**Evaluation of Road Safety Audit Recommendations and Their Implementation Impact**

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**Abstract:** - Road safety audits are systematic evaluations conducted to identify potential safety issues and recommend improvements during the planning, design, or operational stages of road projects. The primary goal is to evaluate the current infrastructure and operational safety standards to identify potential risks and suggest improvements. The audit includes an in-depth analysis of the highway's design, traffic flow, signage, and overall road conditions. By examining accident-prone areas and assessing the effectiveness of existing safety measures, the study aims to pinpoint specific issues that could lead to accidents or other hazards. The findings will help in recommending practical solutions to enhance road safety, such as better signage, improved road markings, and modifications to road design. These recommendations will be aimed at reducing accidents, improving traffic flow, and ensuring a safer travel experience for all road users on NH53. This study examines the methodologies employed in road safety audits and their impact on minimizing risk factors for road users. The project also provides a comprehensive framework for integrating safety measures into road projects, emphasizing the role of collaboration among stakeholders, including engineers, planners, and policymakers. The findings of this project will serve as a valuable resource for enhancing road safety practices and contribute to the broader goal of reducing traffic-related fatalities and injuries.

**Keywords:** Road Safety Audit (RSA), Traffic Safety, Crash Reduction, Audit Recommendations, Transportation Engineering, NH-53, Risk Assessment.

**I. INTRODUCTION**

The "4-Laning of Kondhali-Talegaon from km 50.00 to km 100.00 section of NH-53 (Length 50 Km)" project in Maharashtra is currently in the maintenance stage, a crucial phase aimed at safeguarding and enhancing the road's structural and functional integrity. This stage is vital for ensuring that the recently upgraded four-lane highway remains in optimal condition, providing a safe and efficient route for regional connectivity. During the maintenance phase, regular activities are carried out to address the wear and tear caused by traffic, environmental factors, and the passage of time. These activities include routine inspections, resurfacing, crack sealing, drainage maintenance, and the repair of safety features such as road signage, barriers, and lighting systems. By systematically addressing these elements, the maintenance efforts aim to ensure that the road remains safe for all users, offering a smooth and reliable travel experience. In addition to reactive maintenance, the stage also emphasizes preventive measures that focus on avoiding potential issues before they arise. This proactive approach helps in reducing the need for extensive repairs in the future and ensures the longevity of the highway, making it more resilient to the growing traffic loads and climatic impacts. The overall goal of the maintenance activities is to guarantee that the highway continues to serve as a vital corridor for the movement of goods and passengers, supporting the economic growth and development of the region while maintaining high standards of safety and reliability for all users. Road safety remains a critical concern in civil engineering and urban planning, particularly in a rapidly developing country like India. With increasing vehicle numbers, growing urbanization, and infrastructural developments, road safety challenges have become more complex. Despite advancements in road design and infrastructure, road accidents continue to pose significant social, economic, and environmental challenges. Therefore, implementing comprehensive road safety measures has become imperative to reduce fatalities and improve overall safety conditions. A Road Safety Audit (RSA) is a proactive evaluation process that identifies potential hazards and risks in road infrastructure before or during its development or maintenance. Conducting road safety audits aims to prevent accidents by recommending feasible safety improvements that adhere to engineering standards and guidelines. Various road safety audit protocols and checklists are developed based on national and international guidelines, such as the Indian Road Congress (IRC) standards and ISO norms. In the past decade, numerous initiatives have been undertaken by local authorities and central agencies in India to conduct safety audits on highways, urban roads, and rural areas. However, the impact of these audits on reducing accidents and enhancing safety standards often remains inadequately documented and assessed. Many studies highlight recommendations made by road safety audits but fall short of analyzing the long-term outcomes and real-world implementation effectiveness.

**1.1 NATIONAL HIGHWAY- 53 (NH-53)**

National Highway 53 (NH53) is one of the most important highways in India, connecting various cities and regions, and playing a crucial role in the country's transportation network. As a busy route, it carries a large volume of vehicles daily, making road safety a top priority for travelers and authorities alike. National Highway 53, combination of old (NH6 Surat-Kolkata), (NH200 Bilaspur-Chandikhole) & (NH5A Chandikhole-Paradeep) is a national highway in India.It connects Hajira in Gujarat and Paradeep port in Odisha. NH-53 traverses the states of Gujarat, Maharashtra, Chhattisgarh and Odisha in India. The road is the part of AH46 network in India and it is officially listed as running over 1975 km (1227 mi) from Kolkata to Surat. it is also known as Surat - Kolkata Highway. It passes through Maharashtra, Chhattisgarh and Odisha states. The National Highway Authority of India (NHAI) has created a Guinness World Record of constructing the longest highway stretch of 75 kilometres (km) between Amravati and Akola in the least time--105 hours and 33 minutes. The newly constructed road is part of National Highway 53. The purpose of this audit is to carefully examine the current state of the highway, identify areas where safety could be compromised, and propose practical solutions to address these concerns. By evaluating various aspects such as road design, traffic management, and existing safety measures, this study aims to create a safer environment for everyone using NH53. The insights gained from this audit will not only highlight the immediate improvements needed but also guide long-term strategies for maintaining and enhancing road safety on this critical highway.

