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EXAMINING ROAD AND TRAFFIC CONDITIONSIN ACCORDANCE WITH ROAD SAFETY RULES

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Abstract
This experimental work attempts to identify the Impacts of Roadway Condition, Traffic and Manmade Features on Road Safety in the Haryana State.
This piece of work contains the data collected from NH-71 highway on the section from Rewari to Jind in Haryana,their analysis and results are derived.The study is divided in four sections, at each section study is conducted by accidental statistics reports and usage studies which further contains accumulation studies and duration studies.The results and recommendations reported in this study will help the administration, the planners and the traffic engineers in evolving better road safety techniques in these areas, also on the same pattern this can be used for other sectors of Haryana state.

Key words: Road, Traffic, Safety rules etc.

1. Introduction

Road crashes take away the right to life of 3,000 people every day. This is a global humanitarian disaster, and it is man-made. (Global Road Safety Partnership Annual Report 2015). Road safety is one of the most important problems in our society. Every year 1.2 million of people are killed and between 20 and 50 million people are injured in road accidents. If current trends continue road traffic accidents are predicted to be third leading contributor to the global burden of Disease and injury by 2020.India had earned the dubious distinction of having more number of fatalities due to road accidents in the world. Road safety is emerging as a major social concern around the world especially in India (Shivkumar and Krishnaraj).Accidents are a drain on the national economy and may lead to disablement, death, damage to health and property, social suffering and general degradation of environment.

To minimize the no of crashes by any kind and severity expected to occur on the entity during a specific period is known as road safety. Accidents and the fatalities on road are the result of inter-play of a number of factors. Road users in India are heterogeneous in nature, ranging from pedestrians, animal- driven carts, bi-cycles, rickshaws, hand carts and tractor trolleys, to various categories of two/three wheelers, motor cars, buses, trucks, and multi-axle commercial vehicles etc., Keeping above facts in mind we proposed to carry out a study which was aimed to fulfill the following motives: (i) To study the annual, monthly, daily and hourly variation in accident rate on selected Stretch of urban two-lane road.(ii) To study the effect of traffic volume, density and capacity on accident rate on urban Two-lane road.(iii) To study the maintenance of road surface and shoulder on rate of accident.(iv) To develop an accident prediction model based on AADT, road condition,road side Features.

2. Data collection

The only information available for accident studies is the FIR (First Information Report) lodged in the police stations. The data from these records of last ten years (2002-2015) 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, tractor,motor cycle, tanker, tailor(articulated vehicle),truck and bus.

2.1 Road selected for study

The road from Rewari to Jind on NH-71 was chosen for this study. The following stretches were selected for data collection. The study area is shown in fig.1:
(i) Rewari to Jhajjar, (1-48) Km
(ii) Jhajjar to Rohtak, (48-83) Km
(iii) Rohtak to Lakhan Majra, (83-112) Km
(iv) Lakhan Majra to Jind, (112-148) Km

2.2Data collected from Police Records

With the prior permission of the concerned S.P, the accident data were collected on NH-71 highway from four police stations as shown in Table 1.

Table 1 Police stations and road sections covered

PoliceStation	Roadsectioncoveredunderthepolicestation
Rewari	1 Km to 25 Km on NH-71
Jhajjar	26 Km to 65 Km on NH-71
Rohtak	66 Km to 99 Km on NH-71
Jind	126 Km to 148 Km on NH-71

Accident details during 2002-2015 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 2002-2015 are shown in Table 2.

Table2Detailsofaccidents

Year	Fatal	Majorinjury	Minorinjury
2002	15	16	37
2003	11	35	50
2004	16	25	45
2005	20	32	39
2006	21	34	40
2007	18	41	84
2009	4	24	61
2013	13	32	81
2014	18	34	84
2015	11	30	58
Total	147	303	579

In addition to the above, traffic volume data were also obtained from PWD records. These are shown in Table 3.

