

Original Article

# Road Safety Audit: A Case Study of Rural Road on SH 117 in Ramanagara District, Karnataka

V. Pampapathi<sup>1</sup>, T. R. Nikhil<sup>2</sup>, Yateen Lokesh<sup>3</sup>

<sup>1</sup>Ramaiah University of Applied Sciences, Bengaluru, Karnataka, India.

<sup>2,3</sup>Department of civil engineering Ramaiah University of Applied Sciences, Bengaluru, Karnataka, India.

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**Abstract** - From the actual conditions of rural road accident in our country shows that the current rural road safety is facing a grim situation and emphasizes the need to conduct a rural road safety audit. The road safety audit is a systematic and formal process of checking the safety aspects of road schemes before they are built. This article analyzes the factors affecting safety in rural road accidents from humans, vehicles, road, external environment and other factors, and summarizes the connotation and the steps of rural road traffic safety audit. The goal is to uncover any potential safety issues so that, when it is feasible, the design can be altered to minimize them. Irrespective of the scheme, designers, professional and experienced auditors conduct the audit. This project aims at these problems existing in the implementation process of rural roads & proposes the corresponding solutions to support the work of rural road traffic safety audit.

**Keywords** - Road Safety Audit, Safety Measures, Road Accidents.

## 1. Introduction

A road safety audit is a systematic and formal process of examining the safety aspects of road schemes prior to construction. The audit is performed by trained and experienced auditors who are not affiliated with the scheme's designers. The principle of "prevention is better than cure" governs road safety auditing. A planning stage is much less expensive than having to change asphalt or concrete after the scheme has been built.

Other countries' experience suggests that conducting road safety audits and acting on the results can prevent or reduce the severity of at least one-third of all crashes. Road safety audits are appropriate for all types of road construction, including rehabilitation, upgrade, and new construction. They can also aid in determining the safety of traffic control and signage at roadworks traffic management schemes and major roadside building development (e.g., shopping malls, parking lots, recreation centres, etc.) existing roads.

Safety audits involve three distinct parties, each with a specific role to play: the Auditor, the Designer, and the Client:

- The Client commissions the Auditor (audit team) to carry out the audit and provide a report that identifies the safety problems and suggests what should be done about them.
- The person in charge of the design is the designer (often a consultant). They will be invited to comment on the

audit report for any changes in the design for the audit report to the client.

- The Client is the party responsible for the design (often a consultant)

## 2. Objectives of the Study

The primary objective of undertaking a road safety audit on the rural road is to ensure increased safety for the users. Specifically, the objectives and various tasks to be achieved can be stated as follows:

1. To obtain data related to accidents and road geometry.
2. To collect traffic and road inventory of Rural road (Hanumanahalli to Tenganaikanahalli) SH-117 of Ramanagara District.
3. To study the detailed concept of Road safety analysis, i.e. detailed design stage audit.
4. To examine safety features and suggest remedial measures to ensure safety for road users.

## 3. Literature Review

In rural roads, scientific approaches have been used to identify accident black Spot sections, including nodes and links based on the data relating to terrain, number of lanes, traffic volume and number, and the severity of accidents[2]. The purpose of the study is to assess the road safety audit of a segment of the state's rural roads SH-32, with a particular emphasis on assessing the advantages of the suggested improvements that have resulted from shortcomings detected during the audit process[5]. RSA depends on the guideline of an autonomous audit. The procedure uncovers the inclusion



of the Client, Designer, Auditor and Road User[8]. To analyse the impact of roadway geometry and traffic conditions on the road stretch and build a statistical relationship between accident rates and numerous accident-causing factors, it was investigated how to identify accident-prone locations on the road from FIR. [12]. The RSA is to evaluate ventures for potential mishaps end/lessening on the premise of road client learning, characteristics and aptitudes, day/night, and wet/dry road conditions. It suggested on the outline and before planning of agreement archives to evaluate itemized intersection design, markings, signs, signals, lighting points of interest, Detail Design of junctions, design of geometrics, Cross-fall Marking and Signs, Side drains, Embankment slopes, Presence of clear zone, Traffic Signals Lighting [13]. According to a study, the increasing severity and frequency of recent road traffic accidents (RTAs) in India involving modern vehicles have raised serious concerns about road safety and presented a significant challenge to everyone involved in transportation policy, planning, regulation, law enforcement, engineering, and civil society[15].

