CHAPTER-4

INDICATIVE DESIGN STANDARDS & SPECIFICATIONS

4.1 DESIGN PHILOSOPHY

Road sector from Km 125.00 to Km 250 of NH-54 Keitum to Thualthu is being improved to 2-lane paved shoulder National Highway Standard / specifications. The project road will have two lane carriageway facilities. 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 following items 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 MORTH circulars and specifications as applicable to National Highways and the Concession Agreement stipulations in this respect. In the absence of any definite provisions on any particular issue, the following standards shall be referred to in that order.

- Bureau of Indian Standards
- American Association of State Highway and Transport Officials (AASHTO)
- American Society of Testing Materials(ASTM)
- British Standards
- Any other National or International Standard as considered suitable

In case certain provisions are not available and uncertainties exist, these will be discussed with NHIDCL / Mizoram PWD (NH) / MORTH and consensus reached.

4.2 SPECIFICATIONS

The material to be used in the Project work (including facilities there on) shall conform to MORTH Specifications for Road & Bridge Works 5th Rev. 2013. Where these specifications are silent in regard to certain specifications for the material in question, in that case, specifications under Bureau of Indian Standard/AASHTO/ASTM/BS shall apply in that order. But where these specifications are silent, the specifications for the material in question shall be got designed from the Consultant.

4.3 GEOMETRIC DESIGN STANDARDS

For this Project Highway, Geometric Design Standards as per

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

4.3.1 Terrain Classification:

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

Terrain Classification

Terrain	Cross Slope (%)
Rolling	>0 upto25
Mountainous	>25 upto 60
Steep	> 60

This Road Corridor is generally in steep mountainous terrain.

4.3.2 Design Speed:

Road Classification	Mountainous Terrain	
	Ruling	Minimum
National Highway	50 km/hr	40 km/hr

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

Minimum design speed should be adopted in sections where site conditions or economic do not permit a design based on the ruling design speed. This will be adopted in consultation with the client.

4.3.3 Cross Section Elements:

- **Right of Way (ROW)**

IRC: 73-1980 Table-3 recommends the following land width for National Highway:

ROW Width

Sl No	Road Classification	Mountainous and steep Terrain	
		Open areas	Built-up areas
		Normal	Normal
1	National Highways	24m	20m

The existing ROW along the project road is not uniform. The width of ROW is not defined on the road. ROW of 24 will be maintained. However there are stretches where the ROW has been encroached. It would require restoration to 24/20m width.

- **2-Lane Carriageway:**

Total road width	:	12.000 meter
Carriageway	:	7.000 m
Paved Shoulder	:	2 X 1.5
Earthen Shoulder Hill side (including Drain)	:	1 X 1.0
Earthen Shoulder Valley side	:	1 X 1.0

- **Cross-slope**

Each carriageway shall have cross slope of 2.50 per cent

The paved shoulder shall have a slope of 2.50 per cent

The earthen 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:**

❖ **Super elevation**

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 super elevation not required

Design speed (km/hr)	Radius (m)					
	Proposed as per IRC	4%	3%	2.5%	2%	1.7%
20		50	60	70	90	10

25	73	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

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

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

4.4 Hair-Pin Bends

Hair-pin bends where unavoidable, may be designed either as a circular curve with transition at each end, or as a compound circular curve. The following criteria should be followed normally for their design.

a) Minimum design speed - 20 km/h

b) Minimum roadway width at apex

National / State Highways - 11.5m for double-lane

		-	9.0m for single-lane
c)	Minimum radius for the inner curve	-	15.0 m
d)	Minimum length of transition curve	-	15.0 m
e)	Gradient		
	Maximum	-	1 in 40 (2.5%)
	Minimum	-	1 in 200 (0,5%)
f)	Super-elevation	-	1 in 10 (10%)

At hair-pin bends, the full roadway with will be surfaced

4.5 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**	**21 to 40**	**41 to 60**	**61 to 100**	**101 to 300**	**Above 300**
Extra width(m) 2 Lane	1.5	1.5	1.2	0.90	0.60	Nil

Wherever the radius is less than the specified minimum design speed, the transition curve, super elevation 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**
	Transition length - metres				
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		
200	20	15			
250	15	15			
300	15	NR			
400	15				
500	NR				

NA-Not Applicable

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	6.9.1.3
IRC : 52-2001, Recommendations about Alignment Survey and Geometric Design of Hill Roads	12.2.1