**II. LITERATURE REVIEW**

**The terminologies referred from literatures for designing are discussed as follows.**

In the research conducted by **Rajat Kumar Gahlaut et al. (2024),[1] titled "Road Safety Audit and Design Compliance on Highway,"** the focus is on evaluating road safety on the Gurugram-Faridabad Highway. The study highlights critical issues such as the lack of a safety consultant, leading to missed opportunities for thorough road safety audits. It also identifies non-compliance with design standards, particularly regarding pedestrian facilities and inadequate curve radii, which contribute to safety risks. Vulnerable road users, including pedestrians and cyclists, are often neglected in highway design, further exacerbating the safety challenges. The research also points to operational safety issues like undeveloped intersections, unauthorized gaps, and uncontrolled cattle movement, all of which pose significant hazards. Despite some improvements in road infrastructure, accidents and fatalities persist, signaling that fundamental safety concerns remain unaddressed. In a separate study by **Ashish and Mhaske (2023) [2] on "Road Safety Audit (RSA) Guidelines of Selected Nations –** A Comparative Review," the researchers analyze RSA practices across seven countries, revealing significant variations in RSA guidelines, definitions, and application phases. The study notes disparities in the content and depth of RSA checklists and forms, as well as inconsistencies in the qualifications and team composition of RSA auditors. Additionally, the lack of focus on legal liabilities in some guidelines and the absence of case studies in others hinder the practical application of RSA processes. The research suggests that RSA guidelines should be tailored to local traffic conditions and infrastructure, offering a roadmap for improving RSA documents to standardize best practices globally. This work is valuable for transport officials, auditors, and policymakers, as it highlights the limitations of current RSA practices and offers recommendations for improvement. Another study, conducted by Mateen Ahemed and **Dr. Sunil Sugandhi (2023), [3] titled "Road Safety Audit: A Detailed Analysis of Dhandhuka to Dholera (SH-20)** in Gujarat State," focuses on the road safety concerns in the Dhandhuka to Dholera stretch of State Highway 20. The study draws attention to the high fatality rates on Indian roads, particularly in states like Tamil Nadu and Madhya Pradesh, where accident rates are alarming. Using various data collection methods such as traffic volume studies, accident data analysis, and road condition evaluations, the researchers identified "black spots" where accidents frequently occur. The findings stress the importance of RSAs as a proactive measure to reduce accidents by addressing design flaws, promoting road safety awareness, and enhancing road user behavior. This detailed analysis underscores the need for continuous road safety evaluations to minimize fatalities and improve highway safety in India. In their paper **"Management of Road Infrastructure Safety" (2016), [4] Persia, Usami, and De Simone** provide a detailed overview of Road Infrastructure Safety Management (RISM), presenting various methodologies designed to improve road safety. RISM involves a mix of reactive and proactive procedures that help road authorities make informed decisions about the safety of road networks. The authors categorize RISM into two approaches: reactive methods, applied to existing infrastructure to address safety issues, and proactive methods, used during the early phases of road development projects to prevent potential hazards. Key RISM tools include Road Safety Impact Assessment (RIA), Road Safety Audits (RSA), Network Safety Ranking (NSR), and Road Assessment Programs (RAP). These procedures ensure that both new and existing infrastructure meet safety standards. The paper also highlights barriers to effective RISM implementation, such as institutional support and funding, and offers successful case studies to promote best practices. In the study by **Vardaki, Papadimitriou, and Kopelias (2014), [5] "Road Safety Audit on a Major Freeway: Implementing Safety Improvements,"** the authors discuss a Road Safety Audit (RSA) conducted on the Attica Freeway (Attiki Odos). The study focuses on identifying hazardous roadway features and implementing positive guidance and self-explaining roads, which encourage safe driving behavior. The RSA identified several safety risks, and the freeway operator promptly addressed these through the application of pilot safety treatments. The study highlights how RSAs can be an effective tool for improving road safety by addressing design and operational flaws. **Gholap et al. (2018),[6] in their study "Road Safety Audit,"** provide a detailed RSA of a road section along K.G. Road (SH 44) in India. The authors focus on identifying black spots, traffic volume, and road conditions to improve safety in the selected area. The RSA involved a comprehensive analysis of road conditions, traffic patterns, and public perception through surveys. The study underscores the need for addressing road infrastructure flaws and implementing