

A CASE STUDY OF ROAD ACCIDENTS IN ANDAMAN NICOBAR ISLANDS

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering degree in Civil Engineering

by

RITWIK SINGH (37200061)

K THIRUPATHI RAO (37200702)



**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

APRIL 2021



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www.sathyabama.ac.in



DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **RITWIK SINGH (Reg.No.37200061)** and **K THIRUPATHI RAO (Reg.No.37200702)** who carried out the project entitled "**A Case Study of Road Accidents in Andaman Nicobar Islands**" under my supervision from December 2020 to April 2021.

Internal Guide
(Mrs. M. Praba)

Head of the Department

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

We, RITWIK SINGH (Reg.No.37200061) and K THIRUPATHI RAO (Reg.No.37200702) hereby declare that the Project Report entitled “**A Case Study of Road Accidents in Andaman Nicobar Islands**” done by under the guidance of **Mrs. M. Praba**, M.E; at Sathyabama Institute of Science And Technology, Chennai is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

1.

2.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Road accidents are of almost inevitable occurrence all around the world and hence a result in loss of life and monetary resources. So, its prevention is of a foremost concern. To reduce the occurrences of the road accident. It is important to have an engineering as well as statistical based towards it. Andaman and Nicobar Islands is being a study area to study occurrences of the accidents and its characteristics and dependencies on the other factors. Here is a statistical model using regression analysis is built, which gained relationship between climatic condition i.e., precipitation and accidents while exponential smoothening method is used for the forecasting of future accidents which results in a rise in some cases while a decline in rest. The finding is checked up with geometric design of the pavement (existing) and recommendation are given as per as IRC codal provision.

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LIST OF SYMBOLS AND ABBREVIATIONS

ABBREVIATION	DESCRIPTION
WHO	World Health Organization
BAC	Blood Alcohol Count
NH	National Highway
SH	State Highway
SUV	Sports Utility Vehicle
PWD	Public Works Department
NHAI	National Highway Authority of India
NHIDCL	National Highway Development Corporation
NHDP	National Highway Development Project
ODR	Other District Roads
VR	Village Roads
%	Percentage
mm	Milimeters
Hrs.	Hours
km	Kilometer
f	Frequency
fx	Mid x Frequency
IRC	Indian Road Congress
SP	Special Publication
ETS	Exponential Smoothing
df	Degree of Freedom
ss	Sum of Squares
MS	Mean Square
F	F static

NOAA	National Oceanic and Atmospheric Administration
CID	Central Investigation Department
TMAX	Maximum Temperature
TMIN	Minimum Temperature
ANOVA	Analysis of Variance
st	smoothed statistic
α	smoothing factor
t	Time period
x1	Year 1
x2	Year2
y1	Accident Cases for year 1
y2	Accident Cases for year 2
x	Year 3
y	Accident cases in year 3
ϵ	Residual Error
Y	Dependent Variable
X	Independent Variable
a	Intercept
b	Slope

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Accident can be called as an unplanned event that leads to loss of property and life accidental deaths are classified as unnatural deaths for statistical purposes. Road accident are being the reason of carelessness of the road users, while being aware of the road safety and traffic regulations. By extensive research work, it is found that, the prime cause of road accidents as over speeding, distraction to the driver, drink and drive, avoiding traffic signals, not abiding with lane discipline and careless overtaking. Road accident-related injuries and deaths varies with gender, and time according to ongoing and carried out researches. There is no total prevention of road accidents, but can be reduced to a certain extent, requiring proper study of the various factors involved for the cause of accidents. It has been studied by the WHO (World Health Organization) that nearly 20 to 30 million of a country's injuries are of the road traffic accidents, which can be avoided by following basic road safety and traffic measures. Countries and cities differ in driving habits, data analysis can reveal, driver related issues, road related issues and other issues associated with it. Richness and authenticity of data and through understanding of issue and data can help building sustainable model for the prevention of it.

1.2 ACCIDENT STUDIES

Road accident poses a severe problem on roadways transportation system. These incurs a big loss over the property, life and productivity. Prevention of road accidents can be accomplished by suitable traffic engineering measures and organization of it. Hence a systematic study of traffic accidents needed to carried out, in this case. Appropriate information about the causes can help to propose the mitigatory measures in relations to design and regulation both.

Investigation of causes, suggestions regarding corrective measures, assessment of existing design, study of proposed design, providing economic explanation to the changes offered by the respective traffic engineer and to validate the improvements, includes as the objective of accidents studies.

The following are considered as the causes of road accidents -:

- I. Vehicle – Mechanical failures such as failure of steering wheel, brakes , engine and bursting of tyre.
- II. Road User - Violation of traffic regulations, absence of mind in traffic situations, reckless driving, fatigue and driving under influence of intoxicants.
- III. Road design parameters – Improper traffic regulatory devices (such as street furniture and traffic signal), lacking geometric features (such as inappropriate sight distance), inappropriate shoulder width and poor lighting on road and inside the tunnel.
- IV. Road conditions – ruts, friction and grip of the surface, slip and skid resistance, pot holes and drainage.
- V. Environmental factors – unreceptive weather such as heavy precipitation, snow, smog, smoke, fog and mist which hinders the perceptibility of the driver and causes road accidents.

At critical stretches of the roads, the periodic statistical study of accident can effectually decrease accident rates, it can be stated as the estimates of severity of the accidents and number of it. Accident density per length of the road, determining accident prone stretches about the road can be achieved with the help of a well-maintained zonal report.

At a specific location or zone across the street can withheld with the statistical analysis for prolonged period, making it possible to do accurate predictions for near as well as further future to reduce accident cases.

CHAPTER 2

LITERATURE REVIEW AND OBJECTIVE OF THE STUDY

2.1 GENERAL

The main purpose of literature review is to offer a thought about the research work conducted within the world. This forms the basis on which one can carry out the work and techniques that can be used for conducting experiments. The following literature review elaborates the research studies made on.

2.2 LITERATURE REVIEW

P. Pramada Valli (2005) has investigated and developed a model by examining the road accident data for major metropolitan cities at all India level. 25 years data dated from 1977 - 2000 were examined to model, and understand the characteristics to the degree of the cause of accidents by means of the concepts of Andresen's equation and Smeed's formula.

Dinesh Mohan (2009) has investigated and found that, how vehicle sales in India affects road traffic fatalities and the age, gender distribution of road traffic fatalities. For the reduction of road traffic injuries emphasis has to be laid by the Indian Policy. For availing the scientific evidence there is a crucial need for proper data collection and segregation.

Subhashish Das et.al (2020) performed the inclusion of speed and weather measures in safety performance function for rural roadways from this article we came to know the relation among vehicle working speed, roadways design elements weather and traffic volume on crash outcomes will greatly benefit the road safety profession in general. From this article we got an idea to develop a model.

Chaturaphat chantith et.al (2020) has measured the productivity loss due to road traffic accident. Thailand needs to raise public awareness about the economic loss due to road traffic accident in Thailand in 2017. By collection of widespread data and analysis enables to compute income losses over time in case of fatalities

permanent incapacities as well as major and minor injuries. The result exposed that at the end of 2017, the total amount of efficiency loss caused by road traffic accident alone was approximately 121 billion baht (45 billion for mortalities 7 for debilities 67.5 for stern injuries and 1.5 for small injuries). Also, they came to know that the danger age group 16-25 age group is bearing the highest problem in all types of accidents.

Gaurav Goel and S.N Sachdeva (2016) analyzed the road accidents on NH-1 between RDN98Km to 148 Km 2016 describing the features and trends of road accidents. The accident data which they collected contains the information like time, date, injury type, vehicle, persons deaths /Injury. Vehicles involved are probable cause of accidents. Based on the study of characteristics of the road accidents, suitable improvement measures are recommended to reduce the accident on the road. The analysis of road accident characteristics in this study includes their total number, nature of accidents, causes of accident, type of injury, type of vehicles involved and time of accident. Based on these features of accidents the analysis is carried in full section.

Dr. Sanjay Kumar Singh and Ashish Mishra (2000) has investigated about the issues and challenges related to the road accident occurrence patterns and causes across the country and metropolitan cities and concluded with statistical arguments about the spreading of it all over India.

Rune Elvik et.al (2019) investigated that with the help of negative binomial regression model, the grievous accidents on the road bridges in Norway is determined during a period of 2010 – 2016. 1368 accidents were found in the total of 6824 bridges. Majority of bridges doesn't record even a single accident, but it does not prove 'zero inflation' as cited. The quantity of accidents were influenced by traffic volume citing it as the most vital issue, 72 of the systematic variation were explained as variety of accident. The quantity of road accidents is proportional to that of traffic volume i.e., accidents / million vehicle kilometers decrease with increase in the traffic volume, hence showing inverse proportionality. Whereas shorter bridges are unsafe than longer bridges.

Saeed Lotfi et.al (2019) has conducted cross-sectional study on integration of all the previous analysis performed on death rate of road traffic accidents from March 21, 2013 to March 20, 2017 in Fars province. To disclose the relationships amongst the factors influencing mortality rates of road traffic accidents, information relating to road traffic accidents mined from resources like Legal medication Organization, Emergency Department & Accident Department and Department of Roads Development of Fars Province, after cleaning the applicable attributes are embedded within the information of all aggregate for any analysis. It's must, to be noted the information is not associated with Fars Province remained deleted, the information is analyzed, transformed and therefore the aggregation amongst varied attributes is known. The combination between this database is completely different attribute likewise because of the FP-growth formula and 2 indexes of support and confidence are calculated, therefore fascinating and effective are rules extracted. Subsequently numerous accident-creating factors, grade of successive interrelationship of each factors in road accidents is recognized and presented. The numerical analysis was conducted by Rapid Miner software.

Sandip Kumar et.al (2020) found that out of 654 road accidents, the majority is comprised with males rounding to 78% and mainly belong to rural areas, based upon hospital comparisons studies. Maximum No.s of accidents have occurred at evening hours rounding to 32.1% and in the month January as 25%. Whereas reducing trends are observed in pedestrian accident cases and for two – wheelers users.

Seidowsky Regine et.al (2015) has investigated that, a new update has been made up in the road operation model in the recent years. Highway networks have become congested, taking users to practice advanced road infrastructure use. Increased environmental needs for the property, have increased the demands of building sustained as well as optimized road networks. So, French motorways as a part of solution, it allowed traffic over the shoulders during the peak hours. Whereas certain amendments in regards with property development, preservation of natural settings and speed limits on the motorways were made. Despite of all the amendments and implementations a thorough study of the recent schemes is vital and identify what impact it has on the road safety and traffic.

Laura Eboli et.al (2020) has investigated that Increasing road accident occurrences are in high concern with the road safety issues. This study has objective to determine the characteristics that can affect the severity of an accident by distinguishing various types of accidents (front end collision, rear end collision). Different categories related to exterior environment, road and driver were grouped with the reference to the issues. She found out differences between the accident severity in the expression of the No.s of fatalities and injuries in relationship with factors influencing various types of crashes. Logistic regression method is utilized governing each influence in the study of accident severity. This study has drawn a conclusion upon logistic regression can be as an accomplished tool for delivering knowledge about the future safety developments in Italy.

Elena Kurakina et. Al (2020) presented a general approach to an efficient approach and crucial measures to confirm road safety. The need for a generalized approach to black spot inspection in traffic accidents is consistent. A general approach is being developed to check black spots in traffic accidents. This model includes interrelationships of sub-systems, factors inclined and causes for the occurrence of black spots of traffic accidents within the system "road user - vehicle - road - external environment". A hierarchy of interrelationships and flows within the system is usually recommended to ensure road safety.

Dr. Sanjay Kumar Singh (2017) analyzed that gender, age, time and month are the factors for variation in accidents related deaths and injuries. Extreme weather conditions and peak operating hours aggravates the road traffic accidents. The difference in risk of death scenario is shown at various states and cities in the country 16 out of 35 states have higher average fatalities than the national average. Traffic safety is found incremental all – over the developed and developing countries, but the case in India is reverse. Citizens of India may observe death of 250,000 due to accident by 2025. If no proper initiative are promoted for the road safety.

2.2 OBJECTIVES

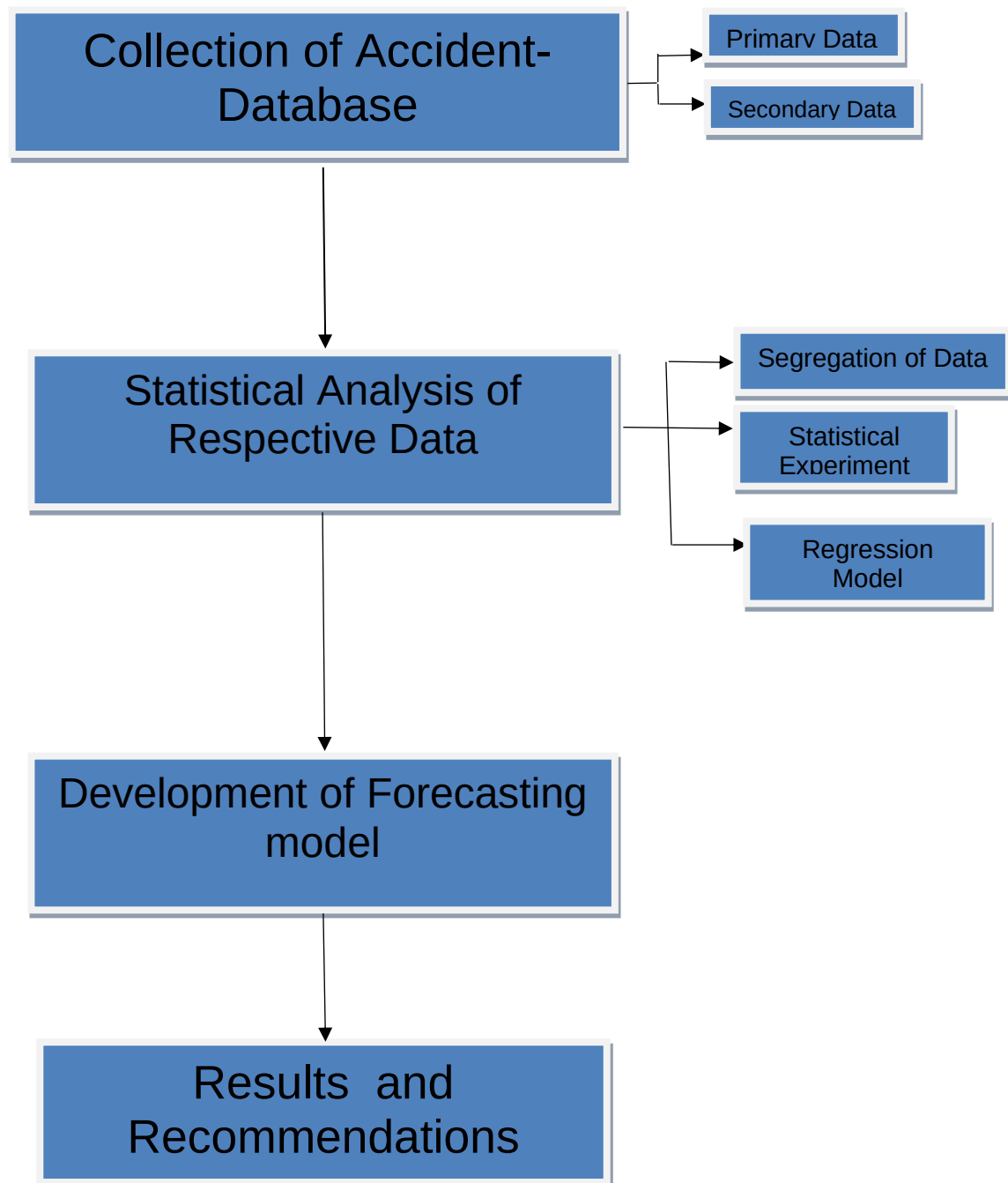
- I. To Develop a forecasting model, to help implementing traffic flow changes, traffic rules and other factor regarding the prevention of future accidents.
- II. To propose remedial measures for reduction of future accidents.

CHAPTER 3

METHODOLOGY

3.1 METHODOLOGY

To achieve the objective of the study the following methodology has been adopted in this project and it shown in fig 3.1



3.2 STUDY AREA

Andaman and Nicobar Islands (11.7401° N, 92.6586° E), is a union territory in India, is a grouped with 572 islands out of which 38 are with settlers at the interval of Andaman Sea and Bay of Bengal.

Island territory is separated from Thailand and Myanmar by the Andaman Sea and Aceh in Indonesia is North to it. It is comprised with two island group namely Andaman and Nicobar, Both the islands are separated by 150km wide 10-degree channel. With Andaman to the North and Nicobar to the south.

The total land cover of island is almost 8,249 sq.km. The territory is comprised with three districts: the Nicobar District has Car Nicobar as its capital, the South Andaman district has Port Blair as its capital and the North and Middle Andaman district has Mayabunder as its capital.

NH 4, is the chief highway in the Indian state of Andaman and Nicobar Islands. It is 230.7 km in length. This highway runs from the capital city Port Blair to Diglipur connecting all key towns of Ferrargunj, kadamtala, Bartang, Rangat, Billy Ground, Nimbudera, Mayabunder and Diglipur. This highway is recognized as the Andaman Trunk Road (The Great Andaman Trunk Road).

NH 4 has been a sustenance for the individuals of the Andaman Islands, particularly for those exist in in the North & Middle part of Andaman district. Prior to 1970s and early 1990s transportation of men and belongings used to carried by sea route which tiresome and slow and takes several days to reach the destination, now it can be completed in a matter of 10–12 hours. Hence easing the movement of indispensable commodities and health care facilities year-round.

The Highway passes over the barrier zone of the Jarawa Reserve amid Jirkatang to Middle Strait where rules are in to curtail traveler contact with the innate tribe of Jarawa. Vehicle with armed companions are only allowed in respective regions.

As per as the census of India 2011, the Andaman Nicobar Islands Union Territory has a population of 3,79,944 inhabitants and having 2,02,330 males which translate to nearly 53.25% of the total population and 1,77,614 which is nearly 46.75% of the population.



Fig 3.1: NH4 in Red in respective map

Previously this length of highway was nomenclature as NH-223. A length of national highway, Mumbai -Pune - Hubli -Bangalore - Chennai was known to be NH 4 before numbering in 2010.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 DATA COLLECTION

The road accident data collection involved the collection of the data regarding the classification such as place of occurrence, time of occurrence, month of occurrence, injuries and fatalities due road accidents, type of road wise occurrence of road accidents, cause of accidents and mode of transport used.

With courtesy to Andaman Nicobar Police CID (Central Investigation Department) the database for the road accidents is obtained. It is a comprehensive database for 5 years (2015 -2019) recording the place of road accident, time of road accident, type of vehicle involved, injuries as well as fatalities due to it.

4.1.1 DATABASE OF INJURIES AND FATALITIES

Road traffic accidents are the foremost cause of injuries, accounting for the highest proportion of deaths from unintentional injuries. They are the principal cause of injury-related disability-adjusted life years, and they pose a significant economic and societal burden. Disdain this problem, RTIs remain a largely abandoned public health problem, particularly in low- and middle-income countries, where urbanization and motorization is swiftly increasing. According to WHO (World Health Organization) Every year the lives of around 1.35 million people are died because of a road traffic crash. Between 20 and 50 million additional people suffer non-fatal injuries, with many experiencing a disability because of their injury. Road traffic injuries cause substantial economic loss to the individuals, their families, and to nations. These losses ascend from cost of treatment along with lost productivity for those died or disabled by their injuries. Traffic crashes cost most countries 3% of their gross domestic product.

Table 4.1: Shows Total No. of Accident cases, injuries, and deaths for year 2015 -2019

Year	Road Accidents		
	Cases	Injured	Died
2015	258	225	23
2016	238	230	17
2017	189	175	21
2018	254	247	19
2019	230	223	20

From the following table one can observe that there are 1169 No. s total road accident cases, 1100 injuries and 100 fatalities. The total No. s of the injuries constitute 95% of the total accident cases while total No. s of fatalities constitutes 8.5% of the total cases.

