



RS AUDIT REPORTS

ROAD SAFETY AUDIT REPORT

REHABILITATION OF DHAKA-SYLHET ROAD (RRMP-III)

Background

The need to do an audit was discussed when the Road Safety Engineering Advisor met the Project Director, Mr Nurul Azan Khan on Wednesday 11th August.

A set of drawings (Volume 4 of 4 : Drawings, Parts I and II, Mouchel and Partners, July 1998) was provided by the consultant.

The persons undertaking the audit were:

Mr Habibur Rahman, EE, Road Safety Division, RHD
Mr Allan Jones, Road Safety Engineering Advisor, RHD
Md. Shahabuddin, AE, Road Safety Division, RHD
Md. Aminul Hoque, SAE, Road Safety Division, RHD

The project road was inspected by the audit team on the 16th and 18th August, 1999.

A meeting took place on 26/8/99 with Mr A Murphy of Roughton International (supervision consultants) to obtain further information on what is proposed.

Presentation of the audit findings

CROSS-SECTION

1. Problem

The separation of the shoulder from the carriageway may not be sufficiently clear, especially once the painted edge line has worn away, and drivers may treat the whole paved area as carriageway. This could result in unsafe behaviour such as overtaking on the nearside and overtaking in the face of oncoming traffic.

Recommendation

Mark the carriageway/shoulder divide with a continuous white edge line made of 5mm thick thermoplastic screed. The shoulder could also be made a little lower than the carriageway, though there is a small safety risk with this. It is essential that the full 1.5m width of paved shoulder is available, as this is the absolute minimum needed to provide safely for NMVs.

2. Problem

The proposal to raise the height of the embankments over much of the road length will make the road more hazardous, especially as the side slopes are so steep (2:1) that any out-of-control vehicle that goes down them will almost certainly overturn.

Recommendation

The necessity of such high embankments should be re-examined in view of the safety concerns. The side slopes should be eased to 4:1 wherever it can be done without too much expense, such as on embankments less than 2m high. On high embankments where the side slope cannot be eased you should consider planting the side slopes with several lines of "soft" trees and bushes, which will help to stop out-of-control vehicles. Another option is to create a small earth mound at the edge of the formation, though care will be needed to ensure that it does not impede drainage.

3. Problem

There appears to be a high volume of pedestrians and NMVs on the first 1.5km from Katchpur Junction, and these vulnerable road users will be at risk of being hit by speeding traffic because of the narrowness of the shoulder.

There are also many accesses into the roadside factories, and vehicles leaving and entering these accesses conflict with the faster-moving through traffic.

Recommendation

Provide segregated service roads on both sides of the main road. They should connect into the main road at limited intervals, preferably by means of roundabouts. They should be wide enough to cater for NMVs as well as access traffic, and should have paved footways.

ALIGNMENT

4. Problem

There are many moderately hazardous sections, such as those with sub-standard vertical and horizontal curves and those on high embankments. Drivers need clear guidance through these sections. Proposed road markings and warning signs may be insufficient.

Recommendation

Provide delineator posts with reflectors (sign B56 in the new Traffic Signs Manual) on all hazardous sections – including horizontal curves of less than about 300m radius.

ROADSIDE COMMUNITIES AND FACILITIES – VULNERABLE ROAD USERS

5. Problem

The proposed improvements in geometry and pavement surface may lead to higher speeds. Many drivers do not slow down on entering built-up areas, and the road environment does not encourage them to do so. This could result in serious safety problems in the built-up areas – especially in the smaller communities on long, straight sections, such as Jashar Bazar, Kamertek Bazar and Balabor Bazar (Contract 2C).

Recommendations

Speed limit signs should be installed (refer to the new Traffic Signs Manual) but these limits should be reinforced by traffic calming measures. These are needed at the entrance to the built-up areas and throughout their length. Such measures may range from gateways and rumble strips to roundabouts and speed humps.

