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IDENTIFICATION AND PRIORITIZATION OF BLACKSPOTS ON NH-7 IN PUNJAB, INDIA

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Abstract --Losses due to road accidents have increased at an alarming rate for the last decade in India. The causative factors for road accidents and injuries are namely vehicular traffic, road and road users. However, prioritization of the factors which leads to accidents is a tedious task. Moreover, the road crashes do not occur uniformly on the entire road network. Accidents tend to cluster around certain junctions and locations called accident black spots. Hence, the identification of such locations is of significant importance. This study aims to identify the accident prone zones within the study stretch of NH-7, in state of Punjab using Accident Severity Index. For the study purpose the accident data from 2012 to 2016 was collected and Blackspots were identified and remedial measures are suggested.

Keywords – Road accident, Black spot, Accident Severity Index, Identification, Prioritization, NH-7

1. INTRODUCTION

In India, the growth of highway network has been tremendous in the last 10 years. This growth of highway network is responsible for rapid urbanisation and increase in vehicular movements. But this development without a commensurate focus on safe roads has created an environment in which young and poor are at a greater risk of injuries and disabilities due to road accidents. This concern needs to be addressed appropriately by all stakeholders due to loss of lives and properties along with disabilities, hospitalisation and loss of GDP due to deaths and injuries on roads. National highways are the major arterial roads connecting different states and cities in the country. They cater to 40 percent of traffic flow; where as National Highways constitute about 2 percent of total road network in the country. In the year 2016, National Highways accounted for 29.6 per cent of total road accidents and 34.5 per cent of total deaths due to accidents [1]. Globally, the threat due to road crashes and injuries on the roads has increased alarmingly. WHO Global Status report on Road Safety (2016), states that road injuries killed 1.4 million people in 2016, about three-quarters (74%) of whom were men and boys. This situation including India poses a serious challenge amongst the low income group countries for providing well built, well-maintained infrastructure, properly enforced laws for a safer population. India accounts for about 10% of road crash fatalities worldwide. In terms of absolute numbers more people die in road crashes in India than anywhere else in the world, including the more populous China.[16]. This paper describes the identification of blackspot on study stretch of NH-7 in State of Punjab as shown in Fig 1.

2. ROAD ACCIDENTS AND CRASHES AT NATIONAL AND STATE LEVEL

2.1 ROAD ACCIDENT

Road accidents are random in nature and can be measured by the number of persons killed and injured due to road accidents, whether on the spot or within 30 days of hospitalisation due to accident. This doesn't accounts for suicides involving the use of road motor vehicles [5].

2.2 BLACKSPOT

The term black spot is used to describe the dangerous points in the road network where accidents tends to cluster due to faulty engineering design, lack of education and poor enforcement of laws [2]. Moreover, these blackspot in the road network should be located, prioritized and effectively eliminated to lower the rate of accidents at such locations. According to Ministry of Road Transport & Highways (MoRTH), Government of India, road accident black spot on National Highways is considered as a road stretch of about 500m in length in which either 10 fatalities took place during last three calendar years or 5 road accidents (involving fatalities/grievous injuries) took place during last three calendar years [3]. Black Spot could be at sharp curve, intersection, straight road section of the road with a higher accident rate [4]. However, selection of dangerous locations is based on detailed study of causes and clustering of road accident and road Severity Index value.

2.3 ROAD ACCIDENT SCENARIO IN INDIA

Road network upgradation and expansion has led to increased motorization index and urbanization in the country. This positive scenario has also led to a negative externality of road accidents. Globally, the injuries due to road accidents are posing a major public health challenge to the concerned authorities due to its huge socio-economic costs. Even in India,

one of the major causes of death amongst the earning age group of 15-35 years has been attributed as Injury from road accidents. The prevailing situation of road accidents for four years have been tabulated below in Table 1 [1]. Deaths and Severity due to road accidents has increased during 2013 to 2016, whereas the number of persons injured due to road accidents has marginally decreased during the same period.

