

The Study of Risk Factors for Road Accidents on Indian Highways NH152

***Vikas Kulheriya¹, Dr. Sumesh Jain², Dr. Sunil Thakur³, Umesh Jhakar⁴, Er. Devander Kumar⁵**

**Research Scholar, Deptt. of Civil Engineering, School of Enineering & Technology, Om Sterling Global University, Hisar, Haryana, India*

Professor, Deptt. of Civil Engineering, School of Enineering & Technology, Om Sterling Global University, Hisar, Haryana, India

Professor, Deptt. of Mechanical Engineering, School of Enineering & Technology, Om Sterling Global University, Hisar, Haryana, India

Research Scholar, Deptt. of Civil Engineering, School of Enineering & Technology, Om Sterling Global University, Hisar, Haryana, India

Assistant Professor, Deptt. of Civil Engineering, School of Enineering & Technology, Om Sterling Global University, Hisar, Haryana, India

Abstract:- In the present paper, the risk variables for highway collisions in situations of mixed traffic are evaluated. Abutting land use, highway, and traffic characteristics served as the foundation for choosing study locations. In order to cover a wide range of these road qualities, the study chose thirteen segments from the state of West Bengal's existing highway network. The crash rate has continuously climbed for years with traffic independent of highway category and conditions, according to a comprehensive research based on site-specific accident data to identify the safety elements of the high-way sections. Mid-block access, pavement and shoulder conditions, vehicle participation, time of day, and road configuration, such as two and multi-lane, are among the risk factors that cause traffic accidents. The empirical finding shows that multi-lane highways have a significantly lower crash rate, but that any crashes that do occur there tend to be more severe. Due to the lane-based, unidirectional traffic movement, it is noteworthy that crash frequencies on such roads are lower during the day. Contrarily, at night, when drivers are less able to adapt to changing traffic conditions, crashes are more likely to occur. On two-lane roadways, however, hazardous driving manoeuvres are the primary cause of collisions. The study also found that frequent mid-block accesses and bad shoulder conditions limit opportunities to correct driving errors and, as a result, raise collision risk. The report then makes proactive recommendations for identifying safety gaps during planning and design.

Keywords: Black Spot, Accidents, Pedestrian, Shoulder, Pavement, Entry Exit Point.

1. Introduction

India's vehicle sector has grown significantly during the past several years. As a result, traffic has beyond its capacity, which has led to an increase in road crashes. A million or more people die on the roads each year, according to the global situation of road safety. Many research have been conducted over many years to provide safe roads for traffic and to look for ways to increase road safety. Researchers in traffic safety are currently trying to pinpoint the variables that primarily influence traffic safety in various road and traffic situations, therefore the quest is far from over.

Numerous studies have found factors that significantly affect traffic accidents. They are driveway density, sight distance, exclusive left- and right-turn lanes, lane and shoulder width, horizontal and vertical alignment, roadside condition, and traffic control. A study found that various variables, including as access density, sight distance, speed limit, and fractions of no-passing zones, had a high connection with crash rates, even though

some of them are interconnected and show a nonlinear relationship with traffic crashes. It should be noted that the majority of research published thus far concentrated on rather uniform traffic. There is an urgent need to take safety measures to prevent such incidents because the number of road accidents is rising significantly in most less developed nations, including India. As a result, the current study made an effort to comprehend how various roadway elements affected traffic safety. To determine the causes of traffic accidents, 13 study locations were chosen. Road safety is significantly impacted by a number of factors, as shown by an analysis of location-specific accident statistics for the last ten years. They are the number of mid-block access points, the kind of pavement and shoulder, the time of day, the kinds of vehicles, and the style of road—multi-lane or two-lane. Additionally, a number of research have discovered that driving at excessive speeds raises crash risk and severity levels. However, a research found that there was no correlation between crashes and speed. The elements that affect highway crashes and their anticipated effects are presented in Table 1. Framework for Highway Accidents' Impact Factors.

Table 1: Highway Crashes and Their Anticipated Effects

References	Aspects	Highway crashes that could take place				
		Head-on	Rear-end	Sideswipe	Bicycle-vehicle	Pedestrian-vehicle
[14,15,17,18]	Operation of passing or overtaking on horizontal shifts and straight stretches	Yes	No	Yes	No	No
[27,28]	Driving when imposed by drugs or alcohol	Yes	Yes	Yes	Yes	Yes
[29]	Climate conditions (Clear, rainy, foggy)	Yes	Yes	Yes	Yes	Yes
[5-8]	Vehicles moving too fast	Yes	Yes	Yes	Yes	Yes
[2,3,7,19,20]	Geometrical aspects: seeing distance, vertical and horizontal curves, and lane and shoulder width	Yes	Yes	Yes	No	No
[4,16]	Number of access points	No	Yes	Yes	No	Yes

[9,10,25,26]	Compositions of the traffic: a greater number of heavy vehicles, slower vehicles, especially non-motorized ones, and driver behaviours	Yes	Yes	Yes	Yes	Yes
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‘No’ -Low possibility; ‘Yes’-High possibility.