6. Problem

It is not clear from the drawings how the buffer blocks between the NMV lane and the carriageway on the Type 6 cross-section (built-up areas) will be spaced (dwg. no. 5009). If they are widely spaced they may not provide sufficient control of access onto the carriageway – and they could also be a hazard to moving vehicles.

Recommendation

Consider providing a continuous divider, with openings only at limited intervals. This could also provide some protection to pedestrians. The end of the divider needs to be clearly marked to avoid it being a hazard.

7. Problem

Roadside masonry drains (Type 6 cross-section) deeper than 250mm may be a hazard to pedestrians and NMVs unless covered (dwg. no. 5009).

Recommendation

Provide a cover on all drains deeper than 250mm.

8. Problem

Sylhet Town section: - in the absence of footways the pedestrians are likely to walk on the NMV lanes, which in turn will discourage the NMVs from using these lanes.

Recommendation

Where there is space provide a footway at the back of the NMV lane. Another option is to explore the possibility of establishing an NMV route at the back of the frontage premises – if NMVs could be transferred onto this, it would leave more space for pedestrian movement alongside the main road.

9. Problem

During much of the day the number of buses waiting at the busier bazars, such as Sherpur Bazar, may far exceed the capacity of the proposed bus bay. Consequently these buses will probably wait on the carriageway where they will be a hazard to through traffic – and passengers joining or leaving the bus may be at risk of being hit by vehicles.

Recommendation

Carry out a survey to determine bus parking needs at the busier bazars, and provide larger-capacity roadside bus parks where necessary.

JUNCTIONS

10. Problem

The proposed Type A design of junction cannot safely handle minor road flows in excess of about 300 vehicles 2-way ADT. Above this traffic level there will be a significant risk of collisions between through traffic and minor road traffic. Regrettably the design consultants seem not to have estimated traffic movements at the junctions, but some of the junctions are certain to be well-trafficked.

Recommendation

The junction designs should be reviewed once the design year turning movements have been estimated. At the busier junctions consideration should be given to either (a) providing vehicles turning right into the minor road with some shelter from the through flow, by means of an offside lane for right-turners, or (b) ensuring the interchange of

traffic flows at a safe speed, by means of a roundabout. The roundabout option is recommended at the busiest junctions, including Brahman Baria, Mirpur By-Pass, Jagadishpur, and Sherpur Bazar. There needs to be a detailed design for each of these major junctions and these should be submitted for safety audit before being finalised.

11. Problem

It appears that some of the new junctions could be on or near bends – see for example Madhabdi By-Pass junction at ch. 24+800 (Contract 1A). This is potentially hazardous, especially if it means that the safe stopping sight distance cannot be achieved.

Recommendation

New junctions should preferably be sited away from bends. The horizontal alignment of the end sections of the by-passes needs to be reviewed with this objective in mind. The requirement to provide safe stopping sight distance must be respected.

12. Problem

Designs for individual junctions are not yet available. There is a risk that priority junctions at the end of the by-passes will be laid out with the 'old' road entering at a skew – see for example Madhabdi By-Pass junction at ch. 24+800 (Contract 1A). Skew junctions tend to have a bad accident record, because of visibility problems and driver confusion over which is the main road.

Recommendation

At all junctions the minor road approach should be aligned so as to join the major road as near to a right angle as possible. The redundant section of the 'old' road must not be used as a slip road for traffic turning left onto or off the major road, and the ends must be completely blocked with earth mounds and planting.

13. Problem

The drawings are unclear but it appears that the Type A and Type B junctions have excessively large areas of pavement in addition to the carriageway (i.e. 2.5m wide shoulders, plus 1.7m wide strip whose function is unclear). This is likely to encourage drivers of turning vehicles to make the turn at a higher speed than is safe. It will also encourage drivers turning right to cut the corner and go the wrong side of the splitter island (Type A design).