Table 1 Road Accident Parameters:2013-2016

Parameters	2016	2015	2014	2013
Total Accidents in the country	480652	501423	489400	486476
Deaths due to Road Accidents in the country	150785	146133	139671	137572
Persons Injured due to Road Accidents in the country	494624	500279	493474	494893
Deaths per 100 accidents	31.4	29.1	28.5	28.3

(Source: MORT&H, New Delhi, 2016)

2.4 ROAD ACCIDENT SCENARIO IN PUNJAB, INDIA

The statistical figures of Punjab reveals (MORT&H, 2016), it is ranked 11th in loss of lives due to accidents on roads (5077). The Accident Severity is amongst the highest in country (73), the national average being (31.4). From the statistical data, it can be summed up that Deaths due to road crashes is a serious concern in Punjab. Moreover, rate of road accidents and deaths on National Highways and State Highways of Punjab has increased from 2013 to 2016 as shown in Table 2.

Table 2 Road Accidents* in Punjab:2013-2016

Parameters	2016	2015	2014	2013
Total Accidents in Punjab, India	6952	6702	6391	6323
Total number of Accidents on NH in Punjab	2114	2092	1791	1815
Total number of Persons Killed in Punjab (National Highway)	1495	1538	1482	1360
Total number of Accidents on SH in Punjab	2101	1965	1519	2122
Total number of Persons Killed in Punjab (State Highway)	1584	1484	1194	1601
Deaths per 100 accidents	72.6	72.3	73	73

**(Source: MORT&H, New Delhi, 2016)*

Hence, the current study tries to identify and analyze the accident trend and accident parameters in study stretch of NH 7 from Bathinda to Sangrur in Punjab, India (Figure1). Further, the zones of higher accidents have been identified and prioritized using the criteria of Accident Rate and Accident Severity Index (ASI). Accident crash data has been extracted from the FIR record of concerned police stations in the study stretch. The study has summed up the causes of accidents and suggested the remedial measures.

