

SECTION - 5

DESIGN STANDARDS AND SPECIFICATIONS

DESIGN PHILOSOPHY

Up-gradation of the existing road, having formation width of about 6.50m, to a formation width of 12.0m, construction of pavement work for the entire length, construction of culverts and permanent works at essential places, widening and improvement of blind curve portion, realignments at the portions where steep gradients have to be avoided, construction of pucca side drains at needy stretches, and installation of traffic/informatory sign and Kilometer stones.

The project road will have two-lane carriageway facility. The design philosophy that will be followed embodies the following:

- The facility should be of National Highway Standards
- The facility must meet the needs for development activities in the region.
- Travel should be safe, with in-built engineering features
- The facility should be aesthetically pleasing and should not be visually intrusive
- The facility should meet the environmental conditions

Design Standards for the highway requirements have been framed for providing the desirable level of service and safety. For this Project it is proposed to follow Design Standards given in IRC Standards, Codes, Guidelines and Special Publications besides MORT&H circulars and specifications as applicable to National Highways.

GEOMETRIC DESIGN STANDARDS

For this Highway Project, Geometric Design Standards shall be as per the following:

- IRC: 73-1980 shall be generally followed.
- IRC: SP: 19-2001: Manual for survey, investigations and preparation of road projects.
- IRC: 52: Recommendations about the Alignment survey and Geometric Design of Hill Roads (Second Revision).
- IRC-SP-48-1998: Hill Road Manual

Altitude of the road

Altitude of the Project Road lies between 821.0 m to 1365.0 m above the MSL

- **Terrain Classification:**

Terrain as pertinent to the road structure is classified as given in the following table:

Terrain	Cross Slope (%)
Plain	0 - 10
Rolling	> 10 upto 25
Mountainous	> 25 upto 60
Steep	> 60

This Road Corridor is generally in mountainous terrain.

Design Speed:

Sr/No	Mountainous Terrain		Steep Terrain	
	Ruling	Minimum	Ruling	Minimum
1.	50	40	40	30

The ruling design speed should generally be the criterion for correlation of the various design features.

Minimum design speed may be adopted in sections where site conditions or economic do not permit a design based on the ruling design speed. The adopted design speed is 30 Km/hr.

Cross Section Elements:

- **Right of Way (ROW)**

IRC: 73-1980 Table recommends the following land width for National Highways:

ROW Width

Sn	Road Classification	Mountainous and Steep Terrain	
		Open areas	Built-up areas
		Normal	Normal
1	National & State Highways	24	20

The existing ROW along the project road is not uniform. . The width of ROW 24 m and 20 m have been adjusted to accommodated the public concerser provided. However there are stretches where the ROW has been temporarily encroached. However, for improvement of junctions, relocation, etc, design will be as per functional requirement. Additional land acquisition shall be kept to the minimum for these areas

➤ Roadway Details

- **Total Road Width**

Total roadway width shall be 12.00 m.

- **Carriageway Width**

The National Highway shall be designed as a 2- lane carriageway. The width of two lane shall be 7.0 m.

- **Shoulder**

The carriageway width of 7m and paved shoulder width of 1.5 m on each side shall have the same pavement as the carriageway. The remaining 1.0m on each side shall be used to accommodate side drain on hill side or parapet/soft shoulder on valley side. In the hill

side, depending on the total width of side drain, there is a small width remaining between the wall of side drain and paved shoulder, therefore it is also paved to avoid erosion by surface water

- **Cross-Slope**

Each carriageway shall have cross slope of 2.50 per cent
The shoulder shall have a slope of 3.5 per cent.

- **Stopping Sight Distance:**

Sufficient stopping distance is made available for drivers to stop their vehicles when faced with an unexpected obstruction in the carriageway. The safe stopping sight distance, overtaking sight distance as recommended in the manual is as below:

Minimum Recommended Sight Distances

Speed (Km/h)	Safe Stopping Sight Distance (m)	Intermediate Sight Distance (m)
20	20	40
25	25	50
30	30	60
35	40	80
40	45	90
50	60	120

Horizontal Alignment:

- **Superelevation**

No super elevation is proposed when its value obtained is less than the road camber e.g. radii beyond which super elevation is not proposed are as mentioned below:

Radius Beyond Which Superelevation Not Required

Design Speed (km/hr)	Radii (Meters) For Camber of					
		4%	3%	2.5%	2%	1.7%
20	Proposed as per IRC: SP: 48-1998	50	60	70	90	100
25		70	90	110	140	150
30		100	130	160	200	240
35		140	180	220	270	320
40		180	240	280	350	420
50		280	370	450	550	650

- **Radius**

Radii for horizontal curves corresponding to ruling minimum and absolute minimum design speeds are as given below:

Minimum Radius for National Highways
(As per IRC: SP: 48-1998)

Mountainous Terrain		Steep Terrain	
Ruling Min Radius (m)	Absolute Minimum Radius (m)	Ruling Min Radius (m)	Absolute Minimum Radius (m)
80	50	50	30

There will be corresponding speed limit in case the radii are less than the above due to hill physical features and economic consideration.

