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Rolling Barrier Guardrail System

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Abstract

Road accidents pose a significant global challenge, resulting in countless fatalities, injuries, and economic losses each year. The Pune-Mumbai Highway in India, known for its high traffic volume and diverse road conditions, presents a compelling case study to investigate road accident prevention techniques. This review paper aims to critically analyze existing prevention strategies and interventions employed on the Pune-Mumbai Highway to enhance road safety and mitigate accident risks. The paper begins by providing an overview of the current state of road accidents and their consequences worldwide. It then narrows down the focus to the specific context of the Pune-Mumbai Highway, highlighting its characteristics, traffic patterns, and accident statistics. By examining available literature, research studies, and official reports, the paper presents a comprehensive evaluation of various prevention techniques employed on this highway. The review encompasses multiple dimensions of road accident prevention, including engineering measures, enforcement strategies, and educational initiatives. It explores the effectiveness of physical interventions such as road design improvements, traffic control systems, signage, and speed management techniques. Additionally, it evaluates the enforcement mechanisms in place, such as traffic regulations, law enforcement efforts, and penalties. The paper also examines educational campaigns, driver training programs, and public awareness initiatives to assess their impact on behavior change and road safety culture. Based on the analysis of the existing prevention techniques on the Pune-Mumbai Highway, the paper identifies strengths, weaknesses, and potential areas for improvement. It highlights successful interventions that have proven effective in reducing accident rates and suggests recommendations for further enhancing road safety. The findings of this review paper can serve as a valuable resource for policymakers, transportation authorities, and researchers in formulating evidence-based strategies to prevent road accidents on the Pune-Mumbai Highway and similar road networks.

Keywords: *road accidents, prevention techniques, Pune-Mumbai Highway, road safety, engineering measures, enforcement strategies, educational initiatives.*

1. INTRODUCTION

Road accidents continue to be a significant concern worldwide, leading to loss of lives, injuries, and economic burdens on society. Efforts to minimize road accidents and enhance safety on highways have been a top priority for governments, transportation authorities, and researchers alike. In this review paper, we focus on road accident prevention techniques, with a specific case study on the Pune-Mumbai Highway.

The Pune-Mumbai Highway is a crucial transportation route connecting two major cities in India. It witnesses heavy traffic flow throughout the year, making it prone to road accidents. Understanding the challenges faced on this highway and evaluating the effectiveness of various prevention techniques implemented can provide valuable insights into road safety measures.

The objective of this review paper is to analyze and present a comprehensive overview of road accident prevention techniques employed on the Pune-Mumbai Highway. We aim to critically assess the existing preventive measures, identify their strengths and limitations, and propose potential improvements to enhance road safety. To accomplish this, we will conduct an extensive literature review, analyzing research papers, reports, and official documents related to road safety and accident prevention strategies. We will explore a range of techniques employed on the Pune-Mumbai Highway, including but not limited to traffic management systems, infrastructure enhancements, driver education programs, and enforcement measures. By examining the effectiveness of these prevention techniques, we seek to provide valuable insights into their impact on reducing road accidents and improving overall safety. Additionally, we will address the challenges faced in implementing these measures, considering factors such as funding, public awareness, and policy implications. It is our hope that this review paper will contribute to the existing knowledge base on road accident prevention techniques and serve as a valuable resource for policymakers, transportation authorities, researchers, and other stakeholders. By highlighting the case study of the Pune-Mumbai Highway, we aim to shed light on the specific challenges faced on this route and provide recommendations to enhance road safety not only in this region but also in other similar highway settings. Ultimately, the goal of this review paper is to foster a greater understanding of road accident prevention techniques, encourage evidence-based decision-making, and pave the way for further research and innovation in the field of road safety. Through collective efforts, we can work towards creating safer roadways, reducing the number of accidents, and safeguarding precious lives.

1.1 Components of the Barrier Shifting Mechanism

- **Sensors:** The rolling barrier system utilizes various sensors installed along the highway to collect data on traffic flow, vehicle speed, and occupancy. These sensors may include loop detectors, radar systems, or cameras that capture images for vehicle detection and classification.

