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Road Accidental Analysis and Safety Measures: Case Study of Rajasthan State Highway SH-35 (Jhunjhunu-Churu State Highway)

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ABSTRACT

In current scenario, according to the World Health Organization (WHO), crashes of motor vehicle kills about 1.2 million person every year. This is set to increase to 2 million by 2020 untill new safety measures are taken, making injuries in road traffic the third largest cause of death and disability. This paper presents the road accidental analysis on the SH-35 in the state of Rajasthan, India According to the National Crime Records Bureau (NCRB), Ministry of Road Transport and Highway, Law commission of India, Global status report on road safety 2015. One serious road accident in the country occurs each minute and 16 looses their life on roads in India every hour. Delhi (City), Chennai, Jaipur, Bangalore, Mumbai, Kanpur, Lucknow, Agra, Hydrabad, Pune are the top 10 cities with highest number of road death SH-37 is one of the main connectivity from Jhunjhunu to Churu which deals with carriage of the light goods to heavy goods and passenger by bus, truck, car, taxi, motorcycle, tractors etc. Study area was undertaken on road SH-37 from Jhunjhunu to Churu with stretch km 164 to km 211 in Rajasthan state. The increase in vehicle population also make a rise in number of accidents every year. The accident data is analyzed using accident frequency and severity index method. The safety deficiencies were detected to minimize accidents and save the road users.

INTRODUCTION

The State of Rajasthan is one of the most attractive destinations in India and has a conspicuous place on the tourist map of the world. Rajasthan is the largest state in the country geographically, which contributes 10.41 per cent area of the country and 5.67 per cent of national population (census 2011). Healthy transport system is a symbol of good economic health and development of a state. As on 31st March, 2015, the state has highways of total length aprox. 190402 Kms. The density of road in the state is 55.63 km per 100 sq. km. share of registered vehicles in state is 5.65% of total of the India.

Nearly 1.3 million persons die looses their each year on the roads in world, and up to 50 million are injured. Traffic fatalities measured by the proxy of motor vehicle registrations and population, rising traffic volume makes an increase in fatalities per capita. In India, the motor vehicle population is increasing at a higher rate than the economic and population growth. The road network facing the problem of road accidents with the expansion in motorization. Different studies already have been done to linking road traffic fatalities with vehicle ownership, regional population and economic growth.

The lack of initiatives on better roads is the absence of reliable and quality information on safety measures. The data available with the hospitals, insurance, police and legal sectors is disintegrated and needs major revamping. The Surveillance Project in integrated Disease of the Ministry of Health and Family Welfare (MHFW) recognizing this problem proposes to include the injury module as an surplus component. There is a need to develop and a model for surveillance of road traffic injuries to be tested for inclusion in the health information system.
Road Accident Scenario in India

Mobile phones and personalized vehicles in India are increasing with the same growth rate. As an estimate India have that number of cars only if put them together in a single lane, it will reach from New Delhi to New York. Projection of the present trend of vehicles usage reveals a rather ugly and unsustainable situation both in terms of traffic congestion and safety. For instance while the population of India increased by 17.64 percent over the past ten years, the number of licensed vehicles increased by 132 percent over the same period.

According to official statistics, 430,654 people were killed in road traffic crashes in India in 2015 (NCRB 2015). The

situation in India has worsened in recent years. Traffic fatalities increased by about 5.5% per year from 2014 to 2015. This is attributable partly to an increase in the number of vehicles on the road, and partly to the absence of a coordinated official policy to control the problem.

1. 463 Deaths and 1501 injuries per day due to Traffic Accidents.
2. 337 Deaths per day and 1240 injuries per day due to Road Accidents.
3. 73 Deaths per day by Truck/Lorry and 77 deaths by Two-wheeler.

The loss to the Indian economy due to fatalities and accident injuries estimated at 3% of GDP in 1999-2000 is particularly severe as 53.1% of road accident victims were in the age group of 25 to 65 years in 2012, with pedestrians, bicyclists and two-wheelers, who comprise the most unprotected road users, accounting for around 40% of all fatalities. Motor vehicle population has grown at a compound annual growth rate (CAGR) of 10 percent 2009-2015, during fueled by a rising tide of motorization. Concomitantly, traffic risk and exposure have grown. During the year 2014, there were around 5 lakh road accidents, which resulted in deaths of 134,513 people and injured more than 5 lakh persons in India.

