



Road Safety Audit: A Case Study on Samruddhi Mahamarg, Nagpur-Mumbai Expressway (ME-02)

Gajanan B Takey¹, Dr Arun V Parwate², Dr P B Nagarnaik³, Dr D K Parbat⁴

¹PG Student, Dr. Rajendra Gode Institute of Technology & Research, Amravati (MS) India

²Principal, Dr. Rajendra Gode Institute of Technology & Research, Amravati (MS) India

³Professor, Department of Civil Engineering, Dr. Rajendra Gode Institute of Technology & Research, Amravati (MS) India

⁴HoD, Department of Civil Engineering, Government Polytechnic, Bramhapuri (MS) India

ABSTRACT

The goal of the study is to evaluate the Samruddhi Mahamarg Expressway's existing road infrastructure for safety and to identify any potential dangers or hazards. In order to assess the safety performance of expressways, interchanges, and other transportation facilities and pinpoint areas for improvement, the study involves conducting thorough safety audits of those infrastructures. Through this study, stakeholders may increase the safety of roads for all users by better understanding the safety hazards associated with current road infrastructure and making data-driven decisions. The overall goal of this study is to offer a thorough assessment of the security of the road network, to identify possible risks, and to develop suggestions for enhancing safety for all users. The ultimate goal of this study is to improve the safety of the road infrastructure for all users. This can be achieved by identifying and addressing safety issues by conducting Questionnaire

1 Introduction

With 63.72 lakh km of NHS, India has the second-largest road network in the world. State Highways (SHs), main district roads, smaller district roads, and village roads are all types of roadways. With 50,151 kilometers of roads, Maharashtra State is the longest in India.

Road accidents in India -2021 is an annual report released by the Ministry of Road Transport and Highways. The study gives details on a variety of aspects of road accidents throughout the nation in 2021. This report is based on information supplied by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) under the Asia Pacific Road Accident Data (APRAD) base project from police departments of States and Union Territories, which was gathered annually in standardized formats. It contains information about traffic accidents in the context of road length and vehicle population, and it is divided into 10 sections.

Maharashtra is increasingly renowned in India for its outstanding road connections and transportation infrastructure. The fact that the state has the highest state GDP and has consistently been at the forefront of economic growth is something to be proud of. It uses this path as a blueprint to expand village wealth into towns and significant metropolises. Maharashtra's all-encompassing prosperity is fueled by this extensive network of roads, which includes National Highways, Major State Highways, State Highways, Major District Roads, Other District Roads, Rural Roads, and Urban Roads. Nagpur is a developing sub-capital and Mumbai is a well-known worldwide metropolis. Highway construction is a constant effort to speed up growth in all major cities.

2 Objective

The application of safety principles, the improvement and upkeep of roads as a means of accident prevention, and making sure that road users would be exposed to the least amount of danger of accidents on existing roads are the main goals of these studies.

These study specific goals are as follows:

- Determining and evaluating potential risks and dangers related to the layout of the road, the movement of the traffic, and the surrounding area.

- Analysing the efficiency of the current traffic control devices, markings, and signage for a Samruddhi Mahamarg expressway.
- Providing suggestions for enhancing the road infrastructure to lower the likelihood of accidents and injuries.
- Increasing public trust in the safety of the road system, which may result in more utilization and financial gains.
- Analysing the road design's safety performance and pinpointing any flaws or potential improvement areas.
- Finding opportunities to include safety features and procedures, such as traffic calming measures, and better lighting.
- Making recommendations to enhance road safety and lessen the chance and severity of incidents.

3 Literature Review

The purpose of a literature review for RSA is to identify and summarize the existing knowledge and research on RSA, including its benefits, challenges, and best practices. S SanMithra, N. Naveen, M S Renuka [1] highlighted the issues in safety engineering, along with good and bad maintenance practises for Road safety such as Route signs, Interchange signs, Exit signs, Miscellaneous information signs, and Road markings. Gajanan B Takey et.al [2] have given the Comprehensive Review on Road Safety Audit. RSA can be challenging due to the complexity of road systems and the diverse range of stakeholders involved in road projects. Abdul Rahoof, Bipin Kumar Singh [3] explained Road safety review is an essential means for giving careful consideration to road safety amid the configuration of road plans. Key findings from the literature review is that we got to know Importance of road safety audits, Types of road safety audits, Factors affecting road safety audits, Challenges facing road safety audits and Best practices for road safety audits. Overall, road safety audits are an effective method of reducing accidents and improving road safety. By identifying potential safety issues, prioritizing safety improvements, enhancing road user awareness, and improving road infrastructure, road safety audits help ensure that roads are designed and maintained to maximize safety for all road users.

