

**MANUAL**  
**ON**  
**ROAD SAFETY AUDIT**

*(First Revision)*

*Published by:*

**INDIAN ROADS CONGRESS**

Kama Koti Marg,  
Sector-6, R.K. Puram,  
New Delhi-110 022

**AUGUST, 2019**

Price : ₹ 1400/-  
*(Plus Packing & Postage)*

IRC:SP:88-2019

First Published : November, 2010

Reprinted : August, 2013

Reprinted : November, 2017

First Revision : August, 2019

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Printed by India Offset Press, Delhi - 110 064  
1100 Copies

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# MANUAL ON ROAD SAFETY AUDIT

## PREAMBLE

The Manual on Road Safety Audit was first published by the IRC as a Special Publication IRC: SP:88 as “Manual on Road Safety Audit” in the year 2010. It was based on the research study sponsored by the Ministry of Road Transport and Highways to CSIR - Central Road Research Institute (CRR I), New Delhi. However, a need was felt to update and upgrade the contents to address all aspects of road safety audit covering all categories of roads and highways located in both urban and rural areas of the country in line with international best practices.

Accordingly, the work of revision of the Manual was taken up by the Road Safety and Design Committee (H-7) of the Indian Roads Congress. A Sub-group was constituted which comprised of Shri Jacob George (Convener) by including other experts namely, Dr. S. Velmurugan, Shri D.P. Gupta, Dr. Geetam Tiwari, Shri S.K. Popli, Shri Parampreet Singh and Prof. P.K. Agarwal as Sub-Group members. This Sub-group prepared the revised draft by duly taking into consideration the version prepared by the World Bank and forwarded to the IRC sometime back. The above sub-group after series of deliberations prepared the draft revision of IRC:SP:88. Thereafter, H-7 Committee deliberated in detail at its meeting held on 31<sup>st</sup> August, 2018. Based on comments made by the members of the Committee, the sub-group modified the draft further and the same was considered by the Committee at its meeting held on 10<sup>th</sup> October, 2018. The Convener of H-7 Committee, Shri Nirmaljit Singh was authorized to forward the modified draft to IRC after modifying further in light of the deliberations for placing before the Highways Specifications and Standards Committee (HSS). The support received from the World Bank is gratefully acknowledged. The composition of the H-7 Committee is given below:

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The Highways Specifications & Standards Committee considered and approved the draft document in its meeting held on 23<sup>rd</sup> October, 2018. The revised draft incorporating the comments of HSS was subsequently approved by the 216<sup>th</sup> Council in its meeting held on 22<sup>nd</sup> November, 2018 at Nagpur (Maharashtra) for printing.

# **1. AN INTRODUCTION TO THE MANUAL**

## **1.1 A Brief History of Road Safety Audit**

**1.1.1** Road safety audit began in the late 1980s when a Road Safety Engineering (RSE) team in a County in England began to question the number of newly built roads that were appearing in the County's black spot list. With support from the County Surveyor, a policy was developed requiring all new road designs in the County to be checked and approved for Safety by the RSE team prior to construction. This checking process became formalized as Road Safety Audit (RSA) and the RSE team became the first road safety audit team. It can be said that RSA team applied their black spot investigation skills in a proactive way so as to eliminate safety concerns at the design stage. The term "road safety audit" came to be used then, and continues to be used today, to refer to a thorough and detailed examination of a road design from a road safety perspective.

**1.1.2** Similar procedures and policies spread throughout other British road agencies and the first "road safety audit manual" was published by the Institution of Highways and Transportation (IHT) in late 1990 to guide and encourage this new process. The road safety audit process has expanded globally since then, beginning initially in countries such as Australia, New Zealand and Denmark, before spreading through Malaysia, South Africa, and Singapore including India. In 1992, AUSTRROADS developed a set of guidelines for use within Australia and New Zealand. In other parts of the world, road agencies were actively working towards the implementation of road safety audit in their jurisdiction. In subsequent years, many more road agencies in Asia, Europe, North America and parts of the Middle East adopted the Road Safety Audit (RSA) process in ways that best suited their local needs.

## **1.2 Purpose of Road Safety Audit**

This Manual is aimed at the road authorities (decision makers), engineers, technicians, consultants, contractors, concessionaires concerned with road projects, irrespective of category of road or the area where they work. The application of safety principles in the provision, improvement and maintenance of roads as means of accident prevention can be established through road safety audit. Thus, the purpose of this audit is to ensure that road users would be exposed to minimal risks of accidents in both new roads and existing roads.

## **1.3 How to use this Manual**

**1.3.1** This manual has been prepared as an easy-to-read guide for the road safety audit of new road designs and existing roads. It contains details about engaging an audit team and the road safety audit process that will assist the members of audit teams to undertake an audit. This manual is a valuable instructional tool for auditors and for project managers alike.

**1.3.2** To assist with the learning task, this manual includes audit case studies from typical road projects. The case study reports are reduced in length for practical reasons but the important safety findings from each have been placed into a table of findings. The table is simple, easy to read and to understand. It gives a blank column for the Client to use to respond to each recommendation from the audit team.

**1.3.3** To further assist audit teams, a full set of audit checklists is included in this manual. There is one checklist for each stage of audit; these checklists prompt audit teams to consider the multitude of safety issues that can arise in road projects including the safety needs of vulnerable road users.

**1.3.4** To be a good auditor, one should have thorough knowledge and experience in road safety engineering, besides technical qualifications. However, this manual does not present all the technical road safety engineering information that an auditor needs to keep in mind for the audit task. Auditors are advised to refer to the various relevant IRC Codes, Manuals, Guidelines and other international best practices.

## 2. ROAD SAFETY AUDIT: AN OVERVIEW

This section explains the how, what, when, where and why of road safety audits. It provides useful information for everyone with a responsibility for planning, designing, managing, constructing, operating or maintaining roads and highways.

### 2.1 The Road Safety Situation

In India, out of the 4,64,650 road crashes, 1,47,913 fatalities and 4,70,975 injuries had resulted in the year 2017. In economic terms, the cost to the nation is an estimated 3 % of Gross Domestic Product (GDP). A majority of fatalities are in the age group of 18 to 45 years. There is need for coordinated action by all the key stakeholders to address this serious concern. Road Safety Audit on roads is one critical step in that direction.

### 2.2 How can Engineers Reduce Road Trauma?

**2.2.1** The road safety problem involves three components - the human, the vehicle and the road. International research shows that the road plays a crucial role in road crashes.

It is often stated in public discussions that more should be done to improve the behaviour of road users. There are also frequent calls for increased enforcement of the road rules. Both calls reflect the involvement of the human factor in road crashes.

**2.2.2** The roads are also in need of safety improvements and across the country, there are instances of geometric deficiencies, inconsistent pavement markings, missing (or wrong) road signs, traffic signals not operational, inadequate attention to needs of the vulnerable road users. The community expects their roads to provide clear efficient traffic management and high levels of safety, as well as to withstand the weather conditions. Pedestrians and cyclists are often left to cross high speed roads without assistance, especially in case of highway passing through urban settlements and villages. If crashes occur due to design deficiencies, the community will pay a much higher price than the initial capital cost. The cost of serious and fatal crashes can end up costing much more over the life of a road project than the initial capital cost.

**2.2.3** The engineers are not expected to “wash their hands” of the safety problems on the roads and highways. Engineers are an important part of the solution to the road safety problem. Examining how road projects cleared through the traditional system of engineering design and hence checking yields a clear answer to the question of why the road safety audit process is needed in all road authorities:

- Sometimes a new design may include standards inappropriate for the type of road.
- In some cases, outdated standards may be used in a design.
- Sometimes, the combination of various elements of the design may yield a result that is not the best in terms of safety.
- Compromises may be made between traffic carrying capacity and safety which lead to a lessening of safety in the finished road project.
- Sometimes changes are made during construction which does not fully consider operational safety factors.

**2.2.4** Road safety audit seeks to take an overall view of safety in a road project. It highlights safety issues and makes recommendations to minimize the effect of each. Road safety audit will not necessarily make every new design totally “safe” but it does raise safety high on the decision making agenda and it does cause deliberate decisions to be made on the basis of carefully brought out road safety recommendations. The earlier in the design process that an audit is carried out, the easier and less costly it is to achieve change. Early auditing at planning and design stages can achieve better safety results and usually at a much lower remedial cost.

**2.2.5** Road authorities may bear in mind that road safety audit is a more effective process if carried out early in the road design process. It is urged, therefore, to focus on design stage audits.

**2.2.6** In the early years of auditing, some road authorities in some countries tried to “catch-up” with the problems on their existing networks by auditing important roads and highways as a matter of priority. They perceived the audit of an existing road to be the “easiest” stage of audit, the one stage that can be undertaken by existing staff who can use that experience to prepare for later design stage audits. Unfortunately, this practice has left a legacy of numerous audit reports recommending safety improvements that cannot be treated because of funding constraints.

**2.2.7** This, in turn, has led to disillusionment about the entire road safety audit process. The staffs responsible for organizing those audits have questioned why they were carried out. The audits have not produced any real safety benefits for the road users - so why bother?

**2.2.8** Another negative aspect caused by this primary focus on existing road audits has been the mistaken view amongst some engineers that road safety audits and hazardous road location (blackspot) investigations are identical. This is not so.

**2.2.9** Road safety audits are proactive - they try to identify safety issues in a road design. The objective here is accident/crash prevention.

**2.2.10** Road crash investigations are reactive - they examine known crash sites and use crash data to develop cost-effective countermeasures. The objective here is accident/crash reduction.

**2.2.11** The same road safety engineering skills and experience are needed for each process, but it is important to recognize that they are different processes and they produce different deliverables.

**2.2.12** Programmes to reduce road crashes on existing roads through systematic crash investigation programmes (commonly called blackspot programmes) are also vital in any road agency. Such programs have been shown to be cost-effective in reducing the frequency and/or severity of crashes at high crash frequency locations.

**2.2.13** A safety-conscious road agency will therefore include both the blackspot investigation programme and the road safety audit process within its engineering department. Both of these are important and both produce positive road safety benefits to the community. To sum up, RSA is proactive, road crash investigation is reactive.

**2.2.14** Noting these words of caution, road authorities may find that safety audit of existing roads can still hold positive benefits, especially as they rarely have complete crash data to guide

their accident investigation work. By auditing a stretch of existing road, an experienced road safety audit team can identify locations of heightened risk and can recommend cost effective improvements to reduce that risk.

**2.2.15** If any road authority elects to develop such a program, there is need to:

- Clearly define the stretch of the road to be audited and the types of risks/crashes that need attention (e.g. collisions with roadside hazards, or head-on collisions, or pedestrian crashes, or intersection crashes).
- Have an agreed budget available for the remedial work. Unlike many safety issues identified in design stage audits, which may cost little to change, improving safety issues on an existing road may involve significant cost!
- Ask the audit team to prioritize their findings (from highest to lowest) to provide guidance on where to spend programme budget. It is possible that the cost of the recommended remedial work may exceed the budget.

### **2.3 Prevention is Better than Cure**

Road safety audit is summarized with the statement “prevention is better than cure”. Road safety audit is a process of crash prevention – it aims to identify safety concerns in a road design in order for changes to be made while they “are still pencil lines on a piece of paper”. By making changes at the design stage, road safety can be built in to new road projects and the risk to the future users of that road can be minimized.

### **2.4 What is Road Safety Audit?**

**2.4.1** A road safety audit is “a formal, systematic and detailed examination of a road project by an independent and qualified team of auditors that leads to a report of the potential safety concerns in the project.” A formal examination of design would not permit a layout shown below causing unsafe and illegitimate movement. Such potential unsafe situations would be captured in a safety audit and can be modified before implementation.

**2.4.2** It is a formal examination because the audit follows a set process that leads to a formal report which then becomes a part of the record of the whole road project. It is a detailed examination that requires time, knowledge, skill, judgment, depth and detail.

**2.4.3** It requires a team of independent auditors, each of whom is detached from the design team and who are qualified and experienced in road safety engineering practices. Other professionals could also add inputs to an audit, but the main auditors shall invariably have engineering background. Having a team of auditors (rather than a sole auditor) provides a variety of experiences that increases the likelihood of a potential safety concern being detected. Two heads are better than one!

**2.4.4** The outcome of a road safety audit is a road safety audit report that identifies road safety



issues and makes recommendations to remove or reduce the impact of these. Responsibility to implement these recommendations remains with road authority.

**2.4.5** A road safety audit assesses the safety of all road users including car drivers and passengers, pedestrians, bicyclists and motorcyclists, trucks, bus passengers and 3-wheelers and users of animal drawn vehicles.

**2.4.6** Road safety audit is:

- A formal process (not just an informal check).
- Conducted by persons who are independent of the design.
- Conducted by persons with appropriate qualification, training and experience.
- An assessment of road safety issues in a road design, a Traffic Management Plan for road works, a newly completed road scheme, or it can be the identification of safety concerns on any existing road.

**2.4.7** Just as Importantly, a Road Safety Audit is not:

- a check of compliance with standards.
- a substitute for regular design checks.
- a crash investigation.
- an opportunity to re-design a project which needs to be carried out separately.
- a name for a more detailed site inspection.
- a way of assessing or rating a project as good or bad.

**2.4.8** A good road safety audit will be accomplished when:

- Focus is on road safety issues only.
- Keep relevant standards and guidelines in mind while remembering that audit is more than compliance check with standards.
- Consider the needs of all road users (including pedestrians, two/three wheelers, animal drawn vehicles, depending upon their presence and proportion in the traffic) in all weather and lighting conditions.
- It is thorough and comprehensive.
- It is realistic and practical in findings. But do not rule out options because of cost - it is the road authority that will decide whether the investment can be justified.
- Produce audit report promptly - usually within four weeks of the audit inspection.

**2.4.9** Designers are expected to comply with standards but audit job is not to check that they have done this. Auditing job as an auditor is to put himself into the shoes of the future road users of the road – how will they use the new road and what safety problems may some



of them encounter? Undertaking a road safety audit can be described as a combination of art and science – the art of appreciating the needs of the future users of the road coupled with the science of sound engineering principles.

## 2.5 Objectives of Road Safety Audit

**2.5.1** The main objective of road safety audit is to minimize the risk of crashes occurring on an existing road/a new road project and to minimize the severity of any crashes that do occur or are likely to occur.

**2.5.2** There are other objectives too, including:

- To minimize the risk of crashes occurring on adjacent roads (especially at intersections).
- To recognize the importance of safety in road design so that the needs and perceptions of all road users are met, and to achieve a balance between needs where they may be in conflict.
- To reduce the long term costs of a new road project, bearing in mind that unsafe designs may be expensive (or at times even impossible) to correct at a later stage.
- To enhance the awareness of road safety engineering principles by all involved in the process of planning, designing, constructing, operating, managing and maintaining roads and highways.
- To advance the awareness of providing safe road schemes for non-motorized as well as motorized road users.



## 2.6 A Brief Outline of the Key Steps in a Road Safety Audit

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### Step by step through a Road Safety Audit

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- 1 Complying with the road safety audit policy of an organization, make a decision that the project is to be audited.
  - 2 Appoint a safety audit team.
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- 3 Handover (either in person/electronically or in a commencement meeting) all relevant information (the drawings and design reports) about the project to the Team Leader of RSA team.

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  - 4 It is necessary to hold a commencement meeting between the three key parties - Project Manager of the road authority, designers and the audit team to discuss the project and scope of audit.

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  - 5 Afterwards, the audit team begins the audit. The first part of its work is a “desktop” audit of the drawings and design reports.

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  - 6 The audit team then moves to the next part of the audit - a detailed inspection of the site during day time and night time. The team gathers by shooting chainage-wise photographs of all the problematic locations and records its observations. In case chainage-wise information is not available (for example on urban roads); the identified safety concern can be linked with the adjacent landmark on the candidate road stretch. Also, if any good road safety measure is found to be practiced by the road authority during the audit, the same shall be noted and recorded as part of RSA. Further, the audit team is advised to recommend for replication of safe practices at similar such problematic locations in their RSA report. This will in turn help in boosting the morale and confidence of the concerned road authority towards proper upkeep of the road.

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  - 7 Back in the office, the audit team prepares the audit report. When it is written, checked and signed it is submitted to the Project Manager (either in person or electronically).

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  - 8 For large or sensitive projects, there may be a completion meeting in order for the stakeholders to discuss and clarify the key safety issues

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  - 9 A paper trail is a required outcome from an audit and the Project Manager/Road Authority is required to add to this by responding to each audit recommendation – clearly stating what actions will or will not take place. Reasons for not accepting any recommendation shall be recorded.

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  - 10 Thereafter, implement all agreed changes and recommendations.

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## **2.7 Why is Road Safety Audit Necessary?**

**2.7.1** Planning, designing, constructing, operating, managing and maintaining roads and highways is a complex task. The engineers charged with this responsibility usually face a wide variety of competing constraints and issues as they progress with their work.

**2.7.2** Typical constraints include:

- Land acquisition
- Project cost
- Standards and guidelines
- Traffic carrying capacity
- Environmental impacts

- Resettlement and other socio-economic impacts
- Geotechnical conditions
- Archaeological sites
- Safety of road workers and maintenance crews



**2.7.3** The design team and the Project Manager of the road authority work to achieve an optimal solution. But sometimes, compromises are made which can lead to an increase in crash risk. The road safety audit process is now available to input road safety engineering expertise into the design process. The road safety audit team is the group of specialists that injects safety into the road design and assists the road authority to create a road that is as safe as reasonably practical.

## **2.8 The Five Stages of Auditing a Road Project**

**2.8.1** There are five stages of a road project at which a road safety audit can be conducted.

### **Stage 1 Feasibility Stage/Preliminary Design Stage**

**2.8.2** An audit on completion of the planning or feasibility study stage will examine features such as design standards, route choice and continuity with the existing adjacent network, horizontal and vertical alignments, cross sections and interchange/intersection layouts. Careful auditing at this early feasibility study stage can help to reduce the costs and lost time associated with changes that may otherwise be brought about during later audits.

### **Stage 2 Detailed Design Stage**

**2.8.3** This audit stage occurs on completion of the detailed road design (the final DPR) but before the preparation of contract documents. Typical considerations include geometric layout, pavement markings, signals, lighting, road signs, intersection details, clearances to roadside objects (crash barriers/frangibility) and provision for vulnerable road users. Attention to detail at this design stage can do much to reduce the costs and disturbance associated with last minute changes that may otherwise be brought about with a pre-opening audit.

### **Stage 3 Construction Stage**

**2.8.4** This stage of audit takes place during construction of the road works. It examines the

safety of the traffic management plans for each phase of construction for large road projects (i.e. before the works begin), and it also inspects the provisions for road safety at the road work site during the construction period. Typical issues examined include the provisions for pedestrian safety, advanced warning zones, adequate transition zone lengths, worker safety, effective numbers of reflective signs, safe delineation, credible speed limits, temporary crash barriers, lighting and diversions.

#### **Stage 4 Pre-Opening Stage**

**2.8.5** This audit involves a detailed inspection of the new road project immediately prior to its opening. Although most road projects are constructed “under traffic” there is a time just before the Contractor hands over the project when the project is almost complete and when a pre-opening stage audit is undertaken. The new road should be driven, ridden and walked (as appropriate) by the audit team to ensure that the safety needs of all road users are provided for. A night-time inspection is particularly important at this stage to check installation and visibility of signs, markings, delineation, lighting and any other night time/low light related issues.

**2.8.6** The number of project stages at which audits are conducted usually varies according to the classification of the road, and the size of the project. For example, a major road project on an expressway or multilane highway may be audited at each of the project stages. For efficient use of limited resources, smaller projects on roads carrying low volume of traffic may be audited at one or two stages.

#### **Stage 5 Safety Audit of Existing Roads**

**2.8.7** The existing road may be a well-established road dating back decades or it may be a recently upgraded or rehabilitated road. The audit of existing road aims to ensure that the safety features of a road are compatible with the functional classification of the road. It also aims to identify any feature that may develop over time into a safety issue (such as a tree blocking sight lines at an intersection).

**2.8.8** A number of the safety issues found in these audits should be readily addressed through simple and low cost maintenance practices (e.g. tree trimming, sign and line marking renewal, and roadside hazard issues). As such, there are benefits in having maintenance crews trained in road safety reviews so that they can apply their safety knowledge routinely during each shift.

**2.8.9** These crews may not be independent of the existing road network, and they may not be able to look at the road through the eyes of a first time user, but they will be able to eliminate the more obvious safety concerns.

**2.8.10** Another issue with safety audits of existing roads revolves around the use of crash data. Some auditors like to have access to the Police crash data for the road they are auditing. They say it helps them to understand some of the proven safety issues along the road.

**2.8.11** Others argue that this can cause the audit team to focus too closely on the crash sites, possibly overlooking other high risk locations. Whichever option is adopted, the road authority should be very clear in its objectives. If it wants a crash investigation, use crash data together with the audit.

**2.8.12.** The audit team should prioritize its findings according to those that can most readily and cost-effectively be treated. It makes easier for the road authority to undertake the recommended treatments as per available budget.

## **2.9 What Projects are to be Road Safety Audited?**

**2.9.1** All new road projects will benefit from having road safety audits undertaken during the design and construction stages. However, in recognition of the need to apply resources to where they can have maximum effect, road safety audits may be commissioned only at selected stages according to the cost of the road project or the classification of the road.

**2.9.2** It is difficult to be too definitive about the types of road project most in need of an audit but, as a general rule, audit:

- any road project on a high speed road.
- any road project experiencing high volume of traffic and vulnerable road users.

**2.9.3** Another question is about the number of stages of audit to undertake. In general, the larger the road project, the more stages of audit it should have. But remember that it is not the cost of the project that is important; it is the cost of the mistake!

**2.9.4** Safety issues can occur even in minor road projects and if they go unresolved, deaths and injuries may result. Complying with the road safety audit policy (See Section 4.3 for a draft policy) of an organization is an important step forward.

**2.9.5** Safety audit in respect of Rural Roads (Other District Roads and Village Roads) and Roads in Urban Areas may require some special considerations during the audit process. These are discussed briefly in Sections 2.12 and 2.13.