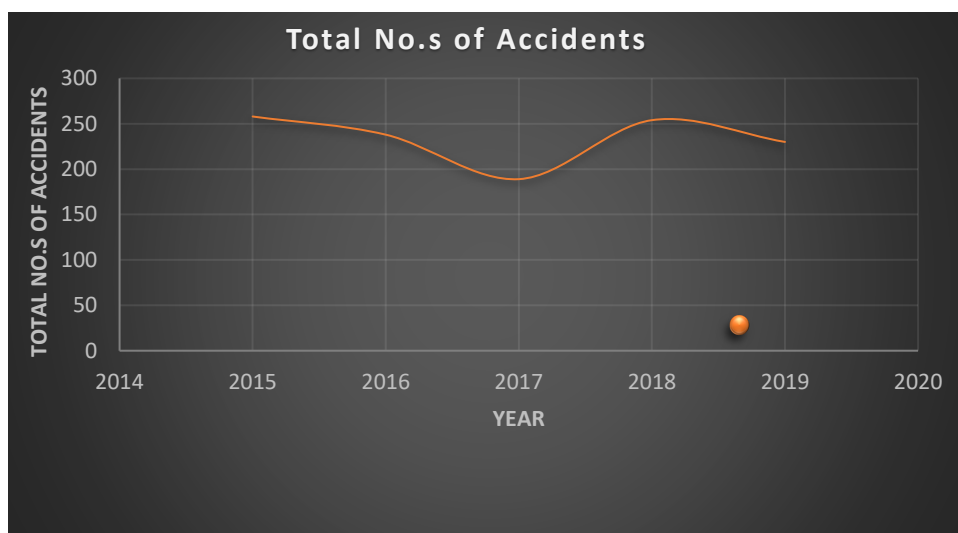


Fig 4.1 :- X, Y Scatter line graph depicting the variation in road accidents for year 2015 – 2019

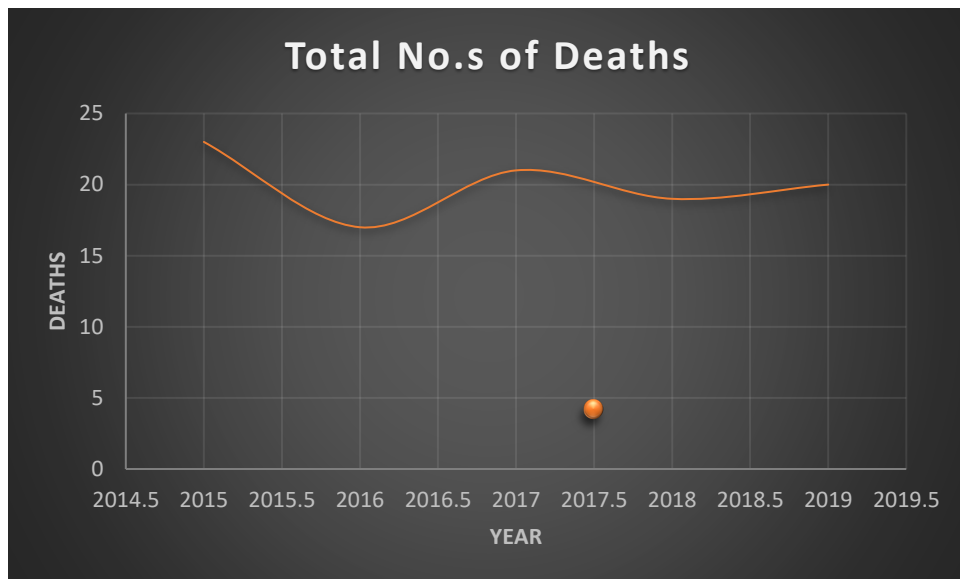


Fig 4.2 :- X, Y Scatter line graph depicting the variation in death due to road accidents for year 2015 – 2019

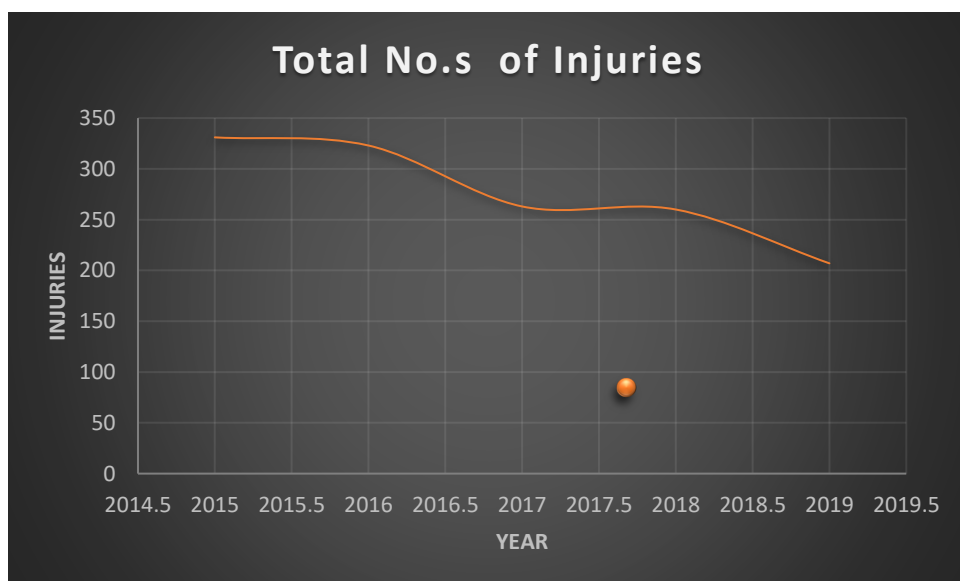


Fig 4.3 :- X, Y Scatter line graph depicting the variation in Injuries due to road accidents for year 2015 – 2019

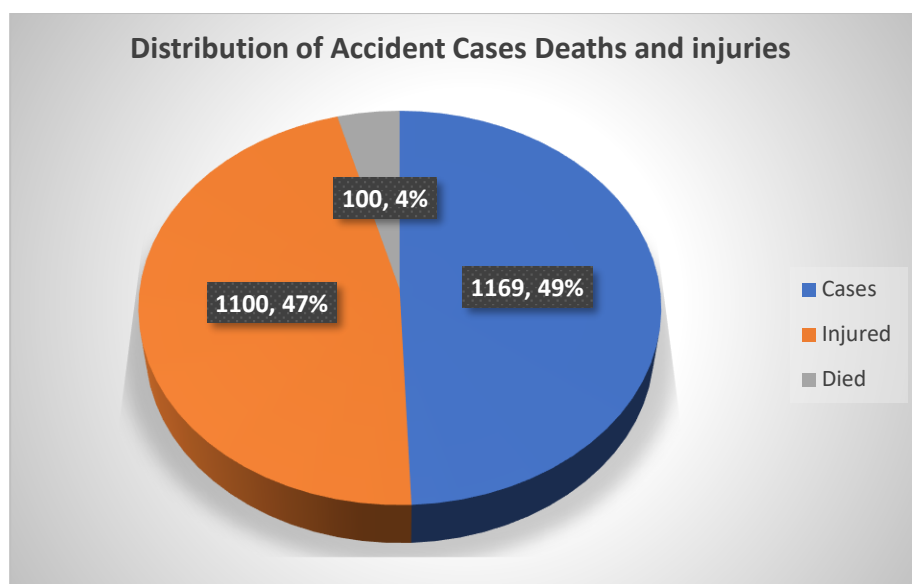


Fig 4.4 :- Pie chart depicting the distribution of total No. s of road accident cases, injuries, and deaths for year 2015 – 2019

From Fig 4.1, 4.2, 4.3 and 4.4, the total No. s of accidents occurred year 2017 is the lowest (189), while in year 2015 being highest as 258. The No. s of deaths were highest in the year 2015 as 23, Whereas lowest in the year 2016 as 17. The No. s of Injuries is highest in the year 2018 as 247 and lowest in the year 2017 as 175 respectively.

4.1.2: DATABASE OF CAUSES OF ROAD ACCIDENTS

The respective database contains the total No. s of the accidents, Injuries due to accidents and fatalities due to it, by mentioned causes such as careless driving, over speeding, driving under influence, animal crossing, lack of infrastructure and unknown causes.

Careless driving denotes to fail to driving a motor vehicle in a careful and cautious manner. careless driving is inadvertent, but nonetheless the driver presented a hazard to other drivers and pedestrians. careless driving can be considered as follows; unlawful lane changes, drivers holding mobile phones, falling asleep while driving, drivers not obeying signals and disobeying traffic signs.

Over speeding can be considered as when the motorist exceeds the designed speed limit. Which can indeed result in a road accident.

Driving under the influence (DUI) is the transgression of driving, functioning, being in control of a vehicle while weakened by alcohol or other drugs, to an extent that reduces the driver unable of operating a motor vehicle carefully. In India, the allowable blood alcohol content (BAC) is set at 0.03% /100ml blood. That meant to be 30mg of alcohol per 100 ml of blood, if the motorist fails to meet the following limit, he/she would be under the offence of violating the section 185 of the Motor Vehicles Act 1988.

Accidents due to animal crossing occurs due to the intervention of the stray animals on the pavement by distracting the motorist. The causes of accidents due animal crossing can be summed up as follows; Distracted driving is the key reason for how these accidents happen. A motorist is distracted driving, being unprepared for the upcoming animal intervention; Overreaction tends to happen in the situations like this. They may spin steering wheel out of control or hit a nearby car. Sometimes a driver's vision is weakened because of the weather. Making it difficult to understand that an animal might be on the street in front of them. Therefore, causing an accident.

Lack of infrastructure can be measured as the cause of the road accidents due to lack of geometric and safety features on the roadways, such as elimination of traffic islands at the intersections, undivided roads (roads without medians) and roads without pedestrian facilities.

While certain causes of the road accidents can be combination of above-mentioned causes or can apart from theses terming unknown causes of accidents.

Table: 4.2 (a) and 4.2 (b) showing the total No. s of Road accidents, injuries and deaths due to respective causes

Table: 4.2(a)

year	Careless Driving / Overtaking			Over Speeding			Driving Under Influence		
	Accidents	Injuries	Deaths	Accident	Injuries	Deaths	Accidents	Injuries	Deaths
2015	95	163	8	108	131	14	30	23	0
2016	79	117	2	124	151	13	27	33	0
2017	18	19	1	133	208	15	13	12	2
2018	16	11	1	153	160	7	20	19	0
2019	96	130	8	40	178	3	41	36	1

Table: 4.2(b)

year	Animal Crossing			Lack of Road Infrastructure			Causes Not Known		
	Accident	Injuries	Deaths	Accidents	Injuries	Deaths	Accident	Injuries	Deaths
2015	4	4	0	4	2	1	14	5	0
2016	1	1	1	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0

From the following table one can observe that the maximum No. s of accident cases are due to over speeding which is 558, while maximum No.s of injuries are due to over speeding which is 828 , while maximum No.s of fatalities are due to over speeding which is 52.

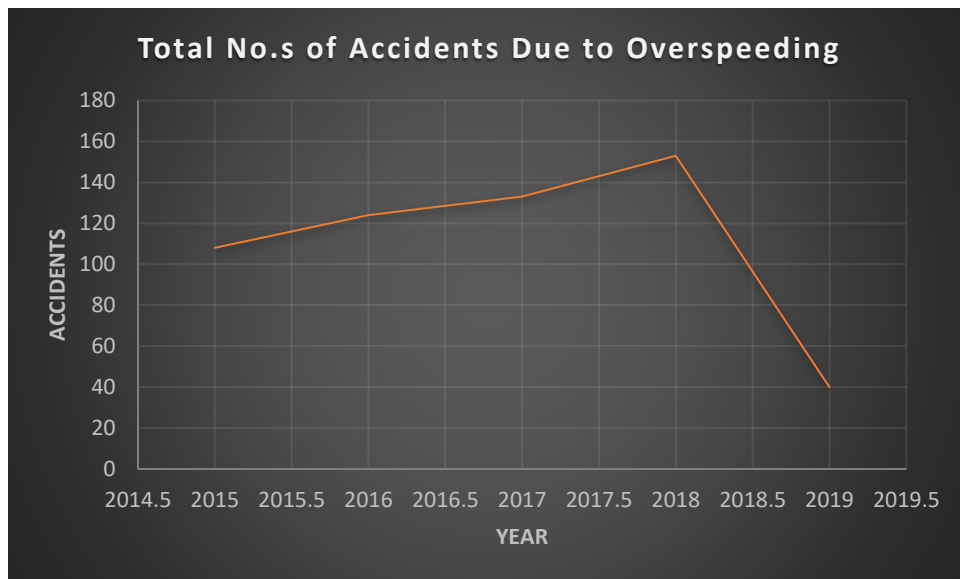


Fig 4.5: X, Y Scattered line graph showing total No. s of Accidents due to Over Speeding

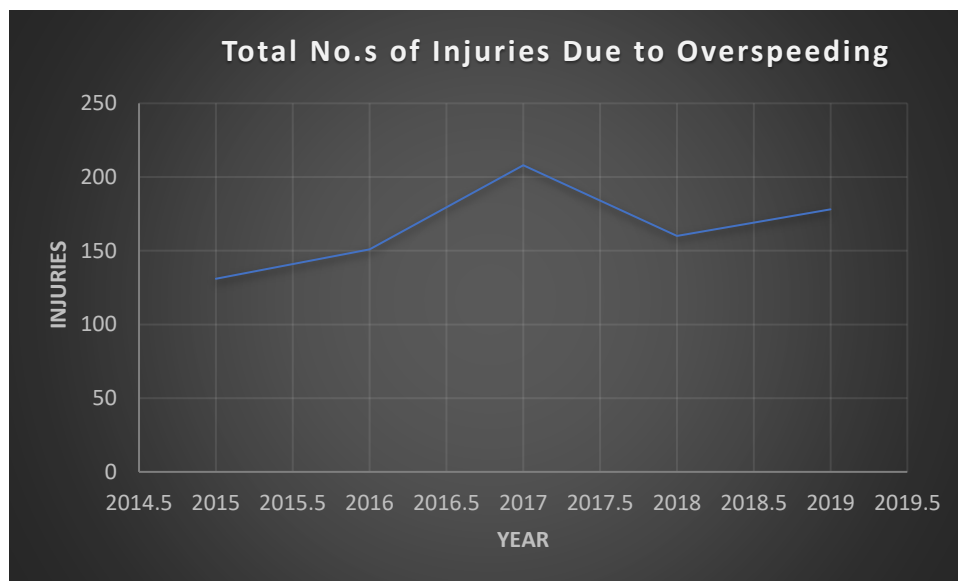


Fig 4.6: X, Y Scattered line graph total No. s of Injuries due to Over Speeding

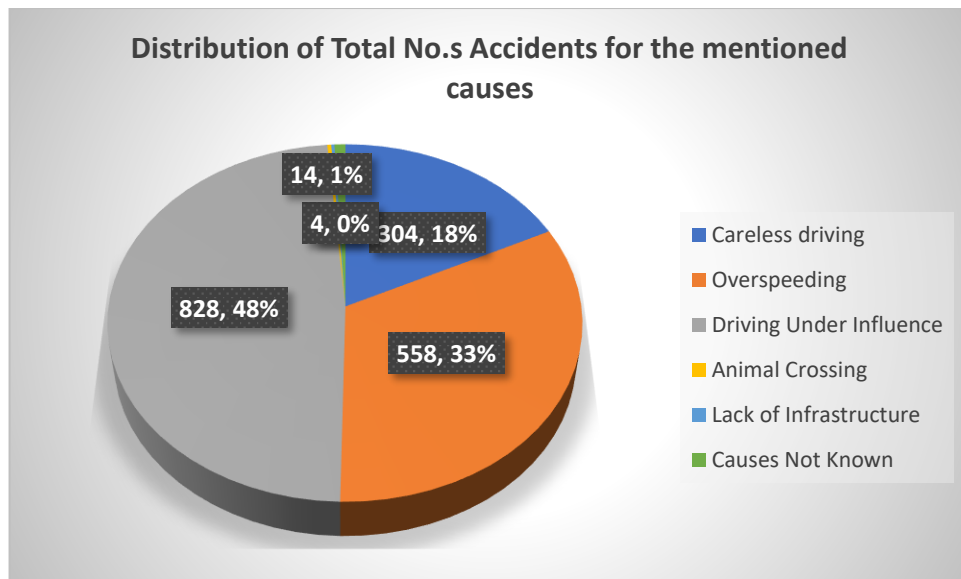


Fig 4.7 :- Pie chart depicting the distribution of total No. s of road accident cases for the mentioned causes

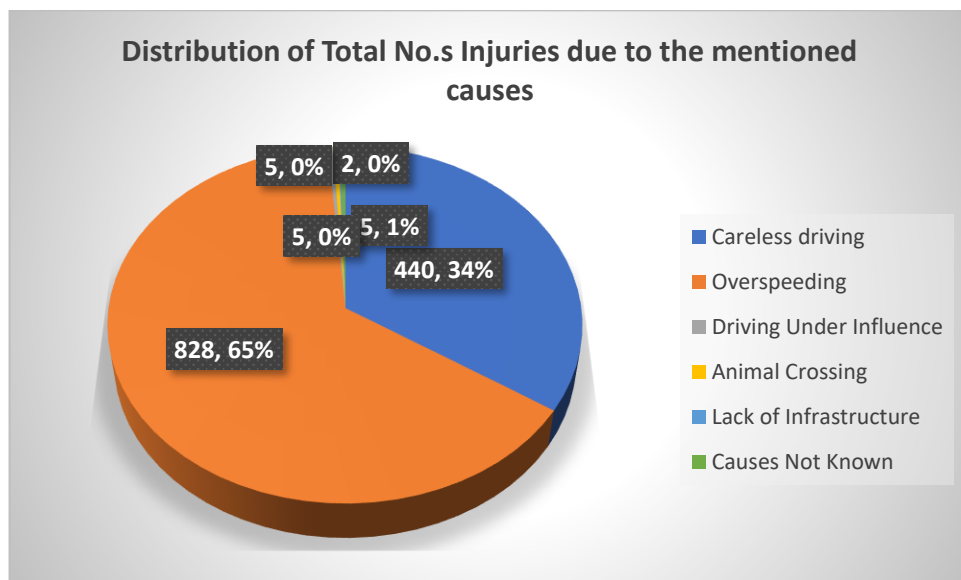


Fig 4.8 :- Pie chart depicting the distribution of total No. s of injuries due to the mentioned causes

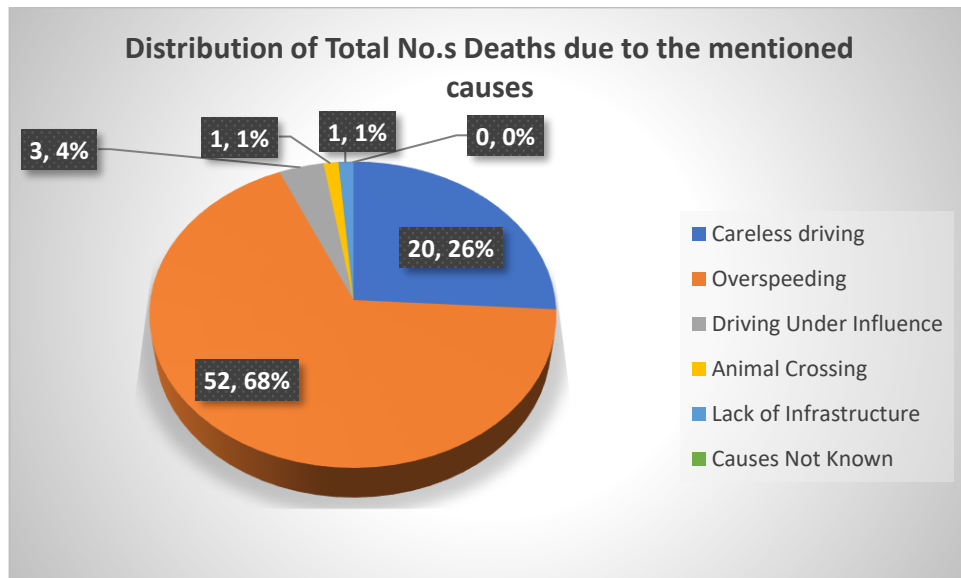


Fig 4.9:- Pie chart depicting the distribution of total No. s of fatalities due the mentioned causes

From Fig 4.5, 4.6, 4.7 ,4.8 and 4.9 the total No. s of accidents due to over speeding were highest in the year 2018 as 153 and lowest in the year 2019 as 40. Total No. s of injuries due to over speeding is highest in the year 2017 as 208 and lowest in the year 2015 as 131. Highest No. s of accidents are by the causes of over speeding (828, 48%). Highest No. s of injuries are due to over speeding as (828, 65%). Highest No. s of fatalities are due to over speeding (52, 65%) respectively.

4.1.3: DATABASE BASED UPON TYPE OF ROAD

This classification includes the various types of roadways that present in the study area, stating total No. s of accidents cases, total No. s of injuries due accidents and fatalities due accidents.

The classification is generally divided into three type namely NH (National Highway), SH (State Highway) and Other Roads (includes-: Rural Roads, District Roads and Arterial Roads).

A network of trunk or system of trunk roads in India, which connects state and national capital and other major cities, is known as National Highway (NH). These road networks are managed and developed by, Public Works Department (PWD), NHAI (National Highway Authority of India) and National Highway and Infrastructure Development Corporation Limited (NHIDCL). NHAI (National Highway Authority of India) is an Institution which governs the development and maintenance of the national highways. It functions below MORTH (Ministry of Road Transport and Highway). The operation and toll collection of the NH is undertooked by the authority having a public-private partnership.

State government undertakes the sustenance and development of state highways. Public works department carries out management and construction of these roads. State Highways are the network of roads which comprises the links between the important cities, districts and towns within the state or union territory and with the National Highways within the neighboring states.

(ODR) Other District Roads, these are roads helping rural areas and providing them with channels to market centers, block development headquarters or major district roads. They link villages with a population of 1000 and above.

Village Roads (VR), these connect villages or a bunch of villages with each other and with the nearest road of a advanced category.

Table: 4.3 showing total No. of accidents, injuries due to accidents and fatalities for the respective type of road

Year	National Highway			State Highway			Other Roads		
	Accidents	Injuries	Deaths	Accidents	Injuries	Deaths	Accidents	Injuries	Deaths
2015	96	119	4	32	40	5	130	172	14
2016	54	100	5	24	38	2	160	185	10
2017	60	123	7	50	45	9	79	95	5
2018	93	98	8	101	99	6	60	63	5
2019	71	74	7	68	56	5	91	77	8

From the following table one can observe that other roads have the highest No. s of cases, Injuries and Fatalities 520, 592, 42 respectively

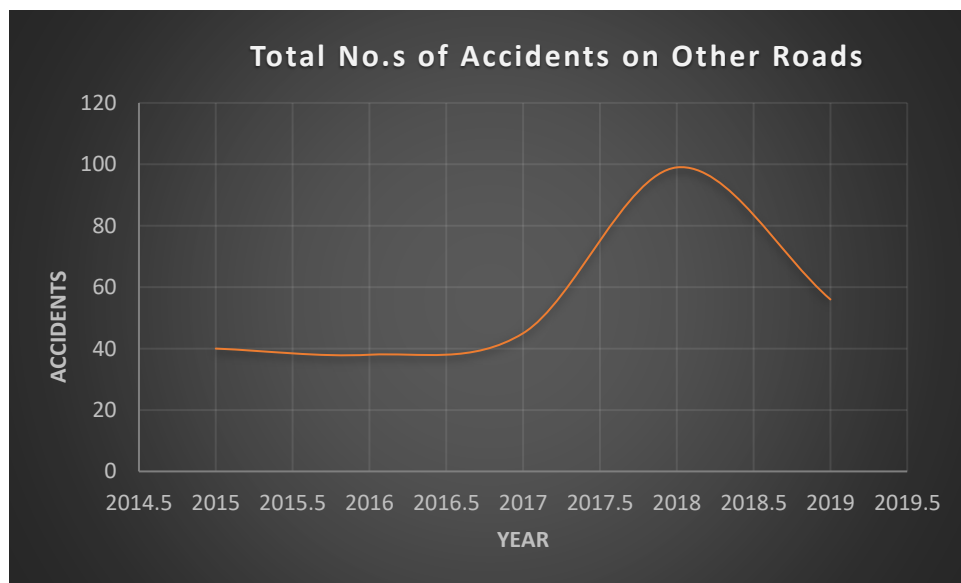


Fig 4.10 :- X, Y Scattered Graph Depicting Total No. s of Accidents occurred on other Roads

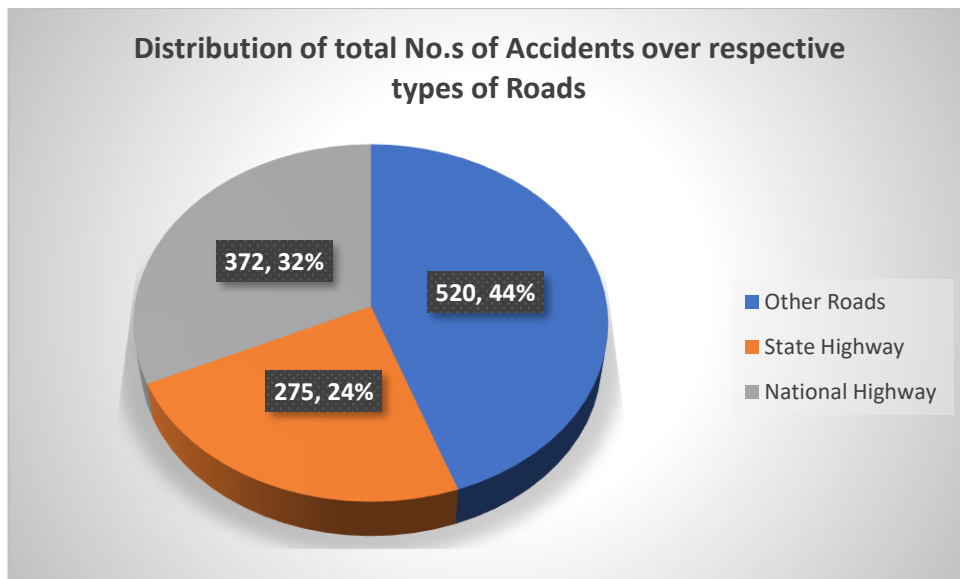


Fig 4.11 :- Pie chart depicting the distribution of total No. s of accidents over respective types of roads