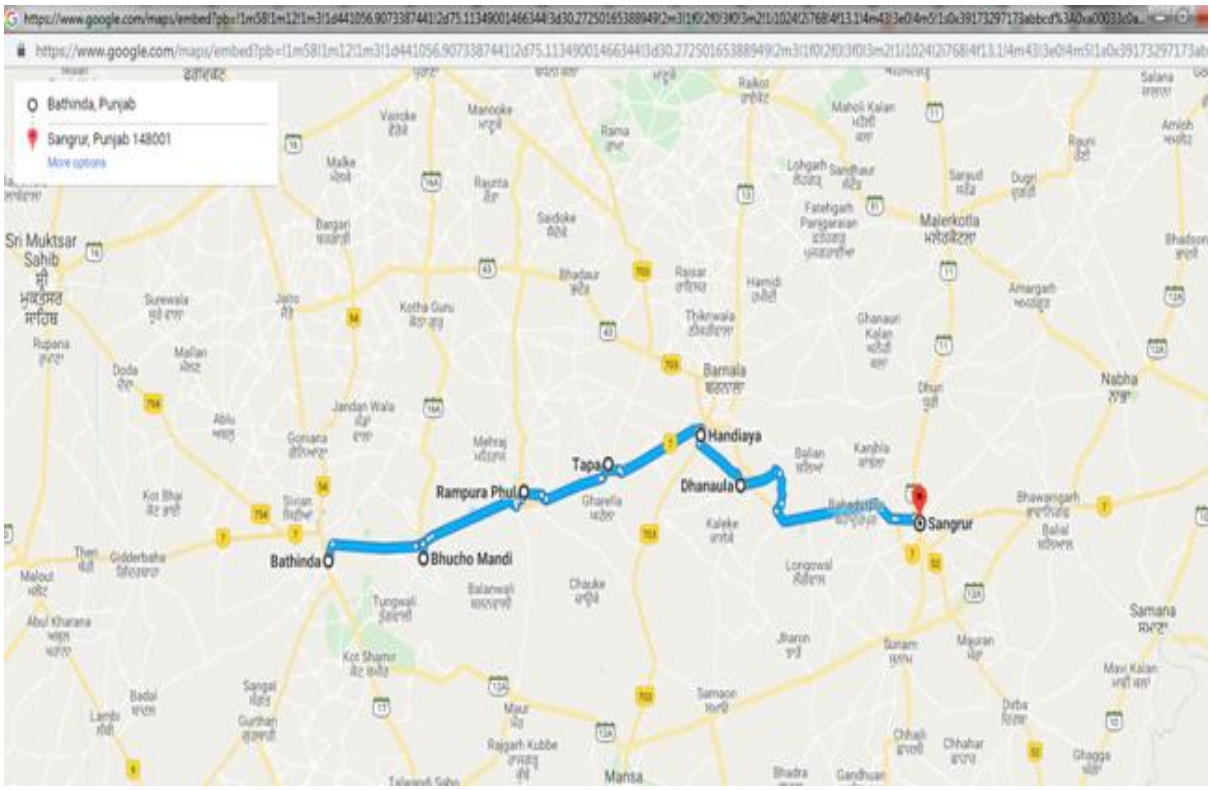


Figure 1: Study Stretch NH-7

3 LITERATURE REVIEW

Karlaftis and Golias (2002) applied hierarchical tree based statistical techniques to study co-relation among various rural road geometric characteristics and accident rates. Further, this rigorous non-parametric methodology was also applied for prediction of accident rates.They concluded that AADT, lane width, serviceability index and pavement friction to be the contributing factors leading to crashes on rural two lane highways [6].

Semeida et al. (2002) have used various statistical models in investigating the factors contributing to accidents on Rural Roads in Egypt. The results of this study showed that in general Multi-layer Perceptron models perform better than the other models used for data prediction. The study concluded that the decrease in shoulder width lead to more and severe accidents, the increase of heavy vehicles percentage in traffic composition lead to more accidents, the increase in trailers and motor cycles percentage lead to more fatal accidents, and also, the increase in the number of openings in road sections leads to more fatal injury accidents[7].

Goswami and Sonowal (2014) have carried out the detailed analysis of causes of road traffic accidents for Dibrugarh area, Assam, India. In their analysis authors used SPSS (13.0) and Ky-plot software with bivariate comparisons, along with Kruskal-Wallis test on accident data obtained from respective police stations during study year 2009. It summed up that Human negligence and behavior is the major cause of Road Traffic Accidents. Further, it showed that accidents increased during day time and rainy season[8].

Bobade, Patil, and Sorate (2015) identified blackspots on their study stretch using Severity Index. They carried out the analysis by ranking the locations with maximum number of accidents. The ranking methodology adopted was to give maximum weightage to factors leading to accidents on larger quantum. Percentages after giving ranking were calculated and accidental blackspots were identified based on these rankings[9]

Apte et al.(2015) employed three approaches namely Weighted Severity Index, Ranking and Accident Density to analyze and identify blackspot on candidate's stretch of NH-4. The researcher's included negligent driving, skidding and loss of control on vehicle as inputs for arriving at Severity Index and Ranking the potential danger zones. Also, a moving window of 500m was used for calculating accident density [10].

Mohan and Landge (2017) identified black spots for a stretch of 13 km on National Highway 6, which connects Amravati to Nagpur. The analysis was done after collecting three year's data from the concerned police stations. The major accidental black spots were identified using Weighted Severity Index method and accident density method [11].

George, Yoyak, and Roy (2018) identified the accident prone zones within Cochin City, using Accident Severity Index Method. In the study, road accident data for the past three years 2014, 2015 and 2016 pertaining to Cochin City was

