Identification and Improvements of Accident black spots on National Highways: A Review

K.L.Prashanth[1], Chethan Gowda R. K[2], Nikhil T. R[3]
[1]Post Graduate Student, Ramaiah University of Applied Sciences, Bengaluru
[2]Assistant Professor, Department of civil engineering, Ramaiah University of Applied Sciences, Bengaluru
[3]Assistant Professor, Department of civil engineering Ramaiah University of Applied Sciences, Bengaluru

Abstract **- India is a large country, and highways play a significant role in the country's development. The national highway system is responsible for the country's civilizational and economic development. As the world's population grows, so does the number of vehicles on road. As the number of vehicles on the road grows, so does the number of accidents. As a result, there must be reduction is accidents proving the safety of roads. Accident causes can be divided into two categories: subjective variables and objective elements. Subjective considerations primarily refer to the psychological effects of drivers and pedestrians on roads, whereas objective factors refer to road conditions, road geometry, and other engineering-related aspects. Because they are intertwined, the research of accidental black spots revolves around the study of road safety, and if road safety is addressed, the number of accidents is likely to decrease. So, the identification of Blackspots and improvements to the specific locations in terms of geometrics of road. Indian National Highways are thus to be engineered considering all these inputs related to safety and design standards. All of these aspects were considered in a critical review, which depicted the scenario of accidents occurring on various Indian roadways, as well as their causes and solutions.**

Index Terms **- Black spot, horizontal curves, national highways, operating speed, road accidents, weighted Severity Index (WSI).**

I.INTRODUCTION

National Highways serving as the main vines of the Transport network of the country. By addressing people and commodities transport requirements, the national highways network is responsible for the growth of civilizations and the economic development of the country. The national highways in India cover a total distance of 70,548 kilometers, accounting for 2% of the country's total road network and carrying 40% of all traffic[9]. According to estimates, India is responsible for roughly 10% of all fatal road accidents worldwide. As a result, a decision has been made to make concerted measures to improve road safety. One of the most effective techniques to road accident prevention is the identification of accident locations, analysis, and treatment of road accident black spots.

Accidental black spots are described as areas of the road where the risk of an accident is high or where accidents happen frequently on national highways. On highways, speed is one of the key factors contributing to traffic accidents and fatalities[1]. Researchers have also verified that the geometric design of roadways, particularly the horizontal alignment, has a significant impact on their quality and safety. The notion of Geometric Design Consistency (GDC) has proven to be the most promising technique for investigating national highway traffic safety requirements. The aspects and qualities of road geometric design are considered in this study, and explanations are offered as to how they affect highway safety. The dimensions of radii, ratio of consecutive curves, dimension of vertical curves, and sight distance conditions all have an impact on road alignment[3]. According to research, curved parts of roadways account for more than half of all fatal crashes. When the horizontal alignment of the road abruptly changes, the motorist must exercise caution both in terms of speed and maneuvers.

Few researchers use Remote Sensing and GIS tools to identify and monitor Accident black spots and conditions of National Highways. The goal of enhancing the efficiency and effectiveness of highway accidents is to develop a system that uses GIS to identify high-rate accident regions and analyze

accidents. As a result, GIS will provide a platform for maintaining and updating accident record databases, as well as analyzing them.

II. CRITICAL REVIEW ON ACCIDENT BLACK SPOTS ON NATIONAL HIGHWAYS

Vani A K, Prathap Kumar N K, Pooja M K (2019) This research looks into the causes of accidents on NH 75 and how to prevent them. This Indian national highway runs across the states of Karnataka (418.7 km, 260.2 mile), Andhra Pradesh (23.40 km, 14.54 mile), and Tamil Nadu (length in 60.7km, 37.7 mile). There are seven major accident zones where major efforts were taken to ensure road users' safety. A complete road survey is conducted on the entire stretch of road to determine the road way geometric restrictions, such as road width, walkway width, and road marking. Accident information is gathered from the local traffic police station. The WSI approach is used to analyse the accident data.

WSI=(41*K)+(4*GI)+(1*MI) 4

Accidents with a WSI of more than 40 are labelled as black spots. The accident data from the traffic police station was analyzed using a weighted severity index for chosen 7 zones on NH-75, with 6 areas classified as black spots based on the index value. Overtaking, over speeding, and careless driving are common causes of accidents, with improved enforcement of traffic regulations and sufficient lighting at intersections being recommended as remedial measures.