## **2.10 Key Groups involved in a Road Safety Audit - their Roles and Responsibilities**

**2.10.1** There are three key groups involved in the road safety audit process:

### **The Client**

**2.10.2** The organization (road authority) that is responsible for the project and which is deemed to be the “owner” of the road on behalf of the government. The Project Manager is the day-to-day representative of the Client on technical matters. While the Client is usually a road authority, it can also be a private investor (concessionaire) for toll roads. However, even in such cases, the road authority being the final Client, will ultimately decide what is to be done (and not to be done) in the road project.

### **Designers**

**2.10.3** A person but usually a team commissioned by the Project Manager for the Client or by the Concessionaire to design and develop the road project. The design team may be a part of the Client organization or may come from a separate consulting company. The designers provide a service to the Client by designing the new road within the stated constraints issued by the Client.

**Audit team**

**2.10.4** A team of normally 2 persons who are qualified as road safety auditors and who are independent of the design and the proposal. The audit team is engaged by the Project Manager for the Client. While the audit team may come from the Client’s organization (provided the team members are clearly independent of the project) they are now increasingly from specialist consultancy companies. The audit team provides a service to the Client by finding safety problems in the design.

**2.10.5** When preparing Terms of Reference for an audit, or engaging an audit team to undertake an audit, it is necessary to be clear about the interaction of these three key groups. There must be shared co-operation and a clear understanding that all groups are ultimately working to one goal. However, the audit team is charged with injecting road safety expertise into the project and there may be occasions when the other groups question what the auditors recommend.

**2.10.6** On such occasions, the audit team should maintain its position and push for the most appropriate safety outcome regardless of where the opposition may come from. The audit team does not have to concern itself with other factors (such as funding, environmental issues, traffic carrying capacity). It is to be borne in mind that road safety audit team is the champion of the cause of road safety. The team members should be clear and firm in promoting the cause of safety.

**2.10.7** At the same time, the audit team should recognize that the Client has the responsibility to weigh up all competing factors and to decide the way forward. The team should put forward its case for safety as clearly as possible but then leave the Client, Project Manager and the design team to decide what will be done. The audit team may be invited to provide additional safety advice during the Completion meeting or afterwards but the team must recognize the right of the Client to ultimately decide.

**2.10.8** The main functions of the key players in the road safety audit are summarized in **Table 2.1**.

**Table 2.1 Main Functions of the Key Players in Road Safety Audit**

Key Player	Main Functions
Client, Project Owner(Govt. and/or Concessionaire)	<ul style="list-style-type: none"> <li>• Expresses a commitment to road safety</li> <li>• Provides funding and resources for safer roads</li> <li>• Considers safety audits as essential</li> <li>• Commissions audits at appropriate times</li> <li>• Selects road safety audit team</li> <li>• Facilitates the response to the recommendations of audits and arranges implementation of recommendations that are accepted and agreed</li> <li>• Attends commencement and completion meetings</li> </ul>

Design Team	<ul style="list-style-type: none"> <li>• Attends commencement and completion meetings</li> <li>• Provides relevant information to safety team</li> <li>• Acts upon and supports the client to provide response to recommendations of audit</li> </ul>
Safety Audit Team	<ul style="list-style-type: none"> <li>• Identifies safety issues in the proposed design</li> <li>• Inspects the site during day as well as night</li> <li>• Makes constructive recommendations to reduce risk of crashes and their severity</li> <li>• Documents safety concerns and recommendations</li> <li>• Holds commencement and completion meetings with the client and design team</li> </ul>

## 2.11 The Benefits of Audits

2.11.1 The established benefits of conducting road safety audits include:

- Reduced “whole of life cycle costs” of a road project.
- Reduced risk of crash and its severity while using the road network.
- Enhanced attention to the safety needs of vulnerable road users.
- Lower costs for remedial work at (future) black spots.
- Reduced overall costs of road trauma to the community.
- Safer road networks are developed.
- They are an important contributor to meeting crash reduction targets.

2.11.2 In the process, the highway profession also benefits from:

- Development of increased understanding and documentation of road safety engineering.
- Enhanced level of importance for road safety engineering.
- Serve to review and update safety standards and procedures.

## 2.12 Rural Roads

2.12.1 Rural roads are generally single lane with low design speeds and low volumes of traffic (both motorized and non-motorized). In some states, these roads have intermediate lane (5.5 m) or two-lane (7.0 m) wide carriageway. With development of rural roads, these roads are experiencing accelerated growth of traffic. One negative externality associated with this is increased potential for accidents.

2.12.2 As with other categories of roads, crashes on rural roads may be caused by one or a combination of several factors such as:

- (i) **Road design:** compromise on geometric design due to land constraints, lack of proper road signs, pavement markings and other traffic control devices, poor intersection

layout, inadequate sight distance, unmanned railway level crossings.

- (ii) **Road condition:** Uneven and slippery road surface, pot holes, sunken shoulders and edge break, rut formation.
- (iii) **Bridge condition:** Gap in expansion joints, worn out bearings, broken parapets.
- (iv) **Road users:** Dangerous driving (excessive speed, excessive alcohol), fatigue, not wearing seat belt/helmets. Sections passing through habitations and schools pose safety risk to pedestrians, cyclists and even cattle and non-motorized vehicles.
- (v) **Vehicles:** Failure of brakes and steering systems, tyre burst, lighting system, night time conspicuity.
- (vi) **Environment factors:** Heavy rainfall, fog, snow, storm, etc. creating unsafe driving environment.

### 2.12.3 *Checklist*

The checklist in Section 7.3 will be applicable for safety audit of rural roads also.

### 2.12.4 *Safety Aspects in Rural Roads*

The road agencies responsible for rural roads need to ensure that safety engineering measures are embedded into the design during preparation of DPRs and estimates.

**2.12.5** The following aspects for improving safety on these roads may be given due attention:

- (a) Road signs and pavement markings should be integral part of road construction and upgradation works. The signs should be retro-reflective and markings done with thermoplastic reflective paints. They will also require regular maintenance to serve the intended purpose. There should be no compromise whatsoever on this requirement in all rural road projects and programmes.
- (b) Where the existing geometrics of the road alignment are poor, efforts should be made to undertake spot improvements identifying such locations. In the meanwhile, appropriate cautionary and speed limit signs should be posted at such locations. Where there is history of or potential for accidents, proper traffic calming measures should be provided with proper advance warning signs.
- (c) Intersections and junctions of rural roads with main roads need special emphasis. The layout design may be finalized in consultation with traffic specialists. Provision of traffic calming measures on rural roads just ahead of their meeting point with the main highway would be of help. There is also need to ensure availability of safe sight distance.
- (d) Provision of bus bays at suitable location close to villages en-route and ramps for providing access to agricultural fields may also be considered. At the end of the road, adequate space needs to be ensured so as to enable turning of buses and other commercial vehicles.
- (e) Provision of proper crash barriers, hazard markers and parapets on bridges and embankments on curves, especially in hill areas with valleys and gorges posing safety hazards.



- (f) Replacing unmanned railway crossings with underpasses/road over bridges or with gates to ensure their closing at the time of train passing through such locations.

## 2.13 Urban Roads

**2.13.1** Urban road is the one with a relatively high density of driveway access located in an urban area and having traffic signals with a minimum spacing of one kilometer. The term 'Urban Road Segment' refers to the length of road with control arrangements at both of its ends, i.e. the upstream and downstream intersections are controlled intersections. Conducting of Road Safety Audit (RSA) of urban roads wherein the interaction of Motorized Traffic (MT) would invariably occur with the Non-Motorized Traffic (NMT). Motorized Traffic primarily consists of buses, cars, two/three wheelers including electric rickshaws with different dimensions and horse power and a minor proportion of goods vehicles (tempos, trucks) share the available road space with NMT traffic which includes cyclists, cycle rickshaws as well as pedestrians [identified as (Vulnerable Road Users)] would have frequent interaction with mixed mode motorized traffic typically witnessed on roads. Therefore, the RSA should ideally aim at providing safer environs considering such issues. Recognizing the emphasis of the Ministry of Housing and Urban Affairs (MOHUA) as well as Urban Local Bodies (ULBs) to provide increased mobility on urban roads during the last two decades, these roads are experiencing accelerated growth of traffic. One negative externality associated with the above phenomenon is the increasing trend of number of road crashes, especially during the lean hours of traffic on urban centers / cities. It is seen that on the urban roads of the country, chainage details are invariably absent. In the absence of the same, it is recommended to refer the adjacent prominent locations on the road judiciously while preparing the RSA report. This would help the road owning authority to implement the suggested changes in a logical manner.

**2.13.2** As witnessed on other categories of roads, the root causes for the incidences of road crashes on urban roads can be attributed to one or a combination of several factors such as:

- **Road design:** compromise on geometric design due to land or Right of Way (RoW) constraints, lack of proper road signs, pavement markings, poor intersection layout, poorly designed and ineffectively placed signalized junction, inadequate sight distance and absence of segregation of NMT from Motorized traffic.
- **Road condition:** Uneven and slippery road surface and pot holes.
- **Geometry:** Poor geometrics coupled with absence of associated road appurtenances at the diverging and merging locations of flyovers.
- **Road users:** Dangerous driving (excessive speed, excessive alcohol), fatigue, not wearing seat belt/helmets.
- **Vehicles:** Failure of brakes and steering systems, tyre burst, lighting system, night time conspicuity.
- **Environment factors:** Heavy rainfall, fog, snow, storm, etc. creating unsafe driving environment due to poor drainage system, inadequate lighting.

### 2.13.3 Checklist

The checklist in Section 7.5 will be applicable for the conduct of safety audit on urban roads as well.

**2.13.4**     *Safety Aspects of Urban Roads*

The road agencies responsible for urban roads need to ensure that safety engineering measures given in Section 7.3 are embedded into the design during preparation of Detailed Project Reports and estimates.

**2.13.5**     The following aspects for improving safety on urban roads may be given due attention:

- (a)     Road signs and pavement markings should be integral part of road construction and upgradation works. The signs should be minimum of micro prismatic grade or better in terms of its retro-reflectivity properties and markings shall be done with thermoplastic retro reflective paints. They will also require regular maintenance to serve the intended purpose. There should be no compromise whatsoever on this requirement for all types of urban roads.
- (b)     Where the existing geometrics of the road alignment are poor, efforts should be made to undertake spot improvements identifying such locations. It is essential to mention in the audit report that till such improvements are carried out, appropriate cautionary and speed limit signs should be posted at such locations. Where there is history of or potential for road crashes, proper traffic calming measures coupled with proper advance warning signs should be suggested in the RSA report.
- (c)     Intersections on urban roads need special treatment in terms of providing facilities for all types of Vulnerable Road Users. The layout design shall be finalized by the Urban Local Bodies (ULBs) in consultation with traffic specialists. Provision of traffic calming measures on urban roads catering to large number of pedestrians crossing the major roads, the recommendation for the erection of Speed Table conforming to IRC:99 would be of help.
- (d)     Provision of bus bays at suitable location at least 75 m away from the intersections.
- (e)     Provision of cement concrete crash barriers, hazard markers and parapets on flyovers and bridges.

### 3. CONDUCTING A ROAD SAFETY AUDIT - THE KEY STEPS

#### 3.1 Road Safety Audit Process

**3.1.1** Road safety audits are undertaken to identify safety concerns in a road design so that those who are responsible for delivering the road project can take these safety concerns into account and make the necessary amendments at an early time.

**3.1.2** The road safety audit process has ten steps. For some small road projects, some of these ten steps may be brief, but the sequence of steps still applies. The 10-step process is illustrated in **Table 3.1**.

**Table 3.1 Road Safety Audit Process**

S. No.	Road Safety Audit Steps	Responsibility
1	Determine that an audit is needed	Road Authority
2	Select a Team Leader, who then selects the audit team	Project Manager of the Road Authority and Road Safety Audit Team Leader
3	Provide information (the drawings and design reports) about the project to the Team Leader	Designer (via Project Manager)
4	Hold a commencement meeting – outline the project and discuss the audit ahead	Project Manager (plus Designer) and the Road Safety Audit Team Leader
5	Assess the drawings and design reports for safety issues (the “desktop” audit)	The Audit Team
6	Inspect the site - day time and night time	The Audit Team
7	Write the audit report, submit to the Project Manager	The Team Leader with assistance from the audit team
8	Hold a completion meeting – to discuss the key safety issues and to clarify outstanding matters	Project Manager (plus Designer) and Road Safety Audit Team Leader
9	Provide response on the Audit report, referring to each and every audit recommendation	Project Manager/Road Authority
10	Follow-up and implement all agreed recommendations and changes	Project Manager and Designer

#### 3.2 Deciding that an Audit is Necessary

**3.2.1** The Project Manager on approval of road authority decides which road projects are to be audited. In some road authorities, decision to audit a project is based on the road hierarchy. Works on expressways or national highways and primary arterials are always audited and usually at several stages. Projects on other roads are likely to be audited at fewer stages.

**3.2.2** A draft road safety audit policy (outlined in Section 4.3) is included in this manual to guide road authorities about the type of road projects that should be audited and the stages of audit that may be undertaken. This draft policy may help the road authority to establish an audit policy that suits the needs of the organization and road users. Any policy should be realistic and it will need to take into account the resources (human and financial) available to the road authority. It may be better to start small and work up.

**3.2.3** Sometimes, in the absence of an audit policy, other criteria may be used to decide about auditing a road project, including:

- At what stages in planning, design and construction will the audit be most useful? (Generally, the design stage would prove the better!)
- Will this road project benefit from an audit? (The answer is almost always yes!)

### **3.3 Selecting the Road Safety Audit Team**

**3.3.1** The road safety audit process is quite straightforward, but the qualification, experience and skills necessary to undertake a successful and worthwhile audit are quite substantial and extensive. The audit team needs to be able to interpret technical drawings and design reports, looking for any possible negative (unsafe) features included and at the same time any positive (safe) features left out.

**3.3.2** The audit team also needs to be able to communicate clearly the safety concerns it finds in a report to the Project Manager. Writing a technically competent, clear and yet concise audit report is an important requirement. The report should detail the findings of the audit to the Project Manager and the design team. If they cannot understand the safety concerns detected in the audit, there is a risk they may take decisions which could lead to either a waste of public funds or to unsafe outcomes for road users.

**3.3.3** However, the most significant aspect of good auditors is their ability to “put themselves into the shoes of the future road users” of motorized and non-motorized vehicles and pedestrians. Thus, the auditor will be better positioned to interpret the drawings and design reports and to draw out the key safety concerns for the future.

#### **Good auditors “put themselves into the shoes of the future road users”**

**3.3.4** In order to improve the likelihood of engaging a good audit team, road authorities should make clear in the Terms of Reference that a road safety audit is to be performed by a team (minimum of two persons) that is experienced and expert in the process.

**3.3.5** Successful road safety auditors will have qualification and experience in road safety engineering. This experience will be enhanced if the auditor also has an understanding of:

- Traffic engineering
- Road design and construction techniques
- Aptitude for crash investigation techniques.
- Road user behavior

**3.3.6** There are many benefits of engaging an audit team of two persons to undertake the

audit rather than using a single auditor. The main benefits include:

- Different perspectives of the same issue can be gained. This can arise from the diversity of background and from the different experiences of a team.
- Cross fertilization of ideas. When two professionals discuss safety issues in the office during the “desktop” audit or when on site, they help each other to develop clarity in their ideas and a wider view of the potential safety concerns in the project.
- More knowledge readily available on-site. If the audit team has members with different background, they can assist each other on technical issues. Two heads are better than one.

**A qualified and skilled audit team – with experience relevant to the size and stage of project being audited – is essential**

**3.3.7** The Project Manager appoints the audit team and also specifies the number of team members in the team. The Project Manager may decide to use the draft Terms of Reference (see Section 4.4) to clearly define the requirements for the audit.

**3.3.8** Each audit team should be led by a Senior Road Safety Auditor, having adequate qualification and experience in road safety engineering.

**3.3.9** The audit team leader is responsible for managing the audit, communicating with the Project Team and ensuring that the report is completed on time. The team leader is usually the most experienced member of the audit team and will provide technical guidance and leadership to the other team member.

**3.3.10** In appointing the audit team, the authority may consider the following:

- Is the auditor independent of the project?
- Has the auditor attended an approved audit training programme?
- Has the auditor the necessary qualifications, experience and skills for this size and stage of project?
- Is the auditor able to see potential safety concerns from different road users’ points of view?

**3.3.11** The first essential ingredient in any road safety qualification and audit team is road safety engineering experience. In addition, it is important to select member with relevant experience: is the project an expressway or a local street; is it an urban or a rural road project? What stage of audit is involved? One of the most critical elements in any road safety audit is the judgment, technical knowledge and skills of the audit team. There is no substitute for an experienced road safety audit team that understands the audit process and is able to foresee potential safety concerns.

**3.3.12** How many people should be in an audit team? This depends on the size of the audit task. However, as a general rule, a team of two members may be considered for most audits. For minor projects on low volume roads in low speed locations, the team may comprise of one Senior Road Safety Auditor along with one Apprentice Auditor who is qualified civil engineer and trained in road safety.

**3.3.13** Audits can provide an opportunity for less experienced staff to be “assistant and/or apprentices” on a team and to learn about the process and the skills involved.

### **3.4 Providing all the Background Information**

**3.4.1** The project team/design team provides a copy of all the necessary drawings and reports to the audit team leader to permit a thorough road safety audit to take place.

**3.4.2** Care is needed to make sure that the audit team is given the latest version of drawings and design reports in order to minimize the chance they could be looking at an obsolete drawing.

**3.4.3** For some audits (usually small projects), there may be only a very few A-3 sized drawings. For other projects (large projects on national highways and expressways), there may be hundreds of drawings and a number of detailed reports for the audit team to examine. It does take time and resources to gather together all the current drawings and documents. The Project Manager and the design team should be aware of this and should keep this in view when commissioning an audit.



**3.4.4** One of the first tasks for the audit team is to list all of the drawings and reports that have been given to it for the audit. This list becomes a part of the audit report.

### **3.5 Holding a Commencement Meeting**

**3.5.1** Commencement meetings enable the audit team leader to meet with the Project Manager and also the design manager.

**3.5.2** Commencement meetings provide an opportunity to explain the audit process to the Project Manager and designers, and to reassure them (if needed) that the audit will help their project. Sometimes, especially during the early days of audit in a new organization, some Project Managers and designers may feel a little threatened by having an audit undertaken on their project.

**3.5.3** After gaining experience with audits however, almost all Project Managers welcome the safety inputs their project can gain from audits. They start to see audits as the main opportunity to inject road safety expertise into their project. This is positive and beneficial to all.

**3.5.4** The Commencement meeting is also a time for the designer to explain where compromises may have been made in the design. Often the designers will already have safety concerns about parts of their design.

**3.5.5** This meeting also provides an opportunity for the audit team to request any other

information that it feels is necessary. The audit team will not be able to inspect the site under all traffic or weather conditions, so if particular conditions are important (e.g. traffic conditions during market days), the audit team should be advised.

**3.5.6** As audits become more common, commencement meetings will become less significant. The audit Team Leader will receive the drawings attached to an email.

### **3.6 Checking the Drawings, Design Reports and Documents**

**3.6.1** This “desktop” audit involves reviewing the drawings design reports and other documents in the office before and after carrying out the inspections.

**3.6.2** Take time to closely examine the drawings. Scribble on the drawings and reports as necessary, and mark issues to be more closely examined out on site. List the possible safety concerns to be checked on site, making use of the checklists as required.

**3.6.3** When back in the office, the audit team uses the drawings and design reports again to double check for safety concerns now it knows more about the site and its traffic conditions.

**3.6.4** The process of reviewing the documents and inspecting the site is repeated as required until the audit team is satisfied that it has identified all safety concerns that can reasonably be expected to be identified from the drawings.

### **3.7 Inspecting the Site**

**3.7.1** The location of the new road proposal is to be inspected - by the entire audit team - during day time and again at night time.

**3.7.2** The inspection involves taking the drawings and reports of the proposal out to the site and inspecting the whole site – trying to imagine what the finished road project will look like and how it will operate. During the site inspection, the audit team should “put itself into the shoes of the future road users” of the road project.

**3.7.3** While on site, take lots of photographs. A few of these can be used in the audit report, while the entire stock of photos can serve as historical record of the audit assignment. They can also help the audit team to remember a specific safety concern when back in the office writing the audit report. Keeping a record of observations and safety findings on-site can be a challenge. Pen and paper will work but is often hard to manage in hot, dusty, windy, humid or wet conditions. Experienced auditors now tend to record their observations verbally direct on to a digital recorder or a smart phone. These enable more detailed observations to be recorded and in a shorter time. They are easier to use on-site and they give a digital record that can be stored in a computer for possible historical use.

**3.7.4** While inspecting the site, auditors need to anticipate whether different light (day and night) conditions or weather (fog, rain) conditions may create safety concerns on the completed road. The team is expected to look beyond the limits of the project and to include adjacent sections of road in the audit. Transition zones, where the new road merges into the existing road system can often become locations of increased risk. It is not uncommon for additional delineation to be recommended in the “old section” of highway by the audit team as a way of transitioning road users safely from the new to the existing road.

**3.7.5** Remember that the inspection should be undertaken from the point of view of all the likely road user groups - not just motorists. There are a wide variety of road users, each with quite different safety needs. It is best to consider them all while undertaking the audit.



### **3.8 Writing the Road Safety Audit Report**

**3.8.1** Writing the report is the responsibility of the Audit Team Leader. Other team member(s) should double check the report, and provide comments on it.

**3.8.2** Occasionally a section or two will be written by a team member. But in most cases, the Team Leader is the one who completes the report, signs it and submits it to the Project Manager.

**3.8.3** Audit reports are concise reports with brief, but technically clear descriptions of each of the safety concerns that have been identified. It is best if the report follows an agreed format; this makes it easier for the team to write and importantly it assists project managers and designers to respond. The Case Studies in Section 6 of this manual make use of the tabular format for presenting safety concerns and recommendations.