4 Problem Statement

To make sure that roads are safe and functional, road audit surveys are essential. This article presents the findings of a proposal to conduct a road safety audit in order to pinpoint the primary reason why accidents occur on the Samruthi Mahamarg. As many as 900 accidents, many of which were fatal, occurred on the Samruthi Mahamarg in the first 100 days following its opening. This is the primary issue with the expressway.

4.1 Study Area

In this case study, one of the major expressways, the Nagpur-Mumbai Super Communication expressway called Samruddhi Mahamarg will be undertaken for a safety audit.

The Samruddhi Mahamarg is an under Construction 6 lane wide (Expandable to 8-lane) 701 km long access-controlled Expressway in Maharashtra, India. The Section of Samruddhi Mahamarg from chainage km 10+300 (Wayfal Village) to km 106+000[IC-06] (Package II) of 95.7 km long in Wardha district will be undertaken for detailed study and safety audit at post-opening stage. Toll plaza is shown in Fig 1.

Figure 1: TOLL PLAZA AT CH. 10+475 (Near Nagpur)



5 Methodology – Methodology adopted in the survey is mentioned in flow chart and shown in fig 2

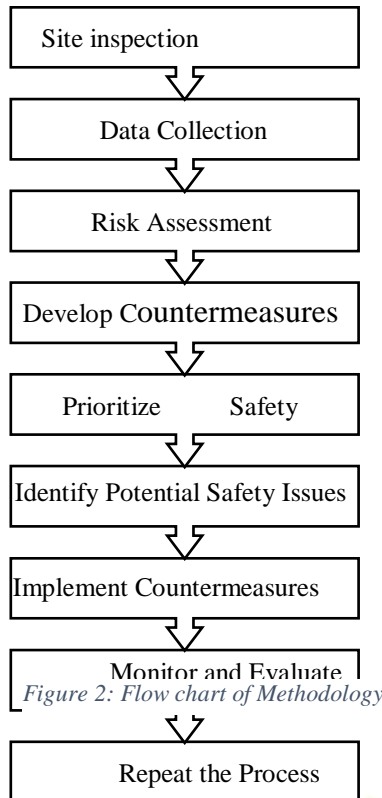


Figure 2: Flow chart of Methodology

Site Visit: The audit process begins with a site visit to physically inspect the road infrastructure, including road geometry, traffic control devices, road surface condition, and adjacent land use.

Data Collection: Data collection involves gathering and analyzing a wide range of data, including traffic volume and speed, crash history, road user behaviour, and land use.

Risk Assessment: A quantitative and qualitative method of assessing the potential hazards and risks associated with the road infrastructure is conducted.

Identify Potential Safety Issues: Based on the risk assessment, potential safety issues are identified, such as high-speed areas, sharp curves, poor lighting, and inadequate signage.

Prioritize Safety Improvements: The safety issues identified are then prioritized based on their potential impact on reducing accidents.

Develop Countermeasures: Appropriate countermeasures are developed to address the prioritized

safety issues, such as speed reduction measures, intersection improvements, or better lighting.

Implement Countermeasures: The countermeasures are implemented,

such as installing new signs, pavement markings, or traffic signals

Monitor and Evaluate: The effectiveness of the implemented countermeasures is monitored and evaluated to ensure they are achieving the desired safety outcomes

Repeat the Process: The audit process is repeated regularly to ensure that the road infrastructure continues to meet safety standards and guidelines.

Road safety parameters to be analysed

There are several parameters related to road safety that can be analysed to understand and improve the safety of a particular road or transportation system parameters include speed limit, accident frequency, accident severity, traffic volume, road geometry, weather condition, driver's behaviour, road condition, road signage and marking, emergency response and vehicle maintenance.