Recommendation

The Type A and Type B junction designs need to be reconsidered with a view to encouraging drivers of turning vehicles to take the correct line through the junction at a safe speed. Elements to be examined include: the shoulders (is it necessary to continue the main road shoulders into the minor road?); the corner radii; the need to kerb the edge of the carriageway to guide drivers and discourage corner cutting; and the design of the splitter island.

14. Problem

There appears to be no provision for ensuring that minor roads at junctions join the major road at or near grade. Vehicles cannot safely enter the major road from a slope.

Recommendation

Ensure that the minor road vertical alignment is such that vehicles on the minor road enter the junction at or near grade.

15. Problem

Pedestrians and NMVs are likely to congregate at the junctions in the built-up areas and, unless their movements are controlled and channelled, there could be accidents as motor vehicles try to manoeuvre through the junction.

Recommendation

At all Type A and B junctions in built-up areas there should be kerbed footways, together with pedestrian guardrail to channel pedestrians to safe crossing points. The pedestrian guardrail will also help to discourage NMVs from stopping in the junction.

16. Problem

There are too many private accesses along the first 15 kilometres from Katchpur Junction. These are points where fast-moving through traffic conflicts with slow, turning vehicles.

Recommendation

The opportunity should be taken to rationalise access onto the main road. There is scope for neighbouring premises to share access onto the main road, and this should be encouraged.

17. Problem

The Katchpur Junction has many safety problems and there appears to be no provision in the scheme for improving it.

Recommendation

Consider incorporating a major improvement scheme for Katchpur Junction. This should be safety audited.

BRIDGES AND CULVERTS

18. Problem

A few of the bridge and culvert structures that are to be retained are much narrower than the normal cross-section (e.g. Contract 2C, Structure 63: 105m long, 7.85m wide, and Structure 69 : 9m long, 7.9m wide and no footway). These “pinch-points” are likely to be quite hazardous, as many drivers will not slow down and cross them at a safe speed. Head-on collisions and collisions with NMVs can be expected. Pedestrians will be at risk on those structures with no footways.

Recommendation

The decision to retain these few structures should be reconsidered in view of the safety concerns. Clear and consistent criteria should be used in deciding which structures are to be retained and which are to be replaced. A count of pedestrian and NMV traffic would be useful in determining the seriousness of the problem. If they cannot be widened, an attempt should be made to encourage vehicles to slow down, through the use of signs (speed limits?) and possibly rumble strips. Parapets may be a hazard and will need protection and signing.

19. Problem

The bridges and some culverts do not have shoulders, so, where there are NMVs, they will have to share the carriageway with the MVs. The NMVs may move onto the carriageway in front of speeding vehicles. The difference in speeds between NMVs and MVs will lead to unsafe overtaking on the bridges.

Recommendation

A count of NMV traffic would be useful in determining the seriousness of the problem. The decision not to provide shoulders should be reviewed with the help of this information. If it is not possible to widen the problem bridges and culverts, an attempt should be made to encourage the MVs to slow down, through the use of signs (speed limits?) and possibly rumble strips – but for maximum effectiveness this treatment should be restricted to bridges and culverts where there is an NMV problem.

20. Problem

Some of the new culverts have footways and parapets, and some do not, and it is unclear why. Pedestrians may be at risk on culverts without footways, especially if the culvert is more than a few metres long.

Recommendation

The provision of footways on new culverts should be reviewed. Clear and consistent criteria should be used in deciding which culverts should have footways and which should not. It is recognised that the replacement of a shoulder by a footway could affect the safety of NMVs. A count of pedestrian and NMV traffic would be useful in determining where the balance of risk lies.

21. Problem

Where footways are to be provided on bridges and culverts they extend only to the ends of the bridge deck. Consequently there is a short section where the pedestrian is unprotected but cannot take avoiding action because of the parapet.

Recommendation

Footways should extend to the end of the parapet and then be ramped down and flared away from the carriageway edge. This treatment should also be applied on those bridges that are to be retained.