**3.8.4** The audit report should contain:

- A title page - with the name of the road project and its location.
- A brief description of the road project – what type of project, why it has been proposed, and the stage of the audit.
- The names of the road safety audit team members.
- Dates of the audit inspections and the weather conditions on-site at those times.
- A table of all the safety concerns found from the desktop audit as well as from the site inspection.
- A risk rating (see Section 4.6) for each safety concern.
- A practical and clear recommendation for corrective action for each safety concern.
- Digital photographs of important safety concerns linked/aligned with the road chainage as far as possible.
- A statement signed and dated by the Team Leader on behalf of the team, indicating that the team has audited the drawings, inspected the site and identified the road



safety concerns noted in the report.

- A list of all drawings, reports and documents reviewed as part of the audit, including drawing numbers and dates. This may be useful for reference later as large road projects often have several generations of drawings. It may prove necessary at a later time to be quite specific about the actual drawing and design report that was audited.

### 3.8.5 When writing the audit report:

- List all the identified safety concerns (and recommendations for each) either:
  - in order from highest risk to lowest risk, or
  - in groups of similar concerns (e.g. cross section matters, intersection lay out, geometric deficiency, pedestrian matters), or
  - by chainage along the project stretch.
- Clearly describe each safety concern and its location.
- Add photographs if they can clarify a specific safety concern.
- Avoid being too specific with the recommendations unless certain that the specific recommendation is the only one.
- In framing a recommendation, think about high/low cost and short/long term options.
- Be realistic in making recommendations - take into account the level of risk associated with the safety concern and the cost likely to rectify it.
- Be constructive, clear and practical about how the safety concern might be eliminated or lessened.
- Maintain professional credibility. An audit report can often demonstrate the technical knowledge, skills and experience of the audit team, and especially the Team Leader.
- Avoid redesigning any part of the project – that is for the design team to do.

### 3.8.6 An example of writing audit recommendations:

The audit team leader ensures that all audit recommendations in the report indicate the direction in which a solution should be sought, rather than specifying the solution. Auditors usually don't know about the project constraints - if they become too prescriptive, they may prescribe impractical remedies to a safety concern, and in turn may end up losing credibility.

For example, during a design stage audit, an audit team discovers a steep side slope beside a national highway. The slope will clearly be undrivable, it will be within the clear zone and it will clearly be a safety concern. The drawings do not show any action proposed for this location.

Identifying and reporting the safety concern is the first and most important thing for the audit team to do. Being too specific with a recommendation when there are several options available can lead to difficulties. In this case, recommending to the Project Manager to "Install crash barrier" will often be seen as too prescriptive, and in some situations, it may not be the technically sound recommendation due to issues that are not known to the audit team. Recommending in an audit report to "Flatten the embankment or shield it" is just as technically sound and it guides the

design team towards a range of options.

Therefore, when writing the audit report and developing appropriate recommendations, audit teams should address the following aspects:

- Avoid specifying solutions in too much detail.
- Be realistic - take into account the level of risk associated with the safety concern and the cost likely to rectify it.
- Avoid redesigning – that is for the design team to do.
- Remember there may be high cost/low cost and short term/long term solutions.
- Be constructive about how the safety concern might be eliminated or perhaps reduced.
- Maintain professional credibility.

Remember – the audit team “guides” but it is the responsibility of the Project Manager and the designers (not the audit team) to make the final decision about the solution and to arrange for any redesign.

### **3.9 Holding a Completion Meeting**

**3.9.1** The Project Manager is responsible for arranging a completion meeting involving:

- The Audit Team Leader,
- The Project Manager, and
- The Designer/Design team.

**3.9.2** At this meeting, the road safety audit findings and recommendations are tabled and discussed. The meeting provides an opportunity for the auditor, the Project Manager and the design team to discuss all and any issues in the report. This will usually involve a discussion of each safety concern, its risk rating and priority and its recommended ways to overcome the identified safety problem.

**3.9.3** The meeting should be held in a professional and co-operative manner with a spirit of all parties working together for the enhanced safety of road users. It should not become a meeting of blame game, or serious dispute. A safety audit is a positive activity that helps to improve road safety for all road users by highlighting potential safety concerns before they become problems.

**3.9.4** A Project Manager may ask for an audit report to be altered or to have some safety concerns removed. This happens rarely and it is neither professional nor ethical. In such cases, the Team Leader must not entertain any suggestion of altering a report to “soften” the audit findings.

**3.9.5** The Project Manager is required to provide his response in writing to each and every recommendation in the report. At that time, he/she will be able to state why a recommendation has not been able to be accepted. The audit process is a professional, transparent and positive process with one goal – to improve safety for all road users.

**3.9.6** With passage of time, completion meetings might become less common. Similar to commencement meetings, the completion meeting will eventually give way to a transfer of the audit report via email to the Project Manager.

### **3.10 Providing Response to the Audit Report**

**3.10.1** The Project Manager is required to provide response in writing to each audit recommendation in the report.

He/she can either:

- Accept it completely (and develop solutions to overcome or reduce the safety concern); or
- Accept the safety concern but not agree to the recommendation. In these cases, he/she will seek alternative ways to resolve the safety concern; or
- Not accept the recommendation (explaining clearly why this decision has been taken).

**3.10.2** To provide useful feedback, the Project Manager should send a copy of the response to the audit Team Leader for information. The audit team should note the responses and where possible learn from them. The team should be aware that they should not create an on-going dispute over which recommendations have or have not been accepted.



**3.10.3** As mentioned earlier, the audit team “guides” but it is the responsibility of the Project Manager and the designers (not the audit team) to make the final decision about the solution and to arrange for any redesign.

### **Deciding the way forward**

**3.10.4** The audit team has quite a straight forward task – to identify all the safety concerns that might exist in a road design for a new road project. If there is any doubt about whether or not an issue is likely to become a safety concern, the usual routine is to include that issue – just in case!

**3.10.5** A part of the audit process that is often more challenging and demanding rests with the Project Manager and the road authority. How does the client decide whether or not to accept an audit recommendation? It is neither always possible nor practical to agree with all recommendations as some of these may involve large additional expenses that will affect progress with the project. In practice, this challenge facing the decision makers usually only arises with the ‘very expensive’ recommendations and occasionally with ‘complex’ recommendations; it rarely happens with simple and/or low cost recommendations.

**3.10.6** As a guiding principle, when faced with an audit recommendation that is difficult to resolve, the Project Manager needs to consider and weigh up the following aspects:

- How often might crashes occur? (weekly, monthly, yearly)
- How serious might such crashes be? (fatal, injury, property damage only),
- What will it cost to remedy (or at least reduce) the problem? With most safety concerns, there are usually several alternative remedies.
- How effective can each alternative be expected to be?

### **3.11 Following up and Implementing Agreed Recommendations and Changes**

**3.11.1** A road safety audit achieves nothing for the road users until its recommendations are discussed, decided and implemented.

**3.11.2** As mentioned earlier, in many audits, particularly while the project is still in the design stage, the changes can be made at low cost. At times, however, an audit may reveal safety concerns that cause difficult decisions to be made by the Project Manager, usually because the cost of remedial action is so high.

**3.11.3** In these cases, the usual options available to the Project Manager include:

- staging the improvement work over an increased period of time, possibly into the next financial year when more funding may be available.
- seeking an increase in the project budget to allow the desired countermeasures.

**3.11.4** These are all valid decisions, provided they are committed in writing in the response report with clear reasons given. The audit process can direct Project Managers towards a safer alternative but the onus lies on the Project Manager to ultimately decide on the course of action and its implementation. As long as all competing issues are clearly and fully considered for each identified safety concern, the audit team should be satisfied that its contribution has been of value to the project.

## 4. MANAGING ROAD SAFETY AUDIT

This Section outlines some of the main points in managing a road safety audit. It provides useful information to help to get road safety audit started in an organization, as well as information about developing a road safety audit policy for an organization. Essential information for those responsible for commissioning road safety audits is provided.

Road safety audit is a process that road authorities should embrace as part of an overall strategic approach to road safety. However, for those road authorities with comparatively less experience with road safety audits, there may be some uncertainty about how best to go about implementing the process into their planning/design/construction programs.

This Section provides some guidance and advice for decision makers, managers, engineers and staff of road authorities. It offers special assistance to those who are responsible for implementing the road safety audit process within their organization, or who are required to engage consultants or safety auditors to carry out safety audits of their road projects.

### 4.1 Putting Road Safety Audit to Work in the Road Authority

For those road authorities yet to introduce the road safety audit process into their road planning/design/construction process, the following points provide guidance about the way forward:

- Whether there is a formal commitment to improving road safety and this kind of support and empowerment is critical to creating a “safety culture” within a road authority.
- Include road safety in the Action Plan of organization, and commit to developing a Road Safety Action Plan.
- Develop a Road Safety Action Plan. Base it on relevant road safety strategies (such as existing national and state road safety strategies). There is need to include a programme for the treatment of hazardous road locations (a blackspot programme) as well as the road safety audit process.
- Hold an open meeting of senior technical staff to discuss and address the important road safety audit issues that will arise in the organization. In so doing, develop an audit policy and a set of basic audit practices which meet the needs of organization. Points that may arise in that meeting include:
  - How will the organization get adequate road safety audit skills and resources?
  - What needs to be done for the audit process to be understood by senior executives, managers, designers and potential auditors?
  - Designers may initially express reluctance at having their work audited. How can this be addressed?
  - How much training is required and for whom (departmental manager, engineers, designers, potential auditors)?
  - What road projects are to be audited in the organization? Only the largest projects, or only those on the busiest roads, or maybe urban only, or perhaps all projects above a certain cost or length.

- How will road safety audit requirement be incorporated into design and construction contracts?
  - What proportion/number of projects will be audited? At what design stages will audits be conducted?
  - Who will be conducting audits? Will it be outsourced? If so, how to find and decide on auditors – best value for money, skills or experience? Who manages the panel of certified road safety auditors? Who can give advice on these issues?
  - How will audit recommendations be dealt with? Who will decide to accept or reject the more “difficult” recommendations? A formal process is required.
  - How will audit findings be fed back into the design process to improve future designs?
- Get started. Consider calling in a team of qualified and experienced road safety auditors to undertake some pilot projects of road designs. Use their findings in a training workshop that includes managers, designers and potential future auditors as participants. Practical examples are very convincing. Designers and Project Managers of the road authorities quickly become audit supporters when they see for themselves some of the safety issues that arise in some road designs.
  - Adhere to the agreed road safety audit policy to improve designs before they are built. Get feedback from auditors, designers and managers and then modify the audit policy and the audit process to best suit the road authority as experience grows.
  - Be prepared for some mistakes but take time to learn from those mistakes so that the road safety audit process can develop and grow in the organization. After gaining experience with design stage audits, consider undertaking safety audits of the existing road network (possibly in conjunction with a program of treating hazardous road locations).
  - Let the senior executives know how the audit process is progressing in the organization. Give them examples of where road users have benefited because of the road safety improvements generated through the audit process, and let them know how staff members are learning new skills as a result of the process.
  - Keep it going! Once road safety audit becomes established in the organization there can be a temptation to believe that it will happen automatically. This may or may not be so. Monitor the quality and the quantity of audit reports. Maintain a training and awareness program. Ensure that road safety audit is promoted with continued energy and passion.

## 4.2 Options for having a Road Safety Audit undertaken

**4.2.1** The road authority for a road project is responsible for appointing a Project Manager to oversee the project on its behalf. There are three key attributes that the Project Manager should ensure when engaging a team of road safety auditors.

The audit team should be:

- **Qualified** – satisfy the requirements laid down for a Senior Road Safety Auditor/Auditor.

- **Experienced** – demonstrated experience with the type of road project and the stage of audit.
- **Independent** – clearly have no previous involvement in the planning or design of the road project.

**4.2.2** Without a qualified and experienced audit team, the road authority may end up with an audit report that fails to add value to the project. If the team is not fully independent of the project, they could be too forgiving of some of the safety issues involved because they know of the design constraints that have led to them. Independence is important for the fresh identification of safety issues, as well as to ward off possible accusations of “soft” audits.

**4.2.3** With these key attributes in mind, the main options for getting audits done are:

- Engage an independent consultancy firm – have the Project Manager engage an experienced consultancy firm to do the audit. This option ensures that the audit is independent, and over time may lead to a competitive market in providing audit services to road authorities. A sample Terms of Reference for a road safety audit is given in Section 4.4.
- Use in-house staff – this option has the advantage that it is quick and easy to arrange, and it can mean that the auditors can see the scheme through to completion. It is necessary to ensure that the staff used are trained and experienced in road safety audit and are independent of the design. By adding to their practical audit experience, the in-house staff can develop their awareness of the audit process and they may therefore be more discerning when obtaining audits in the future.

### **4.3 A suggested Road Safety Audit Policy**

**4.3.1** There is a need for all staff in a road authority to be clear about what road projects are to be audited and at what stages this should be done. It is equally important to ensure that road safety audit becomes firmly established in a road authority.

**4.3.2** Both of these needs are best satisfied by formulating a road safety audit policy by the authority.

**4.3.3** Such a policy should detail the type of road project to be audited, the stage(s) of audit that will be undertaken and the reporting and response systems. The policy should be disseminated widely to all professionals in the road authority, as well as to all professionals who have dealings with the authority on road and safety related matters.

**4.3.4** An example of a draft road safety audit policy for the road authority is given below. It is to be remembered that any policy (whether about road safety audits or any other subject) should be a “living” document. It should be reviewed and updated as experience with the process grows within the road authority.

“Road projects to be undertaken by the [insert name of road authority] will be road safety audited at the following stages (refer **Table 4.1**) according to the class of the road, in accordance with the procedures contained in IRC:SP:88 titled, “Manual on Road Safety Audit”:

**Table 4.1 Suggested Stages of RSA**

<b>Audit</b>	<b>Expressways</b>	<b>National Highways</b>	<b>State Highways</b>	<b>Major District Roads</b>	<b>Urban Arterial, Sub Arterial and Collector Roads</b>	<b>Local Streets, Rural Roads</b>
Planning	✓	Optional	Optional	Optional	Optional	N/A
(DPR) Design*	✓	✓	✓	✓	✓	✓
Construction	✓	✓	✓	Optional	Optional	Optional
Pre-opening	✓	✓	✓	Optional	✓	Optional
Existing Roads	According to local policy and resources					

\* For BoT, Annuity, Hybrid Annuity, EPC, the stage of Feasibility Report by the Road Authority and later Design Stage by the Concessionaire or the Contractor as relevant

The road authority should consider the resources available and the demands for the coming years in formulating its audit policy. Once agreed, the policy should be widely promoted throughout the authority so that staff is aware of its importance and to confirm that they use it to guide them in their audit work.

**4.4 Draft Terms of Reference for Commissioning a Road Safety Audit**

**4.4.1** The following draft Terms of Reference is provided for use by the road authority and their Project Managers when required to engage suitable consultants or others to carry out a road safety audit. Details of the proposal and specific issues to do with the management of the audit are to be inserted where shown.

**Terms of Reference for a [insert name of road authority]**

**Stage Road Safety Audit of [insert name of the road project]**

**Background**

**4.4.2** The [insert name of road authority] has developed a proposal to [insert a brief description of the type and location of the proposal] in order to provide improved capacity and traffic performance along this road stretch/bridge project as well as increased safety for all road users.

**The Task**

**4.4.3** The task in this assignment is to carry out a [insert stage name] stage road safety audit of the proposed [insert name of project] so that potential road safety problems can be identified, discussed and minimized before the project is completed. The audit shall be undertaken in accordance with the process detailed in this manual.

**Scope of Services**

The scope of services required of the audit team will include, but is not necessarily limited to, the following:



1. That the audit be undertaken by an audit team of two auditors.
2. That the Team Leader is a Senior Road Safety Auditor and is empanelled as such by the competent authority.
3. Attendance by the Audit Team at a commencement meeting with the Project Manager and designers in order to obtain full information about the proposal and an understanding of the background to the project. A review of all documents provided by the Project Manager prior to inspecting the site and again prior to finalizing the audit report.
4. Day and night time inspections of the entire site so as to get a better understanding of the existing traffic situation and thus provide an insight into how the finished project will look.
5. The auditors may consult the appropriate checklist in the “Manual on Road Safety Audit”, but not limit their audit to the concerns listed therein. They should look at the safety needs of all road users of this location, especially vulnerable road users.
6. Preparation of a concise road safety audit report in the format outlined in the Manual.
7. The audit report shall include a clear description of all safety concerns which have been identified. It shall contain practical recommendations for each safety concern which shall be of an appropriate and specific nature.
8. The Team Leader is to sign and submit the audit report to the Project Manager.
9. The Audit Team Leader is to attend the Project Manager’s Completion Meeting in order to answer questions about the audit findings and to discuss the audit recommendations and possible design changes and/or remedial treatments.

The following information will be made available by the road authority to the audit team leader for the audit: [insert the list of reports, drawings, data, etc.]

**Note:** As experience grows with road safety audits, the road authority may decide to hand over the drawings and design reports without holding a commencement meeting. Similarly there may not be any need for a completion meeting once the audit process is well established in the organization.

### **Qualifications and Experience**

**4.4.4** The audit services are to be provided by a team comprising two road safety engineering specialists and shall be road safety auditors. Sound knowledge of road safety engineering and practical experience in highway design and traffic engineering is required by the audit team.

### **Required Inputs**

[Adjust these requirements to suit the scale and complexity of the project]

The assignment is expected to take up to 20 person days, as follows:

- 6 person days reviewing the reports/drawings and attending the commencement meeting
- 4 person days inspecting the site (day and night time inspections are required)
- 8 person days preparing the road safety audit report.

- 2 person days to attend the completion meeting. (This will normally be held within one month of the audit report being submitted.)

## Reporting

**4.4.5** The Senior Road Safety Auditor shall submit the completed and signed road safety audit report to the Project Manager in electronic format by [write submission date for the audit report]

Any questions about the proposal or the audit are to be directed by the Senior Auditor to [insert name of the responsible engineer] via telephone [insert number] or email [insert email address].

## 4.5 Empanelment of Road Safety Audit Consultant

**4.5.1** The safety auditors for an audit assignment may be taken by the road authority in the central government from national register of road safety auditors, which may be administered by the IRC on behalf of the Ministry of Road Transport and Highways, being the lead agency at the Central Government. The road authorities in the states may also like the IRC to administer the state level registers so as to ensure uniformity of approach in empanelment of road safety auditors.

**4.5.2** Following criteria may be considered for engaging auditor by the consulting firm/consultant.

**4.5.2.1** Senior Road Safety Auditor should:

- be a graduate in civil engineering with more than 10 years' experience in design, construction and maintenance of roads,
- have completed an approved road safety audit training program of at least two weeks duration,
- have a minimum of three years practical experience in road safety, and
- have completed at least five road safety audits. At least three of the five audits must be at a design stage.

**4.5.2.2** Road Safety Auditor should:

- be a graduate in civil engineering with more than 7 years' experience in design, construction and maintenance of roads,
- have completed an approved road safety audit training program of at least two weeks duration,
- have a minimum of two years practical experience in road safety,
- have completed at least three road safety audits.

**4.5.2.3** Road Safety Audit Assistant/Apprentice should:

- be a graduate in civil engineering with more than 2 years' experience in design, construction and maintenance of roads, and

- have completed an approved road safety audit training program of at least two weeks duration.

#### 4.6 Risk Assessment of Safety Concerns and Prioritization of Suggested Recommendations

**4.6.1** When an audit report contains a number of safety concerns, the client/road authority need assistance to assess the risk involved in the safety concerns and also priority level in which recommendations can be adopted.

**4.6.2** Risk is often defined as the likelihood (frequency) of an event times the consequence (severity) of that event. **Table 4.2** gives simple criteria for the risk involved in the safety concerns assessed by the safety auditor. It is a qualitative assessment process and it requires professional judgment of the Audit Team.

**Table 4.2 Criteria for Risk Assessment**

Severity	Description	Examples
Very High	Multiple deaths are likely	High speed, multi-vehicle crashes on expressways. A bus collision at high speed with a bridge abutment.
High	A death and/or serious injuries are likely	High/medium speed vehicle/vehicle collisions. High/medium speed collisions with a fixed roadside object. Pedestrian crashes on rural highways.
Medium	Minor injuries only are likely	Low speed collisions, such as a three-wheeler colliding with a bicyclist, a rear end crash in a slip lane, or a pedestrian struck in a car park.

**4.6.3** **Table 4.3** gives guidance for a safety auditor in assigning priority level for each recommendation that can be considered by the Client/Project Manager in view of the constraints in implementing.

**Table 4.3 Assigning Priority Level for Suggested Recommendations**

Priority	Suggested Treatment Approach
Essential	Where risk is assessed as Very High, the recommendation shall be implemented “at any cost”.
Highly Desirable	Where risk is assessed as High, the recommendation shall be implemented unless cost of remedial treatment is prohibitive and risk can be reduced by an alternative measure.
Desirable	Where risk is assessed as Medium, the recommendation shall be implemented if the safety concerns could not be mitigated even after the implementation of the recommendations under “essential;” and ‘highly desirable’ priority levels for the same location and the risk needs to be reduced further.

## 5. PRACTICES FOR SAFER ROADS

A member of a road safety audit requires examining project drawings, inspecting the site and making decisions about what may be potentially unsafe in the drawings, at the worksite or on the finished road. He/she is expected to understand the audit process, and to be knowledgeable in the field of road safety engineering. He is expected to exercise sound judgement in determining what might, and what might not, be a road safety concern when the project is built.

Auditors therefore need to be knowledgeable and experienced in most, if not all, aspects of the road safety engineering profession.

### 5.1 Starting your Audit

**5.1.1** When you set out to conduct an audit, ask yourself a few simple questions about the drawings:

- Is the proposed cross section suitably safe for the road classification?
- Do the horizontal and vertical alignments suggest any features that may warrant special consideration?
- Will the new road be easily understood by the road users (motorised and non-motorised)?
- Do any parts of the design present direct risk to any group of future road users?
- Are any roadside hazards obvious?
- Has enough been done to assist the safety of vulnerable road users – moving along as well as across the new road?
- Will weather conditions present safety issues for the new road? Will the new road be safe at night?
- If any of these trigger a potential safety concern in your mind, start to think about what may be possible to alter in the design now in a positive manner to improve safety?
- After these questions you will begin to go into more and more detail. The checklists (See Section 7) are provided to help and guide and remind you of some of the safety issues to look out for.