Table3.Trafficvolumedata

YEAR	ADT	AVPCUPERDAY	PCU/HR
2011	14533	24656.11	1027.338075
2012	12584	21501.46	895.8942667
2013	12679	21655.23	902.301225
2014	10484	18102.4	754.2667667
2015	12700	21689.22	903.7175

3. Analysis of data and discussion:

3.1AccidentRateandFrequency

AccidentRate, R= M / L —

WhereM= TotalnoofAccidentsofastretch

L= LengthofRoad

Table4.AccidentRate

Nameofstretch	Length	No ofaccidentsina year	
		Sumof10 year	Accidentrate
Rewari to Jhajjar(I)	5km	208	41.6
Jhajjar to Rohtak (II)	5km	186	36.6
Rohtak to LakhanMajra (III) (III)	5km	84	25.2
Lakhan Majra to Jind (IV)	5km	239	47.8

Table5FrequencyofAccident

Distanceoforigin	Noofaccidents(2002-2015)	Frequency	Totalfrequency
0-5	228	32.5	32.5
6-10	208	29.6	62.1
11-15	26	3.7	65.8
16-20	239	34.1	100
Total	701	100	

FromtheTable4.and5.itisobservedthat frequencyanrateofaccidentismoreforstretch-4followedbystretch-1,2,3respectively.

3.7 Trend of Accidents, Injuries and Fatalities during 2002-2015

The yearly trend of accident per million vehicle-kilometer-years (MVKY) on the road is shown in Fig 15.From the figure it is found that accident rate per MVKY increases in each subsequent Year. The increasing trend in accident rate may be due to increase in population due to town growth, industry growth, poor maintenance of shoulder, electric poles on the road, transformer station on the shoulder, old girth trees on the shoulder, sight distance obstruction due to trees, unsignalized intersection, on street parking of vehicles and lack of general awareness of road safety among road users.

3.8 Traffic and Road side feature Data

The Traffic data were collected from different stretches. Volume, density, speed were calculated from these data which is shown in Table 6

Table 6: Traffic and Roadside features data of four stretches (2015)

Stretch No	ADT	Qmax (pcu/s)	AccessRoad	Treeson Shoulder	Poles	Curves	Shouldercondition	Lighting condition
1	63600	0.82	35	23	53	6	Good	Good
2	32160	0.74	21	25	21	5	Average	Average
3	32160	0.74	6	0	0	3	Poor	Poor
4	48960	0.92	4	1	1	6	Poor	Poor

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

3.9 Surface Property

Skid Number

SN = √ x100

Where

SN=Skid Number

v =Velocity of the Vehicle

g = acceleration due to gravity

l = skid length

The value of skid number for different stretches were calculated by using a Tata Indica V2 car with kerb weight 1050 kg with Two Person are shown in Table 7 .Normally for a Asphaltic surface skid no varies between 70 to 100. From the below observation it is found that surface friction lies in normal limit.

Table 7. Skid Number values of four stretches

STRETCH	SKIDLENGTH(mt)	SPEEDKMPH	BRAKING	SKIDNO
1	8	40	N	77
2	11	50	N	87
3	13	60	N	106
4	12	50	N	80

3.10. Average Surface Texture Depth

Average surface depth was determined by modified sand patch method (Pestle method).Sand passing through 300 micron and retaining on 150 micron was collected as sample.50 ml (85gm) sample was spread evenly on road surface such that it will fill the depression completely in the shape of a circle. The dia of circle was measured.

Average Surface Texture Depth =The average surface texture depth along the stretch are shown in the Table 8

Table 8: Average Surface Texture values of Road Surface

Sample	Vol(ml)	Dia(cm)	AvgDepth(mm)	Remark
1	50	32.5	0.43	Normal
2	50	30	0.5	Normal
3	50	30	0.5	Normal
4	50	30	0.5	Normal
5	50	38.5	0.3	SliperySurface

4. Accident investigation and black spot analysis

4.1 Accident Investigation

Accident no-1

Accident type: Head-on collision
Location: Kosli
Date and Time: MAR 30, 2015; 4.30PM
Vehicle 1: Tata Truck no HR-06/ B-6545
Vehicle 2: Bajaj CT- 100 motor cycle no HR-05/U-3323
Fatalities/Injuries: One person dead and one person severe Injured.

Description: On 30th march 2015 one Bajaj motor cycle with two person collided with a aluminum loaded truck near Kosli around 4.30PM.The motor cycle was coming from captive power plant and truck was moving on highway. 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 presence of old banyan tree on the corner of T-junction and ditches of shoulder was filled with water. The motor cycle could not notice the truck due to that big tree and collided with truck on the highway. The tyre skid mark length was 11mt. The accident diagram is shown in fig 16



Fig16: Accident diagram and photos of stretch I

Accident no: 2

Accident type: collision with tree
Location: Jhajjar
Date and Time: JUN 13, 2012; 12.30PM
Vehicle 1: Asok Leyland trailor
Vehicle 2: Bajaj Auto
Fatalities/Injuries: Two person minor Injured

Description: The trailer was on the highway with normal speed. At a T-junction one auto with nine passenger was changing direction (left turn) from bus stop road to highway.Both vehicles became front to front. The trailer driver applied sudden brake and struks 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 fig17.



