

SECTION - 6

ENGINEERING DESIGN AND CONSTRUCTION PROPOSALS

6.1 GENERAL

This chapter deals with detailed design of various elements of project road, based on the findings of survey and investigations and design standards in the preceding chapters. The proposals include provision for the major items as given in Table.

Project Proposals - Major Items

Sl No.	Item
1	Site Clearance
2	Earthwork
3	Pavement Works
4	Slope Protection Works
5	Culverts
6	Bridges
7	Miscellaneous Works
8	Facilities for Engineers
9	Provision for land Acquisition & Forest Clearance

6.2 CROSS SECTION ELEMENTS & ALIGNMENT

a) Cross Section Elements

Hill road cross-section has the usual components of carriageway, shoulder and longitudinal drain and parapet/railing requirements. The carriageway and shoulder widths are governed by the traffic volume expected on the road. Other components are functions of traffic safety and surface run-off requirements. Roadway, however, is defined as the total width of carriageway and shoulder.

Design Standards for Cross-section Elements

Sl. No.	Design Elements	Dimension in m
1.	Roadway width (including culverts)*	12.00 & 10.8
2	Roadway width at Bridges **	12.90
3	Carriageway width	7.00
4	Cross-slopes / camber (%)	2.5

* Roadway width are including width of side drain and parapet wall

** Roadway width is Overall Width between outermost faces of the railing.

b) Geometric Design

The general alignment of the road under this project is as:

NH 717 (A) Highway from Km 0 /000 to 16/539 Km as per design Chainage

Existing alignment : 11.989 Km

Re-alignment : 4.55 Km

Total length of proposed road : 16.539 Km

Total Length of project road :

Road is designed for 2-Lane (12.00 m roadway with 7.00 m carriageway).

Gradient, being the most important parameter, has been the guiding factor. Ruling gradient less than 6.7% has been achieved in most point of the road and the maximum gradient being 8.70 % from Km 15+ 860 to Km 16+270 (420.0 m) due Airport portion built-up stretch.

c) Realignment of existing road:

For improvement of existing road some stretches, relocation and re-grading are proposed due to which traffic movement on existing road would be disturbed. Permanent diversion will be included in the design as to minimizing the structure damage, reducing cost of resettlement and easy and faster movement of vehicles.

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Sr. No.	Name of Town	Design Chainage		Existing Chainage		Length in Km
		From	To	From	To	
1	Ranipool	0+00	1+400	0+00	2+450	1.40
2	Andheri Khola	5+800	8+950	7+250	12+520	3.15
Total						4.55

d) Horizontal Alignment

The project corridor passes through steep and mountainous terrain. The design speed adopted is 30km/hour (IRC SP: 48). Along the proposed alignment, there will be no hair-pin bend. However minimum design speed has been considered on technical grounds. The vertical and horizontal alignments of the proposed road can be summarized as shown in table below:

Project Road length	No. of Curves with Design Speed in km/h				No. of Curves with Radius (m)		
	<30	30-40	40-50	>50	<30	30-50	>50
16.539 Km	51	181	0	10	30	92	120

e) Vertical Alignment/Gradient

Gradient, being the most important parameter, has been the guiding factor. Ruling gradient (less than 6.5%) has been achieved, the maximum gradient being 8.7 % at few selected stretch.

Summary of Proposed Vertical Alignment

Project road length	Length Distribution (km) and Gradient Class				
	<4%	4%-5%	5%-6%	6%-7%	7%-8%
16.539 Km	5.94 Km	2.53 Km	4.14 Km	3.509 Km	0.420 Km

6.3 Traffic Design Capacity

The width of a pavement is decided on the basis of the traffic volume it can efficiently carry. Traffic studies have been carried out in the vicinity of the project road and produced in this report.

6.4 Design of Embankment / Hill Cutting

Considering the physical features, particularly the terrain, soil classification and hill slope line, typical cross-section (Type 1F to Type 21 F) have been developed for hill road cutting / embankment building.

Concept Plan of the design of the embankment / hill cutting (stretch-wise) has been developed with specific mention of the formation building methodology / type to be adopted.

Compaction of disposal material

Spreading & Compaction of Roadway cutting and excavation from drain and foundation of other structures surplus material in layers not exceeding 300mm thickness at selected disposal location by Dozer at least four passes including construction of approach road to dumping site.