6 Data Collection & Analysis

6.1 Spot Speed Study

A technique for determining the speed of vehicles in a single area on a road is called a spot speed study. As per studies and investigation on Samruddhi Mahamarg, from chainage km 10+300 (Wayfal Village) to km 106+000[IC-06] (package II) of 95.7 km long. Spot speed survey data was been carried out to find the spot speed for the vehicles moving on the expressway. Spot speed was done at every interchange, first at chainage (28+006) second at chainage (42+300) and third at interchange 03 (IC-03), the site location also consists of curve as well as exit point. So as being the exit and curve ahead the speed of the vehicles should in the given speed limit range. The speed limit that is allocated for the Samruddhi Mahamarg by the MSRDC is as follows: Car: 120 km/hr and HCV/LCV: 80 km/hr. Sample size of 200 vehicles were taken to determine the spot speed study at every location using RADAR guns. The measurements are typically taken over a period of time, during which the device is aimed at passing vehicles to measure their speed. At every Location 2 hrs data has been taken and surveyed to determine the spot speed study. From the Study it was analysed that out of 200 vehicles many vehicles are not following their speed limit and exceeding their given speed limit. The table 1 shown below will briefly describe the spot speed survey analysis. Trend of vehicles exceeding the speed is shown in Fig 3. Percentage composition of vehicles are also evaluated and shown in Fig 4.

	Cars	HCVs	LCVs
Total Count of vehicles	200	200	65
Exceeding their Max. Speed	60	40	41

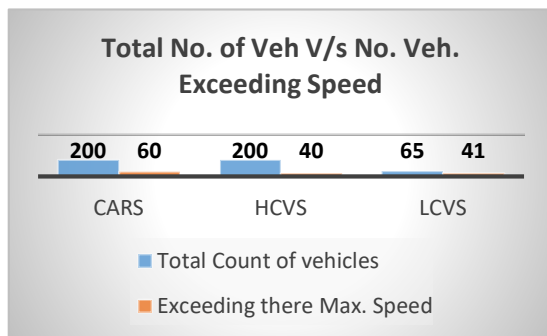


Figure 3: Total No. of veh. V/S No. of Veh. Exceeding speed

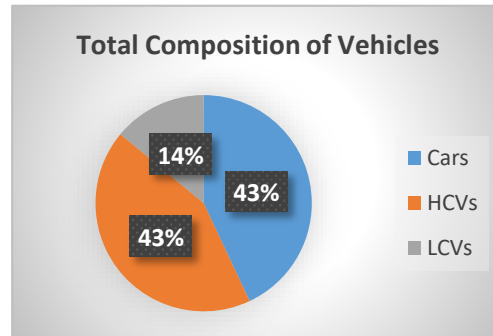


Figure 4: Percentage composition of vehicles

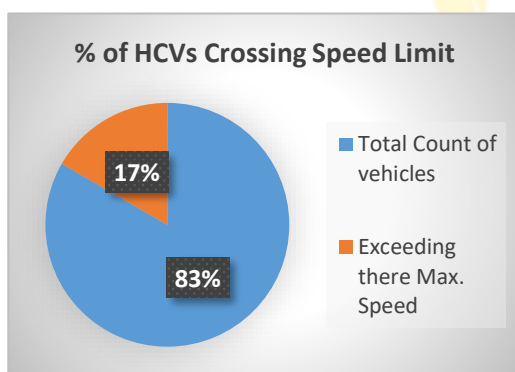


Figure 5: Percentage HCV Crossing Speed Limit

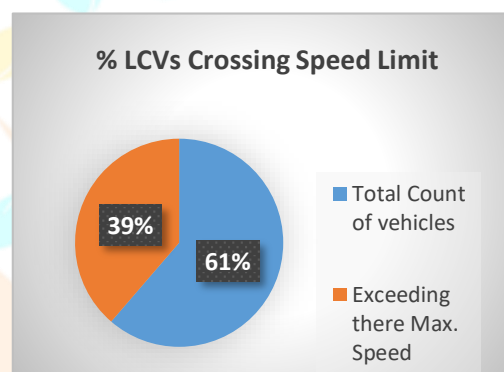


Figure 6: Percentage LCV Crossing speed limit

6.2 Accident Data Study

An accident data study is a method used to analyse data related to road traffic accidents. The goal of such a study is to identify patterns and trends in accident data that can be used to inform decisions about road safety policies, education, and infrastructure improvements. The Accident Data has been collected by MSRDC office, which contains data from December to March from day of inauguration Total accident that has been recorded till now are 237. The Monthwise accident data is presented in Table 2. Monthly Trend of accident is shown Fig 7. The count of accident types are presented in Table 3 and composition of accident type is shown in Fig 8.

