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# Estimation of accident rate at blockspots

## M Anvesh Kumar and B Kalpana

**Abstract**
India is a developing country and safety of road is still in a premature stage. Accident severity is increasing in increasing order due to increasing in vehicle population. Accident leads to disablement, death, damage to health and property, social suffering and general degradation of environment. The road accident situation in India is alarming. Records show that there is loss of 17 lives on an average every hour in our country. 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 to traffic.
NH-16 is one of the major connectivity from Kolkata to Chennai which caters to the need of transportation of light goods to heavy goods and passengers. Study area was undertaken on road NH-16 & NH 65in and around Vijayawada. The study Stretch is a major connectivity to Airport and many more small scale industries based on automobiles. The no of accidents is rising up every year due to increasing vehicles population. 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, Major Injuries, Minor Injuries, Fatalities, blockspots

## 1. Introduction
### 1.1 General
Road crashes take away the right to life of 3, 288 people every day. This is a global humanitarian disaster, and it is man-made. (Global Status Report on Road Safety 2015 by WHO) Road safety is one of the most important problems in our society. Every year 1.2 million of people are killed and between 20 and 50 million people are injured in road accidents. If current trends continue road traffic accidents are predicted to be third leading contributor to the global burden of Disease and injury by 2020 (Torregrosa *et al*., 2012) [2].
India had earned the dubious distinction of having more number of fatalities due to road accidents in the world. Road safety is emerging as a major social concern around the world especially in India. In other words, its ambit spans engineering aspects of both, roads and vehicles on one hand and the provision of health and hospital services for trauma cases in post-crash scenario. Road accident in India is shown in Table 1

**Table 1:** Road accident in India (2005-2015)

| Year | Number of Accidents | | Number of Persons | | Accident Severity* |
|---|---|---|---|---|---|
| | Total | Fatal | Killed | Injured | |
| 2005 | 4,39,255 | 83,491 (19.0) | 94,968 | 465,282 | 21.6 |
| 2006 | 4,60,920 | 93,917 (20.4) | 105,749 | 496,481 | 22.9 |
| 2007 | 4,79,216 | 1,01,161 (21.1) | 114,444 | 513,340 | 23.9 |
| 2008 | 4,84,704 | 1,06,591 (22.0) | 119,860 | 523,193 | 24.7 |
| 2009 | 4,86,384 | 1,10,993 (22.8) | 125,660 | 515,458 | 25.8 |
| 2010 | 4,99,628 | 1,19,558 (23.9) | 134,513 | 527,512 | 26.9 |
| 2011 | 4,97,686 | 1,21,618 (24.4) | 1,42,485 | 5,11,394 | 28.6 |
| 2012 | 4,90,383 | 1,23,093 (25.1) | 1,38,258 | 5,09,667 | 28.2 |
| 2013 | 4,86,476 | 1,22,589(25.2) | 1,37,572 | 4,94,893 | 28.3 |
| 2014 | 4,89,400 | 1,25,828(25.7) | 1,39,671 | 4,93,474 | 28.5 |
| 2015 | 5,01,423 | 1,31,726(26.3) | 1,46,133 | 5,00,279 | 29.1 |

Causes of accidents and their contribution are as follows by statistics of Road accidents in India (2015)

- Drivers fault- 82%
- Defects in road condition- 1.5%
- Defects in motor vehicle- 2.3%
- Fault of bicyclist- 0.7%
- Fault of pedestrian- 1.5%
- Weather condition- 1.2%
- All other causes- 10.8%

Road safety in India is the poorest in the world. Awareness among road users and safe design of road components is necessary to reduce accident involving both human and vehicles.

### 1.11 Road Safety & Various Causes of Accident

Road traffic safety refers to methods and measures for reducing the risk of a person using the road network being killed or seriously injured. Safe road design is now about providing a road environment which ensures vehicle speeds will be within the human tolerances for serious injury and death wherever conflict points exist.