Widening of Pavement at Curves

At sharp horizontal curves, it is necessary to widen the carriageway to facilitate safe passers of vehicle. Extra width to be provided on horizontal curve is given below (refer clause 6.8.5 of IRC: SP: 48: 1998).

Radius of Curve (m)	Upto 20°	20° to 40°	41° to 60°	61° to 100°
Extra width (m) 2 Lane	1.5	1.5	1.2	0.90

Wherever the radius is less than the specified minimum design speed, the transition curve, superelevation and pavement widening will be introduced. This will minimize the intrusion of vehicles on to adjacent lanes, tend to encourage uniformity of speed and increase vehicle speed at the curves.

- **Transition Length**

Transition length is given in Table below:

Transition Length of Curve
(As per IRC: SP: 48-1998)

Curve Radius (m)	Design Speed Km/h				
	50	40	30	25	20
15				NA	30
20				35	20
25			NA	25	20
30			30	25	15
40		NA	25	20	15
50		40	20	15	15
55		40	20	15	15
70	NA	30	15	15	15
80	55	25	15	15	NR
90	45	25	15	15	
100	45	20	15	15	
125	35	15	15	NR	
150	30	15	15		
170	25	15	NR		

Curve Radius (m)	Design Speed Km/h				
	50	40	30	25	20
200	20	15			
300	15	NR			
400	15				
500	NR				

NA-Not Applicable and NR- Transition not required

Vertical Alignment:

- Codal Provisions**

The gradients to be maintained in the design are as per following guidelines:

Codal Reference	Clause No.
IRC : SP-48 – 1998, Hill Road Manual	12.2.1
IRC : SP-52-2001, Recommendations about Alignment Survey and Geometric Design of Hill Roads	6.9.1.3

- Gradients for Different Terrain**

SL. No	Terrain	Ruling Gradient	Limited Gradient	Exceptional Gradient
1	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)

- Gradients upto the ruling gradient may be used as a matter of course in design (Ref. Clause No. 6.9.1.4 of IRC-SP: 48 – 1998).
- The limiting gradients may be used where the topography of a place compels this course or where the adoption of gentler gradients would add enormously to the cost. In such cases, the length of continuous grade steeper than the ruling gradient should be as short as possible. (Ref. Clause No. 6.9.1.5 of IRC-SP:48 – 1998).
- Exceptional gradients are meant to be adopted only in very difficult situations and for short lengths not exceeding 100 m at a stretch. Successive stretches of exceptional gradients must be separated by a minimum length of 100 m having gentler / flatter gradient (Ref. Clause No. 6.9.1.6 of IRC-SP:48 – 1998).
- Vertical Curves**

Minimum length of Vertical Curve (As per IRC: SP: 48-1998)

Design speed km/h	Maximum Grade Change (Percent) Not Requiring A Vertical Curve	Minimum Length Of Vertical Curve (m)
35	1.5	15
40	1.2	20
50	1.0	30

The actual length for the vertical curve shall however be provided as per IRC: 73-1980

GEOTECHNICAL DESIGN

Earth Embankment

- i) The fill material, compaction and other requirements shall conform to IRC: 36-1970. Where these specifications are in variance with the MORT&H specifications, the later shall govern and accordingly followed.
- ii) Side slope of 2:1 is provided

Side Slopes Formation in Cutting

The following values are adopted as per IRC: SP: 48:1998 Clause 7.4.

Side Slope in Cutting

<i>Sl.No.</i>	<i>Item</i>	<i>Slopes of Cutting</i>
1	Ordinary Soil / Heavy Soils	1 : 2
2	Ordinary / Soft Rock	1 : 4
3	Hard rock	80° to 90°

(Explanation: The slope 1: 2 signifies 1 in the horizontal direction and 2 in the vertical)

4.4 ROAD FURNITURES

Km Stones :

Km Stones, 200m stones and 5th km stones shall be provided as per Codal provisions.

Road Signs:

All signs shall be placed on the valley side of the road. Where extra emphasis is warranted, they may be duplicated on the right hand side as well as per IRC: 67-1977. The extreme edge of the sign shall be not less than 2 m from the edge of the carriageway.

Road Marking:

Provisions shall be made for center line marking with ready mixed road marking paint conforming to IS: 164

Safety Barriers:

Guardrails shall be provided on approaches to bridges.

