

**His Majesty's Government of Nepal**

**Road Safety Notes 7**

# **Safety at Bridge**



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Design Branch, Department of Roads  
Ministry of Works and transport**

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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](mailto: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. Introduction

Road accidents are very common on bridge's and. bridge approaches. This note provides advice on how to make bridges and their approaches safer. It will outline and describe the general safety principles to follow with examples but detail design and structural safety is out of its scope.

We hope that the guidelines will be followed by designers of new and rehabilitation projects to make our bridges more safer for road users.

## 2. Review of Typical Accidents:

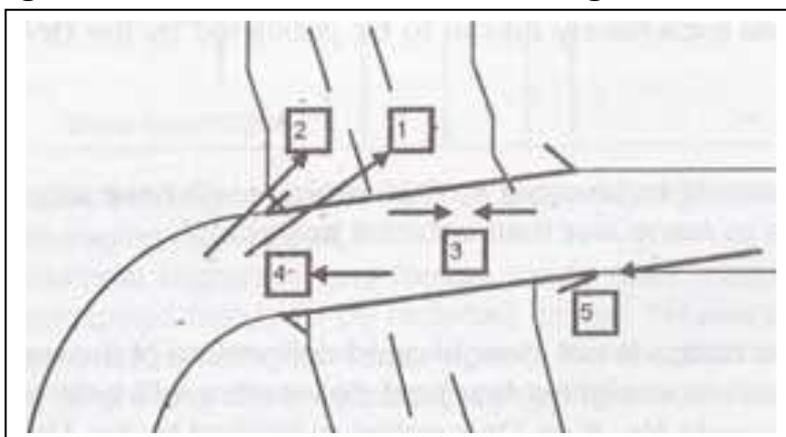
Though no accident data has been collected till date for accidents at bridge sites for the whole country, data collected from Naubise - Mugling sector of Prithvi Highway for the past one and half year has been analyzed to get some insight on typical accidents on bridge sites.

The accidents can be categorized as following (see fig. 1.):

- Roll over accidents: Single vehicle losing control and falling over the bridge or approach
- Head on Collision : Two vehicles colliding head on with each other
- Pedestrian: Pedestrian hit by vehicles
- Vehicle hits parapet: Vehicle hits unprotected end of a parapet

Pedestrian accidents could have been prevented to a large extent if the bridges in question. had proper pedestrian facilities i.e., footways. The other two type of accident could have occurred mainly due to inadequate widening of the bridge carriageway and the approaches being on tight bends without proper delineation and signs. The severity of the accidents too could have been reduced if there had been adequate safety barriers on the approach and parapets able to contain errant vehicles.

**Figure 1. Combination of Accidents at Bridges:**



1. Vehicle falls through the parapet
2. Vehicle leaves the road on the approach section
3. Head - on collision
4. Collision with pedestrian
5. Collision with end of parapet

### 3. Safety Principles

- ***Alignment of bridge and approaches:***  
Generally bridges should be built in a straight alignment with at least 50 metres of straight approach leading to the bridge. From safety point of view safe sight distance should be maintained throughout the bridge approach and on the bridge itself. It is very dangerous for a bridge to be approached on a sharp bend, In hill roads it may be difficult to have 50 metres of straight approach, in which case it will be better to design the bridge on horizontal curve.
- ***Cross Section:***  
Carriageway width across the bridges as recommended in Nepal Road 'Standards (2045) would be desirable, however at least the approach carriageway width should be maintained across the bridge. Bridge carriageway width between 3.75 metres and 7.5 metres could confuse the roadusers as to whether it is a single or double lane bridge, hence should not be generally used.
- ***Provision for pedestrians:***  
Footways should be provided for pedestrians to cross bridges. they are essential on long bridges built to minimum widths where the traffic is fast. Protection to the pedestrian on the footway in form of barrier walls as provided for in DOR standard design is desirable except on lightly trafficked minor road bridges with short span or with little or no pedestrian traffic.
- ***Parapets:***  
Parapets strong enough to contain out - of - control vehicles are a must from safety point of view. They should be forgiving to any colliding vehicle; however their design and placing should be carefully done to avoid its being a hazard in itself. The end of the parapets should generally be protected by use of safety barrier at the end or splaying and extending them on to the approach.
- ***Delineation:***  
The road approaches to the bridge must be well delineated (Post, delineators, chevrons signs, road markings, etc. ) in order to guide drivers safely onto the bridge. Refer safety note No. 5 on Delineation published by the Unit for further advice on delineation.
- ***Safety Barrier:***  
Safety barriers on approaches may be required depending on the nature of the approach. Refer to Road Safety note 6 on Safety barrier to be published by the Unit for further advice on safety barriers.
- ***Signs and Road Marking:***  
Proper signing and road markings needs to be done so that vehicles will have advance warning of any hazards and be able to maneuver their vehicles accordingly.