The various causes of accidents may be due to three factors shown in fig 1

- Driver
- Vehicle
- Environment

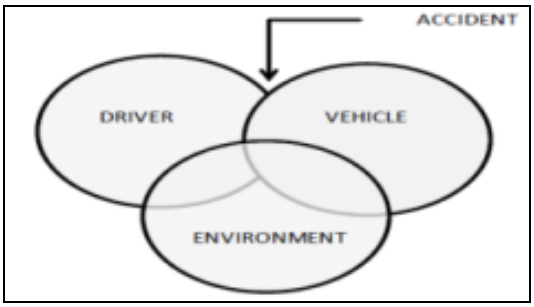


**Fig 1:** Causes of Accident

### 1.2 Need and Objectives of Study

Expansion in the road network, surge in motorization and a rising population of a country contribute towards increasing numbers of road accidents, numbers of registered motor vehicles in the country and the country's population have increased at a rapid rate. During the time period 2006-2015, the number of road accidents in the country decreased at a CAGR of 1.3 per cent. But, the number of road accident fatalities and the number of persons injured in road accidents in the country between 2006 and 2015 increased at4.4 per cent and 0.7 per cent, respectively.

Very little work has been done in India to analyze accidents on two-lane roads.

The major objectives of the present work are listed below

- To study the annual, monthly, daily and hourly variation in accident rate on selected Stretch of urban two-lane road.
- To study the effect of traffic volume, density and capacity on accident rate on urban Two-lane road.
- To study the maintenance of road surface and shoulder on rate of accident.
- To develop an accident prediction model based on AADT, road condition, road side Features.

### 1.3 Outline of the Report

The work has been documented in the following manner. The first chapter gives overall understanding about the present accident scenario at national level. It also includes the importance of the two-lane roads, factors affecting accident and their contribution, and defines objectives of the study. Chapter two is comprised of review of literature. Site selection for data collection, methodology adopted for data collection are discussed in third chapter. Chapter four depicts traffic and surface properties data of Study stretch. Chapter five is comprised of accident investigation and Black Spot analysis. Significant conclusion drawn from study and further work are given in chapter six.

## 2. Review of literature

Many factors may exhibit a measurable influence on driving behavior and traffic safety on two-lane highways (Bhuyan, 2003) [5]. These include, but are not limited to,

- Human factors such as improper judgment of road ahead and traffic, driving under the influence of alcohol or drugs, driver education and experience, young driver, age and sex.
- Traffic factors like speed, volume, density, capacity, traffic mix and variation.
- Vehicle deficiencies, such as defective brake, headlight, tyres, steering and vehicle condition
- Road condition like slippery or skidding road surface, ravels, pot hole, ruts etc.
- Road design such as inadequate sight distances, shoulder width, no of lanes, improper curve design, improper lighting and traffic control devices.
- Weather condition like fog, heavy rainfall, dust, snow etc.
- Other causes such as enforcement, incorrect sign and signals, service station, badly located advertisement, stray animals etc.

### 2.1 Driver characteristics

#### 2.1.1 Age, Gender and Personality

Hassan and Aty (2012) [6] 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.

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.

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

#### 2.1.2 Perception

Conducted a video-based hazard perception test and concluded that male novice driver had relatively longer reaction time and initial risk involved.

Studied about hazard and risk perception among young novice driver and concluded that hazard and risk perception are fundamental skill that young drivers need to develop.

### 2.1.3 Alcohol and Drugs
The leading cause of traumatic death is motor vehicle accidents, falling accidents and blunt trauma. The use of drugs such as alcohol or illicit such as opium, cocaine increases the risk of trauma by traffic collision. Other drugs such as benzodiazepines increase the risk of trauma in elderly people.

### 2.2 Signs and Signals
Developed traffic safety model using regression in New York City. The result shows that signal related countermeasure that are designed to reduce conflict are split phase, timing, signal installation, all pedestrian phase and increasing pedestrian crossing reduces crashes. Countermeasures that are designed to alert driver cognitive attention such as high visibility crosswalks and posted speed limit reduction signs appear to have lesser effect.

### 2.3 Volume
Studied the accident frequency and homogeneous flow of vehicle. It was found that the accident rate decreases when the traffic flow is homogenous in nature. For Lorries there was an decrease in no of accident and for car the accident rate was constant.