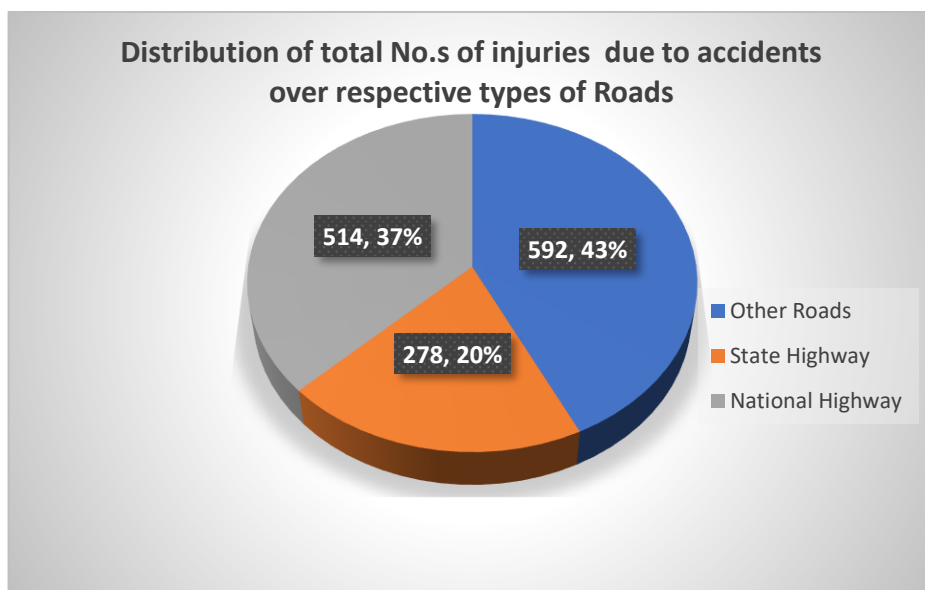


Fig 4.12 :- Pie chart depicting the distribution of total No. s of Injuries due to accidents over respective types of roads

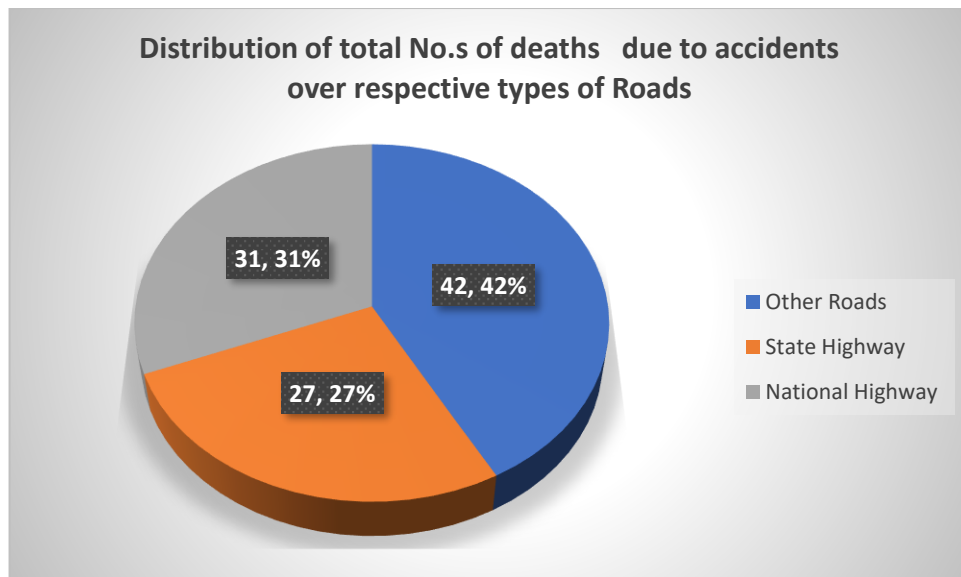


Fig 4.13 :- Pie chart depicting the distribution of total No. s of fatalities due to accidents over respective types of roads

From Fig 4.10, 4.11, 4.12 and 4.13, the total No. s of accidents on the other roads in 2018 is highest being 99 and lowest in the year 2016 as 38. The highest No. s of accidents have been occurred on the other roads (540, 44%). The highest No. s of injuries have been occurred on the other roads (592, 43%) and the highest No. s of deaths have occurred on the other roads from year 2015 -2019 respectively.

4.1.4: DATABASE BASED MODE OF TRANSPORT USED

This type of database includes all the vehicle and mode of transport used by the road user in order to commute.

A truck or lorry is a vehicle designed to move cargo. Trucks vary greatly in size, power, and configuration. Smaller varieties is also mechanically the same as some automobiles. Business trucks may be enormously giant and powerful and should be organized to be mounted with specialized equipment, such as within the case of refuse trucks, hearth trucks, concrete mixers, and suction

A bus could be a road vehicle designed to hold several passengers. Buses will have

a capability as high as three hundred passengers. the foremost common sort is that the single-deck rigid bus, with larger masses carried by public transport and articulated buses, and smaller masses carried by minibuses whereas coaches are used for longer-distance services.

A car which has the capability of going off – road (on a rough or hilly terrain) as well as can be utilized as a passenger car is known as SUV (Sports Utility Vehicle), it has a higher ground clearance and four-wheel drive like features for off – roading purposes.

A tractor is associate degree engineering vehicle specifically designed to deliver a high friction effort (or torque) at slow speeds, for the needs of trucking a trailer or machinery cherish that utilized in agriculture, mining or construction. Most commonly, the term is employed to explain a farm vehicle that has the power and traction to mechanize agricultural tasks, particularly (and originally) tillage, however these days an excellent type of tasks. Agricultural implements is also towed behind or mounted on the tractor, and also the tractor can also offer a source of power if the implement is mechanized.

Two Wheelers are motorized which are either electrically powered or contains an engine that includes bikes, scooters and mopeds.

Road users moving point to point (travelling) on foot or by walking is known as pedestrian.

Table 4.4 (a, b, c): shows the total No. s of accidents occurred by the respective modes of transport

Table: 4.4(a)

Year	Truck/Lorry	Bus	SUV/Station Wagon
	Accidents	Accidents	Accidents
2015	6	3	1
2016	2	2	0
2017	6	0	0
2018	5	4	1
2019	0	1	0

Table: 4.4(b)

Year	Car	Jeep	Tractor
	Accidents	Accidents	Accidents
2015	1	1	1
2016	0	0	0
2017	5	2	1
2018	0	3	0
2019	0	0	0

Table: 4.4(C)

Year	Three-Wheeler/Auto - Rickshaw	Two - Wheeler	Pedestrian
	Accidents	Accidents	Accidents
2015	1	9	0
2016	2	11	0
2017	0	7	0
2018	1	5	0
2019	0	13	6

From above drawn one can infer that maximum of accident cases are due to the use of Two – Wheelers which is 45.

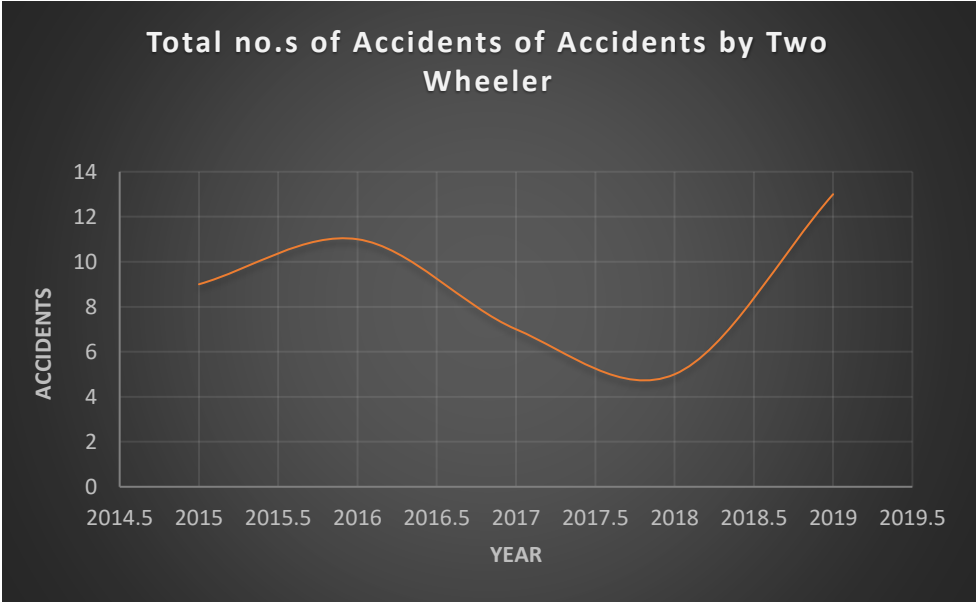


Fig 4.14:- X, Y Scattered Line Graph Depicting Total No. s of Accidents Occurred Due to Two – Wheelers

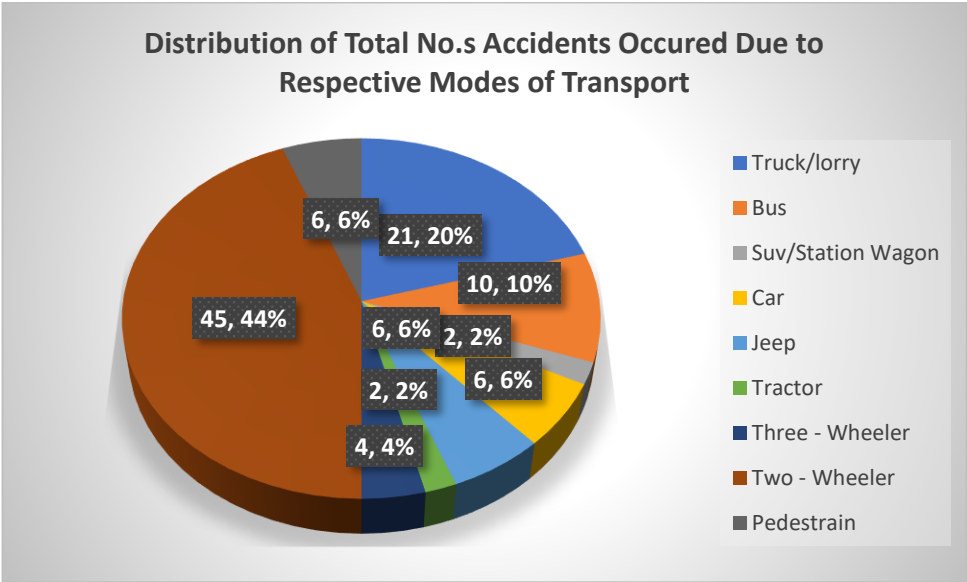


Fig 4.15 :- Pie chart depicting the distribution of total No. s of accidents due to respective modes of transport

From Fig 4.14 and Fig 4.15, the highest No. s of accidents from two - wheelers occurred in the year 2019 as 13, while lowest in the year 2018 as 5 . The maximum No. s of cases have occurred from the Two – wheelers (45, 44%) from 2015 -2019 respectively.

4.1.5: DATABASE CLASSIFIED BASED UPON PLACE OF OCCURRENCE

This type of database contains total No. s of accidents occurred at various place in the study namely classified as rural area (near educational institutions), rural area (near residential area), rural area (near religious place), urban area (near educational institutions), urban area (near residential area), urban area (Nr. religious place) and urban area (Nr. recreational place).

Table 4.5(a, b, c, d and e): showing total No. s of accidents occurred over the respective places

Table: 4.5(a)

Year	Rural Area (Nr. Educational Institution)	Rural Area (Nr. Residential Area)
	Accidents	Accidents
2015	0	9
2016	0	1
2017	0	9
2018	2	5
2019	1	5

Table: 4.5(b)

Year	Rural Area (Religious Place)	Rural Area (Near Recreation Place/ Cinema Hall)
	Accidents	Accidents
2015	0	1
2016	1	0
2017	0	0
2018	1	0
2019	1	0

Table: 4.5(c)

Year	Urban Area (Near School/College /Educational Institution)	Urban Area (Near Residential Area)
	Accidents	Accidents
2015	0	8
2016	1	2
2017	2	3
2018	1	2
2019	2	3

Table: 4.5 (d)

Year	Urban Area (Near Residential Area)	Urban Area (Near Religious Place)
	Accidents	Accidents
2015	8	1
2016	2	1
2017	3	1
2018	2	1
2019	3	1

Table: 4.5(e)

Year	Urban Area (Recreation Place/Cinema hall)
	Accidents
2015	2
2016	0
2017	0
2018	0
2019	0

From the above-mentioned table one can infer that maximum No. s of accidents are occurred in Rural Area (Nr Residential Area) which is 29.

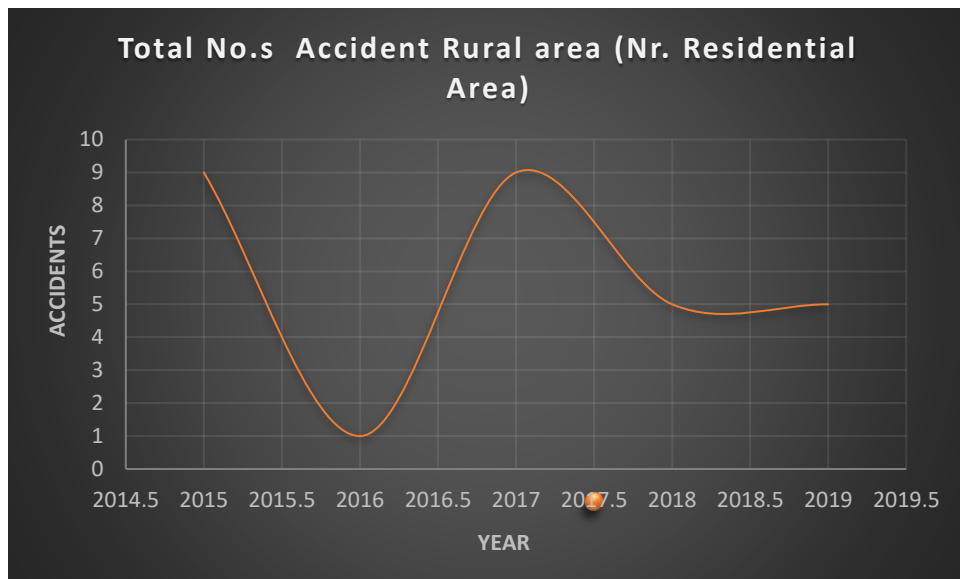


Fig 4.16:- X, Y Scattered Line Graph Depicting total No.s of Accidents Occurred Rural Area (Nr Residential Area)

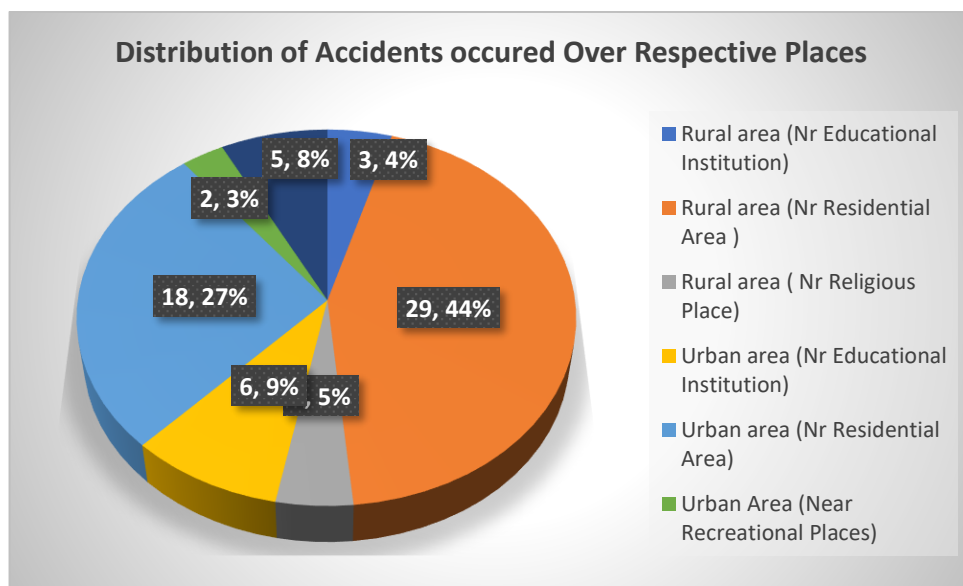


Fig 4.17 :- Pie chart depicting the distribution of total No. s of accidents occurred at respective places

From Fig 4.16 and 4.17, the maximum No. s of cases occurred in the year 2015 as 9 in the residential areas within the proximity of rural area. Whereas Rural area (Nr residential area) has maximum No. s of cases of accidents (29, 44%).

4.1.6: MONTHLY ACCIDENT DATA BASE

This database contains accidents occurred over the month of January to December for the year of 2015 – 2019.

Table 4.6 (a, b): Shows total No's of Accidents occurred over the month of January to December for year 2015 -2019

Table: 4.6(a)

Year	Jan	Feb	Mar	Apr	May	Jun
2015	27	23	23	17	25	26
2016	19	15	23	24	25	13
2017	22	21	12	17	10	16
2018	21	27	17	18	21	14
2019	17	14	29	25	14	23

Table: 4.6(b)

Year	Jul	Aug	Sep	Oct	Nov	Dec
2015	18	15	26	15	23	20
2016	19	26	19	15	21	19
2017	9	17	15	17	20	13
2018	22	32	15	26	20	21
2019	22	14	15	18	20	19

One can infer from the above drawn table that maximum No. s of accidents have occurred in the month of January that is 106.

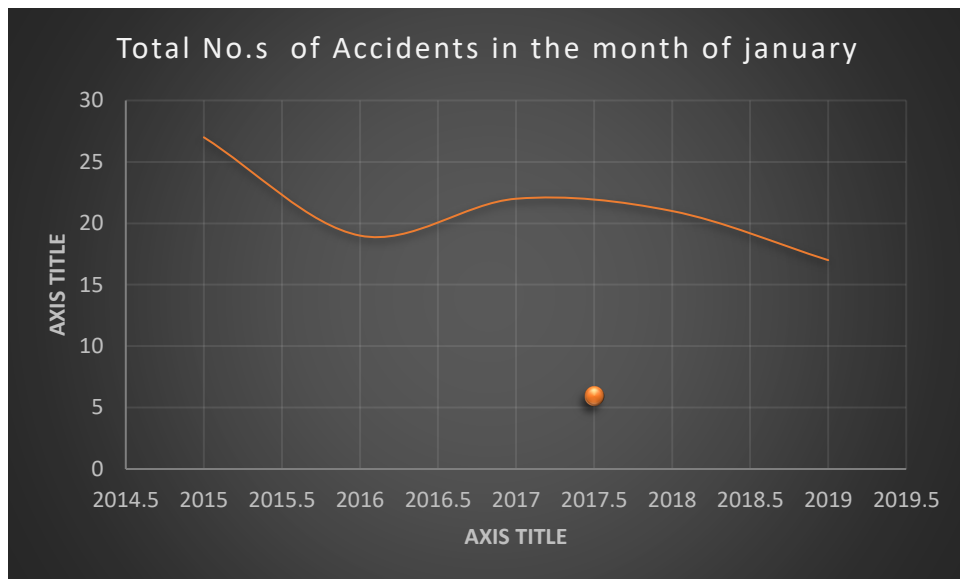


Fig 4.18:- X, Y Scattered Line Graph Depicting Total No. s of Accidents Over the Month of January – December 2015 -2019

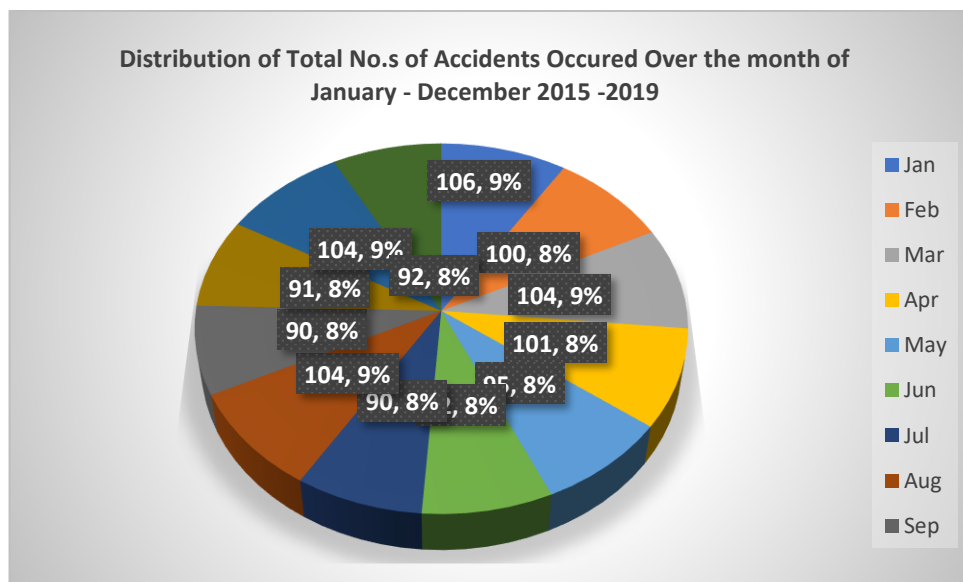


Fig 4.19 :- Pie chart depicting the distribution of total No. s occurred over the month of January – December 2015 -2019

From Fig 4.18 and 4.19, the total No. s of accidents occurred in the month of January is highest in the year 2015 as 27 and from year 2015 – 2019 has the highest No.s of occurred in the month of January as (106,9%) .

4.1.7: TIME OF OCCURRENCE WISE ACCIDENT DATABASE

In the following database accidents occurred over the time of 0000 hrs. – 2400 hrs. are present for the year of 2015 – 2019.