Fig. 17: Accident diagram and photos of stretch II

Accident no: 3
Accident type: collision with tree and compound wall
Location: Lakhan Majra
Date and Time: JUN 12, 2012; 6.10AM
Vehicle 1: Tata truck
Fatalities/Injuries: One person severe Injured and one minor injured

Description: The truck was moving on NH-71.Neartraffic post the truck driver could not notice traffic median due to absence of sign post and signal. The truck ran over median and hit with a tree and finally struck with compound wall. The driver became severe injured and helper became minor injured. The vehicle, tree and the compound wall were completely smashed. The accident diagram is shown in fig18.



Fig18: Accident diagram and photos of stretch III

4.2 Black Spot Analysis

The point where accident occurs frequently is known as black spot or accident point. Analysis is required for improving traffic environment. The detail analysis of four stretches are shown in Table 9-12.

Table9: BlackSpotAnalysisStretch-1

Accident Point	No.s	Problems	Safety Enhancement
Lisana	13	X-Unsignalised,10wGarages, Sight distance obstruction by Shops	Junction Improvement, Sight distance visibility
Palhawas	6	O-Unsignalised,Transformer,2wShowRooms	Junction improvement, Clearance Of obstruction on the Shoulder,
Guroara	8	O-Unsignalised, Taxist and, Stallson the Shoulder	Clearance of obstruction on Shoulder, Sight distance visibility
Machrauli	6	T,Taxistand,Vegetable Market	Clearance of obstruction on Shoulder, Sight distance visibility
Dadanpur	15	X-Signalized,2wgarages,Trees and Poleson Shoulder	Clearance of obstruction on Shoulder, Sight distance visibility
Silana	10	T, Cinema Hall, Treeson Blind Corner, Trees and Poleson Shoulder, Main Bus Stop	Clearance of obstruction on Shoulder, Sight Distance Visibility

Table10: BlackSpotAnalysisStretch-2

Accident Point	No.s	Problems	Safety Enhancement
Jhajjar Byepass	10	Vegetable and Betel shop on Shoulder, Bus Stop	Clearance of Road Side, Speed Restriction
Guddha	14	Vehicle Parking on Shoulder, Trees and Poleson Shoulder	Clearance of Road Side
Dujana Mod	8	Meat and Fish Shop on The Shoulder, Old Trees on The Shoulder	Discouragement of Fish and Meat Shop on The Shoulder, Trees on Shoulder should be removed
Dhandlan	15	Median without Sign on the Road, Temple on the Shoulder, Trees on the Shoulder	Medians to be Painted, obstacle on The Road Should Be Removed
Dighal	10	T,Wine Outlet, Unpainted Median, Trees on Shoulder	Median to be Painted, Junction Improvement
Karontha	6	T,UnpaintedMedian	Junction Improvement

Table 11 Black Spot Analysis Stretch-3

Accident Point	No	Problems	Safety Enhancement
Jind Byepass	10	Steep Gradient	Speed restriction, Junction Improvement
Titoli	15	Trees on Shoulder, Edgedrop	Road maintenance, Shoulder maintenances
Bhagwatipur	6	Bad Shoulder	Shoulder maintenance

Table 12: Black Spot Analysis Stretch-4

AccidentPoint	Nos	Problems	Safety Enhancement
Pauli	24	T, On Road Bus Stop, Auto and Taxi Stand, Trees on Edge, Shop Verandah on Shoulder, S houlder Ponding	Separate Bus Stop, Shoulder obstruction Clearance and Maintenance, Junction Improvement
Hathwala	11	Petrol Pump, Betel and Tea shop on shoulder, Shoulder Ponding by Drain Water, Heavy Machinery Garages	Road Side Clearance, maintenance of Shoulder
Brahmanwas	5	Cinema Hall, Shoulder Drop Off, Old Girth Tree Branches	Visibility by Cutting old Tree Branches, Shoulder Maintenance
Julana	21	Motor Show Room, Dhabas, Shoulder Ponding By Drain	Off Street Parking Facility, Shoulder maintenance