Made a relation between traffic flow and traffic accident. It was from the study that means volume and median speed affect safety. Lane- change crashes tend to occur when there is the highest variability in speed. While rear end crashes tend to cluster where there is a lower variation in speed. There suggestion was to improve traffic engineering and implementation of ITS (Intelligent Transportation System) and enhance driver education.

Studied between road geometric characteristics and accident rate. They found AADT, lane width, Serviceability index, friction, pavement type, access control are the main factor contributing to accidents. Relative importance was 100% for AADT, 72% for lane width, 59% for serviceability, 32% for friction, 30% for pavement type and 14% for rural two-lane road.

## 3. Data collection
The only information available for accident studies is the FIR (First Information Report) lodged in the police stations. The data from these records of last ten years (2006-2015) were extracted from the FIR record filed under IPCno.279/337/338/304 (A). Vehicles those involved in accidents and reported in the F.I.R. The categories of vehicles include tempo, auto, mini-truck, minibus, Tata indica, Tata-407, trecker, motor cycle, tanker, tailor (articulated vehicle), truck and bus.

### 3.1 Road selected for study
Two-lane roads from Gannavaram to Krishnalanka on NH-16 & NH-65 was chosen for this study. The following stretches were selected for data collection. The study area is shown in fig 2

- Gandhi Bomma Centre Gannavaram
- Anjaneya Swamy temple kesarapalli
- Netaji Bridge Centre, Krishnalanka
- Times Hospital, Autonagar

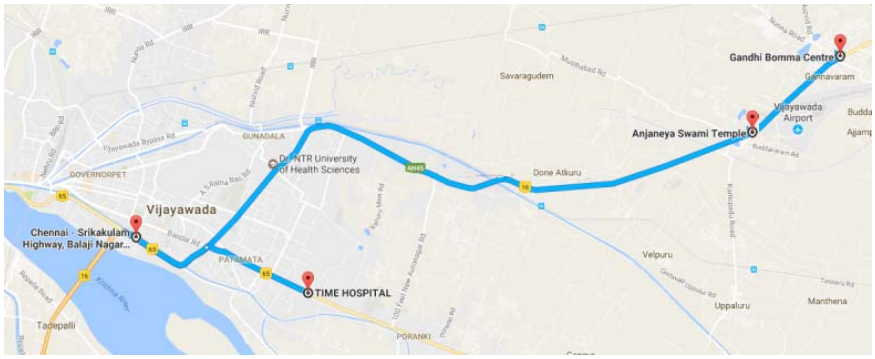


**Fig 2:** Study area Source: Google Map

### 3.2 Data collected from Police Records
The accident data was collected on two-lane highways from three police stations the police stations have their own FIR records of several years. The data from these records of last ten years were extracted from the FIRs filled under IPC NO.279/337/338/304 (A).A sample copy of the proforma is shown in the Table 3.1

**Table 2:** Proforma for accident data from FIR records

| Date/Day/Time | Location of Accident | Details of Accident | Vehicle(s) Involved | Possible Reasons |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Accident details during 2006-2015 on this road section are shown in Table 3.2. Accident data were collected year wise from each police station records then sorted out month wise. Average yearly variation of accidents stretch wise during 2006-2015

**Table 3:** Details of accidents

| Year | Fatal | Major Injury | Minor Injury |
|---|---|---|---|
| 2006 | 15 | 16 | 37 |
| 2007 | 11 | 35 | 50 |
| 2008 | 16 | 25 | 45 |
| 2009 | 20 | 32 | 39 |
| 2010 | 21 | 34 | 40 |
| 2011 | 18 | 41 | 84 |
| 2012 | 4 | 24 | 61 |
| 2013 | 13 | 32 | 81 |
| 2014 | 18 | 34 | 84 |
| 2015 | 11 | 30 | 58 |
| Total | 147 | 303 | 579 |