preventive measures to enhance road user safety. In their work on **"Road Safety Audit of Existing National Highway-44 in the City of Delhi" (2021), [7] Mistry and Rawat** examine the RSA conducted on National Highway-44. The study emphasizes the importance of road safety audits in addressing the growing number of road accidents in India. By using videography and walkthrough inspections, the authors were able to identify issues such as poor road conditions, inadequate signage, and safety management concerns. The study's findings led to several recommendations aimed at improving road safety, including better road design and enhanced traffic management practices. In their study, **Shijil K., Geeva George, and Dr. Praveen A. (2018) [8] conducted a Construction Phase Road Safety Audit (RSA) on the Kottayam Ettumanoor MC Road (SH 01**) to address safety concerns in work zones during extensive maintenance activities. Published in the International Journal of Engineering Research & Technology (IJERT), the paper highlights the role of RSAs in identifying hazards and mitigating risks during road construction. Covering an 11 km stretch, the audit identified four black spots—areas with frequent accidents—and used surveys to collect data from road users. The key issues found were inadequate signage, poor traffic management, and unsafe road conditions, and the authors proposed rectification measures to improve safety for both workers and travelers. **Arundev P.V., Bindhu B.K., and Bino I. Koshy (2016), [9] in their paper Road Safety Audit on Karamana Kaliyikkavila Road (NH 66),** published in IJERT, conducted an RSA on a 12 km stretch of one of the busiest segments of NH 66 in Thiruvananthapuram, Kerala. The audit aimed to address the high accident rate and poor road conditions. Using response surveys and expert opinions, the audit identified issues such as inadequate construction zone warnings, poor road width, and environmental pollution affecting road quality. The study emphasized the need for road expansion and other improvements to enhance safety. In the **Road Safety Auditing of Koratty Intersection (2022),[10] Deepu R., Amrutha K.R., Aswathy P. Sudhi, Fathima Salwa C.K., and Gayathri Jayaprakash** conducted an RSA on the Koratty intersection along NH544. Published in the International Research Journal of Engineering and Technology (IRJET), the study used accident data, spot speed data, road geometry, and traffic volume to assess safety deficiencies. They identified inadequate signage, poor road geometry, and speeding as the main contributors to accidents at the intersection, recommending traffic management improvements and road design modifications. **Zijun Du, Min Deng, Nengchao Lyu, and Yugang Wang (2023) [11] conducted a review titled Road Safety Evaluation Methods Based on Driving Behavior,** published in the Journal of Traffic and Transportation Engineering. This paper examines advancements in road safety evaluations by focusing on driving behavior. The authors analyzed various data collection methods such as vehicle data, physiological data, and questionnaire surveys. They also proposed a comprehensive Driving Behavior Index System that integrates vehicle operation data, driver condition, and subjective responses to better evaluate road safety. Future research directions include exploring more complex environmental factors affecting driving behavior. **Lastly, José Antonio Martín-Jiménez et al. (2018), [12] in their study Road Safety Evaluation through Automatic Extraction of Road Horizontal Alignments from Mobile LiDAR System**, present an innovative methodology that uses LiDAR technology for road safety evaluations. The paper, published in Sensors, outlines how road geometry, particularly horizontal alignments, can affect accident rates. The method employs decision trees and 3D point cloud data to assess road safety conditions and automatically extract alignment parameters, offering both preventive and predictive capabilities. This approach was validated on three stretches of Spanish roads, showing its effectiveness in identifying potential risks before accidents occur. **“Road Safety Audit: A Case Study for Wardha Road in Nagpur City” Manish. D. Katiyari, Prof. S. D. Ghodmare** **[13]** conducted a road safety audit on Wardha Road to enhance safety for road users. By carrying out various activities such as collecting traffic and road inventory data for Wardha Road, gathering accident data, and performing accident data analysis, they derived significant conclusions based on their findings. Their objectives were to minimize the risk of future accidents arising from planning decisions related to new transport infrastructure schemes, reduce the risk of accidents caused by unintended effects of road scheme designs, and lower the long-term costs associated with planning decisions or road schemes. **Road safety audit: a case study on NH-65 Tummala Bharat Kumar, Chukkapalli Jeswanth Chowdary** **[14]** conducted a case study on the four-lane National Highway-65 and drew several conclusions based on data analysis. They identified road markings, shoulder conditions, carriageway conditions, and median openings as significant factors contributing