Road Safety Concern in India

The road accidents deaths and injuries are global phenomena but more sever situation in mixed traffic condition as prevailing on Indian multilane highways. Concept of quality management and sustainable safety have gained ground in the past two decades and may have been among the factors that led policymakers and project managers to realize the need for purely safety -oriented tools. Road Safety Audit (RSA) was originated in Great Britain (1980) is now spread in several countries around the world. The RSA system established in UK spread to USA, New Zealand, Australia, Denmark, Canada, Malaysia, China, Japan and Singapore and now it is used as a model in many countries for the formulation of guidelines and planning of their trunk roads. It is at varying stages of implementation in developing countries like India, South Africa, Thailand, Egypt, Pakistan and Bangladesh.

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Road fatality rates in India are probably among the highest and out of 1.25 million deaths worldwide every year, 10 per cent (about 125,000) of all road deaths are in India.

Table 1. Number of road accident and number of persons involved 2005-2015

Year	No. of Accidents		No. of Persons		Accident Severity *
	Total	Fatal	Killed	Injured	
2005	406726	73589(18.1)	85998	435122	21.1
2006	429910	79357(18.5)	92618	464521	21.5
2007	439255	83491(19.0)	94968	465282	21.6
2008	460920	93917(20.4)	105749	496481	22.9
2009	479216	106161(21.1)	114444	513340	23.9
2010	484704	106591(22.0)	119860	523193	24.7
2011	486384	110993(22.8)	125660	512458	25.8
2012	499628	119558(23.9)	134513	527512	26.9
2013	497686	121618(24.4)	142485	511394	28.6
2014	490383	123093(25.1)	138258	509667	28.2
2015	486476	122589(25.20)	137572	494893	28.3
Source: Information supplied by states/UTs (Police Department). **Figure with parentheses indicate share of fatal accidents of total accidents.** **Accident Severity: Number of person killed per 100 accidents.**					

LITERATURE REVIEW

Reshma and Sheikh (2012) in their study prioritized some of the major accident spots generally referred to as black spots in South Bangalore by using ArcGIS software by assigning possible weights for various accident components. Nagarajan and Cefil (2012), used remote sensing (RS) & GIS for identification of black spots and accident analysis for a particular stretch of NH -45 starting from Tambaram to Chengalpet. Eleven accident locations were identified in the study using high resolution satellite map (IKONS) based on the non-spatial data collected from police department and the field survey conducted in terms of traffic volume and vehicle spot speed, and plotting of the study stretch using Arc GIS software.

Binu B Pillai and Dr. Kurian Joseph (2011) , in their study on Causes and Consequences of Road Accidents in Kerala, pointed, the main causes of road accidents in Kerala are Over speeding and unhealthy competition of vehicles, poor surface conditions, road cutting, lack of pedestrian crossing facilities, uncontrolled access streets and unmanned junctions, bad driving habits and lack of discipline by road users, haphazard parking on road side, absence of proper bus bay and shelter, visual acuity of drivers, encroachments/dumping of materials on road, and protruded lamp post, unscientific check barriers, speed breakers etc.

Wedagama (2010) did a study to investigate the influence of accident related factors and found that the fatality of collision with pedestrians and right angle accidents were respectively about 0.44 and 0.40 times lower than collision with other vehicles and accidents due to other factors. However, light vehicles were 1.67 times more likely than with other motorcycles. Collision with pedestrians, right angle accidents, and heavy and light vehicles were respectively accounted for 31%, 29%, and 63% of motorcycle fatal accidents.

Goswami and Sonowal (2011) did a statistical analysis of road traffic accident data for the year 2009 in Dibrugarh city, Assam, India. Data interpretation was done using Degree of freedom, Chi–square test for goodness of fit, χ 2 – test for independence of attributes and Kruskal - Wallis test. They found that human characteristics (rush and negligence) make 95.38% of the total RTAs. 60% of the accidents were recorded during day time (6 AM to 6 PM). The peak time was between 12 PM to 6 PM (38.46%). The highest numbers of accidents (32.30%) were observed in the heavy rainy season during the months of July –September.

CASE STUDY

1. Objectives of study

i. To study the accident rate on the selected stretch of SH-37.
ii. To study the effect of traffic volume, density and capacity on accident rate of SH-37.
iii. To study the maintenance of road surface and shoulder on rate of accident.
iv. To study the various causes of accidents on SH-37.
v. How to minimize the road accidents.

2. Site Selection for Study Area

Two-lane road from Jhunjhunu to Churu on SH-37 was chosen. For this study the following stretches were selected for data collection. The study area is shown in fig. 1.