22. Problem

The proposed bridge parapet, although widely used in Bangladesh, is not a modern, safety-conscious design. Whilst it cannot be called “unsafe” it does not provide the level of safety that modern designs achieve. The ability of the parapet to safely contain out-of-control vehicles is suspect, especially at the section gaps.

Recommendation

The parapet design should be reviewed. Consideration should be given to providing a safety barrier or kerb between the carriageway and the footway, as this allows the parapet to be designed for pedestrian safety only.

23. Problem

There is no provision for protecting out-of-control vehicles from hitting the end of the parapet or falling down the embankment on the bridge approaches. It is anticipated that guard posts will be installed, but these cannot provide effective, safe protection.

Recommendation

Consider providing effective safety barrier at the ends of bridge parapets and on bridge approaches. If steel beam safety fence is used it must form a continuous face with the bridge parapet and be strongly connected to it.

24. Problem

The rail overbridges have a solid RCC parapet on the bridge deck and an RCC post and rail parapet over the abutments. However, accident experience indicates that a vehicle is just as likely to impact the parapet on the

abutments as on the bridge deck, so this parapet arrangement may not be effective in preventing vehicles from falling onto the rail tracks.

Recommendation

Review the design of the parapet on rail overbridges with the objective of providing the same standard of containment throughout the length of the parapet.

SIGNS AND MARKINGS

25. Problem

The proposed signs and markings (designs, colours, sizes, positioning, etc.) do not follow the new RHD standards.

Recommendation

Provide full signing and marking in accordance with the new RHD standards. Consider the use of thermoplastic markings in view of their superior performance and durability. Work zone signing should be in accordance with the Code of Practice given in the new Traffic Signs Manual.

RSADhak-Syl 9-Sep-99

ROAD SAFETY AUDIT REPORT PROPOSED NEW JUNCTIONS AT HATIKAMRUL AND BONPARA (NALKA – HATIKAMRUL – BONPARA ROAD)

Background

The need to do an audit was discussed when the Road Safety Engineering Advisor met the Project Director, Mr Nurul Azan Khan on Wednesday 11th August.

Drawings of the proposed Hatikamrul junction (dated 27/8/99) and the proposed Bonpara junction (dwg. no. NHB/JUCN./MAHL-) were provided by the consultant. Junction turning movement data for Hatikamrul was also provided.

The persons undertaking the audit were:

Mr Habibur Rahman, EE, Road Safety Division, RHD
Mr Allan Jones, Road Safety Engineering Advisor, RHD
Md. Shahabuddin, AE, Road Safety Division, RHD
Md. Aminul Hoque, SAE, Road Safety Division, RHD

It was not possible for the audit team to inspect the site in the time available.

A meeting took place on 30/8/99 with Mr D. Hansen of DHV Consultants to obtain information on what is proposed.

Presentation of the audit findings

HATIKAMRUL JUNCTION

1. Problem

The safety of a roundabout is very much dependent on being able to keep the speed of motor vehicles down to about 40 km/h. The proposed layout has several features which permit, and may encourage, much higher speeds. These include: the wide entries and exits (2 lanes plus shoulder), the large radius of the entries and exits, and the wide circulatory carriageway. Also, the size of the central island relative to the layout of the entries does not provide sufficient deflection to keep entry speeds down to the required safe level. These problems are most obvious in the left turn from the Bogra road into the Nalka road.

Recommendation

It is recommended that motor vehicle speeds through the junction be constrained by: providing single lane entries and exits; smaller entry and exit radii, and much greater deflection on entry.

2. Problem

NMVs are at risk of being hit by motor vehicles, especially at the entries and exits. The volume of NMVs (currently about 300 per hour) is such that it is worth considering segregating the NMVs from the MVs to avoid the dangerous conflicts.

Recommendation

There are various ways of segregating NMVs but the best would be to build a two-level roundabout with the NMVs circulating at approach road level and the MVs above. This would entail raising the roundabout and letting NMVs circulate on paths below it – using culverts to get under the roundabout approach roads – see Figure 1.

