

1 Risk Assessment & Disaster Management

1.1 Risk Assessment and Mitigation Measures

Risk assessment is a process that seeks to estimate the likelihood of occurrence of adverse effects as a result of major road mishaps, gas tanker explosions, fire hazards, floods, cyclones, earth quakes etc. at Highway projects. Fatality rate on Indian highways is very high mainly due to road accidents. The other adverse impacts due to gas tanker explosions, fire hazards, floods, cyclones, earth quakes etc. are nominal. Elimination of the risk (avoidance of accidents) is given prime importance and National Highway Authority of India (NHAI) has introduced many safety provisions in the design of highway. Some of these are listed below:

- Safety barriers / delineators & hard shoulders on main roads
- Traffic signs and pavement markings
- Underpasses and other grade separators at congested junctions
- Removal of junctions and direct access points on main roads
- Improved median openings with stacking lanes
- Separate provisions and direct access point
- Service roads in towns and villages for segregating local and through traffic

1.2 Mitigation measures considered during design stage

1.2.1 Construction of Bypasses

In the project site, 1 bypass (Solapur Bypass) has been found technically, economically and ecologically viable. The technical viability of the bypass was verified on ground. It is proposed to provide access control along the bypass. Tall growing trees at the outer edges of the right of way and shade bearing trees 5 m towards inside of the bypass are proposed. The space between the two rows will be earmarked for utilities.

1.2.2 Realignments of accident prone location

Based on the data collected from local police (traffic) on accident prone locations and other associated data, a major realignment at Nandani has been proposed.

1.2.3 Construction of Vehicular Underpasses

Turning movement surveys have shown that at all the existing State / National Highway crossings vehicular underpasses are required and few vehicle underpasses are also required in settlement portions catering to road traffic. A total of 11 vehicular underpasses have been proposed in the project. The details of vehicular underpasses have been discussed in the EIA Report.

1.2.4 Construction of Pedestrian Underpasses

It is proposed to prevent direct access from cross roads to the project road, through a judicious combination of service roads and pedestrian underpasses with 3.5m vertical clearance. The extra cost on account of such underpasses will be more than justified by way of decrease in the number of accidents that would have otherwise occurred in the event of direct access to the Highway. A total of 12 pedestrian underpasses have been proposed in the project. The details of vehicular underpasses have been discussed in the EIA Report.

1.2.5 Construction of Cattle/Animal Underpasses

It is proposed to provide animal underpasses in forest areas and cattle underpasses for cattle to cross to

the other side of the village for fodder / water. A total of 4 cattle underpasses have been proposed in the project. The details of vehicular underpasses have been discussed in the EIA Report.

1.2.6 Sight Distances

To avoid unwarranted accident, it is necessary to provide adequate sight distance to permit the drivers enough time and distance to control their vehicles. The safe stopping sight distance, intermediate sight distance and overtaking sight distance are shown below in Table no. 1.

Table 1: Sight Distance Standards

Speed (kmph)	Safe stopping distance (m)	Intermediate sight distance (m)	Overtaking sight distance (m)
20	20	40	-
25	25	50	-
30	30	60	-
40	45	90	165
50	60	120	235
60	80	160	300
65	90	180	340
80	120	240	470
100	180	360	640

The safe stopping sight distance of 180 m is followed for the present project.

1.2.7 Horizontal Alignment

IRC: 38 - 1988 is being followed for design of Horizontal alignment.

1.2.8 Vertical Alignment

IRC: SP: 23 – 1983 is being followed for design of vertical alignment.

1.2.9 Gradients

The gradients is being maintained in the design are as per guidelines of the manual. Refer to Table no. 2.

Table 2: Gradients for Roads in Different Terrains

Sl. No.	Terrain	Ruling Gradient	Limited Gradient	Exceptional Gradient
1	Plain or rolling	3.3% (1 in 30)	5% (1 in 20)	6% (1 in 16.7)
2	Mountainous terrain, and steep terrain having elevation more than 3,000m above the Mean Sea Level	5% (1 in 20)	6% (1 in 16.7)	7% (1 in 14.3)
3	Steep terrain up to 3,000 m height above Mean Sea Level	6% (1 in 16.7)	7% (1 in 14.3)	8% (1 in 12.5)

1.2.10 Combination of Horizontal and Vertical Curves

Where the curves cannot separate entirely, the vertical curves are contained wholly within, or kept wholly outside the horizontal curve. The length of horizontal and vertical curves is kept same and the chainages of their centres made to coincide in the design process. Sharp horizontal curvature is well avoided at / or near top of crest of vertical curve nor the same is introduced at or near the low point of a sag vertical curve. Horizontal alignment and profile are made as flat as possible at intersections, where sight distance is very important.

1.2.11 Drainage Design, Slope protection & New Culverts

Trapezoidal shaped open drain will be proposed near embankment toes. Closed line drains are provided in settlement areas. At high embankments (height exceeding 3m) a system of kerb at edge of paved shoulders and chuting at 25m intervals is proposed to safely dispose off surface water to avoid erosion. For intra-pavement drainage, it is proposed to extend the sub-base layer up to edge of embankment slopes. In the super elevation sections, a drain in the median will be constructed and the openings are provided at regular intervals to collect water. This water will be discharged by providing suitable outfall.

Slope protection in the form of turfing will be proposed on all the embankment slopes. Pitching will be proposed at the toe where the height of embankment is more than 3m. Chutes will be proposed to drain off water in case of high embankments.

➤ Planning for New Culverts

- Weak and distressed culverts to be dismantled. Totally new culverts to be constructed with carriageway and median matching with highway plan and profile drawing.
- Culverts in service road locations to be extended up to the road side longitudinal drain.
- The design invert levels of the existing culvert after widening would be compared with that of the prevailing invert level on the ground. If the design invert level falls below the existing invert level then the existing culvert would be proposed to be replaced with another.

1.2.12 Road Furniture

➤ Road Signs (Danger boards / Speed limits / other hazardous indicators)

All signs shall be placed on the left hand side of the road. Where extra emphasis is warranted, they may be duplicated on the right hand side as well. On non-kerb, the extreme edge of the sign shall be 1.5m-2.0m from the edge of the carriageway. On kerb portion, it shall not be less than 60cm from the edge of the kerb. Arrangement for proper surveillance by NHAI authority personnel after the expiry of the maintenance period by the construction agency shall be done.

➤ Road Marking

Provisions have been made for centre and edge road marking with thermo-plastic paint as per MoRT&H specification in preference to ordinary paint as a way of better caution to the driving motorist. This would help reduce road accidents. Border/Edge lines shall also be marked on both sides of the carriageway along with the centre line. Road studs shall also be provided with pavement marking.

➤ Road Delineators

Provision of road delineators has been made in the design that shall comprise roadway indicators, hazard makers and objects makers. The design shall conform to the recommendation made in IRC-79. Reflective Chevron signs at bends shall also be provided for.

➤ Conducting of Awareness Programmes

NHAI will conduct the awareness programmes to the nearby community, transportation associations, NGOs and other interested parties about road safety, and precautionary measures to be taken in event of major disaster. The details about the warning system, precautionary measures to be taken, rehabilitation station etc. shall be intimated in the public awareness programmes.

➤ Vigilance by Highway Patrolling Unit

The highway patrolling unit under the control of local police will conduct route checks and maintain the safety surveillance.