data sheet was shown in Appendix A. The collected data was tabulated in MS-Access and general analysis has been done like consolidating the total no accidents in each police station, severity wise, monthly distribution of accidents, type of accused and victim vehicle, nature of accident occurred, time wise distribution, type of area,

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

responsibility of driver, etc. 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 [10].

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 Prashanthinagar	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 Entrance	7
On AH-45 Near B.vPalem 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 ChenchugodduPalem 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

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.

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

Type of Accused Vehicle	Type of victim vehicle: Unknown	2W	3W / Auto	Lorry / Tractor	Car / Van	Bus	Cycle	AD V	Total
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%).

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

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.

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 [12].

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 [14].

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

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 Prashanthinagar	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

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

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.vPalem 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 Gowravaram Village	69	13.8	0.8	17.25
On AH-45 Near ChenchugodduPalem 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.

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

ACCIDENT PREDICTION MODEL

DESCRIPTION OF GOWRAVARAM STRETCH

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

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

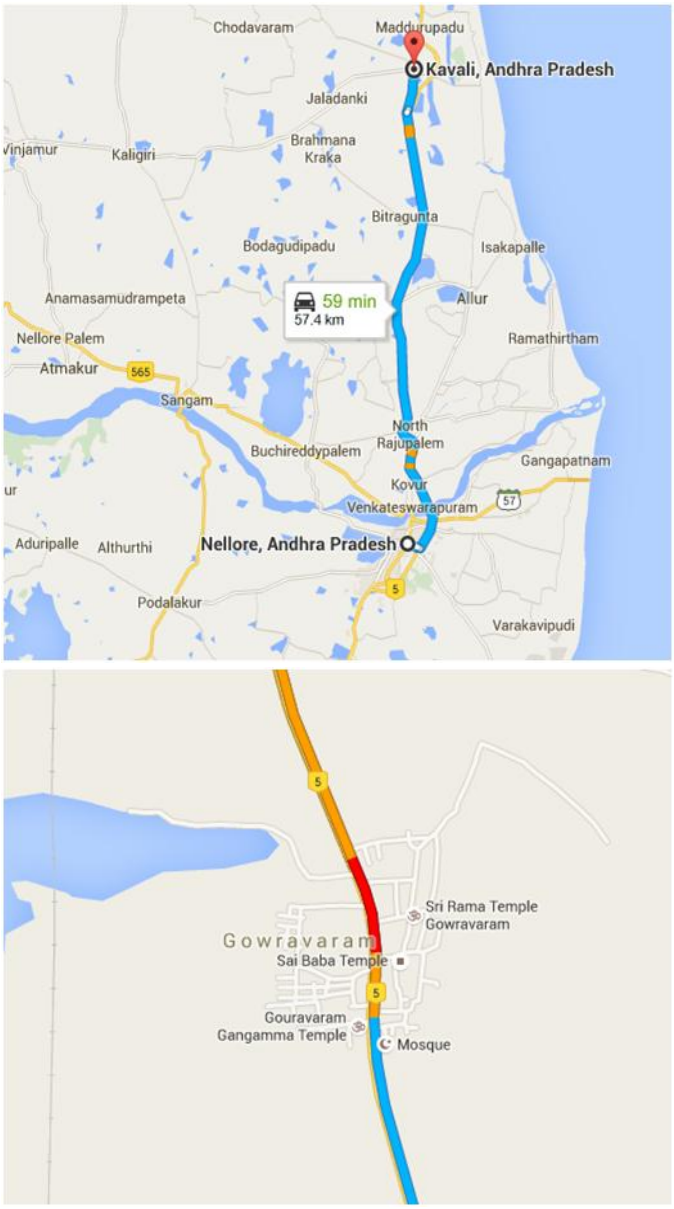

Figure 5.1: Gowravaram Rural stretch map

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.

Location of Accident	Length of stretch (km)	No.of culverts	No.of CR/jun	No.of HC	CWIDTH (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

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

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

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

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 NarasimhaRao, 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

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

[13]. Arapahoe Community College Academy"Accident Investigation manual", June-2002.

[14]. L.R. Kadiyali, "Traffic Engineering and Transport Planning", Khanna Publishers, Sixth Edition, 2004