to accidents on NH-65. The study also observed that moderately moving vehicular traffic causes traffic issues for fast-moving vehicles, as it typically occupies the innermost lane of the national highway. To address this issue, the provision of service roads is recommended to separate slow-moving traffic from fast-moving traffic. Additionally, all unauthorized gaps in the median should be closed, and essential infrastructure such as foot-over bridges should be constructed on a priority basis to enable safe crossing for local residents. Minor and major crossings that are currently undeveloped should be upgraded with proper lighting to reduce accident rates in the surveyed areas. **Accident Analysis of Anandapuram to Anakapalli Stretch via SH-38 S. Naveen Kumar, CH. Deepika** **[15]** conducted a road safety audit on SH-38 between Anandapuram and Anakapalli. Based on the accident analysis, they concluded that accidents occur almost uniformly during both day and night hours; however, the severity index is significantly higher for two-wheelers and trucks during nighttime. This increased severity is attributed to inadequate illumination and the lack of warning measures such as delineation and retro-reflective materials. The analysis also revealed that two major factors contribute to the majority of accidents. Firstly, the discontinuous service roads lead to wrong-side traffic movement as vehicles try to avoid long detours. Secondly, poorly designed access roads from adjacent areas of the highway result in frequent conflicts between local traffic (primarily two-wheelers) and through traffic (mainly goods vehicles). To mitigate these issues, improvements in highway design, enhanced lighting, and the use of effective traffic management measures are recommended. **Road Safety Audit & Remedial Measures-A Case Study of SH-55 Patel Savankumar, et al. [16]** conducted a case study on SH-55, collecting traffic volume and accident data from various sources and drawing key conclusions based on their analysis. One of the findings highlights significant delays in congested areas, whereas in straight rural road segments, delays are reduced, and vehicle speeds increase, which can pose a severe threat in the event of mishaps. Drivers were observed to have a tendency to follow vehicles too closely, failing to maintain the necessary reaction time of at least 3 seconds. For instance, at a speed of 60 km/h, a minimum safe stopping sight distance of 80 meters is required, yet tailgating behavior is common, often leading to excessive honking. Additionally, the study noted frequent violations related to overtaking. Drivers require a minimum of 300 meters for safe overtaking, but these guidelines are often ignored. To address these issues, it is recommended that the local authorities enforce police monitoring at high-risk locations. Furthermore, "No Overtaking" signs should be installed in areas where the risk of accidents is significantly high. Such measures, along with awareness campaigns and stricter enforcement, can help mitigate accidents and enhance road safety on SH-55. **Road Safety Audit for Four Lane National Highways Dr. S. S. Jain, et al. [17]** Dr. S. S. Jain and colleagues developed a comprehensive methodology for conducting road safety audits on four-lane National Highways, using a selected stretch of National Highway-58 (between Km 75.000 and Km 130.000) as a case study. Their investigation revealed that while the upgraded highway significantly improved road standards, factors such as road user behavior and environmental conditions had not advanced correspondingly. Although the design speed of the highway was 100 km/h, actual traffic conditions did not support such speeds safely, with the average vehicle speed increasing from 30–40 km/h to 60–70 km/h—posing significant safety risks. Their data analysis highlighted that poor road markings, deteriorated shoulder conditions, high traffic volume, inappropriate spot speeds, unchecked median openings, and inconsistent carriageway conditions were major contributors to accidents. In particular, the presence of slow-moving traffic in the inner lanes created severe hazards for faster vehicles. **Road Safety Performance Audit for National Highway-44 Preethi S, et al.** **[18]** Preethi S. et al. conducted a road safety performance audit on National Highway-44 based on a road inventory survey. Their study revealed that a significant number of accidents involved male road users. While street lamps were installed along the entire stretch, many were non-functional, contributing to night-time accidents. Traffic signs and road markings were poorly maintained, and key junctions lacked proper lighting, making night driving hazardous. Barricades along the highway were dismantled or destroyed, with no visible efforts for repair or maintenance. Despite a high pedestrian count, crossing facilities were limited to zebra crossings at only a few locations. Rani Junction, which connects roads in all four directions, urgently requires a traffic island, and major junctions such as Devanahalli and Chikballapur lack adequate lighting. Addressing these deficiencies is critical to improving safety and reducing accidents on NH-44.