The junction should be fully signed in accordance with the new RHD standards.

BONPARA JUNCTION

1. Problem

The safety of a roundabout is very much dependent on being able to keep the speed of motor vehicles down to about 40 km/h, and this is especially important where there is a mix of NMV and MV traffic. The proposed layout has several features which permit, and may encourage, much higher speeds. These include: the wide entries and exits (2 lanes plus shoulder), the large radius of the entries and exits, and the wide circulatory carriageway. Also, the size and positioning of the central island relative to the alignment of the entries does not provide sufficient deflection to keep entry speeds down to the required safe level. This last problem is most obvious with the entry from the Pabna

direction, which has no deflection; consequently vehicles will enter the roundabout at too high a speed and either collide with circulating traffic or fail to negotiate the roundabout and run off the road.

Recommendation

It is recommended that motor vehicle speeds through the junction be constrained by: providing single lane entries plus shoulder for NMVs; smaller entry and exit radii, reducing the width of the circulatory carriageway, increasing the size of the central island, and moving the island to the west by a few metres so that its centre is on or near the centreline of all the approach roads. Figure 2 illustrates one way in which this could be done, but other layouts could be devised which would meet the safety objectives.

2. Problem

The volume of NMVs in the junction is such that they need to be guided into following a safe path through the junction. Otherwise there will be too many dangerous conflicts with motor vehicles. The proposed design does not make any provision for NMVs other than a shoulder.

Recommendation

There are various ways of providing for NMVs in roundabouts and the option recommended here is to provide a lane for NMVs around the outer edge of the circulatory carriageway – see Figure 2. This design has been adapted from that commonly used in Holland and Denmark at junctions which are well used by cyclists. The NMV lane markings must be in thick thermoplastic screed which will be more durable and better respected than a paint marking.

3. Problem

The lack of access control, together with the wide circulatory carriageway, will lead to various safety problems. Buses may park in the junction to load or unload passengers. Pedestrians and NMVs may gather in the junction where they will cause congestion and be at risk of being hit by motor vehicles. Pedestrians will also walk on the shoulder in the absence of footways and cross the junction using the central island.

Recommendation

The paved area should be kerbed throughout and footways provided. Pedestrian guardrail should be installed to keep pedestrians out of the junction (and discourage vehicles from stopping) and channel them to crossing points opposite the splitter islands. Building development should be discouraged by creating earth mounds, with suitable landscaping, on the perimeter of the roundabout.

The junction should be fully signed in accordance with the new RHD standards.

Road Safety Audit

Modified Design for Hatikamrul Roundabout

Scale: 1:500

- Central island diameter is 30m
- Circulating carriageway is 10m wide of which the outer 2m is a lane for rickshaws
- Entry and exit radii are 20m
- Minimum entry and exit width is 6m of which the outer 2m is a lane for rickshaws
- Approach road section is a 7.3m carriageway plus 2 x 1.5m wide shoulders
- Limits of paved area should be kerbed and pedestrian guardrail installed
- Junction should be fully signed in accordance with new RHD standards

Road Safety Audit

Modified Design for Bonpara Roundabout

Scale: 1:500

- Central island diameter is 32m
- Circulating carriageway is 9m wide
of which the outer 2m is a lane for
rickshaws
- Entry and exit radii are 20m
- Minimum entry and exit width is 6m of
which the outer 2m is a lane for
rickshaws
- Approach road section is a 7.3m
carriageway plus 2 x 1.5m wide shoulders
- Limits of paved area should be kerbed and
pedestrian guardrail installed
- Junction should be fully signed in accordance
with new RHD standards

Road Safety Audit

**Sketch design for two-level
roundabout at Hatikamrul –
plan and cross-section of
entry from Nalka**

Plan

Cross-section

To Nalka

To Bonpara

To Hatikamrul

To Natore

ROAD SAFETY AUDIT REPORT

PAKSEY BRIDGE CONSTRUCTION PROJECT

Background

The need to do an audit was discussed when the EE Road Safety Division met the Project Director, Mr Shahidul Alam 29 November 1999.