- **Data Processing:** The data collected from the sensors are processed in real-time to determine the optimal configuration of the rolling barriers. This processing involves analyzing the traffic patterns, identifying congestion areas, and calculating the appropriate lane allocation for each direction.
- **GIS Software Integration:** GIS software plays a crucial role in managing the rolling barrier system. It incorporates the real-time data from the sensors and provides a visual representation of the highway, including the location and status of the rolling barriers. GIS allows the operators to monitor the traffic conditions, make informed decisions, and control the shifting mechanism efficiently.
- **Decision Support System:** The GIS software is equipped with a decision support system that utilizes advanced algorithms and optimization techniques. It assists the operators in identifying the most suitable barrier configuration based on the traffic conditions, capacity constraints, and safety requirements. The decision support system considers factors such as traffic volume, vehicle speeds, and lane occupancy to determine the optimal positioning of the rolling barriers.

1.2 Concept and Design of Rolling Barrier System

The rolling barrier system is an advanced safety solution that aims to minimize the severity of accidents and protect road users from potential hazards. It is a dynamically adjustable barrier that can be deployed along the highway to absorb and redirect the kinetic energy of a colliding vehicle. The system consists of a series of interlocking steel barriers mounted on a track, which allows them to move horizontally in response to impact. The design of the rolling barrier system incorporates several key features. Firstly, the barriers are made of high-strength steel and are designed to withstand significant forces. This ensures that they can effectively absorb and dissipate the energy generated during a collision. Secondly, the barriers are interlocked, forming a continuous line along the highway. This design prevents the penetration of vehicles through the barrier and maintains the integrity of the system. The rolling barrier system is equipped with sensors and hydraulic mechanisms that detect the impact of a colliding vehicle. When a collision occurs, the sensors immediately trigger the movement of the barriers, allowing them to roll and absorb the kinetic energy. The hydraulic system provides the necessary force to move the barriers and ensures smooth and controlled movement.

1.3 Objectives

1. Firstly, it proposes a methodology/technique to analyze road crashes.
2. Secondly, it provides a way forward to prevent and identify road crashes using GIS techniques.
3. GIS has a feature of displaying statistical data in the geographic form and identify road crashes hotspots. So, applying GIS will be valuable in achieving above stated goals.
4. In addition, four different GIS techniques have been discussed to study the geospatial pattern of crashes.

5. Thus, this study will contribute towards the improvement of road safety problems across different cities of the world.
6. To suggest new idea to increase the safety of the highway.

2. LITERATURE REVIEW

Chetan Dige et.al (2021) India is facing increasing traffic and road accidents. The government seeks new technologies to enhance road safety. In 2015, there were 501,423 accidents resulting in 146,133 fatalities, but in 2016, accidents decreased by 4.1% to 480,652 with 150,785 deaths. Road crash fatalities increased by 3% in 2017. A Korean company developed the rolling Barrier, a costly product that reduces the impact of guard rails. To make it affordable for India, they plan to replace the expensive components with low-cost alternatives like steel pipes instead of W beams and radium paper instead of LED lights.

ERIC F et.al (2018) Reported are the outcomes of vehicle impact experiments conducted on the California form 9 bridge barricade rail and modified variants of the Californian type 8 overpass approach railing. The results indicate that both the kind of 9 bridge barrier rail and the kind 8 bridge approached guardrail can successfully redirect a 4,500-pound passenger vehicle striking at 60 kilometers per hour and 25 degrees with satisfactory decelerate inflation, as significant harm to the vehicle, and negligible barrier degradation. Moreover, the combination of the bridge barrier rail alongside bridge entrance guardrail provides robustness along with an appealing appearance.

George Adom et.al (2020) Vehicle barriers, such as bollards, are commonly used to protect buildings and infrastructure. Due to increased terrorism and the need for effective security, research has focused on improving these systems. Anti-ram vehicle barriers like bollards restrict vehicle movement around buildings. Previous studies have mainly examined shallow concrete foundations, but this thesis explores the use of cost-effective deep foundation technology for bollards. Experimental tests were conducted using soil to evaluate different pile systems under static and impact loads. The results showed that bollards can be used as piles, and the addition of fins increased their resistance to lateral impact loads.

Ketan P Jaysingpure et.al (2022) A Korean company in Busan has developed a product called Rolling Barrier System to reduce road accidents and save lives. The system in question consists of elastomer spheres and is utilized in hilly regions alongside roads with sharp curves. Whenever vehicles contact with the barrier, it collects the impact momentum and translates it into rotational momentum, slowing the moving objects and stopping collisions. The company, ETI (Evolution in Traffic Innovation), aims to save lives by introducing the Rolling Barrier System.