After verification of black spots, different static models for road accidents, a different technique for reducing road accidents and road safety audits for various stretches in India. Identified the different black spot locations and gave suitable solutions to reduce road accidents at those locations. It concludes that a road safety audit is a better option to reduce road accidents and save people's life. It also provides better safety, better serviceability, good comfort and consumption of less time.

#### 4. Problem Statement

This article provides the results of a preliminary design stage road safety audit of a proposal to duplicate 9km of State highway in SW Karnataka.

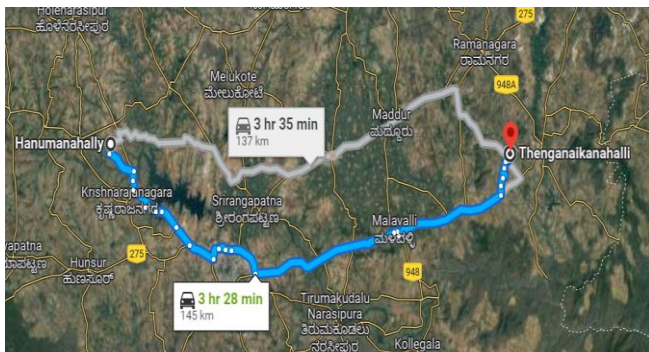


Fig. 1 Study area from 0+210 to 80+160 (Hanumanahalli to Tenganaikanahalli)

Note. The image was created from google maps to show the distance between the preferred study area, i.e. from Nelamangala toll plaza to Shanthi grama toll plaza. (<https://www.google.com/maps>)

#### 4.1. Study Area

The study area was selected in the state of Karnataka, through which State Highway-117 passes. For study purposes, a 9 km stretch of road was selected from Hanumanahalli to Tenganaikanahalli via Gerahalli, Kanakapura Taluk, Ramanagar District.

#### 4.2. Methodology

This report provides the major findings of a preliminary design stage road safety audit of a section of a state highway proposed for duplication next year. The task will include the construction of two new bridges (one over a river, one over a railway line), three two-way side roads totalling 1.8km in length, 10 new culverts and one major new intersection. The highway passes through two villages, and special attention is being paid to the design to minimise the impact of the new road on these villages.

Methodology mainly includes the process as closely as possible to ensure that the audit is both formal and systematic. The process is the same regardless of the type or scale of the project being audited, but the amount of work involved in each step varies. The flow chart in Figure 2 depicts the steps in the audit process.

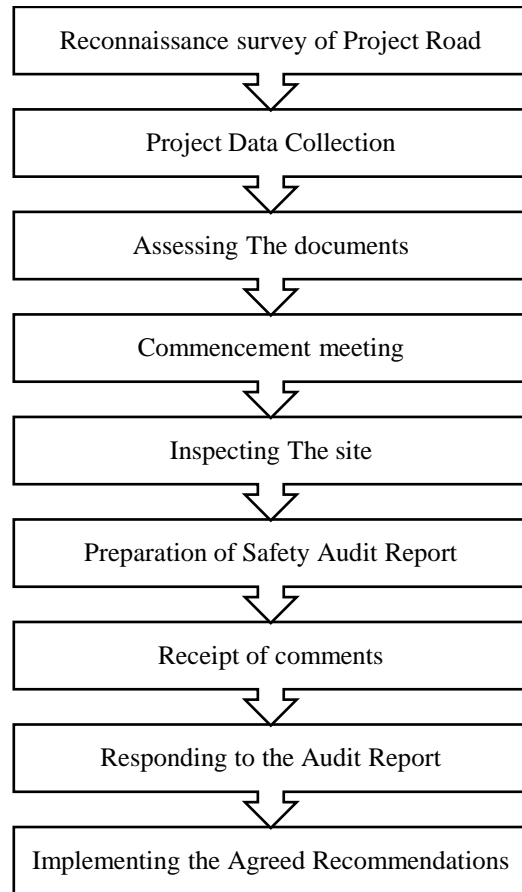


Fig. 2 Flow chart of Road Safety Audit

4.3. Five Stages of Road Safety Auditing

The first three audit stages are concerned with the initial design (planning), draught design, and detailed design. Stages 4 to 5 of the audit process occur after the project is completed: inspection before the project is opened to traffic and regular audits or monitoring of existing roads.