Drawings (Paksey Bridge Construction Project, Tender Documents, November / December 1998) were provided by the supervision consultants.

The persons undertaking the audit were:

Mr Habibur Rahman, EE, Road Safety Division, RHD
Mr Allan Jones, Road Safety Engineering Advisor, RHD
Mr Arif Ahmed, Road Safety Engineering Consultant, RHD

It was not possible for the audit team to inspect the site.

A meeting took place on 20 December with the Messrs Round and Aves of the supervision consultants to seek clarification of some points, and have a preliminary discussion about the main safety concerns.

Presentation of audit findings

A. CROSS-SECTION

A1. Problem

Lack of provision for NMVs on the bridge means that they will be at risk of being hit by MVs.

Recommendation

If NMVs are permitted on the bridge they should be given a lane of minimum 1.5m width. Ideally this should be segregated from the MV lanes by a safety barrier. If physical segregation is not possible a rickshaw lane marking (sign F19) should be laid, preferably in thermoplastic screed.

A2. Problem

On the connecting and approach roads NMVs and pedestrians may prefer to use the carriageway unless the DBST on the shoulder provides a smooth, comfortable surface. Demarcation of the carriageway / shoulder may be unclear if road paint is used.

Recommendation

Ensure that DBST on shoulder produces a smooth surface. Consider using thermoplastic screed to mark the edge of the carriageway (sign F9).

B. ALIGNMENT

B1. Problem

There are a number of moderately hazardous sections (bends, sections on high embankments, etc.) on the connecting roads and drivers will need clear guidance through them. Road markings may be insufficient.

Recommendation

Provide delineator posts with reflectors (sign B56) on hazardous sections, such as:

West Connecting Road (WCR): curve at ch. 2080 (posts could be used to block view of "old" road for northbound traffic); high embanked section at ch. 5275

East Connecting Road (ECR): high embanked section between ch. 2975 and ch. 3425 (Shahapur Roundabout); high embanked section at ch. 9650 (Dasuria culvert)

C. JUNCTIONS

C1. Problem

In general the roundabout designs fail to restrict entry and circulating speeds to the low levels necessary for safe mixing of MVs, NMVs, and pedestrians. Roundabouts of particular concern are:

(a) Shahapur Roundabout on ECR – insufficient deflection is provided to slow down traffic entering the roundabout from the west and going north to Dasuria – this is dangerous

(b) Dasuria Roundabout on ECR – insufficient deflection on the entry from the east

Recommendation

Modify roundabout designs to control entry speeds to 20 km/h or below. This involves consideration of entry widths, entry radii, and size and position of centre island. For safety all roundabouts must be fully signed in

accordance with the provisions of the BRTA Traffic Signs Manual. See also problem D3 regarding pedestrian safety at the roundabouts.

C2. Problem

The T-junction at ch. 2930 on ECR just west of Shahapur Market gives rise to a number of safety concerns, as follows. Ghost-island layouts of this kind are thought to be inappropriate for Bangladesh, as drivers will probably ignore the ghost-island marking and will regard the extra carriageway width as an invitation to overtake. The ghost island arrangement does not assist traffic turning right out of the minor road, and this is likely to be the dominant traffic movement. Moreover the alignment of the minor road approach is particularly awkward. Drivers approaching the junction along the minor road from Iswardi may fail to appreciate that the road bends very sharply to the left – especially as the straight ahead movement is still permitted. The channelising island in the minor road is too short to be effective and easily seen and could be a hazard, especially at night.

Recommendation

The design of this junction needs to be completely re-thought. A forecast of DY junction turning movements would be useful. A roundabout may be the most safe and effective way of handling the traffic movements. A single lane dualling layout could also be considered but would not be as safe as a well-designed roundabout.

