# Chapter 5 DESIGN STANDARDS AND SPECIFICATIONS

# 5. DESIGN STANDARDS AND SPECIFICATIONS

Design standards for this project will conform with "Manual of Standard & Specifications for two laning of State Highways (IRC: SP:73-2007)", "Specification for Road and Bridge Work" by Government of India, MORTH and various relevant IRC Standards and BIS Standards. Also "Geometric Design Standards for Highways" published by Ministry of Construction, Public Works, Myanmar, also reviewed for understanding. For comparison, design standards of Myanmar also summarised below, however Indian Standards has been adopted for the project.

# 5.1 GENERAL CONSIDERATIONS FOR ROAD/ BRIDGE APPROACHES

- a) This section lays down the standards for Geometric Design and general features for existing Bridge approaches/ existing road to two-lane with shoulders.
- b) The Geometric Design of the Project Highway will conform to the standards set out in this chapter as a minimum.
- c) Existing Horizontal Curves which are found deficient in radius, layout, transition lengths or super-elevation will be corrected to the specified standards. Similarly deficiencies in the vertical alignment will also be corrected.

Standards which will be used for this project are summarised in Table 5.1

~~~			IRC Standards				
Sl. No.	Design Specification	Unit	it Terrain				
			Plain	Rolling	Hilly	Steep	
	Design Speed						
1	i) Ruling	Km/ hr	100	80	50	40	
	ii) Minimum		80	65	40	30	
	ROW						
2	i) Built-up areas	m	30	30	30	30	
	ii) Open areas		70	70	70	70	
3	Bridge Cross section (With Footpath)						
	Overall Width	m	14.8	14.8	12.0	12.0	
	Carriageway on Bridge Section	m	10.5	10.5	7.5	7.5	
	Crash Barrier		0.9 (2x0.45)	0.9 (2x0.45)	0.9 (2x0.45)	0.9 (2x0.45)	