**5.1.2** Remember the general aim of an audit is to produce a new road that is as safe as reasonably practical. Ask yourself, will the new road:

- Warn
- Inform
- Guide
- Control
- Forgive

**5.1.3** From experience with road safety audits, a few common safety concerns emerge frequently. In order to promote safety for all road users and to raise awareness of these common safety concerns, the following sections give some brief advice on the safest way forward.

## Vulnerable Road Users

**5.1.4** The country has a mix of traffic that is perhaps unique in the world. Pedestrians, bicyclists, motorcyclists, rickshaws and animal drawn carts mix with cars, trucks buses and countless other vehicles at all times of day and night. This presents special challenges for road designers and road safety auditors.

**5.1.5** One of the most important things that the member of an audit team can do is to put himself into the shoes of the vulnerable road user. You should walk the site, ride a bicycle through the site, maybe use a rickshaw at the site and try to foresee the special safety needs of these large groups of road users.

**5.1.6** Many safety enhancements can be made to help these groups. Mostly they start with an appreciation of the real needs of the users and a general principle not to impose restrictions on their mobility. Such actions are rarely successful. Instead, try to work with these road users and provide simple low cost enhancements that can assist their mobility and their safety.



### Night Time Visibility

**5.1.7** Roads are used both day and night, and so they should be inspected during night time as well as day time. Some locations look very different at night; they may or may not have street lighting. Some street lighting can create visual deceit. Older people generally have poorer eyesight and this makes reading road signs more difficult than it is for younger people. This is made worse after dark, so particular attention should be paid to night time conspicuity and visibility for the elderly. Perception of widths and distances by older drivers also becomes more difficult at night time.



### Visual Deceit

**5.1.8** At some locations, visual cues along a road may give the wrong message to a small number of drivers/riders. A long row of trees, or power lines, can give an impression that the road continues straight. Then, if the road takes a bend, some drivers will be misled by the trees or the power poles and may proceed in the wrong direction. This can occur regardless of the number of warning or guide signs telling them otherwise. This “visual deceit” can be strong; audit teams need to consider it and report on it as and when necessary.



## Speed Management

**5.1.9** High speed is a major contributor in serious crashes. Auditors should check the drawings to ensure that the operating speeds of the new road can be managed within levels that are appropriate for the design speed of the road.

**5.1.10** Firstly, ensure that the design speed and the likely operating speeds match each other. Otherwise some drivers may be caught by surprise at curves.

**5.1.11** Secondly, be satisfied that there will be a suitable speed limit imposed. This will need adequate speed restriction signs along the route to remind drivers/riders of the speed limit.

**5.1.12** Thirdly, consider the need to reduce operating speeds through “self-enforcing” measures such as traffic calming in towns and villages (such as gateway treatments, raised crossings, road narrowing) or by speed enforcement (such as speed cameras).



## 5.2 Technical Tips for Audit Teams: Warn, Inform, Guide, Control and Forgive

During every audit you should ask these basic questions – will the future road users be warned, informed, guided, controlled and forgiven on the new road? The answers you get will help your audit.

✓



### Warn

Warnings can be given by signs, pavement markings or rumble strips. The message should be clear and simple. Will more warnings be necessary on the new road?

✓



### Inform

Information is best provided in small amounts, and drivers are not overloaded with too many destination names to be read and take action on high speed to take decision on approaches to junction. Direction signs and lane direction arrows are examples of providing necessary information to drivers/riders. Does the design show enough information for safety and fonts are bigger enough to be read by driver on approach speed? What about the position from junction to be seen by driver for minimum visibility distance?

✓



**Guide**

Road users may need additional guidance at some locations - such as where their route changes direction unexpectedly. This occurs often at road work diversions and at sharp curves on hill roads. There must be no surprises on roads. Do the road works, or does the design for the new road, need additional devices to guide the future road users?

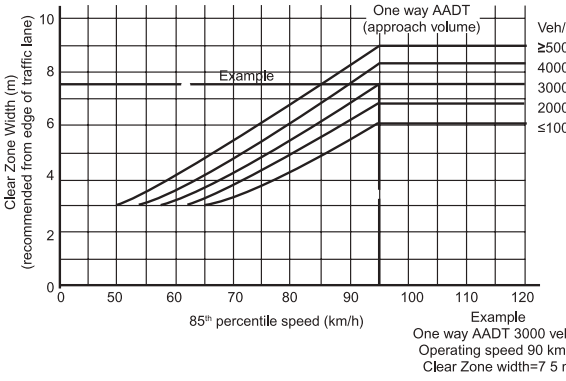
✓



**Control**

Safe control of intersections is a necessary part of a safe road network. If two roads are intersecting, both having comparable traffic volume uncontrolled T intersection would be unsafe, where roundabout would be a safe traffic control. Does the design have other additional traffic control devices for safety? If the roundabout is getting locked few hours, can it be signalized roundabout to control for those few hours and remaining hours would operate as roundabout with priority from rule to have traffic control during lean hours also, as normal roundabout for round the clock safe traffic control.

✓

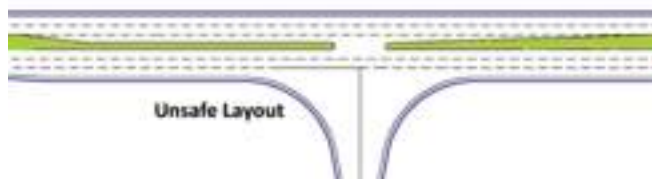


**Forgive**

What is the clear zone for the project? Has the roadside hazard management strategy been applied? What can be done to manage any remaining roadside hazards to reduce the risk to the occupants of vehicles that leave the road? Barrier should be your last option; if used it must be installed correctly.

**5.3 Technical Tips for Audit Teams: Safety Elements in Junction Layouts**

Various geometric elements are critical for safe maneuvering of vehicle in priority, roundabout and signal controlled junctions.



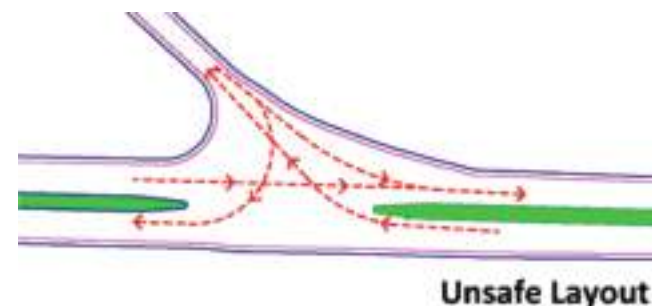
**Geometric elements in Priority Junction (Unsafe Layout)**

Too much deceleration length in storage lane side promotes illegitimate overtaking by through traffic. Tapering for acceleration for right turning movement will create wide area effect and could be used by through people and the storage lane will be encroached by through movement. Wide open area on side road creates uncontrolled reckless movement



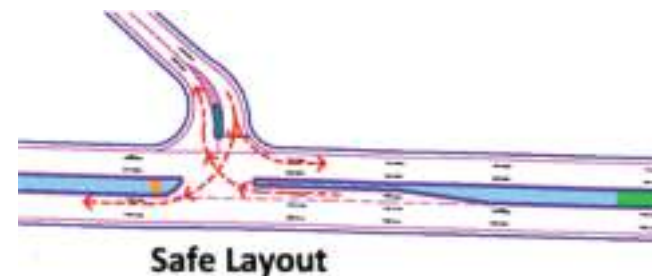
**Geometric elements in Priority Junction (Safe Layout)**

Storage length shall be the optimum length based on right turning traffic volume or for actual deceleration length. Median tip shall be reshaped in such a way that storage lane would remain neutral, not to be encroached by through movement. On side road, provide triangular island of more than 6sqm and splitter island of minimum 1.5m width to serve as refuge space for pedestrians and also to install signs and would remain intact, without being hit by vehicles.



**Geometric elements in Priority Junction (Unsafe Layout)**

By virtue of skewed joining, side road merges at high speed and unable to see the high speed traffic coming from main carriageway. In order to facilitate right turn movement from side road to main, median opening kept high. Median opening is eccentrically located, resulting in high speed exit from main road to side road.



**Geometric elements in Priority Junction (Safe Layout)**

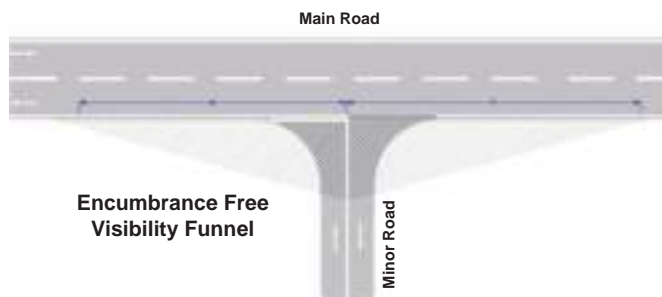
Side road alignment has been brought nearly perpendicular that side road to main road and main road to side road turning movement would take place at controlled speed. Median opening has been kept not more than 20m to avoid reckless movement at junction. Vegetation and other boards that obscure visibility have been removed from central median for a length of safe stopping distance to enhance the mutual visibility of traffic approaching junction.





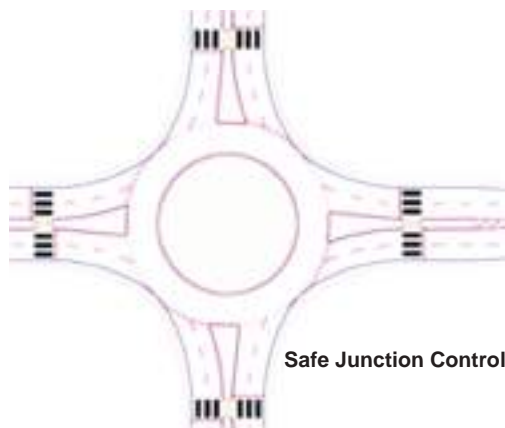
### Geometric elements in Priority Junction (Safer and Unsafe Practice)

When a side road traffic joins the main road, it has to wait to get a gap. If the vertical profile of intersecting minor road is not flat enough, it would be difficult for vehicles to wait in climbing position at the Stop Line as it is expected any vehicle entering from minor road should obey the 'Stop Sign' and 'Stop Line' ear marked on the minor road. Hence it is advisable that the minor road shall be flat for a minimum distance of 5 and desirably up to 10 m if the proportion of goods traffic entering from the minor road is substantial.



### Geometric elements in Priority Junction (Safer and Unsafe Practice)

When a side road traffic joins the main road, it has to see the gap in the main road to turn right or left and sometime cross to other side. If the visibility funnel is occupied, it would really affect the mutual visibility of traffic in main road and that coming from side road. Hence visibility funnel shall always be kept encumbrance free.



### Geometric elements in Roundabout (Safe Layout)

Position of central island should be such that through movement of traffic even from extreme left land should not take place. Island on approach road to roundabout should be deflecting that approach speed gets reduced, so as to give priority to traffic already in the circulatory carriageway.

## 5.4 Technical Tips for Audit Teams: Roadside Hazards

### 5.4.1 Roadside hazard management

Roadside hazards are a major road safety risk. The five part strategy for managing roadside hazards can guide a road safety audit team in their roadside hazard management.

**Step 1** - Keep vehicles on the road

**Step 2** - Remove fixed objects from within the “clear zone” of the road

**Step 3** - Relocate hazards to locations outside the “clear zone”

**Step 4** - Alter the hazard to reduce the severity of a collision

**Step 5** - Install crash barrier to shield errant vehicles from the hazard

---

**1 Has enough been done to keep vehicles on the road?**

A combination of good geometrical design, good information for drivers and good maintenance of the road is needed. An early stage of audit (such as planning/feasibility) can focus on geometric design and sealed shoulders to minimize run-off-road risk. In later audits, other safety options to reduce run-off-road crashes such as tactile edge lines, warning signs, guideposts and chevron alignment markers should be questioned if not shown in the drawings.

---

**2 Remove fixed objects from the clear zone**

What clear zone has been used in the design? Is it appropriate? What fixed objects (defined as those with a diameter of 100mm or greater) remain in the clear zone? They should be removed, if possible.

---

**3 Relocate hazards from the roadside  
(to a position outside the “clear zone”)**

If it is not possible to remove a fixed object from the clear zone, the next option is to relocate it further off the road. Is this feasible? Experience and judgement is necessary in such cases and the actions in Steps 4 and/or 5 may be brought in at this point. For example, a lighting column pole may be able to be relocated 8 metres further from the road, but it will be less effective in lighting the road from there. The team may recommend a 4m relocation and a slip based lighting column as a safer option.

---

**4 Alter the hazard to reduce the severity of a collision**

Safer forms of road furniture now exist. Large signs can be placed on “weakened” sign posts. Frangible lighting columns are available (slip based or impact absorbent) to absorb the energy of an impacting vehicle and reduce injuries. Drivable end walls for culverts can reduce injuries.

---

**5 Install crash barrier to shield errant vehicles from the hazard**

When the first four steps in the strategy have been exhausted, the installation of crash barriers may be the only remaining option. The purpose of crash barriers is to protect the humans who are inside an errant vehicle from striking a more serious roadside hazard. Audit teams should understand that even a crash barrier is a fixed object, and can cause injury when struck. If used, the audit team will need to check they are correctly designed and installed in accordance with IRC:119. Safe end terminals are important. Traffic attenuators can be provided to shield a hazard at gore area i.e. traffic bifurcation location, complying general criteria for provision given in IRC:SP:87, IRC:84 and IRC:SP:99 respectively for 6 lane, 4 lane and Expressway Manual.



**Fixed hazards in gore areas on high speed roads are especially hazardous**



**Impact Attenuators at gore areas having high speed traffic bifurcation**

## 5.4.2 Installation of Roadside Barriers

5.4.2.1 It is common for designers to propose crash barrier in a design when roadside hazards are known to exist beside a project road. However, barrier should only be installed when the severity of a crash with a hazard will be greater than a crash with the barrier itself. Crash barriers are roadside hazards; they can be especially dangerous if they are not correctly designed and installed. Therefore, after assessing that barrier is required, auditors should check that the correct type has been selected and that it has been designed correctly?

5.4.2.2 Auditors should look closely at the standard drawings for the barrier details. The correct design and installation of crash barrier is a skilled task. Audit teams may need to refer to technical guidelines in IRC for more information. Some may even decide to add an additional expert on the team to assist in deliberations about the crash barrier.

5.4.2.3 Crash barrier shall be long enough to fully shield the hazard. Short lengths of barrier are a common safety concern in audit reports!

5.4.2.4 Lateral placement of the barrier is very critical. It shall be such that a bumper of an errant vehicle hits crash barrier before its wheel touches, if at all kerb has been provided. Also, barrier shall be sufficiently offset from the hazard sufficiently to accommodate deflection of the barrier? If at all the barrier is installed some distance from paved edge, the distance between paved edge and barrier shall be uniformly grade not more 1:10 slope and kept intact.

5.4.2.5 Ensure that the barrier height, overlap of the metal beam, orientation of posts is correct as per standard and safe end terminal have been provided.

5.4.2.6 Removing a hazard is the best option for an audit early enough in the DPR process.

## 5.5 Technical Tips for Auditors: Road Signs & Pavement Markings

5.5.1 Avoid using signs as a quick or cheap “fix” to all safety issues. They may be an acceptable solution to some safety issues; however, you should discuss whether or not a sign is the best solution to a problem. If you decide to recommend the use of a sign it is necessary to remember the basic principles of good signing, and then check for these in later stage audits.

**5.5.2** Pavement markings play an important role in the safety performance. Significance of marking is that driver cannot get rid of pavement marking as he drives on road; hence a properly laid marking as per codal provisions would give clear cut message and would definitely influence driving behavior.

### Road Signs

X



#### Conspicuous

The sign must be able to be seen. This is a new and reflective sign but it has been poorly located and it cannot be seen by drivers/riders. If a sign cannot be seen, it cannot be of any use to the road users.

X



#### Clear

The shape and colour of the sign, as well as the legend/symbol, have to be able to be read from a suitable distance. This sign is no longer able to be read.

X



#### Comprehensible

All signs have to be able to be understood. Using standard signs is a good starting point as drivers become used to the sign colour/shape/meaning. This non-standard direction sign could leave some drivers confused. Driver confusion leads to errors and sometimes crashes. Auditors should guard against situations that can lead to driver confusion.

X

**Credible**

The message conveyed by a sign has to be believable. This sign informs drivers of a narrow bridge. It is not the standard warning sign for a narrow bridge but importantly the road remains at full width across the bridge. The sign is incorrect as it leads to a lack of sign credibility.

X

**Consistent**

Each sign used for a task should look the same as each other sign used for that task. There is a standard "Road Worker" warning sign for use at road work sites. But the sign at the road works in this photo is quite different from the standard "Road Worker" warning sign. Such inconsistency leads to a decrease in driver compliance with signs.

X

**Correct**

Every sign used should be the correct sign for the purpose. It may be better not to use a sign than to use the wrong sign!

This "Keep Left" sign is conspicuous, but it is not the correct (legally enforceable) sign.

X

**Design**

Sign design shall be uniform as per guidelines given in IRC:67. For a driver to read in a moving position, only one destination for forward destination and one destination on right destination. The other destination with distances can be placed immediately after the junction to reassurance sign and could be on small font size as it is to be seen by a driver after negotiating a junction at low speed.

X

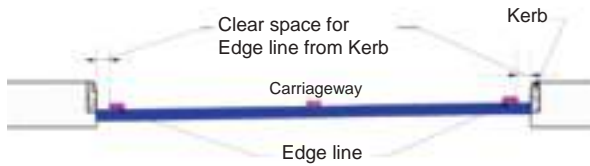


**Placement**

Placement of sign really matters. Picture here shows that STOP sign placed 40m ahead. Placement of signs also shall be governed as per IRC:67.

**Pavement Markings**

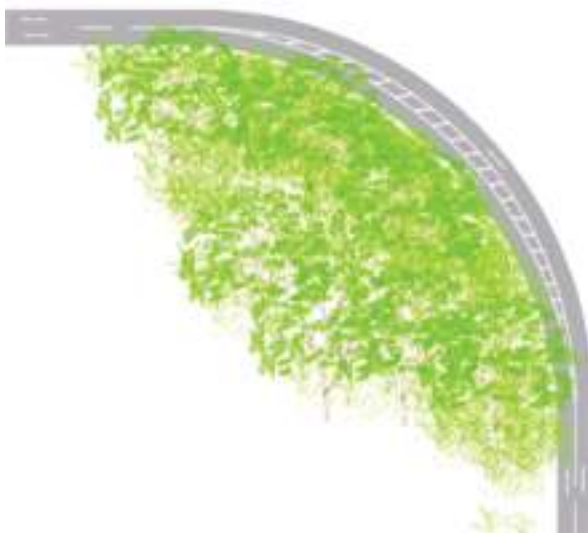
✓



**Set Back Distance for Edge Line**

Edge line marked on roads has tremendous bearing on road safety. If edge line is placed very close to kerb, it is generally covered by soil, dirt and even stagnated water. To address this issue, a shyness distance of 0.5m shall be provided from the vertical face of kerb/edge and shall be kept clean for the continued performance of edge line.

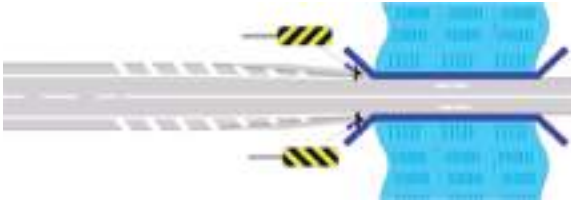
✓



**Low Cost Measures to Discourage Overtaking**

A sharp curve with restricted forward visibility could be witnessing head on collision crashes. Providing a central median shall be the durable solution. But any median at the center of traffic movement shall be of 1.5m to accommodate signs to make the hazard visible at the middle of the road. Reasonable width is required to serve as refuge space for a pedestrian to cross. Minimum 5.5m paved width is required on one side of physical median to allow passage of two vehicles. In such situation, psychological median made of ladder hatching as shown will be a solution to discourage head on collision

✓



### Hazard Marking where Paved width gets reduced

In hazardous location where paved width gets reduced and will be challenge to discourage drivers to align to reduced paved width as shown here. Hence, hazardous marking shown for 100 to 200m ahead of reduced width will be a solution, as detailed in IRC:35.

✓



### Marking that affects Users' Behavior

Physical island enveloped by marked island would be a safer practice, wherein the physical island is set back in line with edge of paved shoulder. This will prevent island hit accident if a vehicle attempts to move forward using the paved shoulder. The width of the slip lane can be marked in such a way that two vehicles would not run parallel while turning. As a result the marked island will be much larger than the physical island and island would be much conspicuous.

## 5.6 Technical Tips for Auditors: Pedestrians

Pedestrians are the largest and most vulnerable group of road users. Use signalised crossings to give pedestrians time separation from vehicles to cross busy roads. Use medians or refuges to give them spatial separation from vehicles. Overpasses/subways are not popular and should only be used as a “last resort” to segregate pedestrians and vehicles on roads with high speeds and high traffic volumes.



### High Risk Pedestrians

An audit team needs to consider the safety needs of all pedestrians, and in particular the safety needs of high risk groups such as school-aged pedestrians, elderly pedestrians, the disabled and intoxicated pedestrians.



### In the Shoes of the Pedestrian

The audit team should walk the site (day and night) to check for pedestrian issues. Pedestrians need to be able to clearly see where they should go. While this may be clear to engineers on a plan, it is not always obvious on the ground.