Table 4.7(a, b, c): shows the total No. s of accidents occurred at time of 000hrs. – 2400 hrs. over for the year 2015 – 2019

Table: 4.7(a)

Year	0000 hrs. - 0300 hrs.	0300 hrs. - 0600 hrs.	0600 hrs. - 0900 hrs.
2015	1	3	25
2016	8	9	29
2017	3	7	20
2018	6	10	35
2019	9	3	26

Table: 4.7(b)

Year	0900 hrs. - 1200 hrs.	1200 hrs. - 1500 hrs.	1500 hrs. - 1800 hrs.
2015	45	39	48
2016	34	49	52
2017	27	33	41
2018	38	40	48
2019	39	42	43

Table: 4.7(c)

Year	1800 hrs. - 2100 hrs.	2100 hrs. - 2400 hrs.
2015	57	36
2016	40	17
2017	39	19
2018	52	25
2019	42	26

From the above drawn table one can infer that maximum No. s of accidents have occurred over time of 1500 hrs. – 1800 hrs. which is 232.

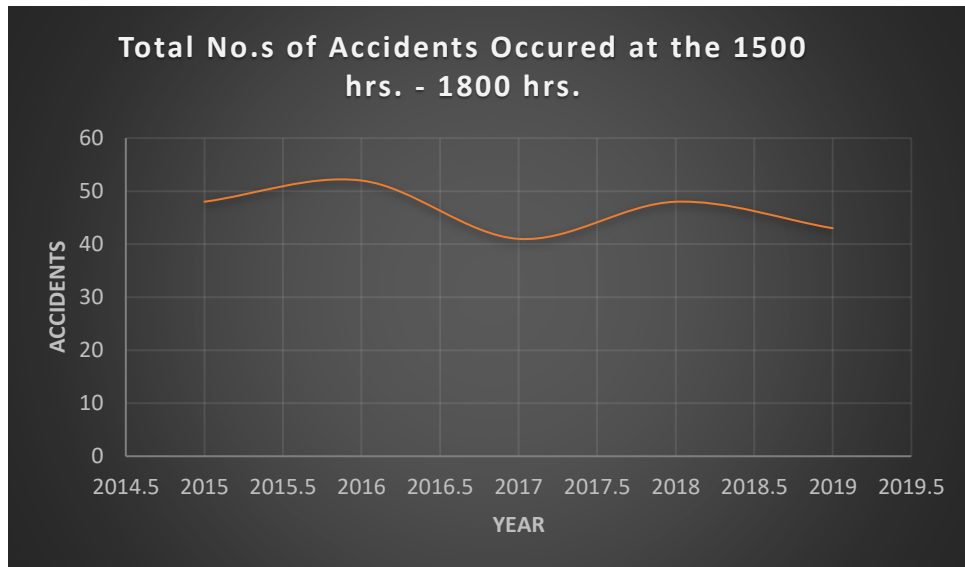


Fig 4.20 :- X, Y Scattered Line Graph Depicting Total No. s of Accidents at the time 1800 hrs. – 2100 hrs. from 2015 -2019

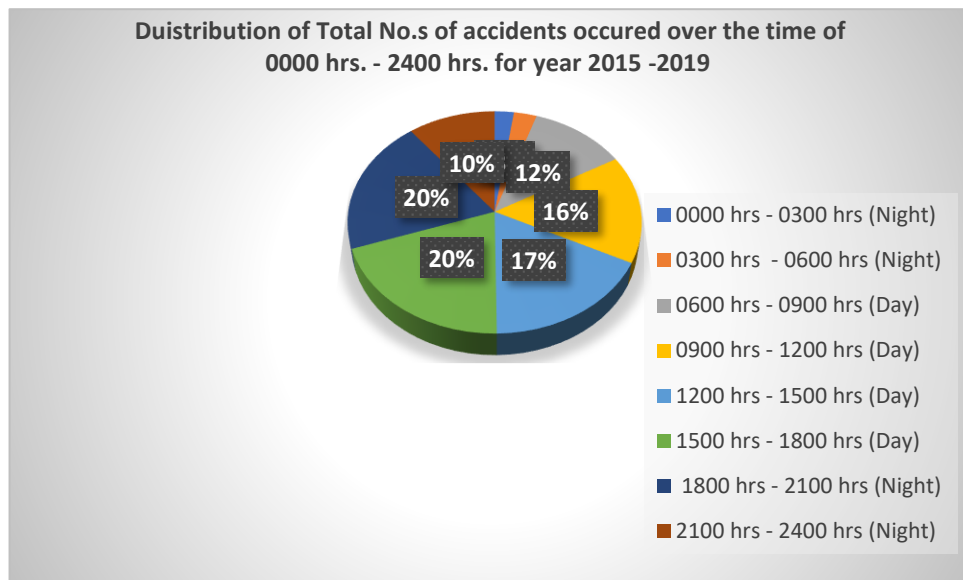


Fig 4.21 :- Pie chart depicting the distribution of total No. s Accidents occurred at time 0000 hrs. - 2400 hrs. from 2015 -2019

From Fig 4.20 and 4.21, the total No. s of accidents occurred at the time 1500 hrs. – 1800 hrs. is highest in year 2016 as 52 and lowest in the year 2017 as 41. Whereas the time period of 1500 – 1800 hrs. concedes highest No. s accidents 20% of the total No.s of accidents occurred at various times from year 2015 – 2019 respectively.

4.2: COLLECTION OF PRIMARY DATA:

Primary data are the database which are collected by virtue physical observation or experimentation, in this case the primary data collected is the spot speed survey data and the geometric features of the pavement.

4.2.1 SPOT SPEED SURVEY:

Over a short distance the measurement of a traffic parameter is accomplished by spot speed survey. Spot speed is includes measurement of individual vehicle speed of a particular (sample) vehicle passing the respective spot on the road. To determine the speed distribution of a traffic stream at a particular location, spot speed study is conducted. Vehicle speed percentiles are found as a result of spot speed survey and can be used for decision making in relations to speed limit and design speeds.

Following are the applications of spot speed survey

- I. Traffic control and planning.
- II. Speed Trends.
- III. Geometric Design.
- IV. Accident studies.

Methodology for Spot Speed Study

This method, comprises of markings on pavement placed crossways to the pavement at ends of the either sides. Observer has to start or stops the watch as soon as vehicle moves through the lines. The respective method, requires at least two observers to gather the data, one of which is at the starting point for start as well as stop the stop watch and other one is at end of the point to give signal for stopping the watch when vehicle moves through the end line.

Data Presentation

Frequency Distribution Table

Since the data is collected as per the prescribed conditions, arranging spot speed values in accordance to their extents is accomplished. Thereby the data is selected for an interval speed and grouping of data has been made based upon the considered range. Now, the frequency distribution table is prepared.

Frequency Distribution Curve

The percentage frequency of observations for each speed group inside the group is plotted versus the mid speed of the group. Pace of traffic flow and the modal speed can be determined using this curve. Since very few diverges from mean speed and maximum of them moves near the mean speed, this curve shapes up as anormal distribution curve.

Cumulative Frequency Distribution Curve

For every speed group, the percent cumulative frequency of observations is premeditated versus the upper limit of the speed group. Because of the plot, the upper limit of speed group is considered. The distribution curve has the point connected by a smooth curve reducing the distance between the points falling below and above the line.

LOCATION: GARACHARAMA
 WEATHER: CLOUDY DAY
 TYPE OF ROAD: NH 4
 MEASUREMENT TECHNIQUE: MANUAL

DATE: 17-02-20
 TIME: 2:30 - 6:30 PM
 BASE LENGTH: 50m
 VEHICLE: 50 BUSES

Table 4.8: Frequency Distribution table for the buses

Speed Range	Mid Speed (Kmph)	Frequency, f	Frequency, %	Cumulative Frequency	Cumulative Frequency, %	fx
0 -10	5	0	0	0	0	0
10-20	15	0	0	0	0	0
20 -30	25	0	0	0	0	0
30 - 40	35	0	0	0	0	0
40 -50	45	21	42	21	42	945
50 -60	55	19	38	40	80	1045
60 -70	65	8	16	48	96	520
70 -80	75	2	0	50	100	150
80 -90	85	0	0	50	100	0
90 -100	95	0	0	50	100	0
100 -110	105	0	0	50	100	0
	Total	50			Total	2260

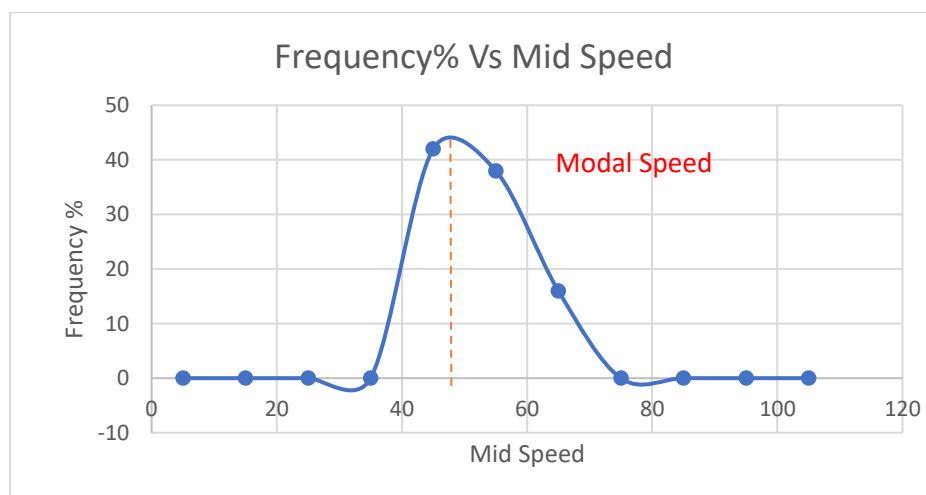


Fig 4.22: Frequency Distribution Curve For the following spot Speed Data

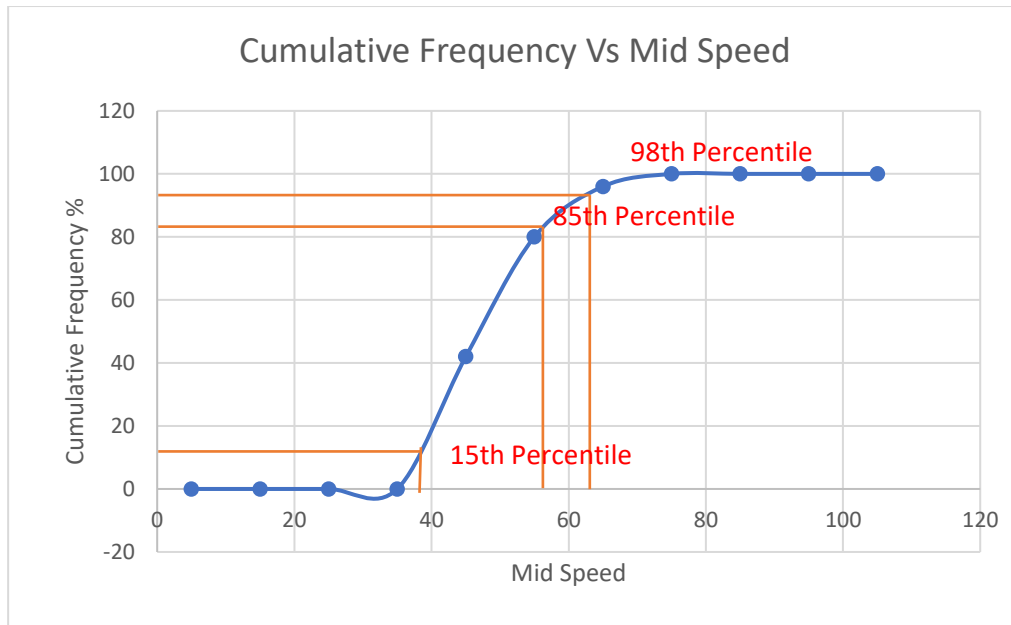


Fig 4.23: Cumulative Frequency Distribution Curve For the following spot Speed Data

Observation from the study -:

Upper Speed – 85th percentile = 55 km/hr.

Lower Speed – 15th Percentile = 38 Km/hr.

Design Speed – 98th Percentile = 65 Km/hr.

Average Bus Speed = 45.2 Km/h

LOCATION: GARACHARAMA

WEATHER: CLOUDY DAY

TYPE OF ROAD: NH 4

MEASUREMENT TECHNIQUE: MANUAL

DATE: 17-02-20

TIME: 2:30 - 6:30 PM

BASE LENGTH: 50m

VEHICLE: 50 CARS

Table 4.9: Frequency Distribution table for the car

Speed Range	Mid Speed (Kmph)	Frequency, f	Frequency, %	Cumulative Frequency	Cumulative Frequency, %	fx
0 -10	5	0	0	0	0	0
10-20	15	0	0	0	0	0
20 -30	25	0	0	0	0	0
30 - 40	35	0	0	0	0	0
40 -50	45	1	2	1	2	45
50 -60	55	5	10	6	12	165
60 -70	65	20	40	26	52	1300
70 -80	75	14	28	40	80	1050
80 -90	85	5	10	50	100	425
90 -100	95	5	10	50	100	475
100 -110	105	0	0	50	100	0
	Total	50			Total	3460

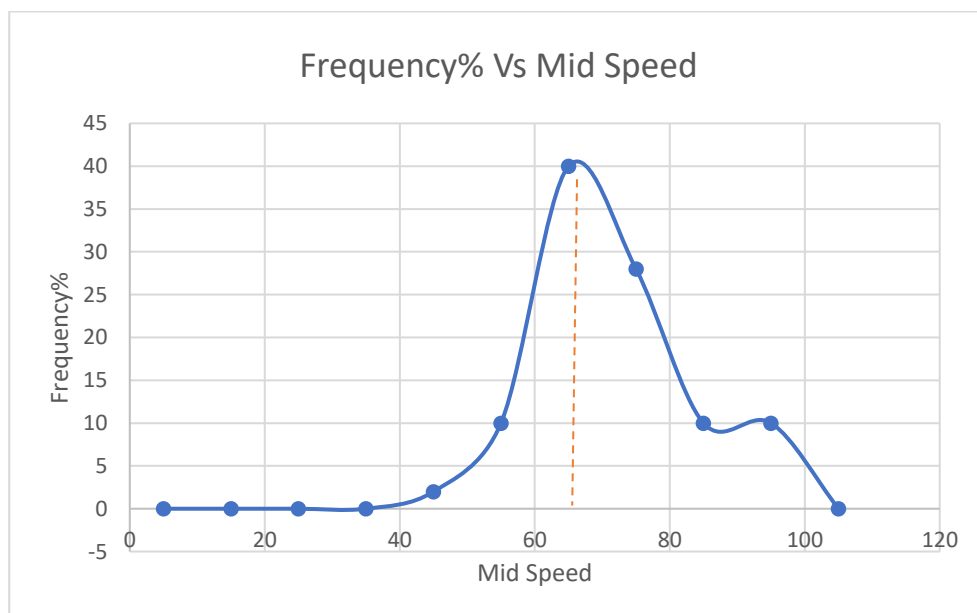


Fig 4.24: Frequency Distribution Curve For the following spot Speed Data

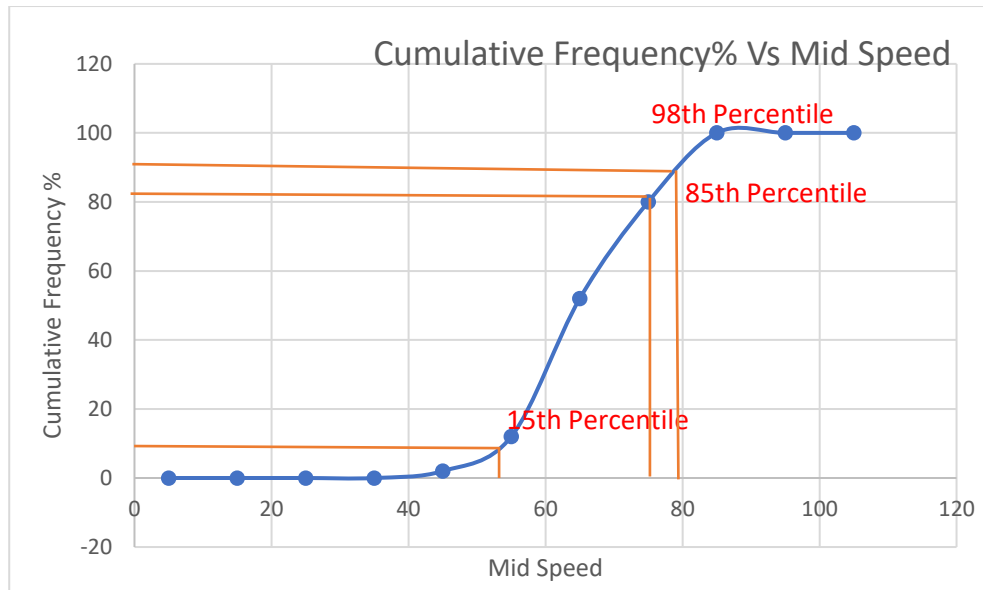


Fig 4.25: Cumulative Frequency Distribution Curve For the following spot Speed Data

Observation from the study -:

Upper Speed – 85th percentile = 75 km/hr.

Lower Speed – 15th Percentile = 50 Km/hr.

Design Speed – 98th Percentile = 85Km/hr.

Average Car Speed = 69.2Km/hr.

LOCATION: GARACHARAMA
 WEATHER: CLOUDY DAY
 TYPE OF ROAD: NH 4
 MEASUREMENT TECHNIQUE: MANUAL

DATE: 17-02-20
 TIME: 2:30 - 6:30 PM
 BASE LENGTH: 50m
 VEHICLE: 50 TRUCKS

Table 4.10: Frequency Distribution table for the Trucks

Speed Range	Mid Speed (Kmph)	Frequency f	Frequency, %	Cumulative Frequency	Cumulative Frequency, %	fx
0 -10	5	0	0	0	0	0
10-20	15	0	0	0	0	0
20 -30	25	1	2	1	2	25
30 - 40	35	1	2	2	4	35
40 -50	45	15	30	17	34	675
50 -60	55	20	40	37	74	1110
60 -70	65	6	12	43	86	390
70 -80	75	7	14	50	100	525
80 -90	85	0	0	50	100	0
90 -100	95	0	0	50	100	0
100 -110	105	0	0	50	100	0
	Total	50			Total	2760

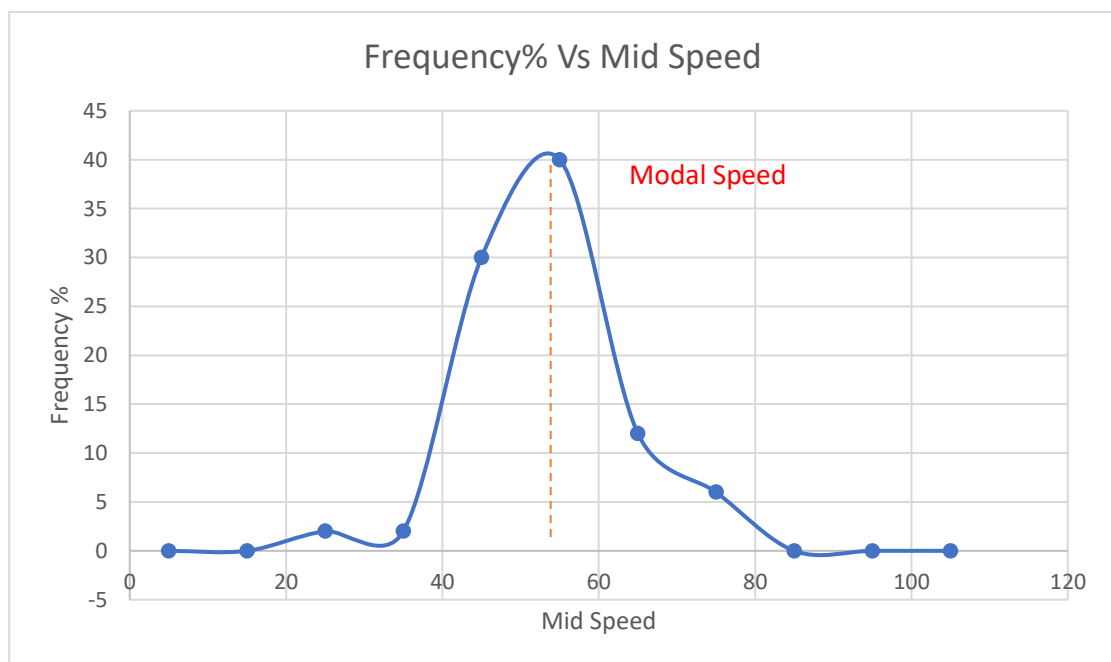


Fig 4.26: Frequency Distribution Curve For the following spot Speed Data

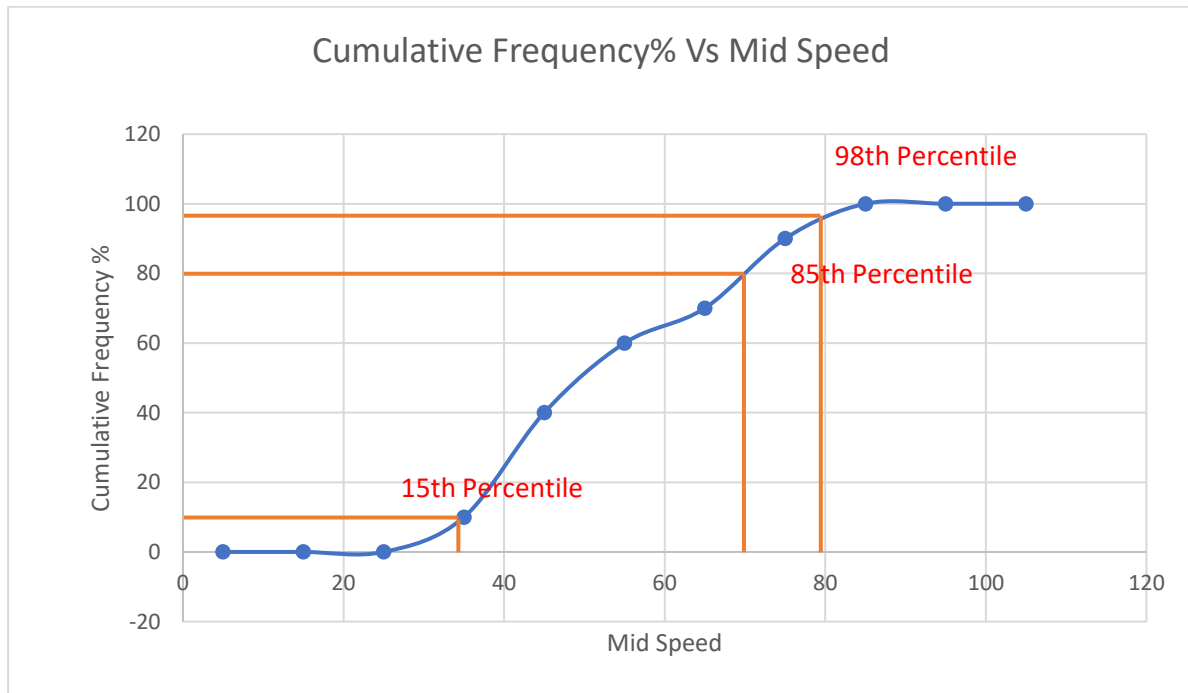


Fig 4.27: Cumulative Frequency Distribution Curve For the following spot Speed Data

Observation from the study -:

Upper Speed – 85th percentile = 70 km/hr.