4.3.1. Initial Feasibility Studies (Stage 1)

Audits at this stage can have an impact on fundamental issues like design standards, cross-section, route selection, impact on the surrounding road network, and the number, location, and layout of intersections. If a bad or inappropriate decision is made, it will almost certainly be impossible to fix the problem later in the design process.

4.3.2. Preliminary Design (Stage 2)

The preliminary or draught design will determine the standards, cross-section, alignment, and junction layout.

4.3.3. Detailed Design(Stage 3)

This audit occurs after the detailed road design is completed but before the construction contract documents are prepared and the land acquisition is finalized. It is an opportunity to inspect all details, such as signs and markings, safety barriers, roadside obstacles, pedestrian facilities, and connections to existing roads.

4.3.4. Pre-Operating Stage(Stage 4)

This audit is performed immediately before the road is opened to traffic and includes a thorough inspection of the road as well as all signs and road furniture. The goal is to look for any potentially hazardous features that were not apparent in previous stages, as well as to ensure that all design details have been correctly implemented.

5. Accident Data Collection and Analysis

5.1. Identified Black Spots from Police Data

As per studies and investigation on SH 117, i.e. from Hanumanahalli to Tenganakanahalli, 6 black spots were identified with no. of accidents, no. of fatalities and no. of grievous injuries throughout the study area of 84.09 km.

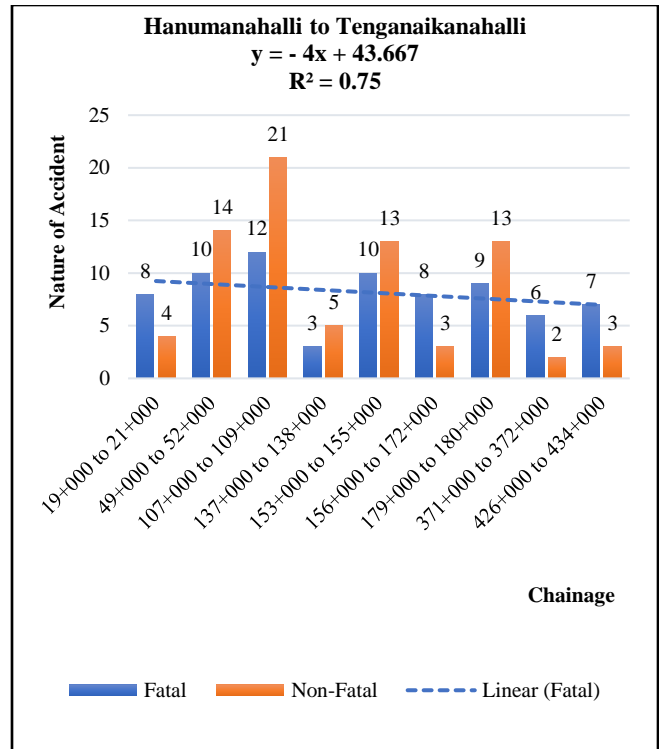


Fig. 4 Regression analysis of accident data

Note :A regression model was developed to analyze the relation between no. of accidents and fatal accidents which is occurring on identified black spots.

- A linear trend was observed to be the worst-fit equation with a coefficient determination value below 0.5.
- The polynomial trend was observed to be the best fit with the coefficient of determination 1, i.e.  $R^2 = 1$ .

5.2. Identified Black Spots from PWD (Public works Department), Karnataka

Each accident's data, including its location, nature of the accident, cause of the accident, chainage of the stretch, date of the accident, and so on, was input into excel for determining the chainage-wise location of the accident.

Table 1. Accident data from the Police station

SH 117 Accident Data For the Last 5 Years from 2018-2022					
S.L. No	Year	No. of Accidents	Fatal-(Members)	Major Injury-(Members)	Minor Injury - (Members)
1	2018	32	12	35	29
2	2019	29	19	41	44
3	2020	18	6	38	36
4	2021	24	11	42	52
5	2022	32	18	38	25
	Total	65	56	194	186

Note : This table represents the total no. of accidents for the last five consecutive years collected from the Public works department, Karnataka

**Table 2. Chainage-wise accident data**

Chainage	Nature of Accident	
	Fatal	Non-Fatal
109+500 to 115+000	8	4
115+000 to 120+000	10	14
120+000 to 125+000	12	21
125+000 to 130+000	3	5
130+000 to 135+000	10	13
135+000 to 140+000	8	3
150+000 to 155+000	7	3
155+000 to 160+000	12	3
160+000 to 165+000	22	28

Note: Illustration of chainage-wise accident data collected from Public Works Department, Karnataka.