	Foot Path	m	3 (2x1.5)	3 (2x1.5)	1.5	1.5	

Table 5.1: Design Standards

			IRC Standards			
Sl. No.	Design Specification	Unit	Terrain			
110.			Plain	Rolling	Hilly	Steep
	Railing	m	0.4 (2x0.20)	0.4 (2x0.20)	0.6 (2x0.30)	0.6 (2x0.30)
	Safety Kerbs	m	-	-	-	-
4	Bridge Cross section (Without Footpath)					
	Overall Width	m	12.9	12.9	10.0	10.0
	Carriageway on Bridge Section	m	10.5	10.5	7.5	7.5
	Crash Barrier		0.9 (2x0.45)	0.9 (2x0.45)	0.9 (2x0.45)	0.9 (2x0.45)
	Foot Path	m	-	-	-	-
	Railing	m	-	-	-	-
	Safety Kerbs		1.5 (2x0.75)	1.5 (2x0.75)	1.6 (2x0.8)	1.6 (2x0.8)
5	Road cross section					
	Width of Carriageway for Road section	m	7.0	7.0	7.0	7.0
	Width of Shoulder for road section					
6	i) Open Country areas	m	2x2.5	2x2.5		e – 1.0m de – 2.0 m
	ii) Built-up areas		2x2.5	2x2.5		e – 1.0m de – 2.0 m
	Minimum Radii of Horizontal curve					
7	i) Desirable	m	360	230	90	60
	ii) Minimum		230	155	60	30
	Camber/ crossfall					
8	i) Bituminous		2.5	2.5	2.5	2.5
	ii) Cement Concrete	%	2.0	2.0	2.0	2.0
	iii) Metal/ Gravel		2.5	2.5	2.5	2.5
	iv) Earthen		4.0	4.0	4.0	4.0

			IRC Standards				
Sl. No.	Design Specification	Unit	Terrain				
			Plain	Rolling	Hilly	Steep	
9	Superelevation (Max.)	m	7.0	7.0	7.0	7.0	
10	Gradient						
10	i) Ruling	%	3.3	3.3	5.0	6.0	
	ii) Limiting	%	5.0	5.0	6.0	7.0	
	Sight Distance						
11	i) Stopping	m	180	120	60	45	
11	ii) Intermediate	m	360	240	120	90	
	ii) Overtaking		640	470	235	165	
12	Roadway Width	m	12.0		-	xclusive of and drain)	

"Geometric Design Standards for Highways" published by Ministry of Construction, Public Works, Myanmar, are summarised in *Table 5.2* 

Table 5.2: Geo	ometric Design	Standards for	Highways,	Myanmar
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Sl. No.	Design Specification	Myanmar Standards
