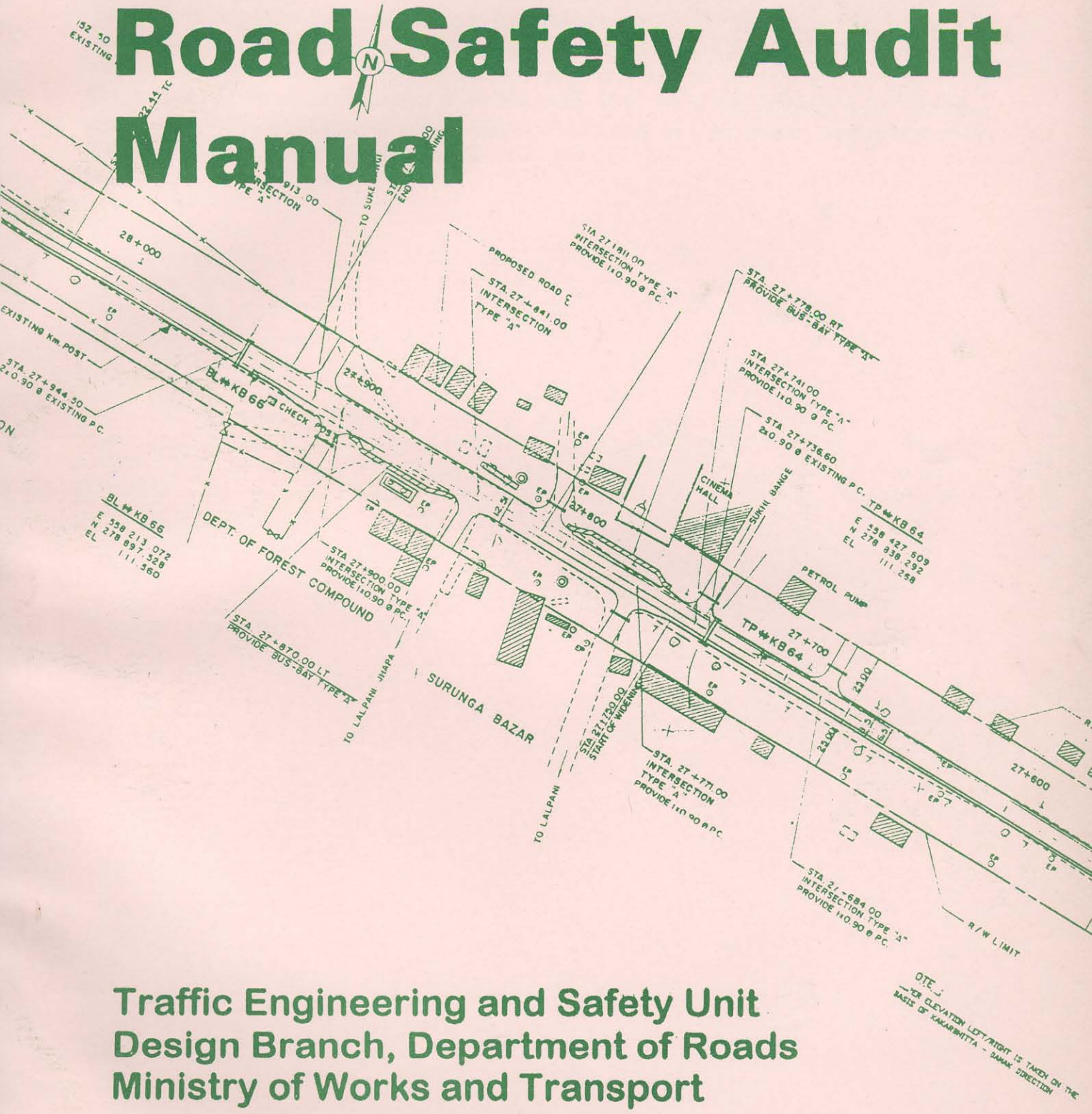
His Majesty's Government of Nepal
Road Safety Note 4

Road Safety Audit Manual



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Design Branch, Department of Roads
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ROAD SAFETY NOTES

Road Safety Notes are produced by the Traffic Engineering and Safety Unit of the Department of Roads as a means of increasing road safety awareness amongst highway engineers and others. Some of the Notes provide information on aspects of the road accident situation Nepal, whilst others give detailed technical advice on highway safety measures. The Traffic Engineering and Safety Unit was set up in Baisakh 2052 to provide a road safety and traffic engineering service, and is based in the Design Branch of the Department of Roads at Babarmahal, Kathmandu. The Unit Head (telephone/fax 262 843, e-mail: tesu@dor.mos.com.np) will be pleased to receive comments and suggestions which will help improve the Road Safety Notes.

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1 Explanation of Road Safety Audit

1.1 What is Road Safety Audit?

In simple terms safety audit is *"a systematic method of checking the safety aspects of road schemes in order to detect potential safety hazards before the road is open to traffic"*. The principle behind it is that *"prevention is better than cure"*. Road user error is the major cause of road accidents, but defects in the road environment (poor alignment, inadequate signing, dangerous obstacles, etc) are a contributory factor in many cases. Remedying these defects at the design stage is a very cheap and effective way of reducing road accidents - and is much easier than trying to train all road users to the level where they no longer make errors. Road safety audits assess how the road will work once it is open to traffic, focusing on the safety of users - including pedestrians, cyclists, motorcyclists, truck and bus drivers, car drivers, and others. A Road Safety Audit Report is produced which identifies any road safety deficiencies and recommends ways in which these can be overcome. The Report is submitted to the Director General, who, after discussing the recommendations with the project manager, will decide what changes are to be made to the project. **It is the Department's policy that all major new road projects undergo a safety audit** (see Appendix A for a copy of the Director General's instruction of 20 August 1995).