Traffic conditions and geometric factors both significantly influence the likelihood of crashes. For example, wider lanes reduce crash rates because they act as a safety net against driver error or distraction. According to a few studies, truck lane limits lessen traffic accidents; when such restrictions are put in place, 4 and 17.6% less accidents were recorded. Truck lane restriction removes slower cars from the traffic stream, improving traffic flow and lowering the likelihood of auto-truck collisions. Road safety is greatly impacted by drivers' risk-taking attitude during overtaking manoeuvres. On two-lane highways with mixed traffic, unsafe overtaking attempts are common; these operations are influenced by drivers' characteristics, roadway layout, traffic flow, and composition. Even while existing operational standards for passing sight distance satisfy the requirements of acceptable risk levels, passing at night is reportedly relatively safer. Drivers can predict an enemy vehicle's position before it becomes apparent at night thanks to its headlights. As a result, when making overtaking judgements, they display a conservative mindset.

Road accidents are thought to be significantly influenced by access point density. When access density is increased by one unit, a research on two-lane highways in steep terrain found a 4.36% increase in total accidents. Regular entry points hinder main traffic and raise the risk of rear-end collisions and side-impact accidents. Such risk is further increased by inadequate sight distance and traffic signs at intersections. Another issue is the presence of large speed differences in mixed traffic; this is caused by the fact that vehicle characteristics change greatly depending on the kind of vehicle.

Undivided roadways' horizontal curves are the site of a significant number of recorded incidents. It has been discovered that a number of variables, including the length of the curve and degree of curvature, have an impact on the safety features of horizontal curves. The need of adequate sight distance, pavement friction, road markings, and traffic signs is further emphasised by the fact that major incidents can occasionally arise from drivers failing to notice an oncoming horizontal curve. Therefore, operating speeds on horizontal curves should be kept much below the design speed of the high-ways.

The dynamics of traffic have changed in the modern period with the advent of fuel-efficient and powerful new generation automobiles. Frequently, there is a mix of slow-moving and fast-moving automobiles in traffic. The rate of accidents gradually rises as a result of significant speed differences. The impact is greater when there is a high volume of traffic and a significant proportion of slower moving cars. This fact affects highway safety together with geometry issues, pavement issues, and shoulder issues. Road accidents are a substantial cause of death worldwide and a considerable source of ambiguity in traffic system design, according to the global status report on road safety. Therefore, the current study's goals were to assess road accident risk factors in mixed traffic on the basis of extensive field data.

2. Objectives

The study attempts to comprehend safety issues on roads under (a) various roadway characteristics, such as pavement and shoulder width, their conditions, and highway accessibility. The temporal variability of the exogenous variable in terms of daytime and nighttime exposures on drivers' visibility and (c) mixed traffic

situations that exhibit a wide range of vehicle types in terms of statics and dynamics in its composition by way of the multi-faceted computational framework are examples of (b) varied driving conditions via innate cognitive mechanisms. Therefore, the goal of the study was to identify the variables influencing the safety of roadways through extensive field research and a thorough investigation of past crash incidences.

The aim of this study is to investigate spatio-temporal traffic crash patterns to gain a better understanding of the causation of road accidents, and their interaction.

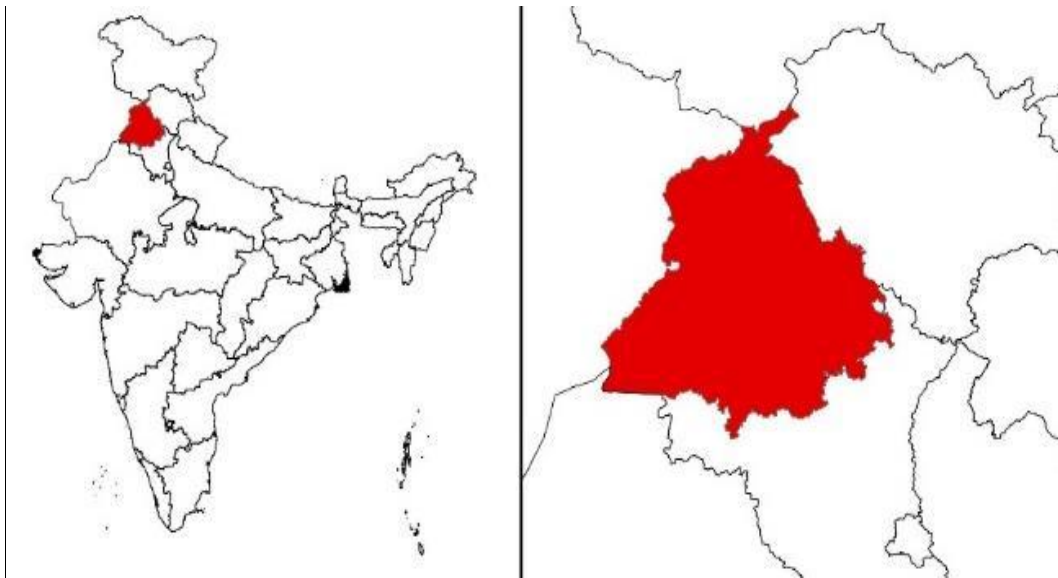


Fig. 1: Location of Study Site Punjab.