### Footpaths

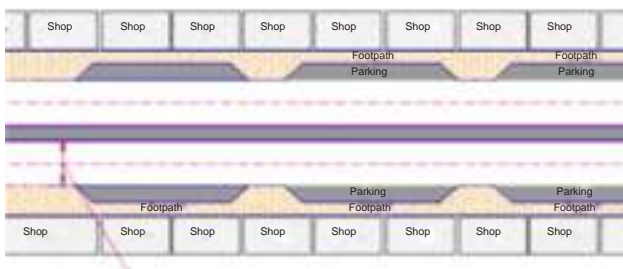
Footpaths are desirable to provide pedestrians with their own space on which to walk, especially in urban areas. Auditors should check to ensure they are wide enough for the expected volumes, and are continuous. Wherever gaps are unavoidable, proper ramps should be provided to cater for elderly and differently abled people. In later audit stages, they should check that kerb crossings are provided and the footpaths are clear of obstacles.





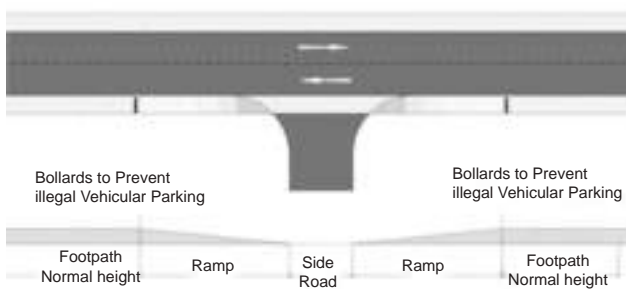
### Paved Shoulders

In rural areas, wherever there is considerable pedestrian movement near inhabited areas, schools etc., paved shoulders will give pedestrians their own space on which to walk. They also help bicyclists, motorcyclists and animal drawn carts. Auditors should check the cross sectional drawings and question if paved shoulders are not proposed in such stretches.



### Legitimate space for Pedestrians

Highway passing through a settlement should have space for pedestrian movement along and across the carriageway. Pedestrians should be able to cross the traffic way in shortest distance not more than two array of vehicles. Median width also should be wide enough to serve as a refuge space. Considering the mix of traffic occupying urban roads, a lane width can be reduced to give proper width for the pedestrians.



### User friendly Footpath

The line and grade of footpath, especially at locations side/access road comes, it should be such that it can be user friendly, lest perhaps pedestrians tempted to use the traffic way. The maintenance of footpath is of utmost importance and footpath should not have unexpected openings and hazardous things causing pedestrians to avoid using them.

## 5.7 Principles for Safer Design

The principles for safe design can be obtained from relevant IRC publications and some of them are listed below.

IRC:35                Code of Practice for Road Markings

IRC:67                Code of Practice for Road Signs

IRC:SP:88-2019

IRC:79	Recommended Practice for Road Delineators
IRC:SP:73	Manual of Specifications and Standards for Two Laning of Highways with Paved Shoulders
IRC:SP:84	Manual of Specifications and Standards for Four Laning of Highways
IRC:SP:87	Manual of Specifications and Standards for Six Laning of Highways
IRC:SP:99	Manual of Specifications and Standards for Expressways
IRC:65	Guidelines for Planning and Design of Roundabouts
IRC:99	Guidelines for Traffic Calming Measures in Urban and Rural Areas
IRC:SP:55	Guidelines for Traffic Management in Work Zones
IRC:119	Guidelines for Traffic Safety Barriers
IRC:103	Guidelines for Pedestrian Facilities
IRC:11	Recommended Practice for Design and Layout of Cycle Tracks
IRC:SP:41	Guidelines on the Design of At-Grade Intersections in Rural and Urban Areas
IRC:SP:90	Manual for Grade Separators and Elevated Structures
IRC:SP:91	Guidelines for Road Tunnels
IRC:92	Guidelines for the Design of Interchanges in Urban Areas
IRC:82	Code of Practice for Maintenance of Bituminous Roads Surfaces
IRC:87	Guidelines for Formwork, Falsework and Temporary Structures for Road Bridges
IRC:73	Geometric Design Standards for Rural (Non-Urban) Highways
IRC:86	Geometric Design Standards for Urban Roads and Streets
IRC:SP:48	Hill Road Manual

## 6. SAFETY AUDIT CASE STUDIES AND REPORTING

This section gives the results of four road safety audits of roads. The main audit findings are summarized and are presented in a standard format. The layout of these audit reports, including the tabular presentation of the audit findings, is suggested to be a useful template for use in road safety audit reports. To have uniformity, the issues are arranged in the order as in the checklist. It also allows space for the Project Manager to provide response to each recommendation.

Four case studies showcase some of the safety concerns that typically arise at different stages of audit and on different types of road projects. The focus in these case studies is on design stage, construction stage, pre-opening stage audits including existing road audit. The four case studies show audits of different road projects. One of the projects is audited at two stages (DPR and pre-opening) to show the relative differences in the typical safety concerns that might be identified in an early versus a later stage of audit.

### 6.1 Case Study 1: DPR Stage Audit

**6.1.1** The project corridor taken up for rehabilitation and widening of a state highway between km 86.0 and km 142.0 has been subjected to road safety audit by reviewing the Detailed Project Report (DPR) and drawings of the above project corridor by a two member RSA team.

#### 6.1.2 Audit Team

Two team members including a Senior Road Safety Auditor have been involved in the above RSA.

#### 6.1.3 Project Background

A 56 km section of two-lane two-way state highway is to be rehabilitated and widened. This section of highway commences in a flat area of rural land and is basically straight and flat for the first half until it reaches a wooded hill area for the second 28 km. The road is presently 6m wide (2 x 3m lanes) with unsealed 1m wide shoulders along both sides. The proposal shows a 7m wide pavement (2 x 3.5m wide lanes) and unsealed 1.5m wide shoulders on both sides. An 80km/h design speed has been used for the flat section and a 50km/h design speed has been used in the hill section. The highway passes through two towns and eight villages. Ten new bus lay-bys are included in the proposal. No change is proposed to the six existing bridges.

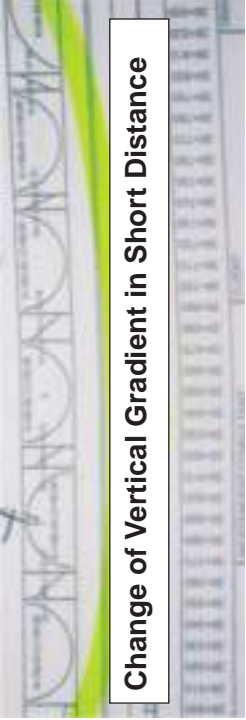
#### 6.1.4 Audit Details



The road authority requests a road safety audit of the DPR. The Project Manager selects a road safety audit team and provides him with the ToRs for the audit. The senior auditor, on viewing the size and stage of the project, invites a colleague to join him in the audit team.


**6.1.5** The Project Manager has the design team which provided the audit team with a complete set of the latest drawings, as well as the design report prepared for the project corridor.


**6.1.6** The team then travels to the location of the proposed highway rehabilitation; they inspect the entire length during day and night. The audit team also inspects the highway for a few kilometres outside the 56km long section in order to check that those nearby areas won't become high risk locations after the work is finished and traffic speeds increase.


**6.1.7** Format of a road safety audit report is presented in the prescribed template. All the titles of issues as listed in the checklist are reproduced to impress that all issues as in the checklist shall be verified and all issues shall be reported with exact location in the road safety audit of the given road. Being a sample report, only a few issues are picked up and shown below:

No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with images if any)	Risk	Description (with figures if any)	Priority	
1	<b>Horizontal &amp; Vertical Alignment</b>				
1.1	<p>The left hand curve near km 128.9 has a much shorter radius than any other curve in this section of the highway. It will be one of the “sharpest” curves on the entire highway. Some drivers/riders, especially those travelling westwards (downhill) may be caught by surprise at the small radius of this curve, and run-off-road crashes could result. The drawings are silent about what is intended to address this risk.</p>	Very High	<p>Review the design to increase the radius of this curve</p> <p>If this is not feasible, ensure that the shoulders are paved on both sides of the highway for at least 100 m either side of the apex of the curve. Ensure the outer shoulder is sloped to match the super elevation of the carriageway at that point.</p> <p>Provide Crash barrier on outer edge of curve</p> <p>Provide chevron signs on the outside of the curve. Also, pavement markings and road studs to help drivers to judge the change in alignment.</p> <p>Provide Psychological traffic calming measures to alert the driver about the approaching hazard.</p>	Desirable Highly Desirable	
1.2	<p>The vertical grade has been changed at short distance and even with broken back curves as shown here with a reason of minimizing the profile correction course. Traffic plying through this road section could be multi-axle trucks, and sometimes even carrying liquid commodities, where the frequent changes of vertical grade will make the centre of gravity to oscillate, leading to toppling of vehicles.</p> 	High		Essential	Highly Desirable

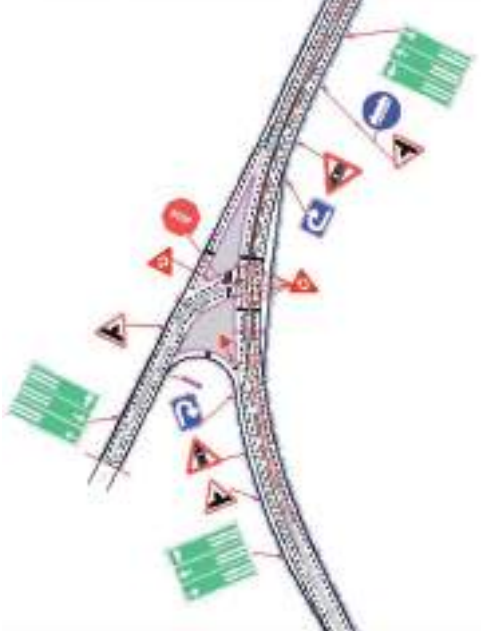
No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with images if any)	Risk	Description (with figures if any)	Priority	
			For any reason, vertical profile cannot be corrected as stated above, provide adequate measures with signs and markings to alert and warn the drivers about the hazard.	Essential	
<b>2</b>	<b>Typical Cross Sections</b>				
2.1	<p>The drawings show a 1.5 m wide unpaved shoulder along both sides of the highway. Unpaved shoulders discourage vulnerable road users from walking/riding on them as shown in picture (especially during the monsoon period). They become damaged when heavy vehicles drive on them. This can lead to deep drop-offs from the pavement which in turn becomes a hazard for small vehicles. There are many pedestrians, bicyclists and motorcyclists using this highway. They need the protection of a paved shoulder.</p> 	High	<p>Review the proposed cross section to provide a paved 1.5m wide shoulder along both sides of the highway for the entire project highway.</p> <p>If paved shoulder cannot be provided for entire project highway, provide at least for the section where pedestrians and bicyclists are predominately present like villages and settlements.</p> <p>For sections of road with predominant pedestrian and bicyclist, provide gateway measures to reduce speed with road humps, speed limit signs, and road markings as given in IRC:99.</p> 	<p>Desirable</p> <p>Highly Desirable</p> <p>Essential</p>	

No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with images if any)	Risk	Description (with figures if any)	Priority	
3	New/existing road interface				
4	Staged Works				
5	Intersections				
5.1	<p>The junction near km 93.2 is a Y junction. Y junction promotes high turning speed from main road to side road and side road to main road. Also, being a Y junction, the traffic approaching from side cannot see the main road traffic so as to give way to main road traffic</p>	Very High	<p>Redesign this intersection to eliminate the Y junction and convert it preferably to a T junction, whereby side road to main road and main road to side traffic would not turn at high speed as shown in the revised layout.</p> <p>If not feasible due to non-availability of land, provide speed breaker for side road at 5 - 6 m from major road, clear up the visibility funnel from objects and plantations that obscure the visibility.</p> <p>Provide signs and marking for a Priority Major T Junction as given in IRC:SP:73.</p>	<p>Highly Desirable</p> <p>Essential</p> <p>Essential</p>	
					
6	Interchanges				
7	Adjacent Land				

No	Safety Concerns & Audit Findings		Risk	Recommendations		Client Response
	Description (with images if any)	Description (with figures if any)		Description (with figures if any)	Priority	
<b>8</b>	<b>Roadside Hazards</b>					
8.1	<p>There are steep undrivable roadsides in the hill section between km 130 - 134 (approx.). These are within the clear zone for this highway and they are roadside hazards. The drawings are silent about any safety improvements along this area. The slopes cannot be “softened” due to the topography.</p> 	<p>Provide adequate delineation of the section between km 130 - 134 using Chevron signs, delineator posts as well as centre lines, edge lines and advanced warning signs.</p> <p>Provide paved shoulders through this section, ensuring the outer shoulder matches the super elevation of the curve.</p> <p>Install suitable safety barrier in those locations where the side slope begins within the 5m clear zone (measured from the edge line).</p>	Very High	Essential		
<b>9</b>	<b>Vulnerable road users (pedestrians, bicyclists, two wheelers and three wheelers and animal drawn carts)</b>					
9.1	<p>This highway passes through two towns and 8 villages. Traffic speeds at present are quite low because of the road condition. However, when the highway is rehabilitated and widened, speeds will increase. For the safety of vulnerable road users in the towns and villages, it will be vital to manage speeds on the new highway.</p>	<p>Install Gateways on both sides of the highway at the entrance to each town and village. Provide gateway signs placed in platforms with traffic calming measures. Repeat the speed reducing measures within the settlements to avoid traffic accelerating within speed zone as per IRC:99</p>	High	Essential		

No	Safety Concerns & Audit Findings		Recommendations		Client Response	
	Description (with images if any)	Risk	Description (with figures if any)	Priority		
			<p>Provide raised footpath or paver block at same level of carriageway to create space for pedestrian movement along the road and that would create gateway effect.</p> <p>Install street lights for all town and village reaches to ensure that a minimum of 40 lux available on the carriageway and all types of non motorized traffic facilities provided on the project corridor.</p>	<p>Highly desirable</p> <p>Desirable</p>		
<b>10</b>	<b>Signs, pavement marking and delineation</b>					
10.1	<p>The direction information signs are very critical for junction for the safe operation as it involves many turning movements having major decision making at such points. The design of direction board shown in the DPR is not as per IRC standards. Also, obsolete Red reflector signs are used. Signs are positioned in close distance.</p>		<p>Provide direction information (both Advance information sign and Flag type direction sign) and other hazard markers as shown in IRC:67.</p> <p>All direction signs are to be redesigned as per the guidance given in IRC:67 for the actual approach speed to have boards of optimum size.</p> <p>Replace triangle shaped red reflector signs with Object Hazard Marker and mark them precisely in the drawings.</p>		<p>Essential</p> <p>Essential</p> <p>Essential</p>	



No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with images if any)	Risk	Description (with figures if any)	Priority	
			<p>Provide minimum 2 to 3 second travel time distance between two sign boards. This needs to be fixed in accordance with the proposed Speed Limit for the section under consideration.</p>	Essential	
11	<b>Parking</b>				
12	<b>Lighting and night time issues</b>				
13	<b>Drainage</b>				
14	<b>General road safety considerations</b>				

**6.1.8 Certification**

The Audit Team has carried out this DPR stage road safety audit conforming to IRC Manual on Road Safety Audit.

Signed

Team Leader on behalf of the RSA Team (Dated.....)

## **6.2 Case Study 2: Construction Stage Audit**

**6.2.1** Construction stage road safety audit of the upgrading of a 235 km section of National Highway.

### **6.2.2 Audit Team**

A team of three members including a Senior Road Safety Auditor have been involved in the Construction Stage RSA. Ideally, such types of construction stage RSA should be conducted at every 3 to 4 month interval till the project corridor is declared ready for pre-opening stage RSA by the audit team. After each of the construction stage RSA visits, compliance need to be submitted by the client to the audit team.

### **6.2.3 Project Background**

A 235 km section of a National Highway between two major regional cities is to be upgraded. One section (65 km) will be upgraded to become a 4-lane divided highway; the remainder will be widened to become a six lane divided highway. There will be 17 new flyovers and four new interchanges in this major road project. The Contractor has decided to reduce construction time by having up to 12 work sites underway at the same time.

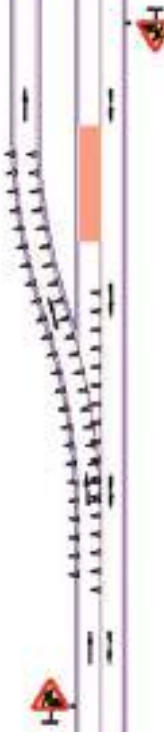

### **6.2.4 Audit Details**



The road authority requests a road safety audit of the road works. The Project Manager decides to engage an audit team of three members as he considers that this highway improvement is a significant one that will benefit from a larger audit team. The Project Manager ensures the team size is made clear in the ToRs for the audit.

**6.2.5** This is the first safety audit that has been conducted on this project. No design stage audits were conducted. The Project Manager therefore decides to hold a commencement meeting to discuss the project and the audit.



**6.2.6** The audit team begins by undertaking a “desktop” audit of the traffic management plans for the construction work and subsequently carried out the audit.


**6.2.7** Format of a road safety audit report is presented in the prescribed template. All the titles of issues as listed in the checklist are reproduced to impress that all issues as in the checklist shall be verified and all issues shall be reported with exact location in the road safety audit of the given road. Being a sample report, only a few issues are picked up in the report given below:


No	Safety Concerns & Audit Findings Description (with images if any)	Recommendations		Priority	Client Response
		Risk	Description (with figures if any)		
1	<p><b>Traffic management plan (design and implementation)</b></p> <p>For the construction scenario as shown in the Traffic Management Plan (TMP), half of the carriageway will be taken up for work, wherein traffic approaching from one side would have to be diverted. In the TMP, "Road work Ahead" sign has been shown to indicate that road works is progressing, but traffic control and traffic diversion are not clearly established without which high speed head-on collision can occur.</p> 	Very High	<p>Install traffic 'diversion ahead' signs and 'turn-left' sign for the traffic approaching from left-hand side. For the traffic approaching from right-hand side, provide 'Two Way Traffic' sign.</p> <p>Install traffic signs from the hazard/diversion point clearly showing the spacing as given in IRC:SP:55.</p>	Essential	
2	<p><b>Speed control</b></p> <p>There are no speed restriction or repeater speed restriction signs shown in the worksite. Consistent application of a suggested 40km/h speed limit in the work zones along with complete absence of any form of traffic calming measures.</p> 	Very High	<p>Install duplicate pairs of 40 km/h speed restriction signs at an interval of every 300 m in the work zone.</p> <p>Provide appropriate traffic calming measures also to reduce the speed on approaches to work site and maintain the speed of traffic as it passes through work area.</p> <p>Liaise with local Police to enforce the speed limit.</p>	Essential	

No	Safety Concerns & Audit Findings		Recommendations		Priority	Client Response
	Description (with images if any)	Risk	Description (with figures if any)			
3	<p><b>Signs, signals, pavement marking and delineation</b></p> <p>Many of the road signs were not standard. Many were made of old material such as corrugated iron.</p> 	Very High	<p>Provide standard diversion boards as given in IRC:SP:55</p> <p>Traffic control devices should be placed in such way that an approaching vehicle to the approach transition zone or work zone can see clearly and can take appropriate action.</p>	Highly Desirable Highly Desirable		
4	<p><b>Diversions from one carriageway to the other</b></p> <p>At this location, traffic has to be transferred from one carriageway to other, where measures provided on the ground are grossly inadequate. The situation is highly dangerous being a remote area without any street light etc.</p> 	High	<p>Provide transition length as per the taper rate given in IRC:SP:55 for transfer of traffic.</p>	Highly Desirable		


No	Safety Concerns & Audit Findings Description (with images if any)	Risk	Recommendations		Priority	Client Response
			Description (with figures if any)			
4.1	<p><b>Reasonably good Diversion Practice;</b> Such safety Measures shall be replicated at Other Chainages on the Project Corridor.</p> 	High	<p>Provide barricade and reflective traffic cones to clearly define traffic path from one side to other as per IRC:SP:55.</p> <p>Speed breakers require proper retro reflective paint supported with the Cautionary Sign Board; Need to be removed after construction.</p> <p>However, Speed breakers require proper retro reflective paint supported with Cautionary sign board erected at least 45 m before the Hump.</p>	<p>Highly Desirable</p> <p>Highly Desirable</p> <p>Highly Desirable</p>		
5	<p><b>Road Surface and Edge Drop Issues</b></p>  <p>Edge drop was observed at many locations on the Project Corridor taken for expansion.</p>	High	<p>Wherever, the edge drop is more than 0.5 metres, it is essential to place the series of New Jersey barriers in place of the concrete poles tied with ribbons. This measure shall be taken up on priority basis immediately.</p>	Essential		


No	Safety Concerns & Audit Findings Description (with images if any)	Recommendations		Priority	Client Response
		Risk	Description (with figures if any)		
6	<p><b>Crash barriers</b></p>  <p>At this location, abrupt ending of MCB without integrating with CCB creates hazardous situation for the errant vehicle.</p>	High	MCB shall be extended up to parapet wall as per IRC:119, by overlapping for at least 50 cms over the parapet wall.	Essential	
7	<p><b>Work site access</b></p>				
8	<p><b>Median Openings</b></p> <p>Close the unauthorized openings; Frequent/unauthorized median gaps can become potential black spots during construction stage as well as leading to Pre COD.</p> 	High	<p>Shall be at a minimum interval of every 2 km only in case of typical open/non-inhabitant areas</p> <p>Shall be between 500 Metres to 1 km in case of urban/built up areas</p>	Essential	

No	Safety Concerns & Audit Findings Description (with images if any)	Risk	Recommendations		Priority	Client Response
			Description (with figures if any)			
9	<b>Road worker safety</b>					
9.1	<p>While on-site it was noted that most of the road workers were not wearing safety vests. Reflective safety vests are essential for road workers. They must be seen by drivers/riders in sufficient time to avoid collisions.</p> 	Very High	Require the Contractor to supply reflective safety vests and other PPE to all workers working on the site.	Highly Desirable		
				Direct all workers to wear the vests at all time when working.	Highly Desirable	
				Direct the Supervision Consultant to be strict in the enforcement of this directive.	Highly Desirable	

No	Safety Concerns & Audit Findings		Risk	Recommendations		Priority	Client Response
	Description (with images if any)	Description (with figures if any)					
10	<p><b>Vulnerable road users (pedestrians, bicyclists, two wheelers and three wheelers and animal drawn carts) through the work site</b></p>						
10.1	<p>Concrete filled barrels were used as delineators and to hold some "Diversion" signs at eight work sites. These are highly dangerous if struck by a small vehicle or especially a motorcyclist.</p> 	<p>Ensure that the work zone is clearly conspicuous and that any barricade used is located well beyond the diversion and is a forgiving device (i.e. not concrete).</p> <p>Provide standard reflective boards as per IRC:SP:55.</p>	<p>Very High</p>	<p>Highly Desirable</p> <p>Highly Desirable</p>			
11	<p><b>Safety at night</b></p>						
11.1	<p>Poor quality signs were being used at worksite. More than 70 % of the signs used were non retro-reflective and could not be seen at night during the night time inspection. The use of non- reflective signs (and some were made of corrugated iron) increases the risk of night time collisions. At most diversions, the existing line making is still very visible and it directs drivers/riders straight into the barricades.</p>	<p>Provide retro reflective sign as given in IRC:SP:55. Being a road sign, it shall be retro reflective in nature for night time performance.</p> <p>Efforts must be made to remove misleading pavement marking lines in existing carriageway.</p>	<p>Very High</p>	<p>Highly Desirable</p> <p>Highly Desirable</p>			



No	Safety Concerns & Audit Findings Description (with images if any)	Risk	Recommendations		Priority	Client Response
			Risk	Description (with figures if any)		
						
11.2	<p>At many locations substantial amounts of road building materials is being stored adjacent to main travelled way. They occupied useful lane space and they were not delineated. There is a risk that a driver/rider could lose control if they strike any of these storage heaps, especially at night if travelling at high speeds.</p> <p>At certain locations, there is plenty of space to store the material off the travelled way while at the remaining locations, additional strong delineation of the storage area may be the only option.</p>	High	Direct the Contractor to store all material off the road (and preferably outside the clear zone of the road).	Highly Desirable		

No	Safety Concerns & Audit Findings Description (with images if any)	Risk	Recommendations Description (with figures if any)		Priority	Client Response
			<p>If this is not possible for logistical reasons, ensure the Contractor delineates the storage areas for both day and night time.</p>	Highly Desirable		
			<p>Ensure the Contractor removes the materials as quickly as possible</p>	Highly Desirable		

**6.2.8 Certification**

The Audit Team has carried out this worksite safety audit according to the IRC Manual on Road Safety Audit and Guidelines for Traffic Management in Work zones (IRC:SP:55)

Signed

Team Leader on behalf of the RSA Team (Dated.....)