Lower Speed – 15th Percentile = 35 Km/hr.

Design Speed – 98th Percentile = 80Km/hr.

Average Truck Speed = 55.2Km/hr.

LOCATION: GARACHRAMA
 WEATHER: CLOUDY DAY
 TYPE OF ROAD: NH4
 MEASUREMENT TECHNIQUE: MANUAL

DATE: 17-02-21
 TIME: 2:00 -6:30 AM
 BASE LENGTH: 50 m
 VEHICLE: 50 TWO -WHEELER

Table 4.11: Frequency Distribution table for the Two -Wheeler

Speed Range	Mid Speed (Kmph)	Frequency f	Frequency, %	Cumulative Frequency	Cumulative Frequency %	fx
0 -10	5	0	0	0	0	0
10-20	15	0	0	0	0	0
20 -30	25	0	0	0	0	0
30 - 40	35	5	10	5	10	175
40 -50	45	10	20	20	40	450
50 -60	55	20	40	30	60	1100
60 -70	65	5	10	35	70	325
70 -80	75	5	10	45	90	375
80 -90	85	5	10	50	100	425
90 -100	95	0	0	50	100	0
100 -110	105	0	0	50	100	0
	Total	50			Total	2850

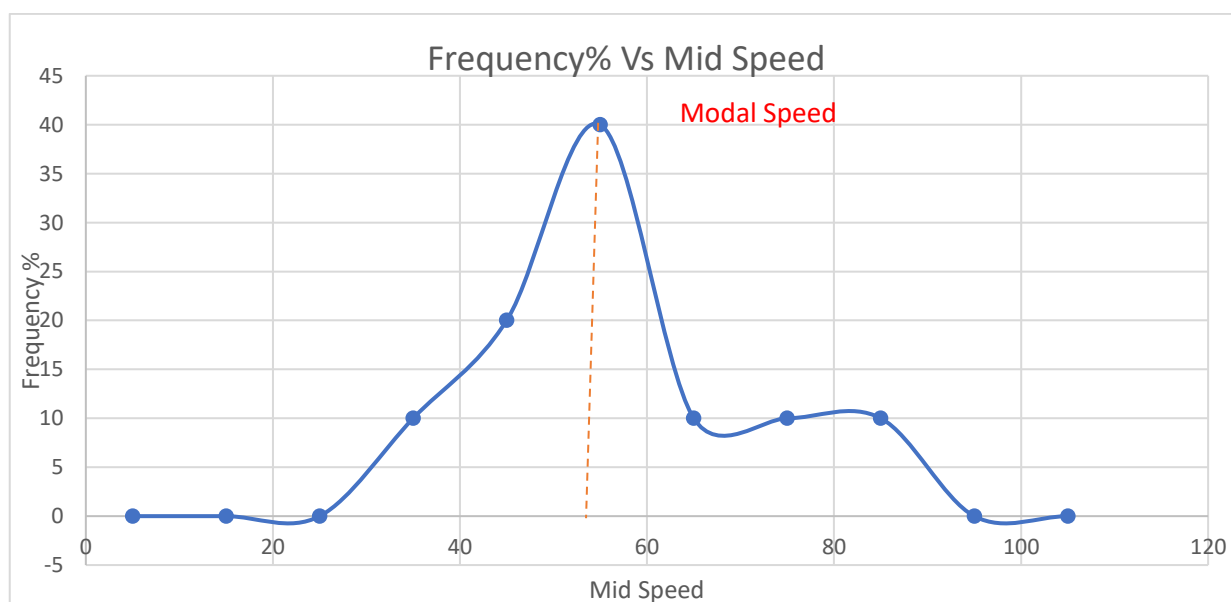


Fig 4.28: Frequency Distribution Curve for the following spot speed

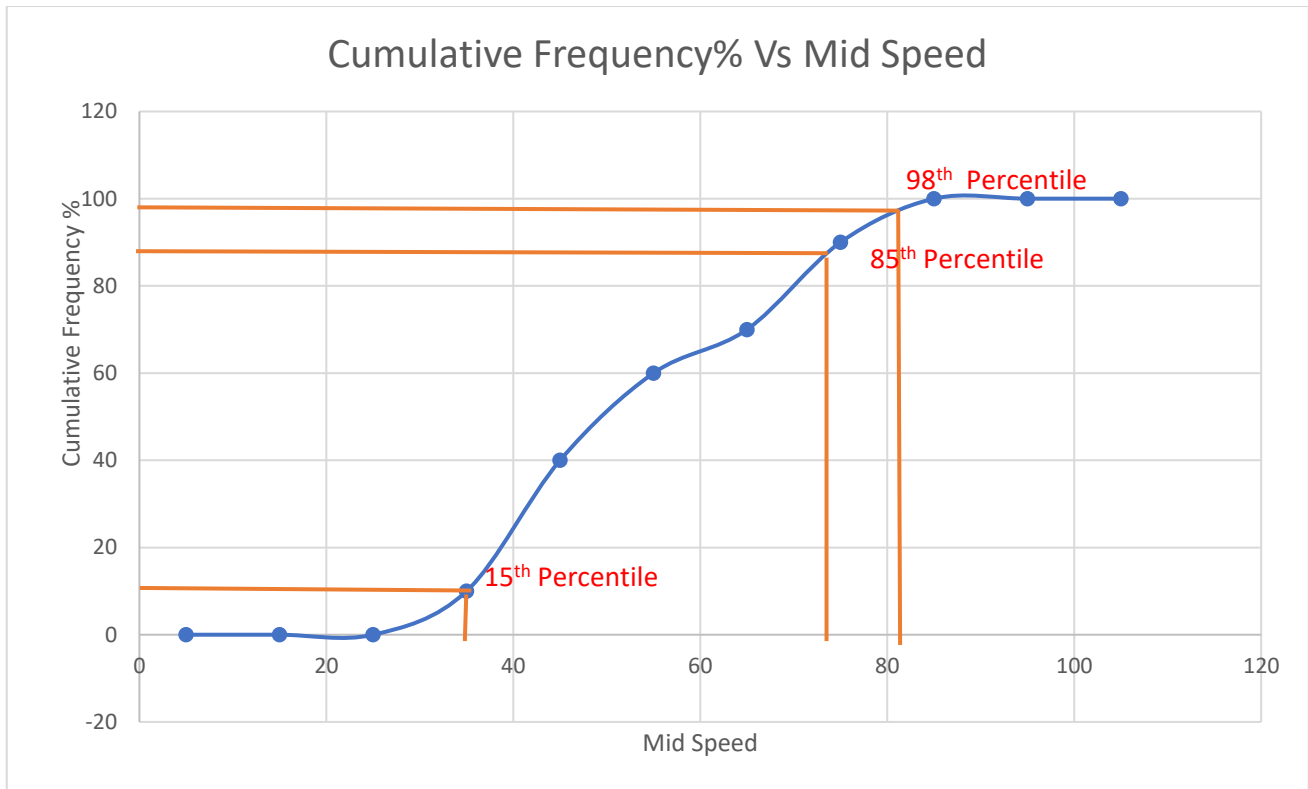


Fig 4.29: Cumulative Frequency Distribution Curve for following spot speed

Observations from the study -:

Upper Speed – 85th percentile = 70 km/hr.

Lower Speed – 15th Percentile = 35 Km/hr.

Design Speed – 98th Percentile = 84Km/hr.

Average Two-Wheeler Speed = 57Km/hr.

4.2.2: COLLECTION OF GEOMETRIC DESIGN OF PAVEMENT

The geometric plan of streets is the part of parkway designing worried about the situating of the actual components of the street as indicated by norms and limitations. The fundamental goals in geometric plan are to enhance productivity and security while limiting cost and ecological harm. Geometric plan likewise influences an arising fifth goal called "bearableness," which is characterized as planning streets to encourage more extensive local area objectives, including giving admittance to work, schools, organizations and homes, oblige a scope of travel modes like strolling, bicycling, travel, and cars, and limiting fuel use, outflows furthermore, natural harm. The features normally considered are the cross-section elements, sight distance consideration, horizontal curvature, gradients, and intersection.

The plan of these highlights is to an incredible broaden impacted by driver conduct and brain science, vehicle attributes, traffic qualities like speed and volume. Appropriate mathematical plan will help in the decrease of mishaps and their seriousness.

Following are the factors which affects the geometric design of the pavement:-

- I. Road classification, Highway alignment.
- II. Surface characteristics of pavement.
- III. Cross-sectional components like, various widths of roads, cross slope and features in the road boundaries.

- IV. Features like transition curve, super elevation, set back distance and extra widening includes in the horizontal alignment.
- V. Vertical alignment includes, sight distance, gradient and design of length of curves.

A emergency halting lane, that is provided on the outskirts of a road is known as **shoulder**, can be utilized for overtaking and passing in case of reduced carriageway width for single lane roads it is essential to be equipped with a shoulder.

Medians are the brought obstructions up in the middle part of the road or street are proper in a few areas and not proper in others. They are a passerby advantage, since they can fill in as a position of shelter for people on foot who get through a road intersection or at midblock. They give space for road trees and other finishing which, thus, can help decrease speeds by altering the appeal of a road. They additionally have benefits for driver wellbeing when they supplant focus turn paths. Wanted turning developments should be deliberately given with the goal that drivers are not compelled to go on wrong courses, for example, private roads or a dangerous U-turn condition isn't made.

Surface drainage is concerned about eliminating all water that is available on the asphalt surface, shoulder surface or some other surface from which it might stream onto the asphalt. If not methodically eliminated, this water can gather under and debilitate the asphalt structure.

In this project the collected geometric design data includes width of the lane of pavement, width of the median, width of the shoulder and type of drainage.

Table 4.12: Geometric Design Data for respective locations

S.No.	Location in degrees	Median Width (in m)	Lane Width (in m)	Shoulder Width (in m)	Drainage Type
1	11.5141940, 92.711945	NA	3.5	1	NA
2	11.549493, 92.729206	NA	3.52	1	NA
3	11.725566, 92.654691	NA	3.5	1	NA
4	11.603162, 92.686500	NA	3.48	1	NA
5	11.602911, 92.69188	NA	3.5	1	NA
6	11.837063, 92.654217	NA	3.5	1	NA
7	11.841531, 92.653856	NA	3.46	1	NA
8	11.674149, 92.644588	NA	3.5	1	NA
9	11.691881, 92.641638	NA	3.45	1	NA



Fig 4.30: One Lane Road with Two Way Traffic



Fig 4.31: Measurement of the width of the Pavement

4.2.3: COLLECTION CLIMATE DATA

Climate Data Record is "a time collection of measurements of enough length, consistency and continuity to decide weather variability and change. With the courtesy of NOAA (National Oceanic and Atmospheric Administration) a complete weather database is received for 12 months 2015 -2019 containing day by day common precipitation, common most temperature and minimal temperature which was in addition drawn into month-to-month averages for the cause of mission work.

Keys -:

TMAX – Maximum Temperature in degree centigrade

TMIN – Minimum Temperature in degree centigrade

PRCP – Precipitation in mm.

**Table 4.13(a, b, c): Representing climate data from January to December for year
2015 – 2019**

Table 4.14 (a)

year	Jan			Feb			Mar			Apr		
	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN
2015	12.17	30	22.4	5.16	30.7	25.6	1.9	32.7	24.5	7	33	24.5
2016	17.77	31.1	23.4	5.13	32.6	23.8	0	31.3	24.6	7.005	33.4	25.7
2017	6.83	30.7	23	5.18	31.2	23.6	1	31.8	23.8	10.16	32.3	25.4
2018	9.11	29.5	23.6	7.2	31.4	23.5	10.3	31.5	23.5	1.78	32.1	25.5
2019	8.71	30	24.4	5.15	30.6	24.3	14	32	23	8.5	32.2	25.2

Table 4.13 (b)

year	May			Jun			Jul			Aug		
	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN
2015	15.49	32	25	13.4	30.6	25	8.9	30.7	25.4	14.5	30.4	24.6
2016	11.15	32.5	26.4	13.1	30.2	25	7.2	30.2	25	11.31	30.8	25.2
2017	25.12	35.7	33	25.1	30.6	24.4	8.75	29.8	24.4	17.43	29.7	24.6
2018	18.5	33	25	27.8	29.8	24.4	5.8	28.6	25.2	12.41	30.7	24.3
2019	8.59	32.5	25.3	19.5	30	25	4.3	28	25	21.77	29.2	23.8

Table 4.13 (c)

year	Sep			Oct			Nov			Dec		
	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN	PRCP	TMAX	TMIN
2015	14.4	30	24.2	9.66	31	24.5	6.53	30.8	25	8.22	31	24.7
2016	27.4	30	23.7	4.6	29.8	24.3	10.38	30.6	25	27.43	29.8	24
2017	16.41	30.1	24.7	4.4	30	24.6	9.36	30.5	25.2	16.9	30	24.3
2018	9.13	28.2	24.2	13.94	30.8	24.5	21.4	30.5	24.8	10.8	30	24
2019	22.5	30	23.7	11.86	32	24.8	2.53	31	24.6	0.5	31	24.8

4.3: STATISTICAL MODELLING

A mathematical model that exemplifies a set of statistical conventions regarding the generation of sample data is known as statistical model. Statistical model signifies, frequently an ideal data-generating process. According to mathematical terms, the statistical model is generally supposed of as couple (S, P) , where S is the set of likely observations and P is a set of probability distributions on S .

It is presumed that there is a "true" probability distribution made by the process that generates the experiential data. We select P to characterize a set which contains a distribution that sufficiently approximates the true distribution.

4.3.1: REGRESSION ANALYSIS

A set of statistical devices used for the approximation of relationships between a dependent variable and independent variables is known as regression analysis. Regression analysis is used to evaluate the strength of the relationship between variables for the modeling of it.

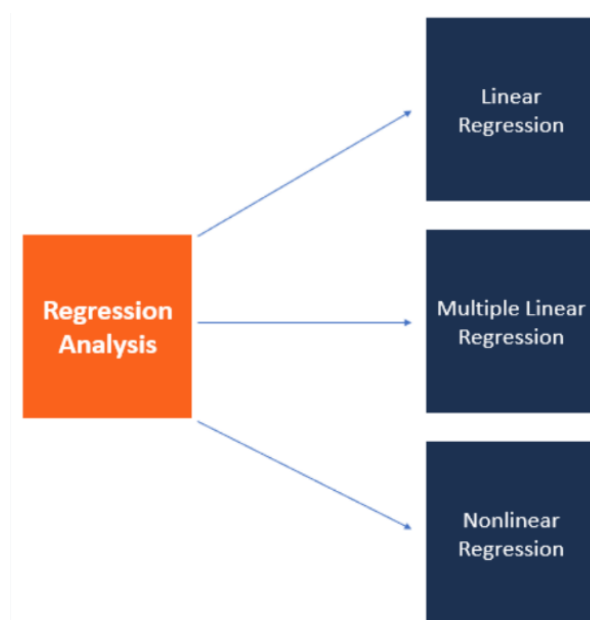


Fig 4.32 -: Types of Regression Analysis

Linear regression analysis is based on six fundamental assumptions:

- I. Slope and intercept show a linear variation amongst independent and dependent variables.
- II. Random variables are not independent.
- III. Zero should be the value of residual error.
- IV. All observations are constant across the value of residual error.
- V. All observations are not correlated with value of residual error.
- VI. Normal Distribution is followed by the residual error.

Simple linear regression model evaluates the association between a independent variable and dependent variable. Simple linear regression model is expressed using the following equation:

$$Y = bx + \epsilon$$

Where:

Y – Dependent variable

X – Independent variable

a – Intercept

b – Slope

ϵ – Residual error

4.3.2: DEVELOPMENT OF REGRESSION MODEL

In this project work to develop the regression model software used is Microsoft Excel 2019. Microsoft Excel is a worksheet developed and created by Microsoft. Microsoft Excel 2019 contains graphing instruments, calculations tools, macro programming language known as Visual Basic and pivot tables. Microsoft excel has been a very extensively utilized worksheet

for the Microsoft Windows operating system. Microsoft Excel is a part of the Microsoft Office package. It has commanding analytical tools included within has the capability to study large amounts of data to determine patterns and trends which will affect decision making.

The process of building a regression model is as follows-:

Step1 -: Selection of appropriate data (i.e., selection of dependent and independent variables).

Step 2 -: Setting up the confidence level interval.

Step 3 -: Interpretation of the output result

Selection of Appropriate Data

Table 4.14: Data for the Regression analysis (contains monthly average No's of Accidents and Monthly average precipitation for 5 years 2015 - 2019)

Month	Accidents	Precipitation
Jan	20	9.4
Feb	21	11.5
Mar	19	12.7
Apr	18	15.9
May	21	17.5
Jun	18	16.6
Jul	18	17.9
Aug	21	20.5
Sep	18	24.8
Oct	18	23.5
Nov	18	25
Dec	19	28

The primary and secondary collected data were considered for the regression analysis. The dependent variable in this case is the database of monthly average No. s accidents occurring for 5 years (2015 -2019), while independent Variables (criterion variables) were considered as average climatological data for the same 5 years, spot speed data and geometric design

The Regression function of the data analysis tool in Microsoft Excel 2019 is used for regression modelling. The modelling was carried with extensive testing of the criterion variables (dependent variables) and checked upon the fulfillment of the required criteria.

The required criteria come under ANOVA (Analysis of Variance) parameter called 'significance F'. Significance F is the probability of the null hypothesis in the regression cannot be rejected, it is the ratio of mean regression sum of squares to the mean error. Basically, it provides the probability that the developed model wrong, hence the lower the value better the statistical model. In this the value for significant f should be 0.05 or less. For the fulfillment respective criterion, regression model was from with accident cases dependent on the monthly average rainfall(precipitation) for 5 years period (2015 -2019).

Output of The Regression Analysis

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.624954535
R Square	0.390568171
Adjusted R Square	0.322853523
Standard Error	1.131557524
Observations	12

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	7.385289045	7.385289	5.767854	0.039791035
Residual	9	11.52380186	1.280422		
Total	10	18.90909091			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>
Intercept	16.79800347	1.013856552	16.56842	4.74E-08	14.50450061
X	0.139656489	0.058150574	2.401636	0.039791	0.008110751

RESIDUAL OUTPUT

<i>Observation</i>	<i>Predicted Accidents</i>	<i>Residuals</i>
1	19.66096	0.339039
2	20.06597	0.934035
3	20.28942	-1.28942
4	17.7337	0.266298
5	18.79509	-0.79509
6	19.00458	1.995424
7	19.1163	-1.1163
8	19.29785	-1.29785
9	19.88441	1.115588
10	18.04095	-0.04095
11	18.11077	-0.11077
12	18.30908	-0.69092

Interpretation of results

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.624954535
R Square	0.390568171
Adjusted R Square	0.322853523
Standard Error	1.131557524
Observations	11

The measurement of strength in a linear relationship between two variables is determined by **Multiple R** (correlation coefficient). Correlation coefficient can vary as -1 to 1. The relationship strength is determined by its absolute value. The Absolute value is proportional to the strength of the relationship.

Following are the inferences made based upon the Multiple R value.

-1 = a strong negative relationship

0 = means no relationship at all

1 = a strong positive relationship

In this case the Multiple R is 0.624954535 which infers the relationship between the variable measures 62%

Coefficient of Determination is known as **R Square**. which indicates goodness of fit. It expresses the points falling on regression line. R^2 is calculated from sum of squared deviations of original data's respective mean.

In this case the R square value is 0.390568171 which means nearly 39% of the points lies on regression line.

The number of independent variables with adjusted R square values in the model, are known as **Adjusted R-Square**.

The goodness-of-fit measure that illustrates the exactness of the regression analysis is called **Standard Error** – the certainty of the regression equation is inversely proportional to the value of standard error. It represents an absolute measure of the average distance of the data points fall from the regression line.

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	7.385289045	7.385289	5.767854	0.039791035
Residual	9	11.52380186	1.280422		
Total	10	18.90909091			

Here, ANOVA Stands for Analysis of Variance

It separates the sum of squares into individual components that provides data about the stages of inconsistency within the regression model:

- I. df is the number of the degrees of freedom associated with the sources of variance.
- II. SS is the sum of squares.
- III. MS is the mean square.
- IV. F is the F statistic, or F-test for the null hypothesis.
- V. Significance F is the P-value of F.

Significance Of (value) represents of how statistically significant the results of regression analysis are. Significance F value less than 0.05 (5%), is acceptable for the model. Significance Of value greater than 0.05 can imply to revise, the model and the choice of independent.