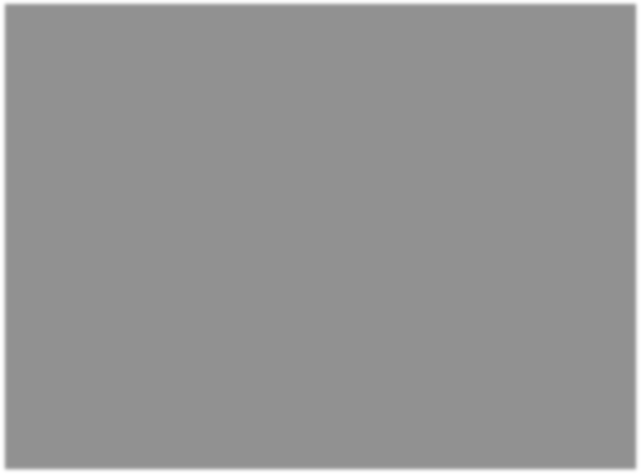
**III. PROPOSED METHODOLOGY**

**3.1 METHODOLOGY**

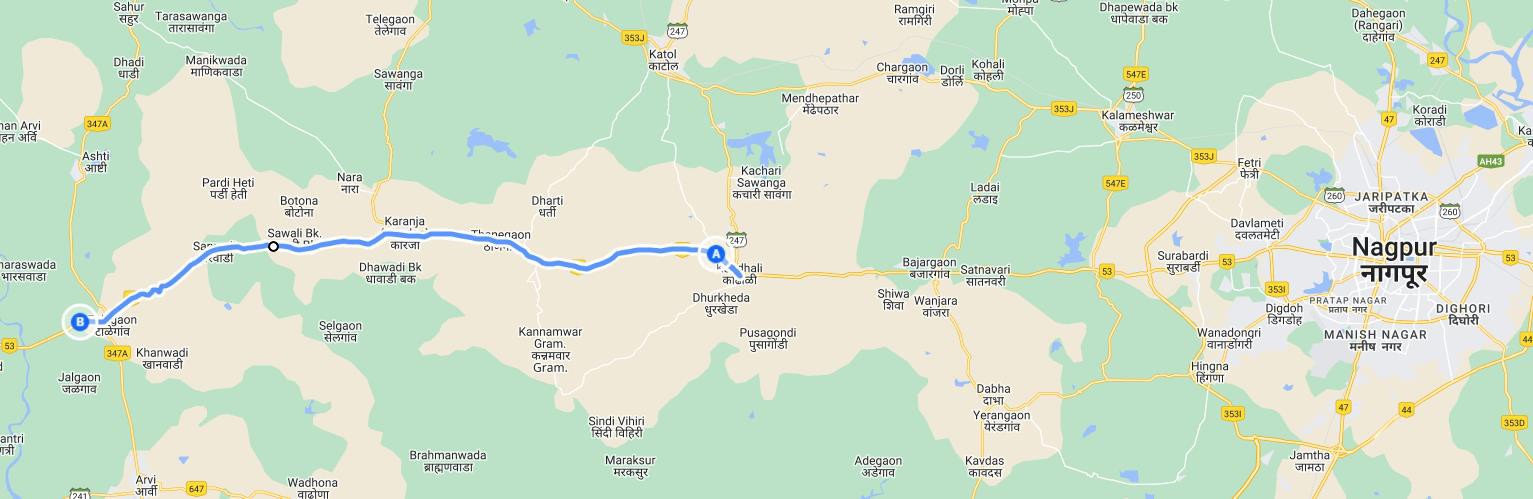
A Road Safety Audit is a systematic and formal procedure designed to evaluate the accident potential and safety performance associated with new road schemes, the upgrading, and rehabilitation of existing roads, as well as ongoing road maintenance activities. It serves as a crucial component of highway planning, design, construction, and maintenance, ensuring that safety considerations are embedded into every stage of a road project. The road safety audit necessitates a thorough and objective evaluation of accident risks, incorporating the perspectives of experts who assess the design and operational features of a project. The primary goal of a road safety audit is to ensure that new highway schemes operate with the highest possible level of safety for all users, including pedestrians, cyclists, and motor vehicles. To achieve this objective, safety must be a core consideration throughout the entire lifecycle of a road project, from the initial planning stages to construction, and continuing into operation and maintenance. The audit must follow the guidelines outlined in the IRC SP-88-2019 manual, which provides comprehensive checklists and procedural steps for evaluating safety during the operation and maintenance stages. These checklists are presented in Annexure-A and serve as a practical tool to identify potential hazards and areas of risk. Additionally, the manual includes specific instructions for preparing audit reports, documenting observations, and formulating actionable recommendations to address any identified safety concerns.

**3.2 STUDY AREA**

4-laning of Kondhali-Talegaon from km 50.00 to km 100.00 section of NH-53 (Length 50Km)” in the state of Maharashtra: The proposed project for four-laning of the Kondhali-Talegaon section of NH-53, spanning a length of 50 km from km 50.00 to km 100.00 in the state of Maharashtra, aims to enhance the overall infrastructure and connectivity, facilitating smoother transportation and economic growth. However, it is crucial to assess the potential environmental impacts associated with this project, as these impacts may affect the local ecology, air quality, water resources, biodiversity, and community health. The project includes widening existing roads, constructing new pavements, implementing proper drainage systems, and creating service roads, intersections, and bypasses to maintain a continuous flow of traffic.



**Fig.3.1: Project Location Map**



End Ch.

100+000

Starting Ch.