1.2 Who does the auditing?

To be effective the audit needs to be carried out by a specialist (or team of specialists) who are independent of the design process. In this way the auditors will be taking a fresh look at the project without the distraction of having been involved in their design. It is too much to expect the highway designer to provide an unbiased appraisal of his own design. And it is desirable for the auditing to be done by road safety specialists who, through practice in auditing, and research into accidents, have gained experience in identifying potential hazards. The Traffic Engineering and Safety Unit (TESU) in the Department of Roads has been given responsibility for safety auditing the Department's road projects.

1.3 What should be audited?

All road projects, even those involving no more than a new access onto a highway, can have safety implications, but in practice, and until staff resources increase, it will be best to limit safety audit to the larger projects and the more important roads.. Minor projects where safety clearly is an issue, such as alterations to busy junctions, should also be audited. Whilst the scope for safety audit is greatest with new roads and bridges, it is also appropriate for rehabilitation projects, as many of these involve significant changes to the road layout and geometry. In summary, the following types of schemes should be audited:

National highways - all new construction and rehabilitation on these roads:

Mahendra Rajmarg	Dhulikhel - Sindhuli -	Rapti Rajmarg
Tribuvan Rajpath	Bhittamod Rajmarg	Ratna Rajmarg
Amiko Rajmarg	Mechi Rajmarg	Karnali Rajmarg
Prithvi Rajmarg	Koshi Rajmarg	Mahakali Rajmarg
Narayanghat - Mugling Rajmarg	Sagarmatha Rajmarg	Seti Rajmarg
	Siddhartha Rajmarg	

Feeder roads - any schemes which do not conform to the Department's Feeder Road Standards or have potentially hazardous elements

Urban roads - all major new construction or rehabilitation - all works at busy junctions - all signing schemes

1.4 At what stages will projects be audited?

The earlier a project is audited the more scope there is to change things. In projects where there is a choice of route or standards, or there are known safety problems, the design team should discuss these with TESU at the feasibility study stage, or prior to project design. The main audit is done after the detailed design is complete. Any changes to the design arising from the audit ought to be incorporated before the project goes out to tender. In some cases there will not be time for this, and any major changes or additions will have to be actioned by means of variation orders. A final audit should be made after completion of the works and prior to the opening of the road - this is for checking such things as signing, road marking, and placement of road furniture. It is conventional to refer to four audit stages:

Stage 1 Audit	Feasibility study
Stage 2 Audit	Draft design
Stage 3 Audit	Detailed design - the main audit
Stage 4 Audit	Pre-opening

1.5 Responsibilities

Safety audit is not a comprehensive check on the technical aspects of a road project. It does not check whether the DoR's highway design standards have been followed. And it has nothing to do with checking whether structures such as bridges can safely take the loads that may be imposed on them. It is an assessment of the road safety aspects only. The highway designers (usually a firm of private consultants) remain responsible for all technical aspects and continue to report to the project manager, who retains overall control.

Audit involves one set of professionals checking the work of other professionals, and this calls for much diplomacy and respect. Auditors must try and understand the background to design decisions and avoid being over-critical and petty. Highway designers whose work is being audited should keep an open mind and accept that the audit team may be able to improve on the safety aspect of the design - to the benefit of everyone. The audit process brings specialist advice into the design process - it is not a test of the competence of the highway designers.

Highway designers must always be given a chance to respond to the findings of the audit team, but the decision as to whether to make changes to the project rests with the Department of Roads. It is important that senior Departmental staff have some understanding of safety engineering principles, so that they can come to a sound decision.

1.6 Costs and benefits

It may be thought that auditors will make recommendations which will greatly increase the cost of the project, but this is rarely the case. Most changes concern such things as signing, marking, layout details, and pedestrian facilities, which cost little, especially if they are adopted in the early stages of the design process. Cost-benefit analysis of common safety features usually shows very good rates of return, as in most cases we only have to prevent a few casualty accidents to recover the cost of the safety measure. And it has been suggested (from a limited British study) that one-third of future accidents at road improvements could be prevented by road safety audit. Where the impact on costs is very significant the auditors will have to weigh whether the cost is justified by the likely savings in accidents. Even in cases where the audit report recommendations cannot be adopted because of cost constraints the process of auditing will have been helpful in drawing attention to the safety issues.

2 Conducting a Road Safety Audit

2.1 Introduction

This section of the manual contains a step-by-step guide to the practice of road safety audit. The process is illustrated in the flowchart shown overleaf. Audit practice will vary according to circumstances and in the case of minor projects some of the steps may be quite brief and informal, but the sequence of steps will remain broadly the same. It is important that the project manager takes an active interest, retains overall control, and makes the key decisions in consultation with the Director General. The situation should never arise where TESU is negotiating directly with the designers over changes to the design.