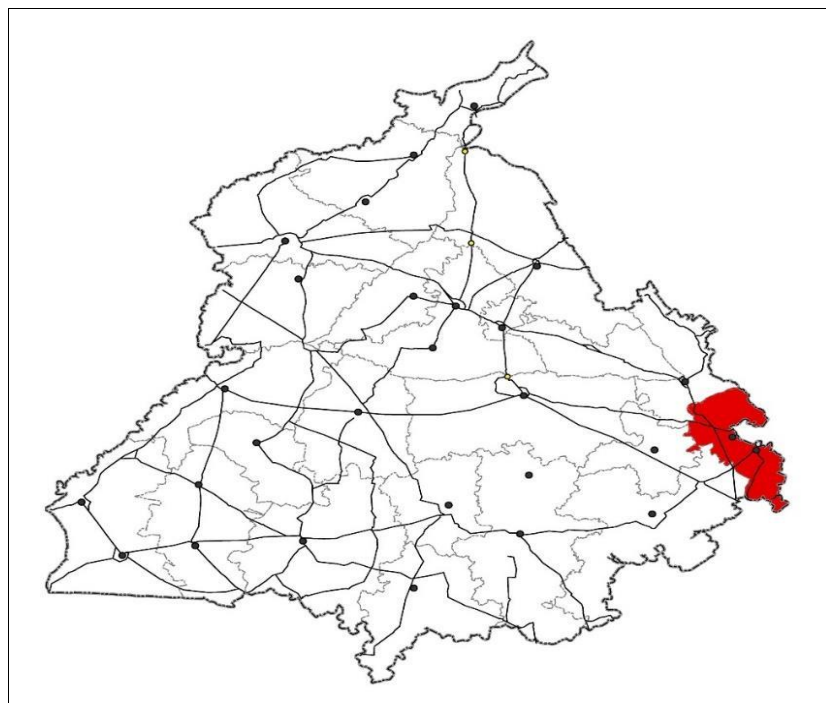


Fig. 2: Location of Punjab Area SAS Nagar at (NH 152).

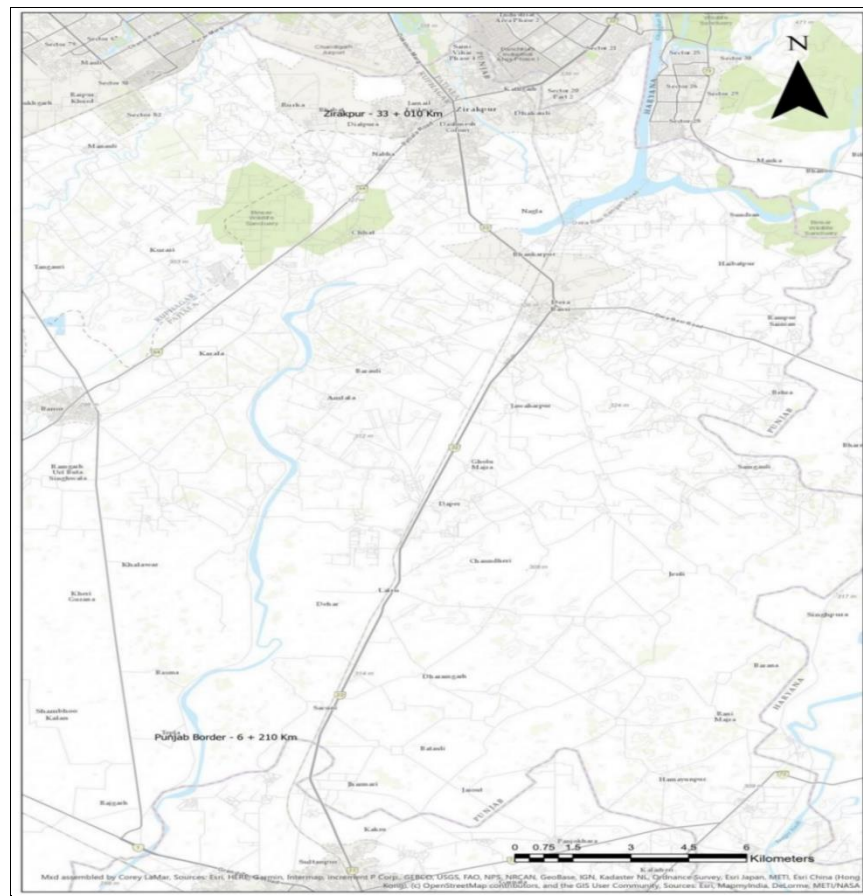


Fig. 3: Index Map of NH-152 in Punjab Area.

3. Study sites and field data:

NH-152 runs along the periphery of Eastern Border of SAS Nagar District, Punjab. This 34.225 km long national Highway connects Ambala (Haryana) to Zirakpur (Punjab). Out of the total length, 29.01 km stretch lies in the Punjab State and part of the project corridor, starting from Village Jharmari to Chandigarh Barrier, Zirakpur. SAS Nagar comprises of 19 Police stations and NH-152 passes through three of them, those are Lalru, Dera Bassi, and Zirakpur. The project has one 450 m long 12 Lane Toll Plaza at Km 23+080, near village Dappar. By looking at still photos of the pavement surfaces that were acquired during the field survey, the study awarded the following condition grades for the study sections using the Asphalt PASER Manual.