LIU Yichao (2013) The impact of objective elements such as road conditions, traffic safety facilities, along-the-line environment, and traffic flow on the establishment of highway traffic accident prone areas is examined in this paper. The median strip plays a vital role in traffic safety on high-grade roadways. A fence is installed in the separation zone, which can lower the number of traffic accidents by 15% to 20% and the severity of the accidents. When the width of a road lane is less than 4.5 metres, the rate of traffic accidents decreases considerably. If the lane is excessively broad, some vehicles will try to overtake using the extra lane width, which will increase the number of accidents. Vehicle damage and traffic accidents can occur if the radius and length of a convex vertical curve are too small and short. Long steep slopes induce acceleration, which causes the vehicle's speed to be too high or too low, resulting in accidents. When the sight distance is less than 100 m, the accident rate rises sharply as the sight distance decreases. The researcher confirms the influencing variables of highway accident black spots, conclude the cause analysis, and implements prevention and management strategies for the highway section's accident black spot.

Hameed Aswad Mohammed (2013) Focused to improve roadway design and reduce hazardous spots, and studies focused on safety and geometric design objects. Highway geometric design features and attributes are considered in this study, and explanations are offered as to how they effect highway safety to what extent. Carriageway, horizontal curvature, median, shoulder, and vertical curve are some of the key geometric design components that might affect highway safety. Horizontal curves have higher crash rates than tangent parts, according to previous study. Accidents will occur if the superelevation value is incorrect or if there is no superelevation. Horizontal alignment has regularly shown that accidents grow with ever sharper curves, according to researchers based on traffic safety to roadway relates. In comparison to up-gradients, accidents increase with down-gradients. It examines the findings of investigations in different nations and presents current international understanding of the relationship between safety and the key non-intersection geometric design criteria.

Snehal Bobade – Sorate, Anuj U. Manerikar, Devika J. Buttepatil (2016) This study objects to identify road accidents black spots of NH – 4 from study area of chainage (82.00 to 83.00) by studying accident data acquired by NHAI of year 2014-2015. Aim of this paper was to find out accidental prone areas on NH-4 by seeing different parameters such as; nature, classification and causes of accident by Ranking Method. The constraint which is reason for road accident was given highest rank. Here, Severity index is calculated for severity of a particular location of highway accidents.

Severity Index =(ß/ Σ W) × 100 Where, Σ W =(w1) +(w2) +(w3)+…….(w10).

Overall 34 locations were identified with nature of parameter on severity index i.e classification and causes of road accidents, which indicate accidental black spot. It was sure that overspeed, skidding and

grievous injuries where responsible for greater number of accidents.

Vivek, Rakesh Saini (2015) Studied on collection of accident data from secondary source and identifying road accident-prone spots. This paper lays prominence on accident studies of NH- 3 in Una District, Himachal Pradesh, India. In this, accident data is collected from respective near by police stations. And WSI method has been adopted for analysis. Weighted Severity Index,

(WSI) = (5 x K) + (3 x GI) + (1 x MI)

Here, K is the count of deaths, GI is the count of grievous injuries, MI is count of minor injuries. It is observed that WSI value of Shiv bari was found to be highest i.e., location of road which has highest WSI value and it is considered as black spot. Highest the severity value more the hazardous spot of road. According to the WSI value from the gathered information, the top five areas were designated as black spots, and some suggestions for improving the transportation arrangement were made.And deficits like carriageway width is less, inadequate super elevation design, absence of shoulder are main cause of accidents.

Pritam Kashi, Yugandhar Shinde, Siddhant Dhavare (2019) This paper objects to identify the accidental black spots on the NH-48 extending from Bhujbal Chowk (Wakad Brige) to Chandani Chowk having a length 12 km. The analysis of accidental black spots was done from primary and secondary data. Primary data was collected by conducting physical survey on NH-48 and secondary data (Existing data) was collected from NHAI for two years (2017-2018). The primary and secondary data was analysed by ranking method, weight severity method and accidental density method then accidental black spots were detected on NH-48. All together 9 black spots were detected in the stretch of 12km on NH-48. Studies carried out on the stretch spanning from Bhujbal Chowk to Chandani Chowk has found out that one of the major reason of accidents is the rear end collisions which occurs due to improper transition, over speeding, loss of control over vehicle and visibility at junction.

