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Review Article

Identification & Analysis of Black Spots on National Highways – A Current Scenario

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Abstract: *The development of the nation's states is said to be mostly facilitated by national highways and expressways. Because of the enormous cost associated with them, road traffic accidents have been identified as one of the unfavorable factors that contribute to the stifling of economic progress in developing countries. This raises social and economic concerns. The number of automobiles on the road increases in parallel with global population growth. Accident rates go up in direct correlation to the increase in the number of vehicles on the road. Therefore, there must be a decrease in accidents to demonstrate the safety of roadways. Subjective factors and objective aspects can be used to categorize accident causes. While objective factors include things like road conditions, road geometry, and other engineering-related elements, subjective issues mostly refer to the psychological issues of drivers and pedestrians on roads. The study of unintentional black spots focuses on the study of road safety because the two are interwoven, and if road safety is addressed, the likelihood of accidents lowering raises. Therefore, it is essential to identify "black spots" and make modifications to the specific places in terms of road geometry. Thus, it is needed to take into account all of these design and safety-related considerations when engineering Indian National Highways. These factors were taken into account in a comprehensive study that presented the reality of accidents happening on various Indian roadways, along with their causes and solutions.*

Keywords: *Black spots, National Highways, Fatalities, Grievous Injuries, Weighted Severity Index.*

I. INTRODUCTION

National Highways are the core components of the nation's transportation network. India's national highways span a total of 70,548 kilometers, making up 2% of the nation's whole road system and transporting 40% of all traffic [11].Road Traffic Injuries (RTIs) are viewed as a significant public health issue on a global scale. India's road crash severity increased from 37.5 in 2020 to 38.6 (deaths per 100 crashes) in 2021, according to data from the Save Life Foundation. Road crash fatality probability is correlated with crash severity. The chance of fatalities in a traffic accident increases with collision severity. Road accident reports increased from 3,54,796 in 2020 to 4,03,116 in 2021, according to statistics from the National Crime Records Bureau (NCRB). In the meantime, the number of people killed in traffic accidents climbed by 16.8%, from 1, 33,201 in 2020 to 1,55,622 in 2021. 3,71,884 individuals were hurt in car accidents last year. Additionally, from 0.45 in 2020 to 0.53 in 2021, the number of fatalities per thousand cars increased. As a result, it was decided to take coordinated action to increase road safety. The location, analysis, and management of road accident black spots are some of the most effective methods for preventing accidents on the road. Accidental black spots are parts of the road where accidents are more likely to occur or occur more frequently on freeways.

II. LITERATURE REVIEW

By compiling accident data over the previous five years**, Deepdarshan et al. [1]** discussed the Mangalore accident situation. To lower accident rates, he also concentrated on the causes of accidents and proposed the three E's. Engineering, Enforcement, and Education are the three "E's" mentioned above. KPJ Junction, Mukka Junction, and Kulai Junction were the three blackspots found in Mangalore City. A few easy solutions include establishing ample road furniture, speed breakers, lane markers, pedestrian crossings, and decent lighting. As a mitigation strategy, pavement maintenance is recommended. The long-term improvements include enlarging the pavement and shoulders, installing traffic signals, installing speed bumps, and expanding the underpass.

Using a safe system approach, **Yadav et al. [2]** have emphasized reducing black spots on national highways. The investigation will focus on a segment of NH-66 that runs for 8 kilometers across Kerala's Alappuzha district. The accident severity index (ASI) method analysis is done on the accident data that has been gathered. Black spots were detected, and short-term solutions were proposed before long-term solutions could be implemented based on the severity index values.

A few of the short-term initiatives include junction enhancement, zebra crossings, accident barriers, solar studs, filling of shoulders, etc. **Shaikh et al. [3]** concentrated on a 15-kilometer stretch of Kanakpura Road, Bangalore, of the National Highway (NH-209) to confront the black spots based on police records. According to him, lowering the number of black spots will assist in lowering the rate of accidents. This stretch has eight black spots, with the majority of deaths occurring in the last five years at Nelguri Kere Junction. Several corrective measures, including highway realignment for good sight distances, resurfacing to counteract unevenness, curtailing illegal parking, providing walkways and pedestrian crossings, widening of roads, and most notably, road signs and route markings, were suggested as an outcome of comprehensive and detailed traffic surveys, spot speed studies, and pavement performance surveys.

To assess the efficacy of the road, **Goyal et al. [4]** conducted a Road Safety Audit (RSA). Through RSA, one may pinpoint accident hotspots and suggest mitigating measures that are site-specific. The project route is a 25.45 km continuous stretch of road (State Highway) in Karnataka's northeast that passes through the villages of Hulasur, Belur, Betbalkunda, and then Basavakalyana. Skidding and head-on collisions were the most common types of incidents, which tended to happen near the entrances to built-up areas during the evening peak hours, or from 7:00 p.m. to 8:00 p.m. Accidental locations were located using the Ministry of Road Transport and Highways (MoRTH) technique, which involved observing a short portion (minimum 100m) and proposing all necessary corrective actions.