	Design Speed (mile/hour)	
1	a) Flat Country	60
1	b) Rolling Country	50
	c) Mountainous Country	40
2	Number of Lanes	2
3	Width of Lane (feet)	11 (min.) 12 (desirable)
4	Right of Way (feet)	100 (min.) 150 (desirable)
	Minimum width of shoulder (feet)	
	a) Flat Country	8
5	b) Rolling Country	8
	c) Mountainous Country	6
6	Minimum width of Formation (feet)	
6	a) Flat Country	40

SI. No.	Design Specification	Myanmar Standards
	b) Rolling Country	40
	c) Mountainous Country	36
	Earth Slope	
	a) Flat or Rolling Country	2:1
7	b) Mountainous Country	
/	i) Cut height - 0-4 feet	2:1
	ii) Cut height - 4-20 feet	13/4:1
	iii) Cut height - Over 20 feet	11/2:1
	Maximum Grades (%)	
0	a) Flat Country	3
8	b) Rolling Country	4
	c) Mountainous Country	6
9	Maximum Superelevation	10
10	Bridges:- kerb to Kerb Width (feet)	26 (min.) 30 (desirable)
11	Width of Culverts	Full Shoulder Width

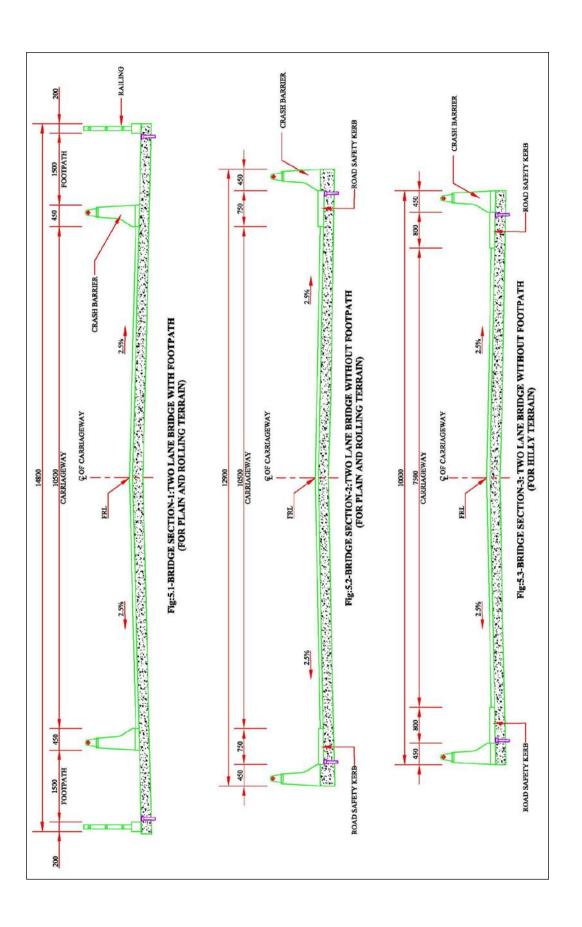
# 5.2 **PROPOSED TYPICAL CROSS SECTIONS**

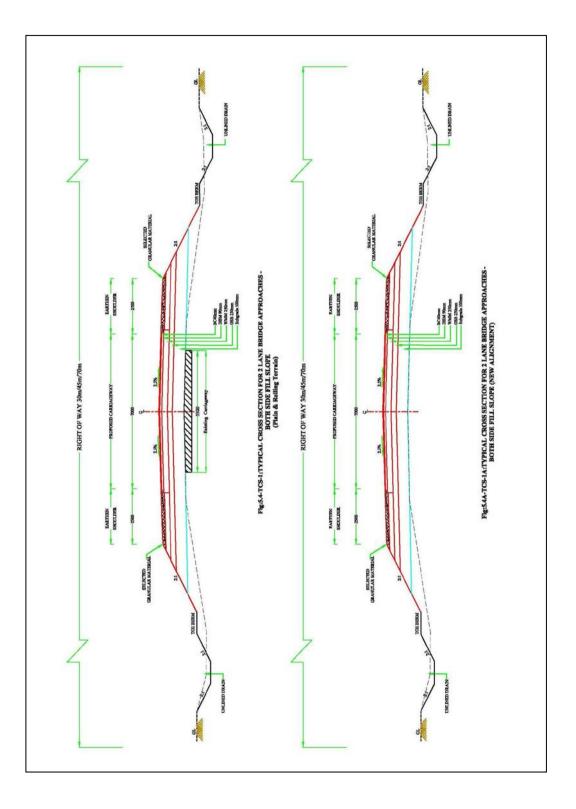
The geometric standard as given in IRC:SP:73-2007 will be followed. The cross section for major/ minor bridges coming over project road will be as per MORTH notification on **"Width of bridges on 2 lane National Highways (with and without Footpath)** letter No. RW/NH/33044/2/88-S&R(B) dated 24<sup>th</sup> March 2009 and **"Width of bridges on 2 lane National Highways on Hills** (with and without Footpath) letter no. RW/NH/33044/2/88-S&R(B) dated 21<sup>st</sup> Oct 2009 and IRC:SP:73-2007 are as under:-

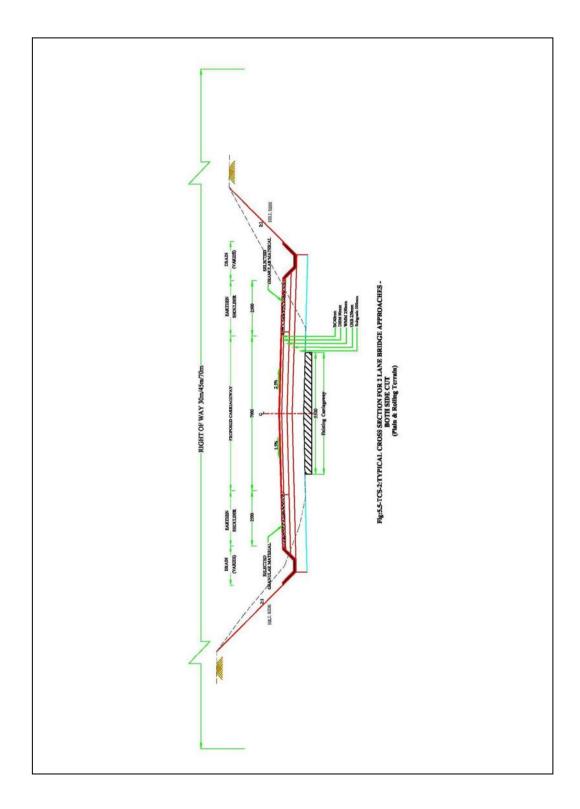
- i) Bridge Section 1- Two lane carriageway with footpath in Plain and Rolling Terrain
- ii) Bridge Section 2-Two lane carriageway without footpath in Plain and Rolling Terrain