**6. Checklist for Existing Road**



- Are the prevailing speed levels within desirable limits?

- Are there signs of other conflict situations and minor accidents?
- Are the surface and carriageway markings in good condition?
- Are medians and islands of adequate width for the likely users?
- Are there signs of pedestrian traffic in places that seem hazardous to pedestrians?
- Does there appear to be a need for more or better crossing facilities for pedestrians?
- Are overtaking opportunities available for heavy vehicles where volumes are high?
- Is sufficient warning provided in advance of breaks in service roads and openings in medians for traffic using the multilane highway?
- Does there appear to be a need for more or better facilities for cyclists?
- Are the specified distances to rigid obstacles maintained for all group road users?






**7. Site Visit Findings**




After identifying black spots, a site visit was conducted to find the deficiencies/ issues causing the accidents. Observations and suggestions are shown in table 3.

**Table 3. List of Remarks, Solutions provided and Suggestions**

SL No.	Chainage	Site Photos	Description of Road Issue	Recommendation as per IRC	Road Safety Risk Assessment
1	19+000 to 21+000		<b>Horizontal Curve</b> Poor sight distance at a curve causes the risk of the head-on collision	Provide curve warning sign boards as per IRC:67-201	High
2	15+600 to 17+200		<b>Waterbody/tank/nala on LHS of carriageway</b> Errant vehicles may fall into the canal.	Metal Beam Crash Barrier to be provided along the road as per IRC: SP: 88-2019	High



<p>3</p> <p>17+900 to 18+000</p>		<p><b>Horizontal Curve</b> Poor sight distance causes the risk of the head-on collision</p>	<p>Provide Curve Warning Sign as per IRC: 67 - 2012</p>	<p>High</p>
<p>4</p> <p>37+100 to 37+200</p>		<p><b>Horizontal Curve</b> Poor sight distance at a curve causes the risk of the head-on collision</p>	<p>Provide Curve Warning Sign as per IRC: 67 - 2012</p>	<p>High</p>
<p>5</p> <p>56+200 to 56+400</p>		<p><b>Y Junction Point</b> Possible collision with the through traffic.</p>	<p>Provide Cautionary Sign boards indicating junction ahead as per IRC 67-2012</p>	<p>High</p>
<p>6</p> <p>86+100 to 86+200</p>		<p><b>Design of Start Point/T Junction</b> Possible collision with the through traffic.</p>	<p>Provide junction warning sign boards as per IRC:67-2012</p>	<p>High</p>
<p>7</p> <p>87+850 to 87+900</p>		<p><b>T - Junction Point/End Point</b> Possible collision with the through traffic</p>	<p>Provide junction warning sign board as per IRC:67- 2012</p>	<p>High</p>

8	99+600 to 99+850		<b>Sharp Horizontal Curve</b> Poor sight distance causes the risk of the head-on collision	Provide Curve Warning Sign as per IRC: 67 - 2012	Very High
9	121+000 to 121+400		Formation of ruts, cracks, and potholes.	Cracks and potholes. The road should be repaired immediately.	High
10	45+000 to 46+000		<b>S-Curve</b> Poor sight distance at the curve causes the risk of a head-on collision	Provide Cautionary Sign boards viz S curve ahead as per IRC 67-2012.	High

## 8. Detailed Estimate of Road safety of Rural road (SH 117)

Table 4. Detailed Estimate of road safety SW 117 from Hanumanahalli to Tenkanayakanahalli

Name of the work: Improvements to Road from Hanumanahalli to Tenkanayakanahalli Via Gerahalli in Kanakpur Taluk, Ramnagara District					
ABSTRACT ESTIMATE ( ROAD SAFETY).					
SUB ESTIMATE					
SL No.	Description	Unit.	Qty	Rate	Amount
1	Metal Beam Crash Barrier	Cum	17.82	395.52	7048
2	Boundary Pillars	Nos	500	577.83	288915
3	Providing and fixing of retro-reflectorisrd cautionary, mandatory Sign Boards	Each	40	2343.25	93730
4	Providing, laying, rumble strips	Unit	2	18348.42	36697
5	Retro-reflectorisrd Traffic Signs	No.s	35	2343.3	82104
				<b>Rs</b>	<b>5,08,494</b>