50+000

**Fig.3.2: Kondhali-Talegaon (Route Map)**

**3.3 DATA COLLECTION**

**3.3.1 Operation/ Maintenance Stage Safety Audit**

The road safety audit at maintenance stage shall be conducted in accordance with the IRC: SP: 88-2019. An audit of existing road way to determine, if the safety needs of all road users are currently being served. Points to be emphasized are adequacy of roadway, roadside and intersections, interchanges, grade separators, location of bus stops, truck laybyes, need of Vulnerable Road Users (VRUs), access management etc.

At this stage of audit, the safety consultant team shall visit the existing road as per schedule given in ToR. The tasks shall be included but not limited the following-

1. Consultation with the competent authorities;
2. Mobilisation, Interaction with stakeholders;
3. Detailed reconnaissance surveys;
4. Collection of Crash data and its analysis;
5. Black spot identifications and preparation of report;
6. Conducting topographic survey;
7. Conducting hourly Traffic Volume Counts, pedestrians count (along & across) and bicycle counts;
8. Analysis of these traffic data;
9. Conducting existing stage audit, which shall be covered but not limited to the following:

* Audit of Sight Distances;
* Audit of Intersections;
* Audit of Interchanges;
* Audit of Cross Sections;
* Audit of Roadside Hazards;
* Audit of Drainage;
* Audit of Signs, Pavement Markings and Delineation;
* Audit of Vulnerable Road Users (pedestrians, bicyclists, two wheelers and three wheelers, and animal drawn carts);
* Audit of Access to Property and Developments;
* Audit of Lighting and Night Time Issues;
* Audit of General Road Safety Considerations, like Is the road as safe as practical given the local weather conditions (sunrise, sunset, snow, fog, storms, and wind) and is the road surface free of gravel and sand, and with good skid resistance etc;
* Audit of Guardrails, Hedges and Railings;
* Audit of bus- bays/truck lay-byes;
* Audit of Roadside Facilities;

1. Conducting audit completion meeting;
2. Preparation and submission of Safety Audit Report (O&M Stage);
3. Preparation and submission of Safety Audit Compliance Report;
4. Conduct Safety Workshop with representative from NHAI, Concessionaire/Contractor, IE/AE at College/Secondary School/Habitations along the highways;
5. The road safety audit team of the Safety Consultant shall visit the site and take observations as mentioned above. After a detailed analysis of these observations, recommendations will be provided in the RSA report in-line with the relevant clause of IRC guidelines/manuals.

**IV. RESULTS & DISCUSSION**

**4.1 FINDINGS & IMPACT ASSESSMENT**

Some of the safety concerns at a few locations were captured and summarized below, along with the preliminary observations as per the relevant IRC standards. The details of the safety observations and appropriate recommendations are given below.

**1. Sight Distances**

**Safety Concern:** At several locations, the sight distance at a minor road intersection is obstructed by overgrown bushes, vegetation, and encroachments. These obstructions prevent drivers from clearly seeing oncoming traffic from either the main or minor road. As a result, there is a significant safety risk, as drivers may not have adequate time to react to approaching vehicles, increasing the chances of collisions and accidents. Inadequate sight distance compromises the safety of all road users, including vehicles, two-wheelers, and pedestrians, and poses a critical hazard that needs to be addressed urgently. Attached below are photographs showcasing a few problematic locations where the visibility obstruction is evident.

**Recommendation:** To effectively mitigate safety hazards caused by obstructed sight distances at intersections, it is crucial to undertake systematic vegetation management. Overgrown vegetation, bushes, and tree branches significantly hinder driver visibility, particularly on the minor and main carriageways, and thus, should be trimmed or completely removed to ensure clear sight lines. Regular maintenance through continuous monitoring and periodic trimming is essential to prevent re-growth and maintain optimal visibility. Additionally, all forms of encroachment that interfere with sight distances must be promptly identified and removed. A collaborative approach involving local authorities and traffic management agencies is vital, including community awareness programs to encourage active participation from residents and landowners in maintaining roadside vegetation.

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| **KM 54+500** |
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| **KM 58+435** |
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**Fig.4.1: Sight Distances**

**2. Intersection/Junctions**

**Safety Concern:** At the following locations – KM 54+500, KM 56+693, KM 68+000, KM 76+830, and others – the signboards for side roads at the junctions are either partially installed or missing entirely. This poses a serious safety hazard for road users, as the lack of proper signage can result in confusion and misjudgment, increasing the likelihood of accidents. Road users, including drivers, two-wheelers, and pedestrians, may not be adequately warned of an upcoming minor junction, leading to sudden stops, collisions, and dangerous interactions. The absence of appropriate signage compromises overall road safety and hinders effective traffic management. Attached are the photographs showcasing the problematic locations for better visualization of the issues.