**Table 4:** Details of accident stretch wise

| Year | Fatal | | | | | Major | | | | | Minor | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S4 | Total | S1 | S2 | S3 | S4 | Total | S1 | S2 | S3 | S4 | Total |
| 2006 | 9 | 3 | 0 | 6 | 15 | 4 | 5 | 1 | 6 | 16 | 15 | 8 | 2 | 12 | 37 |
| 2007 | 6 | 3 | 0 | 2 | 11 | 10 | 18 | 1 | 6 | 35 | 10 | 26 | 2 | 12 | 50 |
| 2008 | 3 | 1 | 1 | 11 | 16 | 5 | 13 | 0 | 7 | 25 | 11 | 24 | 0 | 10 | 45 |
| 2009 | 9 | 4 | 1 | 6 | 20 | 7 | 17 | 2 | 6 | 32 | 10 | 20 | 2 | 7 | 39 |
| 2010 | 10 | 3 | 1 | 7 | 21 | 11 | 11 | 2 | 10 | 34 | 14 | 12 | 1 | 13 | 40 |
| 2011 | 6 | 4 | 1 | 7 | 18 | 23 | 3 | 2 | 13 | 41 | 33 | 15 | 7 | 29 | 84 |
| 2012 | 1 | 2 | 0 | 1 | 4 | 9 | 10 | 1 | 4 | 24 | 14 | 23 | 2 | 22 | 61 |
| 2013 | 6 | 2 | 3 | 2 | 13 | 18 | 7 | 3 | 4 | 32 | 22 | 18 | 5 | 36 | 81 |
| 2014 | 8 | 3 | 0 | 7 | 18 | 25 | | 9 | 0 | 34 | 36 | 18 | 2 | 28 | 84 |
| 2015 | 2 | 3 | 1 | 5 | 11 | 10 | 6 | 1 | 13 | 30 | 16 | 16 | 3 | 23 | 58 |
| Total | 60 | 28 | 8 | 54 | 147 | 122 | 90 | 22 | 69 | 303 | 181 | 180 | 26 | 192 | 579 |

### 3.3 Data collected from P.W.D Records

P.W.D (Public Works Department) records are the main source of details of road. The proforma used to record these details is shown in Table 3.4

**Table 5:** Proforma for details of road section

| | |
|---|---|
| Width of Carriage way in Mt | 7 |
| Width of Formation in Mt | 12 |
| Width of Land in Mt | 45 |

In addition to the above, traffic volume data were also obtained from PWD records. These are shown in Table 3.5

**Table 6:** Traffic volume data

| YEAR | ADT | AV PCU PER DAY | PCU/HR |
|---|---|---|---|
| 2002 | 14533 | 24656.11 | 1027.338075 |
| 2003 | 12584 | 21501.46 | 895.8942667 |
| 2004 | 12679 | 21655.23 | 902.301225 |
| 2005 | 10484 | 18102.4 | 754.2667667 |
| 2006 | 12700 | 21689.22 | 903.7175 |

## 4. Analysis of data and discussion

### 4.1 Accident Rate and Frequency

Accident Rate = M/L Where,

M = Total no of Accidents of a stretch

L = Length of Road

**Table 7:** Accident Rate

| Name of Stretch | Length | No of accidents in a year | |
|---|---|---|---|
| | | Sum of 10 Years | Accident Rate |
| Gandhi Bomma Centre, Gannavaram | 5 km | 228 | 45.6 |
| AnjaneyaSwamy Temple, Kesarapalli | 5 km | 208 | 41.6 |
| Netaji Bridge, Krishna Lanka | 5 km | 26 | 5.2 |
| Times Hospital, Autonagar | 5 km | 239 | 47.8 |

**Table 8:** Frequency of Accident

| Distance of origin | No of accidents (2006-2015) | Frequency | Total frequency |
|---|---|---|---|
| 0-5 | 228 | 32.5 | 32.5 |
| 6-10 | 208 | 29.6 | 62.1 |
| 11-15 | 26 | 3.7 | 65.8 |
| 16-20 | 239 | 34.1 | 100 |
| Total | 701 | 100 | |

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

### 4.2 Annual Variation in Accidents

Fig 3 shows the annual variation in accidents of total stretches during year 2006-2015. It is observed that percentage accidents are increasing relatively in most of the year. In the year 2011 accident rate was high and low in the year 2006.It may be due to increase in no of vehicles, bad traffic environment, and increase in population.