K Geetha Rani, B Srikanth (2018) In this paper highway geometric design and safety is studied in order to improve highway design and avoid hazardous spots. Safety has been investigated in relation to design factors such as shoulder width, super elevation, median width, curve radius, horizontal and vertical curves, lane width, sight distance, and so on. After reviewing several studies on cross-sectional and alignment parameters it has been found that, the presence of a median, certain types of accidents, such as head-on collisions, are reduced. Horizontal curves with gradients and surfaces having low coefficients of friction, they become more dangerous. In this approach, highway geometric design components and attributes are taken into account, and explanations on how they effect highway safety are provided.

Jeena Johny A, Jisha Akkara (2019) This paper is focused on influence of alignment parameters in the accidents rate. A methodology is suggested for evaluating two-lane highway uniformity and safety through alignment parameter. The study area selected was part of three state highways in Kerala i.e Kulapully to Perumbilavu (SH39,SH23-31KM)- 36 Curves, Pannithadam to Ottupara (SH50-16KM)- 24 Curves, Vazhakode to Pazhayannur (SH73-18KM)- 27 Curves. The geometric data collected for this study included information about the horizontal curves. Previous five years (2013-2017) highway accident data were gathered from respective police stations of nearby area. Alignment indices of the 33 sections were found out. The plots are drawn between the number of accidents and alignment indices which shows more correlation with the accident rate. And it is found out that major accidents show more correlation with the alignment indices. With significant variables different trials of modelling were done. The dependent variables are Minor accidents, Major accidents, Fatal accidents, Total accidents and EPDO. The Ratio of curve length to tangent length, Ratio of curve length to road length, Average curve length, Average Tangent Length, was found to be the most influencing variables on the accidents on horizontal curves have strong relations on accidents.

Athira Mohan, V.S. Landge (2017) This paper objects to identify the accident locations along Amravati-Nagpur highway length from Asian highway no. 46. The top accident-black spot were selected as accident prone section based on Weighted Severity Index Method and recommendations are made for improvement the highway safety. The study area from Futaila chouk to Outer ring road stretch (13km) was chosen for black spot studies and some of major busy places such as Wadi and Wadhamma. On identified black spots, a comprehensive road inventory study

was carried out for particular highway stretch to measure highway geometric parameters like road width, type of shoulders, median, surface condition, edge obstruction, road markings, road signs etc. Accident data was taken from local police stations for three consecutive years (2014-2016). The five major black spots along the national highway were identified based on a study of crash data using the severity index technique and the density method.

Vishrut Landge, A.K.Sharma (2013) Studied to identify APL (Accident prone location) along the NH-58 which connects from New Delhi to Mana. Road accident data is collected for previous three years. Babkov coefficient method is adopted to identify criticality of each stretch of road for various parameters of geometric design of road. If the babkov coefficient value surpasses 25 for new highways and 15 for old highways, a portion of highway is designated as APL..

(K) = (K1 x K2 x K3 x K4 … x K14)

Traffic and road geometry data was collected for each portion of highway. Nine black spots were identified using this technique. As data provided from police stations too showed high rate of accident at particular spots. Modelling for causative factors like multiple regression technique was done from the collected traffic and geometric parameters. Spot speed, Shoulder width and percentage of heavy vehicle were selected for modelling purpose as independent variables. Spot speed demonstrates that when speed rises, the number of accidents rises as well. Separate lane was suggested for non-motorized and animal drawn vehicles along NH-58 , Speed limit of 60 Kmph should be mandatory on particular highway and accident prone board to be installed every 100 m before every identified black spot will help reduce the fatal accidents.

Snehal Bobade, Jalindar R Patil, Raviraj R Sorate (2015) Studied on identification of highway accidental locations on NH-9 i.e Pune-Solapur Highway and Mumbai-Pune Expressway by method of ranking. Study area was selected from 76 km to 78 km for experimental investigation on Mumbai-Pune Expressway as pilot study. According to data collected by MSRDC, more number of accidents is witnessed from km 76 to km 78 in recent past. The top three vital parameters were small secondary road meeting the main highway in a steep slope, right turns of road on down slope, footpath or cattle crossing. Based on the ranks calculated after giving percentages of black spot the location or area is identified as black spot.