From the following output one can build the regression equation, since it is simple linear regression model

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	16.79800347	1.013856552	16.56842	4.74E-08	14.50450061	19.0915063
x	0.139656489	0.058150574	2.401636	0.039791	0.008110751	0.27120223

$$y = 0.139656489x + 16.79800347 \text{ (Required Regression Equation)}$$

Here, y = No. s of Accidents, x = Precipitation (in mm) , 0.139656489 is the co-efficient and 16.79800347 is intercept

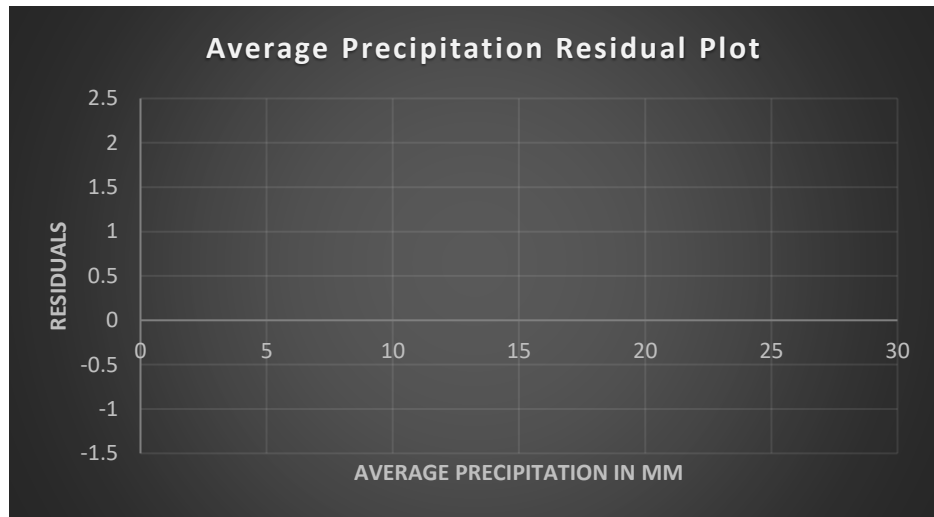


Fig 4.33: Residual Plot for the Average Precipitation in mm

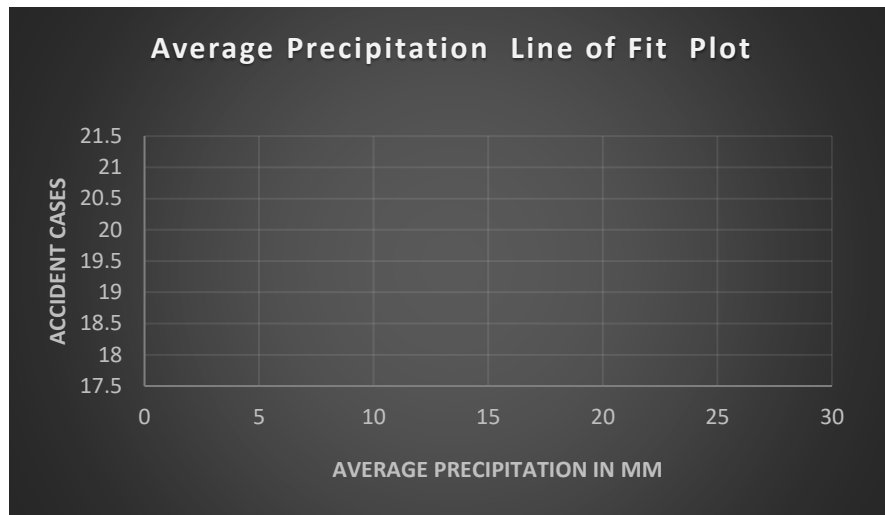


Fig 4.34: Line of fit Plot for the Predicted Values

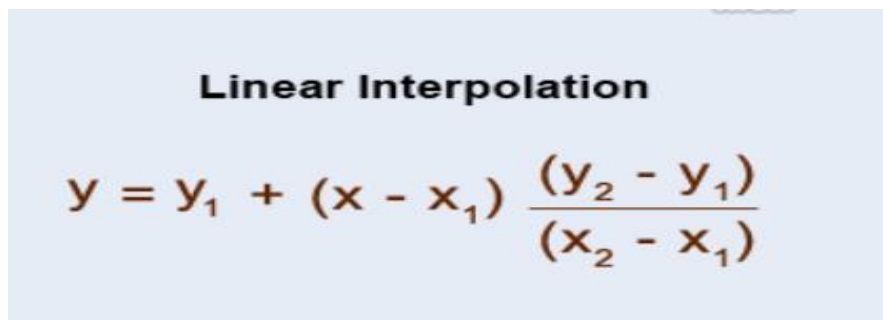
4.4: DEVELOPMENT OF FORECASTING MODEL

The procedure of making estimates of future based upon past as well as present data by examination of trends is called forecasting. Prediction is a similar entity, but in all-purpose terms. Both are known to be prescribed statistical methods implementing, longitudinal, time series and cross-sectional data.

In this project a quantitative forecasting for the database relating to the cases collected is made get an estimate of the future accidents. Analyzing the existing data, it is inferred that it does represent any linear with respect to time following exponential smoothing to be considered for the forecasting.

Here Microsoft Excel 2019 software has been utilized to perform forecasting using its forecast function, a database of 25 year have been obtained using it (i.e., from year 2020 -2044). Prior to forecast the database it is has been interpolated and hence hypothetical forecast is obtained.

Interpolation - Method of creating new data points inside the range of a distinct group of known data points is known as interpolation is widely used numerical analysis method.



Linear Interpolation

$$y = y_1 + (x - x_1) \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

Fig 4.35: Formula Used for interpolation

Here,

x_1 – Year 1

y_1 – Accident cases for the respective year (x_1).

x2 – Year 2

y2 – Accident cases for the respective year (x2).

x – year 3

y(unknown)- Accident cases for the respective year (x).

Exponential smoothing is a method to do the smoothing of time series data applying exponential window function. In the database containing no clear trend or seasonality this method is applicable. In this method the averages are weighted over exponential increasing or decreasing over the time on contrary with the moving average, where the averages are weighted equally.

This method is successor of Poisson's recursive exponential window functions in convolutions, and Kolmogorov & Zurbenko's recursive moving averages.

The exponential smoothing formula is given by:

$$s_t = \alpha x_t + (1 - \alpha) s_{t-1} = s_{t-1} + \alpha (x_t - s_{t-1})$$

Here,

s_t = smoothed statistic, it is the simple weighted average of current observation x_t

s_{t-1} = previous smoothed statistic

α = smoothing factor of data; $0 < \alpha < 1$

t = time period

The larger the value of smoothing factor, the lesser would be the smoothing. α value near to 1 has lesser smoothing outcome and while recent changes in the data have a greater weight and vice – versa.

Exponential smoothing using Microsoft Excel 2019

It figures or predicts a future worth dependent on existing (verifiable) values by utilizing the AAA rendition of the Exponential Smoothing (ETS) calculation. The anticipated worth is a continuation of the authentic qualities in the predetermined deadline, which ought to be a continuation of the course of events. One can utilize this capacity to anticipate future deals, stock prerequisites, or shopper patterns.

Command used for forecasting -:

Syntax -:

FORECAST.ETS (target date, values, timeline. [seasonality],[data completion],[aggregation])

Following are the arguments for the syntax -:

Target_ date - The data point for which you want to predict a value.

Values - Values are the historical values, for which you want to forecast the next points.

Timeline -The independent array or range of numeric data. The dates in the timeline must have a consistent step between them and can't be zero.

Seasonality - A numeric value. The default value of 1 means Excel detects seasonality automatically for the forecast and uses positive, whole numbers for the length of the seasonal pattern. 0 indicates no seasonality, meaning the prediction will be linear.

Data completion - Although the timeline requires a constant step between data points, FORECAST.ETS supports up to 30% missing data, and will automatically adjust for it.

Aggregation - Although the timeline requires a constant step between data points, FORECAST.ETS will aggregate multiple points which have the same time stamp. The aggregation parameter is a numeric value indicating which method will be used to aggregate several values with the same time stamp.

**Table 4.15: Total No. s of Accidents, Fatalities and injuries predicted for the year
2020 – 2044**

Year	Road Accidents		
	Cases	Injured	Died
2020	231	258	18
2021	228	240	16
2022	235	291	17
2023	227	265	15
2024	234	313	15
2025	228	291	13
2026	235	338	14
2027	228	315	12
2028	235	363	12
2029	229	340	10
2030	235	387	11
2031	229	364	9
2032	236	412	9
2033	229	389	7
2034	236	437	8
2035	229	414	6
2036	236	461	6
2037	230	438	4
2038	237	486	5
2039	230	463	3
2040	237	511	3
2041	230	487	1
2042	237	535	2
2043	231	512	0
2044	238	560	0

From the above drawn table one can observe that the accidents cases predicted for the year 2020 -2044 are 5810, while injuries and fatalities are 9870 and 216 respectively.

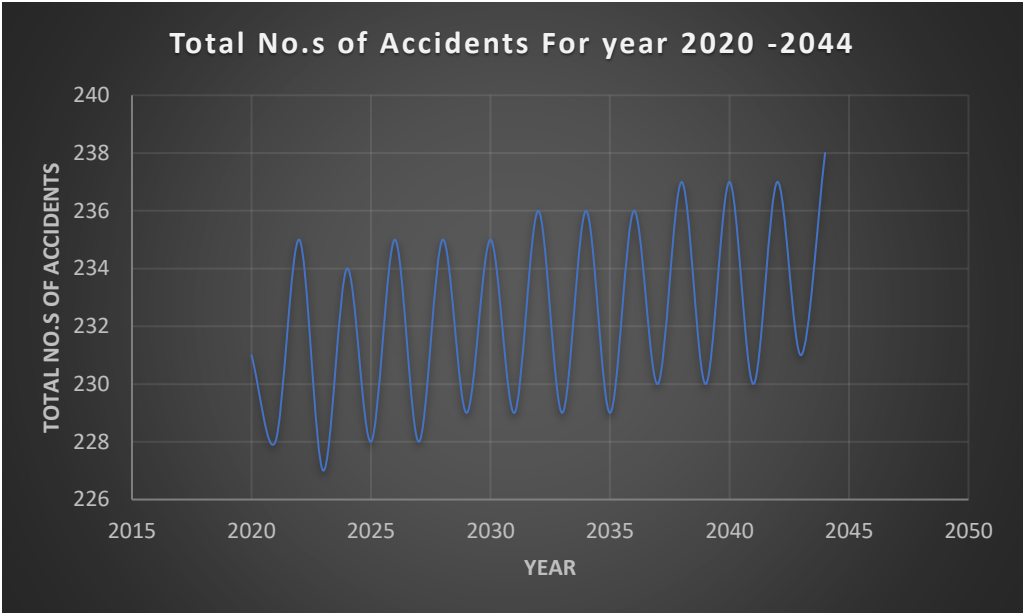


Fig 4.36 :- X, Y Scattered Graph Showing Total No.s of Accidents predicted for the year 2020 -2044

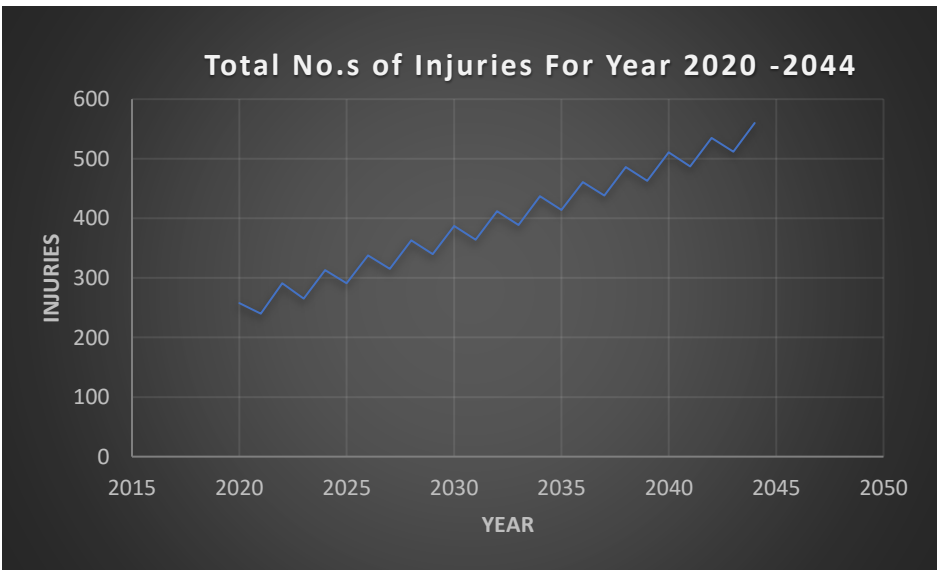


Fig 4.37 :- X, Y Scattered Graph Showing Total No. s of Injuries predicted for the year 2020 -2044



Fig 4.38 - :X, Y Scattered Graph Showing Total No.s of Fatalities predicted for the year 2020 -2044

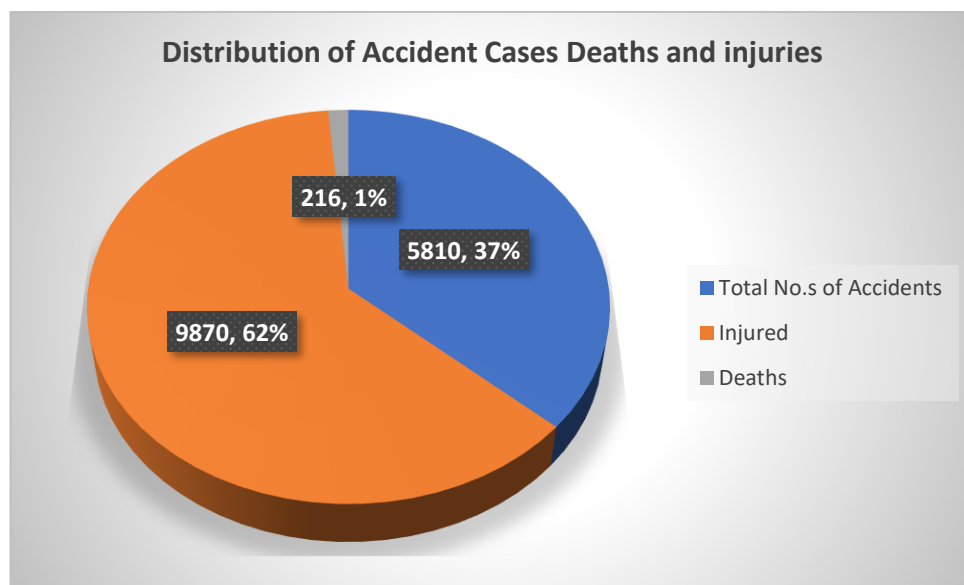


Fig 4.39 -: Pie chart depicting the distribution of predicted total No. s of road accident cases, injuries, and deaths for year 2020 -2044

From Fig 4.36, 4.37, 4.38 and 4.39 the total No. s of accidents predicted for the year 2020 - 2044 records highest in the year 2044 as 238. The maximum No. s of predicted injuries is for the year 2044 as 560 and maximum No. s of fatalities is in the year 2020 as 18. The injuries comprise of 62%, the accident comprises of 37% and the fatalities comprises of 1% of the total predictions respectively.

Table 4.16: Total No. s of Accidents, Fatalities and injuries predicted due to the mentioned causes for the year 2020 – 2044

year	Careless Driving / Overtaking			Over Speeding			Driving Under Influence of Drugs/Alcohol		
	Accidents	Injuries	Death	Accidents	Injuries	Death	Accidents	Injuries	Deaths
2020	96	110	6	110	187	11	44	39	1
2021	97	113	7	113	188	12	46	43	2
2022	97	99	7	112	187	11	49	46	2
2023	99	106	8	116	107	13	52	49	2
2024	98	88	8	115	150	13	54	52	2
2025	100	95	9	118	110	15	57	55	2
2026	103	79	9	118	157	14	60	59	3
2027	104	86	10	121	147	16	63	62	3
2028	109	69	10	120	100	16	65	65	3
2029	111	76	11	124	111	18	68	68	3
2030	115	59	11	123	123	17	71	72	4
2031	117	67	12	126	50	19	73	75	4
2032	115	50	12	126	70	19	76	78	4
2033	119	57	13	129	117	21	79	81	4
2034	121	40	13	128	123	20	81	84	4
2035	123	47	14	132	140	22	84	88	5
2036	127	30	14	131	60	22	87	91	5
2037	129	38	15	134	68	24	89	94	5
2038	131	21	15	134	70	23	92	97	5
2039	136	28	16	137	126	25	95	100	5
2040	140	11	16	137	139	25	97	104	6
2041	144	18	17	140	176	27	100	107	6
2042	155	2	17	139	90	26	103	110	6
2043	160	9	18	142	156	28	106	113	6
2044	167	4	18	144	150	30	109	117	7

From the above drawn table one can observe that the maximum No.s of accident cases , Injuries and fatalities are due to the cause over speeding which are 3169, 3102 and 487 respectively.

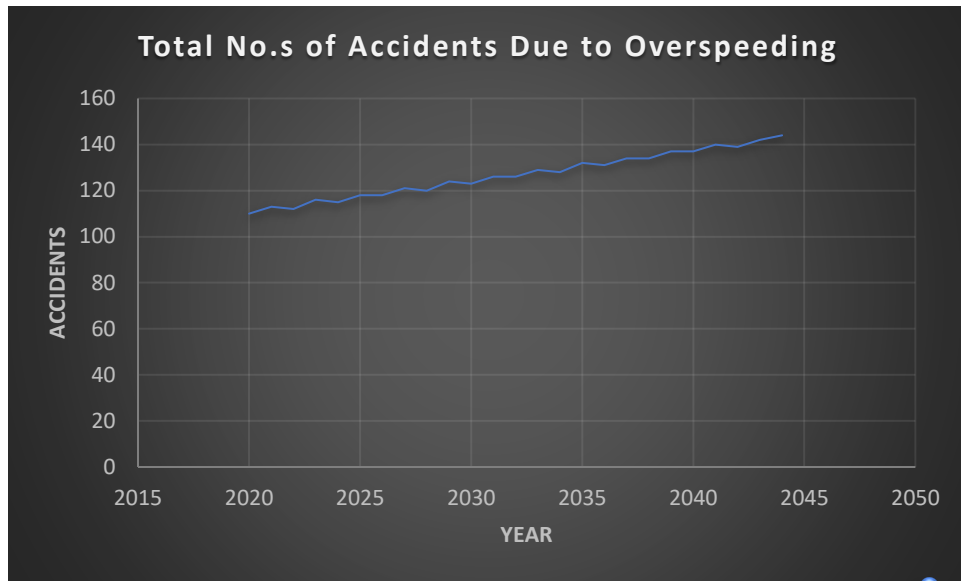


Fig 4.40:- X, Y Scattered Graph Showing Total No. s of Accidents due to overspeeding predicted for the year 2020 -2044



Fig 4.41 :- X, Y Scattered Graph Showing Total No. s of Injuries due to overspeeding predicted for the year 2020 -2044

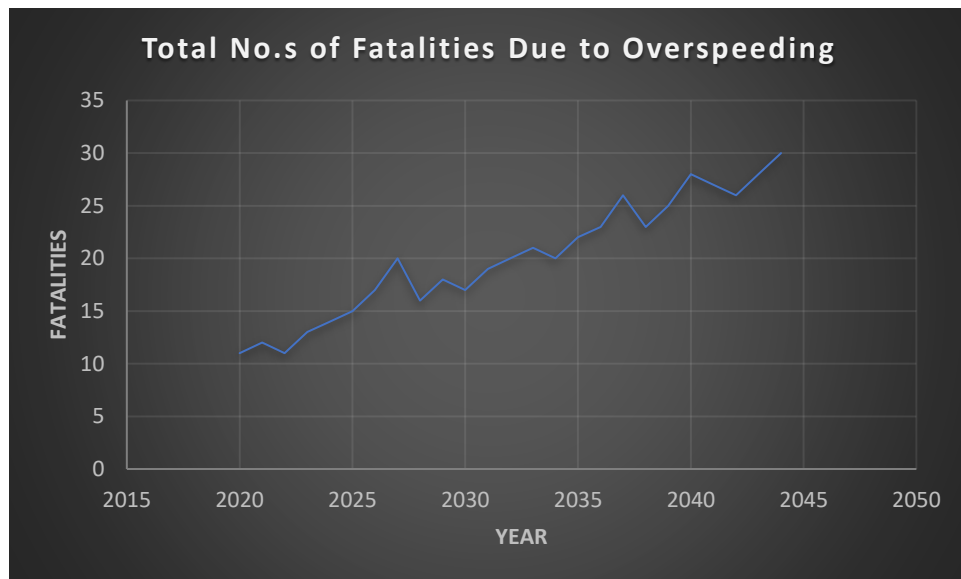


Fig 4.42 :- X, Y Scattered Graph Showing Total No. s of fatalities due to overspeeding predicted for the year 2020 -2044

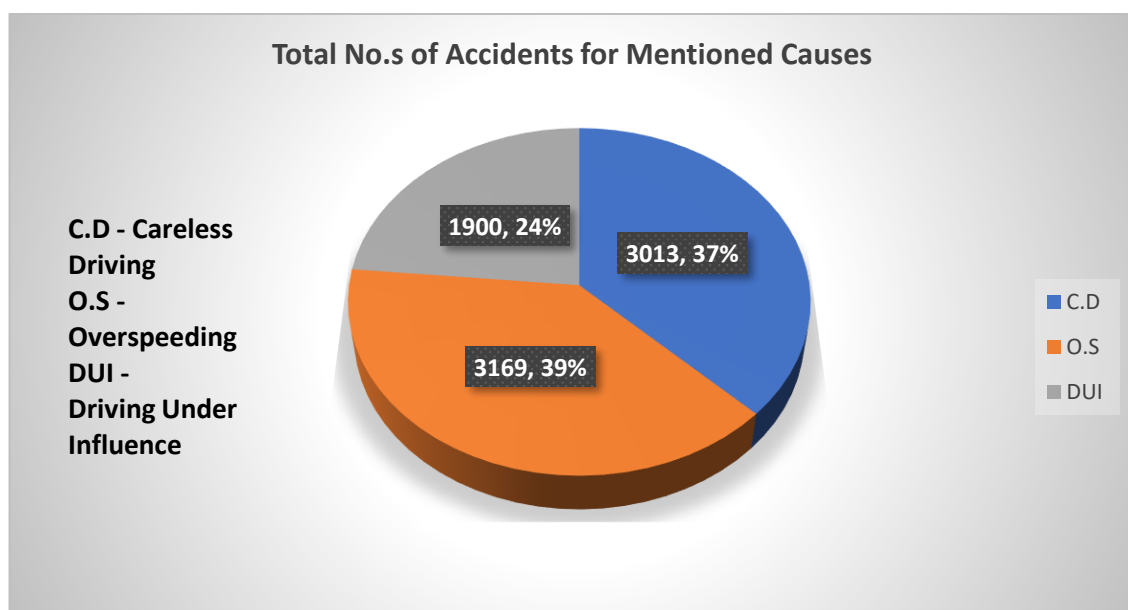


Fig 4.43 :- Pie chart depicting the distribution of predicted total No. s of road accident cases, injuries, and deaths for mentioned causes from year 2020 -2044

From Fig 4.40, 4.41, 4.42 and 4.43, the total No. s of accidents occurred due to over speeding occurred maximum in the year 2044 as 144 and minimum in the year 2020 as 110. Total No. s of injuries due to over speeding is maximum in the year 2022 as 188 and minimum in the year 2031 as 50. The total No. s of deaths due to over speeding is maximum in the year 2044

as 30 and minimum in the year 2020 and 2022 as 11. The accidents due over speeding constitute 39% and 37% in careless driving as well as 24% in driving under influence respectively.

Table 4.17: Total No. s of Accidents, for the respective modes of transport predicted for the year 2020 – 2044

Year	Truck/Lorry	Bus	Two - Wheeler	Pedestrian
	Accidents	Accidents	Accidents	Accidents
2020	4	3	11	6
2021	4	1	10	9
2022	3	3	13	11
2023	3	1	14	14
2024	3	3	15	13
2025	2	1	16	17
2026	2	3	17	19
2027	2	1	21	24
2028	1	3	18	22
2029	1	1	19	26
2030	1	3	20	27
2031	1	1	23	30
2032	0	3	26	31
2033	0	1	25	35
2034	0	3	24	34
2035	0	1	27	39
2036	0	3	26	38
2037	0	1	28	45
2038	0	3	29	42
2039	0	1	33	46
2040	0	3	31	47
2041	0	1	32	51
2042	0	3	35	50
2043	0	1	37	54
2044	0	3	34	55

From the above drawn table one can observe that the maximum No. s of accident cases are of pedestrians which is 785.