### 4.3 Monthly Variation in Accidents

Fig 4 shows the monthly variation in accidents. 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.

### 4.4 Hourly Variation in Accidents

Fig 5 shows hourly variation in accidents. One can observe more accidents occurs in between 8PM to 9PM.In this hour line truck (Truck Series) start their long journey. In the late night they use marijuana as a result reaction time increases and loss of control occurs. Some drivers make the vehicle over load. In India load capacity is 10 ton or 16.2 ton for goods carriage but they carry more than that results uncontrolled and leads to accidents.

### 4.5 Vehicles Involved in Fatalities

Vehicle users related to fatalities during 2006-2015 are shown in pie chart in percent. The results indicate that 59 percent of fatalities are due to truck drivers followed by 26 percent by unknown driver, 7 percent by motor cycles,5 percent by car and jeep,3percent by bus respectively as shown in fig 6 They consume alcohol and drugs in long driving. As a result reaction time increases and loss of control occurs during speed driving leads to fatalities.

### 4.6 Accidents Related to Traffic Volume

In order to find the relationship between accident rate and traffic volume, accident rate was presented in two forms. And in other case, it was the number of accidents that occur in a road section per million vehicles (MV) taken in terms of passenger car unit (PCU) per Kilometer (K) per year (Y), represented as Accident per MVKY.

Fig 7 shows the plot between accidents per MVKY and AADT on the road. It was found that accident per MVKY increases with increase in AADT. It may due to faulty design and operational features of highway and influence of other parameters like roadside features, shoulder condition and operational environment.