- iii) Bridge Section 3-Two lane carriageway without footpath in Hill Terrain
- iv) TCS-1: 2-lane Bridge approaches Both side fill slope (Plain and Rolling Terrain)
- v) TCS-1A: 2-lane Bridge approaches Both side fill slope (New Alignment)
- vi) TCS-2 : 2-lane Bridge approaches Both side cut slope (Plain and Rolling Terrain)
- vii) TCS-3 : 2-lane Bridge approaches Both side fill slope (Hilly Terrain)
- viii) TCS-4 : 2-lane Bridge approaches Left side cut and right side fill slope (Hilly Terrain)

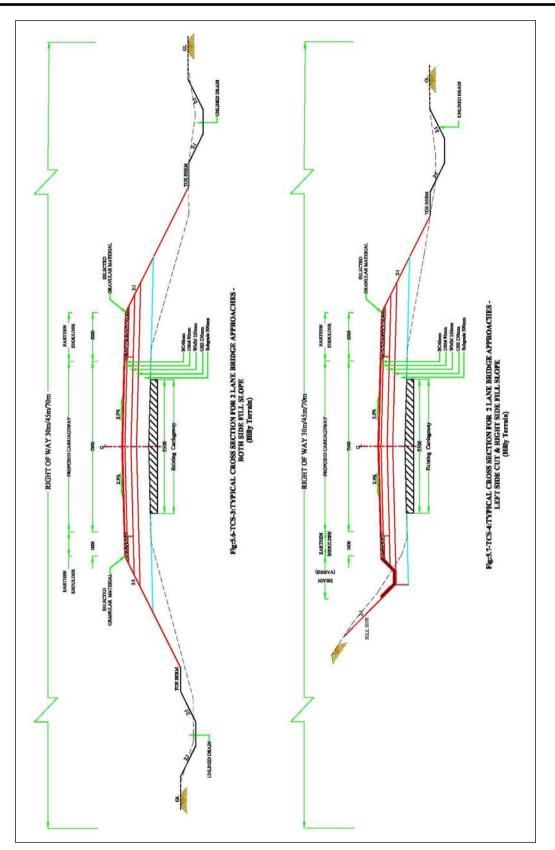
- ix) TCS-5 : 2-lane Bridge approaches Both side cut slope (Hilly Terrain)
- x) TCS-6 : 2-lane Bridge approaches Both side Retaining wall (Hilly Terrain)
- xi) TCS-7 : 2-lane Bridge approaches Left side fill slope and right side Retaining wall (Hilly Terrain)
- xii) TCS-8 : 2-lane Bridge approaches Left side Retaining wall and right side cut slope (Plain and Rolling Terrain)
- xiii) TCS-9 : 2-lane Bridge approaches Left side breast wall and right side Retaining wall (Hilly Terrain)
- xiv) TCS-10 : 2-lane Bridge approaches Left side cut slope right side Retaining wall (Hilly Terrain)
- xv) TCS-11 : 2-lane Bridge approaches Left side breast wall and right side fill slope (Hilly Terrain)
- xvi) TCS-12 : 2-lane Bridge approaches Left side fill slope and right side cut slope (Plain and Rolling Terrain)
- xvii) TCS-13(a) : 2-lane Bridge approaches Left side retaining wall and right side fill slope (New Alignment)
- xviii) TCS-13(b) : 2-lane Bridge approaches Left side retaining wall and right side fill slope
- xix) TCS-14(a) : 2-lane Bridge approaches Both side Breast wall (Plain and Rolling Terrain)