**Recommendation:** To enhance the safety of road users at intersections and address visibility and communication deficiencies, a set of crucial interventions aligned with IRC 67-2022 guidelines is strongly recommended. One of the primary measures involves the installation of speed breakers on side roads at each minor junction to effectively reduce vehicle speeds and allow drivers more time to react. To complement this, clearly visible "Speed Breaker" signboards should be installed well in advance of the speed breakers to alert drivers and ensure gradual deceleration. Additionally, "Major Road Ahead" signboards should be positioned on the side road approaches at appropriate distances, providing sufficient advance notice of the intersection and aiding in timely decision-making. The installation of "STOP" signboards at the junction of side roads is also essential to ensure vehicles come to a complete halt before merging onto the main carriageway, thereby improving control and minimizing collision risks. Lastly, regular maintenance checks should be conducted to verify that all signboards and speed breakers are intact, properly positioned, and compliant with safety standards, ensuring their long-term effectiveness and reliability.

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| **KM 54+500** |
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| **KM. 56+693** |
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| **KM 68+000** |
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**Fig.4.2: Intersection/Junctions**

**3. Roadside Hazards**

**Safety Concern:** At multiple locations, serious deficiencies have been observed in the installation of the Metal Beam Crash Barrier (MBCB), posing a significant threat to road user safety. One of the major concerns is the partial installation of MBCBs along curves, where continuous protection is most crucial to prevent vehicles from veering off the roadway. Additionally, the absence of proper end treatments further reduces the barrier’s effectiveness, as improperly terminated MBCBs can become hazardous themselves during collisions. Another critical issue is the presence of gaps within the barrier system, which disrupts its intended continuity and compromises its ability to absorb and dissipate impact forces. These shortcomings severely diminish the overall performance of the crash barriers, especially in high-risk areas such as sharp horizontal curves and elevated embankments, where the likelihood and severity of accidents are significantly higher. As a result, the current condition of the MBCBs not only undermines their protective function but also increases the risk of serious injury or fatalities for drivers, passengers, and nearby pedestrians. Supporting photographs of these unsafe installations are provided for reference and further evaluation.

**Recommendation:** To effectively mitigate the safety risks posed by the faulty installation and poor maintenance of Metal Beam Crash Barriers (MBCBs), several corrective measures are recommended in accordance with the guidelines of IRC 119-2015. First and foremost, it is imperative to ensure the proper and robust installation of MBCBs at critical locations such as high embankments and sharp curves, where the likelihood of vehicles losing control is significantly higher. These installations must be continuous and capable of absorbing impact forces effectively. Additionally, the end treatments of MBCBs must be correctly completed as per IRC specifications. This includes the incorporation of terminal sections and crash-worthy end features that prevent vehicles from colliding directly with exposed barrier ends, thereby minimizing injury risk. Observed gaps in the barriers should be immediately addressed by restoring continuity to maintain the structural and protective integrity of the system. Furthermore, regular inspections must be carried out to monitor the alignment, condition, and effectiveness of MBCBs. Timely maintenance, including repairs and replacements, should be undertaken to ensure that all crash barriers remain compliant with IRC standards and fully functional, thereby enhancing road safety and reducing the potential for severe accidents.

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| **KM 60+800** |
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| **KM. 73+250** |
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**Fig.4.3: Roadside Hazards**

**4.** **Signs, Pavement Marking and Delineation**

**Safety Concern:** Several critical deficiencies in road infrastructure have been identified, each posing significant safety risks to all categories of road users. A major concern is the presence of faded or entirely missing road markings and chevron markings on the main carriageway, which severely impairs lane visibility and directional guidance—particularly during nighttime travel or under poor weather conditions. In addition, the installation of road studs is incomplete, especially at median openings and junctions, thus limiting their effectiveness in delineating lanes and improving night-time navigation. Another key safety lapse is the absence of Object Hazard Markers (OHM) in front of Metal Beam Crash Barriers (MBCBs) and parapet walls. Without these markers, drivers are unable to anticipate and avoid potential fixed hazards on the roadway, increasing the probability of severe collisions. These infrastructural shortcomings collectively diminish road visibility, reduce driver reaction times, and compromise overall communication between the road environment and its users. The attached photographic documentation illustrates the extent and specific locations of these issues for further review and necessary intervention.

**Recommendation:** To address the aforementioned safety deficiencies and align with established road safety standards, a comprehensive set of measures is recommended in accordance with IRC 35-2015 and IRC 67-2022. First, all road markings and chevron markings on the main carriageway should be reapplied and regularly refreshed to ensure high visibility and proper reflectivity, particularly on curves, at junctions, and in high-traffic areas. These markings must strictly adhere to IRC 35-2015 specifications to provide clear lane guidance and directional information. In addition, road studs should be newly installed or replaced at all median openings and intersections, using high-quality, reflective materials that enhance visibility during low-light and adverse weather conditions. Another critical intervention involves the installation of Object Hazard Markers (OHMs) before Metal Beam Crash Barriers (MBCBs) and parapet walls, following IRC 67-2022 guidelines. These markers should be made of durable, retro-reflective materials to effectively alert drivers to upcoming fixed obstacles. To ensure sustained safety performance, regular inspection and maintenance protocols must be instituted. These should involve routine assessments of road markings, studs, and OHMs, with timely repairs and replacements conducted wherever necessary to uphold consistent safety standards.