Table 2: Monthwise Accident data

Monthwise Accident Data	
December 22	35
January 23	63
February 23	72
March 23	67
Total	237

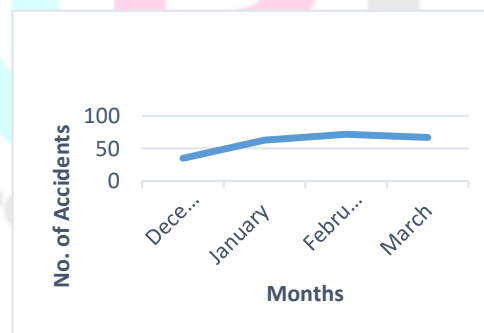


Figure 7: Monthwise trend of accidents

Table 4: causes of accident type (count)

Cause Of Accident	No. Of Accidents
Human	35
Animal	87
Total	122

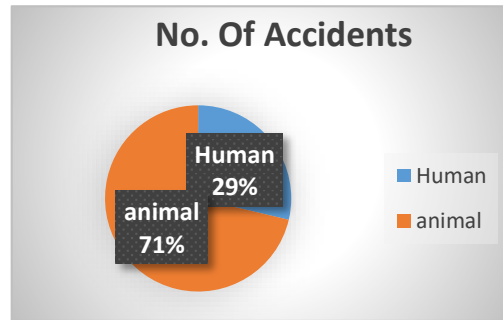


Figure 9: Composition of causes of accident type

Table 3: Various causes of accident type (count)

Row Labels	Count of Accident Type
Fire	1
Major	7
Mechanical Failure	105
Minor	104
Out of Fuel	20
Grand Total	237

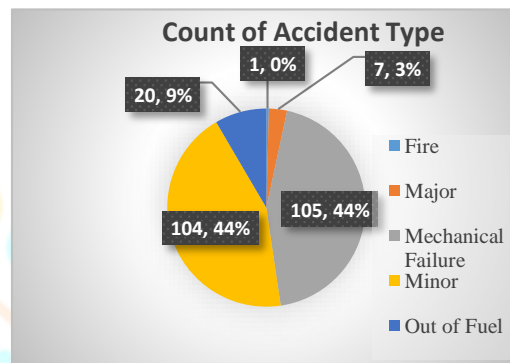


Figure 8: Composition of count of accident type

The causes of accident types are presented in Table 4 and composition of causes accident type is shown in Fig 9.

6.3 Lane Discipline

On a multi-lane road or highway, maintaining lane discipline is the act of driving in the proper lane. It entails observing traffic laws and operating a vehicle in a way that is secure and mindful of other road users. For a number of reasons, lane discipline is crucial. It primarily contributes to lowering the likelihood of traffic crashes and accidents. Drivers are less likely to collide with other cars or roadside items when they stay in their allotted lane. In addition, maintaining correct lane discipline can aid in enhancing traffic flow and easing congestion on congested highways. For Lane Discipline Survey we collected sample size of 100 trucks on the current road stretch.

It was observed that many trucks drivers are not following truck discipline the data has been analysed .The analysis of lane discipline are presented in Table 5 and composition of truck following lane discipline is shown in Fig 10.

Table 5: Analysis of lane discipline

	No. of Trucks
Total Count of Trucks	100
No. of Trucks not Following their Lane	51

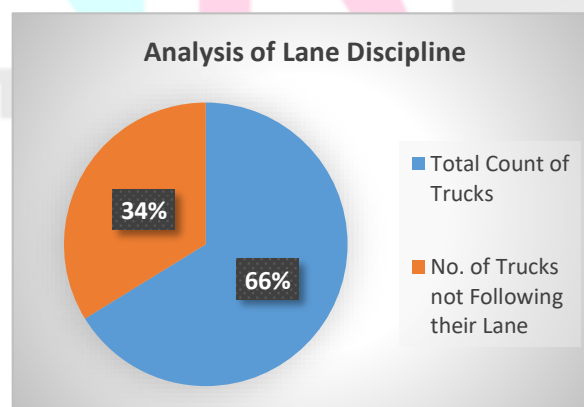


Figure10 : Composition of Trucks following lane discipline

6.4 Questionnaire Survey

The questionnaire can be utilized in a variety of sectors, including social sciences, marketing, health, and education. It is often delivered via a variety of means, including online, mail, telephone, or in-person. The information gathered from the questionnaire survey can be utilized to guide decision-making by being evaluated to learn more about the perceptions, attitudes, and actions of the respondents.