- TCS-14(b) : 2-lane Bridge approaches Left side Cut slope and right side Breast wall (Plain and Rolling Terrain)
- TCS-15 : 2-lane Bridge approaches Left side fill slope and right side Retaining wall (New Alignment)

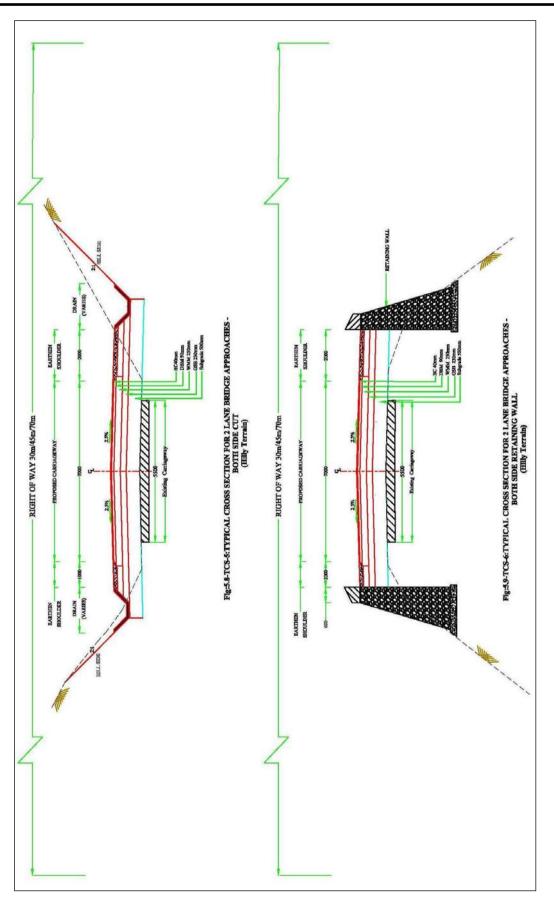
The Bridge Sections are shown in *Fig. 5.1to 5.3 and* typical Cross Sections for Bridge Approaches are shown in *Fig. 5.2 to 5.20*.

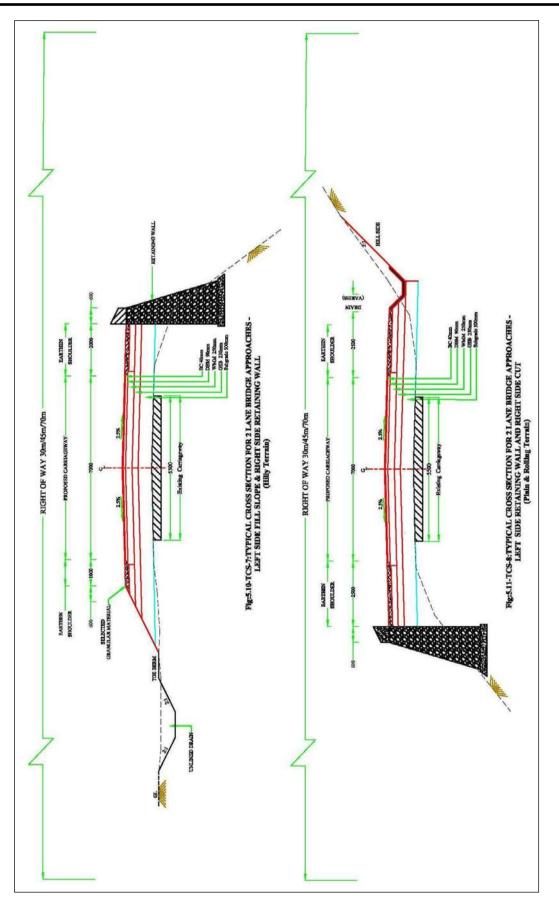


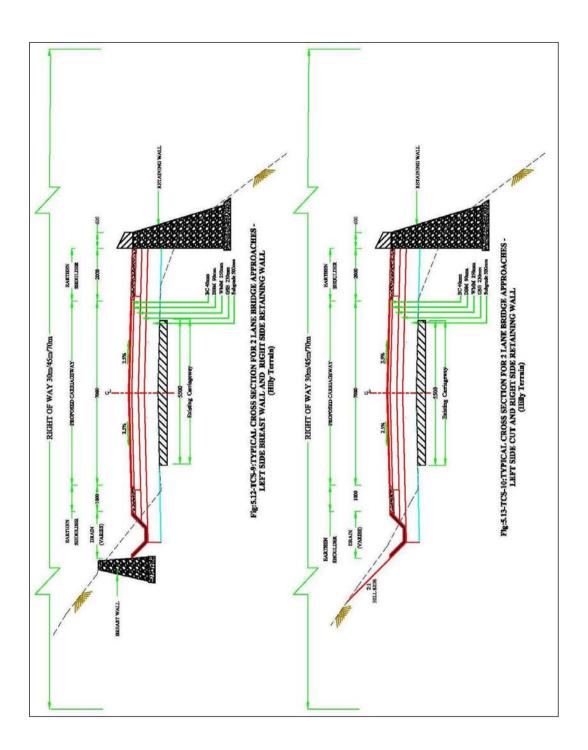


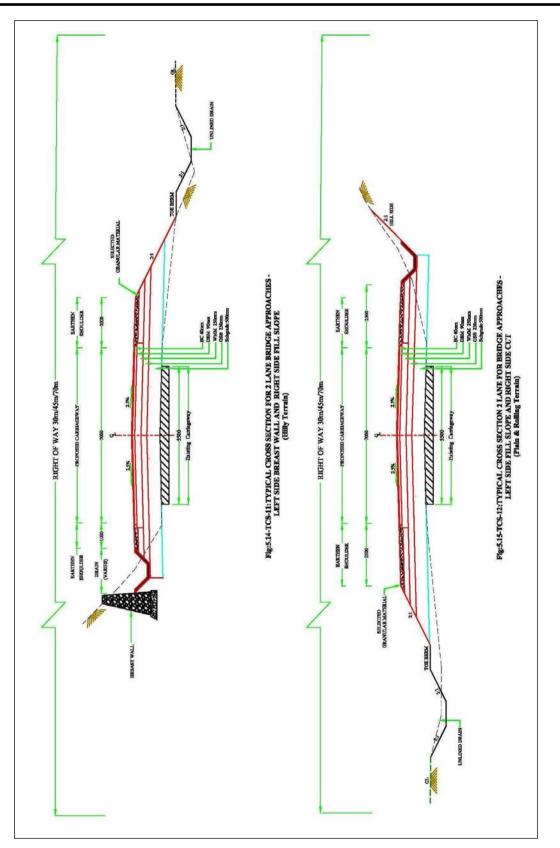


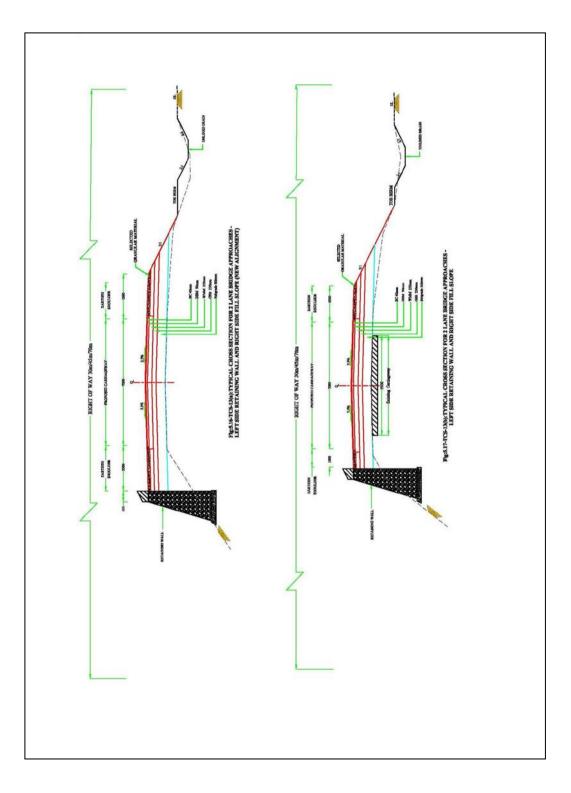


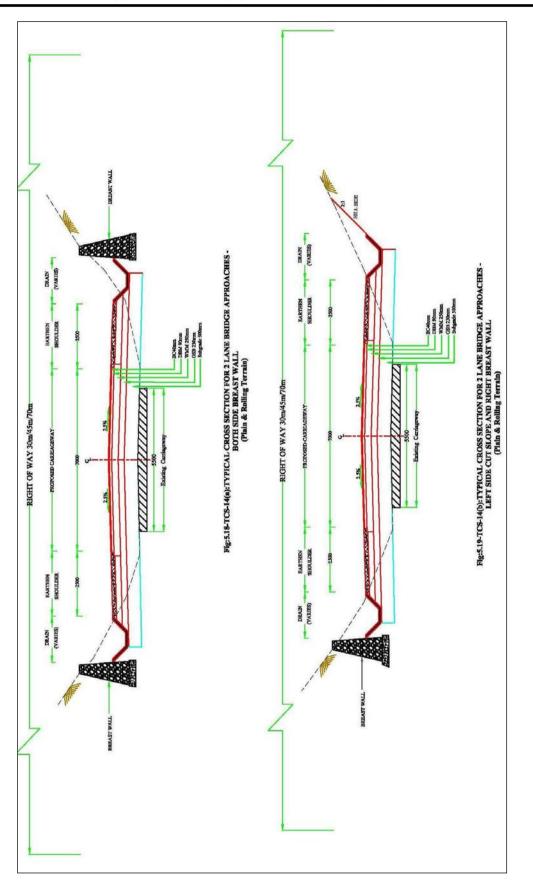


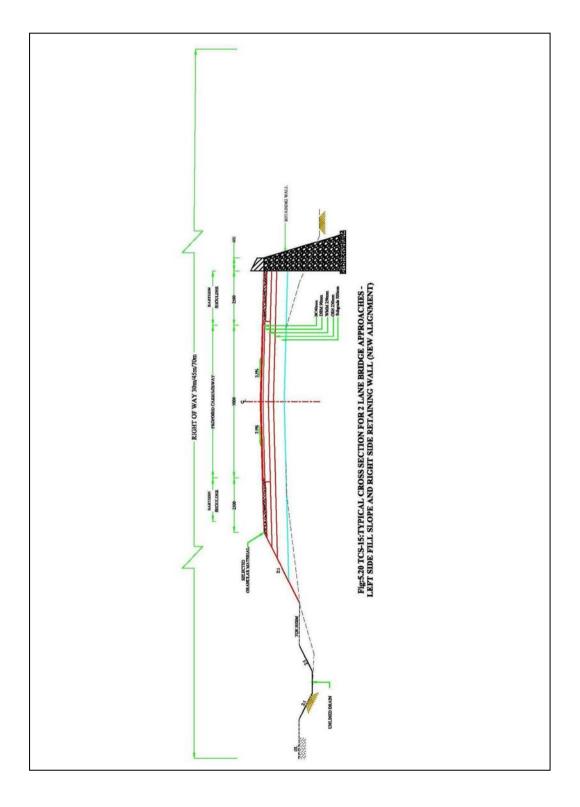












#### 5.3 DESIGN CODES AND STANDARDS

Design of all proposed structures is in accordance with the provisions of the following IRC Codes:

IRC: 5-1998	-	Section I- General Features of Design (Seventh Revision)
IRC: 6-2014	-	Section II- Loads and Stresses (Revised Edition)
IRC: 112-2011	-	Code of Practice for Concrete Road Bridges
IRC: 22-2008	-	Section IV- Composite construction for Road Bridges (Second Revision)
IRC: 24-2001	-	Section V- Steel Road Bridges (Second Revision)
IRC: 78-2014	-	Section VII- Foundations and Substructure (Revised Edition)
IRC:83 (Part I)- 1999	-	Section IX (Part I), Metallic Bearings
IRC:83 (Part II)- 1999	-	Section IX (Part II), Elastomeric Bearings
IRC:83 (Part III)-2002	-	Section IX (Part III), POT, POT cum PTFE, PIN and Metallic Guide Bearings
IRC: 87-1984	-	Guidelines for the Design and Erection of False work for Road Bridges
IRC: 89-1997	-	Guidelines for Design and Construction of River Training and Control Works for Road Bridges (First Revision)
IRC:SP:64-2005		Guidelines for the Analysis and Design of Cast-in-Place Voided Slab Superstructure