- "Excellent" condition: a brand-new surface, such as an overlay or fresh construction.
- "Good" condition: edge-running longitudinal cracks, transverse cracks with a width of 6 mm and a spacing of 3 m, and minimal to no ravelling.
- "Average" condition: block cracking, longitudinal cracks, transverse cracks [width 6-12 mm; spacing 3 m], little ravelling, and sporadic patching.
- "Poor" condition: large spots, rutting, and alligator cracking (25 percent of the surface). A new surface, i.e., new construction or an overlay, is in excellent shape.

Similarly, the study rated the shoulder conditions seen at various locations based on the surface (paved or unpaved), slope (for proper drainage), breadth, rutting, irregularities in the cross slope, and quality of materials. The safety of roadways is impacted by the growth of plants along the wayside, which prevent cars from using the shoulder as an emergency lane. A detailed examination of the site photos made it easier to rate the photographs on a five-point scale and define shoulder condition in terms of "excellent," "good," "average," and

"poor" based on prior knowledge. Since sight visibility is a major factor in access point safety, the study classified access points into three categories based on visibility restrictions: "high," "moderate," and "no."

The study is conducted over the National Highways (picture below) falling in the state of Punjab. Only the National Highways, which are toll roads are considered in the scope of the study. This report is a detail out the Road Accident scenario of NH 152, which falls in the district of S.A.S. Nagar of Punjab. The NH 152 is a total length of 29.1 km falling in the state of Punjab, starting from km 10+950 up to km 39+000 is a part of the study. The section from Zirakpur Chowk (Km 39+000) to K-Point (39+960) is already under Improvement, hence, up to Km 39+000 i.e. 28.05 Km long has been considered in this study.

Table 2: Details of Toll Plaza on NH-152 (Dappar).

Location of Toll Plaza	Number of Lanes	Starting Chainage	End Chainage	Length of Toll Plaza Zone
At Km 23+080 on NH-152 in Dappar (Punjab)	12 Lanes	Km 23+885	23+305	450m



Fig. 4: Dapper Toll Plaza.

As a result, the current study made an effort to investigate the underlying causes of such traffic accidents and focus on any possible links between human-related factors and the risk of such collisions. As a result, the crash data from study site was excluded from the current examination because it was thought that it would cause confusion in the analysis. On six-lane roadways, it was discovered that 2.3 accidents per km per year, which is a quite high amount. The likelihood of a vehicle becoming involved in a traffic accident is high on these roads since only one lane is used for all directions of traffic. This is especially true when there are inadequate sight distances at curves and crossroads.

4. Factors affecting road crashes: a data-driven approach:

Road traffic accidents significantly increased in many less developed nations around the world over decades, which led to a major increase in the number of fatalities. The devastating effects of such incidents nearly always result in significant financial loss for a nation's gross domestic product as well as psychological stress for the families of the victims. In order to decrease traffic accidents, it therefore becomes imperative to pinpoint the risk factors and provide remedial actions. Although the researchers have identified a number of risk variables for traffic accidents (see Fig. 2), the majority of those studies are on routes with more or less uniform traffic. However, just a few studies that have so far concentrated on roads with mixed traffic do not sufficiently define the effects of those characteristics. Therefore, the study's goal was to propose a data-driven strategy for identifying the causes of traffic crashes and their effects, particularly in situations with mixed traffic.

4.1. Effects of heterogeneity in traffic mix:

Due to the intricacy of the flow pattern, road accidents are a serious issue for motorways with mixed traffic. As a result, a variety of vehicle types in terms of their sizes, shapes, maneuverability, and lack of lane discipline were used in the study's mixed traffic experiments. Different vehicle types exhibit considerably different following behaviors as this traffic moves longitudinally, which causes vehicles to slow down, frequently oscillate to the side, and quickly manoeuvre. Based on the leading vehicle types, drivers choose their manoeuvring strategies. When following big trucks and two- and three-wheelers that fall into either the motorised or non-motorized categories, their actions frequently prove to be crucial. Drivers' risk-taking behaviors eventually alter the safe driving environment and add another risk element that affects road safety. When compared to mixed traffic, homogeneous traffic exhibits rigorous lane discipline, uniformity in driving conduct, and vehicle features, creating a situation that is very different.

Numerous vehicle types, including non-motorized ones, can be seen in the typical traffic at the study sites. On multi-lane highways, however, a large percentage of heavy vehicles are present, while on six-lane highways, truck, bus and heavy vehicle predominate. Local travellers are encouraged to use highway segments by the ease of access to nearby communities, further increasing the heterogeneity of the traffic mix. The significant speed difference that results in this higher interaction level among traffic also lowers traffic speeds and capacity. Such places' roadside frictions have an effect on these parameters as well. As a result, the current study made an effort to investigate how mixed traffic effects highway safety. The findings show that significant variations in a vehicle's acceleration and braking capabilities frequently cause irresponsible driving that ignores lane discipline, creating safety problems.

4.2. Effects of shoulder types and conditions:

Road cross-sectional features like carriageway and shoulder width have a big impact on how people drive. The number of lanes determines the width of the carriageway, and the width of each lane is determined by the size of the vehicles and the necessary lateral clearance. Assuming a vehicle's width of 2.44 m and side clearances of roughly 0.53 m on either side, the current guidelines advise a minimum lane width of 3.5m. Provide supplemental pavement for automobiles on rural roads; it allows for driver error and provides room for an emergency stop. Therefore, the width of the shoulder and its quality have an effect on driving performance and, as a result, the likelihood of having a traffic accident.