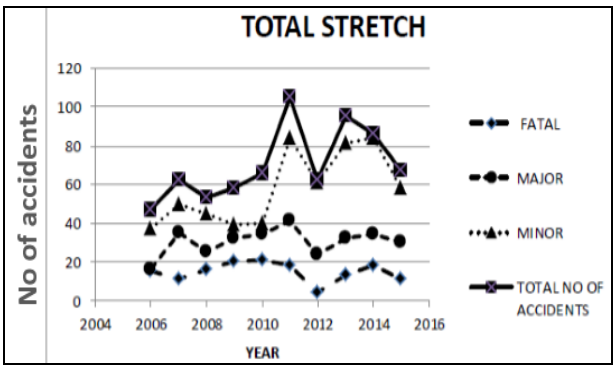


**Fig 3:** Annual variation in accidents of total stretch

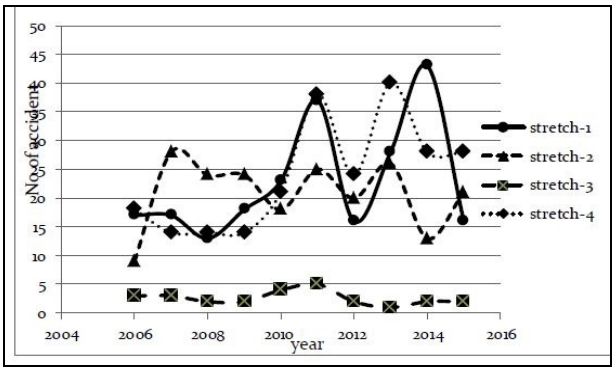


**Fig 4:** Annual variation in accidents of four stretches

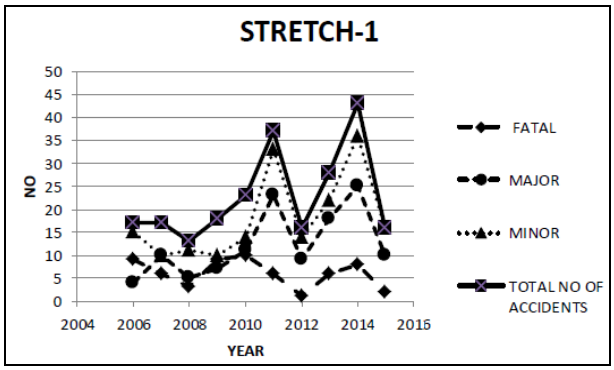


**Fig 5:** Annual variation in accidents of stretch 1

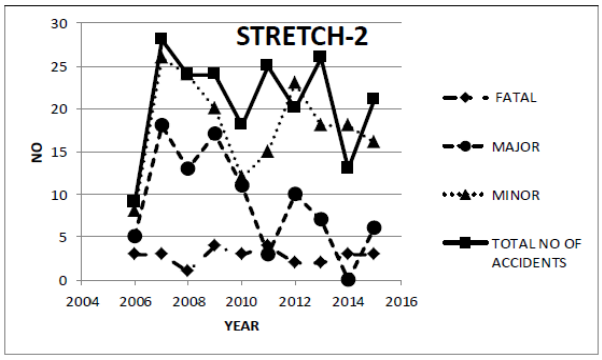


**Fig 6:** Annual variation in accidents of stretch 2

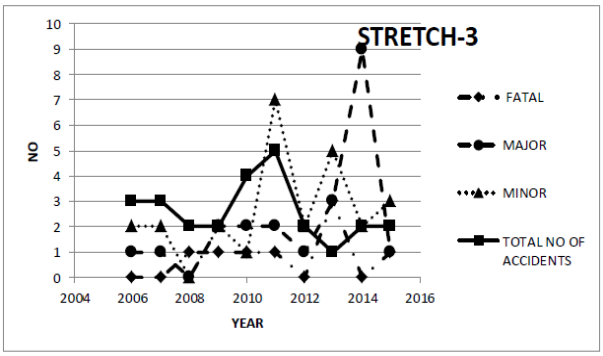


**Fig 7:** Annual variation in accidents of stretch

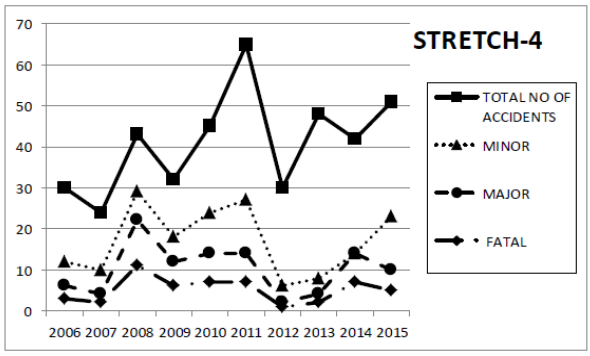


**Fig 8:** Annual variation in accidents of stretch 4

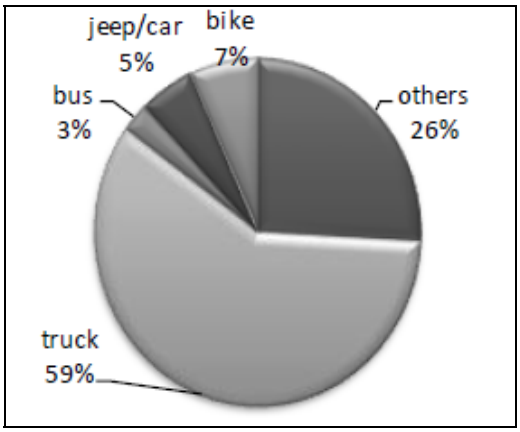


**Fig 9:** Vehicle involved in fatalities during (2006-2015)

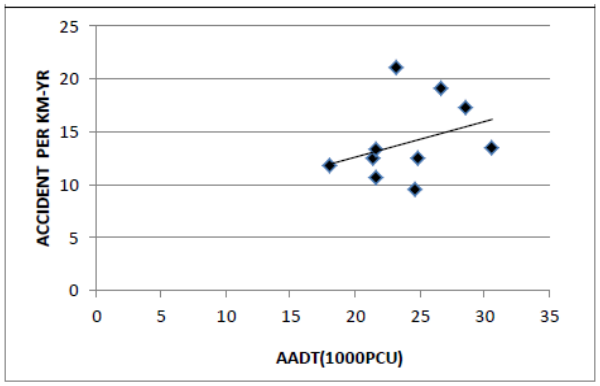


**Fig 10:** Accidents per km-year as related to traffic volume

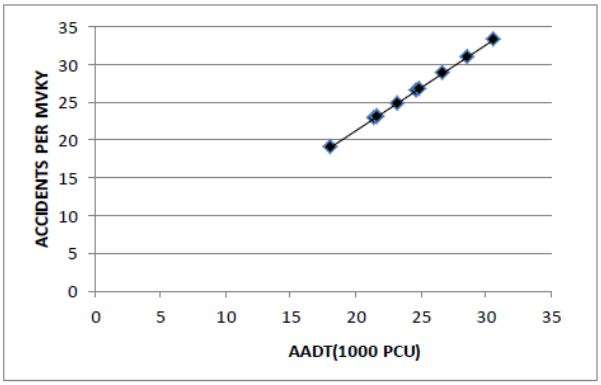


**Fig 11:** Accidents per MVKY as related to traffic volume

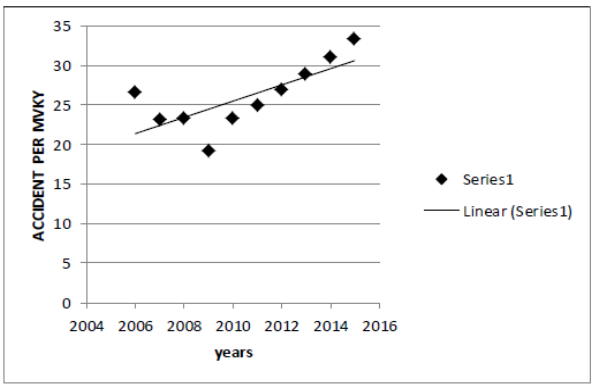


**Fig 12:** Trend of Accidents (2006-2015)

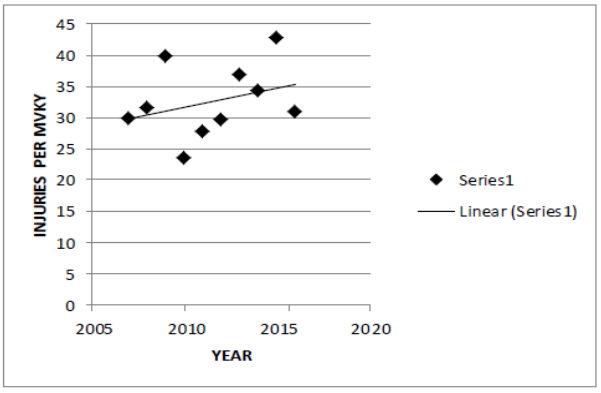


**Fig 13:** Trend of injuries

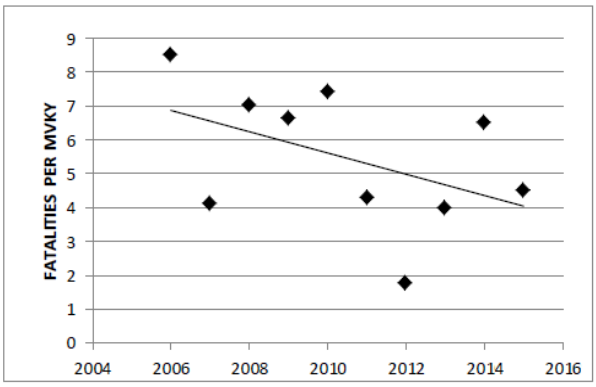


**Fig 14:** Trend of Fatalities (2006-2015)

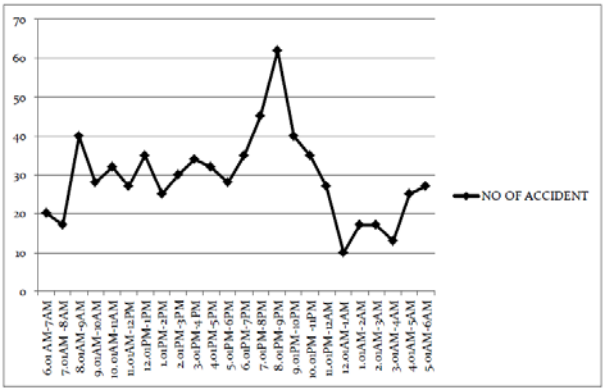


**Fig 15:** Accident time wise (2006-2015)

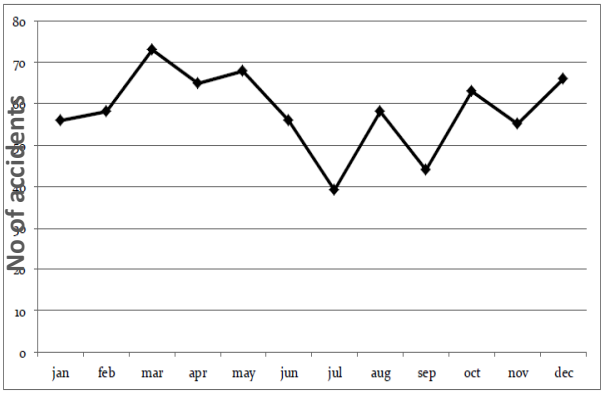


**Fig 16:** Accident month wise (2006-2015)

### 4.7. Trend of Accidents, Injuries and Fatalities during 2006-2015

The yearly trend of accident per million vehicle-kilometer-years (MVKY) on the road is shown in Fig 8. From the figure