IRC:SP:66-2005		Guidelines for Design of Continuous Bridges
IRC:SP:69-2005		Guidelines & Specifications for Expansion Joints
IRC:SP:70-2005		Guidelines for the Use of High Performance Concrete in Bridges
IRC:SP:73-2007		Manual of Standards and Specifications for Two Lanning of State Highways on BOT basis

MORTH Specifications for Road and Bridges Works, 2013 (Fifth Revision)

MORTH notification on **"Width of bridges on 2 lane National Highways (with and without Footpath)** letter No. RW/NH/33044/2/88-S&R(B) dated 24<sup>th</sup> March 2009

MORTH notification on **"Width of bridges on 2 lane National Highways on Hills (with and without Footpath)** letter No. RW/NH/33044/2/88-S&R(B) dated 21<sup>st</sup> Oct 2009

MORTH Circular No. RW/NH-34059/1/96-S&R dated 30.11.2000 regarding expansion joints.

Whenever IRC codes are silent, relevant BIS codes will be followed. In case where even BIS codes are silent, other suitable international codes of practices like BS: 5400, AASHTO and EURO codes will be adopted.

#### 5.4 DESIGN STANDARDS FOR ROADS

#### 5.4.1 Horizontal Alignment

The essential elements of the horizontal alignment are as under:

- a) Radius of the Horizontal Curve
- b) Super elevation
- c) Transition Length
- d) Sight Distance

The basic considerations for the horizontal alignment will be as under:

- 1) The curves will be designed to have the largest possible radius and in no case less than the minimum value corresponding to the design speed.
- 2) Sharp curves will not be introduced at the end of the long tangent.
- 3) Long Curves with Suitable Transitions will generally be provided.
- 4) Reverse Curves will be avoided as far as possible.
- 5) Horizontal Alignment will be coordinated well the vertical alignment.