In light of this, the current study made an effort to comprehend how shoulder conditions affected traffic circumstances when there was mixed traffic. By taking into account site-specific data from twelve study locations, the analysis found various shoulder circumstances responsible for traffic collisions (see Table 1). Based on shoulder conditions, study sites were rated as excellent, good, average, and poor.



Fig. 5: Black Spot Location Sarsini Turn.



Fig. 6: Black Spot Location of Alamgir Turn.

It was discovered that road crashes are significantly reduced when shoulders are well-maintained due to the impact of shoulder condition. This is due to the fact that poorly maintained shoulders do not give drivers enough room to correct their driving mistakes. It eventually causes drivers to become more fatigued, especially while overtaking. Notably, unpaved shoulders were found to increase the likelihood of traffic accidents. By exhibiting descriptive statistics of ten-year crash data in a box plot, the figure illustrates the influence of shoulder types, such as paved or unpaved, on the likelihood of traffic crashes. An additional field investigation in this context reveals that there is a very significant risk of vehicular skidding when there are unpaved shoulders, especially during the monsoon. Similar findings are also supported by other international studies.

4.3. Impact of pavement condition:

An important element in ensuring passenger safety and quality of ride is the state of the pavement. It significantly affects road traffic safety, according to several studies, and timely pavement care is regarded as a key step for enhancing road safety. Still, the few studies that have so far examined the connection between pavement conditions and crash occurrences have not sufficiently examined the effects of poor pavement

conditions on on-road crashes. Researchers advise providing reasonably decent pavement to guarantee a safer road environment for users, even though it is not clear how such bad pavement conditions are related to traffic crashes.

The study made an effort to consider collision frequencies under various pavement conditions. Field research reveals some weather effects (such as precipitation) that may have contributed to a number of these crash events. the friction at the tire-pavement interface, for instance gets diminished in the presence of water and can result in an accident. The braking distance is shown in Eq. 1 where v is the speed, g is the acceleration from gravity, and f is the design coefficient of friction, which is 0.4–0.35. For dry pavement surfaces, the coefficient of friction is almost 0.5; however, when the surface is wet, the value drops significantly, leading to crash events. This is further worse when road markers are difficult to see through a thin layer of water and rut pathways or distress are still hidden, impairing drivers' ability to distinguish lanes and putting them in danger. Such weather-related accidents are inherent to the highlighted crash statistics.

$$L = \frac{v^2}{2g\left(f + \frac{n}{100}\right)}$$

4.4. Effects of Entry exit points:

Highways are risky when there is direct access to neighbouring homes, especially when there is insufficient sight distance at those mid-block access spots. Numerous studies have demonstrated that excessive access point density significantly raises the probability of accidents. Such risk is made more worse by mixed traffic, which includes a variety of vehicle kinds. A case study on the assessment of crash risks at highway entry points, where mixed traffic is the norm and sight visibility is limited because of the presence of vending firms, recently revealed an exaggeration of crash risks. The association between access point density and crash incidence has been the subject of numerous research for many years, but the precise trend of this relationship is less certain. Understanding the impact of entry exit points on crash rates and identifying the trends of correlations between access point density and crash data on highways require systematic investigation.

The prospect of motorised two-wheeled and slower vehicles, including non-motorized ones, sharing the road on highway parts, even for local transportation, may result from frequent access to highways. As a result, the traffic displays the characteristics of really mixed traffic, with a variety of vehicles making up its makeup. Platoons arise as a result of the large speed variances. When confined inside platoons, drivers of quicker cars, and especially bike riders, try to manoeuvre quickly to escape impediment. Such a propensity dramatically increases their demand for visual distance. Inadequate corner clearance and a lack of accessible sight distance are caused by the presence of roadside vending businesses at access locations that are beyond of permitted bounds. This prevents faster cars from manoeuvring safely.

Accordingly, the study classified access points into three groups based solely on restrictions on sight visibility: (a) access points with 'high' restrictions - more likely to experience accidents as a result of insufficient sight visibility: corner clearance at access points is insufficient due to the frequent vending shops and larger built areas, (b) access points with 'moderate' restrictions - greater sight visibility as a result of relatively fewer vending shops at the intersection, and (c) access points with 'low' restrictions.

Additionally, observations show that frequent access sites hinder main highway traffic and lower safety. According to investigations based on ten years of site-specific accident data, the density of such access points significantly increases the likelihood of crash incidents on roadways. The current study indicated that inappropriately designed access points greatly reduced the likelihood of such accidents, whereas badly maintained access points [see Fig. 4.a-d] exaggerated those possibilities.



Fig. 7: Black Spot Location due To Entry and Exit Point At Near SBI Lalru.

4.5. The role of various types of vehicle:

Another critical element that has a substantial impact on highway crashes and their severity is the kind of vehicle. The severity varies across different types of vehicles, according to several research. Additionally, motorbike and passenger car involvement in traffic accidents is widespread, especially as a result of the over-speeding and quick agility of such vehicles.