it is found that accident rate per MVKY increases in each subsequent Year. The increasing trend in accident rate may be due to increase in population due to town growth, industry growth, poor maintenance of shoulder, electric poles on the road, transformer station on the shoulder, old girth trees on the shoulder, sight distance obstruction due to trees, unsignalized intersection, on street parking of vehicles and lack of general awareness of road safety among road users.

**Table 9:** Traffic and Roadside features data of four stretches (2015)

| Stretch No | ADT | Qmax (pcu/s) | Road Access | Shoulder Trees on | Poles | Curves | Shoulder condition | Lighting condition |
|---|---|---|---|---|---|---|---|---|
| 1 | 63000 | 0.85 | 32 | 53 | 23 | 9 | Good | Good |
| 2 | 35160 | 0.74 | 51 | 52 | 51 | 2 | Average | Average |
| 3 | 35160 | 0.74 | 9 | 0 | 0 | 3 | Poor | Poor |
| 4 | 48960 | 0.95 | 4 | 1 | 1 | 9 | Poor | Poor |

From the table it is observed that flow for traffic condition exceeds the limit for a two way traffic flow of two lane system as per IRC. Hence wider of lane is necessary.

### 4.9 Surface Property

Skid Number SN = $\sqrt{\frac{v^2}{2gl}}$ x 100

Where
SN=Skid Number
v =Velocity of the Vehicle
g = acceleration due to gravity
l = skid length

The value of skid number for different stretches were calculated by using a Tata Indica V2 car with kerb weight 1050 kg with Two Person are shown in Table 4.4. Normally for a Asphaltic surface skid no varies between 70 to 100. From the below observation it is found that surface friction lies in normal limit.