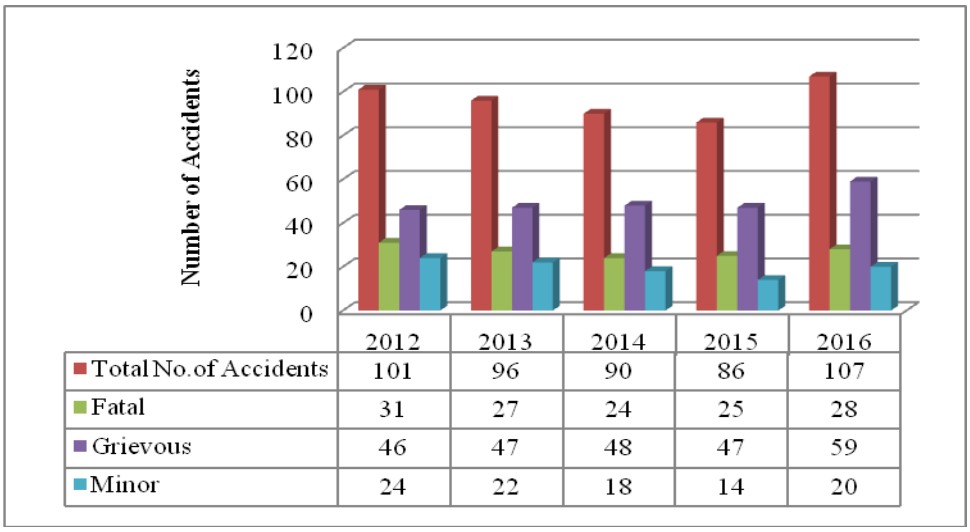
collected. Further, Road safety analysis was conducted at all the identified black spots to understand the condition of the road. The parameters included were drop off measurement, sight distance measurement, clear zone measurement, road width and footpath measurement, checking the visibility of signs and signals, checking the illuminance of the road, measuring the road surface distress and night time visibility[12] .

Mor et al. (2018) used Accident Severity Index (ASI), Weighted Severity Index (WSI) and critical crash rate (CCR) method for identifying blackspots on the candidate stretch of Baddi Pinjore road. Further, they deliberated on characteristics of road accident data, found and prioritize blackspot and also suggested remedial measures for removal of blackspots [13].

4 ROAD CRASH DATA COLLECTION AND ANALYSIS.

4.1 TREND OF ACCIDENT IN STUDY STRETCH

From the accident data for 2012 to 2016 as presented in Fig 2, it can be seen that, the total number of accidents and grievous accidents is highest in 2016.

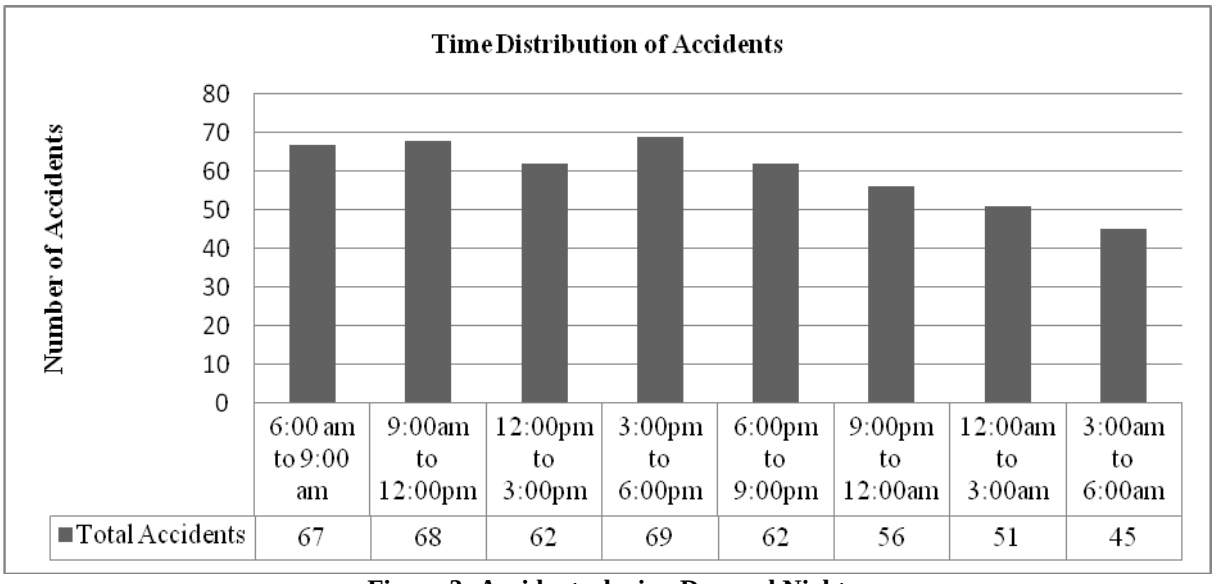


	2012	2013	2014	2015	2016
Total No.of Accidents	101	96	90	86	107
Fatal	31	27	24	25	28
Grievous	46	47	48	47	59
Minor	24	22	18	14	20

Figure 2: Crash Data Analysis

4.2 ACCIDENTS DURING DAY AND NIGHT

It is observed that majority of accidents have taken place during the day time (Figure 3) in all the 5 years from 2012 to 2016. In day time (6am to 6pm) the accident occurrence is higher suggesting vehicles moving in day light are involved in more number of accidents than during night time. The accidents during night (6pm to 6am) were comparatively on the lesser side. It may be noted that the traffic volume and density is more during day time as compared to night time which may be one of the reasons.