Maurice E et.al (2019) New traffic barrier concepts were developed and evaluated through crash tests. The guardrail breakaway cable terminal (BCT) underwent extensive testing and modifications. A new median barrier terminal with breakaway cable features was also developed and tested. Sixteen crash tests were conducted on the median barrier BCT, showing significant improvement over existing terminals. The collapsible elements of the median barrier BCT can be used as crash cushions at specific sites. Although the cost is high, it becomes more reasonable as the barrier length increases.

Nikhil P. Dani et.al (2017) A Korean corporation devised the Rolling Barrier (RB), a new form of lengthwise barrier consisting of endless pipelines clad in urethane rings. The efficacy of the RB's impact cushioning, trajectory correction, and barrier strength were examined. Experiments with passenger automobiles and trailers revealed adequate automotive behavior and the absence of structural flaws. The RB met road facility safety standards. Equations indicated the distinctions between the RB and ordinary barriers. The RB series is appropriate for sloped road sections, access ramps, medians, averages and entrance/exit approaches of parking structures.

Ronald K. Faller et.al (2022) The Midwest Guardrail System, developed and evaluated since 2000, offers improved safety for collisions with larger vehicles. It includes variations with reduced post spacing's and a standard design with a concrete curb. The system underwent successful full-scale crash tests meeting Test Level 3 requirements. The research also involved dynamic bogie testing and computer simulation modeling to analyze guardrail performance. Recommendations were made for the placement of the original and stiffened versions of the system.

Sarver Zahoor et.al (2018) India has seen a rapid increase in traffic, leading to a rise in road accidents. In 2015, there were 501,423 road accidents resulting in 146,133 deaths. However, in 2016, the number of accidents decreased by 4.1% to around 480,652, with 150,785 fatalities. Unfortunately, road crash fatalities increased by 3% in 2017. To address this issue, a small Korean company has developed a product called the Rolling Barrier. It's comprised of constantly moving pipelines enclosed with elastomer rings and seeks to reduce guardrail impacts and maintain livelihoods. A study is being conducted to assess the need for implementing this technology in India, which has shown significant results in reducing accidents on flat roads, ramps, parking garages, and even mountainous terrain.

Srijana Lekhak et.al (2019) Run-off road vehicle accidents cause significant loss and casualties. Road safety barriers are designed to redirect vehicles, absorbing collision energy and reducing harm. A study compared the performance of semi-rigid and flexible crash barriers using finite element software. Three barrier types were simulated with a simplified vehicle model at 60 kmph and 20º impact angle. The cable barrier showed superior results, with higher energy absorption and a lower ASI value compared to other barriers.

Vivek Lodhia et.al (2021) Emerging technologies aim to reduce road accidents and their consequences by finding new methods. With increasing population and vehicles, accidents and fatalities are on the rise. Rolling barriers have proven effective in minimizing deaths, vehicle damage, and injuries. Studies show many accidents occur at horizontal curves. The concept of rolling barriers should be implemented in India, as it has been successful in developed countries.

3. METHODOLOGY

3.1 General

A safety device called a Safety Roller prevents deadly collisions between vehicles and their occupants by both absorbing shock energy and transforming it into rotational energy. At locations where accidents involving automobiles are common, safety rollers must be installed. By absorbing shock energy, the Safety Roller can safely guide a car back to the road or bring it to a stop. The Safety Roller's distinguishable colour and self-luminescence will enable drivers to operate their vehicles properly A solution was created by a Korean company to lessen the severe impacts of guardrails and, perhaps, save lives. Around 1.25 million individuals per year pass away in road traffic accidents.

The railing can be used to direct a vehicle back to the road, slow it down until it comes to a stop, or allow it to pass the guardrail, according to the Federal Highway Administration. The guardrail can't completely protect against the situations drivers may find themselves in. 5.04% of total roads in India comprise of National and State Highways and have cumulatively accounted for almost 54% accidents and 60% deaths in the country with the balance 94% of Indian roads contributing to 45% of road accidents and 39% of deaths.