## 9. Summary and Conclusion

The Road Safety Audit of SH-117 detected several issues related to sight distance, road signs, pavement markings, vulnerable road user needs, intersections, roadside hazards, footpaths, medians, pedestrian guard rails etc. This research looked at accident data from the Hanumanahalli to Tenkanayakanahalli to find possible causes and black spots. The study was an effort to identify the problem areas in the Ramanagara district. Road safety analyses were carried out at all the hotspots to determine the condition of the road. Road Safety analysis can be used to determine factors influencing crashes and give remedial measures.

The following are the study's main findings:

- A rear-end collision and subsequent sliding were shown to be the cause of the majority of accidents.
- The village junction on the freeway was the scene of a high number of accidents.
- Most of the accidents are caused due to poor pavement markings and maintenance.

### 9.1. Recommendations

Due to the existence of local dwellings, Dhabas, garages, or road vendors, proper access management should be considered. According to IRC-67-2012, suitable signage of hotels, homes, and others shall be given before these regarded areas as a short-term remedy.

- The road is intended to carry high-speed traffic. The road consists of mixed traffic, which includes bicycles and significant pedestrian traffic.
- Provision of adequate infrastructure and facilities for non-motorized traffic.
- Repair, replace, and maintain existing pedestrian facilities such as footpaths, railing, kerb ramps, safety bollards, median refuges, etc.
- Adequate carriageway width and shoulder width should be provided.

## References

- [1] Shalini Kanuganti et al., "Road Safety Analysis Using Multi Criteria Approach: A Case Study in India," *Transportation Research Procedia*, vol. 25, pp. 4653-4665, 2017. *Crossref*, <https://doi.org/10.1016/j.trpro.2017.05.299>
- [2] Xuchun S. Tu, "Application of RISC for Road Safety Program Development," *Transportation Research Procedia*, vol. 25c, pp. 1925-1935, 2017. *Crossref*, <https://doi.org/10.1016/j.trpro.2017.05.185>
- [3] Abdul Raheem, and Bipin Kumar Singh, "Road Safety and Road Safety Audit in India: A Review," *International Journal for Technological Research in Engineering*, vol. 4, no. 7, pp. 1011-1014, 2017.
- [4] Athanasios Theofilatos, and George Yannis, "A Review of the Effect of Traffic and Weather Characteristics on Road Safety," *Accident Analysis & Prevention*, vol. 72c, pp. 244-256, 2014.
- [5] Md Izharul Haqu et al., "Accident Analysis and Road Safety Audit: A Case Study on Nh-76," *IOP Conference Series: Earth and Environmental Science*, vol. 1086, 2022. *Crossref*, <https://doi.org/10.1088/1755-1315/1086/1/012025>
- [6] P. V. Arundev B. K. Bindhu Bino, and I. Koshy, "Road Safety Audit on Karamana Kaliyikkavila Road (NH 66)," *International Journal of Engineering Research & Technology*, vol. 5, no. 4, pp. 321-326, 2016.
- [7] Pampapathi V, Nikhil T R, and Yateen Lokesh, "Road Safety and Road Safety Audit of Rural Roads in India: A Review," *International Journal of Scientific Research*, vol. 12, no. 2, 2023. *Crossref*, <https://www.doi.org/10.36106/ijsr>
- [8] Tummala Bharat Kumar, and Chukkapalli Jeswanth Chowdary, "Road Safety Audit: A Case Study on Nh-65," *International Journal of Engineering & Technology*, pp. 69-74.

## 10. Conclusion

The following conclusions were drawn based on Road Safety Audit conducted on the project highway.