**Table 10:** Skid Number values of four stretches

| STRETCH | SKID LENGTH(mt) | SPEED KMPH | BRAKING | SKID NO |
|---|---|---|---|---|
| 1 | 8 | 40 | N | 77 |
| 2 | 11 | 50 | N | 87 |
| 3 | 13 | 60 | N | 106 |
| 4 | 12 | 50 | N | 80 |

## 5. Conclusions and recommendations

### 5.1 Conclusions

1. The available literatures on accident analysis indicate that 82 percent of road accidents in India are caused due to driver's error.
2. Heavy vehicles like truck are involved in maximum no of accident on two-lane roads. It is estimated that fatalities caused by truck is 59% followed by other (26%) and bike (7%) and jeep (5%) and bus (3%).Road safety awareness should be raised among road user.
3. Stretch IV has the highest no of accidents which accounts for 34.1% 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.
4. Stretch I have the second highest no of accidents accounts for 32.5% of total accident. The Accident rate can be reduced by providing signalized junction, junction improvement, and shoulder Clearance, installation of humps, shifting of poles, removal of trees near the edge of pavement etc.
5. No of accidents in stretch III accounts for 29.6% 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.
6. Stretch II has minimum no of accidents accounts for 3.7% of total accidents. Speed limit reduction near junction should be reduced to prevent accidents.

## 6. References


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