### 6.3 Case Study 3 : Pre-opening Stage

#### Audit

**6.3.1** Pre-opening stage road safety audit of the rehabilitation and widening of the state highway between km 76.0 and km 142.0.

#### 6.3.2 Audit Team

A team of three members including a Senior Road Safety Auditor have been involved in the Pre-opening Stage RSA. Ideally, any road subjected to pre-opening stage RSA should have undergone audit starting from Design Stage RSA followed by Construction Stage RSA at every 3 to 4 month interval. It is expected all the pending safety issues pointed out in the previous stages of RSA as well as any other new minor safety related issues have to be addressed by the client as the RSA team would not suggest any major changes to the project corridor at this stage. This is because after the completion of Pre-Opening Stage RSA and the submission of compliance letter by the road owning agencies, the road would be opened to traffic operations. After the road is opened for traffic operations, it is also prudent to solicit the views of the road users by conducting the roadside questionnaire survey on the project corridor. This survey should focus primarily on any of the missing road safety issues, on the Project Corridor and the same should be conducted within 3 to 4 months from the start of normal traffic operations.

#### 6.3.3 Project Background



A 66 km section of road section comprises of 10 km of 4-lane divided bypass of an industrial town and remaining 56 km of two-lane two-way highway has been rehabilitated and widened. The highway commences in a flat rural area and leads into a hill area. The 4-lane divided carriageway comprises of 2 x 7.25 m wide carriageway with 1.5 m wide paved shoulder and 4.5 m wide median and 2-lane road section comprises of 7m wide pavement (2 x 3.5 m wide lanes) and unsealed 1.5 m wide shoulders on both sides. Km 76 to 86 of 4-lane section has not been audited in the design stage. But the km 86 to 142 km has been audited and as a result in the towns and villages, within one kilometer of each and on selected curves, the shoulders have been sealed as a result of the DPR stage audit recommendations.


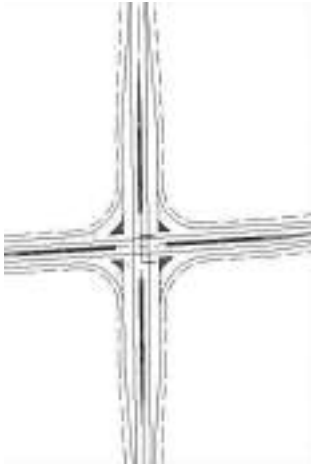

#### 6.3.4 Audit Details


The road authority requests a road safety audit of the new work. The Project Manager decides to engage the same audit team which had previously (20 months earlier) audited the DPR drawings.


**6.3.5** The audit team spends time inspecting the finished roads as well as the drawings to consider as what recommendations can be included even at this stage of pre-opening audit causing least disturbance to contract and time over run. They visited the site both during day and night and also received the “Good for Construction” drawings.



**6.3.6** Format of a road safety audit report is presented in the prescribed template. All the titles of issues as listed in the checklist are reproduced to impress that all issues as in the checklist shall be verified and all issues shall be reported with exact location in the road safety audit of the given road. Being a sample report, only a few issues are picked up in the report and shown below.

No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with Images If any)	Risk	Description (with Figures if any)	Priority	
	<b>Pre-Opening Stage</b>				
<b>1</b>	<b>New/Existing Road Interface</b>				
1.1	<p>When a side road traffic joins the main road, it has to wait to get a gap. In the picture shown here, it would be impossible for 2 wheelers to stop to wait in climbing position, rather they take the risk to enter the main road that may lead to major accidents.</p> 	Very High	<p>Provide side road profile near to flat gradient that vehicle can wait comfortably.</p> <p>Remove all objects that fall within visibility funnel to ensure visibility between main road and side road traffic.</p>	Highly Desirable Essential	
1.2	<p>Four informal openings appear to have been created through the median – possibly by nearby people who wish to minimize their travel distances. However such informal openings create high risk situations as they are not provided with proper signage, they do not have sheltered turn lanes in which turning vehicles can slow and stop. In addition, the median often becomes damaged and sand/gravel is drawn onto the road, creating a skidding hazard.</p>	High	<p>Provide formal safe U turn facility as given in IRC:SP:84.</p> 	Highly Desirable	


No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with Images If any)	Risk	Description (with Figures if any)	Priority	
			<p>At locations, where storage space cannot be accommodated, provide median cut of 30m. This opening and 4.5m median width serve a neutral space, not to be encroached by through traffic.</p> <p>Around 120 to 150m distance from median tip shall be cleared of all plantations and objects that obscure visibility.</p>	Essential	
<b>2</b>	<b>Intersections</b>				
2.1	<p>The two intersecting roads having more or less same traffic and the road junction has been developed as per the figure shown here. But four armed cross road junction without control is highly unsafe in operation. Right angle collision on high speed without being deflected could be fatal, especially in off peak hours and at nights.</p> 	Very High	<p>Convert cross road junction into roundabout as shown here, which can be made within the outer extremities of present construction, even though it involves dismantling islands already made.</p> 	Highly desirable	
<b>3</b>	<b>Interchanges</b>		<p>If cross road junction cannot be converted into roundabout, provide speed breaker on all four arms of junction. Also provide transverse bar marking to alert drivers about approaching speed breaker.</p>	Essential	



No	Safety Concerns & Audit Findings		Risk	Recommendations		Client Response
	Description (with Images If any)	Description (with Figures if any)		Description (with Figures if any)	Priority	
4	<b>Signs, pavement marking and delineation</b>					
4.1	<p>The curves in the hill area have been delineated inconsistently. Several (such as at km 124.4 and km 125.5) have many Chevron signs installed. However, others have Chevron signs in one direction only and the other direction is not delineated. Several curves that need Chevron signs have none. At one curve, the Chevron signs are incorrectly installed on the inside of the curve. Such inconsistent delineation can cause some drivers/riders to be caught by surprise and run-off-road crashes could result.</p> 	High	<p>Ensure that chevron alignment signs are installed consistently at all curves as stipulated in IRC:SP:73.</p> <p>Install Chevron signs according to spacing criteria given in IRC:67 for various radii.</p>	Essential	Essential	
4.2	<p>The “Right Hand Curve” warning sign for the curve at km 101.1 is located too far from the curve. It is almost 300m from the curve. Most drivers/riders will forget the message by the time they reach the curve .</p>	High	<p>Relocate this warning sign to a position approx. 50m before the curve.</p> <p>Check all warning signs installed in the project highway and if required relocate them to the distance as given in IRC:67 for warning signs.</p>	Highly Desirable	Highly Desirable	


No	Safety Concerns & Audit Findings		Risk	Recommendations		Client Response
	Description (with Images If any)	Image		Description (with Figures if any)	Priority	
4.3	<p>The "Left Hand Curve" warning sign for the curve at km 121.1 conflicts with the nearby chevron alignment marker which points to the right. Some drivers could be confused by the apparent mixed messages.</p>		High	<p>Install chevron signs with spacing as given in IRC:67; for which curve length shall be start of transition to end of transition.</p> <p>Check all warning signs installed in the project highway and if required relocate them to the distance as given in IRC:67 for warning signs. Ensure that between any two signs, there shall be 2 to 3 seconds travel time.</p>	Highly Desirable	

No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with Images If any)	Risk	Description (with Figures if any)	Priority	
<b>5</b>	<b>Roadside hazards</b>				
5.1	<p>The terminal ends of these barriers are the old style “fish tail” end. These have a bad history of spearing an impacting vehicle and they should not be used. In addition, barrier has not been installed at the other two bridges (on either approach).</p> <p>W beam barrier has been installed at four of the six bridges to shield the side slope on each approach. None of the barrier has been stiffened nor correctly affixed to the bridge parapets. There is a risk of pocketing at these bridges.</p> 	High	<p>Replace the “fish tail” end terminals with a suitable end terminal as per IRC:119.</p> <p>Ensure the barrier is stiffened (with reduced post spacing) and firmly attached to the bridge parapets)</p> 	<p>Highly Desirable</p> <p>Highly Desirable</p>	
5.2	<p>Crash barrier has been installed to shield a number of roadside hazards. Most of the barrier installations appear adequate but there are six sections (all between km 12-14) that are too short. The barrier is too short to fully shield the hazard and it is possible that some errant vehicles may pass behind or in front of the barrier to strike the hazard.</p> <p>The ramped down terminals are another safety concern that should not have been installed.</p>	High	<p>This section of barrier needs to be extended by at least 20m in order to shield the direction sign</p>	Highly Desirable	



No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with Images If any)	Risk	Description (with Figures if any)	Priority	
			<p>Lengthen these six sections of barrier so that the required barrier length as needed for each hazard is satisfied.</p> <p>Provide end treatment as given in IRC:119.</p>	<p>Highly Desirable</p> <p>Highly Desirable</p>	
<b>6</b>	<b>Vulnerable road users (pedestrians, bicyclists, two wheelers and three wheelers, and animal drawn carts)</b>				
6.1	<p>This highway passes through a number of villages; traffic calming has been installed in three of these villages. It is understood that the other towns and villages will also be traffic calmed in the coming two years. However, a variety of hump profiles have been used. Most of the road humps have no warning signs and several have non-standard pavement markings. Six humps have no markings at all. It is important for safety that drivers/riders receive consistent messages about traffic control.</p>	<p>Very High</p>	<p>Replace any non-standard road humps with flat topped road humps as given in IRC:99.</p> <p>Ensure all humps are provided with proper signs and pavement markings consistently through each village.</p> <p>Provide Transverse Bar marking ahead of road hump to warn of hump ahead as given in IRC:99</p>	<p>Essential</p> <p>Essential</p> <p>Essential</p>	

No	Safety Concerns & Audit Findings		Risk	Recommendations		Client Response
	Description (with Images If any)	Description (with Figures if any)		Description (with Figures if any)	Priority	
	<p>Note: Safety concerns like three people in a bike and that too without helmet and for which recommendation such as to penalize them and wearing helmet are not expected to include in a safety audit report</p> 					
<b>7</b>	<b>Drainage</b>					
7.1	<p>An uncovered concrete drain exists along the central median for more than 5km. It is a roadside hazard within the clear zone. It is recommended that it should be fully covered with a suitable drivable cover. If an earlier audit had been conducted, it is likely it would have recommended this drain be not constructed here.</p> 	<p>Fully cover the drain with a suitable drivable cover.</p> <p>Install plastic guide posts along the median to provide good delineation to help to keep drivers/riders on the road</p>	Very High	Highly Desirable	Highly Desirable	

No	Safety Concerns & Audit Findings		Risk	Recommendations		Client Response
	Description (with Images If any)			Description (with Figures if any)	Priority	
8	Landscaping					
9	Lighting and night time issues					
10	Access to property and developments					
11	General road safety considerations					
	Ambulance and Trauma Care Attendants 		Very High	Staff deputed in the ambulances and trauma care centers have to undergo Level-IV Training before Pre-COD.	Essential	

**6.3.7 Certification**

The Audit Team has carried out this pre-opening stage road safety audit according to the IRC Manual on Road Safety Audit.

Signed

Team Leader on behalf of the RSA Team (Dated.....)

## **6.4 Case Study 4: Existing Road Audit**

**6.4.1** Road Safety Audit was conducted on the existing 47 km long section of 4-lane road between Hazira and Palsana (Surat) in Gujarat.

### **6.4.2 Audit Team**

Two team members including a Senior Road Safety Auditor.

### **6.4.3 Project Background**



The subject road section connects Hazira with Palsana near Surat, at the intersection of NH-53 (old NH-6) and NH-48 (old NH-8). It passes through plain terrain and carries heavy commercial and passenger traffic.

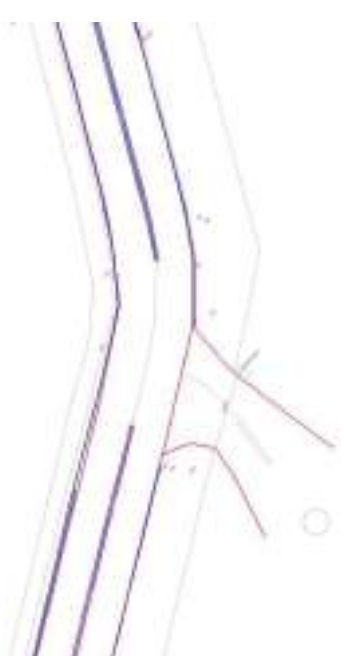
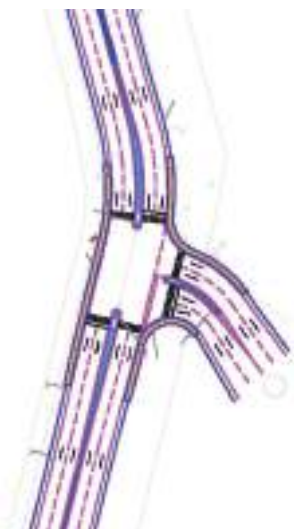

### **6.4.4 Audit Details**

The road authority requests a road safety audit of the existing road. The Project Manager decides to engage an experienced audit team.


**6.4.5** The audit team spends time inspecting roads both day and night. The Project Manager made available as-built drawings also to the Audit Team as well as traffic and accident data that are readily available with them.

**6.4.6** Format of a road safety audit report is presented in the prescribed template. All the titles of issues as listed in the checklist are reproduced to impress that all issues as in the checklist shall be verified and all issues shall be reported with exact location in the road safety audit of the given road. Being a sample report, only a few issues are picked up in the report given below.

No	Safety Concerns & Audit Findings		Risk	Recommendations		Client Response
	Description (with Images If any)			Description (with Figures if any)	Priority	
<b>1</b>	<b>Sight Distances</b>					
1.1	<p>The storage lane for side road and U-turn provided here is highly unsafe as deceleration length, comprising 130m storage lane and 50m taper with 30 m median opening is rather more than required. Moreover, the median plantation up to the median tip obscures the visibility of vehicles emerging from opposite carriageway.</p> 	Very High	<p>Reduce “wide area effect” in the storage lane to be converted with say 40m storage lane + 15m taper + 20m median opening</p> <p>Provide Hazard marker at the exposed median tip</p> <p>Remove median plantation for 120m from median tip to enhance visibility</p> <p>If alteration of physical islands is not possible immediately, the wide area effect can be avoided by the markings as shown below.</p> 	Highly desirable		
<b>2</b>	<b>Intersections</b>					
2.1	<p>Intersection at km 3+500</p> <p>The wide median opening and also side road without channelization in the junction can promote reckless movement. Because of the junction layout, the traffic bound to Hazira may get confused.</p>	High	<p>Reduce the median opening to 20m and through movement is deflected geometrically and establish junction control by Splitter Island and bringing side road more perpendicular.</p>	Highly Desirable		

No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with Images If any)	Risk	Description (with Figures if any)	Priority	
			<p>Remove the median plantation and unwarranted signs and objects that obscure the visibility for a distance 100m from median tip.</p> 	<p>Essential Highly Desirable</p>	
<b>3</b>	<b>Interchanges</b>				
3.1	<p>KRIBHCO Railway Over Bridge/Flyover at km 12+920</p> <p>The sight line is obstructed between traffic approach from slip road and that coming out of ROB/flyover vent.</p> <p>The corner island is not properly shaped to prevent illegitimate movement.</p> 	<p>Very High</p>	<p>Deflect the traffic that is approaching from slip road by another 4.5m to enhance the visibility between traffic approach from slip road and that coming out of VUP/flyover vent.</p>	<p>Highly Desirable</p>	

No	Safety Concerns & Audit Findings		Recommendations		Client Response
	Description (with Images If any)	Risk	Description (with Figures if any)	Priority	
			<p>Provide psychological traffic calming measures for traffic approaching through slip road.</p> <p>Reshape the islands of the junction below ROB/Flyover to avoid the illegitimate movement.</p> <p>Provide footpath to facilitate movement of pedestrians and vehicles.</p>	<p>Essential</p> <p>Essential</p> <p>Essential</p>	
<b>4</b>	<b>Cross sections</b>				
<b>5</b>	<b>Roadside Hazards</b>				
<b>6</b>	<b>Drainage</b>				
<b>7</b>	<b>Signs, pavement markings and delineation</b>				
7.1	<p>Undivided Carriageway at km 21+000</p> <p>The carriageway of the Tapi bridge and approach is of 4-lane width without physical separation. This can cause reckless overtaking. There is no clue about the approaching bridge and footpath is also not user-friendly.</p>	<p>Very High</p>	<p>Provide new Jersey barrier type median to segregate the opposing traffic and reduce opportunity for reckless overtaking on bridge and its approach.</p>	<p>Essential</p>	

No	Safety Concerns & Audit Findings		Recommendations			Client Response
	Description (with Images If any)	Risk	Description (with Figures if any)	Priority		
				<p>Provide No-overtaking sign on the bridge approach.</p> <p>Pave the footpath with tiles and make the footpath walkable.</p> <p>Reposition the hazard marker so that driver can judge the exact edge of hazard protruding into carriageway.</p>	<p>Essential</p> <p>Essential</p> <p>Essential</p>	
<b>8</b>	<b>Vulnerable road users (pedestrians, bicyclists, two wheelers and three wheelers, and animal drawn carts)</b>					
<b>9</b>	<b>Access to property and developments</b>					
<b>10</b>	<b>Lighting and night time issues</b>					
<b>11</b>	<b>General road safety considerations</b>					

**6.4.7 Certification**

The Audit Team has carried out this existing road safety audit according to the IRC Manual on Road Safety Audit.

Signed

Team Leader on behalf of the RSA Team (Dated.....)



## 7. ROAD SAFETY AUDIT CHECKLISTS

While engineers may be described as problem solvers, road safety auditors are best thought of as problem finders! To help them in their problem finding work, a set of checklists can be a useful memory jogger.

### 7.1 The Purpose of these Checklists

**7.1.1** The following set of checklists has been developed for use in road safety audits. They include references to the typical road types and road projects that are common. The checklists remind audit teams to always consider the safety needs of the vulnerable road users (pedestrians, bicyclists, rickshaw pullers and three wheelers) in equal measure to the safety needs of motorised road users (car, truck and bus users).

**7.1.2** Checklists are intended to reduce the risk that important safety concerns may be overlooked during an audit. However they cannot be a substitute for knowledge or for experience. The use of the checklists also requires sound judgement.

**7.1.3** Checklists should therefore be considered as a list of reminders to help in audit. There are different road projects on different types of roads and in many varied topographical locations. Therefore these checklists may, or may not, be fully applicable to all road projects. Be prepared to expand each list as and when necessary.

**7.1.4** These checklists are intended to be photocopied. It is recommended that the originals are kept intact for subsequent audits. The photocopies can be taken on site and used as necessary. The completed checklists are kept by the audit team for future reference. It is not necessary to attach completed checklists to an audit report or to pass them to the Client.

**7.1.5** The road safety audit report is the necessary deliverable from an audit.

### 7.2 When and how to use the Checklists

**7.2.1** There are five recognised stages of audit in India, including the road safety audit of existing roads. Checklists for each stage are contained in this Section.

**7.2.2** It is suggested that the audit team leader uses the checklists as follows:

- Determine which checklist is needed, based on the stage of the project.
- Have the checklist(s) photocopied. Use the copy for the desktop audit and the site inspection.
- Remind team members that a successful audit is not achieved simply by just ticking off each item on the checklist. The topics in each checklist cover only the common elements of a road project; they are detailed but are not exhaustive.
- Remember too that some checklist items may not be relevant to the project being audited. Auditors need to therefore exercise their own judgement about the safety of any feature in the design of the project. This is where knowledge, experience and judgement are paramount.