#### Transition Curves

The minimum length of transition curve will be determined from the following two considerations and the larger of the two values will be adopted for design:

i) Rate of Change of Centrifugal Acceleration

Ls =  $0.0215 \text{ V}^3/\text{CR}$ 

Where:

Ls = Length of Transition Curve in meters

V = Speed in Km/hr

R = Radius of Circular Curve in meters

C=80/ (75+V) (Subject to a maximum of 0.80 and minimum of 0.50)

 Rate of Change of Super elevation should not be such as not to cause discomfort of travelers. Further Rate of Change of Super elevation should not be steeper than 1 in 150 for roads in Plain/Rolling Terrain, and 1 in 60 in Mountainous/Steep Terrain.

The formula for minimum length of Transition Curve on the basis is:

 $Ls=2.7 V^2 /R.$ 

## 5.4.2 Vertical alignment

- a) The vertical alignment will be designed so as to provide a smooth longitudinal profile.
- b) Gradients corresponding to the ruling gradients will be followed in the vertical alignment design.

c) Long Vertical Curves will be provided at all grade changes.

## 5.4.3 Road Embankment

- a) Where the bottom of existing Subgrade is 0.60 m above the HFL, the existing height of embankment can be retained.
- b) Where the bottom of existing Subgrade is less than 0.60 m from the HFL, the existing height of the embankment should be raised to ensure a minimum 1.0 m clearance of the bottom of Subgrade from HFL.
- c) Where road is passing through an area not affected by floods and is free from any drainage problem/ water ponding/ overtopping situations with water table being quite deep, to the extent that Subgrade is not likely to be affected by the capillary saturation, then the minimum clearance of 0.6 m of the bottom of Subgrade from existing ground level is desirable.
- d) For the new road, the bottom of Subgrade will be 1.0 m above the HFL.
- e) High embankments (height 6 m or more) in all soils will be designed for stability.
- f) On High embankments, the protection measures will consist of the following:
  - Vegetative Cover
  - Kerb Channels
  - Chute
  - Stone Pitching/Cement Concrete Block Pitching
  - In case of cut section slope stability measures such as Pitching, breast walls, etc. will be provided.
- g) The Side Slopes of the cuttings will be provided as per the nature of soil encountered.
- h) Side slopes should not be steeper than 2H: 1V unless soil is retained by suitable soil retaining structures.

## 5.4.4 Road Safety Devices

The Road Safety Devices will consist of the following:

- a) Road Markings
- b) Traffic Signs
- c) Safety Barriers
- d) Railings
- e) Delineators where required

## Road Markings

- a) Road Markings will comprise of carriageway markings such as longitudinal markings and object markings such as raised pavement markers (Cat's Eyes or Road Studs).
- b) All markings will conform to IRC: 35.

## **Road** Signs

a) Three types of Road signs will generally be provided (such as Mandatory / Regulatory, Cautionary / Warnings, and informatory signs.

b) Locations of Signs will conform to IRC: 67 and Section 800 of MORTH Specifications.

#### Roadside Safety Barriers

The following types of Road Safety Barriers will be provided on the Project Road Sections:

- a) Semi-rigid type such as "W" Beam Type Steel Barriers will be provided on the high Embankment Section.
- b) Rigid Type such as Concrete Crash Barriers will be provided on the bridges.

#### Road Drainage

The general design guidelines for the Road Drainage will be as under:

- a) The design of drains will be carried out in accordance with IRC: SP: 42 and IRC:SP:50
- b) For surface drainage, the estimation of design discharge and the design of drain Sections will be as per the procedure given in IRC:SP:42.
- c) The longitudinal slope of the drain will not be less than 0.5 % for lined drains and 1.0 % for unlined drains.
- d) The side slopes of the unlined drains will not be steeper than 2H: 1V.
- e) The drains on the paved areas will be provided with CC linings.
- f) The drainage of high embankment will be provided with the provision of kerb channel and CC lined chutes.
- g) The chute drains and drains at toe of the embankment will be of plain cement concrete (M-15 grade).
- h) Necessary sub-surface drains will be provided as required.

#### 5.5 DESIGN STANDARDS FOR BRIDGES

#### 5.5.1 Material

#### Cement

For construction of structures 43 grade ordinary Portland cement conforming to IS: 8112 and 53 grade ordinary Portland cement conforming to IS: 12269 will be used.

## Admixtures

To improve workability of concrete, admixtures conforming to IS: 9103 will be used.

## Aggregates

Aggregates will consists of clean, hard, strong, dense, non-porous and durable crushed stone for coarse aggregates and natural particles for sand. The aggregates will conform to IS: 383 and will be tested to conform to IS: 2386 parts I to VIII. Size of coarse aggregate will be selected as per mix design requirement.

## Water

Water used for mixing and curing will be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water will not be less than 6.

## Concrete

The grade of concrete will be as per design requirement and mentioned in execution drawings for each component of the structure. Cement and water content will be as per mix design requirement.

## Reinforcement

Deformed or TMT reinforcement bar conforming to IS: 1786 will be used for components of the structures. The reinforcement grade will be Fe500.