2.2 Sending the project to TESU for audit

In most cases projects will be referred to TESU either by the Deputy Director General; Foreign Cooperation Branch, or the project manager. It is worth repeating that **the earlier a road is audited within the design and development process the better.**. The Head of TESU must keep himself informed about forthcoming road projects, and, if it seems that the need for a safety audit has been overlooked, the matter should be raised with the appropriate DDG, either directly or through the DDG (Design).

2.3 Obtaining the project reports and plans

The project manager must supply TESU with all the necessary information for a thorough audit. This will include scheme reports, drawings and detailed items of works and their quantities. It will often be necessary for TESU to actively seek extra information. **Unfortunately the designs for some major rehabilitation projects are so lacking in detail that it is impossible to carry out a proper safety audit**. The information required for a thorough safety audit is:

- standard cross-sections - including detail of side slopes and side drains
- detailed section plans showing horizontal and vertical alignment, and position of bridges, culverts, accesses, lay-bys, roadside development, safety barrier and signing
- details of curve treatment - geometry, carriageway widening, superelevation, etc
- plan of standard junction layout, including signing and marking
- detailed layout plans for all major junctions, including signing and marking
- designs for safety barrier, footways, bridge parapets, delineators, bus lay-bys, etc

It is recognised that fully-detailed plans can be costly to produce, especially if the base mapping is not available, but they are of very great benefit in project planning and control, as well as in maintenance management. TESU may need to collect supplementary information, such as the accident history for the site/route, traffic data, and weather patterns.

2.4 Studying the plans - inspecting the site

These two tasks take place about the same time. The auditors familiarise themselves with the site and try and understand what is proposed. Based on their experience, and a check on whether DoR / TESU standards and safety advice have been followed the auditors will then make a preliminary assessment of the safety performance and accident potential of the road improvement.

2.5 Holding a commencement meeting with the highway design team

The purpose of this meeting is to exchange information. It is an opportunity for the auditors to clear up any doubts about what is proposed and find out the reasoning behind specific design decisions. There is also merit in getting the designers' initial reaction to some of the amendments that are being considered. It will often be necessary to explain the purpose and workings of the audit process to the design team. Sometimes it is convenient and helpful to combine the commencement meeting with the site inspection.

2.6 Undertaking the audit

It has been found that the use of checklists or memory prompts is a valuable tool in ensuring that nothing is forgotten during the audit. These typically list the types of issues and problems that can arise in road improvements. Section 5 contains a set of checklists which are appropriate for auditing road projects in Nepal. The key principles for a good safety audit are:

- consider the needs of all road users (including pedestrians (especially children), cyclists, motor-cyclists, truck and bus drivers, as well as car drivers)
- be thorough and comprehensive
- be realistic and practical
- stick to road safety aspects
- check compliance with relevant standards and guidelines (while remembering that compliance with standards does not guarantee that the road will be safe)
- use a team of at least two auditors - one to do the audit proper and the other to review it

It is recommended that the site be revisited at this stage. Inspecting the site during darkness as well as daylight is important, especially if it is either an urban scheme, or it is a Stage 4 audit. The inspection should include adjacent sections of road, because there will often be safety problems at the joint between the new and old sections.

2.7 Writing the Road Safety Audit Report

The audit report sets out clearly what the problems are and makes recommendations on how they can be remedied. The recommendations on corrective action should give a clear indication of what needs to be done, but it will not normally be appropriate to provide a detailed design - that is the job of the highway designers. In some cases there may be no obvious solution to the problem, but the problem should still be identified in the report. The audit report does not give an overall assessment of the design, so there is no need to refer to the good points of the design. It is essential that the location of the problems be clearly identified and this can usually best be done by referring to the chainage. However, it may sometimes be necessary to provide diagrams, sketch plans, or annotated copies of the scheme drawings. Appendix B contains an extract from a typical audit report. Once the report is finalised it is submitted to the Director General and a copy is sent to the project manager.

2.8 Agreeing the changes with the Director General and the project manager

When the Director General has had time to read and assess the audit report, the auditors should seek a meeting with him and the project manager. Decisions will be taken at this meeting about what changes (if any) are to be made to the project.

2.9 Holding a completion meeting with the project manager and the designers

The purpose of this is to discuss the corrective action with the designers, make any necessary amendments, and agree how to follow these up. By the end of the meeting the

project manager must have given the designers (usually a firm of consulting engineers) clear instructions on what to do, and a written copy will be sent on to them.. A copy will also be sent to the Director General for final approval.

2.10 Follow-up

It will usually be necessary for the auditors to continue to provide advice and technical support to the designers and the project implementation team regarding the agreed measures. The project manager will be responsible for ensuring that any necessary variation order is prepared, is approved by appropriate authorities, and is implemented. It is very important that TESU be consulted about any changes to the design that occur after the Audit Report has been submitted.

The Steps in a Road Safety Audit

The Step	Responsibility of :
Project referred to TESU for audit	Concerned DDG or Project Manager in consultation with the DG
↓	
Project reports and plans sent to TESU	Project Manager
↓	
Study plans and inspect site	TESU
↓	
Hold commencement meeting with the designers	TESU
↓	
Undertake the audit	TESU
↓	
Write the audit report Submit to DG and Project Manager	TESU
↓	
Discuss and agree changes with DG and Project Manager	TESU & Project Manager together with DG
↓	
Hold completion meeting with Project Manager and designers Report on action to be taken is then sent to design team, and to the DG for final approval	Project Manager
↓	
Follow-up	TESU & Project Manager & project implementation team

3 Principles for Designing Safer Roads

3.1 Introduction

This section of the manual looks briefly at the basic safety principles. Safety audits are done by assessing schemes with the help of detailed checklists, but things can still be overlooked unless the auditors always have the basic principles in mind. This section will also help scheme designers get a better understanding of how to go about designing safer roads.