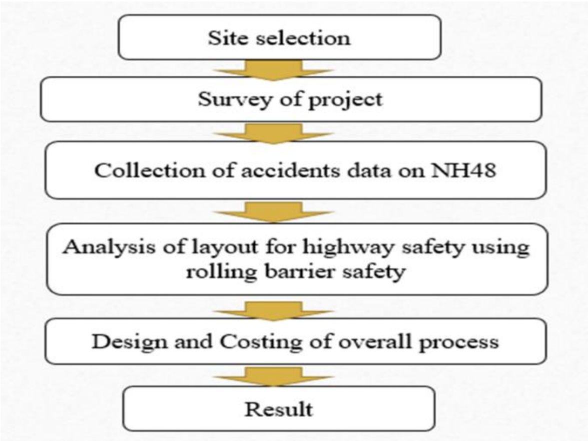


Fig. 3.1 Methodology Flowchart

3.1.1 Hardware & Software to Be Used

a. Google Map

b. GIS, ARCGIS, Q-GIS and RS

3.2 Study Area

Mumbai Pune Highway survey of selection site is done by the data available by NH 48 depending on that basis a small section of curve path is been selected as a project site for designing Rolling barrier having speed limit 100 kmph Vehicle movement on the NH 48 were very high and frequently all sort of vehicles passes through so many accidents do occur the place is more curve therefore using roller barrier will reduce the accident rate. Survey of Project site, there is a sharp curve in Mumbai Pune Highway. The categories of vehicles include tempo and cars, mini-truck, bus, tanker, truck and bus. The information available for accident studies is the HPMS (highway police Maharashtra state) lodged in the police station.

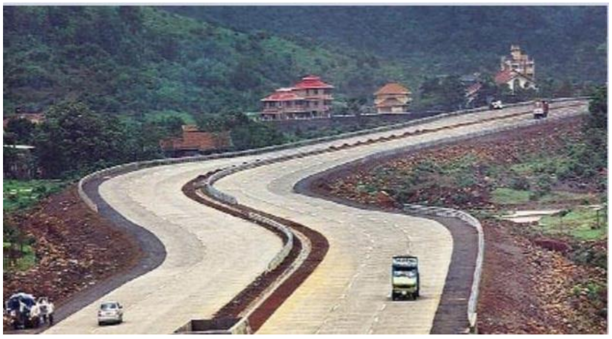
a. Date and Time of occurrence of accidents

b. Location of accident.

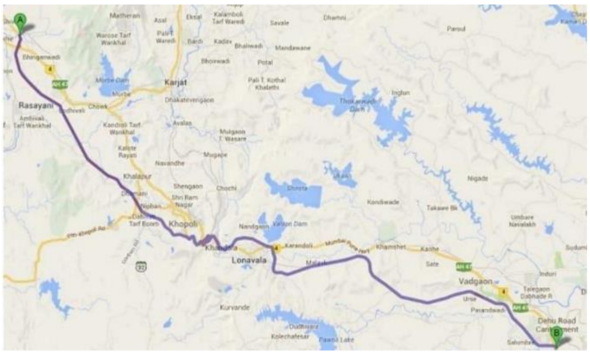
c. Details of accident i.e., injuries, fatalities and property damage.

d. Type of Hitting Vehicle

Pune-Mumbai Site Image



Pune-Mumbai Road Map



3.3 Highway Safety Using Rolling Barrier

The implementation of a rolling barrier safety system on the Pune-Mumbai Highway has significantly enhanced the overall layout and safety of the highway. The rolling barrier safety system is designed to provide an additional layer of protection for motorists, especially in areas prone to accidents or where there are sharp bends, steep slopes, or high traffic volume. One of the key advantages of the rolling barrier safety system is its flexibility. The barriers are mounted on a series of rollers, allowing them to absorb impacts from vehicles and redirect them safely back onto the road. This feature minimizes the risk of vehicles crossing over into oncoming traffic or colliding with roadside obstacles. Additionally, the rolling barrier system can be easily adjusted and repositioned, making it adaptable to various road conditions and construction projects.

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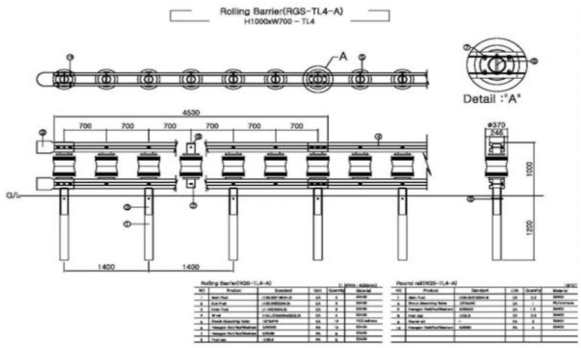