(i) Jhunjhunu to Bissau Km 164 to Km 198
(ii) Bissau to Churu Km 198 to Km 211

Fig 1. Study area Source: Google Map

3. Data collecion

Data collected from Police Records

The information available for accident studies is the FIR (First Information Report) lodged in the police stations. The data from these records of last ten years (2005-2015) were extracted from the FIR record filed under IPCno.279/337/338/304 (A).Vehicles those involved in accidents and reported in the F.I.R. The categories of vehicles include tempo, auto, mini-truck, minibus, Tata indica,Tata-407,trecker,motor cycle, tanker, tailor(articulated vehicle) truck and bus.

With the prior permission of the concerned S.P, the accident data were collected on two-lane state highway from three police stations as shown in Table 2.

Table 2. Police stations and road sections covered

S.No.	Police Station	Road section covered under the police station
1	Jhunjhunu	Km 164 to Km 191 on SH-37
2	Bissau	Km 191 to Km 201 on SH-37
3	Churu	Km 201 to Km 211 on SH-37

The police stations have their own FIR records of several years. The data from these records of last ten years were extracted from the FIRs filled under IPC NO.279/337/338/304 (A). Accident details during 2005-2015 on this road section are shown in Table 2. Accident data were collected year wise from each police station records then sorted out month wise. Average yearly variation of accidents stretch wise during 2005-2015 are shown in Table 3.

Table 3. Details of Accidents

Year	Fatal	Major injury	Minor injury
2005	**16**	**18**	**37**
2006	**11**	**35**	**48**
2007	**21**	**24**	**39**
2008	**22**	**29**	**43**
2009	**18**	**34**	**49**
2010	**19**	**21**	**41**
2011	**28**	**29**	**55**
2012	**24**	**31**	**48**
2013	**29**	**34**	**59**
2014	**25**	**30**	**62**
2015	**28**	**33**	**68**
Total	**241**	**318**	**549**

Table 4 Details of accident stretch wise

	Fatal			Major			Minor		
Year	**S1**	**S2**	**Total**	**S1**	**S2**	**Total**	**S1**	**S2**	**Total**
2005	11	5	**16**	10	8	**18**	20	17	**37**
2006	6	5	**11**	23	12	**35**	22	26	**48**
2007	15	6	**21**	12	12	**24**	29	10	**39**
2008	12	10	**22**	16	13	**29**	20	23	**43**
2009	9	9	**18**	12	22	**34**	25	24	**49**
2010	10	9	**19**	11	10	**21**	14	27	**41**
2011	15	13	**28**	13	16	**29**	25	30	**55**
2012	13	11	**24**	15	16	**31**	28	20	**48**
2013	19	10	**29**	17	17	**34**	39	20	**59**
2014	15	10	**25**	18	12	**30**	45	17	**62**
2015	18	10	**28**	22	11	**33**	48	20	**68**
Total	143	98	**241**	169	149	**318**	315	234	**549**

S1- Stretch 1 S2-Stretch 2

3.3 Data collected from P.W.D Records

P.W.D (Public Works Department) records are the main source of details of road. The performa used to record these details is shown in Table 5

Table 5 Performa for details of road section

Width of carriageway in mt.	7
Width of Formation in mt.	9

Table 6 Traffic volume data

Year	ADT (Average Daily Traffic)	Average PCU per day	PCU/Hour
2005	12876	21889.20	912.05
2006	13654	23211.80	967.16
2007	13943	23703.10	987.63
2008	14273	24264.10	1011.00
2009	14453	24570.10	1023.75
2010	15872	27141.12	1130.88
2011	15430	26385.30	1099.39
2012	14831	25509.32	1062.89
2013	15239	26058.69	1085.77
2014	16240	27770.40	1157.10
2015	16558	28148.60	1172.86

4. Analysis of data

Accident Rate= $\frac{M}{L}$

Where M= Total no. of Accidents of a stretch

L= Length of Road

Table 7: Accident Rate

Name of Stretch	Length	No. of accidents in year	
		Sum of 10 years	Accident rate
Jhunjhunu to Bissau (S1)	**34 km**	**379**	**11.147059**
Bissau to Churu (S2)	**13 km**	**127**	**9.7692308**

Annual Variation in Accidents

Fig. 7 shows the annual variation in accidents of total stretches during year 2005-2015. It is observed that percentage accidents are increasing relatively in most of the year. In the year 2015 accident rate was high and low in the year 2005. It may be due to increase in the vehicle population, urbanization, increase in population and some time bad traffic environment.