	6:00 am to 9:00 am	9:00am to 12:00pm	12:00pm to 3:00pm	3:00pm to 6:00pm	6:00pm to 9:00pm	9:00pm to 12:00am	12:00am to 3:00am	3:00am to 6:00am
Total Accidents	67	68	62	69	62	56	51	45

Figure 3: Accidents during Day and Night

4.3 TYPE OF VEHICLES INVOLVED IN ACCIDENTS

Two wheelers, Cars and Buses are seen to be contributing to a greater extent to accidents from the data given in Figure 4. Further, a few unknown vehicles are reported to be responsible for accidents suggesting that these accidents could have happened in the night involving cars or truck.

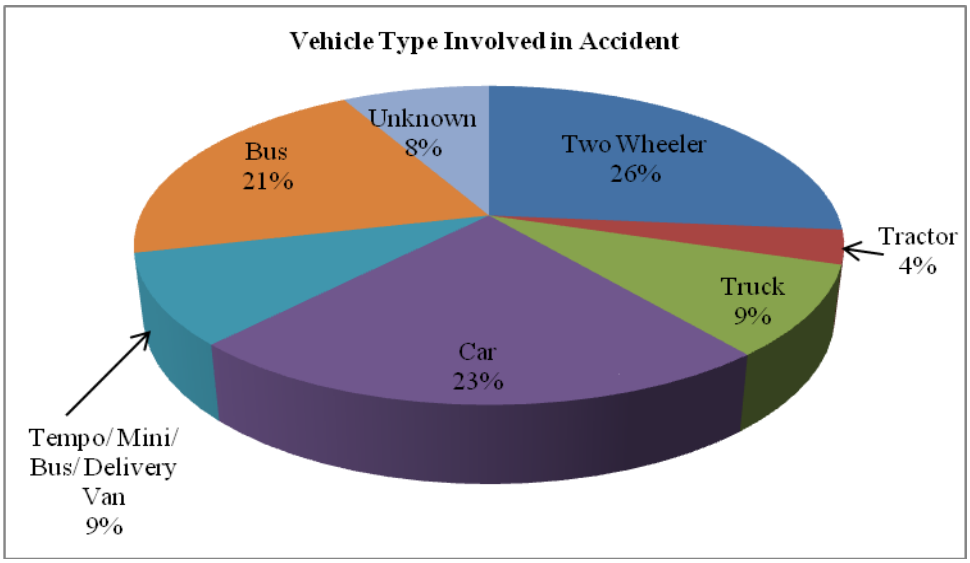
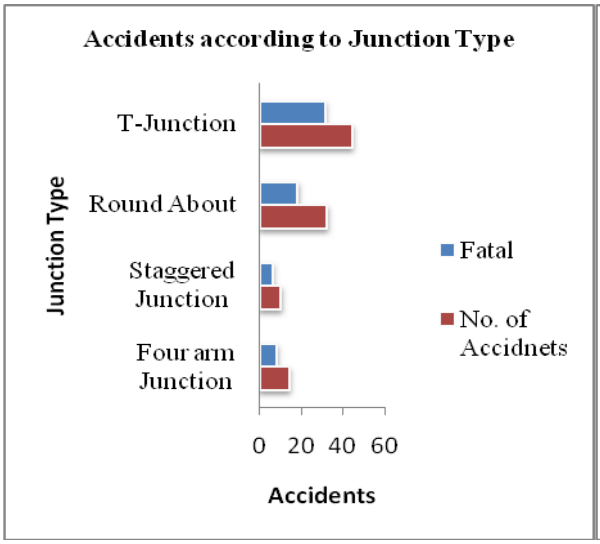


Figure 4: Vehicle's involved in Accidents

4.4 ACCIDENTS ACCORDING TO TYPE OF JUNCTION AND NATURE

The analysis further reveals that number of fatal accidents on T junction is quite high (Figure 5). Moreover, Figure 6 points out that in most case the nature of accident is head on collision (28%). It also, shows that percentage of hit and run cases and hit from back is also significant in study stretch. This may be the reason for more number of fatal accidents on candidates stretch.



