

**Impacts of Roadway Condition and Traffic on Road Safety**Ashish R. Bijwe¹, Prof. S. K. Kitukale²¹Civil Engineering, D. R. G. I. T & R, Amravati²Civil Engineering, D. R. G. I. T & R, Amravati

Abstract—Road safety in India is the poorest in the world. Road safety is one of the most important problems in our society. In India the rate of accident is directly proportional to increasing number of vehicles. According to MORTH-2014 India has the highest number of accidents in the world. Accident severity has been increasing year by year due to increasing in number of vehicles. Road users in India are heterogeneous in nature, ranging from pedestrians, animal-driven carts, bi-cycles, rickshaws, hand carts and tractor trolleys, to various categories of two/three wheelers, motor cars, buses, trucks, and multi-axle commercial vehicles etc. Accident leads to disablement, death, damage to health and property, social suffering and general degradation of environment. The high accident rate is largely attributed to the inadequacy of the highways and other main roads to meet the traffic demands, road user behavior, vehicle defects, poor road geometrics and visibility. Road accidents inflict heavy economic loss to the country. Road Safety is necessary to reduce accident involving both human and vehicles there by making the road more safe and user friendly.

National Highway 6, commonly referred to as NH 6, is a busy National Highway in India that runs through Gujarat, Maharashtra, Chhattisgarh, Odisha, Jharkhand and West Bengal state in India. The highway passes through the cities of Surat, Dhule, Jalgaon, Bhusawal, Amravati, Nagpur, Bhandara, Durg, Raipur, Mahasamund, Sambalpur, Kolkata. The road is the part of National Highway network of India, and it is officially listed as running over 1,949 km from Mumbai to Kolkata. It is also known as Mumbai Road. NH-06 is one of the major connectivity from Nagpur to Amravati which caters to the need of transportation of light goods to heavy goods and passengers. The number of accidents is rising up every year due to increasing number of vehicles. The location in a roadway where the traffic accident often occurs is called a black spot. The accident data is analyzed using accident frequency and severity index method. The safety deficiencies were detected to minimize accidents and save the road users. The deficiencies along with the measures for further improvement have been presented in this thesis.

Keywords- Accidents, Black spot, Highway, Road Safety, Traffic

I. INTRODUCTION

The frequency of traffic collisions in India is amongst the highest in the world. A National Crime Records Bureau (NCRB) report revealed that every year, more than 135,000 traffic collision-related deaths occur in India.

More than 10 lakh people in India have lost their lives to road accidents in the last 10 years. India has the dubious distinction of leading the world in road crash fatalities – 10% of total global road deaths occur here. In 2013 alone, almost 1,40,000 people were killed and close to 5,00,000 were seriously injured or permanently disabled.

The "Global Status Report on Road Safety" published by the World Health Organization (WHO) identified the major causes of traffic collisions as driving over the speed limit, driving under the influence, and not using helmets and seat belts. Failure to maintain lane or yield to oncoming traffic when turning are prime causes of accidents on four lane, non-access controlled National Highways. The report noted users of motorcycles and motor-powered three-wheelers constitute the second largest group of traffic collision deaths.

An accident which occurred or originated on a road open to public traffic resulting in either in injury or loss of life, or damage to property, in which at least one moving vehicle was involved is known as road accident. Accidents are a drain on the national economy and may lead to disablement, death, damage to health and property, social suffering and general degradation of environment.

To minimize the no of crashes by any kind and severity expected to occur on the entity during a specific period is known as road safety. Accidents and the fatalities on road are the result of inter-play of a number of factors. Road users in India are heterogeneous in nature, ranging from pedestrians, animal-driven carts, bi-cycles, rickshaws, hand carts and tractor trolleys, to various categories of two/three wheelers, motor cars, buses, trucks, and multi-axle commercial vehicles etc., The vehicle population has been steadily increasing because of change in the style of living of people. Increase in vehicle population with limited road space used by a large variety of vehicles has heightened the need and urgency for a well thought-out policy on the issue of road safety. In India the rate of accident is directly proportional to growth of vehicle population.