Arun Kumar, Ajay Singh Chauhan, Abhishek Thakur (2016) This article investigates the length of NH-21A between BADDI and NALAGARH, which is prone to accidents, and provides information to the beneficiaries. The data collected from PWD was analysed, and the sites where the most accidents occurred were found. For the collision condition diagram of the specific accident location, IRC 53:1982 was used. To determine accident black spot locations, data from respective police stations was collected over the past five years (2009-2014). After compiling the data, five black spots were identified, three of which were T-junctions and two of which were intersections with the highest number of accidents. Crash spots on the highway length were identified by reviewing the FIRs obtained from the police station, and then crash diagrams were created using the data from the FIRs. The most deaths, horrific injuries, and minor accidents happened near union Sandholi, whereas large accidents occurred in Kishanpura. High and mixed traffic volumes, overtaking, and vehicle speeding are all factors that contribute to accidents on NH 21 A. Heavy trucks and two-wheelers were responsible for the majority of highway accidents. For the enrichment and benefit of society, the analysis of these black spots and other pertinent data will be shared with the police department.

S.U.Bobade, J.R.Patil, R.R.Sorate (2015) This paper identifies black spot on Pune – Solapure highway .Accidental black spots analysis is done the help of several methods like ranking and severity index by using secondary data. Remedial measures are suggested to betterment of the performance of highway safety. For this study 40 km to 50 km has been taken as study area, and total 35 accidents occurred on this particular stretch from 2013 to 2014. From analysis it was clear that total 9 accident spots are above the baseline of severity index i.e 22.42 with the parameter such as nature of accident ,11 accidental spots are above the baseline of severity index i.e 31 with classification of accidents and 18 accident spots are above the baseline of severity index i.e 21 with causes of accidents which evidently show the presence of accidental prone locations. Using the approach of ranking and severity index, accidental black spots were discovered by taking into account all of these factors.

Apparao G P, Mallikarjunareddy, SSSV Gopala Raju (2013) Studied on present situation of traffic accident information on NH-58 in Uttarakhand from Meerut to Muzaffarnagar was examined. and Identification of accident black spots by using GIS on preferred highway. The study area was selected from km 75 to km which lies between 77° 30'00 E to 77° 45'00 E Longitude and 29° 0'00 N to 32°5'30 N Latitude points. The geo referenced raster picture of Muzzaffanagar district was scanned for this project using Arc GIS9.3 software. The measure tool in ArcGIS9.3 was used to identify the actual area of the accidents. When compared to comparable destinations with similar features, a location's crash rate is enticingly greater than the average crash rate, then location is termed as an Accidental Black Spot. Determination of identified location's crash rate was calculated as

$$RMV= \frac{A*100,000,000}{VT}$$

Critical crash rate was calculated as

$$CR=AVR + \frac{0.5}{TB} + TF \sqrt{\frac{AVR}{TB}}$$

Comparing the crash rate of the location to the critical crash rate. The location is classified as an accidental black spot if the proportion of the area's crash rate to the Critical crash rate of the specific type of facility is higher than 1.5. The sections' Crash Ratio can be utilised to prioritise the Safety Development programme.

F. F. Saccomanno, R. Grossi, D. Greco (2017) Studied two application models for determining the probability of accidents and defining safety black spot along a highway were. This application involves a study area of 25-km highway stretch in southern part Italy, and road accident data were collected from period 1993–1999. In this paper the two models are compared along SS107 i.e multivariate Poisson regression model and empirical Bayesian (EB) model. Starting with Poisson relapse model, detailed count of accidents of SS107 (from the PS information base) is communicated as component of various road geometric features.

$$P(Xi)=\frac{(\mu X \text{Expi})^{Xi}}{Xi} X e^{\mu \text{Expi}}$$

Over the entire study area of highway i.e 25 km, proportion to the 181 incidents reported in the PS database, the Poisson regression model reports around 217 accidents. EB model presents a few outcomes from the contextual investigation application to SS107.

$$\alpha i= \frac{E(m\,i)}{E(mi)+E(mi)^2/k}$$

The findings suggested that the different models in measuring the mean predicted number of accidents in each category had a good level of consistency. Over the selected stretch of SS107 highway, Poisson model identified 43 Black spot areas as compared to EB model with 36 black spots. From practical perspective, EB model appears to be more adoptable in this case (i.e., SS107).

Sanjith Anchan, Basavaraja N H, H Gangadhara Bhat (2015) Studied identification of accident black spots by using remote sensing & GIS techniques for particular portion of National highway-75, i.e from Nelyadi to Sakaleshpura. 58 km road stretch was selected from Nelyadi to Sakaleshpura connecting Mangalore-Bangalore highway as study area. The methodology utilized for the accident investigation in current study is done in two sections i.e spatial data and its related analysis, and non-spatial data and its analysis. In this study toposheet from survey of India has been taken to prepare a base map. The digital data was geo-referenced and processed into GIS software (ArcGIS 9.4). Road accident data obtained from respective police stations for consecutive 4 years and black spots were plotted by obtaining the GPS co-ordinates of particular locations. By its geographic referencing capabilities, remote sensing and GIS are a far better fit for black spot analysis than traditional approaches, according to the findings of this study (both spatial and non-spatial analysis). This strategy for reducing accidents will be extremely beneficial to the National Highway System, Highway Authorities, and Police Departments.