- Audit team members are encouraged to think broadly about the safety of the future road users of the road project and not to be restricted only to items on the checklists.
- The checklists have been so worded that a negative answer (NO) to any question means that there is a safety issue that may need to be included in the audit report.
- A positive (YES) answer given to any question means that issue has been examined but is not considered likely to present a safety issue to the future road users.
- The NA (Not Applicable) column is provided for completeness as there will be many occasions when some items on the checklists are not relevant to the proposal being audited.
- Add notes in the Comments column as felt necessary to remind to alert the audit team where the safety issues are located and what they are.
- Some auditors may elect to use digital recorders or mobile phones to record their observations while on site. This is often easier than writing notes on the copies of the checklists and it can provide an opportunity for more details to be recorded in a shorter period of time.

### **7.3 The Road Safety Audit Checklists**

**7.3.1** Following Checklists are included:

**Table 7.1** Checklist for Planning/Feasibility Stage

**Table 7.2** Checklist for Detailed Design Stage

**Table 7.3** Checklist for Construction Stage

**Table 7.4** Checklist for Pre-opening Stage

**Table 7.5** Checklist for Audit of Existing Roads

**7.3.2** A separate checklist for Detailed Design Stage Audit of Rural Roads (Refer **Table 7.6**) has been included for rural roads.

**Table 7.1 Checklist for Feasibility Stage/Preliminary Design Stage Audit**

Issue	Yes	No	NA	Comments
<b>1. Road Design Standards</b>				
Are the design standards being used appropriate (considering the class of terrain, mix of traffic including Vulnerable Road Users and the function of the proposed road)?				
Has the design speed been adopted considering the hierarchy of Road and mix of traffic including Vulnerable Road Users?				
Will the likely speed limit on the proposed road be compatible with the design speed and mix of traffic, non-motorized traffic including pedestrians?				
Does the route fit in with the physical constraints imposed by the topography?				
Does the project road relieve routes or sites with bad accident records?				
Check for consistency throughout the route; note any location where alignment standard changes abruptly and is not as would be expected by drivers.				
<b>2. Alignment</b>				
Will the design speed be “safe” with regard to horizontal and vertical alignment?				
Does the alignment (horizontal and vertical) give sufficient forward visibility for the selected design speed? (Check for inadequate stopping sight distances)?				
Will horizontal and vertical alignments be safe and consistent, especially at interchanges and intersections?				
Will all merging, diverging and weaving areas be “safe”?				
Is the proposal consistent with the adjacent road network?				
Do the horizontal and vertical alignments fit together comfortably? (Check for bad combinations, such as a sharp bend immediately after a summit curve, and sag curve within a bend).				

Issue	Yes	No	NA	Comments
Will sight distances be satisfactory – especially at intersections and property accesses?				
Does the alignment provide safe overtaking opportunities? Does it avoid creating situations where the forward visibility is marginal for overtaking (neither clearly adequate nor inadequate)?				
Does the treatment at curves, proposed if any, make appropriate, adequate and safe provision for transition curves, super elevation and extra width of carriageway and formation?				
Does the vertical alignment pose excessive demands on the power of heavy vehicles? Has it been designed so those maximum grades are interspersed with recovery grades?				
<b>3. Visibility and Sight Distance</b>				
Are sight and stopping distances adequate throughout the proposal?				
Is the design free of sight restrictions (maybe due to buildings, trees, signs, or rock slopes)?				
Does the design and proposal within an encumbrance free ROW allow adequate visibility for an approaching driver to see a pedestrian waiting to cross the road?				
Does the design and proposal within an encumbrance free ROW allow adequate visibility funnel for an approaching driver to see a vehicle waiting to cross the carriageway from side road or storage lane of median?				
<b>4. Staged Works</b>				
If the scheme is to be constructed in stages, are the stages arranged to ensure maximum safety?				
If the scheme is a stage towards a wider or dual carriageway, is the design adequate to clearly impart this message to drivers? (Always look for misleading things that could confuse drivers/riders)				

Issue	Yes	No	NA	Comments
Is the transition between single and dual carriageway (either way) handled safely?				
<b>5. Cross Section</b>				
Are the widths of the carriageway, shoulders, medians (if any), service roads in accordance with standards and adequate for the function of the road and volume and the mix of traffic likely to use it?				
Check whether bridges have footpaths and they have proper gradients/crash barriers/parapets.				
a) Existing Bridges				
b) New proposed Bridges				
c) Approaches of proposed VUP/PUPs				
Note any location where the cross-section standard changes abruptly along the route or is otherwise inconsistent with driver expectations.				
Have the shoulders and side slopes been designed to a safe standard and note any locations with inadequate shoulder width?				
Have the side drains been designed to a safe standard? Are the batter slopes and drains safe for run-off vehicles to traverse?				
Check whether the cross-section has adequate provision for the Vulnerable Road Users including persons with disabilities:				
(a) Pedestrians: Have paved footpath, adequate refuge width on median and proper ramps, up and down kerbs, where there is regular pedestrian traffic?				
(b) Bicyclists: Segregated areas (e.g. paved shoulders) where numbers are significant.				
In particular, is the cross section wide enough to provide sheltered turn lanes within the median (in case of divided carriageway)? Is it possible to provide storage lane for small vehicles that really need protection without being exposed to through traffic.				

Issue	Yes	No	NA	Comments
If a median is proposed, will it be wide enough for the safe installation of street lighting, where required either during the proposed works or later?				
Does the cross section avoid unsafe compromises at bridges and other narrowing's? (NOTE: It is desirable for safety to continue full width shoulders across bridges and other narrowings).				
Are overtaking and/or climbing lanes proposed if needed?				
Are all roadside hazards (existing and proposed) being managed "safely"? (NOTE: Check if a clear zone has been used during the development of the proposal and assess if that clear zone will be adequate).				
<b>6. Interchanges</b>				
Are all features of each interchange design "safe"?				
Will the type of interchange be understood by road users?				
<b>7. Intersections</b>				
The type of junction (T-type, staggered, signal controlled, roundabout) suitable for the function of the two or more roads, the traffic volume, the traffic movements (pedestrians and vehicular) and the site constraints? Is it safest alternative?				
Does the layout encourage slow controlled speed at and on the approach to stop/give way lines and other critical decision points?				
Are the number and distribution of proposed intersections suitable in relation to the function of the new road, the surrounding road network, and access for all traffic?				
Are the Median openings for U-turn proposed to minimise wrong way movements?				
Is each intersection easily identified and understood from all approaches?				

Issue	Yes	No	NA	Comments
Is there adequate provision for channelizing the different streams of traffic? (Check the provision for right turn lanes, deceleration lanes and acceleration lanes?)				
Is adequate provision made for pedestrians and non-motorised vehicles?				
Will all necessary turns (including U turns) be able to be made safely?				
Are sight lines within each intersection adequate and free of obstruction by fixed objects such as buildings, overpass structures, traffic signs or vegetation?				
Is the design free of all Y junctions?				
Is the proposed traffic control at each intersection (Stop/Give Way, roundabout, traffic signals) as “safe” as practical?				
Is the provision of night times lighting adequate, if not what are the deficiencies?				
<b>8 Vulnerable Road Users (pedestrians, bicyclists, two wheelers and three wheelers, animal drawn carts)</b>				
Will pedestrians (particularly the young, old and disabled) be able to safely walk along both sides of the road? (NOTE: Consider the expected traffic speeds on the new road).				
Will pedestrians (particularly the young, old and disabled) be able to safely cross the road? (NOTE: Consider the expected traffic speeds on the new road).				
Do all vulnerable road users have connectivity along their route, and lateral clearance to motor traffic?				
Is the proposal free of “squeeze” points where vulnerable road users may be exposed to traffic?				
Does the proposal provide adequate width of pedestrian footpath and ensure sight distance?				
<b>9. Matching in to the existing Road Network</b>				
At the interface between the new and the existing roads, has sufficient attention been given to safety matters?				

Issue	Yes	No	NA	Comments
Is the interface between the new and existing well away from any hazard (such as a crest, a bend, a roadside hazard or where there may be poor visibility?)				
If the proposal cuts across established paths (village roads, pedestrian walkways etc), has attention been given to providing safe alternative routes for the users of those paths?				
<b>10. General Road Safety Issues</b>				
Are safety measures taken on sections of the road having special events, festivals, market places or other intermittent activities?				
Are railway level crossings suitably identified and safe treatments proposed?				
Are sufficient truck rest areas proposed with toilet facilities?				
Are sufficient rest areas proposed?				
Will the new road be as safe as practical given the local weather conditions (sunrise, sunset, fog, snow, dust storms, or monsoonal storms)?				
Is the proposal likely to be free of “visual deceit”?				
Has the proposal taken safe account of animals on the road, including wild animals crossing from adjacent forests or fields?				
<b>11. Roadside Hazards</b>				
Are there any roadside hazards which appear to have been left out in the design?				
Are crash barriers proposed where only necessary?				
Is the type of barrier proposed suitable for this location?				
Are impact attenuators provided in gore area?				
Do the standard drawings indicate that the barrier terminals will be a suitably safe type?				



Issue	Yes	No	NA	Comments
Do the standard drawings indicate a safe connection of the barrier to bridge abutments, together with the necessary reduction in post spacing to stiffen the barrier and prevent “pocketing”.				
<b>12. Providing for Public Transport</b>				
Does the design provide for all forms of public transport that will use the new road?				
Are bus lay-bys to be provided at places where passengers are most likely to use them?				
Are footways/footpaths proposed to and from bus stops and other key public transport locations assist passengers for safe commuting?				
Have suitable paved waiting areas been proposed for three-wheelers/cycle rickshaws?				
<b>13. Nigh Time Issues</b>				
Will the interface between the new road and the old road be obvious and as safe as practical at night?				
Will the proposed geometry be understandable for road users to traverse at night?				
Is the placement of electric poles safely located?				
<b>14. Road Maintenance Vehicles</b>				
Will road maintenance vehicles be able to work safely on the new road?				
<b>15. Drainage</b>				
Will the road be well drained?				
Will the drains be covered, or located behind crash barrier?				
Yes = likely to be satisfactory for safety				
No = there are possible safety issues				
NA = not applicable				

**Table 7.2 Checklist for Detailed Design Stage Audit**

Issue	Yes	No	NA	Comments
<b>1. Horizontal and Vertical Alignment</b>				
Will the design speed be “safe” with regard to horizontal and vertical alignment?				
Does the alignment (horizontal and vertical) give sufficient forward visibility for the selected design speed? (Check for inadequate stopping sight distances)?				
Will horizontal and vertical alignments be safe and consistent, especially at interchanges and intersections?				
Will all merging, diverging and weaving areas be “safe”?				
Is the proposal consistent with the adjacent road network?				
Do the horizontal and vertical alignments fit together comfortably? (Check for bad combinations, such as a sharp bend immediately after a summit curve, and sag curve within a bend).				
Will sight distances be satisfactory – especially at intersections and property accesses?				
Does the alignment provide safe overtaking opportunities? Does it avoid creating situations where the forward visibility is marginal for overtaking (neither clearly adequate nor inadequate)?				
Does the treatment at curves, proposed if any, make appropriate, adequate and safe provision for transition curves, super elevation and extra width of carriageway and formation?				
Does the vertical alignment pose excessive demands on the power of heavy vehicles? Has it been designed so those maximum grades are interspersed with recovery grades?				
<b>2. Typical Cross Sections</b>				
Are the widths of the carriageway, shoulders, medians (if any), service roads in accordance with standards and adequate for the function of the road and volume and the mix of traffic likely to use it?				

Issue	Yes	No	NA	Comments
<p>Check whether bridges have footpaths and they have proper gradients/crash barriers/parapets.</p>				
<p>a) Existing Bridges</p> <p>b) New proposed Bridges</p> <p>c) Approaches of proposed VUP/PUPs</p>				
<p>Note any location where the cross-section standard changes abruptly along the route or is otherwise inconsistent with driver expectations.</p>				
<p>Have the shoulders and side slopes been designed to a safe standard and note any locations with inadequate shoulder width?</p>				
<p>Have the side drains been designed to a safe standard? Are the batter slopes and drains safe for run-off vehicles to traverse?</p>				
<p>Check whether the cross-section has adequate provision for the Vulnerable Road Users including persons with disabilities:</p>				
<p>(a) Pedestrians: Have paved footpath, adequate refuge width on median and proper ramps, up and down kerbs, where there is regular pedestrian traffic?</p> <p>(b) Bicyclists: Segregated areas (e.g. paved shoulders) where numbers are significant.</p>				
<p>In particular, is the cross section wide enough to provide sheltered turn lanes within the median (in case of divided carriageway)? Is it possible to provide storage lane for small vehicles that really need protection without being exposed to through traffic.</p>				
<p>If a median is proposed, will it be wide enough for the safe installation of street lighting where required either during the proposed works or later?</p>				
<p>Does the cross section avoid unsafe compromises at bridges and other narrowings? (NOTE: It is desirable for safety to continue full width shoulders across bridges and through narrowings).</p>				

Issue	Yes	No	NA	Comments
Are all roadside hazards (existing and proposed) being managed “safely”? (NOTE: Check if a clear zone has been used during the development of the proposal and assess if that clear zone will be adequate).				
Are shoulders proposed to be paved?				
Are overtaking and/or climbing lanes proposed, especially in hill sections?				
Is safe provision to be made for breakdown vehicles, and emergency vehicles?				
<b>3. New/existing Road Interface</b>				
Will the transition from old road to the new scheme be “safe”?				
<b>4. Staged Works</b>				
If the scheme is to be constructed in stages, are the stages arranged to ensure maximum safety?				
Is the transition between single and dual carriageway (either way) handled safely?				
<b>5. Intersections</b>				
The type of junction (T-type, staggered, signal controlled, roundabout) suitable for the function of the two or more roads, the traffic volume, the traffic movements (pedestrians and vehicular) and the site constraints?				
Does the layout encourage slow controlled speed at and on the approach to stop/give way lines and other critical decision points?				
Are the number and distribution of proposed intersections suitable in relation to the function of the new road, the surrounding road network, and access for all traffic?				
Are the Median openings for U-turn proposed to minimize wrong way movements?				

Issue	Yes	No	NA	Comments
Is each intersection easily identified and understood from all approaches?				
Is there adequate provision for channelizing the different streams of traffic? (Check the provision for right turn lanes, deceleration lanes and acceleration lanes?)				
Is adequate provision made for pedestrians and non-motorised vehicles?				
Are pedestrian crossing places marked, and are pedestrians channeled to these crossings?				
Will all necessary turns (including U turns) be able to be made safely?				
Are sight lines within each intersection adequate and free of obstruction by fixed objects such as buildings, overpass structures, traffic signs or vegetation?				
Is the design free of all Y junctions?				
Is the proposed traffic control at each intersection (Stop/Give Way, roundabout, traffic signals) as "safe" as practical?				
Is the provision of night times lighting adequate, if not what are the deficiencies?				
Will traffic signal control at the intersection(s) be clearly seen and understood?				
With roundabouts, is adequate deflection provided for all approaches?				
Are correct signs shown for all approaches to the roundabout?				
For other intersections, are Stop/Give Way signs shown and correctly located for maximum conspicuity?				
Is the specific designs/proposal and even typical layouts when applied allows adequate visibility for an approaching driver to see a pedestrian waiting to cross the road?				

Issue	Yes	No	NA	Comments
<p>Is the specific designs/proposal and even typical layouts when applied allows adequate visibility funnel for an approaching driver to see a vehicle waiting to cross the carriageway from side road or storage lane of median?</p>				
<b>6. Interchanges</b>				
<p>Are sight lines open and free of obstruction at all merges and diverges?</p>				
<p>Are the distances between decisions making points sufficient for safety?</p>				
<p>Is the signing scheme for each interchange clear and will it be easily understood by road users?</p>				
<p>Are all roadside hazards in the interchange identified and safely protected?</p>				
<b>7. Adjacent Land</b>				
<p>Will all accesses to and from adjacent land/properties be “safe”?</p>				
<p>Is fencing provided in rural areas to keep animals from straying onto the road?</p>				
<b>8. Roadside Hazards</b>				
<p>Are crash barriers provided only where necessary?</p>				
<p>Is the type of each proposed barrier suitable for its location?</p>				
<p>Do the standard drawings indicate that the barrier terminals will be a suitably safe type?</p>				
<p>Are impact attenuators provided in gore area?</p>				
<p>Do the standard drawings indicate a safe connection of the barrier to bridge abutments, together with the necessary reduction in post spacing to stiffen the barrier and prevent “pocketing”.</p>				

Issue	Yes	No	NA	Comments
<b>9. Vulnerable Road Users (pedestrians, bicyclists, two wheelers and three wheelers and animal drawn carts)</b>				
Do all vulnerable road users have connectivity along their route, with suitable lateral clearance to motor traffic?				
Will pedestrians (particularly the young, old and disabled) be able to safely walk along both sides of the road?				
Is the design free of “squeeze” points where vulnerable road users may be exposed to traffic?				
Will pedestrians (particularly the young, old and disabled) be able to safely cross the road?				
Are dropped kerbs provided at all intersections and mid-block locations where pedestrians are to cross?				
If formal crossings are proposed, are these conspicuous on each approach?				
Are the correct signs and pavement markings proposed for each pedestrian facility?				
Will each crossing facility be well illuminated at night so that pedestrians can be well seen by drivers/riders?				
If mid-block traffic signals are proposed, will these have pedestrian push buttons?				
Are pedestrian paths to be provided through medians to permit pedestrians to cross “at road level” and to assist disabled pedestrians with improved access?				
Has adequate provision been made for safe parking and stopping by three-wheelers/cycle rickshaws?				
<b>10. Signs, Pavement Markings and Delineation</b>				
Do all signs (regulatory, warning and direction) shown in the DPR accord with the 6 C’s (Conspicuous, Clear, Comprehensible, Credible, Consistent, and Correct) of good signage and as per IRC:67?				

Issue	Yes	No	NA	Comments
Are Informatory signs provided for the category/function road proposed? (Check for Shoulder mounted and Gantry Signs)				
Overhead signs – size, message information adequate, languages as per IRC standards.				
Will all larger (more than 100mm diameter) sign supports be located outside the clear zone, or else be frangible?				
Is good delineation (curve warning signs, advisory speed signs, guide posts and chevron alignment markers) provided where required?				
Safety Audit of VMS				
i) Horizontal clearance of vertical post of sign from carriageway edge				
ii) Vertical clearance of VMS signs at highest point on carriageway				
iii) Readability of VMS signs during Day/Night.				
Check for any unauthorized traffic signs and use of non-standard signs (color and shape)				
Location and spacing of signs				
a) Note locations where there are too many signs placed				
b) Note the signs placed too close to each other				
Are all junctions provided with advance direction sign, distance information sign and intersection sign etc.?				
Has correct type of pavement markings been used in various situations (e.g. lane line, edge line etc.)?				
Are correct colour used for laying road markings?				
Is there any deficiency in the delineation of merge and diverge areas, including situations where ‘through’ traffic may inadvertently lead into auxiliary and turn lanes?				
Are zebra crossing markings provided at junctions and mid-blocks of the sections (depending upon the movement of pedestrian)?				



Issue	Yes	No	NA	Comments
Is positioning of stop lines appropriate?				
Are the directional arrows marked on the pavement guiding the driver or creating confusion to the driver?				
Are there locations where there is a lack of ‘Hazard markings’ at approach end of island, medians and culverts/bridges etc.?				
Have retro-reflective markers/road studs been installed? Where coloured markers are used, have they been installed correctly?				
If chevron alignment markers are installed, have the correct types of markers been used?				
Do the drawings also indicate high quality reflective material (red on left, white on right) atop each guide post?				
<b>11. Parking</b>				
Have sealed and marked areas been provided for parking?				
Will the parking be adequate and safe?				
<b>12. Emergency Service Vehicle Access</b>				
Has provision been made for safe access and movements by emergency vehicles?				
Are median openings frequent, visible and well signed?				
<b>13. Lighting and Night Time Issues</b>				
Will all signs be located where they can be easily seen at night?				
Are the critical locations (intersections, pedestrian facilities, Bus bays, bus stops, truck lay bye, toll plaza etc.) proposed to be lit?				
Is lighting provided on road sections passing through built up areas, service roads, above and below the grade separator, underpass,etc				

Issue	Yes	No	NA	Comments
Are the proposed lighting scheme and illumination levels of an appropriate standard, consistent with the needs of the location, pedestrian and other factors?				
Will the proposed geometry be understandable for road users to traverse at night?				
Do the standard drawings indicate that the lighting columns will be frangible?				
If the columns are not frangible, have other actions been taken to make these safe for road users?				
Are there any lighting poles in the median(less than 2m wide) unprotected by crash barriers?				
Identify the locations where street lighting columns constitute a hazard to traffic (on the outside of sharp curves, on small islands, noses of medians) or which may conflict visually with traffic signals or signs?				
<b>14. Drainage</b>				
Does the design provide adequate drainage?				
Will drains be covered, or located outside the clear zone, or shielded behind crash barrier?				
<b>15. General Road Safety Considerations</b>				
Is the new road as safe as practical given the local weather (sunrise, sunset, snow, fog, rain, wind)?				
Is the project free of all “visual deceit”?				
Is the road surface free of gravel and sand, and with good skid resistance?				
Yes = likely to be satisfactory for safety				
No = there are possible safety issues				
NA = not applicable				

**Table 7.3 Checklist for Construction Stage Audit**

Issue	Yes	No	NA	Comments
<b>1. Traffic Management Plan (Design and Implementation)</b>				
Has a traffic management plan (TMP) been prepared for the road work site as per IRC:SP:55?				
Has the TMP been approved by the Supervision Consultant or other authorized person?				
Does the Contractor have an appointed Safety Engineer who is responsible for road safety at the work site, including checking the condition of the installed TMP every day?				
Does the TMP provide adequate and correct signage, delineation for all road users under all traffic conditions?				
Does the TMP provide work site protection (barriers) for all road users under all traffic conditions?				
Has the TMP been implemented correctly at the road work site?				
Is the advanced warning zone adequately signed to alert approaching road users of the presence of the road works?				
Is the transition zone correctly and adequately signed and delineated to guide approaching road users into their correct path?				
Road Works Stage				
Is the termination zone adequately signed to advise road users that they are past the road works and may return to normal road/highway speeds?				
Are the flagmen highly conspicuous and placed where they can give clear instructions to approaching drivers/riders in advance of the work site?				
Has the safety buffer zone been provided as per IRC:SP:55?				