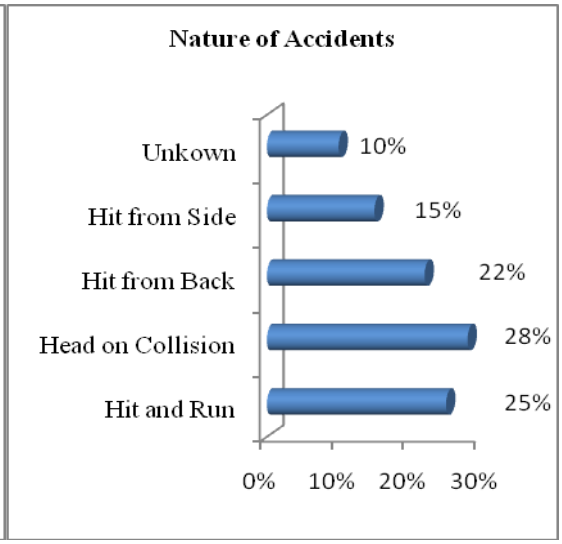


Figure 5: Junction Type **Figure 6: Nature of Accidents**

5 STUDY AREA

The detailing about the study area is given in the sections below. In the first section the details of National Highway 7 (NH 7) which connects Bathinda-Sangrur route are briefed. The second section deals with the details of the area under the current study.

5.1 STUDY ROUTE-NH 7

It is one of the major highways connecting the northern states of Punjab, Haryana, Himachal Pradesh and Uttarakhand. It starts from Indo-Pak border and goes up to Rajpura and crosses NH 205A near Banur in the state of Punjab, before connecting Panchkula in state of Haryana. This Highway route covers a distance of 700km.

5.2 BATHINDA –SANGRUR ROAD STRETCH

Identification of the accident-prone location on NH-7 has been done on a select stretch of 100 km from Bathinda to Sangrur. The accident data for the stretch has been collected from the concerned police stations. The data is collected from 2012 to 2016 when the study stretch was not upgraded.

6 METHODOLOGY

In literature it is observed that no universally accepted definition of a blackspot is available. Extensive literature study shows that, some researchers rank locations by Accident Rate, some use Accident Frequency and some applied Accident Severity Index. Currently, the researchers have also used combinations to modulate the site conditions in a better manner. In literature a few research articles were studied in which ranking of potential blackspot location has been carried out on the basis of accident types considered susceptible to treatment. The current study has adopted the following criteria for analysis:

The whole stretch was divided into sections of 5km [14] each and total 20 sections were analysed . The Accident Rate and Severity Index for the section are calculated. The detailed analysis (Table 3) for the selected criteria was prepared for the National Highway under consideration. Blackspot is location which has Accident Rate (AR) and Severity Index (SI) more than the threshold value of the study area. The threshold value calculation has been as tabulated in Table 4 [3].

Severity Index (SI) =N_f*X_1+N_g*X_2+N_m*X_3[15]
N_f = No. of fatal accidents at the location in last 5 years.
X_1= Weightage assigned to fatal accidents=6
N_g= No. of grievous accidents at the location in last 5 years.
X_2= Weightage assigned to grievous accidents=3
N_m= No. of minor accidents at the location in last 5 years.
X_3= Weightage assigned to minor accidents=1

6.1 FATAL, GRIEVOUS AND MINOR ACCIDENTS [17]

Fatal accidents are defined as accidents in which one or more persons were killed.
Grievous accidents are defined as accidents in which person(s) were grievously injured.
Minor accidents are considered in study as property damage and no person was injured or killed.

In present study the blackspots have been ranked on priority basis as First, Second, Third and Fourth order blackspots [3].