6.5 Pavement Proposal

The provision for pavement includes different layers of sub-base, base, and surfacing course as appropriate throughout the whole stretch of the road.

Granular Sub-base (GSB): 250mm thick sub-base layer of crushed stone aggregate has been proposed. The sub-base course has been extended up to full width of the formation.

Extra quantities for widening at curves, major and minor junction locations are calculated separately and final quantities are worked out.

#Wet Mix Macadam Base (WMM): 250mm thick base layer of Wet Mix Macadam is proposed for 7.0m width.

#Dense Bituminous Macadam of 60 mm thick and 40mm thick of Bituminous Concrete as surfacing course has been proposed.

6.6 Pavement Design

It is based upon CVD-464, CBR-6%, Traffic msa -20, Design period - 15 years, VDF-1.5, Annual Growth of traffic rate 7.5% and Design speed 30.00 Km/h. However the proposed pavement composition is based on CBR-5% and msa -10.

Pavement composition is designed as under:

Proposed pavement.

BC	:	40 mm
DBM	:	90 mm
WMM in 2-layers	:	250mm
GSB in 2-layers	:	260 mm
Total	:	640 mm

Shoulder Design

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

6.7 Culverts:

The project road traverses through mountainous and steep terrains with several natural drainages such as deep gorges, depressions, etc., where perennial water and rain water runoff are collected. Sometimes the storm runoff is accompanied by large quantities of debris from upstream side of the nallahs. Cross-drainage structures/culverts are required at these locations. From the field survey and investigations and geometric design of alignment the requirement of culverts for the whole length of the project have been identified.

Sr.No.	Type of culvert	Description	Span X Depth	Km 0 to Km 16.539
1	Type -1	Pipe Culvert	1.2 D	8
2	Type - 2	Pipe Culvert	1.2 D	22
3	Type - 1	Box Culvert	2.0 X 2.0	37
4	Type - 2	Box Culvert	3.0 x 3.0	4
			Total	71

6.8 Slope Protection works:

Adequate Protective structures are proposed for retaining of cut/fill slopes to ensure stability of the road formation at locations where required. The proposed type and length of each structure are shown in the table below:

Sr.No.	Description of Item	Unit	Quantity
1	Retaining Wall 3.00m high	Rm	730.00
2	Retaining Wall 4.00m high	Rm	760.00
3	RCC Retaining Wall 5.00m high	Rm	405.00
4	RCC Retaining Wall 7.00m high	Rm	235.00
5	RCC Retaining Wall 9.00m high	Rm	20.00
6	Breast Wall 2.00m high	Rm	4065.00
7	Breast Wall 3.00m high	Rm	1655.00
8	Gabion Wall 2.00 m high	Rm	1040.00
9	Gabion Wall 3.00 m high	Rm	1070.00
10	Toe Wall 2.00 m high	Rm	530.00
11	Toe Wall 3.00 m high	Rm	490.00
12	Cut Slope Wall	Rm	3000
13	Seeding and Mulching (Soil Cut Slope)	sqm	30000

Sr.No.	Description of Item	Unit	Quantity
14	Vegetation Mat (Steep Slope)	sqm	1400
15	Crib Work (F300)	sqm	300
16	Crib Work (F500)	sqm	400
17	Groundwater Drainage Work	metre	1500
18	Anchor Work	Rm	200
19	Rock-bolt Work	Rm	150

6.9 DRAINAGE & BRIDGE DESIGN

Pavement Drainage includes camber / cross fall of 2.50%.

Slope 3.5 % has been considered for drainage of shoulders.

Roadside drains are designed as Lined drains.

Sr.No.	Type	Package-1	Remarks
1	Type-1	10396	Ordinary Soil stretch Rocky & Steep Stretch & Catch water drain at box cutting portion
2	Type-2	8989	Built up area

Chutes of the culverts form part of the culvert structure to lead the discharge to the catch-pit or to natural drainage channel.