### 4. Approaches /Transitions

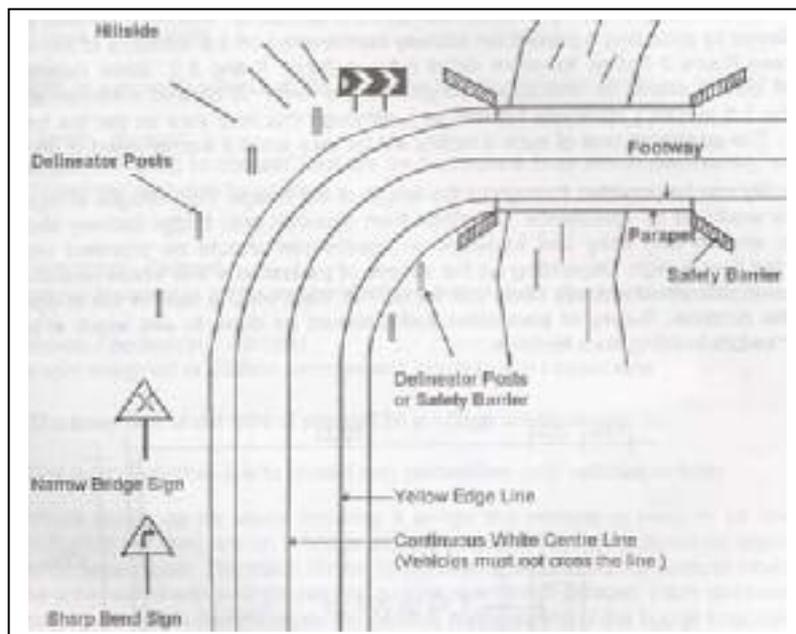
Where approach road leading to the bridge is not straight good delineation of the road is necessary. Even where the approach is straight a few post delineators will help guide drivers onto the bridge. Refer safety note No. 5 on Delineation published by, the Unit for further advice on delineation. Depending on the height and the side slope of the embankment safety barrier may be required which can also act as delineation of the road, Refer Road Safety note 6 on Safety barrier to be published by the Unit for further advice on safety barriers.

The end of the parapets should be protected by use of safety barriers or by extending and splaying them away from the -carriageway on the approach to prevent vehicles from hitting the parapet end, however access to bridge footway should not be obstructed ( see figure 2 & 10 ). The parapet end can be protected by using gabion, cement masonry or steel barriers.

For bridges on bends more prominent signing and marking in form of chevron signs, barrier centre lines, and other delineation measures are required.

Safety barriers on the outer side of the curve may be required irrespective of the embankment height depending on the radius of the curve and if the road alignment of the road leading to the curve is at a down gradient and or very straight for a long stretch encouraging high speed.

Figure 2. Bridge Approach



In National highways and feeder roads road markings can be done at critical points where speed needs to be reduced; speed breakers can only be used on minor roads with minimum traffic to reduce speed. For location indicating the position of delineators, their height and distance from the edge of road refer Road Safety note 5 on Delineation.

## 5. Provision for Pedestrians

In many places, bridges are probably the only means by which pedestrians can cross the rivers, and so proper provision has substantial social as well as safety implications.

Where bridges have been built with restricted carriageway width, there may not even be adequate clearance for a truck to pass a pedestrian in safety. On longer bridges, it may not even be possible for a pedestrian to make a 'safe' decision on whether to commence crossing, and accident rates may be high. As flows increase, the problem become worse.