C3. Problem

In general the T-junction designs do not take sufficient account of the need to: keep speeds of turning vehicles to a safe, low level; make priorities clear, guide the path of turning vehicles. Short channelising islands in the minor road approach can help pedestrians, but from experience of these in Bangladesh drivers will often go the wrong side of them, especially where large corner radii facilitate this. Junctions of particular concern are:

- ECR ch. 4225 – stagger between the minor roads is insufficient to prevent drivers on minor road treating it as crossroads
- ch. 7100 – priorities at the secondary junction are not clear
- ch. 8400 – the skewed alignment of the minor road increases the risk of accidents
- ch. 9450 – stagger between the minor roads is insufficient

WCR ch. 2350 – priorities at the secondary junction are unclear

Recommendation

Review the design of the T-junctions, especially corner radii, channelising islands, stagger distances, and guidance on priorities.

D. PEDESTRIANS

D1. Problem

The bridge may be used by considerable numbers of pedestrians, but the facilities provided for them are inadequate. Specific concerns are:

- (a) The footway is too narrow to enable pedestrians to overtake or cross each other without one of them having to step into the carriageway. Where two pedestrians are walking together across the bridge they will probably walk in the carriageway.
- (b) The location of the pedestrian stairways appears not to be related to likely pedestrian movement desire lines.
- (c) The footway appears to end at the abutments, and pedestrians walking between there and the top of the stairways or the terminal roundabouts will be unprotected, and over part of this length will be walking in front of safety barrier.
- (d) No provision has been made for pedestrians who want to walk parallel to the river to cross the approach roads. If they use the stairways as currently located they will be faced with crossing a dual carriageway road with a safety barrier in the centre.

Recommendation

Review the likely usage of the bridge by pedestrians, estimate the likely movement desire lines, and incorporate appropriate facilities. Particular attention should be paid to getting the pedestrians to and from the bridge footway in a convenient and safe manner.

D2. Problem

There are many places where the connecting roads pass through established communities and inevitably there will be a lot of pedestrian crossing movements. There appears to be no provision for safe crossings other than at the subways. Pedestrians may come up the embankment and suddenly appear on the carriageway giving drivers little time to avoid them.

Recommendation

Examine pedestrian movements in the area; try to determine likely crossing points; and consider providing appropriate facilities (eg., steps up the embankment, paved shoulder area, pedestrian guardrail, and delineator posts / warning signs) at these crossing points. Crossing flows are probably insufficient to warrant formal pedestrian crossings.

D3. Problem

There is no provision for pedestrians at the roundabouts, and this means that they will walk in the carriageways and cross everywhere. This will put them at risk of being hit by motor vehicles.

Recommendation

Examine the pedestrian movements in the area, try to determine movement desire lines through the roundabouts; and consider providing appropriate facilities, such as footways, crossing points on the channelising islands, etc.

E. BUSES AND BUS USERS

E1. Problem

Buses stopping on the carriageway are a hazard to other traffic. Passengers waiting on the carriageway for buses are at risk of being hit by vehicles. There appears to be no provision for bus facilities in the scheme other than an "Area for Future Bus Facility" near the Shahapur Roundabout. In the absence of details of how and when this will be made to work it can be assumed that buses will stop on the carriageway.

Recommendation

Forecast bus movements in the area after the bridge is open; try to determine likely stopping points, and consider providing bus lay-bys at these points.

F. SAFETY BARRIER / GUARDRAIL

F1. Problem

Out-of-control vehicles should be protected from falling off the high embanked approach roads by the provision of safety barrier or guardrail. The steel safety barrier on the bridge approaches appears to extend 150m from the bridge abutments, but this is not far enough to give a reasonable degree of protection (at this point on the west approach the embankment is 7m high). Nor does it extend over the hazardous transition from the wide road formation with low median to narrow formation with concrete median barrier. Moreover there are insufficient details given of the connection between the steel barrier and the bridge parapet (this connection is critical for the effectiveness of the barrier installation) and the end treatment.