- No segregation of traffic existed along the project highway.
- Facilities for pedestrians and other vulnerable road users were not per prescribed standards • Presence of hazardous objects such as trees, portable concrete crash barriers, broken kerbs and footpaths, etc.
- Poor conditions of road signs and pavement markings.
- Visibility obstructions to various shoulder-mounted road signs and gantry signs.
- Non-standard road signs were used at many locations.
- Road signs and markings are missing at important locations such as intersections, sharp horizontal curves, service road entry and exit ramps, median openings, etc.
- Road markings were missing at many locations.
- Retro-reflective raised pavement markers and traffic impact attenuators are missing along the highway.
- The poor condition of metal beam crash barriers.
- Broken and damaged pedestrian guard rails at many locations.
- Inadequate visibility at intersections.
- Excessive growth and inadequate maintenance of trees and shrubs

## Acknowledgement

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- [9] Devang G Patel et al., "Road Safety Audit of Selected Stretch from Umreth Junction to Vasad Junction," *International Journal of Science and Modern Engineering*, vol. 1, no. 6, pp. 50-55, 2013.
- [10] IRC SP 84-2009, Manual of Specifications and Standards for Four Lanning of Through Public Private Partnership.
- [11] Ms.Indhumathy, and Mrs.Thenmozhi.P, "Assess the Knowledge and Practice on Road Safety Regulations Among Primary School Children in Rural Community," *SSRG International Journal of Medical Science*, vol. 3, no. 8, Pp. 1-4, 2016. *Crossref*, <https://doi.org/10.14445/23939117/IJMS-V3I8P101>
- [12] Krunal Baraiya et al., "Road Safety Audit: A Case Study Navsari to Chikhli National Highway 48," *International Journal of Latest Engineering and Management Research*, vol. 2, no. 3, pp. 35-38, 2017.
- [13] Manish.D.Katiyari, and Prof.S.D.Ghodmare, "Road Safety Audit: A Case Study for Wardha Road in Nagpur City," *Journal of Engineering Research and Applications*, vol. 4, no. 11, pp. 23-26, 2014.
- [14] Naveen Namala et al., "Road Safety Audit of Rural Roads," *International Journal of Civil Engineering and Technology*, vol. 8, no. 4, pp. 752-761.
- [15] Parikh Vaidehi Ashokbhai, and Dr. A.M. Jain, "Road Safety Audit: An Identification of Black Spots on Busy Corridor Between Marol-Naroda of Ahmedabad City," *International Journal of Engineering and Technical Research*, vol. 2, no. 3, pp. 86-89, 2014.
- [16] Zarulazam Eusofe, and H. Evdorides, "Assessment of Road Safety Management at Institutional Level in Malaysia," *IATSS Research*, vol. 14, no. 4, pp. 172-181, 2017. *Crossref*, <https://doi.org/10.1016/j.iatssr.2017.03.002>
- [17] Jeena Johny A, and Jisha Akkara, "Two Lane Highway Consistency Based on Alignment Indices," *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 8, no. 1, pp. 229-233, 2019.
- [18] Sivakumar B et al., "Two Wheeler Riding Behaviour Among Youth- A Case Study From Manjeri," *SSRG International Journal of Civil Engineering*, vol. 5, no. 5, pp. 34-36, 2018. *Crossref*, <https://doi.org/10.14445/23488352/IJCE-V5I5P107>
- [19] K. Vigneshkumar, and P. Vijay, "Study on Road Safety Improvement in India," *International Journal of Research in Engineering and Technology*, vol. 3, pp. 198-201, 2014.
- [20] Snehal U Bobade, Jalindar R Patil, and Raviraj R Sorate, "Identification of Accidental Black Spots on National Highways and Expressways," *International Journal of Research in Advent Technology*, 2015.
- [21] Kaplesh Rajput et al., "A Review on Evaluation of Speed Breakers in India," *SSRG International Journal of Civil Engineering*, vol. 7, no. 7, pp. 1-6, 2020. *Crossref*, <https://doi.org/10.14445/23488352/IJCE-V7I7P101>
- [22] Sisay Alemu Munea et al., "Evaluating the Impact of Various Geometric Characteristics of Rural Two Lane Road on Traffic Safety in Ethiopia," *SSRG International Journal of Civil Engineering*, vol. 7, no. 6, pp. 1-11, 2020. *Crossref*, <https://doi.org/10.14445/23488352/IJCE-V7I6P101>
- [23] IRC: SP: 88-2010. Manual on Road Safety Audit, Indian Road Congress, New Delhi, India.
- [24] Transportation Research Board, Highway Capacity Manual, HCM 2000, National Research Council, 2000.
- [25] IRC 73-1980, Geometric Design Standards for Rural (Non-Urban) Highways.
- [26] IRC 86-1983, Geometric Design Standards for Urban Roads in Plains.