Gradients for Different Terrain

SL. No	Terrain	Ruling gradient	Limiting gradient	Exceptional gradient
1	Steep terrain up to 3,000 m height above mean sea level	6 % (1 in16.7)	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: 36-2010. 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

Sn	*Item*	*Slopes of Cutting*
1	Ordinary Soil / Heavy Soils	1 : 1 to ½ : 1

Sn	*Item*	*Slopes of Cutting*
2	Ordinary / Soft Rock	¼ : 1 to 1/8 : 1
3	Hard rock	80^0 to 90^0 to Horizontal

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

4.6 ROAD FURNITURE

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 hill side as well as per IRC: 67-2012. 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 thermo-plastic paint as per IRC: 35-1997.

Safety Barriers:

Guardrail shall be provided on approaches to bridges and high embankments.

4.7 BRIDGES & 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.

- For bridge on 2-lane NH the carriageway width shall be 10.50m The deck width including carriageway footpath and crash barrier/railing is required to be kept 14.80m for 2-lanes (MORTH letter No RW/NH/33044/2/88 –SOR (B) Date 24/3/09.

- The bridge components shall be designed at least with 2-lanes of class 'A' loading or one lane of class 70R loading.

- NH-54 (Keitum to Thualthu) falls under Zone-V of seismic zone as provided in IRC: 6-2014.

- 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: 5-2015	Standard Specification & Code of practice for Road Bridges. Section – I General Features of Design (Seventh Revision)
IRC: 6-2014	Standard Specification & Code of practice for Road Bridges. Section – II Loads & Stresses (Fourth Revision)
IRC:112:2011	Code of Practice for Concrete Road Bridges
IRC: 22-2015	Standard Specification & Code of practice for Road Bridges. Section – VI Composite Construction (First Revision)
IRC: 24-2010	Standard Specification & Code of practice for Road Bridges. Section – V Steel Road Bridges (Second Revision)
IRC: 73-1980	Geometric Design standards for Rural (Non-Urban) Highways.
IRC: 78-2014	Standard Specification & Code of practice for Road Bridges. Section – VII Foundation & Substructure (First Revision)
IRC: 83-2015	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings, Part-I Roller & Rocker Bearings (Second Revision)
IRC: 83-2015	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings (Elastomeric Bearings), Part II (First Revision)

IRC: 83-2002	Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part III: POT, POT-CUM- PTFE, PIN and Metallic Guide Bearings
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.
IRC:SP:73-2015	Manual of Standards & Specifications for Two Laning of State Highways on B.O.T. Basis

4.8 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/m^2.
- RCC crash barriers P1 type as per IRC: 6 -2014

- **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:** Seismic effects as per IRC:6:2014
- **Loading due to Crash barrier:** As per IRC: 6 – 2014
- **Temperature Effect:**

(i) Temperature stresses to be worked out as per Clause 215 of IRC: 6 – 2014.

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

In the present case t = +/- 25^0 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.

4.9 PAVEMENT DESIGN

Design for new pavement has been carried out in accordance with the latest version of IRC: 37-2012.

4.10 DRAINAGE

- An effective drainage system for drainage of road shall be designed as per stipulations of IRC SP: 42-2014.
- The road side channel will be rectangular V-shaped 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 section R.C.C covered drain in built-up area. This will be lined drain to drain out in the open field or to the defined outfall points. V shaped unlined drain will be adopted in the hard rock hill sections V shaped lined drain will be provided in soil and soft rock sections.
- The superstructure of bridges shall be drained with suitable drainage spouts.

4.11 TRAFFIC SAFETY MEASURES

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

4.12 TECHNICAL SPECIFICATIONS

- In the absence of any definite provisions on any particular issue in the aforesaid Specifications, reference may be made to the codes, standards and specifications of IRC, MORT&H guide lines and official publications as applicable to National Highways, AASHTO, ASTM, BS or any other international standards in that order. Where even these are silent, the construction and completion of the works shall conform to sound Engineering practice as approved by the Engineer.

- The material to be used in the Project work (including facilities there on) shall conform to MORT&H Specifications for Road & Bridge Works 5th Rev. 2013. Where these specifications are silent in regard to certain specifications for the material in question, in that case, specifications under Bureau of Indian Standard/AASHTO/ASTM/BS shall apply in that order. But where these specifications are silent, the specifications for the material in question shall be got approved from the Independent Consultant.