II. LITERATURE REVIEW

Hassan and Aty (2012)[1] studied 680 young driver behavior involvement in traffic crash in Florida. The result revealed that aggressive violation, in-vehicle distraction and demographic characteristics were the significant factors affecting young drivers involvement in crashes at the age of 16-17. Invehicle distraction, attitude towards speeding and demographics characteristics were the significant factors effect young drivers crash risk at the age of 18-24.

Constantinou et al.,(2011) [2] found that young novice driver (<25 yrs.) are in high risk related to traffic offence. The study was based on gender, sex, age and personality.

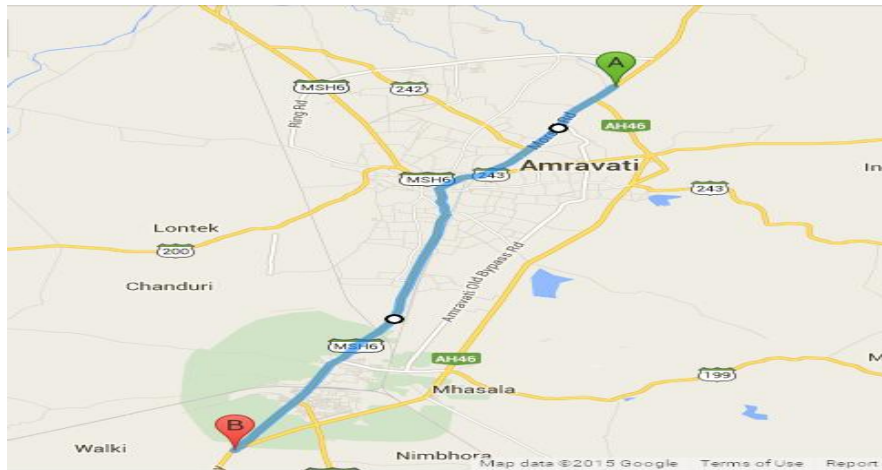
Chandraratna et al.,(2006) [3] studied licensed driver involvement in a crash. Using logistic regression it was found very young and old male drivers are responsible due to both speeding and non-speeding.

III. DATA COLLECTION

The data collection of the accidents is primarily *obtained from* the police station. Information available for accident studies is the FIR (First Information Report) lodged. The data collected from only the FIR record filed under IPC no.279/ 337/ 338/ 304(A) Indian Penal Code (IPC) is the main criminal code of India.

A. ROAD SELECTED FOR STUDY

Two-lane road from Hotel Gauri Inn to New Badnera on NH-06 was chosen For this study. The study stretch was divided into four equal stretches of each 5Km length. The Study Stretch is shown in Fig. 3.1 The accident data's are shown in shown in table. 3.1



“Figure 3.1 Study Area Source: Google Map”
“Table 3.1 Details of Accidents”

| Year | Fatal | Major Injury | Minor Injury |
|-------|-------|--------------|--------------|
| 2004 | 5 | 20 | 39 |
| 2005 | 9 | 25 | 46 |
| 2006 | 6 | 17 | 30 |
| 2007 | 6 | 25 | 38 |
| 2008 | 5 | 17 | 37 |
| 2009 | 7 | 25 | 47 |
| 2010 | 12 | 23 | 51 |
| 2011 | 7 | 22 | 43 |
| 2012 | 8 | 20 | 40 |
| 2013 | 10 | 29 | 44 |
| Total | 75 | 223 | 415 |

IV. ANALYSIS OF DATA AND DISCUSSION

A. ACCIDENT RATE AND FREQUENCY

Accident Rate =M/L

Where, M = Total no of Accidents of a stretch, L= Length of Road

“Table 4.1. Accident Rate”

| Name of Stretch | Length | No. of Accidents in a Year | |
|-------------------------------------|--------|----------------------------|---------------|
| | | Sum of 10 Year | Accident Rate |
| Hotel Gauri Inn To Irwin Square | 5km | 277 | 55.4 |
| Irwin Square To Jaika Motors | 5km | 353 | 70.6 |
| Jaika Motors To Railway Bridge | 5km | 43 | 8.6 |
| Railway Bridge To New Badnera NH-06 | 5km | 40 | 8 |