On narrow two lane bridges vehicle speeds may be high, and vehicles may not have sufficient extra clearance for pedestrians to be passed safely. The problem may be particularly severe in locations where approach roads lead to a single lane bridge. Fast approaching traffic is then suddenly constrained to a much narrower area and may have problems in safely negotiating the bridge in any case. The presence of unprotected pedestrians on the bridge using up part of the limited space available increases the likelihood of accidents occurring.

Where possible a segregated footway should continue across the bridge (Refer to Standard DOR Design, fig. 9). Where road-space is limited, an economic solution may be achieved by providing a pedestrian footway cantilevered off the structure of the road bridge (see figure 3 below, for more detail refer to figure 7 and 8). Since motorized vehicles cannot use it, its structural strength can be lower. A desired minimum width would be 1.5 metres (minimum 1.0 metres), although this may vary as per the traffic volume. The additional cost of such a facility will be very small if incorporated at design stage.

If no facility can be provided throughout the length of -the bridge, then refuges at regular intervals would be of assistance. Transition from shoulder onto bridge footway should also be smooth and easy and footways on approaches should be provided where pedestrian flow is high. Depending on the volume of pedestrians and where availability of space is restrained footway could just be built at least on one side of the bridge to solve the problem. Survey of pedestrian traffic should be done to see which side is popular before building such facilities.

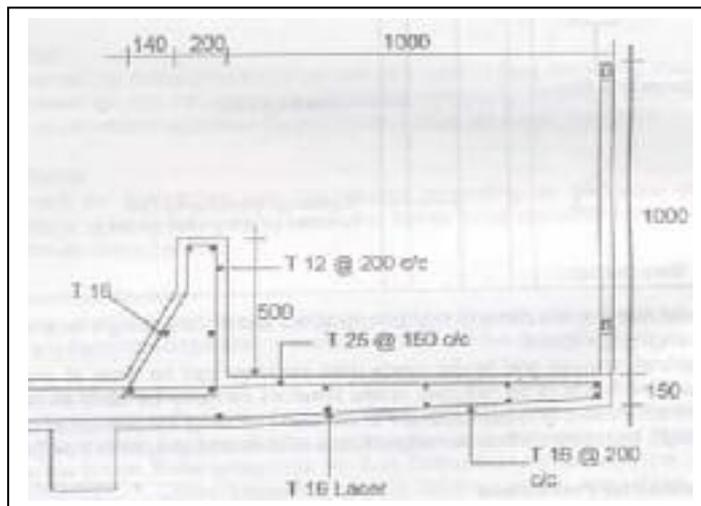


Figure 3. Cantilevered Footway

## 6. Parapets

Parapets are safeguard against a vehicle which is out of control plunging over the edge of the bridge. They also protect pedestrians from falling. In addition they may be required to protect the area below in certain circumstances. Design approach is usually based on 'containment' requirement in terms of a specified weight of vehicle and its approach angle and speed.

It would be impractical to stipulate that a parapet should be capable of containing any vehicle traveling at any speed. The parapets suggested in this note are designed to contain only light vehicles and slow moving heavy vehicles . A parapet which would be sure to contain a heavy vehicle moving at high speed would be massive in structure and too costly.

### 6.1 Types of Parapets

Parapet is a protective fence at the edge of a bridge or similar structure. It could be

- **Vehicle - Parapet**  
parapet designed to contain vehicles on a structure from which pedestrian, animals and cyclist are excluded by order.
- **Pedestrian - Parapet**  
A parapet designed to safeguard pedestrians, but not intended to contain vehicles.

- **Vehicle I pedestrian - Parapet**

A parapet designed to contain vehicles and to safeguard pedestrians.