To identify accident-prone areas, **Vijay et al. [5]** chose a section of NH-48 where there will be 51% deaths in the years 2019, 2020, and 2021. There were 16 places in all, at various chainages, and depending on how severe the crashes were, both short- and long-term solutions, as well as a cost analysis, are advised. The lack of crash barriers, unlawful median gaps, encroachments, on-street parking, inconsistent route markings, the absence of solar studs at pedestrian crossings, the absence of critical road signs, etc. were some of the engineering concerns that were present throughout the NH-48 section. The study suggests several actions, including installing weigh-in-motion facilities at toll plazas to detect overloaded vehicles, CCTV surveillance along the highway stretch every 10 kilometers, all the necessary pavement markings recommended in IRC:35-2015, and the installation of traffic sign boards at intersections, horizontal and vertical curves, median gaps, etc. by IRC:67:2012.

Nikhil et al. [6] chose a portion of NH-3 that has been 96.90 kilometers long, from Gonde to Vadape, to identify the occurrences and advise essential actions in order to reduce the accident rates. The second-largest highway network in the world is found in India, and despite being the backbone of our country's transportation system, highway accidents, of which the majorities were fatal, were common. Sinnar Road Junction (CH. 453+000/453+500) and New Kasara Ghat (CH. 470+500/471+000) were two accidental locations that had been discovered, and their respective average severity indexes (ASI) were 81 and 68. Accident causes were examined, and it was found that immediate action would be more helpful in overcoming trouble spots.

Anuj et al. [7] discovered that the nation's road or land transportation system has a wide service that allows for the fast and secure transit of people and goods from one area to another. Roads should be free from incidental damages brought on by drivers, pedestrians, or poor road geometry in order to promote safer mobility. The Weighted Severity Index (WSI) and Accident Density Method were used to detect accidental locations along the stretch of NH-4 (ADM). For a specific incident detected, the root of the incident was determined, and effective disciplinary actions were advised.

According to **Snehal et al. [8]**, there have been numerous accidents on the Mumbai-Pune Expressway, but there has been little research done to counter them. Likewise, she noted that human error rather than faulty road geometry causes these incidents to arise. By applying the ranking method, the most essential parameter was given the lowest score and the percentage value for discovered blackspots was determined. It was advised that separate studies should be conducted to eliminate the effects that pose a risk to both pedestrians and motorists.

The Sirmour District in Himachal Pradesh's NH-72 has undergone an incidental spot study by **Surbhi et al. [9]** PWD and NHAI have previously identified the four black spots along a 9-kilometer section between Dhaulakuan and Kyarda. Using the Weighted Severity Index Method (WSI), she also emphasized the seriousness of injuries at these pre-identified hotspots and gave recommendations for improvements. According to IRC standards, a drawing for Misserwala, the location that is most likely to cause accidents, was provided along with corrected measurements.

In order to identify high-risk accident zones, **Athira et al. [10]** studied the Asian Highway (AH-46) between Nagpur and Amravati. They used the Weighted Severity Index (WSI) method. Recent data on road accidents show that the densely populated

state of Maharashtra has the highest accident rate, necessitating the need for safety measures. Five unintentional zones were found using the WSI Method, and changes such as appropriate road signs, route markings, drainage facilities, junction layout, and the requirement for traffic signal construction were thoroughly reviewed.

Manisha et al. [17] study present road traffic conditions. The analysis will be performed based on the wheel load that the existing road can support with the present volume of traffic. The IRC traffic flow principles will also be taken into account for this study. If the road has to be expanded, the project will also include the provision for construction along the desired stretch of the road, the number of additional lanes required to meet IRC requirements, and an evaluation of the project's financial feasibility. Actual daily traffic will be calculated to determine the results and conclusion based on the survey's traffic density (ADT). She suggested that the composite pavement can be used to add new lanes to the work.

III. METHODOLOGY

A. Identification of Black Spots:

The black spot identification process is a method to locate those spots on road stretches that are particularly dangerous i.e, the black spots. Black spots are detected on the basis of the number of casualties or grievous injuries that happened in a particular area. These mishaps may be caused due to natural or man-made faults. Accidents are caused by skidding during monsoons, inappropriate sight distances due to incorrect vertical alignments, repeated horizontal curves, motorist psychology, human error, super elevation, absence of traffic calming measures, traffic signs boards, etc. The identification of black spots on NHs is based on two criteria:[12].

a) The number of black spots with 5or more accidents in3years.

b) The number of black spots with 10 or more fatalities in 3years.