“Table 4.2. Frequency of Accident”

| Distance of Origin | No. of Accidents (2004-2013) | Frequency | Total Frequency |
|--------------------|------------------------------|-----------|-----------------|
| 0 to 5 | 277 | 38.84 | 38.84 |
| 6 to 10 | 353 | 49.51 | 88.35 |
| 11 to 15 | 43 | 6.03 | 94.38 |
| 16 to 20 | 40 | 5.62 | 100 |
| Total | 713 | 100 | |

From the Table 4.1 and 4.2 it is observed that frequency and rate of accident is more for stretch-2 followed by stretch-1, 3,4 respectively

B. ANNUAL VARIATION IN ACCIDENTS

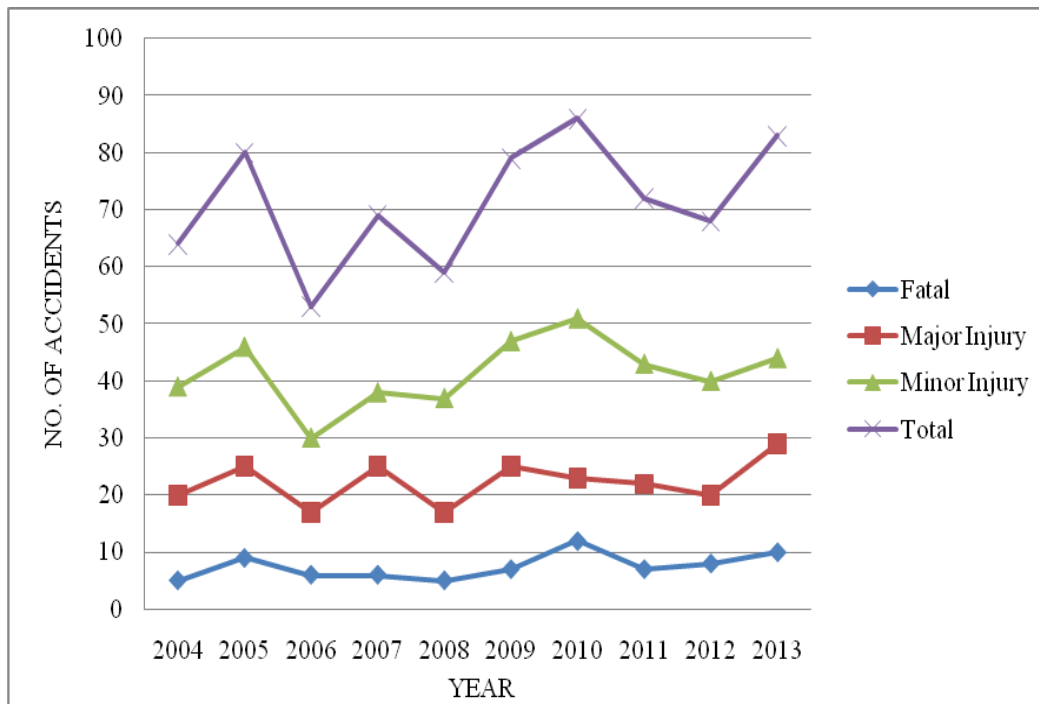
Fig. 4.1 shows the annual variation in accidents of total stretches during year 2004-2013. It is observed that percentage accidents are increasing relatively in most of the year. In the year 2010 accident rate was high and low in the year 2006. It may be due to increase in no of vehicles, bad shoulder, bad speed breakers and road without marking. It is observed that no of accidents are more for stretch-2 and 1 are more higher than stretch -3 and 4. This is because of high traffic volume on stretch 2. Accident rate is more due to more no of commercial and noncommercial vehicles on the road.