A questionnaire survey was administered during day and night time for this investigation. The following is a list of the questions asked to drivers and passengers:

- Did the driver feel that the journey was tiresome and monotonous?
- Did they have trouble in their vision at night because of the glare of light from cars coming from the other side?
- Could you see the sign boards clearly?
- Were messages displayed on sign boards clear to read?
- How convenient was their trip?
- Do they have any suggestions to enhance the driving experience?

At the IC-06 toll plaza, a questionnaire survey was also conducted with an RTO officer, and the question asked was as follows:

- What are the main challenges that users of this expressway face?
- What were the accident's primary causes?
- What time of day did the majority of accidents occur?
- How do they uphold the law and order?
- What conditions or knowledge must a road user have in order to operate a vehicle on this expressway?
- What steps can be taken to improve road users' safety?

6.5 Road Inventory Survey

The road inventory survey's major goal is to obtain precise information that may be utilized to create maintenance schedules that are effective and to decide on future road construction projects. Depending on the scale and complexity of the road network, the survey can be carried out using a variety of techniques, including manual inspections, mobile mapping systems, or remote sensing technology.

In this study, a road inventory survey is conducted using a manual inspection technique. The following observations were made:

- Examining the pavement surface for any significant deterioration or damage of any kind.
- Verifying that sign boards are clearly visible for a vehicle moving at the permitted speed.
- If adequate drainage is offered.
- Accessibility to various roadside amenities like gas stations, garages, entertainment areas, restrooms, hotels, and restaurants.
- The state of the sign boards.

7 Recommendations

The Hindu Hrudaysamrat Balasaheb Thakare Maharashtra Samrudhi Mahamarg Expressway can be made safer for drivers and more enjoyable for users by implementing the following suggestions and to assist drivers in getting to their destinations in a safe and comfortable manner.

7.1 Recommended Infrastructure

The following infrastructure needs to be put in place for the Samruddhi Mahamarg Expressway to carry traffic safely and comfortably:

7.1.1 Speed Cameras

Speed cameras can be an efficient tool for enhancing safety on Samrudhi Mahamarg Expressway. As overspeeding was noted, it will discourage drivers from doing so, because they risk receiving a challan if they go over the posted speed limit.

7.1.2 CCTV Cameras

CCTV cameras can be deployed on expressways for a number of reasons, including traffic flow monitoring, incident detection, enhancing general safety, and determining whether or not a vehicle is adhering to lane discipline.

7.1.3 Feedback Signs

A smart speed limiting solution is required because of the rising number of road accidents on the Samruddhi Mahamarg Expressway caused by speeding and the limitations of the current speed limit signs. (Reference- Clause 2.7.2, IRC: 99-2018)

The purpose of a Driver Feedback Sign (DFS) is to provide the driver with real-time feedback regarding the speed of the vehicle. It uses radar to gauge the vehicle's speed and shows that speed in real-time on an LED display. These signs may be programmed to flash when drivers go over the posted speed limit.

7.1.4 Variable Sign Board

Variable signboards' main objective is to give drivers access to real-time data so they may make educated judgments regarding their route and speed. For instance, if there is an accident up ahead, a message warning cars to slow down and use caution will be displayed on the signboard. Similarly, to this the signboard will recommend alternate routes if there is excessive traffic or road works.

Highway management systems must have variable signboards since they help with traffic flow, congestion reduction, and overall express safety. These signboards can also lower the chance of accidents and speed up travel times for vehicles by giving timely information to vehicles. (Refer IRC: SP: 85-2010 Guidelines for Variable Message Signs)

7.1.5 Telephone Booths

Telephone booths should be erected at frequent intervals because they are essential for providing emergency communication and help to travellers, especially in rural or remote regions with poor cell phone service.

7.1.6 Recreational places

There should be recreation places at every 50 Km to 100 Km stretch on Samruddhi Mahamarg Expressway as these locations can give travellers a break from driving and the chance to get fresh, eat something, or enjoy some downtime. On expressways, there should be the following leisure areas: Rest areas, Service areas, Scenic vistas, Parks and natural reserves, Theme parks, and attractions.

7.2 Counselling Sessions for Road User

Counselling sessions should be provided at toll booths to raise awareness among drivers. A brief instructional video regarding how to operate the Samruddhi Mahamarg Expressway, what safety precautions should be taken, and what are the consequences of not adhering to the posted speed limit should be displayed at toll booths

7.3 Traffic Control Devices

7.3.1 Road Markings (As per Clause 7.7, IRC: 35-2015)

Raised profile edge lines should be provided near the median. It is a continuous line marking with ribs spaced regularly across the line. The benefit of ribs is that, under wet situations, the vertical edges of the elevated ribs are visibly visible above the water film. The additional benefit of raised ribs is that when a vehicle passes over them, the ribs emit loud vibrations that serve as a warning to drivers.