Kinana	44	Dhaba, Village Area both Side, Chicken Center, Meat and Tea shop on Shoulder, Curve Sight Distance obstructed by old and dead Trees	Curve Sight Distance Visibility. Shoulder maintenance, Speed Restriction, Off Street Parking Facility
Gatauli	32	Ditches on Shoulder, Curves Sight Distance obstructed by Trees, Shoulder covered by Grass and Shrubs, Motor Garages, Vertical Curve	Shoulder maintenance, Sight Distance Visibility Near Curves, Off Street parking facility

4.3 Accident Prediction Model

Caliberation of Model

The accident per year was regressed with ADT and Road side features. The general form of equation with zero intercept is represented as No of accident = 0.504 x Vol+ 1.825 x No of Trees and Poles on Shoulder + 19.87 x No of curves - 59.49 x shoulder condition.
The above equation shows that accidents increases with increasing in ADT, No of Trees and Poles on shoulder and no of Curves. The accident decreases with increase in shoulder condition. Hence regular maintenance of road should be done. Old girth trees should be removed.

Validation of Model

Table 13 and Fig 23 shows the statistical validation of the fitted model.

Table 13: Statistical Validation of Model

Name of Stretch	Actual Value(Yi)	Value from Model(Y)	Error(e)	e^2
1	16	15.28	-0.72	0.5184
2	21	20.6	-0.4	0.16
3	2	1.83	-0.17	0.0289
4	28	27.76	-0.24	0.0576

Co efficientofdetermination $R^2 = SS_R/SS_Y$

$S_{YY}=\sum Y_i^2-(\sum Y_i)^2/n$

$SS_E=\sum e^2$

$SS_R=S_{YY}-SS_E$

$R^2= SS_R/S_{YY}$

For the above data R^2=0.99. Model holds a good fit.

Chi-Square Test

H_0=No significant difference between expected and observed data

χ^2_{cal}=0.059561

χ^2_{crit}(At 5% level of significance with df 3)=2.366

$\chi^2_{cal}<\chi^2_{crit}$ Hence accept Null Hypothesis

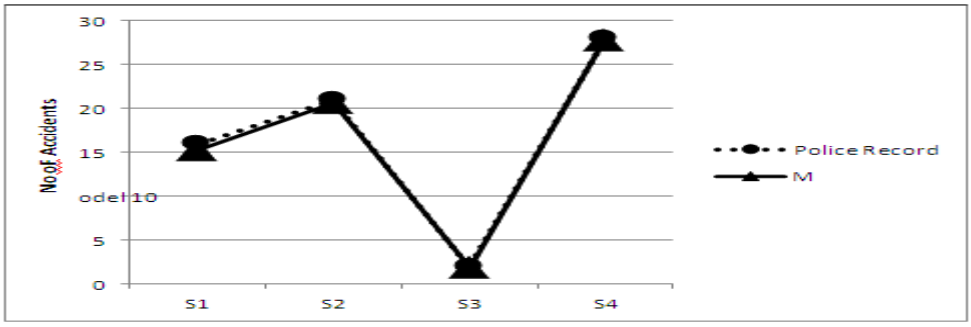


Fig23Comparisonofobservationandmodeldata

5. Conclusions and recommendations

From the given study, the following conclusions have been drawn:

(1) The available literatures on accident analysis indicate that 77.5 percent of road accidents in India are caused due to driver's error.(2) Heavy vehicles like truck are involved in maximum no of accident on two-lane roads. It is estimated that fatalities caused by truck is 59 % followed by other (26%) and bike (7%) and jeep (5%) and bus (3%).Road safety awareness should be raised among road user.(3) Stretch IV has the highest no of accidents which accounts for 47.8% of total accidents.The accident rate can be decreased by road side clearance, proper maintenance of shoulders, lighting, and junction improvement. Speed limit should be brought down by providing humps near accident spots. Sight distance near curves should be obstruction free.(4) Stretch I have the second highest no of accidents accounts for 41.6% of total accident. The accident rate can be reduced by providing signalized junction, junction improvement, and shoulder Clearance, installation of humps, shifting of poles, removal of trees near the edge of pavement etc.(5) No of accidents in stretch II accounts for 36.6% of total accidents. The accident rate can be minimized by clearing-off shoulders, reducing speed limit, junction improvement, providing Signals on the median, shifting structures on the shoulder.(6) Stretch III has minimum no of accidents accounts for 25.2% of total accidents. Speed limit reduction near junction should be reduced to prevent accidents.

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