For these investigations, the research conducted a traffic volume count survey to establish annual average daily traffic (AADT), as historical traffic data was not available for the studied parts. It was essential to employ a suitable approach to extrapolate monthly traffic levels over the course of a year due to variations in traffic flow across months or seasons. In order to create seasonal correction factors, a method based on data from petrol and diesel sales through random sampling along the study sections was employed.

By using AADT data from the base year to anticipate historical traffic, appropriate prediction models were used to account for traffic growth rates.

Table 3 Indicates that the average fatality rate per kilometre/year on this highway corridor is 2.3; this is 5 times than the average of the death rates on National Highways in India. This makes this entire corridor vulnerable and unsafe. In order to develop better understanding between engineering or enforcement issues, a detailed road safety assessment and speed surveys are performed and details have been are given in the next section. Corridor wise and Black Spot wise road assessment details are given in the subsequent sections of this report. (2017-2020)

Overall, out of 28 segments, 12 segments are found to be more vulnerable, where the average road accident fatality rate per kilometre is higher average value of 2.3.

Table 3: Kilometer Wise Road Accident Details And Fatality Rate Per Km/Year (2017-2020).

Study Site	Highway Sagement	No. Of Accident	No. Of Fatalities	No. Of serious Injuries	No. of Minor Injuries	Fatality Rate/Km/ Year
1	10.903-12.0	14	9	7	2	2.5
2	12.0-13.0	2	1	3	0	0.25
3	13.0-14.0	21	17	10	0	4.25
4	14.0-15.0	7	5	5	0	1.25
5	15.0-16.0	11	8	6	0	2
6	16.0-17.0	7	2	9	2	0.5
7	17.0-18.0	27	18	11	0	4.5
8	18.0-19.0	32	22	16	4	5.5
9	19.0-20.0	10	6	4	0	1.5
10	20.0-21.0	15	6	14	3	1.5
11	21.0-22.0	5	1	4	0	0.25
12	22.0-23.0	13	9	8	0	2.25
13	23.0-24.0	6	3	6	1	0.75
14	24.0-25.0	11	9	2	3	2.25
15	25.0-26.0	10	6	7	3	1.5
16	26.0-27.0	5	2	3	0	0.5
17	27.0-28.0	23	17	11	3	4.25
18	28.0-29.0	11	6	3	2	1.5
19	29.0-30.0	19	12	8	6	3
20	30.0-31.0	15	11	5	2	2.75
21	31.0-32.0	12	8	5	1	2
22	32.0-33.0	22	14	15	5	3.5
23	33.0-34.0	7	6	1	2	1.5
24	34.0-35.0	21	9	15	1	2.25
25	35.0-36.0	17	11	7	7	2.75
26	36.0-37.0	22	13	13	1	3.25
27	37.0-38.0	21	8	14	4	2
28	38.0-39.0	26	18	19	4	4.5
Total		412	257	231	56	