4.5 PAVEMENT DESIGN

Design for flexible pavement has been carried out in accordance with the latest version of IRC: 37-2001.

Drainage

- An effective drainage system for drainage of road shall be designed as per stipulations of IRC SP: 42-1994.
- The road side channel will be trapezoidal and V shape of adequate capacity to carry 100% surface runoff of drainage area of highway ROW. It will be drained to the nearest available natural water course. We propose to adopt semi trapezoidal section as space is a not a constraint and it is more efficient and economical. This will be lined drain to drain out in the open field or to the defined outfall points. Semi trapezoidal shaped lined drain will also be adopted in the hard rock hill sections.
- The superstructure of bridges shall be drained with suitable drainage spouts.

Traffic Safety Measures

The design layout and materials chosen for the safety barrier shall suitably blend with the surrounding and shall further conform to MORT&H circulars and shall be finalized in consultation with and approved by PWD.

Culverts

- All Cross- Drainage structures shall be classified as culverts, minor bridges & major bridges depending on the length of the structure as per IRC standards. Structures up to 6m length fall into the category of culverts, more than 6m but up to 60m in length as minor bridges and beyond 60m length as major bridges.
- The deck width is required to be kept the same as that of the roadway for 2-lanes
- The bridge components shall be designed at least carry one lane of Class 70R for every two lanes with one lane of Class A for the remaining lanes, if any, or one lane of Class A for each lane.
- Entire project area falls under Zone-IV of seismic zone as provided in IRC: 6-2000 Clause 222
- The list of IRC codes given below but not limiting to shall be referred during formulation of the design and drawings of bridges.

List of IRC Codes

IRC: 5-1998	Standard Specification & Code of practice for Road Bridges. Section – I General Features of Design (Seventh Revision)
IRC: 6-2010	Standard Specification & Code of practice for Road Bridges. Section – II Loads & Stresses (Fourth Revision)
IRC: 18-2000	Design Criteria for Pre-stressed Concrete Road Bridges (Post- Tensioned Concrete) (Third Revision)
IRC: 21-1997	Standard Specification & Code of practice for Road Bridges. Section – III Cement Concrete Plain & Reinforced (Second Revision)
IRC: 22-1986	Standard Specification & Code of practice for Road Bridges. Section – VI Composite Construction (First Revision)
IRC: 24-2001	Standard Specification & Code of practice for Road Bridges. Section – V Steel Road Bridges (Second Revision)
IRC: 45-1972	Recommendations for Estimating the Resistance of soil below the maximum Scour Level in the Design of Well Foundations of Bridges.
IRC: 73-1980	Geometric Design standards for Rural (Non-Urban) Highways.
IRC: 78-1983	Standard Specification & Code of practice for Road Bridges. Section – VII Foundation & Substructure (First Revision)
IRC: 83-1987	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings, Part-II Elastomeric Bearings
IRC: 83-1987	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings, Part-II POT,POT CUM PTFE, PIN Bearing
IRC: 89-1997	Guidelines for Design & Construction of River training & control works for road bridges.
IRC:SP:33-1989	Guidelines on supplemental Measures for Design, Detailing & Durability of Important Bridge Structures.

Design loads

- **Dead Loads:**

Apart from all the actual dead loads, irrespective of the type of wearing coat and crash barrier proposed, the structure shall be designed to allow for

- Wearing coat load = 2 kN/m².
- RCC Railing as per Standard Drawing

- **Live Loads:**

The bridge shall be designed to carry one lane of Class 70R for every two lanes with one lane of Class A for the remaining lanes, if any, or one lane of Class A for each lane.

- **Seismic Effects:**

- (i) Basic horizontal seismic co-efficient - As per zone IV
(Table 5 & fig 11 of IRC: 6-2000)
- (ii) Importance Factor - 1.5
Reinforcement detailing of structures shall conform to the provisions of IS 13920

Loading due to RCC Railing: **As per Standard Drawing**

- **Temperature Effect:**

- (i) Temperature stresses to be worked out as per Clause 218 of IRC: 6 - 2000.

For design of structure the temperature range to account for temperature effect shall be:

In the present case $t = \pm 25^{\circ} \text{C}$

- (ii) The superstructures shall also be designed for effects of distribution of temperature across the deck depth. For calculation of thermal forces effect of 'E' value of concrete should be taken as 50% of the instantaneous value as to account for effects of creep on thermal strains.

- **Differential Settlement:** 6 mm with instantaneous E value of concrete. This will be deemed to cover lifting of superstructure also.

TECHNICAL SPECIFICATIONS

The work will be executed as per MORT&H Specifications for Road & Bridge Works 5th Revision 2013