### 6.2 The selection of the type of parapet for a bridge would depend on:

- First decide whether it is to protect only pedestrian, only vehicles or both.
- Likelihood of vehicle impacts - the bridge approached at a bend
- Visual merits, a,,s for users crossing a bridge the parapet is likely to be the only indication that they are on a bridge structure, and so is of a fundamental importance to its appearance. The basic choice is between a solid concrete parapet which may be surmounted with a single rail and a more open metal parapet. Each can have their own visual merits depending on the general configuration of the bridge structure.
- Load that the structure can carry as other things being equal on a three or four span 'bridge on a local road with consequent light loading, it would seem inappropriate to introduce heavy concrete parapets onto a structure which would otherwise be slender.
- Availability / cost of materials would also play a significant role on the choice.
- Space available for placing the parapet would also play a major part in selection as adequate space needs to be left for footway for pedestrians or in the case Of bridges which have been already built the space may be restrictive.

### 6.3 Suggested parapet design. (Consult Bridge Unit, Design Branch, DOR, Babarmahal for details)

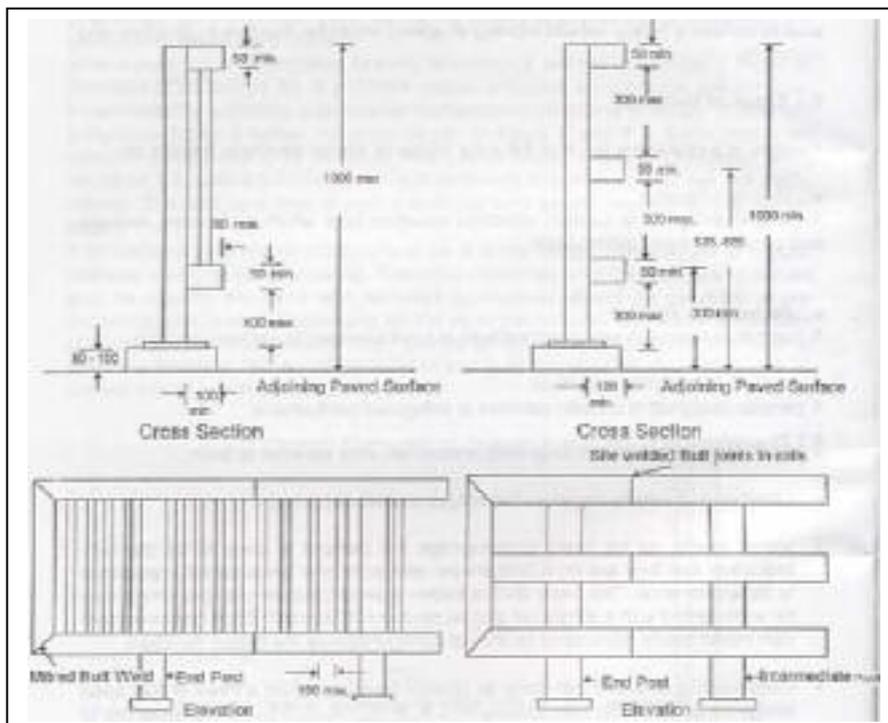
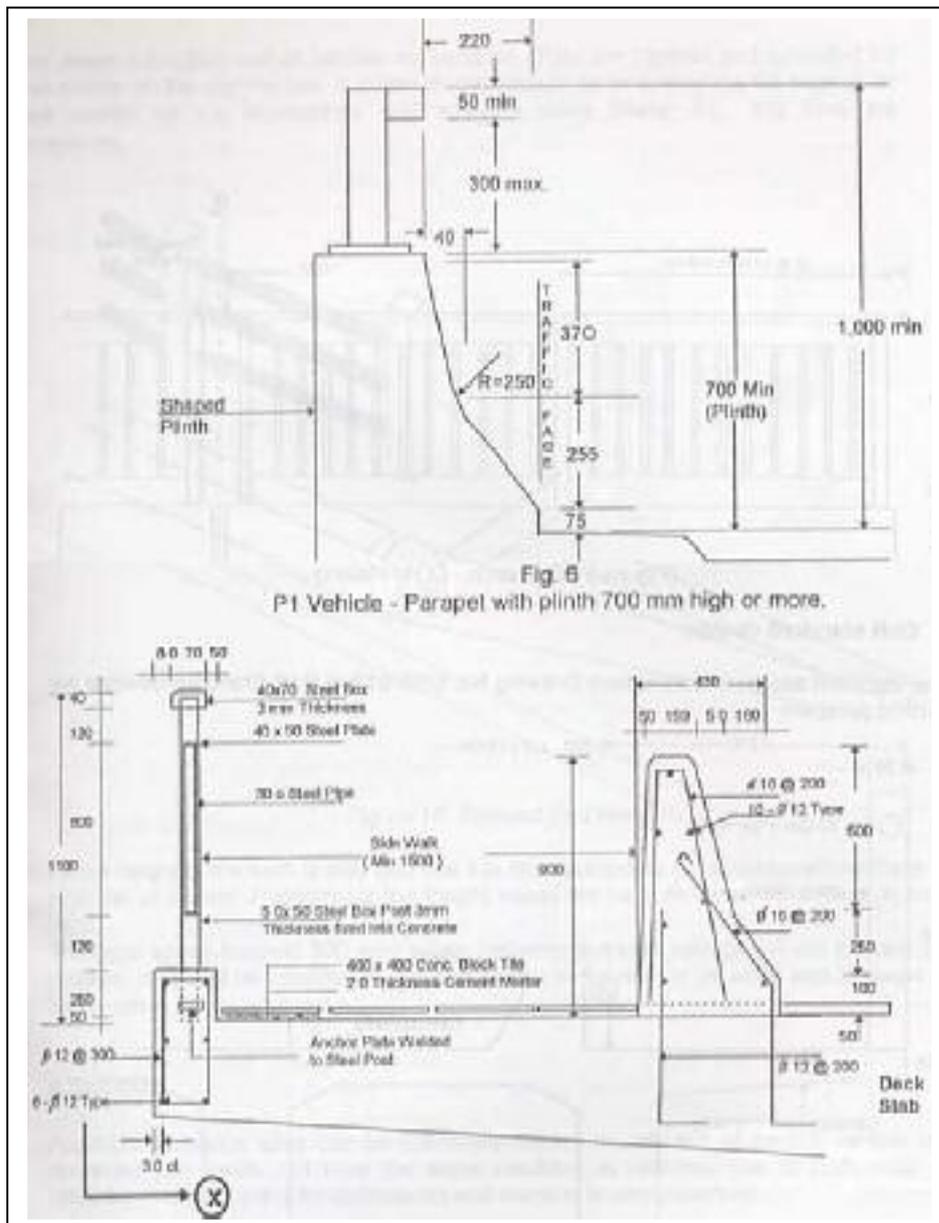