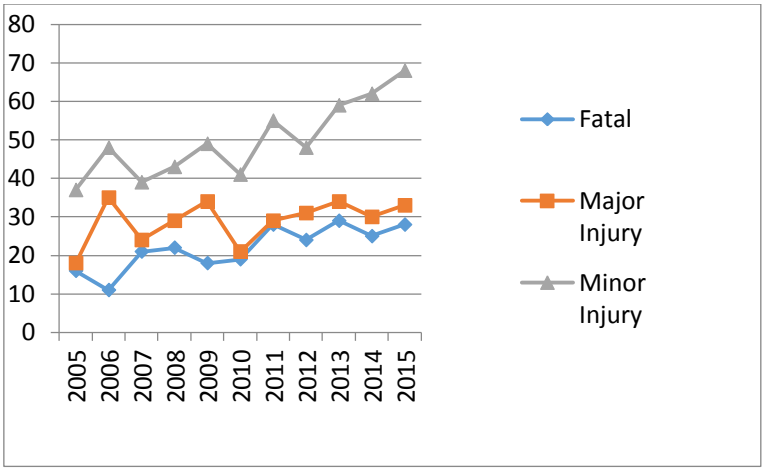

Fig. 8: Annual Variation in Accidents

Fig. 8: shows annual variation in accidents of the twostretches. It is observed that no of accidents are more for stretch-1 than stretch 2 .This is because of high traffic volume on stretch 1. Traffic volume decreases on stretch-2. Stretch-1 has high population density as this is also the long stretch. Accident rate is more due to more no of commercial and noncommercial vehicles on the road, bad traffic environment.

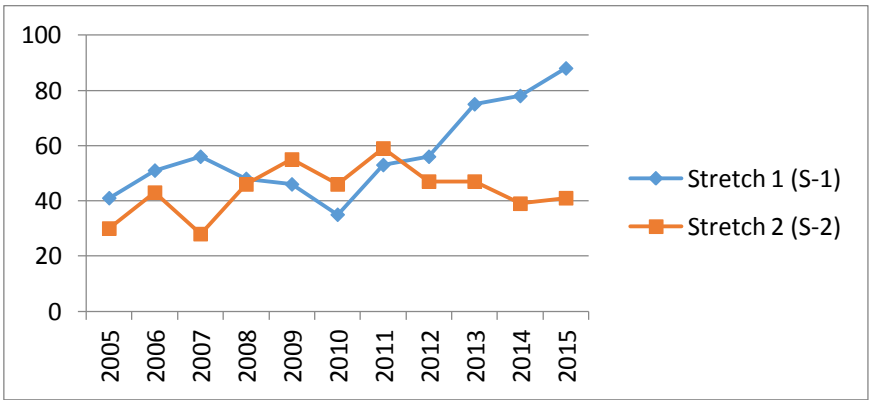

Fig. 9: Annual Variation in Accidents of S-1 and S-2

Monthly Variations in Accidents

Fig 9: shows the monthly variation in accident. Peak accident occurs in summer season and in winter season i.e. in the month of May, June, December and January. Problems in the summer months are due to inconvenient heat which results in bursting of tyres and excess heat in vehicles engine. Problems in winter months are accident due to insufficient sight distance due to fog.

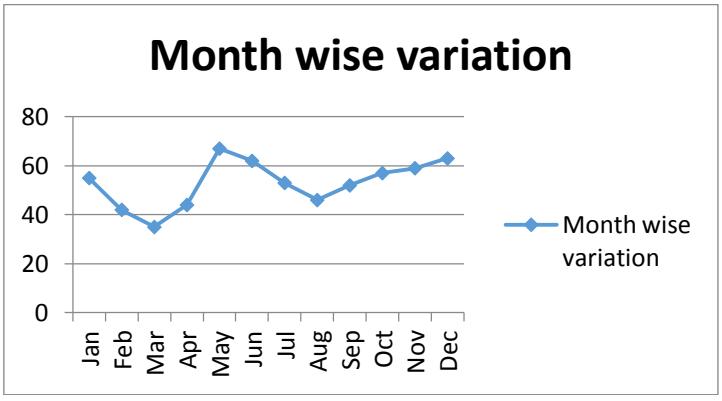

Fig 10: Monthly Variations in Accident

Vehicles involved in fatalities

Vehicle involved in fatalities during 2005-2015 are shown in pie chart in the terms of percentage. The results indicate that 36% of fatalities are due to trucks and buses, 32% of fatalities are due to car and utility vehicles, 21% of fatalities are due two wheelers, 16% of fatalities are due tempo and 5% fatalities are due to others motorized and non-motorized vehicles. The percentage of fatalities are high in case of trucks and buses, car and utility vehicles because this means of transportation is used for long distance and carrying for goods in stipulated time so this will results in speedy and rough driving some time drivers consumes alcohol which results in bad reaction time and such acts results in road accidents.