The key principles are thought to be:

- DESIGNING FOR ALL ROAD USERS
- PROVIDING A CLEAR AND CONSISTENT MESSAGE TO THE DRIVER
- ENCOURAGING APPROPRIATE SPEEDS AND BEHAVIOUR BY DESIGN
- REDUCING CONFLICTS
- MAKING ALLOWANCE FOR THE BAD OR IMPAIRED DRIVER
- CREATING A FORGIVING ROAD

3.2 Designing for all road users

There has been a tendency in the past for scheme designers to concentrate wholly on the pavement engineering aspects of new and improved roads. For example, it is quite common to find that when the scheme road goes through a town or village there is no change in provision, and no attempt is made to tackle the different needs and problems that are found there. Consequently when the road is opened to traffic, the higher speeds made possible by the improved road surface result in increased pedestrian accidents. But it is not just pedestrian needs that are forgotten - it is the needs of cyclists, rickshaw drivers, bus drivers and their passengers, people who need to park their vehicles at the roadside, and people whose property fronts the roads and need access to it. They have all got a legitimate need to use the road and, if this is ignored, there will be problems and accidents. A proper consideration of the needs of all road users has implications for almost all aspects of highway design, including carriageway width, shoulder design, side slopes, side drains and many others.

3.3 Providing a clear and consistent message to the driver

Safe designs are those which result in a road which can be easily read and understood by the driver and present him or her with no nasty surprises. This is a particularly important consideration when designing alignment - a sharp bend after a long straight section or just beyond a summit curve is sure to produce accidents - but it is also very relevant to the design of junctions. Drivers can be warned of difficult or potentially confusing situations (and guided through them) with good signing, but it is much better to design out the problem completely if at all possible.

3.4 Encouraging appropriate speeds and behaviour by design

In a way this is a refinement of "providing a clear and consistent message to the driver". We can influence traffic speed by altering the look of the road. If a high-speed road looks the same (same width, same shoulder treatment, etc) as it passes through a village it is not surprising if drivers do not slow down; this is a common fault of rehabilitation schemes on our national highways. Where we want drivers to slow down we must give them clear visual clues, such as changing the shoulder treatment, providing a footway, and installing very

prominent signing. Similarly, at urban roundabouts we should follow the principle of "tight radius entry - easy exit", so that the layout encourages low entry speeds.

3.5 Reducing conflicts

Conflicts, whether between vehicle streams, or vehicle types, or vehicles and pedestrians are always associated with accidents. Often they cannot be avoided entirely, but there is great scope for making them safer by design - such as by replacing cross-roads with roundabouts or staggered junctions, by separating service areas from the through road carriageway, and by using guardrail to channel pedestrians to safer crossing points.

3.6 Making allowance for the bad or impaired driver

A safe road is one which recognises the realities and limitations of human skills. It must not place demands upon the driver which are beyond his or her ability to manage. And although we cannot design for the very worst drivers or those who are drunk, some allowance must be made for the fact that no-one can drive perfectly all the time. So designs which seem safe enough for the good driver, need to be re-examined for ways of making them very safe.

3.7 Creating a forgiving road

A safe road is one which forgives a driver's mistake or a failure on his vehicle. Many accidents involve the vehicle leaving the road and hitting a roadside object or falling down a hill, so more needs to be done to reduce the severity of these loss of control accidents. This means trying to maintain a roadside clear zone and putting more effort into protecting the motorist from those roadside hazards which cannot be removed. And we should not forget the need to protect pedestrians and other road users from hazards - especially deep, open side drains.

4 Some common problems

4.1 Introduction

This section sets out some of the more common safety problems that have been found in the schemes that have been audited up to now. It should be of interest to both auditors and highway designers.

4.2 Inappropriate use of standard designs

Standard designs for such things as side slopes and side drains (which are often designed for worst case situations) are sometimes used in circumstances where they are not appropriate. This results in side drains which are far too deep and side slopes which are unnecessarily steep - both of which make the road more hazardous than it need be.

4.3 Schemes ignore roadside communities

Roadside communities are places where there are pedestrians, buses, parked vehicles, roadside markets, etc., yet many rehabilitation schemes make little or no provision for these, and the resulting conflicts and chaos leads to accidents.

4.4 Signing is inadequate

The general standard of traffic signing in Nepal is very poor and this is believed to be one of the key factors in explaining why the country's road accident situation is so bad. Rehabilitation schemes often do little to improve the standard of signing. Typically, scheme documents refer to "signing according to DoR standards" but, as there have been no proper standards, this does not mean much. The signs that are provided are usually of a low-quality and are not reflective, so they are impossible to read at night - when about 30% of all accidents occur. The recent adoption of a new signing system by the Department and the forthcoming publication of a Traffic Signs Manual provide the basis for a major upgrading of traffic signing in Nepal, to be lead by the rehabilitation schemes. One of the priorities must be improved delineation by means of road markings, chevron signs and post delineators with reflectors.