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| **KM 56+250** |
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| **KM. 87+600** |
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**Fig.4.4: Signs, Pavement Marking and Delineation**

**5. Access to property and developments**

**Safety Concern:** The absence of acceleration and deceleration lanes for fuel pump locations poses a significant safety hazard for road users. These critical lanes enable vehicles to safely accelerate or decelerate without disrupting the flow of traffic on the main carriageway. The lack of these lanes can result in sudden stops, abrupt lane changes, and collisions, endangering the safety of drivers, passengers, two-wheelers, and pedestrians. Attached below are photographs showcasing the problematic fuel pump locations where the acceleration and deceleration lanes are missing.

**Recommendation:** To mitigate the safety risks arising from the absence of acceleration and deceleration lanes at fuel pump locations, it is essential to implement corrective measures in accordance with Clause 6.1 of IRC 12-2016. The construction of dedicated acceleration and deceleration lanes must be carried out to ensure the smooth merging and diverging of vehicles, thereby avoiding disruptions to the main carriageway traffic flow. These lanes should be constructed with precise adherence to IRC 12-2016 design standards, taking into account the required lane length, width, gradient, and sight visibility. Responsibility for the construction and associated costs should lie with the respective fuel pump owners, as mandated, and a formal agreement should be established with the concerned highway authority to ensure accountability. Furthermore, quality assurance must be prioritized by employing approved materials and conducting regular inspections to ensure compliance with design and safety specifications. To enhance driver awareness and facilitate safer vehicle movement, appropriate signage and road markings must be installed along the lanes, using reflective and durable materials for high visibility in both daytime and nighttime conditions. These measures collectively aim to improve safety and operational efficiency at fuel pump junctions along highways.

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| **KM 85+100** |
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**Fig.4.5: Access to property and developments**

**6.** **Lightning and night time issues**

**Safety Concern:** At various locations such as toll plazas, bus bays, grade-separated structures, interchanges, and other critical areas, the absence of proper lighting infrastructure poses significant night-time visibility hazards. Insufficient lighting increases the risk of accidents, collisions, and injuries, as drivers, pedestrians, and two-wheelers may not be able to accurately judge distances, identify obstacles, or react in time. Attached below are photographs showcasing areas where lighting is missing, highlighting the visibility issues faced by road users.

**Recommendation:** To mitigate night-time visibility hazards and ensure enhanced safety for all road users, it is imperative to implement lighting improvements in accordance with IRC: SP: 84-2019. Adequate lighting infrastructure should be installed at critical locations, including grade-separated structures (such as flyovers and underpasses), interchanges, toll plazas, truck lay-byes, bus bays and shelters, service roads on both sides, and built-up sections with high traffic density. These installations must comply with the design and performance standards prescribed in IRC: SP: 84-2019, covering essential parameters like illumination levels, fixture spacing, and energy efficiency. Preference should be given to the use of high-performance LED lighting systems that not only meet visibility requirements but also offer durability and energy savings. Furthermore, a systematic maintenance and inspection protocol should be established to ensure continuous operation of lighting systems, with periodic checks to identify and rectify issues such as damaged fixtures, misalignments, or obstructions. Complementing these efforts, reflective road signage and pavement markings should be provided to further enhance night-time visibility, ensuring that both drivers and pedestrians can navigate safely during dark or low-light conditions.

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| **KM 56+250** |
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| **KM. 68+000** |
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**Fig.4.6: Lightning and night time issues**

**CONCLUSION**

In conclusion, the project on Road Safety Audit Impact Assessment emphasizes the crucial role of safety audits as an integral part of road development and maintenance projects. The audit not only identifies hazards but also offers practical solutions that improve the safety performance of highways, roads, and traffic systems. Adopting a comprehensive approach that includes technologies like AI, IoT, sustainable materials, and community education ensures a holistic and sustainable solution to road safety challenges. The integration of well-established guidelines, such as those in IRC SP-88-2019, with modern engineering practices and technological advancements, will contribute significantly to safer road environments. Future initiatives should continue to explore sustainable infrastructure solutions, data-driven predictive tools, and collaborative approaches among stakeholders to achieve long-lasting improvements. Ultimately, the project highlights that proactive road safety audits are not just regulatory necessities but also essential investments that save lives, reduce economic losses, and support environmental conservation. A commitment to continuous assessment, research, and innovation will drive progress in creating roads that prioritize safety, sustainability, and functionality, benefiting society as a whole.

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