C. MONTHLY VARIATION IN ACCIDENTS

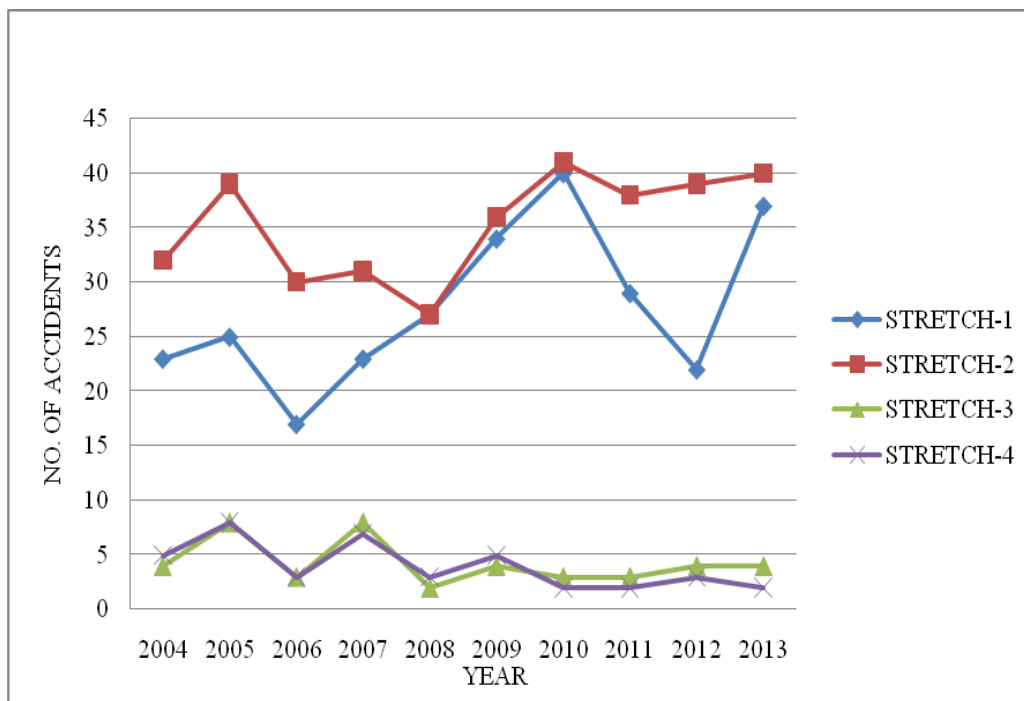
The monthly variation in accidents of total stretches during year 2004-2013. Peak accident occurs in summer season i.e. in the month of March, April and may. This is due to distraction related to environment. Problem in these months are glare, fatigue, inconvenient heat.

D. HOURLY VARIATION IN ACCIDENTS

Hourly variation in accidents one can observe more accidents occurs in between 7PM to 9PM. In this hour line truck (Truck Series) starts their long journey. Most of the driver do not use speedometer as they drive by approximation. Speed crosses limiting speed as a result accident occur. Also they drink and drive in the evening hour. In the late night they use marijuana as a result reaction time increases and loss of contro occurs.



“Figure.4.1 Annual Variation in Accidents of Total Stretch”