6.10 BRIDGE WORK

S/N	From	To	Super structure	Foundation	Remarks	Length in m	Remarks	
1	1000.0	1380.0	PSC	Pile	Ranikhola	380.0	Proposed	Alignment
2	2440.00	2500.00	RCC	Open	Aho Khola	60.0	Existing	Ex.Road
3	6100.00	6120.00	RCC	Open	Andheri Khola	20.0	Existing	Ex.Road

6.11 ROAD SIGN AND MARKINGS

The project design includes (a) Mandatory / Regulatory Signs, (b) Cautionary / Warning Signs and (c) Information Signs , Route Marker Signs are provided .KM Stones are included as per type design.

6.12 STREET FURNITURE

Traffic Safety Posts and Parapet Walls are included.

Traffic Signs Marking & other Road Appurtenances

6.13 DIVERSION OF EXISTING ROAD DURING CONSTRUCTION

For improvement of existing road some stretches localized, relocation and re-grading are proposed. Due to which traffic movement on existing road will be hamper .Therefore temporary diversion of existing is very much necessary during construction period.

6.14 MAINTENANCE OF EXISTING ROAD:

The existing road is the main route to provide connectivity between Sub-Division Head Quarters of the East District and Green Field Airport to rest of Sikkim. The minimum construction time provided for completion of the project is 4(four) years during which maintenance by the PIU will be no longer convenient as the site possession is resorted to hand over to the contractor till completion of the project. Under this circumstance, it is inevitable to keep provision for yearly maintenance of the existing road during construction and hence a provision of Rs.59.54 lakhs per year is made to make the road playable for all type of vehicles without serious interruption of the traffic flow throughout the year.

Scope of maintenance:

- 1) Maintenance of Earthen Shoulder (filling with fresh soil).
- 2) Filling Pot- holes and Patch Repairs with open - graded Premix surfacing, 20mm.
- 3) Hill Side Drain Clearance.
- 4) Land Slide Clearance in soil/ rock
- 5) Clearing Grass and Removal of Rubbish.
- 6) Maintenance/repair of culvert/Retaining wall.
- 7) Clearance of culvert before monsoon
- 8) Removal of land slide

6.15 ROADSIDE AMENITIES

The continuous long distance travel on highways at speed is liable to cause fatigue as also mental tension to the road users. Moreover, the monotony of driving over long sections in the rural areas with no likelihood of any cross traffic brings sense of complacency in many drivers. and such distractions could result in serious accidents.

Sr.No.	Description	Nos.	Location
1	Public Toilet	2	Near Ranikhola & Paykong
2	Bus Shed	2	
3	Bazar Shed	2	

6.16 DESIGN OF INTERSECTION/JUNCTIONS

Provisions have been made for the improvement of road junctions along the project road. Based on the survey there are 8 junctions/ intersections as mentioned below:-

Sr.No.	Design Chainage	Side	Remarks	Shape	Type
1	60	RHS	Take off point Junction with NH-10	Y	Major
2	1380	LHS	Junction with existing NH -717A	Y	Major
3	5800	LHS	Take off point 2nd diversion	Y	Minor
4	8880	LHS	Merging with Existing NH-717A	Y	Minor
5	12880	LHS	junction with Rolep Road	Y	Minor
6	13620	LHS	junction with Village Link road	Y	Minor
7	14400	LHS	Junction with Noapgaon approach road	Y	Minor
8	15500	LHS	Junction with existing NH -717B	Y	Major

These Junctions needed major improvement as compared

1.0 Junction at Ch. 0+00

Location : Junction with NH-10 Take off
Shape : Y-Shape
Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is considered suitable.

2.0 Junction at Ch. 1+380

Location : Merging with Existing NH-717A
Shape : Y-Shape
Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is considered suitable.

3.0 Junction at Ch.5+800

Location : Take off point 2nd diversion
Shape : Y -Shape
Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

4.0 Junction at Ch. 8+880

Location : Merging with Existing NH-717A
Shape : Y -Shape
Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

5.0 Junction at Ch. 12+880

Location : Junction with Rolep Road
Shape : Y -Shape
Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

6.0 Junction at Ch. 13+620

Location : junction with Village Link road
Shape : Y -Shape
Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

7.0 Junction at Ch. 14+400

Location : Junction with Noapgaon approach road
Shape : Y -Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is not considered suitable.

8.0 Junction at Ch. 15+550

Location : Junction with existing NH -717B

Shape : Y-Shape

Design : This junction is designed as a simple meeting point with open space for the traffic. Regulation by rotary or traffic island is considered suitable.