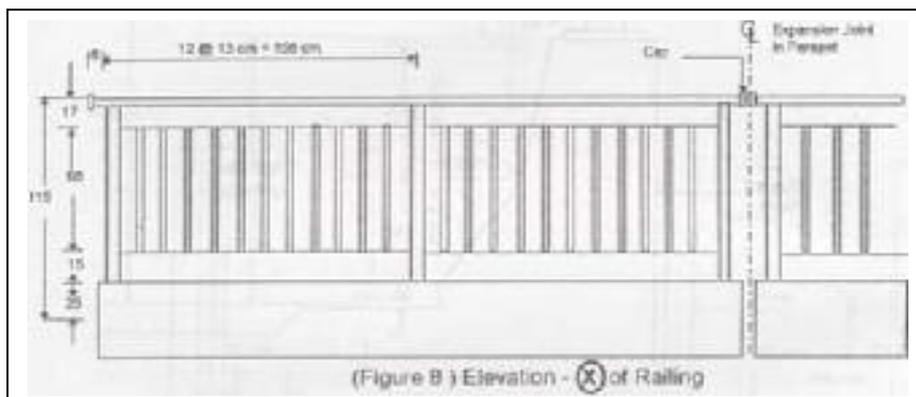
Fig. 4. P2'Vehicle - Pedestrian' parapet, bridges where speed is restricted to 48 Km / h. Pedestrian

Fig. 5. Dimension of P2 Vehicle - for use in road Parapet.

The horizontal rails are kept in front of the posts to deflect the vehicles back on to the bridge. There should be a strong connection between the rails including the expansion joints to prevent them from coming loose and exposing free ends when struck. These free ends could penetrate the vehicle causing serious injuries to the occupants.