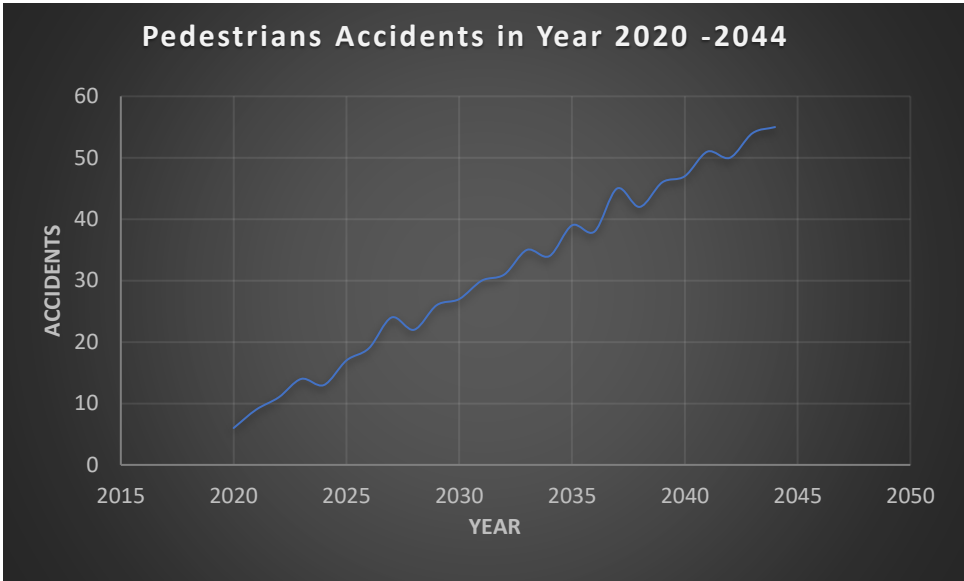


Fig 4.44 :- X, Y Scattered Graph Showing Total No. s of accidents of pedestrians predicted for the year 2020 -2044

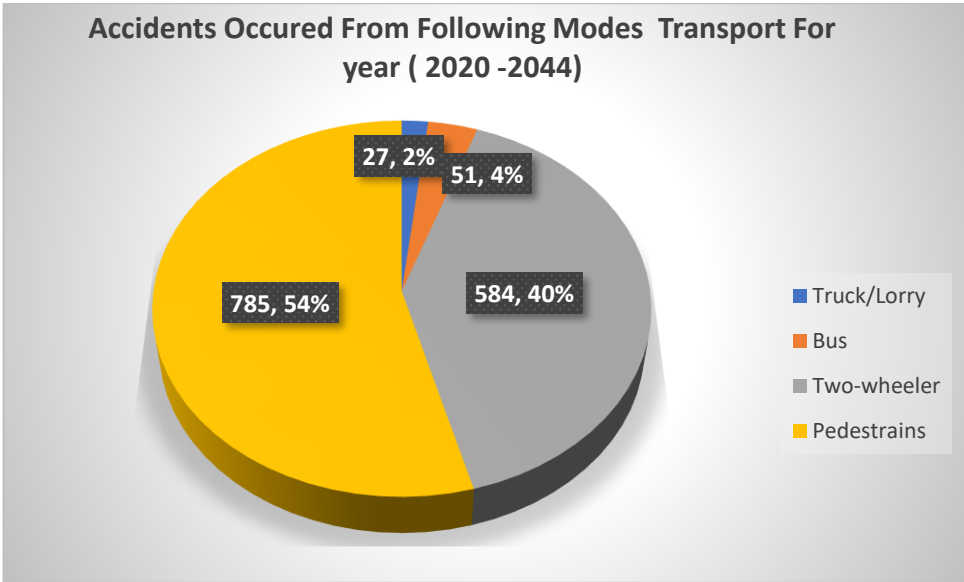


Fig 4.45:- Pie chart depicting the distribution of predicted total No. s of road accident cases, for mentioned modes of transport from year 2020 -2044

From Fig 4.44 and 4.45 the total No. s of pedestrian accidents occurred in the year 2044 is the highest as 55, while in year 2020 being lowest as 6. Whereas pedestrian constitute 54% of the total cases, two – wheeler constitute as 40%, bus constitute as 4% and truck or lorry constitute as 2% respectively.

Table 4.18: Total No. s of Predicted Accidents, for the respective Types of roads for the year 2020 – 2044

Year	National Highway			State Highway			Other Roads		
	Accidents	Injuries	Deaths	Accidents	Injuries	Deaths	Accidents	Injuries	Deaths
2020	78	79	9	113	67	6	87	91	5
2021	82	80	9	119	67	9	84	51	6
2022	86	66	10	127	70	7	59	38	4
2023	84	64	10	134	70	9	62	0	5
2024	90	51	11	141	73	7	32	0	3
2025	90	50	11	148	73	9	35	0	4
2026	94	36	12	156	76	8	7	0	2
2027	94	35	12	163	76	10	10	0	3
2028	99	22	13	170	79	8	0	0	1
2029	99	21	14	177	79	10	0	0	3
2030	103	7	14	184	82	9	0	0	0
2031	103	6	15	191	82	11	0	0	0
2032	108	0	16	199	85	9	0	0	0
2033	108	0	16	206	84	11	0	0	0
2034	112	0	17	213	88	9	0	0	0
2035	112	0	17	220	87	12	0	0	0
2036	117	0	18	228	91	10	0	0	0
2037	117	0	18	234	90	12	0	0	0
2038	121	0	19	242	94	10	0	0	0
2039	121	0	19	249	93	13	0	0	0
2040	126	0	20	256	97	11	0	0	0
2041	126	0	20	263	96	13	0	0	0
2042	130	0	21	271	100	11	0	0	0
2043	130	0	21	278	99	13	0	0	0
2044	135	0	22	285	103	12	0	0	0

From the above drawn table one can observe that the maximum No. s of accident cases, injuries and deaths occurred are occurred on State Highways which is 4967, 2101 and 249 respectively.

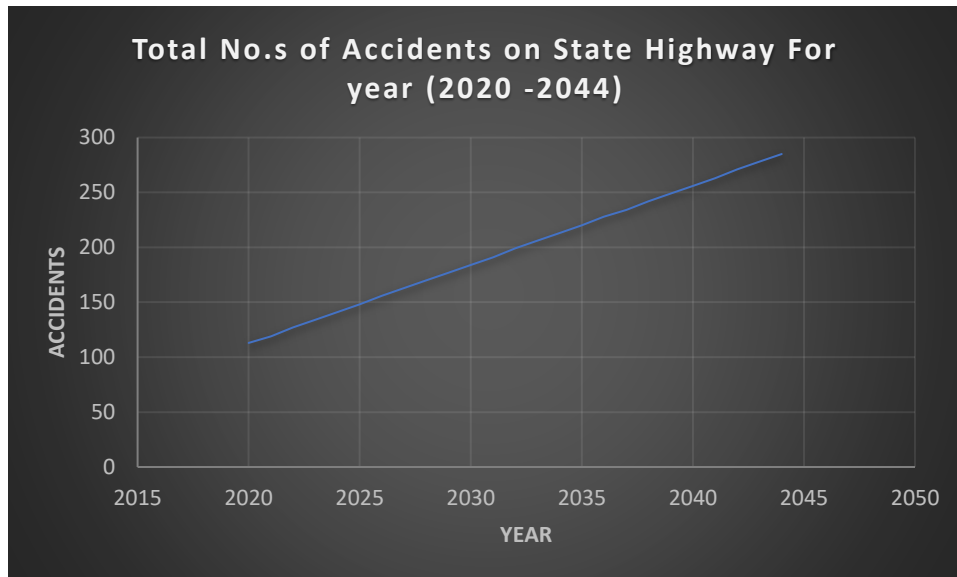


Fig 4.46 :- X, Y Scattered Graph Depicting Total No. s of accidents occurred on State Highway for year 2020 -2024

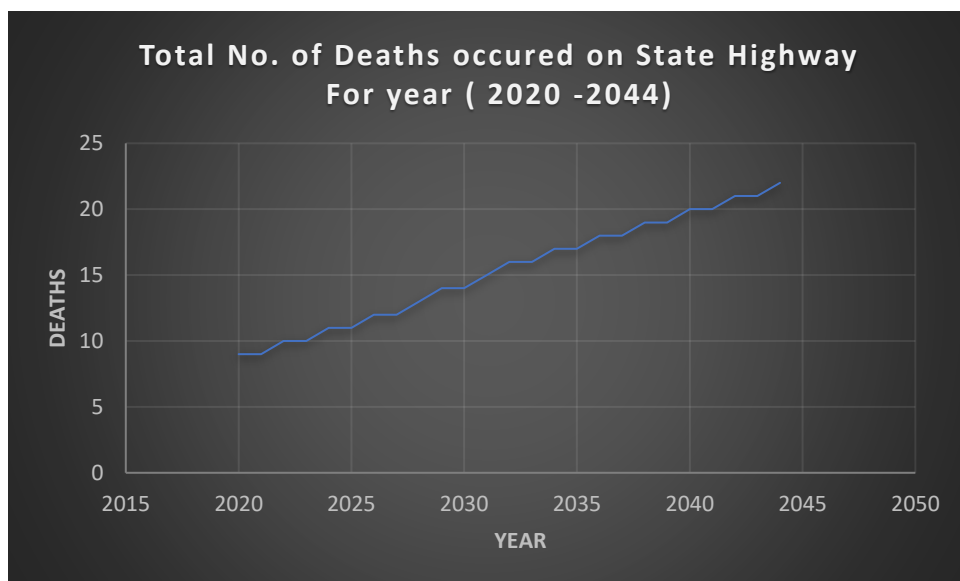


Fig 4.47 :- X, Y Scattered Graph Depicting Total No. s of Deaths due to accidents occurred on state highway for year 2020 -2044

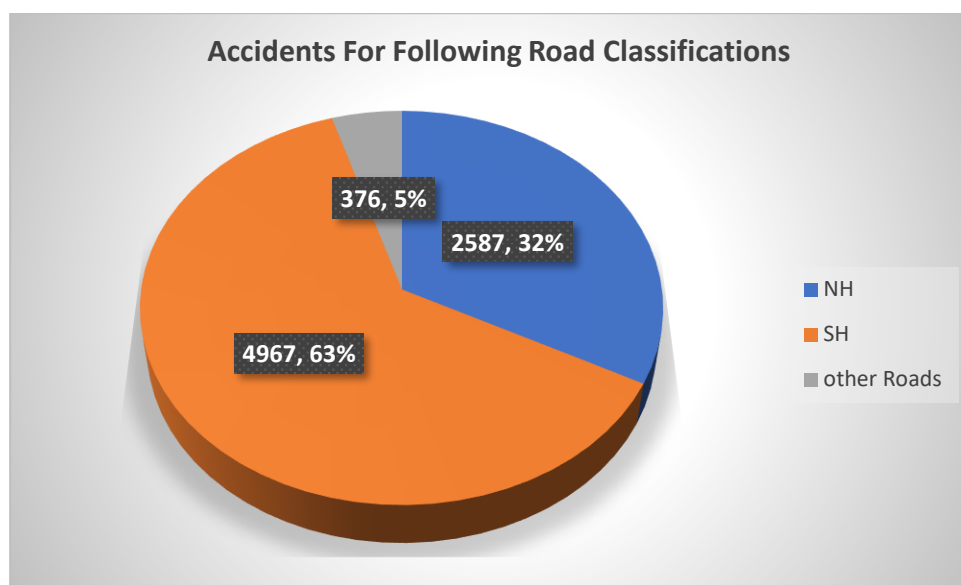


Fig 4.48 :- Pie chart depicting the distribution of total No. s of predicted accidents over respective types of roads from year 2020 -2044

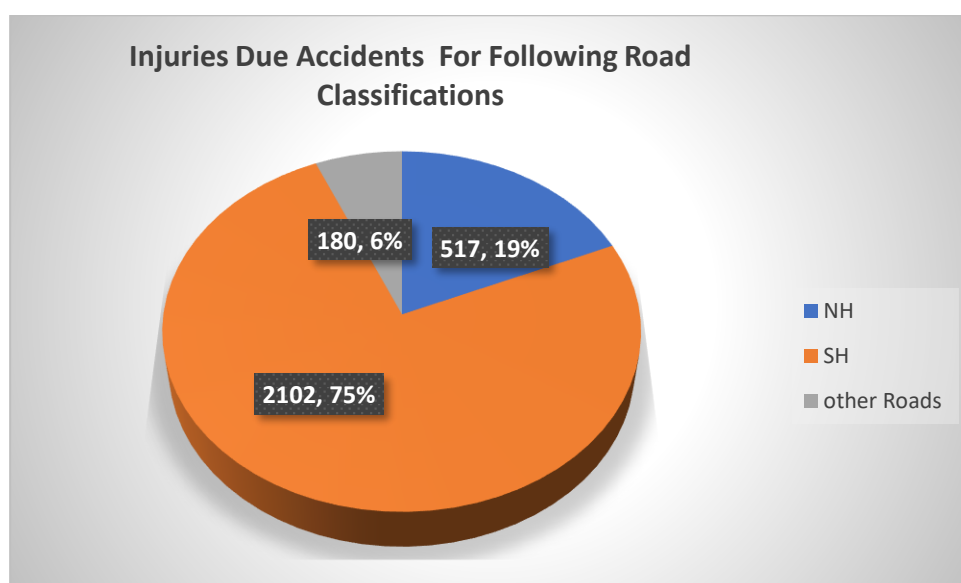


Fig 4.49 :- Pie chart depicting the distribution of total No. s of predicted injuries due to accidents over respective types of roads from year 2020 -2024

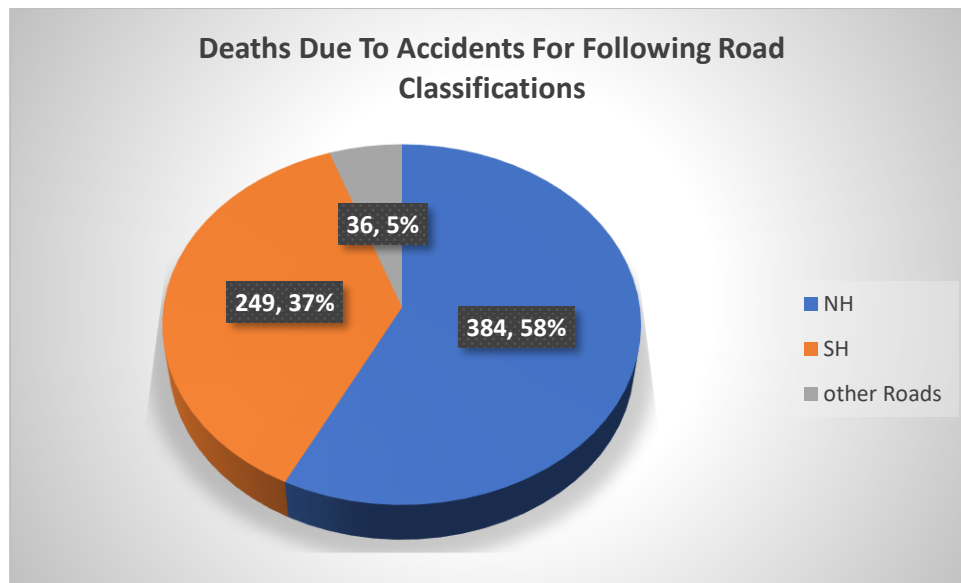


Fig 4.50 :- Pie chart depicting the distribution of total No. s of predicted deaths due to accidents over respective types of roads from year 2020 -2044

From Fig 4.46, 4.47, 4.48 ,4.49 and 4.50, the total No. s of accidents occurred on state highways is the highest in the year 2044 as 285, while in year 2020 being lowest as 113. The No. s of deaths were highest in the year 2044 as 22, Whereas lowest in the year 2020 as 9. The distribution over total No. s of accidents constitutes National Highways has 32%, state highway has 63% and 5% on the other Roads. The distribution of total No. s of injuries constitutes 32% cases from National Highway, 75% from state highway and 6% from the other roads. Whereas distribution for deaths constitutes 58% on National Highway, 37% on the State Highways and 5% on other roads respectively.

Table: 4.19(a,b): Representing Total No.s of predicted Accidents over Different Places predicted for year 2020 -2044

Table: 4.19(a)

Year	Rural Area (Nr. Educational Institution)	Rural Area (Nr. Residential Area)	Rural Area (Nr. Religious Place)
	Total	Total	Total
2020	3	5	7
2021	2	10	3
2022	4	6	8
2023	3	10	4
2024	5	7	9
2025	4	11	5
2026	6	7	9
2027	5	12	6
2028	7	8	10
2029	6	13	6
2030	8	9	11
2031	7	14	7
2032	9	10	11
2033	8	15	8
2034	9	11	12
2035	9	16	8
2036	10	12	13
2037	10	16	9
2038	11	13	14
2039	11	17	10
2040	12	13	14
2041	12	18	11
2042	13	14	15
2043	13	19	11
2044	14	15	16

Table: 4.19(b)

Year	Urban Area (Near School/College /Educational Institution)	Urban Area (Near Residential Area)	Urban Area (Near Religious Place)
	Total	Total	Total
2020	2	3	1
2021	3	6	1
2022	3	5	1
2023	4	7	1
2024	4	6	1
2025	4	8	1
2026	5	7	1
2027	5	9	1
2028	5	8	1
2029	6	10	1
2030	6	9	1
2031	7	11	1
2032	7	10	1
2033	7	13	1
2034	8	11	1
2035	8	14	1
2036	8	12	1
2037	9	15	1
2038	9	13	1
2039	10	16	1
2040	10	15	1
2041	10	17	1
2042	11	16	1
2043	11	18	1
2044	11	17	1

From the above drawn table one can observe that the maximum No.s of accident cases, are from rural area (Nr residential area) which is 301.

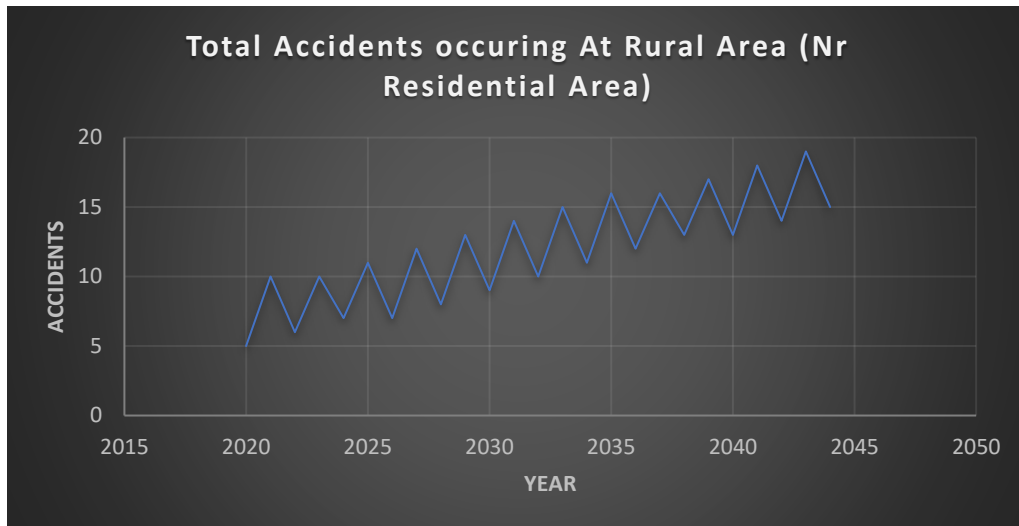


Fig 4.51 :- X, Y Scattered Graph Depicting Total No. s of predicted accident in Rural area (Nr. Residential Area) for year 2020 -2044

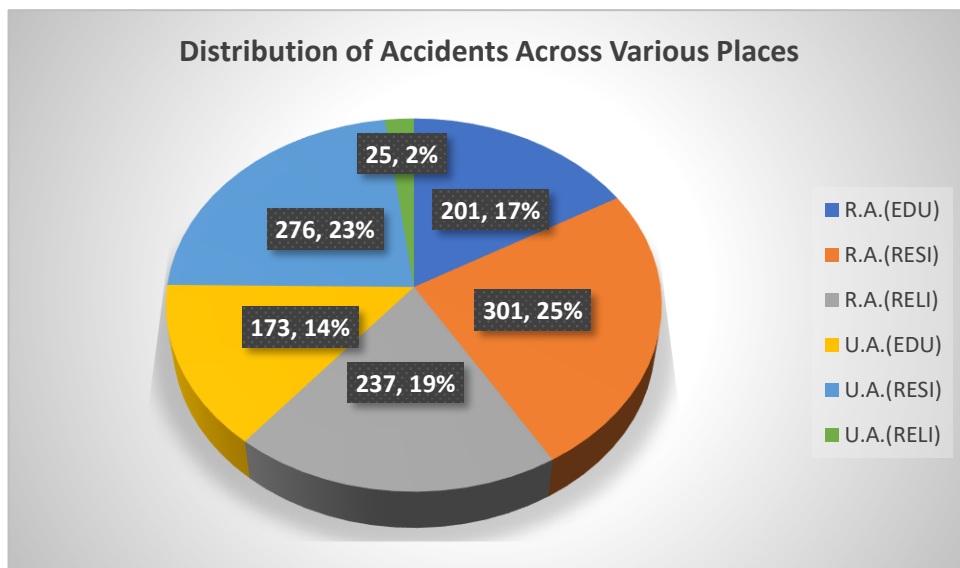


Fig 4.52 :- Pie chart depicting the distribution of total No. s of predicted accidents over place of occurrence from year 2020 -2044

From Fig 4.51 and 4.52 the total No. s of accidents occurred at the Rural area (Nr Residential area) highest in 2044 as 15 and lowest in 2020 as 5. The distribution of accidents at the respective places as follows 19 % from the rural area (Nr religious place), 25% from rural area (Nr residential area), 17% from rural area (Nr education institution), 2% from urban area (Nr Religious Place), 23% from the urban area (Nr residential area) and 14% from the urban area (Nr educational Institutions) respectively.

Table: 4.20: Representing Total No. s of predicted Accidents over the month of January to December predicted for year 2020 -2044

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	21	23	25	22	18	20	24	32	14	28	19	22
2021	22	18	30	23	11	26	25	16	16	25	19	21
2022	21	24	34	25	19	24	29	32	14	33	19	23
2023	21	17	38	26	11	31	30	16	15	29	18	22
2024	20	25	40	26	17	28	33	33	13	38	18	25
2025	21	18	44	28	10	35	35	17	15	33	18	23
2026	20	24	47	28	17	33	38	34	12	42	17	26
2027	21	18	51	30	9	40	39	18	14	38	17	25
2028	20	25	54	30	16	37	43	35	11	47	16	27
2029	21	18	58	32	9	44	44	19	13	42	17	26
2030	19	25	61	32	15	41	47	36	10	51	16	29
2031	20	18	65	33	8	48	49	20	12	47	16	27
2032	19	25	68	34	14	46	52	36	10	56	15	30
2033	20	18	72	35	7	53	53	20	11	51	15	29
2034	19	25	75	36	13	50	56	37	9	60	15	31
2035	20	19	79	37	6	57	58	21	10	56	15	30
2036	19	25	82	38	12	54	61	38	8	65	14	33
2037	19	19	85	39	5	62	62	22	9	60	14	31
2038	18	26	88	40	12	59	66	39	7	70	13	34
2039	19	19	92	41	5	66	67	23	8	65	13	33
2040	18	26	95	42	11	63	70	40	6	74	13	36
2041	19	19	99	43	4	70	71	24	8	69	13	34
2042	18	26	102	44	10	68	75	40	5	79	12	37
2043	19	19	106	45	3	75	76	24	7	74	12	36
2044	17	26	109	46	9	72	79	41	4	83	11	38

From the above drawn table one can observe that the maximum No.s of accident cases, are occurred in the month of march that is 1699.