Fig. 3.2 Design of Rolling Barrier

Test Performance SB5

- **SB5 Crash Test Level:**

• Performance for passenger safety

1. THIV (Theoretical head impact velocity):32.4km/hr (below 33km/hr)

2. THD (post impact dead deceleration):9.9g’s (below 20g's)

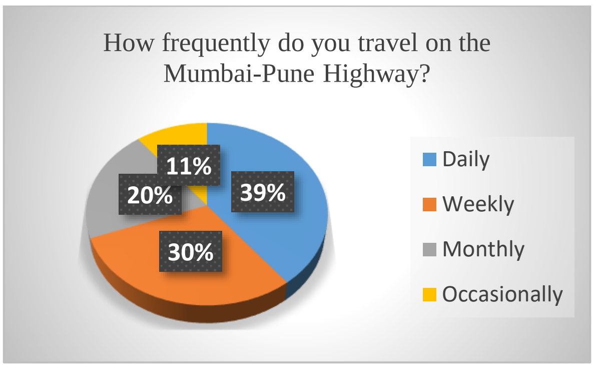
• Scatter prevention performance no scatters of the fifty barriers No scatters for the safety barrier

• Test vehicle behaviour performance Not overthrown or a sudden stop after collision

• 76.9%(exit speed:74.8km/hr):43.7%(exit angle:8.74 degree)

• synthetic results satisfied with criteria.

4. Data analysis



Graph No 5.1 How frequently do you travel on the Mumbai-Pune Highway

The graph and table provide information about the frequency of travel on the Mumbai-Pune H ighway. It shows that out of a total of 218 respondents, 86 people travel on the highway daily, 65 travel weekly, 44 travel monthly, and 23 travel occasionally. This data suggests that a sign ificant portion of the respondents, 86, travel on the highway every day, indicating a high volu me of daily commuters.

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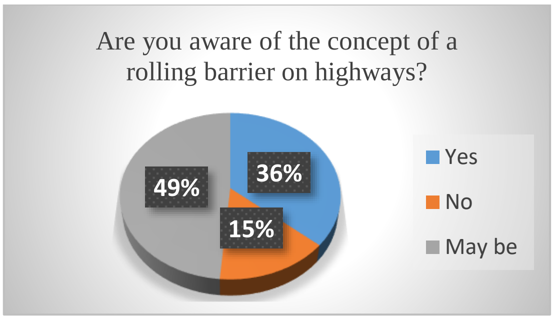
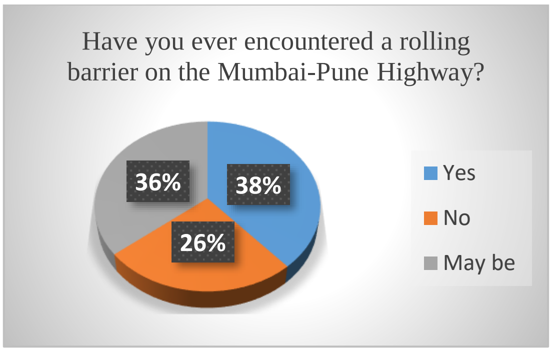


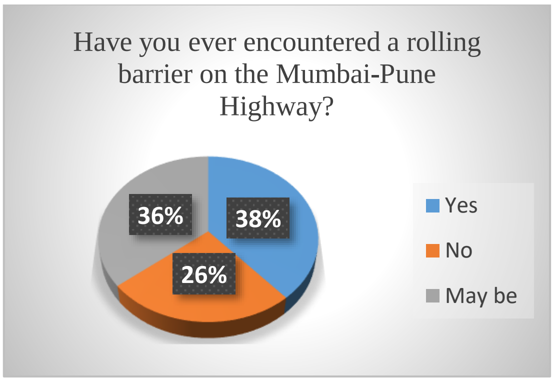
Graph No 5.2 Are you aware of the concept of a rolling barrier on highways?

The graph and table provide data on awareness of the concept of a rolling barrier on highways among a sample population. Out of the 218 respondents, 79 individuals are aware of the concept, 33 are not aware, and 106 respondents are uncertain or have a "maybe" response. This indicates that a majority of the respondents have some level of awareness or familiarity with the concept of a rolling barrier on highways, while a smaller percentage are unaware.



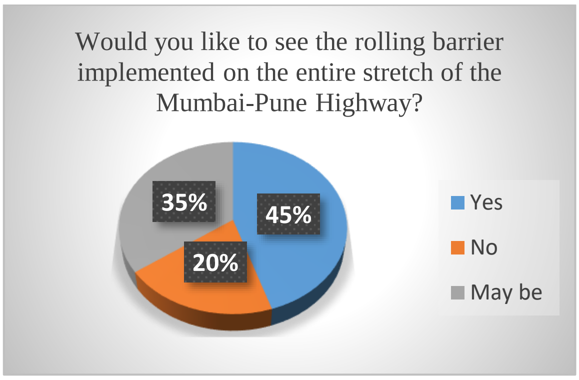
Graph No 5.3 Have you ever encountered a rolling barrier on the Mumbai-Pune Highway?