7.3.2 Sign Boards

- More signboards warning drivers that there may be an animal crossing ahead are needed. According to observations made during the survey, there is a potential for accidents because monkeys have been seen crossing the road close to bridge sections.
- If a vehicle is moving at the desired speed limit, the Emergency Contact Number indicated sign boards should have a larger font size because they were difficult to see from a distance.
- A gantry sign board should be available to display the lane-by-lane speed limit and the minimum speed limit.
- There should be "No Stopping No Standing" signboards placed close to the bridge. As trucks were found to be parked under the bridge during the survey for shelter, creating a blind spot and raising the risk of an accident.

7.4 Implementation of ITS in Samruddhi Mahamarg Expressway

Expressway safety and efficiency can be greatly improved by intelligent transportation systems (ITS), especially in places with heavy traffic. India's Samruddhi Mahamarg Expressway, a high-speed route between Mumbai and Nagpur, could benefit from the use of ITS.

Here are some ways in which ITS can be implemented in Samruddhi Mahamarg Expressway:

1. Advanced Traffic Management System (ATMS): By giving the control centre real-time traffic statistics, ATMS can assist in regulating traffic on the expressway. This may facilitate quicker incident detection and response, which will shorten response times and increase safety.

2. Variable Message Signs (VMS): VMS can be installed along the expressway to give travellers up-to-the-minute information on weather, roadwork and traffic patterns. By directing traffic to alternative routes, can ease congestion while also enhancing driver safety by alerting them to potential dangers.

3. Intelligent Speed Adaptation (ISA): ISA can be used to regulate expressway traffic speed based on weather and traffic circumstances. ISA systems use GPS and other technologies to monitor a vehicle's speed and provide feedback to the driver. Ensuring that drivers stay under the acceptable speed limit, can aid in reducing accidents.

4. Incident Detection and Response System (IDRS): IDRS can assist in more rapidly and correctly detecting problems like accidents, road works and breakdowns. This can aid in quicker road clearing times, more effective incident response, and increased safety.

Overall, adding ITS to the Samruddhi Mahamarg Expressway can aid with safety enhancements, traffic flow reductions, and overall expressway performance.

7.5 Recommendation to Improve Law and Enforcement on Samruddhi Mahamarg Expressway

The Samruddhi Mahamarg Expressway's law and enforcement might be greatly enhanced by putting the following suggestions into practice, making it safer and more secure for all its users.

- In order to uphold the law and provide speed enforcement, speed guns must be made available to RTO personnel.
- RTO authorities should have the authority to inspect vehicles, and the number of passengers inside, and to halt them, which is currently unavailable, according to RTO officials.

8 References:

- 1) S SanMithra, N. Naveen, M S Renuka, "Road safety audit of the noida – greater noida expressway", international journal of research and analytical reviews (ijrar.org) (E-ISSN 2348-1269, P- ISSN 2349-5138) www.ijrar.org Volume 6, Issue 1, 2019, pp.1079-1087.
- 2) Gajanan B Takey, Dr Arun V Parwate, Dr P B Nagarnaik, Dr D K Parbat, "Comprehensive Review on Road Safety Audit", International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) ISSN: 2319-8753, p-ISSN: 2347-6710 www.ijirset.com Volume 12 Issue 4 2023 pp. 2729-2732.
- 3) Abdul Rahoof, Bipin Kumar Singh, "Road Safety and Road Safety Audit In India: A Review", Volume 4, Issue 7, March-2017.
- 4) Ministry of Road Transport and Highways, Road Accidents in India Annual Report India- 2021, [Online].Available:- [Press Information Bureau \(pib.gov.in\)](http://PressInformationBureau.pib.gov.in)
- 5) Manual on Road Safety Audit, IRC: SP: 88-2019.
- 6) Guidelines for Variable Message Signs, IRC: SP: 85-2010.
- 7) Manual for Specifications and Standards for Expressways, IRC: SP: 99-2013.
- 8) Code of Practice for Road Markings, IRC: 35-2015.
- 9) Guidelines for Traffic Calming Measures in Urban and Rural Areas, IRC: 99- 2018.
- 10) Code of Practice for Road Signs, IRC: 67- 2012.