Vehicle-parapet and railing for bridges with footway



## 7. DoR Standard design

The standard design of barrier kerb Drawing No DSS 019 of DoR Standard Designs are vehicles parapets

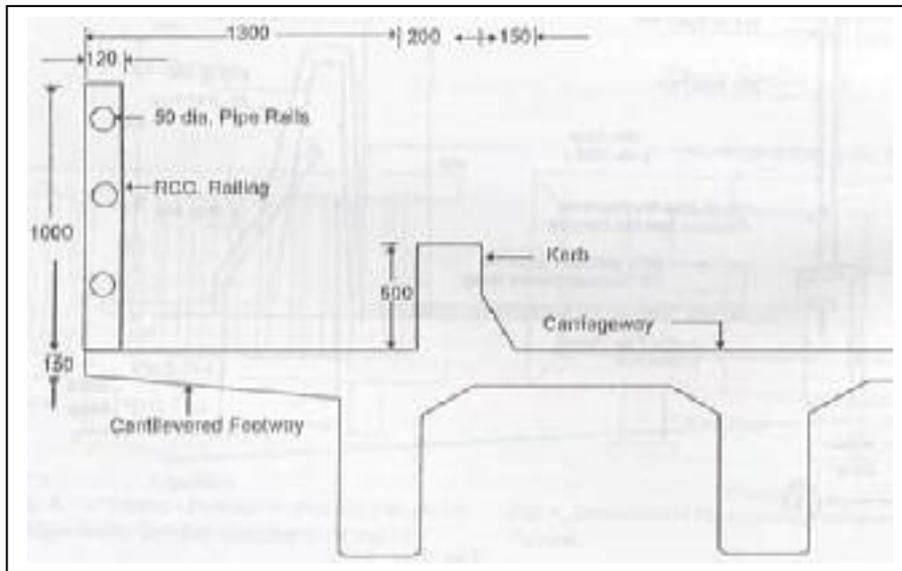
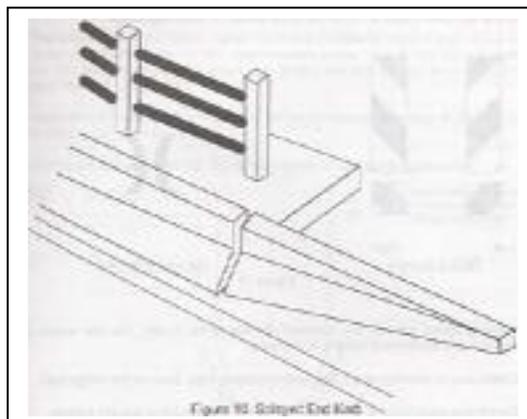


Figure 9. DoR Standard Design

They seem to function well as barriers for vehicles. They are tapered and extended for three metres on the approaches. A better practice would be to extend the full section for three metres on the approaches and splaying away (Refer Fig. 10) from the Carriageway.

As the height of the kerb is only 500 mm it is not appropriate for situation where there is high risk of impact. Furthermore the height would not be sufficient if the bridge is on a bond.

The large space (around 300 mm) space between the pipe railings will not be safe for children. It should be modified to the one shown in figure 9 to be safer and for ease in construction and maintenance.

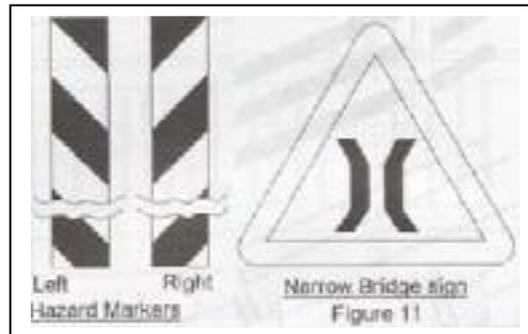


## 8. SIGNING

Accidents at bridge sites can be especially severe as any out of control vehicle not contained can easily roll over the edge resulting in fatalities due to high drop or drowning, hence signing for delineation and warning is very important.