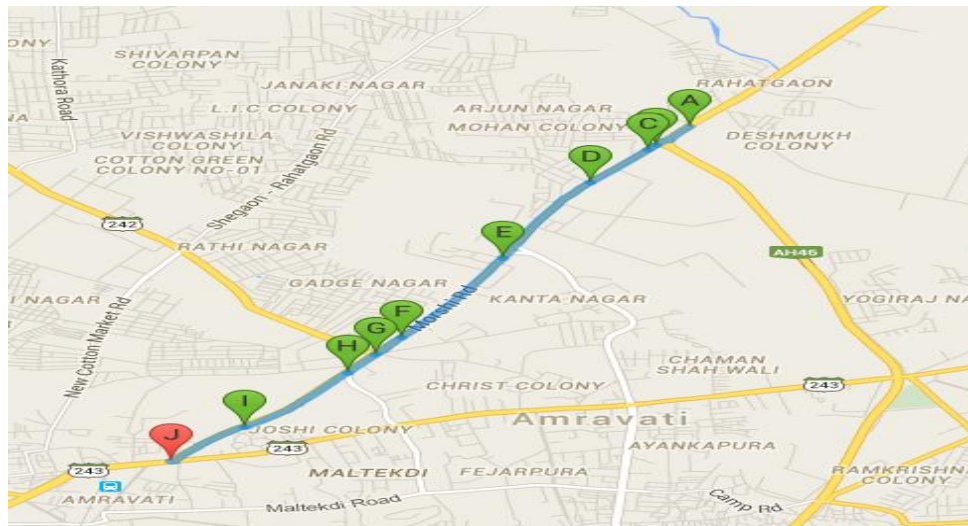
“Figure.4.2 Annual Variation in Accidents of Four Stretches”

E. TREND OF ACCIDENTS, INJURIES AND FATALITIES DURING 2004-2013

The increasing trend in accident rate may be due to increase in population due to town growth, poor maintenance of shoulder, electric poles on the road, transformer station on the shoulder, old girth trees on the shoulder, improper road markings, sight distance obstruction due to trees, unsignalized intersection, on street parking of vehicles, improper median, improper speed-breakers and lack of general awareness of road safety among road users.

V. BLACK SPOT ANALYSIS

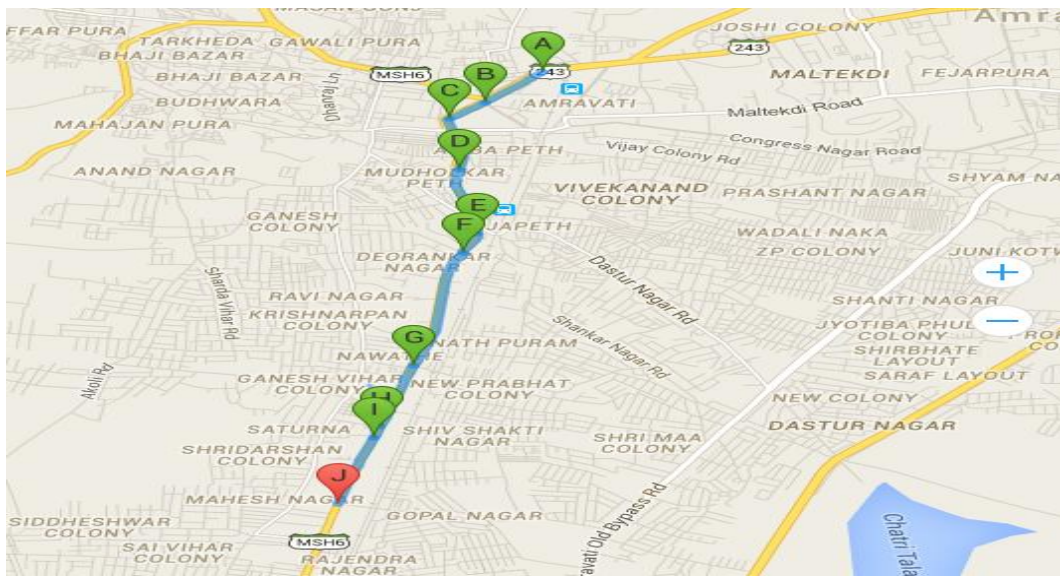
The point where accident occurs frequently is known as black spot or accident point. Analysis is required for improving traffic environment. The detail analysis of four stretches are shown in Fig5.3-5.6 and Table 5.1-5.4