4.5 Too little attention is given to creating a forgiving road

Not enough thought is given to safety when designing side slopes, side drains, bridge parapets, pedestrian guardrails and other roadside furniture. In many cases the problem arises because of the use of a standard design which is inappropriate for the particular circumstances (see para. 4.2). It is also essential to make more provision for safety barrier especially on the busier national highways - at present there is an over-reliance on confidence blocks, which have proved to be wholly ineffective in containing errant vehicles.

5 Road Safety Audit Checklists

5.1 Purpose and use of the checklists

There are very many aspects to consider when doing a safety audit, and the use of checklists can help you avoid forgetting something. The first checklist set out below is a very general one for use by highway designers who want a quick guide to what safety features they need to consider. It is followed by a set of ten detailed checklists for use by the specialists responsible for auditing highway schemes. The checklists are only a guide and will not mean much to someone who does not have knowledge and experience of the safety aspects of highway design.

5.2 Summary checklist

The checklist below gives the safety features that need to be considered for three categories of highway. Note that this is a very generalised summary of needs, and site circumstances and other constraints must be taken into account before deciding what provision to make.

National Highways with AADT ≥ 1,000

- Alignment must be consistent - no unexpected sharp curves or steep grades (if this is unavoidable they must be very well signed)
- Cross-section must be consistent - no narrow sections or narrow bridges (if this is unavoidable they must be very well signed)
- Metalled shoulders of adequate width must be provided - taking account of the volume of pedestrians and non-motorised vehicles
- Superelevation and carriageway widening must be provided on curves - spiral transition curves to be considered
- Side slopes and side drains must be safe and forgiving (refer to Road Safety Note (RSN) No. 2 "Designing Safer Side Drains")
- Curves and other difficult sections must be well signed (refer to RSN5 "Delineation Measures")
- Safety barrier must be provided at hazardous sites (refer to forthcoming RSN on safety barrier)
- Footways, parking areas, and service roads must be provided in towns and villages
- Side drains are to be covered on sections through towns and villages
- Layout and control of junctions is to be simple and obvious
- Laybys are to be provided at bus stops and popular truck stops
- Road and junctions are to be fully signed (refer to forthcoming Traffic Signs Manual) with retroreflective traffic signs
- Centre line and edge line road markings must be provided
- DoR Standards on gradients for Trunk Roads must be complied with
- Clearly-marked overtaking sections must be provided on long hills

National Highways and Feeder Roads with AADT < 1,000 but ≥ 150

- Inconsistencies in alignment and cross-section, if unavoidable, are to be very well signed
- Sharp curves and other difficult sections must be well signed (refer to RSN5 "Delineation Measures")
- Superelevation and carriageway widening must be provided on curves
- Side slopes and side drains must be safe and forgiving (refer to RSN2 "Designing Safer Side Drains")

- Side drains are to be covered through towns and villages
- Shoulders may need to be widened on sections where there are many pedestrians and non-motorised vehicles
- Exposed sections (big drops at the road edge) are to be marked by closely-spaced post delineators, and errant vehicles are to be protected by safety barrier if the place is especially hazardous (refer to forthcoming RSN on safety barrier)
- Footways, parking areas, and service roads must be provided in the larger towns and villages
- Layout and control of junctions is to be simple and obvious
- Essential signs are to be provided
- A centre line is to be marked on all roads which are 5.5m wide or wider
- For Feeder Roads, the DoR Design Standards for Feeder Roads must be complied with.

Feeder Roads and other rural roads with AADT < 150

- Major inconsistencies in alignment and cross-section, if unavoidable, are to be well signed
- Very sharp curves and other difficult sections should be signed - the use of post delineators is recommended (refer to RSN5 "Delineation Measures")
- Carriageway widening may be required on sharp curves
- Consider gravelling or hard surfacing the most difficult sections - such as very steep gradients
- Side drains must be safe and forgiving (refer to RSN2 "Designing Safer Side Drains")
- On single lane roads provision must be made for passing places at least every 500 metres
- DoR Design Standards for Feeder Roads must be complied with.

5.3 Detailed checklists

Ten checklists have been devised which are appropriate to the kind of highway schemes that are commonly encountered in Nepal. They are:

1 Planning
2 Cross-section
3 Alignment
4 Roadside communities and facilities
5a Junctions - general
5b Junctions - general
5c Junctions - additional checks for roundabouts
5d Junctions - additional checks for signal-controlled junctions
6 Special road users
7 Signs, markings and lighting
8 Roadside hazards

Some matters, such as pedestrian needs, are covered in more than one set of checklists, but this is inevitable given the complex interrelationships involved . Determine which sets of checklists will be needed and then use them (copies are available from TESU) to do the audit - noting down your findings in brief against each check. You should keep the completed checklists for record purposes, but there is no need to include them in the main audit report.

Checklist 1 - Planning

Scheme title:

Section reference: **Chainage:**

1.1 Is there a development plan or development strategy for the area and, if so, does the project conform to this ?

1.2 Is the proposed design appropriate in relation to the forecast traffic volumes and traffic characteristics ?

1.3 Does the route fit in with the physical constraints imposed by the topography ?

1.4 Does the route serve major generators of traffic in a safe and adequate manner ?

1.5 Is the frequency of junctions and their type appropriate for the function of the road and its design speed ?

1.6 Does the project road fit in well with the existing road network ?
(Check for potential problems at the joins - Check whether changes in traffic volumes will cause problems)

1.7 Does the project road relieve routes or sites with bad accident records ? Does it have any harmful effects on safety on the surrounding road network ?