Sudipa Chatterjee, Sudeshna Mitra (2019) The purpose of this research was to uncover the critical safety hazards that were discovered during RSA on two major two-lane undivided highways in West Bengal, India. Also, to recommend appropriate countermeasures to reduce the number of incidents caused by risky locations. RSA is a well-known method for assessing the safety of accident-prone areas. RSAs can be carried out in five stages: (i) planning, (ii) preliminary design, (iii) detailed design, (v) building, and (vi) operation and maintenance of an pre-existing road. Here 137-kilometer long NH 117, which stretches from north to south across three main

West Bengal districts, was chosen as the study region. During the audit, the team observed the type of geometry and traffic behaviour at the site that might result in an accident of varying severity. Hazardous aspects were divided into three categories by the RSA team: road geometry, road infrastructure, and road users. The most accident-prone areas on both routes were discovered to have horizontal curves. At horizontal curves on two of the study highways, insufficient visual distance was regularly recorded. Finally, it was discovered that road users lack a fundamental understanding of road safety.

Kundan Meshram, H.S. Goliya (2013) Studied on analysis of accidents on NH-3 i.e. from Indore to Dhamnod. The accident data for analysis is collected from respective police station from 2009 to 2011. The traffic data was collected from year 2009 to 2011 and converted into Average Daily Traffic. The year wise severity Index, was calculated from 2009 to 2011 i.e. 19.97 ,18.42 & 20.8 in 2011. The traffic flow is seen increasing from year to year in present study. Accidents occurring in urban part of Indore is more than 35 % of total accidents in each year. This is due to over speeding of vehicles. The maximum number of deaths is been registered in rural highway portion and this is due to heavy load vehicles coming from villages. In taken study area, the occurrence of fatal accidents is 2 in a week and 6 for minor accidents in a week. The accidents caused by inadequate road geometry are very less in city than accidents caused by road geometry in highway.

H. A. S. Sandhu, Gyanendra Singh, M. S. Sisodia (2016) The goal of this research is to demonstrate how a Geographical Information System (GIS) may be used to identify black spot areas on roadways. With the aid of the Kernel Density Estimation (KDE) technique, the discovered black spot zones was graded based on the severity of vehicle collisions in the surrounding areas.

Zambom and Dias also looked at the use of KDE in econometrics (2012).The Gurgaon-Jaipur segment of NH 8 from kilometre 42.700 to km 273.000 is being considered for a case study. NHAI provides statistics on vehicle collisions for the year 2012, which is used to identify black spots. ESRI ArcGIS was used to create the base map. Spatial locations, such as GPS coordinates, of each accident site are also gathered using existing records, Google Earth, and on-site visits. For the same, ESRI's ARC GIS software is utilised. At each site, attribute data is manually entered and the location's Severity Index (SI) is computed.

SI=6.0 x X1 +3 x X2 + 1.2 x X3 +X4

The severity index for accidents in this study is 6.0 for death, 3.0 for serious, 1.2 for minor injury, and 0.8 for accidents that merely cause property damage. The selected Gurgaon-Jaipur National Highway length is imported into the ArcGIS software application, as well as vehicle crash data. The radius and cell value were used to determine Kernel Density. To begin, the Kernel density is drawn using the default settings of the ArcGIS 10.1 software tool. Kernel Density is set at radius 4629 m cell value 555 by default. Based on Kernel Density, the radius 1500 m with cell value 100 produced the best results out of all the radius and cell values tested. As a result, black spots on the Gurgaon-Jaipur stretch were identified using a Kernel density map with a radius of 1500 m and a cell value of 100. The positions of black dots were chosen according to their Kernel density. Using the Kernel density Estimation technique, seven black spots were discovered on the Gurgaon-Jaipur section of NH-8 (at km 61.940, 63.150, 71.880, 106.00, 1235.240, 129.32, and 184.840). This method of recognizing and rating black spot-on highway sections is both efficient and dependable.