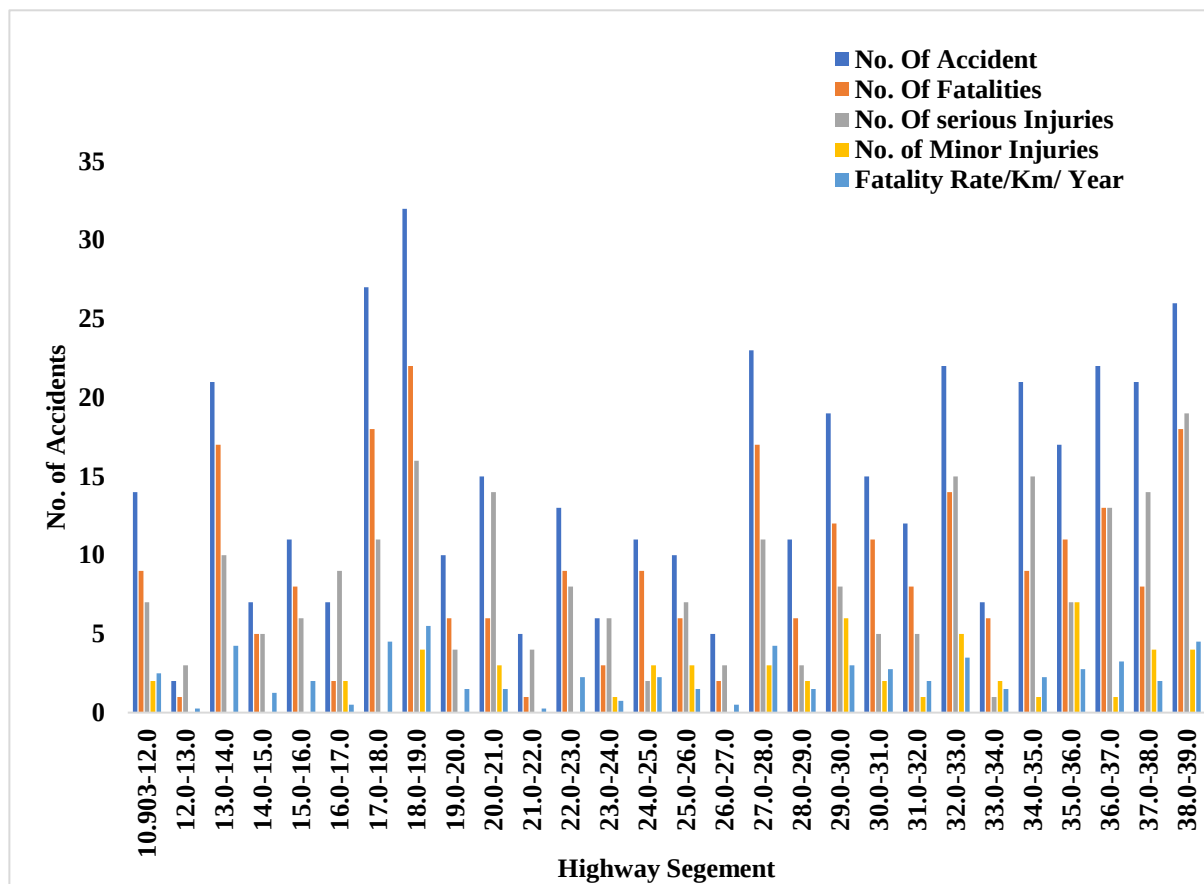


Fig. 8: Analysis of Kilometer Wise Road Accidents and Fatalities Rate Per Kilometer.

5. Evaluation of Existing Accidental Black Spot – Before and After Studies

Generally, Accident Severity Index (A.S.I.) is computed to identify the hazardous locations on the project corridor. In order to quantify the criticality of a black spot, a system of assigning scores has been adopted based on the severity of accident. The score termed as Accident Severity Index (A.S.I.). Accident Severity Index is a dimensionless value indicating the level of hazard of a spot on the road. The following equation has been used;

$$ASI = (N_f \times W_f) + (N_g \times W_g) + (N_m \times W_m)$$

Whereas

N_f = No. of Fatal Accidents at the Spot in the last 3 years

W_f = Weightage assigned to fatal accident is 6

N_g = No. of grievous injury accidents at the Spot in the last 3 years

W_g = Weightage assigned to grievous accident is 3

N_m = No. of minor injury accidents at the Spot in the last 3 years

W_m = Weightage assigned to minor accidents is 1

Table 4: Total Road Accidents On Nh-152 Study Area.

Year	Cases	Fatal	Serious	Minor
2017	128	83	77	14
2018	122	64	70	11
2019	97	61	57	16

2020	65	49	27	15
Total	412	257	231	56

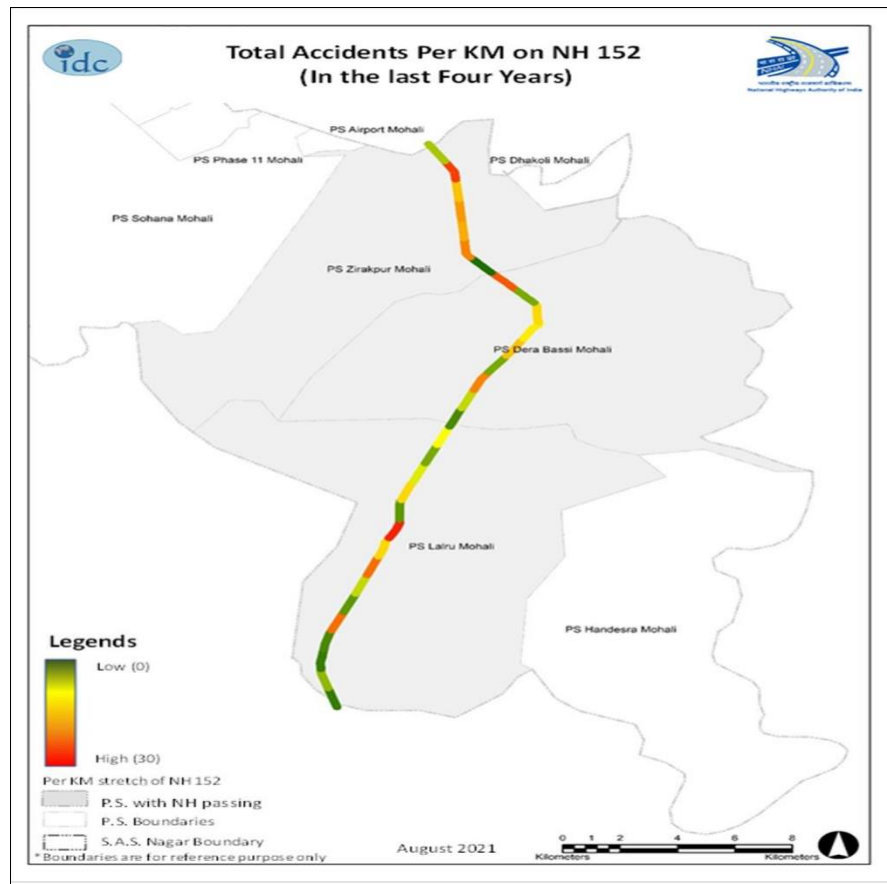


Fig. 9: Total Map Showing Accidents Per Km On Nh 152.