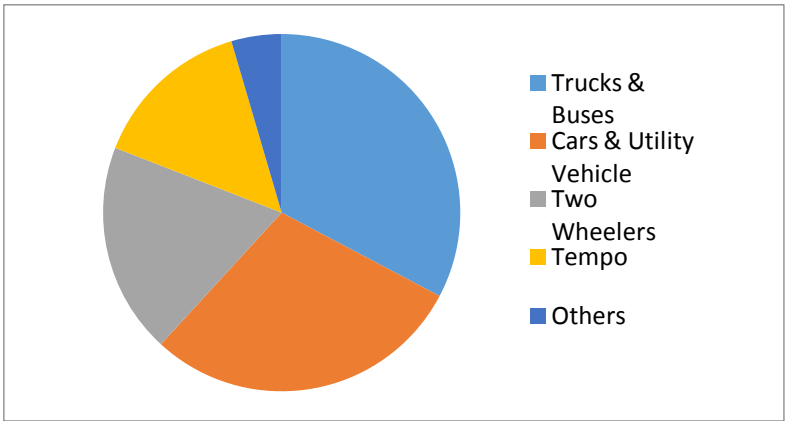

Fig. 11: Vehicle involved in fatalities

Road side features data

The study area are consists of two stretches S1 and S2. Stretch S1 lies between Km 164-Km198 and Stretch S2 lies between Km198-Km 211.

Stretch S1 consists of curves on the way. During studying I found that the wearing course of the pavement is destroyed and having potholes which is due to extreme variations in the temperature in summer and winter season this will results in riding discomfort to small vehicles like cars and motorcycles.

Stretch S2 consists of some high vertical curves. In S2 some places the width of the wearing course is getting short and some where its reduced to 6 mt also. The edges of both side are destroyed maximum times. At a sharp curve after Bissau the inner edge is totally damaged which results in riding discomfort and accidents.

A common problem which is seen in both the stretches is that at the curve the signs boards are damaged or they fed off due to sunlight, they are not properly glowing in night times. At the curve the highway delineators are invisible or partially visible due to considerable height of bushes around the highway delineators.

CONCLUSION

Accident Investigation
Accident No. 1
Accident type: Head-on collision
Location: Maarigsar Stand
Date and Time: May 4, 2015, 4:50PM
Vehicle 1: Tata Truck
Vehicle 2: Hero Honda Splendor motor cycle
Fatalities/Injuries: One person dead on the spot and one person severe injured.

Description: On 4th May 2015 one Hero Honda Splendor motor cycle with two person collided with a aluminium loaded truck at Kabirsar stand around 4.50PM.The motor cycle was coming from Churu and truck was going on highway towards Churu. The motor cycle rushed to the right side of truck front. The truck applied brake and turned towards left side. The bike fell down under the rear right wheels. The victims were severely injured. The rider lost his right leg completely and left leg scratched while other was under truck with severe knee and head injuries. The rider had used helmet and saved from head injury. The ambulance came after 30 minutes and took victims to the hospital. The victims were two brothers from Jajpur town and rider lost his life after two hour of incident. Cause of accident was due to overtaking the long truck. The motor cycle could not notice the truck due to the high speed and collided with truck on the highway. The accident photo is shown in fig 12

Fig 12: Maarigsar accident photo

Accident No. 2
Accident type: Collision with tree
Location: Nand Stand
Date and Time: June 14, 2014, 12:50PM
Vehicle 1: Ashok Leyland trailer
Vehicle 2: Bajaj Auto (3 Wheeler)
Fatalities/Injuries: Two persons minor injured

Description: The trailer was on the highway with normal speed. At a T-junction one auto with nine passengers was changing direction (left turn) from bus stop road to highway. Both vehicles became front to front. The trailer driver applied sudden brake and stroked the vehicle with a old tree present at corner of junction. The auto was escaped from collision. Driver and helper became injured. The accident diagram is shown in fig. 13.

Fig 13: Nand stand Accident Photo

Conclusions and Recommendations

1. The cause of the maximum number of accidents is faulty construction practices on SH-35.
2. The stretch S-1contains more no of accidents as comparison to stretch S-2. This is due to also that length of the stretch S-2 is less than the S-1.
3. Overtaking of the vehicles is main cause in most of the accidents.
4. The road side features cannot be neglected because the things like hidden signs, damaged edges, bearing course having potholes, improper design of vertical and horizontal curves, boulders at edges etc sometimes results in road accidents.
5. The reaction time to the driver in night will be affected by the eroded road makings when it is compared to day time.
6. The signs and signal must be with hi gloss reflectors instead of red paint.
7. Proper maintenance like cutting of bushes and cutting of trees which results in sight distance must be rectified.
8. The informatory, warning signs and regulatory must be properly installed as per the requirement of the places.

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