Table 3: Severity Index and Accident Rate (2012-2016)

S.No.	Chainage	No. of Accidents	Fatal	Grievous	Minor	Severity Index	Accident Rate
1	RD 131.7-136.7	27	10	13	4	103	5.4
2	RD 136.7-141.8	16	4	8	4	52	3.2
3	RD 141.8-146.8	36	6	22	8	110	7.2
4	RD 146.8-151.7	18	5	9	4	61	3.6
5	RD 151.7-156.7	22	6	12	4	76	4.4
6	RD 156.7-161.7	18	4	12	2	62	3.6
7	RD 161.7-166.8	20	5	13	2	71	4
8	RD 166.8-171.6	28	9	13	6	99	5.6
9	RD 171.6-176.8	33	9	16	8	110	6.6
10	RD 176.8-181.8	22	8	8	6	78	4.4
11	RD 181.8-186.8	18	6	9	3	66	3.6
12	RD 186.8-191.8	37	11	17	9	126	7.4
13	RD 191.8-196.8	32	9	18	5	113	6.4
14	RD 196.8-201.8	17	4	10	3	57	3.4
15	RD 201.8-206.8	32	10	18	4	118	6.4
16	RD 206.8-211.8	12	5	5	2	47	2.4
17	RD 211.8-216.8	20	5	8	7	61	4
18	RD 216.8-221.9	28	6	14	8	78	4.4
19	RD 221.9-226.9	20	6	10	4	70	4
20	RD 226.9-232.0	24	7	12	5	83	4.8

Table 4: Threshold Value Criteria

Priority	Threshold value
First order blackspots	Mean+1.5* Standard Deviation
Second order blackspots	Mean+ Standard Deviation
Third order blackspots	Mean +0.5 *Standard Deviation
Fourth order blackspots	Mean

First order Blackspots: There are many accidents on the study section and the accident rate and severity is high. This means a high potential for improvement with major change in geometric design.
Second order Blackspots: Accident rate and severity is high and are also equally important to be considered for improvement on priority.
Third order Blackspots: Accident rate is comparatively lesser and cost effective measures can be used to rectify the spots.
Fourth order Blackspots: When the section containing blackspot is identified in any of the above categories and is removed, the fourth order can be dealt with proper detailing and up gradation of section.

Table 5: Blackspots on the Study Stretch

Blacks pot No.	Chainage	Priority	Reasons for Accidents	Suggestive Remedial Measures
1	RD 131.7-136.7	Third	High speed , insufficient sight distance and shoulders	Existing carriageway be upgraded to divided four lane carriageway, highway geometric design as per IRC 73.
2	RD 141.8-146.8	Second	Heavy traffic, improper junction design	Proper pavement marking, design of junction as per IRC-SP-41.
3	RD 166.8-171.6	Third	High speed, insufficient Shoulders	Existing carriageway be upgraded to divided four lane carriageway, proper traffic signs to be installed.
4	RD 171.6-176.8	Second	Heavy traffic, access roads, insufficient shoulders	Junction should be improved, shoulder width to be increased.
5	RD 186.8-191.8	First	High right turning traffic, traffic volume of buses and cars is heavy, insufficient sight distance , shoulder width insufficient	Proper pavement marking, grade separator should be constructed.
6	RD 191.8-196.8	Second	Lesser carriageway width, road side friction, volume of buses and cars is heavy, improper sight distance on curve, shoulder width insufficient	Existing carriageway be upgraded to divided four lane carriageway, highway geometric design as per IRC 73, bypass to be provided for through traffic.
7	RD 201.8-206.8	Second	Access to minor roads, high speed, no signs, insufficient sight distance	Speed calming measures to be provided, proper signs to be installed, access to minor roads should be improved.
8	RD 226.9-232.0	Fourth	Merging traffic, entry point of the town, high speed , heavy traffic, insufficient overtaking sight distance, insufficient shoulders	Pavement marking should be proper, warning signs to be installed and shoulder width should be increased.