“Figure.5.1 Black Spot Points Stretch-1”
“Table 5.1 Black Spot Analysis Stretch-1”

| Accident Point | Nos. | Problems | Safety Enhancement |
|-------------------------------------|------|--|--|
| Akash Travels | 4 | Taxi stand, Trees on the Shoulder, Plants on Shoulder | Clearance of obstruction on the Shoulder |
| Arjun Nagar | 17 | T, Trees on Blind Corner | Trees on Shoulder should be removed |
| Baba Corner | 14 | Bad Shoulder, On Street Parking of Vehicles | Off Street Parking Facility, Shoulder maintenances |
| Dr. P. D. Polytechnic College | 3 | X-Unsignalised, Auto stand, School, Bus Stop, Edge drop | Junction Improvement |
| I.T.I College | 9 | Bus Stop, Paved Shoulder with no Marking | maintenance of Shoulder |
| Jawaharlal Nehru Sports stadium | 6 | 2w garages, Motor garages | Speed Restriction |
| Kalim Petrol Pump | 2 | Bad Shoulder, Edge drop | Shoulder maintenances |
| New Bypass T Point | 18 | T, Trees on Blind Corner, Bus Stop, Shop Verandah on Shoulder | Trees on Shoulder should be removed, Road Marking |
| Panchvati Square | 40 | Taxi stand, Trees and Poles on Shoulder, Median without Sign on the Road | Junction Improvement, maintenance of Shoulder |
| Panchvati Square, Flyover | 5 | sharp curve, Road without Marking | Speed Restriction, Road Marking |
| Power house | 22 | T, Road without Marking, Bad Shoulder, Taxi stand | Road Marking, Shoulder maintenances |
| Rathi High School | 4 | Bus Stop, Paved Shoulder with no Marking | Shoulder maintenances |
| Santa Dnyaneshwar Sanskrutik Bhavan | 17 | Median without Sign on the Road, School, Steep Gradient | Speed Restriction, Medians to be Painted |
| Shivaji Agriculture College | 10 | X-Unsignalised, Curve Sight Distance obstructed by old and dead Trees | Junction Improvement, Clearance of Road Side |
| Shivaji Science College | 8 | Median without Sign on the Road, School, Steep Gradient | Medians to be Painted, Shoulder maintenances |
| Traffic Police Station | 9 | Bus Stop, Teashop on Shoulder, Stalls on the Shoulder | Shoulder obstruction Clearance |
| Yashwantrao | 3 | Unpainted Median, Bad Shoulder | Shoulder maintenances , |

| | | |
|------------|--|-----------------------|
| University | | Medians to be Painted |
|------------|--|-----------------------|



“Figure.5.2. Black Spot Points Stretch-2”
“Table 5.2 Black Spot Analysis Stretch-2”

| Accident Point | Nos. | Problems | Safety Enhancement |
|---------------------|------|---|---|
| A.M.C. | 4 | Bad Shoulder, Edge drop, Auto stand, Stalls on the Shoulder | Clearance of Road Side, maintenance of Shoulder |
| Bajaj Showroom | 9 | T, Edge drop, Motor Show Room, Unpainted Median | Speed Breakers maintenance, Medians to be Painted |
| Benam Square | 21 | Plants on Shoulder, Road without Marking | Clearance Of obstruction on the Shoulder |
| Bhartiya College | 3 | Stalls on the Shoulder, Old Trees on The Shoulder, Auto stand | obstacle on The Road Should Be Removed |
| Gadre Square | 32 | Auto stand, Bad Shoulder, Road without Marking | Curve Sight Distance Visibility |
| Gopal Nagar T Point | 12 | T, Auto stand, Bus Stop, Unpainted Median, Vegetable Market, Unsignalised | Junction Improvement, Medians to be Painted |
| Gulshan Plaza | 6 | Plants on Shoulder, Bad Shoulder, Bad Parking | Off Street Parking Facility |

| Accident Point | Nos. | Problems | Safety Enhancement |
|----------------------|------|--|---|
| Irwin Square | 31 | Auto stand, Road without Marking, Vehicle Parking on Shoulde, Unpainted Median | Installation of Speed Breakers, Marking |
| Irwin Square Flyover | 6 | Road without Marking, Improper street light, | Speed Restriction, Road Marking |