Recommendation

Review the need for safety barrier on the bridge approaches as well as the installation details.

F2. Problem

The ends of the concrete New Jersey Barrier on the bridge approaches (dwg. BA/404) are potentially hazardous and need to be well marked.

Recommendation

Mark the ends of the barrier with reflective Dangerous Obstruction marker plates (sign B49).

F3. Problem

The drawings of the end treatment of the safety barrier installations (connecting roads) fail to provide for a concrete end block. This is necessary to protect any pedestrians, cyclists, or other vulnerable road users who may get thrown against the end of the barrier. Alternatively the end of the beam can be buried into the ground.

Recommendation

Review the end treatment of the safety barrier.

F4. Problem

All the roundabouts except Dasuria are on embankments of about 3m height. If the side slopes of the embankments are steeper than 1:4 they will be sufficiently hazardous in this location to warrant safety barrier around the outer perimeter. At Shahapur Roundabout (see C1 for concerns about its design) the southern arm is on an embanked sharp bend and this also needs safety barrier.

Recommendation

Consider making the side slopes of the embankments at roundabouts 1:4 or less. If this is not possible consider installing safety barrier around the perimeter.

G. BRIDGE PARAPETS

G1. Problem

The RCC post and rail parapet proposed for the subways and culverts is not a modern safety-conscious design. It is believed to have limited capability to contain out-of-control vehicles.

Recommendation

Review the parapet design.

G2. Problem

On the canal bridge (ECR) the parapet on the south-west side and its extension wall may restrict visibility of the rail crossing, particularly for north-bound car drivers. Although crossing gates are to be provided it cannot be assumed that these will always be in place.

Recommendation

Consider replacing the solid parapet and extension wall with a more open design which will give car drivers some view of the rail approaches to the crossing.

H. SIGNS AND MARKINGS

H1. Problem

The proposed signs and markings (designs, colours, sizes, positioning, etc.) do not follow the new BRTA standards.

Recommendation

Provide full signing and marking in accordance with the provisions of the BRTA Traffic Signs Manual. Critical signs should be reflective. Consider the use of thermoplastic road markings in view of their superior performance and durability. Particular care is needed with the signing of the rail crossing on the West Connecting Road, and advice and approval should be sought from the railway authorities. A detailed signing and marking plan should be prepared for the whole scheme and this should be made available for safety audit. Workzone signing should be in accordance with the Code of Practice given in the Traffic Signs Manual.

I. LIGHTING

II. Problem

It appears that the lighting scheme extends only to the bridge abutments, so the stairways, the transition from narrow formation to wide formation, and the remainder of the approach roads will be unlit at night. These sections will seem very dark when compared to the bridge itself, and this adds to the accident risk, especially if pedestrians use the bridge at night.

Recommendation

Consider extending the lighting scheme to and including the terminal roundabouts. If this is not possible then the lighting should at least cover the stairways and the transition section.

J. OTHER CONCERNS

J1. Problem

Detailed plans are not available for significant elements of the scheme, including:

- a) the toll plaza
- b) the upgraded section between the east terminal roundabout and the East Connecting Road
- c) the side road (dual carriageway) leading south from the Shahapur Roundabout
- d) the bus facility at Shahapur.

All of these elements could have safety problems and could have significant safety implications for the rest of the scheme.

Recommendation

These above elements need to be designed at an early stage and the plans should be made available for safety audit.

J2. Problem

Experience suggests that local communities affected by new roads and bridges often have difficulty in coping with the new traffic situation, and as result there are many pedestrian accidents in the first few months after opening.

Local children and others often steal or damage signs and road furniture

Recommendation

It is strongly recommended that Community Road Safety Officers be employed to inform local communities of what is being built, how to use it safely, and why they should respect what is being provided. It will be essential to work with local Police, teachers, and community leaders.