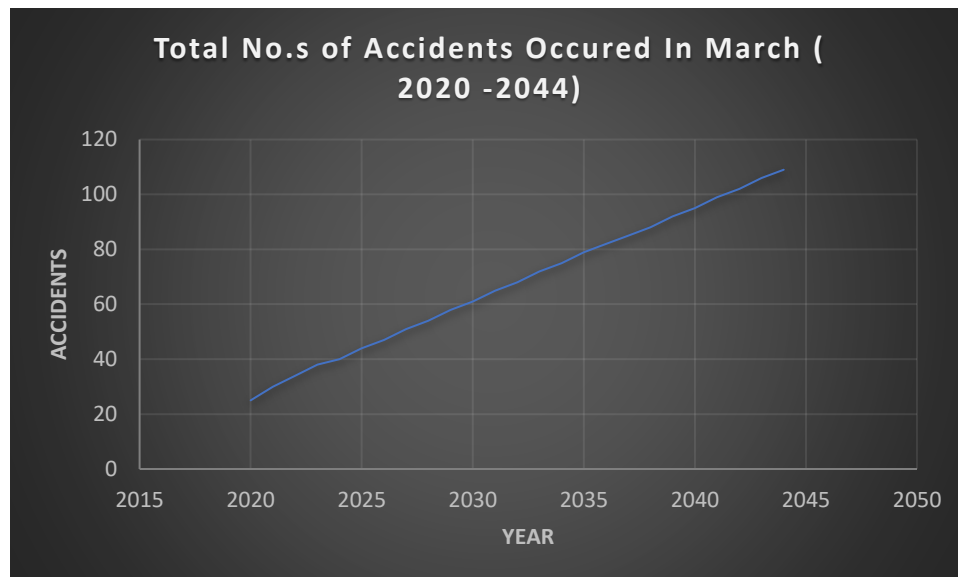


Fig 4.53:- X, Y Scattered Graph Depicting Total No. s of predicted accident in month of march for year 2020 -2044

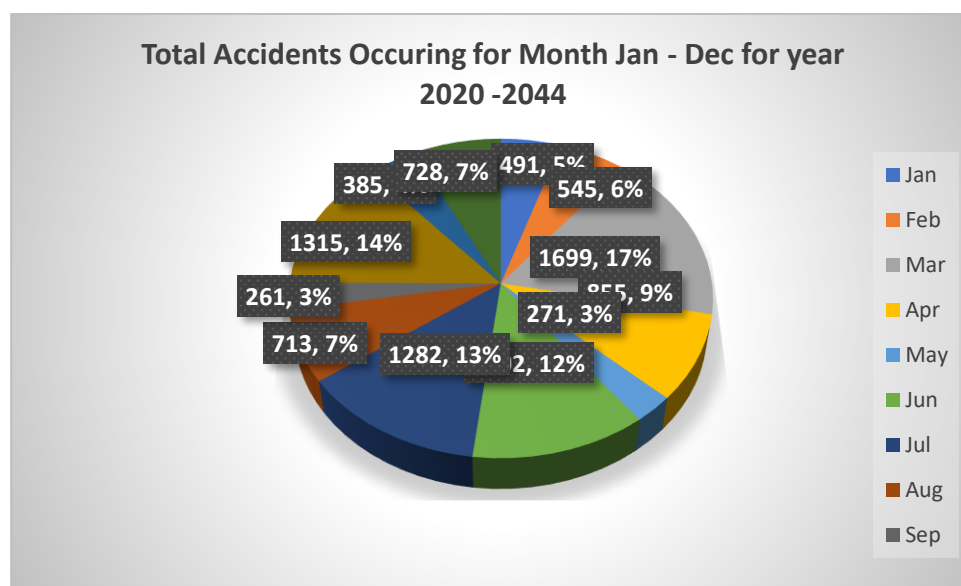


Fig 4.54 :- Pie chart depicting the distribution of total No. s of predicted accidents for the month January to December for year 2020 -2044

From Fig 4.53 and 4.54 the maximum No. s of accidents in the march is in year 2044 as 109 and lowest in the year 2020 as 25. The distribution of total No. s accidents is maximum for the month of march comprising 17% of the total accidents and lowest for the month of September being 3% of the total accidents for the predicted years of 2020 – 2044.

Table 4.21 (a,b) : Representing Total No. s of predicted Accidents for time 000hrs. – 2400hrs from year 2020 -2044

Table: 4.21(a)

Year	0000 hrs. - 0300 hrs.	0300 hrs. - 0600 hrs.	0600 hrs. - 0900 hrs.	0900 hrs. - 1200 hrs.
2020	9	12	36	37
2021	11	10	29	42
2022	13	14	40	44
2023	14	12	32	45
2024	15	16	43	47
2025	17	13	35	49
2026	18	18	46	51
2027	19	15	38	53
2028	21	19	49	55
2029	22	17	41	57
2030	24	21	52	59
2031	25	19	44	61
2032	26	23	55	63
2033	28	21	48	65
2034	29	25	59	67
2035	30	22	51	70
2036	32	26	62	72
2037	33	24	54	74
2038	34	28	65	76
2039	36	26	57	78
2040	37	30	68	80
2041	38	28	60	82
2042	40	32	71	84
2043	41	29	63	86
2044	43	34	74	88

Table: 4.21(b)

Year	1200 hrs. - 1500 hrs.	1500 hrs. - 1800 hrs.	1800 hrs. - 2100 hrs.	2100 hrs. - 2400 hrs.
2020	43	47	43	23
2021	42	41	40	27
2022	46	47	43	27
2023	45	40	40	28
2024	47	45	42	29
2025	48	39	39	30
2026	49	44	42	31
2027	55	38	39	32
2028	51	43	41	33
2029	54	37	38	34
2030	53	42	41	35
2031	56	36	37	36
2032	58	41	40	37
2033	55	34	37	38
2034	57	40	39	39
2035	60	33	36	40
2036	59	39	39	41
2037	64	32	36	42
2038	63	38	38	43
2039	61	31	35	44
2040	62	36	38	45
2041	66	30	34	46
2042	69	35	37	46
2043	65	29	34	48
2044	68	34	36	48

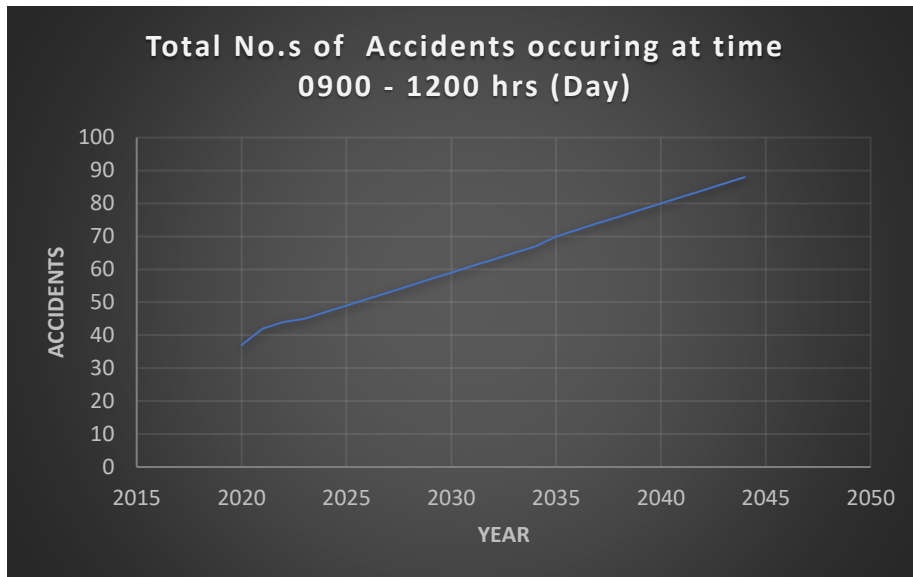


Fig 4.55 :- X, Y Scattered Graph Depicting Total No. s of predicted accident for time 0900hrs. - 1200hrs (day) from year 2020 -2044

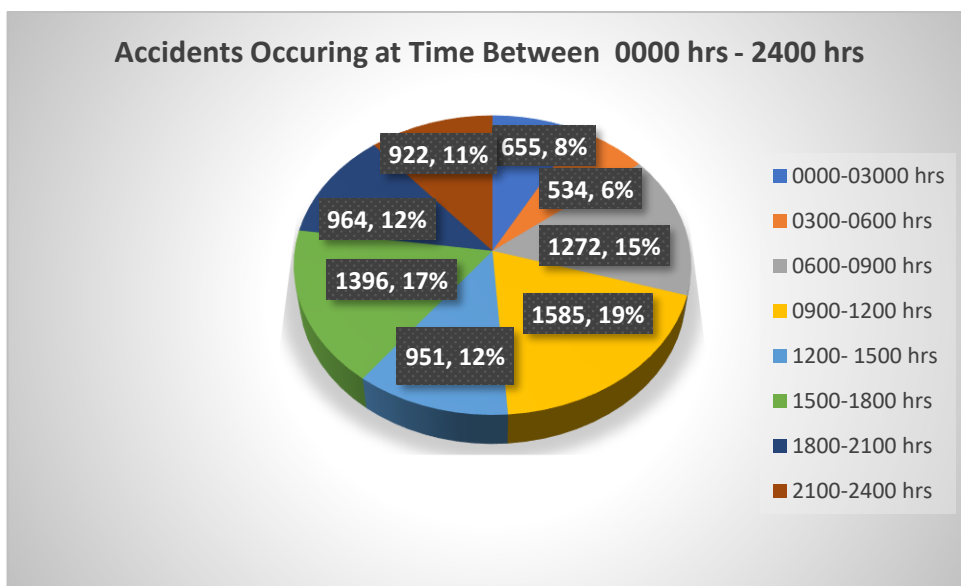


Fig 4.56:- Pie chart depicting the distribution of total No. s of predicted accidents at respective time of occurrence from year 2020 -2044

From Fig 4.55 and 4.56 the maximum No. s of accidents for the time duration 0900 hrs. – 1200hrs. is in year 2044 as 88 and lowest in the year 2020 as 37. The distribution of total No. s accidents is maximum for the time duration 0900 – 1200 hrs. constituting 19% of the total accidents and lowest for the time period 0000 – 0300 hrs. being 8% of the total accidents for the predicted years of 2020 – 2044 respectively.

CHAPTER 5

SUMMARY AND RESULTS

5.1 SUMMARY

5.1.1 FINDINGS FROM THE FORECASTING AND STATISTICAL MODELLING

The forecasting model has provided a comprehensive data for accident cases projected for the year 2020 -2044.

Involving various risk factors which can be responsible for the future accidents and hence based upon that we can find the possible mitigatory measures for its prevention.

The pavement features and climate also play an important role in providing the mitigatory measures.

The highest risk considering the causes is over speeding which accounts for 3169 accident cases, 3102 and 487 deaths, which is highest amongst all the other causes over a course of 25-year 2020 -2044.

The risk considering the type of roads the State Highways can be most vulnerable accounting 4967 accident cases, 2101 injuries and 249 deaths for the next 25 year.

Whereas the mode of transport which is venerable is two – wheeler (motorized) which accounts 584 cases of accidents and pedestrian being the most vulnerable non – motorized mode of transport having 785 cases of accidents for the next year.

Considering the place of occurrence most of accidents obtained for rural areas (Nr. Residential Area) accounting 301 accident cases.

While based on time of occurrence the most accidents can occur for the time 0900hrs. – 1200hrs accounting 1585 cases of accidents.

Whereas for the month march has the maximum No. s of predicted accidents which is `1699.

Summarizing to whole forecasting there could a total of 5810 accident cases , 9870 injuries due to it and 216 deaths can occur over 25 years (2020 -2044).

The statistical model builds up direct relationship between total No. s of accidents and precipitation in mm.

Building up linear relationship forming an equation $y = 0.139656489x + 16.79800347$

Where, y = No. s of Accidents, x = Precipitation (in mm) , 0.139656489 is the co-efficient and 16.79800347 is intercept .

5.1.2 RECOMMENDATIONS

With the analysis done over project work, it is inferred that the present situation and future situation does cope with the pedestrian facilities and the study area lacks it.

Here are, several recommendations which can help to avoid the future accidents, they in the adherence of the IRC codes, provisions and guidelines, whereas certain recommendations are based sole observation.

According to **clause 10.2 (IRC: 70 -2017)** green Corridors can be provided in the study area, they are corridors sideways of natural landscapes such as lakes, water bodies and parks can be established as exclusive facility for walking. Motor vehicle are prohibited on this establishments. A clear width of 4m should be provided for the pedestrians.

According to **clause 10.3 (IRC: 70 - 2017)** footpaths can be provided in the study area, footpaths endorse safe and easy pedestrian movement by separating two – wheelers and cars from them. A major percentage of trips, particularly under 2 km, are carried on foot. Hence accommodating pedestrians is an essential.

Some of the norms and principles to design footpaths are given below:

A multi – functional, pedestrian and frontage zone should be included in the footpath as cited in IRC 103: “Guidelines for pedestrian facilities”, the width of footpath depends upon the pedestrian volume and must be decreased and increased accordingly.

The footpath must have a maximum height of 150 mm above the carriageway, the respective surface should be smooth and uniform for all the users including those with the walking disabilities (on wheelchair). The gratings ought to be flushed and levelled, openings should not exceed 10mm (wide) and must have slip resistance. The gratings should not entrap little wheels in case of using wheelchair or a shopping trolley.

Existing vehicle leaving, intersection boxes and different blocks will be taken out or readjusted, to let loose space for footpaths and focus on road conveniences like road furniture, finishing, and trees.

Footpaths and different components of it ought to be available to all, in consistence with space standards for barrier free built and Ministry of Urban Development's Guidelines, for Elderly persons and People of disabilities (2016).

According to **clause 10.4 (IRC: 70 – 2017)** a median decreases struggle between inverse headings of traffic and goes about as common shelter yet has continuous enough breaks to debilitate engine vehicle users from driving off course. Medians can help smooth out traffic and guarantee security on higher-speed roads where there is a danger of crashes including right-turning traffic. Moreover, they keep speeding drivers from intersection into the contradicting roadway. Medians improve security for walkers by working as shelter islands, which permit people on foot to cross each bearing of movement in turn. Focal medians can oblige different components like lighting, arranging, walker and cycling streets, utilities, ad sheets and so on Medians that broaden excessively far with no chances to cross, turn right, or make a U-turn make the opposite side unavailable and superfluously increment the all-out distance voyaged. They support vehicle development on some unacceptable side, consequently bargaining wellbeing. Subsequently, the arrangement of breaks in a middle at fitting spans is basic. In some cases, guardrails or high controls are worked to keep people on foot from going across the road. In any case, they are conquered in any case. In the event that a middle isn't adequately wide, walkers may gush out over into the carriageway while trusting that traffic will clear. The suggested width of the middle ought to be 2.0 m to oblige the length of wheelchair. The base width of median must be 1.2 m minimum (IRC:103). Hence the provision of a median has to be made.

According to **clause 10.5 (IRC: 70 -2017)** Grade separated facilities, for example, skywalks and foot over bridges are regularly hazardous, distant and badly arranged to numerous beneficiaries. skywalks to connect rail line or public vehicle terminal walker spans with key objections, given that doing so doesn't bargain passerby, non-mechanized vehicle and vehicular framework underneath the skywalk. Skywalks ought to be incorporated deliberately with the abutting land use, mass quick travel stations, Intermediate Public Transport stands and markets. They ought to be sufficiently bright, effectively available and safe.

According to **clause 10.6.1 (IRC: 70 -2017)** Traffic furniture, that vehicles from diverting or mounting on the footpath are known as bollards. Bollards must be present at the practical locations to prohibit the entry of bicycles into the footpaths. Two bollards should be separated by clear space of 1.2 m. Staggered bollards don't restrict bikes and make it harder for them to go through, while permitting advantageous access for wheelchair users and cyclists.

According to **clause 10.6.2 (IRC: 70 – 2017)** presently developed guard rails hinder user's admittance to pathways. Their reasonable use can assist with guaranteeing that passer-by go across the roads at foreordained and safe areas. As the guard rails would restrict the development of pedestrians to the pathway, it is necessitated that adequate width of trail be made accessible (IRC:103).

According to **clause 10.6.4 (IRC: 70 – 2017)** crossfalls should just be given where it is essential to provide seepage and ought to be 1:50 most extreme. On the off chance that the adjustment in cross fall is extreme to such an extent that one a foot of a pedestrian or wheel of a wheelchair leaves the ground, it might make the wheelchair or pedestrian fall. More extreme slopes will in general mislead carts and wheelchairs. Where falls are not satisfactory, sediment will gather after rain and cause the surface to get slip prone.

According to **clause 3.2.2. (IRC: SP 44 - 1996)** In the event that there is no Kerb pathway, or assigned shoulder, the people on foot should walk near the correct roadside with the end goal that they are confronting the approaching traffic and can see it walkers should keep as near the roadside and not walk in excess of two next to each other. They should keep one behind the other if conceivable, especially in hefty rush hour gridlock or in helpless light and at corners.

According to **clause 3.2.3. (IRC: SP 44 - 1996)** Kids, up to the age of seven ought not be permitted alone out and about. Elderly persons should go with them and they should be in between the traffic and the children. They should consistently keep their hands held tightly and they should allow the children run into the streets.

According to **clause 3.2.5. (IRC: SP 44 - 1996)** Blind people strolling along a street should convey one stick/leave painted brightly or fixed with bright tapes of adequate width. Wearing of bright colored garments is a must requirement.

According to clause **3.2.6. (IRC: SP 44 - 1996)** A group of people marching on the road (e.g., returning from work at night) should keep to the left.

According to clause **3.5.4. (IRC: SP 44 - 1996)** Strolling in downpour, perceivability from vehicles is diminished because of downpour along these lines as around evening time. Street surface gets slippery and strolling and halting distance of vehicles and different vehicles increments. While coming down, people on foot additionally risk slipping and falling. People on foot should not, thusly, block their vision by umbrella and leave a lot of time for intersection. Stay away from run across the street.

From the analysis and regression modelling, it is found that the rainfall directly affects the number of accidents occurred, hence recommendations are provided with the adherence of IRC with guidelines and provision for driving safely in rain.

According **clause 6.15.2. (IRC: SP 44 – 1996)** at the point when it downpours, perceivability is chopped down, windscreen gets misted over, street surface gets dangerous and walkers in their tension to try not to get drenched stumbled into the streets. Consequently, drive gradually and keep longer distance between the vehicle in front and offer manner to walkers. carefully and maintain a significant distance from abrupt beginning, overwhelming and turning. Such moves can cause slips and overwhelming under wet conditions. Downpour mollifies the ground and can cause avalanches. Try not to get excessively near the external edge of winding slope streets, Because of the oil and mud which progressively coat the outside of cleared streets, they are most tricky when it initially starts to rain and before oil and mud moves washed away. At the point when you go through a profound puddle of water there is threat that water spills into the brake drums making the brakes breakdown. As such abstain from going through profound water and in the wake of going through, test the brake and press the water out by rehashed utilization of brakes till the brakes grab hold. Moderate down under such conditions. Be certain that your breeze screen wipers are good to go. Keep the windscreen clean of residue, oil and so on At the point when your inside glass mists up clean it with dry material and open the side window. Put on the radiator whenever introduced in the vehicle.

From the analysis it is predicted that the two are going to have maximum numbers of accidents in the upcoming years, hence with the adherence of the IRC provision the accidents from two-wheelers can be avoided

As indicated by **Clause 1.3 (IRC: SP 44 – 1996)** evade power stops or abrupt turning, continue to check the street surface ahead for tricky spots, street knocks, broken asphalts, free rock, wet leaves or articles lying out and about. Search in front for vehicles halting or turning ahead. Prior to turning, check back see reflect for following vehicles and gauge its separation from you. Record for convexity of mirror at the same time: Before changing path and making a turn make a last head check by turning your head and seeing over the shoulder for traffic behind you. Turn just in the event that it is protected to turn and demonstrate fitting arm signal. Keep distance among yourself and different vehicles. Under conventional conditions, keep in any event two seconds distance among yourself and the vehicle ahead. While overwhelming get well far from the vehicle to maintain a strategic distance from a side swipe, leaving huge horizontal hole to an enormous truck. These vehicles can make blasts that can influence your controls. You have more space for blunder on the off chance that you are in your path. Try not to overwhelm from some unacceptable side or from where you are not anticipated. Try not to impart a path to another vehicle. Try not to ride between vehicles. Deter others from imparting the path to you by keeping in the focal point of the path. Watch out for dangerous and lopsided surfaces, furrows and grinding, and decrease speeds at turns. For halting consistently utilize both the brakes. Apply front brake consistently without locking the wheel, it gives 3/4th of your slowing down power. Utilize back brake at the same time without locking the wheel. Try not to utilize front brake alone or you may topple. Make a snappy go to try not to hit the obstruction in front. While riding in bunch, stay away from others and drive in staggered arrangement with 2 seconds distance between riders. While surpassing do it each in turn. Try not to drive when you are exhausted, smoking or affected by liquor or medications. Riding an engine cycle is undeniably more requesting than driving a vehicle. Stop, pause and rest till you are typical.

Over speeding has been prime cause of road accidents, as it is observed from the predicted database

Recommendation to avoid to accidents due over speeding are as follows -:

According to IRC – SP- 84-2014 the design speed for highways can be as follows referring to clause 2.2.1 and table 2.1

2.2.1 The design speeds given in Table 2.1 shall be adopted for various terrain classifications (Terrain is classified by the general slope of the ground across the highway alignment

while speed limits for various types and classes is issued by Ministry of Road Transport (April 6th 2018)

Miscellaneous Recommendations -:

From the observation at the study, it is found certain geometric and road user feature missing at the respective pavements therefore following are the recommendations that can be adhered.

- I. Provide street light along the length of pavement.
- II. Tie all the animals such as cow and buffaloes before 5:00pm to avoid accidents.
- III. Provide street furniture's like washrooms for the road users.
- IV. Provide medians wherever necessary.
- V. Provide side drains, culverts and main drains.



Figure 5.1(a)



Figure 5.1(b)

Figure 5.1(a) and 5.1(b) showing there is no street light on the highway and domesticated animals like cow is sitting on middle of road

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