Data Coding: The data is coded to analyses the number of accidents, date of occurrence, location of occurrence, number of deaths, affecting vehicle, victim vehicle. In its simplest form, the police F.I.R. will include a narrative description about the road crash

6. Conclusion:

In particular, the risk variables for incidents involving mixed traffic are examined in this paper. The paper identifies several elements that might impact the safety aspects of highways based on field investigations of highways with heterogeneous traffic patterns and site-specific crash data. The report also explains how those characteristics affect an accident incidence that occurs on a roadway and makes numerous inferences as a result.

The shoulders on either side of a carriageway serve as auxiliary lanes, offer space for parking on the road, and occasionally aid in correcting driving mistakes. According to observations gathered over time, road collisions are significantly reduced when shoulders are paved and well-maintained. However, poorly maintained earthen shoulders do not effectively allow drivers to correct mistakes. In the same way, the state of the pavement has a big impact on how safe passengers are. Roads with great pavement conditions have reduced crash frequencies, according to analysis of crash data for roads that haven't changed much in recent years. The study makes it clear that the likelihood of road accidents rises significantly when pavement is in bad condition.

On multi-lane highways with paved shoulders and outstanding riding quality, accident probabilities are less sensitive to traffic volume, according to analysis of field data. The majority of crashes are caused mostly by

variables connected to driving. The situation on two-lane highways is completely different; in addition to pavement and shoulder issues, traffic volume has a significant impact on safety. Platooning and entrapment of faster cars are frequent in mixed-traffic circumstances since both directional traffic uses a single carriageway, especially at greater traffic volumes.

Impatient drivers frequently engage in risk-taking behaviour and dangerous manoeuvres.

The study sections' crash statistics show that the incident rate is much lower on multi-lane highways than it is on two-lane highways. The severity leading to fatal accidents is, nevertheless, very high on multi-lane highways, according to statistics.

Increased mobility may be implicitly considered to be a crucial element for such a high severity level. However, the survey found that the majority of two-lane roads give access to adjacent land uses.

Crash rates significantly rise according to mid-block access point density and the type of intersection at access points. The analysis clearly shows that the majority of crash incidents are brought on by inadequate sight visibility at approach points. Potential black spots begin to accumulate over time, especially at intersections where vending machines make it difficult for drivers to see clearly.

In addition, several sections of the highway portion are now available to local traffic thanks to this regular access. Eventually, the mix of different vehicle types in the traffic includes two- and three-wheelers, light commercial vehicles, and non-motorized vehicles such as paddle tricycles. They frequently force slower moving vehicles to stall and frequently form platoons in the road. The study found that faster hindered vehicles frequently show reluctance to follow a slower hampered vehicle, which typically travels locally and comes from nearby places. Longer delays cause frustration in some drivers, who then attempt reckless overtaking. However, the study finds that well-designed access points with speed change lanes and no obstructions to sight visibility, allowing for safe traffic merging or diverging, would significantly reduce the likelihood of collision events.

On multi-lane highways, the likelihood of traffic accidents during daylight hours is reduced by a divided carriageway and suitable safety elements. However, the study found that danger rises while driving at night and subsequently concluded that a potential explanation of such an increase might be a reduction in drivers' capacity to handle traffic contingencies. Furthermore, a review of highway occurrences, heavy and light commercial vehicles are frequently involved in traffic accidents, especially on multi-lane highways. Commercial vehicle drivers frequently work a lot of hours cause them to feel sleepy. Given that multi-lane roadways frequently. Under such a flow state, excessive speeding and fatigued driving pose serious transportation safety concerns.

In general, the number of crashes on two-lane highways with mixed traffic is higher throughout the day. The main cause of such a higher prevalence is unsafe passing attempts in mixed traffic. Vehicle streams commonly become compressed as a result of delays brought on by slower moving vehicles. They begin to move in shorter-headway flows [see Fig. 13.a] and make an effort to pass through accepted gaps. Due to this, the majority of accidents are "head-on" and "rear-end" types; on such roadways, roughly 30–35% of accidents are "head-on" types and 20–25% are "rear-end" types. It's interesting to note that nighttime driving on certain routes seemed to be more secure. Drivers are forced to be cautious when passing slower moving traffic because the headlights of oncoming vehicles make them aware.

The study does have some constraints. The premise of the study takes into account past information on crash incidents and field investigations. The conclusions drawn from this data's analysis form the basis of the interpretations.

The report essentially gives an assessment of the risk variables for highway crashes based on empirical data. Establishing a clear link between crash incidences and risk factors was hampered by the lack of an incidence-based analysis approach. Furthermore, due to the lack of case-specific historical incident data, the experimental framework was unable to perform (i) an impact study of (a) varying mixed traffic composition (b) a cluster of pavement distresses/shoulder deformations over a short stretch of roadways (c) and wet pavement surface with

low friction, and (ii) a thorough analysis of vehicle type involvement and time of the day on crash incidents due to a lack of data across all variables.

This study concentrated on particular road and vehicle-related risk factors. Road turbulence brought on by differences in driving styles among other road users may finally result in an accident. For instance, activities brought on by old age, alcohol, mental tension, exhaustion, and compulsive behaviour may result in a collision. Additionally, safety considerations must be included while designing roadways for mixed traffic.

Proactive safety evaluations that take recognised risk variables into account seem crucial while designing roadways. In this regard, the study establishes a foundation for establishing proactive strategies that would take safety into account during the planning and designing phases.

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