- Hazard markers (figure 11) at the end of parapet corners if they are at the edge of the road carriageway with no footway or shoulder.

- Delineators on approach road in form of post delineators or barriers if necessary, to guide the vehicle onto the bridge.
- Proper bridge signs ( figure 11 ), Narrow bridge sign if only the carriageway width is continued without any footway and Narrow bridge sign with supplementary plate if it is a single track bridge to inform the driver about the oncoming bridge



- Warning centre lines on the approach leading to the bridge. The line should be continuous if the forward visibility is restricted.
- Continuous or warning centre lines and continuous edge lines on the bridge itself
- Continuous edge lines on at least 30 metres of the approach to prevent parking

## 9. SINGLE LANE BRIDGE

In feeder and district level roads single lane bridges are sometimes built to keep the cost of such roads low. Before building such bridges careful thought should be given to the traffic volume, visibility and the length of the bridge. High traffic volume in a long narrow bridge with low visibility would warrant double lane bridge.

In accordance to the feeder road standards Annual average daily traffic (AADT) projected for 15 years should not be greater than 50. If there is a high pedestrian flow at present or a possibility in future, then either a cantilevered footway (Refer figure 9) at least on one side which the pedestrians are more likely to use or recesses at interval should be built depending on volume of pedestrians and the length of the bridge.

The minimum forward visibility from both approaches should be the longer one of the following two distances:

- clear up to at least 30 m. on the opposite bank's approach
- the safe stopping sight distance

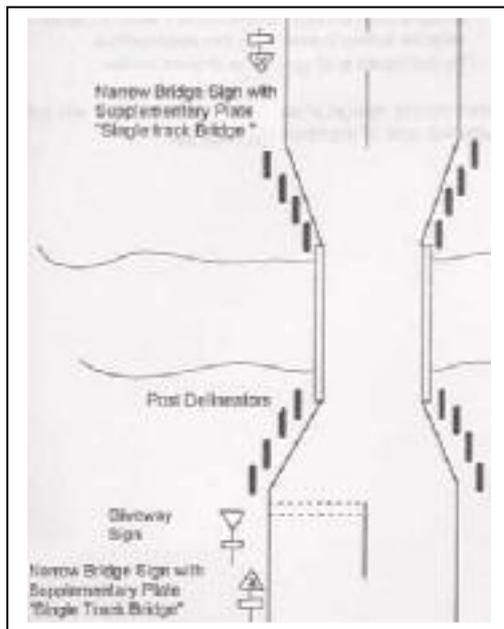
This would safely allow the driver to decide whether to continue or stop to allow the vehicle approaching from the other end to pass first.

The carriageway width of the bridge should be 3.75 m. which is the standard paved carriageway width of a feeder road. Widths larger than this will only cause confusion.

The bridge should be properly signed with hazard plates on parapet ends and a narrow bridge sign (Refer figure 11) with supplementary plates. Weight limit signs if applicable are also required as generally single lane bridges are built to carry lower loads (Feeder road standard - 5 tons total).

There should be continuous edge lines on the bridges carriage way to prevent parking or stopping on the bridge.

Signing at a single lane bridge should be done as shown in the figure below.



## 10. Conclusion

Accidents at bridge sites are usually very severe in nature. Lack of sufficient data restricts a proper analysis of such accident in our road network, however there has been quite a few accidents at such sites in Naubise - Mugling section of Prithvi Highway.

Before rehabilitation or construction of new bridges following safety principles should be taken into consideration:

- Alignment of the bridge - The bridge should be built in straight alignment as far as possible.
- Cross section - At least the approach carriageway width should be maintained on the bridge.
- Provision for pedestrians - Bridges are usually the only means for pedestrians to cross the river hence proper provision for pedestrians is required.
- Parapets - Parapets to restrain vehicles and safeguard pedestrians.
- Delineation - Adequate delineation on the approaches to guide the vehicles safely.
- Safety barriers - Bridges built on high embankment and on bends may require safety barriers on the approaches.
- Signs and Road Markings - To delineate and guide the drivers safely.

If all the measures are incorporated during design phase the additional cost will not be very high and will compare well with the cost of accidents at such sites.