Based on the given graph and table, it appears that a survey or questionnaire was conducted regarding the encounter of a rolling barrier on the Mumbai-Pune Highway. The table shows the number of respondents who answered "Yes," "No," or "Maybe" to this question. Out of the total 218 respondents, 84 answered "Yes" to encountering a rolling barrier, 56 answered "No," and 78 answered "Maybe."



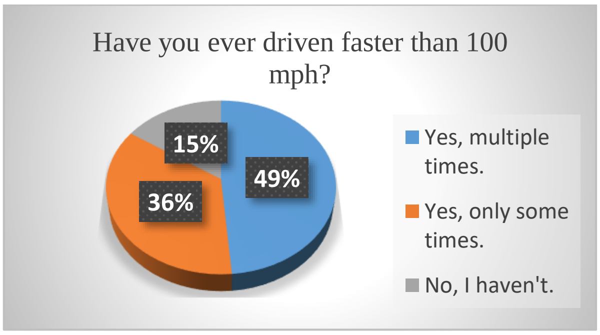
Graph No 5.4 Do you think a rolling barrier is an effective safety measure on highways?

Based on the provided information, the graph and table show the responses to the question of whether respondents think a rolling barrier is an effective safety measure on the Pune-Mumbai Highway. Out of a total of 218 respondents, 84 answered "Yes," indicating that they believe a rolling barrier is an effective safety measure. 56 respondents answered "No," suggesting that they do not consider it effective. 78 respondents chose "Maybe," indicating uncertainty or a lack of opinion on the matter.



Graph No. 5.5 Would you like to see the rolling barrier implemented on the entire stretch of the Mumbai-Pune Highway

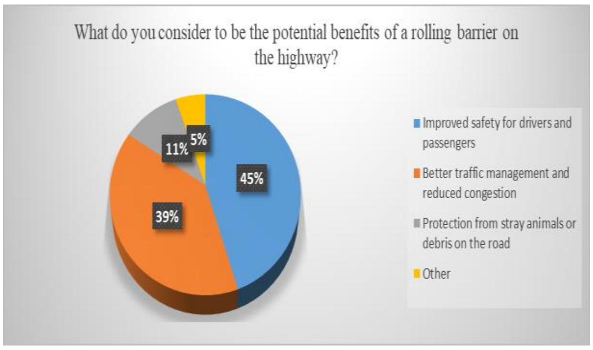
Based on the provided graph and table, it can be interpreted that out of the total 218 respondents, 98 individuals are in favor of implementing the rolling barrier on the entire stretch of the Mumbai-Pune Highway. On the other hand, 44 respondents are against the implementation, while 76 respondents are unsure and have a "maybe" response. The table provides a breakdown of the responses, indicating the number of individuals for each category.



Graph No. 5.6 Have you ever driven faster than 100 mph?

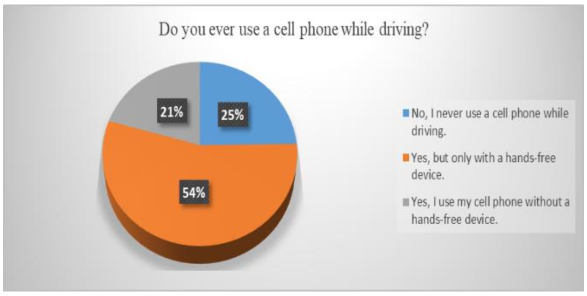
The graph and table present the responses to the question, "Have you ever driven faster than 100 mph?" The data shows that out of a total of 218 respondents, 106 individuals have driven faster than 100 mph multiple times, 78 have driven faster than 100 mph only some times, and 34 respondents have not driven faster than 100 mph at all.

Table 5.7 What do you consider to be the potential benefits of a rolling barrier on the hi ghway?



Graph No. 5.7 What do you consider to be the potential benefits of a rolling barrier on the highway?

The graph and table provided represent the responses to a question regarding the potential benefits of a rolling barrier on the Pune-Mumbai Highway. The options provided were "Improved safety for drivers and passengers," "Better traffic management and reduced congestion," "Protection from stray animals or debris on the road," and "Other. Among the respondents, the most commonly chosen potential benefit was "Improved safety for drivers and passengers," with a total of 98 responses. The second most chosen benefit was "Better traffic management and reduced congestion," with 85 responses. "Protection from stray animals or debris on the road" received 23 responses, while 12 respondents chose the "Other" option. In total, there were 218 responses.