Checklist 2 - Cross-section

Scheme title:

Section reference: **Chainage:**

2.1 Are the widths of the lanes, shoulders, medians (if any) in accordance with standards and adequate for the function of the road and the mix of traffic likely to use it ?

2.2 Are there narrow sections (at bridges, culverts as well as other places) where there could be safety problems ? If they are unavoidable, check whether they are handled as safely as possible.

2.3 Have the shoulders and side slopes been designed to a safe standard ? *(Check whether: shoulders are constructed to a good standard, there is no drop at the carriageway /shoulder join, and that; side slopes are no steeper than 1:4)*

2.4 Have the side drains be designed to a safe standard ? *(Check depth and profile. Refer to RSN2 - Designing Safer Side Drains)*

2.5 Is the transition between the project road and the existing road(s) handled safely ? *(Check for major changes in standards)*

Checklist 3 - Alignment

Scheme title:

Section reference: **Chainage:**

3.1 Is the proposed design speed appropriate to the function of the road, the mix of traffic likely to use it, and the road environment ? *(Check whether different sections need different design speeds)*

3.2 Do the horizontal and vertical alignments generally give sufficient forward visibility for the selected design speed ? *(Check for inadequate stopping sight distances)*

3.3 Are there major inconsistencies in the alignment (such as a sharp bend following a straight downgrade section) and, if so and they are unavoidable, have adequate measures been taken to make drivers aware of them ?

3.4 Do the horizontal and vertical alignments fit together comfortably ? *(Check for bad combinations, such as a sharp bend immediately after a summit curve, and a sag curve within a bend)*

3.5 Does the alignment provide regular, safe overtaking opportunities ? Does it avoid creating situations where the forward visibility is marginal for overtaking (neither clearly adequate or inadequate) ?

3.6 Does the proposed treatment at bends make appropriate, adequate and safe provision for: transition curves on approach, superelevation, and carriageway widening ?

3.7 Does the vertical alignment pose excessive demands on the power of heavy vehicles ? Has it been designed so that maximum grades are interspersed with recovery grades ? Are there passing places to allow faster vehicles to overtake slow-moving heavy vehicles ? Should a climbing lane be provided ? *(Refer to DoR design standards)*

3.8 Is the transition between the project road and the existing road(s) handled safely ?

Checklist 4 - Roadside communities and facilities

Scheme title:

Section reference: **Chainage:**

Place name:

4.1 Does the cross-section, alignment and signing encourage drivers to adjust their speed on entering the town or village and maintain it an appropriate level ? *(Check that it will be quite clear to drivers that the road environment is changing and that they must slow down - Consider traffic calming measures)*

4.2 Is there adequate and safe provision for pedestrians to walk alongside the road and to cross it ? *(Check for provision of footways and safe crossing places. In the busier places check whether pedestrian movements are controlled and channelled by means of guardrail. Check whether side drains are pedestrian-friendly)*

4.3 Is the design and provision of roadside parking and access to properties adequate, controlled and safe ? *(Check provision at the popular bus and truck stopping places especially. Check that the opportunity has been taken to improve any problem sites.)*

4.4 Has the opportunity been taken to improve the traffic and parking situation in the towns and villages through which the road passes ? *(Check for junction improvements, access control, provision of service lanes, parking areas and bus stops).*

Checklist 5a - Junctions - general

Scheme title:

Section reference: **Chainage:**

Junction name:

5.1 Is the junction in a safe location ? *(Check whether there are other junctions too close to it. Check whether approaching drivers will get a clear view of it. Check whether the site permits the junction to be of a proper layout and standard)*

5.2 Is the type of junction (T-junction, staggered junction, signal-controlled junction, roundabout, etc) suitable for the function of the two roads, the traffic volume, the traffic movements (pedestrian and vehicular), and the site constraints ? Is it the safest alternative ?

5.3 Is the layout of the junction adequate for all permitted vehicular movements and for all types of vehicle ? *(Check using turning circle templates for buses and trucks)*

5.4 Will the general type of the junction, its layout and the priority rules be recognised by approaching drivers in adequate time ? Is the route through the junction as simple and clear as possible ? Do the decisions that need to be made by drivers follow a simple, logical and clear sequence ? *(Check for unusual or over-complicated layouts. Check that the signing and marking is correct and clear - if in doubt refer to the Traffic Signs Manual)*

5.5 Does the layout encourage slow controlled speeds at and on the approach to STOP / GIVE WAY lines and other critical decision points ? *(Check for Y and skew junctions which can be a problem. Also roundabouts with inadequate deflection)*

5.6 Are the sight lines at and on the approach to STOP / GIVE WAY lines and other critical decision points adequate and unobstructed ? *(Check for Y and skew junctions which can be a problem. Check signs, lighting columns, pedestrian guardrail, etc)*

Checklist 6b - Junctions - general

Scheme title:

Section reference: **Chainage:**

Junction name:

5.7 Is there adequate provision for channelling (and protecting where necessary) the different streams of traffic ? *(Check the provision for right-turn lanes and storage areas, deceleration lanes, and acceleration lanes)*

5.8 Is adequate provision made for pedestrians and non-motorised vehicles ? *(Check whether it is convenient, easily-seen and understood, capable of being used safely (check intervisibility between pedestrians and vehicles) and large enough to meet demand)*

5.9 Is the provision of night-time lighting adequate ? *(Consider the need for drivers to recognise and understand the junction, and see pedestrians. Consider the needs of pedestrians who are negotiating the junction. Check that the layout of the lighting columns illuminates the junction effectively).*

Checklist 5c - Junctions - additional checks for roundabouts

Scheme title:

Section reference: **Chainage:**

Junction name:

5.10 Is the geometry simple and easily understood ? *(Beware of roundabouts which are not circular, or which have awkward entry paths)*

5.11 Are there too many entries for safe, efficient operation ? Are they sufficiently separated from each other to avoid confusion ?