| | | | |
|-------------------------|----|--|---|
| Jaistambh Square | 17 | Paved Shoulder with no Marking, Unpainted Median, Stalls on the Shoulder | obstacle on The Road Should Be Removed, Speed Restriction |
| Joshi Market, Flyover | 4 | Bad Speed Breakers, sharp curve, Road without Marking | Speed Restriction, Improvement Curve Sight Distance, Speed Breakers maintenance |
| Nawathe Square | 34 | T, Auto stand, Bus Stop, Unpainted Median, Unsignalised, Trees and Poles on Shoulder | Trees on Shoulder should be removed, Junction Improvement, Medians to be Painted |
| Rajapeth Police Station | 6 | Auto stand, Bus Stop, Unpainted Median, Trees and Poles on Shoulder, Bad Shoulder, Road without Marking | Road Marking, Medians to be Painted, maintenance of Shoulder |
| Rajkamal Square | 39 | Auto stand, Unpainted Median, Paved Shoulder with no Marking, Road without Marking, | Junction Improvement, Separate Auto stand, Shoulder maintenances, Road Marking |
| Saturna Square | 16 | T, Auto stand, Bus Stop, Unsignalised, Trees and Poles on Shoulder, Bad Speed Breakers, Road without Marking, Bad Shoulder | Road maintenance, Road Side Clearance, Separate Bus Stop, Visibility by Cutting old Tree Branches |
| Shyam Square, Flyover | 7 | Bad Speed Breakers, sharp curve, Road without Marking | Speed Restriction, Improvement Curve Sight Distance, Speed Breakers maintenance |

A. ACCIDENT PREDICTION MODEL

CALIBERATION OF MODEL

The accident per year was regressed with density and road side features. The general form of equation is represented as

$$\text{No. of accident} = 48.599 \times \text{density} + \text{No. of trees on shoulder} \times 0.7 + \text{No. of curves} \times 4.998 - 8.914 \times \text{shoulder condition.}$$

The above equation shows that accidents increases with increasing in density, no of trees on shoulder and no of curves. The accident decreases with increase in shoulder condition. Hence regular maintenance of road should be done, old girth trees should be removed and widening of lane should be done by making into four lane.

“Table 5.3 Estimated Accidents at 4 Stretches for Validation”

| Stretch | 1 | 2 | 3 | 4 |
|--|-------|-------|-------|--------|
| Accidents Estimated from Prediction Model | 0.934 | 0.949 | 1.038 | 1.0046 |

Sum of the accidents rate = 0.934+0.949+1.038+1.0046 =3.9256

The expected number of accidents rate = $3.9256/4 = 0.981$

Degree of freedom, $df = 4 - 1 = 3$

Chi-square for $df = 3$ and 5% significance level = 7.81

since $0.981 < 7.81$

If $0.981 < 7.81$, we conclude that the null hypothesis is true and that there is no real change due to the improvements.

VI CONCLUSIONS

Stretch II has the highest number of accidents which accounts for 49.51% of total accidents. The accident rate can be decreased by road side clearance, proper maintenance of shoulders, lighting, and junction improvement. Speed limit should be brought down by providing humps near accident spots. Sight distance near curves should be obstruction free. Removal of trees near the edge of pavement etc.

Stretch I have the second highest number of accidents accounts for 38.85% of total accident. The Accident rate can be reduced by providing signalized junction, junction improvement, and shoulder clearance, installation of humps, shifting of poles, sight distance near curves should be obstruction free.

Stretch III number of accidents in accounts for 6.03% of total accidents. The accident rate can be minimized by clearing-off shoulders, reducing speed limit, junction improvement, providing signals on the median, shifting structures on the shoulder.

Stretch IV has minimum number of accidents accounts for 5.61% of total accidents. Speed limit reduction near junction should be reduced to prevent accidents.

The available literatures on accident analysis indicate that 77.5 percent of road accidents in India are caused due to driver's error.

Heavy vehicles like truck are involved in maximum number of accident on two-lane roads. It is estimated that fatalities caused by truck is 59 % followed by other (26%) and bike (7%) and car (5%) and bus (3%). Road safety awareness should be raised among road user.

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