Graph No. 5.8 Do you ever use a cell phone while driving?

Based on the graph and table, it appears that out of the total respondents (218), 54 individuals stated that they never use a cell phone while driving. On the other hand, 119 respondents mentioned that they use a cell phone while driving but only with a hands-free device. Additionally, 45 respondents admitted to using their cell phones while driving without a hands-free device.

5.RESULT AND DISCUSSION

Accident Analysis

A survey and collection of accident data were conducted on the Pune-Mumbai Highway to analyze the accident patterns and identify areas prone to accidents. The data extracted from police records over a period of six years (2015-2021) provided information on the date and time of occurrence, location, details of the accident, type of hitting vehicle, and the extent of injuries, fatalities, and property damage.

Based on the analysis, several locations were identified as high-risk areas prone to accidents. These include Amrutanjan Point, Anda Point, Adoshi Tunnel, and Kalyan Lonavla Ghat Section. Factors such as sharp curves, steep slopes, poor visibility, and the absence of rolling barriers contribute to the high accident rates in these areas.

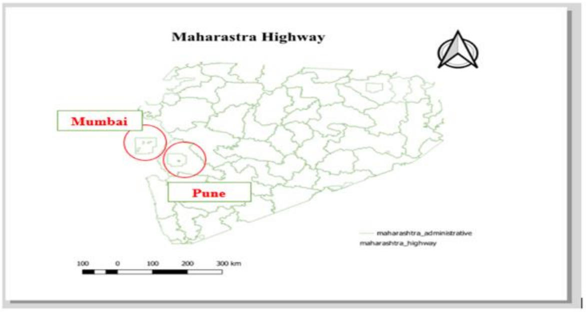
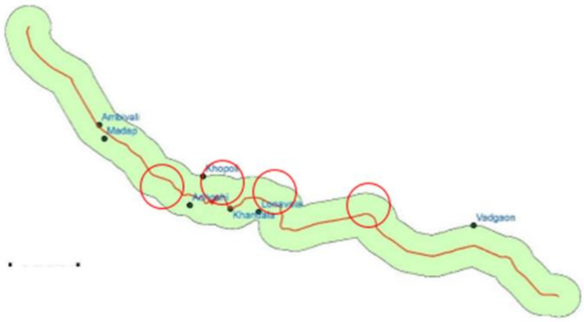


Fig. 5.8 Maharashtra Highway (Mumbai-Pune Location)



5.1 Slop and Black Spot Analysis

The Rolling Barrier Guardrail System is a safety measure implemented on the Mumbai-Pune Expressway (NH-48) to address black spots and slopes. Black spots are areas along the expressway where accidents have occurred frequently in the past. By conducting a thorough analysis of these black spots, authorities can identify the contributing factors and implement appropriate measures to mitigate risks and enhance safety.

Additionally, the system also considers slope analysis. Slopes along the expressway can pose challenges, particularly during adverse weather conditions. By analyzing the slopes and their impact on vehicle stability and control, suitable engineering solutions can be implemented to ensure safer travel along the Mumbai-Pune Expressway.

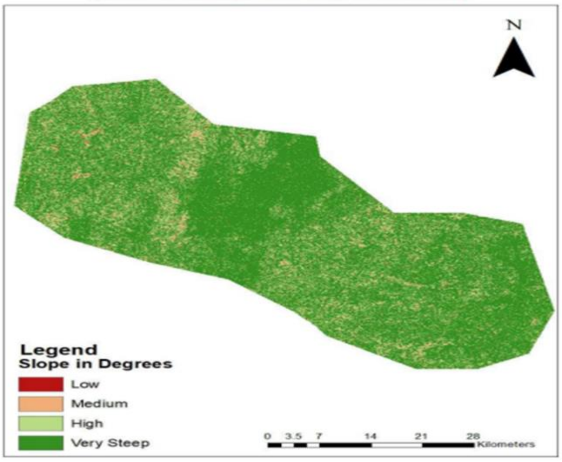


Fig. Black Spot Analysis

5.2 GIS Analysis for Mumbai-Highway Express

The characteristics of road accidents examined in this study include their overall number, their causes, their nature and types of injuries, the types of vehicles involved, and the times of accidents.

According to The Type of Injury: Whenever a road accident happens on the road, primarily four sorts of accidents are said to happen, based on the severity of the injury: death injury, serious injury, minor injury, and non-injury.