Gourav Goel, S.N. Sachdeva (2014) The goal of this study was to find and recommend solutions for accident-prone areas along the NH-1 road section RD 98km-148km (Delhi -Ambala-Amritsar Road). Accident data was obtained from the National Highway Authority of India (NHAI) and SOMA Isolux for four years, from 2007 to 2010. The study also assesses the impact of the 6-lane widening project, which began in May 2009, on traffic accidents. The results are summarized after the data has been analyzed. The impact of 6-lane construction on road accidents was assessed by splitting the total number of accidents into two groups: before and after construction. The idea of Accident Severity Value (ASV) was used to identify accident-prone sites, and field trips were undertaken to assess the real-time conditions. These sub-stretches have been scored 1 to 10 in order of decreasing accident severity value using the notion of accident severity value. The stretch of road between 140 and 144 kilometres is the most accident-prone, followed by 98-104 kilometres and 145-148 kilometres. Following the start of construction work on the NH-1 widening in May 2009,

the frequency of accidents has skyrocketed. It demonstrates that increased building activity has resulted in a large increase in road accidents. Over speeding/driver error, as well as a lack of sufficient control measures, have been identified as the primary causes of most road accidents; therefore, efficient speed regulation measures must be implemented on the road.

Shailendra Singh, Shivam Singh Patel (2020) Studied on accidental black spots by considering parameters such as location and considering the various factors reasons for occurring of accidents by using method of Accident Density. For the investigation, Kanpur-Lucknow-Ayodhya Section of NH-25 & NH-28 was selected for study. According to the data collected for the period June-2014 to August-2018 year, 6042 accidents was recorded. Black spots were identified at merger point of NH-56A&B and NH-25 with huge traffic and location of bus-stop, joining of link road from Industrial area to NH-25 and joining of link road from Sainik School to NH-25. This Black Spot was 3 leg type of location of NH 56 A & B and NH 25. And other Black Spot is at intersection, a village road joins the high-speed corridor in haphazard way. Traffic towards the village road joins the NH in wrongly manner and this merger points turns as frequent accident spot. Depending upon the site condition/requirement the corrective measures needed Short Term Measures only, and in some cases Long Term Measures including Cautionary Measures. Based on Black Spot locations Long Term Measures includes construction of Flyover, Underpass, and Junction Improvement including Crash Barrier also has been taken in Long Term Measures i.e Cautionary accident black spot signs at both ends, solar red blinking signals at both the ends and rumble strips together with rumble strip sign.

M.S. Saran el at (2017) Studied on to locate the highway accident black spots in Kozhikode district, Kerala. The researcher utilized the secondary road accident data of previous three years collected from police stations and Kerala Crime Records Bureau for the study area and accident black spots were prioritized with Weighted Severity method. Primary data such as road survey data, traffic survey data, spot speed studies from the identified accident-prone sections of highway. Coordinate values for all the locations were determined using handheld GPS. The most vulnerable accident black spot stretch identified in GIS analysis are Elathur in Kozhikode urban area and Moodadi in Kozhikode rural area. It was observed from survey that the carriageway width is insufficient in all the stretches to accommodate large heterogeneous traffic during the peak hours. Lack of median and insufficient shoulder width creates head on collision. Over speeding of vehicles mainly causes accidents in these stretches. The identified accidental black spot is a curved stretch having necessary lane width and shoulders. Change of alignment is needed on horizontal curves to avail adequate sight distance. Current study was aimed to identify, evaluate and improve the accidental black spots in Kozhikode district by using Weighted Severity Index method, Geographic Information System and site investigation. The overall methodology was found to be helpful for attaining the above goals provided sufficient data is available.

III. CONCLUSION

The paper provides a comprehensive review in the numerous methods used for to identify accidental black spots on National highways and to recommend preventive measures for the identified highway accidental black spots by prioritizing them and finding out the probable reason of accidents. Based on the review of various studies, findings are concluded as follows: -

1) The accident locations were ranked using the Weighted Severity Index (WSI) technique, which was found to be useful for identifying, estimating, and treating accident black spots on roadways.
2) For analyzed stretches of roadway, the method of accident severity value was utilized to identify higher accident-prone locations.
3) PWD data should be collected in a more consolidated manner.
4) By considering all these parameters method of ranking and severity index are considered to identify accident black spots.
5) Speed barriers should be installed in both directions of highway to 40km/hr to reduce accidents.
6) Automatic traffic signals were installed at intersections and curves.
7) Making use of WSI method, Geographic Information System and site investigation. This methodology was found to be effective for

attaining the above goals provided sufficient data is available.

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