B. Methods Used For Identification of Black Spots:

a) Ranking Method [8]:

With this approach, the parameters that cause accidents are first identified. Then, the parameter that consistently contributes to accident occurrence according to logical analysis is given top rank and the parameter that does not contribute as much to accident occurrence in that specific geographic area is given lower rankings. Only that particular study area can use this methodology. It is also possible to decide on the Ranks by consulting an expert.

b) Accident Density Method [7]:

The number of accidents per unit length for a piece of highway is known as accident density. The accidental density is computed in sections with more than a predetermined number of incidents using a unit length of 500 meters in this technique.

c) Average Severity Index Method [2],[6],[7],[9]:

A dimensionless number used to describe how dangerous a location is called the average Severity Index (ASI). The severity of a discovered unintentional location is calculated using the formula below.

$$\mathbf{ASI = (N_f\ X\ W_f) + (N_g\ X\ W_g)}$$

Where
N_f = Quantity of fatal injuries
W_f = Weightage apportioned to fatal injuries
N_g = Quantity of grievous injuries
W_g = Weightage apportioned to grievous injuries

As part of a road safety audit, the values $W_f = 7$ and $W_g = 3$ were used to identify any "black spots." Minor injuries are given a weighting factor of 1, which is common in many other nations, but India does not use this weighting factor because it is difficult to get local government records of minor injuries and because victims of minor accidents do not often report their cases. The equation presented below is used to compute the average ASI for both the number of accidents and the number of people killed.

$$\mathbf{ASI} = \frac{\mathbf{1}}{\mathbf{2}}\{\mathbf{ASI(n) + ASI(p)}\}$$

Where as
ASI(n)= Severity index of the number of accidents
ASI(p)= Severity index of the number of persons killed

C. Analysis of Blackspots:

Based on the kinds of injuries sustained during collisions, black spots are examined. For each place that has been identified, an accident collision diagram illustrating the cause of the mishap and the number of different accidents types—such as pedestrian struck, head-on collision, hit from behind, hit from the side, hit a stationary object, overturn, etc.—must be generated. According to the cause of accidents, specific engineering corrective actions are recommended and put into action.

D. Conduct Road Safety Audit (Rsa):

An amateur team of auditors or specialists conducts an RSA to evaluate the safety performance of a current or upcoming road or intersection. Instead of accident reduction, the major goal of RSA is accident prevention. From the planning stage through the final design stage, RSA can be used at any point in the project. Additionally, it can be carried out on intersections or roads that have already been built and put into use. The audit assists in identifying methods to reduce crash risk and severity, reduce the need for corrective action after construction, and lower project life-cycle costs.

IV. REMEDIAL MEASURES

As the road infrastructure is essential for the development of the Indian economy at present, appropriate corrective measures from IRC regulations and MORTH specifications are hereby prescribed to decrease the number of accidents on the roads.

a) Installation of mandatory, cautionary, informatory sign boards as per IRC: 67-2022.
b) Pavement markings such as longitudinal marking, transverse marking, hazard marking, block marking, an arrow marking, directional marking, facility marking, etc. should be as per IRC: 35-2015.
c) Provision of traffic calming measures such as rumble strips or speed tables or speed humps as per IRC: 99-2018.
d) Provision of pedestrian facilities such as pedestrian crossings, ramps, and pedestrian subways as per IRC: 103-2012.
e) To protect against roving cars, we can install RCC crash barriers (M40) on all bridges along the highway. (IRC: 21 - 2000).
f) Improvements of existing junctions by providing islands as per IRC SP 041.

V. CONCLUSIONS

In accordance with the study above, it is clear that numerous researchers have worked on the issue of road accidents by using various parameters such as accident nature, accident classification, accident location, accident causes, and various methods like ranking method, Method of weighted severity index, Method of accidental density, etc. in an effort to decrease the number of mishaps. Road accidents, however, are a very unpredictable character and cannot be easily reduced using traditional techniques. To eliminate such accident-causing factors and lessen the severity of unintentional black spots, a separate detailed investigation is required. Researchers have identified the key causes of accidents as follows:

a) Improperly planned horizontal and vertical curvature, a lack of shoulders, uneven pavement width, and other non-standard elements of road geometry.
b) Absence of necessary road furniture such as lane markers, hazardous lighting, warning sign boards, delineators on valley sides, zebra crossings, and speed breakers
c) Driver errors include breaking traffic laws, failing to use safety equipment like seat belts and helmets, being tired or sleepy, being under the influence of alcohol, having poor vision, etc.
d) Vehicle conditions such as type, operating condition, braking defects, over speeding, etc. lead to accidents.

Interest Conflicts:

We, both the authors of this paper declare that the publication of this paper does not involve any conflicts of interest.

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