7 CONCLUSIONS

This paper presents an analysis of road accidents on NH 7, in the state of Punjab, India. Accident Severity Index method has been used to identify, analyze and prioritize the blackspots. The following are the main conclusions drawn from the study:

i) Eight Blackspot locations have been identified on the stretch.
ii) The potential sites have been prioritized on the criteria of threshold value. Since all the points on stretch with fatalities are important but the clustering of these points in a particular stretch is of major importance.

iii) Blackspot sections (chainages) have been identified and the accident locations have been located within the identified stretch. The accidents have been found to concentrate to a certain parts of the straight stretch, junction, a sharp curve, merging points etc.

iv) The ranking based on priority provides a guideline for the improvement measures to be taken for particular section, as locations with higher severity require major investment of finances. Further, it is suggested that the first and second order blackspots be taken up for immediate remedial measures.

It is recommended that statistical analysis of various reasons for occurrence of accidents at all blackspots can be studied using any of suitable computational technique like ANN, regression analysis, fuzzy logic etc. to arrive at proper remedial measures to eliminate blackspot.

8 REFERENCES

[1] Ministry of Road Transport and Highways, Transport Research Wing "Road Accidents in India," 2016.

[2] N. Jain and B. B. Jindal, "Analysis of Causal Factors of Accidents near Mahipalpur Junction on NH-8 in Delhi," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), pp. 16–21,2016.

[3] National Transporation Planning and Research Centre-Report, "Identification and Prioritization of Accident Black Spots in Kerala," 2016.

[4] P. V. Ashokbhai and A. M. Jain, "Road Safety Audit : an Identification of Black Spots on Busy Corridor Between Narol- Naroda of Ahmedabad City," International Journal of Engineering and Technical Research,Vol 2,Issue. 3, pp. 86–89, 2014.

[5] https://data.oecd.org/transport/road-accidents.htm, acessed on 13 January 2017.

[6] M. G. Karlaftis and I. Golias, "Effects of Road Geometry and Traffic Volumes on Rural Roadway Accident Rates," Accident Analysis and Prevention,vol. 34, pp. 357–365, 2002.

[7] A. Semeida, M. El-shabrawy, M. Sabry, M. Sadek, and I. Hashim, "Investigation of Factors Contributing to Accidents on Rural Roads in Egypt,"Journal of Advanced Research,Vol. 2, 2002.

[8] A. Goswami and R. Sonowal, "A Statistical Analysis of Road Traffic Accidents in Dibrugarh City,Assam,India ,"Inerstat, 2011.

[9] S. U. Bobade, J. R. Patil, and R. R. Sorate, "Identification of Accident Black spots on National Highways and Expressways.," International Journal of Research in Advent Technology, National Conference,ACGT, 2015.

[10] R.R.Sorate, R.P. Kulkarni, S.U. Bobade, M.S. Patil, A.M. Talathi, I.Y. Sayyad, S.V.Apte, "Identification of Accident Black Spots on National Highway 4 (New Katraj Tunnel to Chandani Chowk)," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) vol. 12, issue. 3, pp. 61–67, 2015.

[11] A. Mohan and V.S Landge, "Identification of Accident Blackspot on National Highwyas," International Journal of Civil Engineering and Technology (IJCIET) vol. 8, issue. 4, pp. 588–596, 2017.

[12] S. J. George, S. P. Yoyak, and S. S. Roy, "Black Spot Identification Using Accident Severity Index Method," International Journal of current Engineering and Scientific Research (IJCESR) ,Vol 5,issue 3, pp. 63–68, 2018.

[13] N. Mor, Chetna, Dr. Hemant Sood,"Black Spots Identification on Pinjore to Baddi Road," International Journal of Pure and Applied Mathematics, vol. 120, issue. 6, pp. 6473–6488, 2018.

[14] A.N Dehury, A.K Das, A.K Pattnaik, U.Chattraj, P. Bhuyan, M.Panda, "Black Spot Analysis on National Highway - 4," International. Journal of Engineering Research and Application., vol. 3, issue 03, pp. 402–408, 2013.

[15] K..O. Hedman, "Road Traffic Safety Project-Ankara, Black Spot Manual,SweRoad," 2001.

[16] http://www.searo.who.int/india/topics/road_safety_and_injury_prevention/en/ accessed on 21.07.2016

[17] IRC 53-2012," Road Accident Recording Form A-1and A-4" Second revision.