Issue	Yes	No	NA	Comments
<b>2. Speed Control</b>				
Are the speed limit signs conspicuous?				
Are there sufficient numbers of repeater speed restriction signs through the length of the work site?				
Is the signed speed appropriate for safe traffic movement through the work site?				
Have local Police been requested to enforce the signed speed limit through the worksite?				
Are speeds managed (through signs, enforcement and if necessary road humps) so that vehicle operating speeds that pass within one traffic lane width of any work site are 40km/h or lower?				
<b>3. Signs, Signals, Pavement Markings and Delineation</b>				
Are all necessary warning, direction and regulatory signs in place as shown in the TMP?				
Are all existing road signs (those that are unnecessary during the works) covered to avoid distraction or misinformation?				
Are all "Men At Work" signs removed or covered when work is finished for the day (Applicable in case of maintenance works)? (NOTE: Signs must be credible and it brings other signs into disrepute to leave "Men At Work" signs in place if no workers are present).				
Do all signs satisfy the 6C's of good signage practice				
Are temporary traffic signals clearly visible to the approaching drivers/riders?				
If the signals generate traffic queues, can the end of the queue be easily seen by approaching drivers/riders?				
Are pavement markings consistent and clear through the length of the work site for both day and night?				
Is delineation through the site safe for all road users under all anticipated conditions?				

Issue	Yes	No	NA	Comments
With several layers of asphalt typically to be laid for new roads, is temporary lane marking being used on each new layer to guide drivers/riders as an interim safety initiative, especially at night?				
<b>4. Diversions from one Carriageway to the other</b>				
If traffic is to be diverted from one carriageway onto the other, do the advanced warning signs provide clear guidance about the diversion ahead and are they well located to alert all approaching road users?				
Is the transition zone well delineated (with plastic cones and other forgiving devices) to reduce the number of traffic lanes well before the carriageway ends?				
Is the carriageway (on which the work is to take place) fully closed at all intersections?				
Are drivers/riders from the side roads given adequate warning of the two way traffic operation on the sole carriageway open on the main road?				
Is the carriageway (on which the work is to take place) fully and clearly closed off to all traffic?				
Are all drivers/riders in both directions on the other carriageway adequately reminded they are on a two way section of road (such as with "Two Way" warning signs)?				
Is the management of all two way traffic sections through the road work site safe for all road users both day and night?				
<b>5. Road Surface</b>				
Is the road surface suitable for safe movement by all road users, especially two and three wheelers?				
Are paved surfaces swept and kept free of gravel and sand?				
Has a suitable paved surface been provided along with correct lane markings to guide drivers/riders through diversions?				
Have signs and markers/road studs been used to highlight changes in road surface to approaching drivers/riders?				

Issue	Yes	No	NA	Comments
Have signs and markers/studs been used to highlight locations where different layers of asphalt end, causing sudden changes in the road surface for approaching drivers/riders?				
<b>6. Crash barriers</b>				
Are all crash barriers necessary and are they installed correctly?				
Have safe terminals (that are suitable for the operating speeds through the work site) been placed on the end of each section of barrier?				
<b>7. Work Site Access</b>				
Are work site access points located with adequate sight distances for entering and exiting work vehicles?				
Are all site access points closed off to unauthorized traffic?				
Are appropriate traffic controls in place where works traffic and public traffic interact?				
<b>8. Road Worker Safety</b>				
Are all workers and supervisors at the works site wearing good and required PPE as per HSE norms and as per the requirement of activity being performed?				
Is safe ladder provided for workers at site to reach the working platform/area?				
Is working platform provided for safe working with toe guard and railing to prevent worker's fall?				
Is there a suitable safety zone in advance of and beside the work site?				
<b>9. Vulnerable Road Users (pedestrians, bicyclists, two wheelers and three wheelers, and animal drawn carts) through the Work Site</b>				
Are pedestrians, bicyclists, and two/three wheelers able to move safely through the construction zones?				

Issue	Yes	No	NA	Comments
Are vulnerable road users able to cross the road safely?				
In particular, is safe access across the road provided for the young, the elderly and the disabled?				
Have all-weather footways been provided to assist public transport users to reach their stops without walking through the road work site?				
Do the construction layouts and practices allow adequate visibility for an approaching driver to see a pedestrian waiting to cross the road?				
Do the construction layouts and practices allow adequate visibility funnel for an approaching driver to see a small vehicle waiting to cross the carriageway from side road or storage space of median?				
<b>10. Safety at Night</b>				
Are the road works conspicuous to all road users after dark?				
Are travel paths obvious to all road users after dark?				
In particular, do carriageway closures have suitable advance warning zones and transition zones that are conspicuous and clearly delineate for night time?				
Yes = likely to be satisfactory for safety				
No = there are possible safety issues				
NA = not applicable				

**Table 7.4 Checklist for Pre-opening Stage Audit**

Issue	Yes	No	NA	Comments
<b>1. New/Existing Road Interface</b>				
Is the interface between the new road and the old road as safe as practical?				
Where drivers/riders depart the new road and return to the existing network, are they provided with sufficient delineation and pavement markings to compensate for possible increased speeds?				
<b>2. Intersections</b>				
Are sight lines free of obstructions at all intersections?				
Are the intersection layouts clear and visible from all approaches?				
Are traffic signals conspicuous, functioning properly and safely?				
Are the signal timings reasonable and likely to maximise driver/rider compliance?				
Are the signal phasings reasonable and safe, with no conflicting movements?				
Are pedestrian signals installed at each signalised intersection and are they easy to see, with adequate WALK time and clearance time?				
Are roundabouts visible and recognisable from all approaches?				
Are correct advanced warning and suitable direction signs installed on each approach to each roundabout?				
At other intersections are Stop and/or Give Way signs conspicuous and correctly installed to make priority clear?				
<b>3. Interchanges</b>				
Are sight lines open and free of obstruction at all merges and diverges?				



Issue	Yes	No	NA	Comments
Are the distances between decision-making points sufficient for safety?				
Are the direction signs for each interchange clear and easily understood at the anticipated operating speeds?				
<b>4. Signs, Pavement Markings and Delineation</b>				
Do all signs satisfy the 6Cs of good signage practice?				
Is there a need for any more signs to warn, inform, guide, control or delineate?				
Have all unnecessary old signs and markings (including those from the road works) been removed?				
Are the speed zones provided with clear speed restriction signs of a suitable value?				
Are pavement markings continuous, correct and conspicuous?				
Are road signs and road markings tested for retro-reflectivity and conforming to relevant IRC standards?				
Have potentially confusing situations been removed or resolved safely?				
Are guide posts correctly installed in accordance with the layouts shown in the standard drawings?				
Are chevron alignment markers installed where necessary and in accordance with the layouts shown in the standard drawings?				
Is there consistency and uniformity of delineation and markings throughout the scheme?				
Have initiatives been taken to delineate the road and to maximise the chance that vehicles will remain on the road?				
<b>5. Roadside Hazards</b>				
Are all roadside hazards adequately treated i.e. they adequately provided with signs?				

Issue	Yes	No	NA	Comments
Is safety barrier installed where necessary?				
Is barrier correctly and safely installed?				
Are impact attenuators provided in gore area?				
Are all bridge abutments and culverts safely treated?				
Is there a degree of hazard associated with large trees, boulders, etc. and whether these can be treated to improve roadside safety?				
Do the trees and other vegetation obstruct driver and pedestrian sight lines, which are essential for safe traffic operation?				
Is there adequate delineation/visibility of barriers and fences during night times?				
Is any thick growth of vegetation by the roadside enough far back from the edge of the pavement to enable a driver to take protective steps in time if any human or animal should run across the road from behind or within the vegetation?				
Are there any sharp edged or pointed fixtures or tops of supporting verticals on the median crash barriers or on dividers which can hurt a motor cyclist in case of a collision or crash or loss of balance?				
Are there any village name boards or direction boards by the roadside with pointed ends to hurt a passenger in a bus on window seat?				
Bridges/Canal crossings: Are the open spaces by the side of ends of Parapets covered by protective crash barriers or walls to prevent vehicles going into the river or canal?				
Is the vegetation removed and paving in the median at openings in median at junctions or for U Turns or for pedestrian crossings for a length of 120 m on either side of opening to afford complete visibility to drivers?				
Is the height of vegetation in the median less than 60 cm on curves?				

Issue	Yes	No	NA	Comments
Is the median clear of any trees with trunks with girth greater than 30 cm? If not, are such locations enveloped by protective crash barriers?				
Are fixing details of pipe railing such that the entire length of pipe is smooth and continuous without any projection on road ward side?				
Are entrances to abandoned roads properly fenced off?				
<b>6. Vulnerable Road Users (pedestrians, bicyclists, two wheelers and three wheelers, and animal drawn carts)</b>				
Do all vulnerable road users have connectivity along the road, with suitable lateral clearance to motor traffic?				
Will pedestrians (particularly the young, old and disabled) be able to safely walk along the road?				
Are pedestrian crossing places marked, and are pedestrians channeled to these crossings?				
Is the new road free of “squeeze” points where vulnerable road users may be exposed to traffic?				
Will pedestrians (particularly the young, old and disabled) be able to safely cross the road?				
Are dropped kerbs provided at all intersections and mid-block locations where pedestrians are to cross?				
Is the number and placement of the pedestrian facilities adequate and safe for the situation and the pedestrian numbers?				
Is each pedestrian facility clearly marked and conspicuous on each approach?				
Are the correct signs and pavement markings installed at each pedestrian facility?				
Is each crossing facility well illuminated at night so that pedestrians can be seen by drivers/riders?				

Issue	Yes	No	NA	Comments
Do all mid-block traffic signals have pedestrian push buttons to allow pedestrians to register their demand to cross the road?				
Are medians in urban areas free of barriers, suitably wide and with a suitable surface to act as an effective pedestrian refuge?				
Are pedestrian paths provided through medians to permit pedestrians to cross “at road level” and to assist disabled pedestrians?				
Is adequate safe parking and stopping provided for three-wheelers?				
Are bus stops located where passengers will use them?				
Are bus stops well delineated and lit?				
Are bus stops sealed for all-weather use?				
Does the newly constructed road allow adequate visibility for an approaching driver to see a pedestrian waiting to cross the road?				
Does the newly constructed road allow adequate visibility funnel for an approaching driver to see a vehicle waiting to cross the carriageway from side road or storage space of median?				
<b>7. Drainage</b>				
Does the new road appear to have sufficient cross fall or camber and adequate drainage to prevent ponding of rainwater from occurring?				
Are all drains safe (covered, underground or outside the clear zone)?				
<b>8. Landscaping</b>				
Is the landscaping “safe” in terms of roadside hazards? (NOTE: Any tree with a trunk in excess of 100mm diameter is considered a road side hazard if planted within the clear zone).				

Issue	Yes	No	NA	Comments
Does the landscaping permit clear sight lines at all intersections, pedestrian facilities and median openings?				
<b>9. Lighting and Night Time Issues</b>				
Are all signs easy to see and read at night?				
Are the critical locations (intersections, pedestrian facilities, bus bays, bus stops, truck lay bye, toll plaza, etc.) conspicuous at night?				
Is lighting provided on road sections passing through built up areas, service roads, above and below the grade separator, underpass,etc				
Are the illumination levels of an appropriate standard, consistent with the needs of the location, pedestrian and other factors?				
Is the “through route” well signed, line marked and obvious to road users at night?				
Is the new road free of visual deceit for road users at night?				
Are the lighting columns frangible? If not, are they outside the clear zone?				
Are there any lighting poles in the median(less than 2m wide) unprotected by crash barriers?				
<b>10. Access to Property and Developments</b>				
Are all accesses to/from adjoining properties conspicuous and as “safe” as practical?				
Is fencing provided and adequate to keep animals off the road, especially in rural areas?				
<b>11. General Road Safety Considerations</b>				
Is the new road as safe as practical given the local weather (sunrise, sunset, snow, fog, dust storms, or monsoonal storms)?				

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<b>Issue</b>	<b>Yes</b>	<b>No</b>	<b>NA</b>	<b>Comments</b>
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Is the project free of all “visual deceit”?				
Is the road surface free of gravel and sand, and with good skid resistance?				
Have the batter slopes of cuttings been treated to minimise the risk of rocks falling onto the new road?				
Check that all temporary arrangements, signs, etc, have been removed and replaced by permanent arrangements.				

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Yes = likely to be satisfactory for safety

No = there are possible safety issues

NA = not applicable

**Table 7.5 Checklist for Safety Audit of Existing Roads**

Issue	Yes	No	NA	Comments
<b>1. Sight Distances</b>				
Are all sight distances adequate for the speed of traffic using this road?				
Are safe overtaking opportunities provided?				
Are U turn provisions conspicuous and “safe”?				
<b>2. Intersections</b>				
Are all intersections clear and visible?				
Are all traffic signals conspicuous, functioning properly and safely?				
Are roundabouts visible and recognisable from all approaches?				
<b>3. Interchanges</b>				
Are sight lines open and free of obstruction at all merges and diverges?				
Are the distances between decision-making points sufficient for safety at the operating speed?				
Is the direction sign for each interchange clear and easily understood at the operating speed?				
<b>4. Cross Sections</b>				
Are lane widths, shoulder widths and bridge widths, “safe” for the traffic volume and mix?				
Are medians and islands of adequate width for the safety of likely users?				
Are the shoulders suitable for use by all vehicles and road users, including pedestrians, cyclists and animals?				

Issue	Yes	No	NA	Comments
Is appropriate super elevation and extra width of carriageway provided on curves?				
<b>5. Roadside Hazards</b>				
Are all larger (more than 100mm diameter) sign supports located outside the clear zone if they are not frangible?				
Are all crash barriers correctly and safely installed?				
Are any hazards within the agreed clear zone for this road?				
Are crash barriers used only where necessary?				
Are impact attenuators provided in gore area?				
Are all the crash barriers correctly installed?				
<b>6. Drainage</b>				
Is the road well drained?				
Are all drains outside the clear zone, covered, or behind suitable barrier?				
<b>7. Signs, Pavement Markings and Delineation</b>				
Do all signs and pavement markings satisfy the 6C's of good signage and pavement marking practice?				
Is the speed zone "safe", and clearly signed?				
Are pavement markings conspicuous and continuous?				
Are road signs and road markings tested for retro-reflectivity and conforming to relevant IRC standards?				
Is the road well delineated (warning signs, plastic guide posts, chevron alignment markers) installed as necessary and spaced in accordance with installation guidelines?				
Is there a need for more signs to warn, inform, guide, control or delineate?				



Issue	Yes	No	NA	Comments
<b>8. Vulnerable Road Users (pedestrians, bicyclists, two wheelers and three wheelers, and animal drawn carts)</b>				
Do all vulnerable road users have connectivity along the road, with suitable lateral clearance to motor traffic?				
Are pedestrians (particularly the young, old and disabled) able to safely walk along the road?				
Is the road free of “squeeze” points where vulnerable road users are exposed to nearby moving traffic?				
Are pedestrians (particularly the young, old and disabled) able to safely cross the road?				
Are dropped kerbs provided at all intersections and mid-block locations where pedestrians are to cross?				
Is the number and placement of the pedestrian facilities adequate and safe for the situation and the pedestrian numbers?				
Are all the formal crossings clearly marked and conspicuous on each approach?				
Are the correct signs and pavement markings installed at each pedestrian facility?				
Is each crossing facility well illuminated at night so that pedestrians can be seen by drivers/riders?				
Do all mid-block traffic signals have pedestrian push buttons?				
Are pedestrian paths provided through medians to permit pedestrians to cross “at road level” and to assist disabled pedestrians?				
Has adequate provision been made for safe parking and stopping by three-wheelers/cycle rickshaws?				
Does the road allow adequate visibility for an approaching driver to see a pedestrian waiting to cross the road?				

Issue	Yes	No	NA	Comments
Does the road allow adequate visibility funnel for an approaching driver to see a vehicle waiting to cross the carriageway from side road or storage space of median?				
Are bus stops located where passengers will use them?				
Are bus stops well delineated and lit?				
<b>9. Access to Property and Developments</b>				
Are all accesses to/from adjoining properties “safe”?				
<b>10. Lighting and Night Time Issues</b>				
Are the illumination levels of an appropriate standard, consistent with the needs of the location, pedestrian and other factors?				
Are the lighting columns frangible? If not, are they located outside the clear zone?				
Are all signs easy to see and read at night?				
Are the critical locations (intersections, pedestrian facilities, bus bays, bus stops, truck lay bye, toll plaza, etc) conspicuous at night?				
Is lighting provided on road sections passing through built up areas, service roads, above and below the grade separator, underpass,etc				
Is the “through route” well signed, line marked and obvious to road users at night?				
Is the road free of visual deceit for road users at night?				
Is all lighting adequate and safe?				
Are the lighting columns frangible? If not, are they outside the clear zone?				
Is there a need for more signs to warn, inform, guide, control or delineate?				

Issue	Yes	No	NA	Comments
Are there any lighting poles in the median(less than 2m wide) unprotected by crash barriers?				
<b>11. General Road Safety Considerations</b>				
Is the road as safe as practical given the local weather conditions (sunrise, sunset, snow, fog, storms, and wind)?				
Is the road surface free of gravel and sand, and with good skid resistance?				

Yes = likely to be satisfactory for safety

No = there are possible safety issues

NA = not applicable

**Table 7.6 Checklist for Safety Audit of Rural Roads**

Issue	Yes	No	NA	Comments
<b>1. Alignment</b>				
Are operating speeds likely to be commensurate with the design speed?				
Are there any abrupt sharp curves on the road? If so, are warning signs provided on the approaches? Especially when radii of curves are less than the standards.				
Is there sufficient forward visibility available along the road?				
Whether appropriate traffic calming measures and cautionary signs boards are provided where there is compromise on geometrics due to land and other site constraints?				
Is the interface between the new and existing road well away from any hazard (such as a crest, a bend, a roadside hazard or where there may be poor visibility?)				
Are sight and stopping distances adequate throughout the road section?				
Will horizontal and vertical alignment be consistent with safe visibility requirement?				
<b>2. Cross Section</b>				
Is the road wide enough for the traffic?				
Does the cross section include the needs of all road users including pedestrians, cyclists when the road passes through habitation/villages				
Does the cross section avoid unsafe compromises at bridges and other narrowing?				
Is there smooth transition in case of narrow bridges, CD structures and other narrowing?				
Whether the cross fall/camber provided correctly in the design?				

Issue	Yes	No	NA	Comments
Whether super elevation and extra width provided at the curves where required?				
When rural roads are constructed in stages, does the Stage-1 ensure proper safety until Stage-2 is taken up, especially in hill roads?				
Is there provision for bus-stop/safe waiting space for villagers? Are they well positioned?				
<b>3. Road Signs and Pavement Markings</b>				
Is the road (design) provided with reflective edge line markings and centre line markings (where applicable) as per IRC:35?				
Are the edge markings clearly visible at day and night conditions				
Are all required road signs provided as per IRC:67?				
Do the road signs and pavement markings have adequate retro reflectivity as required in IRC:67 and IRC:35?				
Are there no-overtaking sign envisaged at curves at locations of restricted sight distance?				
<b>4. Lighting</b>				
Are lighting facilities sufficient in built-up areas?				
Has street lighting been provided on sections where pedestrians or other vulnerable users are expected during night conditions?				
Is street lighting provided at junctions of rural road with high speed roads?				
<b>5. Road-side Hazards</b>				
Are all delineations and hazard markers in accordance with IRC:79?				

Issue	Yes	No	NA	Comments
Is the right of way free from hazardous road side objects? If not, are the hazardous road side objects delineated well with hazard markers or other treatments?				
Are all hazardous locations/objects protected by safety barriers?				
Are there any roadside hazards which appear to have been left out in the design?				
Is the type of barrier proposed suitable for the location?				
Whether retaining walls and breast walls provided where needed on roads in hilly area?				
Whether parapets provided on retaining walls on road in hilly area?				
Will the barrier terminals be a suitably safe type?				
Is the connection of safety barrier to bridge/ culvert parapet safe?				
<b>6. Schools/Built up areas</b>				
Are traffic calming measures provided near schools and built up area as per IRC:99?				
Has the approaching traffic been warned (through signs and markings) of the presence of the school and children?				
<b>7. Drainage</b>				
Has drainage been provided? Is there any road section which is susceptible for water logging?				
Is the pedestrian walking space affected by provision of drainage?				
<b>8. Junctions</b>				
Is sufficient visibility available for the main road users to spot the traffic approaching from the side road?				

Issue	Yes	No	NA	Comments
Is sufficient visibility (check the visibility splay) available for the minor road user to see the traffic approaching from the side road?				
Has the junction control (priority) been established through markings and road signs? (STOP/GIVEWAY Sign as per IRC:67)				
Is the approach to junction provided with warning signs of the major road ahead?				
Is the road approaching the junction on a gradient?				
Is there a need for speed reduction measure at the mouth of the junction?				
Is the design free of all Y junctions?				
Is the priority established in cross roads through pavement marking and traffic signs?				
Is the junction easily identified and understood from all approaches?				
Are sight lines within each junction adequate and free of obstruction by fixed objects such as buildings, overpass structures, traffic signs or vegetation?				
Is there sufficient visibility (safe braking distance) available for all approaching vehicles?				
<b>9. Railway Level Crossing</b>				
Whether road crosses a railway line and if so, whether a manned crossing or subway or over bridge has been envisaged?				
In case of level crossing, are all traffic calming measures provided with adequate signs and markings as per IRC Codes (IRC:67 and IRC:35)				
<b>10. Other Safety Considerations</b>				
Whether the height of electrical transmission line over the road would have proper vertical clearance.				

Issue	Yes	No	NA	Comments
Is the new road, as safe as practical given the local weather(sunrise, sunset rain, snow, fog, storm, wind)				
Will the new road surface be free of gravel and sand and with good skid resistance				

Yes = likely to be satisfactory for safety

No = there are possible safety issues

NA = not applicable