5.12 Does the design deflect entering traffic sufficiently to ensure entry speeds are no greater than 50 km/h ? *(Check entry path curvature, centre island size and positioning)*

5.13 Is the visibility for entering traffic adequate ? *(Note that, if visibility is too good, it may encourage entry speeds which are too high)*

5.14 Is the visibility for circulating traffic adequate ? *(Check that visibility across the centre island is not unduly obstructed by signs, landscaping or structures)*

5.15 Has the centre island been designed to be forgiving to errant vehicles ?

5.16 Has adequate provision been made for pedestrians to cross the arms of the junction ? *(Guardrail will usually be necessary to channel pedestrians to safe crossing points on the arms)*

5.17 Have the needs of cyclists and other non-motorised vehicles been considered ?

5.18 Does the signing make the priorities clear ? *(Entering traffic must give way to circulating traffic)*

Checklist 5d - Junctions - additional checks for signal-controlled junctions

Scheme title:

Section reference: **Chainage:**

Junction name:

5.19 Do the signal colours and signal sequence conform with the requirements of the Traffic Signs Regulations and the DoR Traffic Signs Manual (to be published) ?

5.20 Do the signals clearly indicate which movements are allowed at any one time ? Are the timings adequate ? *(Check especially the time between stages - the inter-green time)*

5.21 Are the signal heads positioned so that drivers can see them easily, and in time to stop ? *(Check this for drivers at the stop line as well as those approaching at speed - it will usually be necessary to have repeaters)*

5.22 Are the signals for competing phases located so that they are visible only to the traffic for whom they are intended ? *(Check also that there is no risk that pedestrians may be misled by the traffic signals into thinking that it is safe for them to cross)*

5.23 Are all right-turning movements protected (ie there are no conflicting movements) as far as possible ? *(this may not be necessary if there is very little right-turning traffic)*

5.24 Does the signing, marking and channelisation make it clear to drivers what path they should take through the junction ?

5.25 Are pedestrian crossing places marked, and are pedestrians channelled to these crossings ? Are there pedestrian refuges ?

5.26 Are the pedestrian crossings signal-controlled where appropriate ? If so, is there a need for the crossing movements to be fully protected from conflicting traffic movements - for example where there will be serious conflicts with turning traffic ?

5.27 Are the pedestrian signals positioned so that pedestrians can see them ?

5.28 If left turn on red is permitted (yellow filter arrow) will there be a big risk of accidents to pedestrians crossing the road ? *(Check volume of pedestrian crossing movements)*

Checklist 6 - Special road users

Scheme title:

Section reference: **Chainage:**

6.1 Has there been a survey of non-motorised vehicle and pedestrian flows ?

6.2 Will there be any major conflicts between motorised traffic and pedestrians and other road users ?

6.3 Have pedestrians' needs for crossing the road and walking alongside it been provided for ? *(Check particularly in towns and villages and at all junctions - check shoulder width - check whether it is desirable and feasible to provide a segregated footway - check whether steps are provided where pedestrians will have to climb high embankments - to get onto bridges for example)*

6.4 Have measures be taken to reduce the accident risk for children going to and from roadside schools ? *(Pedestrian guardrail may be needed to prevent children from running out into the road)*

6.5 Have the needs of cyclists and other non-motorised vehicles been provided for ?
(Check shoulder width - check the need and feasibility of segregated cycle / cycle rickshaw lanes, especially in towns)

6.6 Is the provision for pedestrians and non-motorised vehicles at bridges and narrow sections adequate in relation to pedestrian and vehicular traffic volumes and traffic speeds ?

6.7 Is the provision of bus stopping places adequate? Is the location, design and signing adequate ?

6.8 Does the volume of motorcycle traffic justify the provision of separate lanes ? *(Check in towns)*

Checklist 7 - Signs, markings and lighting

Scheme title:

Section reference: **Chainage:**

7.1 Is the provision for signing (regulatory, warning and informative signs and delineators) adequate and in accordance with the Traffic Signs Regulations and the DoR's Traffic Signs Manual (to be published) ?

7.2 Are the sign sizes, placement and construction adequate, safe and in accordance with standards ? *(Check whether there is a need for reflective signs)*

7.3 Are the proposed road markings adequate and in accordance with standards ?

7.4 Is the delineation adequate, especially on sections with difficult alignments ? *(Check signs and road markings - refer to TESU Road Safety Note 5).*

7.5 Is there a need for the project road, or parts of it, to be lit at night ?

7.6 Is the proposed lighting scheme (if any) adequate ? Are there any hazardous dark areas ?

7.7 Has the siting of lighting columns been considered from a safety viewpoint ?

7.8 Are frangible or slip-base columns to be provided ?

Checklist 8 - Roadside hazards

Scheme title:

Section reference: **Chainage:**

8.1 Will bridge and culvert parapets, and other obstructions be close to moving traffic ? If so, can they be relocated ? If not, are they adequately signed and, where necessary, protected by safety barrier ?