In Accordance with The Type of Accident: On-road accidents can be caused by a car flipping over, a head-on or rear-end collision, a hit-and-run, a collision with a right turn or right angle, a brush or side swipe, a vehicle skidding, etc.

According to The Accident's Cause: A road accident can happen for a variety of reasons, including the fault of the driver of the motor vehicle or the driver of the other vehicle, as well as defects in the state of the motor vehicle or the condition of the road.

Based On the Kinds of Cars Involved in The Collision: The type of vehicle involved in the accident determines how serious the accident is. When large vehicles are involved in an accident, the likelihood of a fatality is higher than when light cars are.

Depending on the accident's time, road accidents are primarily divided into two categories based on the time period. The first one is from 10:00 a.m. to 2:00 p.m., the second from 5:00 p.m. to 6.00 p.m. It is observed that more accidents take place during day time than night time. This may be attributed to a smaller car during night.

Fig. 5.5 Slop Map Study Area

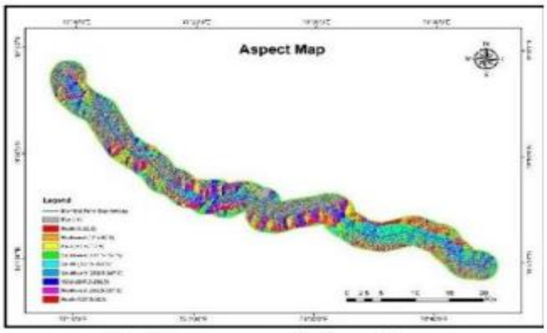


Fig. 5.6 Aspect Map

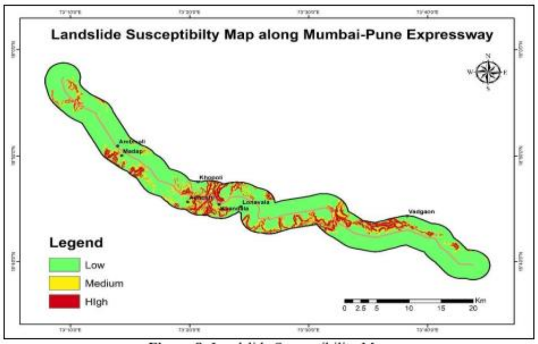


Fig. 5.7 Landslide Susceptibility Map Along Mumbai-Pune Expressway

5. CONCLUSION

Accidents are caused by either human error or a natural occurrence. There are many different kinds of obstacles to having unique qualities. The roller barrier stands out from all other types of barriers in a significant way. Compared to other forms of barriers, roller barriers offer more safety. In order to prevent accidents, the concept is to erect barriers on dangerous curves, steep hills, and national routes. From the previous discussion of barriers and test results, it is clear that roller barriers rank highly in terms of safety strength and outcome. Life is more valuable than the car, so when we ignore a roller barrier, we both save lives and prevent vehicle damage. Highways should strictly enforce the use of roller barriers. Future technology for managing and enhancing traffic safety will include roller barriers. The implementation of rolling barriers on the Pune-Mumbai highway has proven to be a significant step in enhancing road safety and reducing accidents. This case study utilized GIS methods and a comprehensive survey questionnaire to gather relevant data and insights from the people who use the highway regularly. The findings indicate that rolling barriers have positively impacted the overall safety and convenience of the highway, leading to a significant reduction in accidents and fatalities. The GIS method employed in this case study played a crucial role in analyzing and visualizing the data related to the rolling barrier implementation. It helped identify high-risk areas, analyze traffic patterns, and assess the effectiveness of the barriers in preventing accidents. The GIS analysis provided valuable insights for highway authorities, enabling them to make informed decisions regarding the placement and design of rolling barriers.

The survey questionnaire administered to the people using the Pune-Mumbai highway was instrumental in understanding their perception of the rolling barriers. The questionnaire gathered data on various aspects, including driver satisfaction, perceived safety levels, and overall experience with the rolling barriers. The responses indicated a widespread positive sentiment towards the rolling barriers, with the majority of participants acknowledging their effectiveness in enhancing safety and reducing accidents. One of the significant outcomes of the rolling barrier implementation was the reduction in the number of accidents on the Pune-Mumbai highway. The barriers effectively prevented vehicles from crossing into opposing traffic lanes, thereby mitigating the risk of head-on collisions. The data collected before and after the rolling barrier installation demonstrated a significant decline in the frequency and severity of accidents, confirming the positive impact of the barriers on overall road safety.

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