8.2 Are bridge parapets designed to contain errant vehicles, where the speed and volume of traffic warrants it ?

8.3 Are the ends of bridge parapets protected by safety barrier, where the speed and volume of traffic warrants it ? *(Check that if flexible steel beam safety barrier is proposed it is very firmly attached to the bridge parapet it is protecting)*

8.4 Are bridge parapets, bridge railing, and pedestrian guardrail of a safe design ? *(Check that horizontal elements are strongly supported and cannot come loose when hit by a vehicle)*

8.5 Are there any poles or columns located close to moving traffic that could be sited elsewhere ?

8.6 Is safety barrier provided where necessary and where traffic volumes and traffic speeds warrant it ? *(Check for large drops (over 3 metres) especially on the outside of sharp bends and on bridge approaches, as well as hazardous roadside objects that may need protecting)*

8.7 Is the type, detailing, and placement of proposed safety barrier in accordance with TESU design advice ? *(Refer to forthcoming Road Safety Note on safety barrier)*

8.8 Where safety barrier is provided does it protect all roadside objects ? *(Check that there are no signs, lighting columns, etc in front of the barrier)*

Appendix A - Director General's letter

Telex: 2570 Roads NP
Fax: 977-1-225993

His Majesty's Government
MINISTRY OF WORKS & TRANSPORT
Department of Roads

Phone: 2-11109, 2-11377
2-13243, 2-13348
2-15774

Ref. No.
Your Ref. No.

Babar Mahal, Kathmandu.
Date: .. ..
20 August, 1995

Subject:-
SAFETY AUDIT OF ROAD PROJECTS

Deputy Director General / Regional Director / Project Manager / Senior Divisional Engineer

Dear Sir,

All new road projects (building of rehabilitating roads) are to be checked (audited) in order to try and detect potential road safety hazards before the road is open to traffic. The audit will be carried out by the Traffic Engineering and Safety Unit set up within Design Branch. A short paper is enclosed which explains how the audit will work. Please ensure that you refer major projects to the Traffic Engineering and Safety Unit (att. Mr. R A Prasad) for auditing. Any schemes, even minor ones, may be referred to the Unit, if you are particularly concerned about the road safety aspects. Projects will normally be audited at the following stages:

1. On completion of the preliminary design
2. On completion of the detailed design
3. After completion of the work and prior to the road being opened to traffic

You must provide the Traffic Engineering and Safety Unit with full information about the project, including drawings.

Yours faithfully

Mr. M B Karki
Director General

Appendix B - Extract from a typical Road Safety Audit Report

Stage 3 Road Safety Audit Report
Rehabilitation of the Mahendra Highway (H1) Km 0-50

Introduction
This report results from a Stage 3 Road Safety Audit on the proposed scheme to rehabilitate kilometres 0-50 of the Mahendra Highway. The audit was requested by the project consultants and was carried out in September / October 1996 by the Traffic Engineering and Safety Unit of the Department of Roads. The audit comprised an examination of the scheme drawings (Contract Documents, August 1996, prepared by Roughton International in association with East Consult (P) Ltd), an initial discussion with the senior consultant, and an inspection of the road on 3rd September.

Bus Bays at Gaurigunj junction 46+905 and 47+000
The position of the bus-bays at the back of the 3m shoulders makes for an unnecessarily wide carriageway which will encourage excessive speeds and add to the hazards which pedestrians will face when crossing. The bus bay at 46+905 is so close to the junction with the road to Padajunge that it will cause conflicts and visibility problems.
Recommendation: The bus bays should be developed as far as possible within the area proposed for the 3m shoulder. The bus bay at 46+905 should be moved further east away from the junction.

Gaurigunj junction 46+938
The existing layout of this junction is awkward and confusing. The way the side roads enter the main road does not encourage safe, controlled manoeuvres. The proposed treatment (Intersection Type A) does not fully solve the problem.
Recommendation: A staggered junction should be provided with the two opposite side-roads separated by at least 20m. They should enter at or near right angles to the main road centre line. The main road should have 1m shoulders or less (3m shoulders are proposed), in order to discourage parking, assist pedestrians to cross, and promote appropriate speeds.

Bend on approach to Ratuwa Bridge 47+600 to 47+900
The approach to the bridge from the east is particularly hazardous, as it is on a high curved embankment. which follows a long straight section. The alignment may be difficult for some drivers to recognize, especially at night. It is probable that some speeding vehicles will fail to take the bend and will either fall down the embankment or will hit the end of the bridge parapet. The standard bridge approach treatment of confidence blocks does not give sufficient protection to errant vehicles.
Recommendation: Safety barrier should be installed on both sides of the road, from the beginning of the bend up to the bridge parapets. Care should be taken to ensure that the safety barrier will prevent collisions with the ends of the bridge parapets. Delineation should be improved by the provision of chevron signs (single chevrons) at about. 30m intervals on the outside of the bend - placed behind the safety barrier. The ends of the bridge parapets should have hazard markers.

Relevant extracts from scheme drawings