## **Pre-stressing Steel**

Pre-stressing tendons normally take the form of separate wires, wires spun together helically to form strands or bars. For pre-tensioned steel, wires, strands and occasionally bars are used, simply to permit the concrete to bond directly to them; when post-tensioning is used, it is common practice to group the separate tendons together, so as to reduce the number of anchorages and ducts required to accommodate them. When grouped in this way, the tendons in each duct are usually termed a cable.

Uncoated stress relieved low relaxation steel conforming to IS: 14268 will only be used for prestressing steel so as to reduce losses due to relaxation. Data in respect of modulus of elasticity, relaxation loss at 1000 hours, minimum ultimate tensile strength, stress-strain curve etc. will necessarily be obtained from manufacturers. Pre-stressing steel will be subjected to acceptance tests prior to actual use on the works (guidance may be taken from BS: 4447). The modulus of elasticity value, as per acceptance tests, will conform to the design value which will be within a range not more than 5 percent between the maximum and minimum.

Many cables with different arrangements of wires and strands and different methods of anchorage are available as pre-stressing steel. So type and size of cable and methods of anchorage will be decided on the basis of design requirement.

## Sheathing

The duct or sheath for cables to be used of Corrugated HDPE having coefficient of friction as 0.17 and wobble coefficient per meter length of steel 0.0020. The thickness of sheathing will be as specified in Section 13 of IRC:112. The sheathing will conform to the requirements of Section 13 of IRC:112 and test certificate will be furnished by the manufacturer. The joints of all sheathing will be water tight and conform to the provision contained in Clause 13.6 of IRC: 112.

# Void Former

Void former are required to possess the necessary rigidity and integrity of dimensions in addition to being water tight, since special machines are available for manufacturing of corrugated steel void formers, so only corrugated steel void former will be used. The materials and other requirements for void former will conform to the provision of IRC: SP: 64.

# 5.5.2 Design Methodology

# I. Pile Foundation

In general, the design of pile and pile cap will conform to provisions of IRC:78. The various specific assumptions to be made for the design of pile and pile cap will be as follows:

- (a) The vertical load carrying capacity of the pile will be determined based on static formula given in Appendix-5 of IRC:78-2014. The following limiting values will be considered for computation of safe load:
  - Results of sub-soil investigation will be used for adopting the value of angle of internal friction "Ø" and cohesion "C" of the soil.
  - Angle of wall friction ' $\emptyset$ ' to be taken as equal to Angle of internal friction ' $\emptyset$ '.
  - The coefficient of earth pressure, 'K' will be taken as 1.5 while calculating the safe load carrying capacity.
  - The entire overburden will be assumed fully submerged for the purpose of calculation of safe load.
  - Maximum overburden pressure at the bottom of pile for the purpose of calculation of shaft friction and end bearing will be limited to 20 times the diameter of the pile.
  - Factor of safety will be taken as 2.5
- (b) The vertical load carrying capacity as calculated by static formula will be verified by conducting initial load tests on piles conforming to IS:2911 (Part 4).
- (c) The lateral load carrying capacity of the pile will be determined by using empirical formula given in IS:2911 (Part-1/Sec-2) by limiting the lateral deflection of 5mm at its tip considering it as fixed headed pile under normal conditions. The capacity so evaluated will be used purely for the purpose of arriving at the upper bound of lateral load capacity. This deflection limitation will not be applicable in load combination with seismic conditions for which the resulting stresses and the structural capacity of the section would be the governing criteria.
- (d) Soil stiffness for lateral loads will be taken from IS:2911 (Part-1/Sec-2), Appendix C. Unconfined compressive strength will be calculated from the results of Geotechnical Investigation Reports. Cohesion as calculated using unconsolidated un-drained test with required modification of angle of internal friction will be used for working out unconfined compressive strength.
- II. Pile Cap
  - The minimum thickness of pile cap will be kept as 1.5 times the pile diameter.
  - Top of the pile will project 50mm into the pile cap.
  - The top of pile cap will be kept at least 300mm below the ground level in case of urban interchange structures or road over bridges. For bridges on rivers / streams / canals, the bottom of pile cap will be kept at LWL.

- Pile cap will be designed either by truss analogy or by bending theory, depending upon the spacing and number of piles in a pile group. Truss analogy may be used for pile caps with a maximum of 5 piles in a pile group. Beyond 5 piles, bending theory will be used.
- Pile cap will be provided with an offset of at least 150mm beyond the outer face of the outer piles.

# III. Piers & Pier Caps

- The piers are to be designed for combined axial load and biaxial bending as per the provisions of IRC:112.
- Pier cap is checked as either as a flexural member or as a bracket, depending upon the span / depth ratio.
- In case it is a flexural member, the bending moments are checked at the face of pier support. Shear force will be checked at a distance deff away from the face of support.
- In case the pier cap acts as a bracket, the design will conform to provisions of IS:456 in absence of any specific provision in IRC code for bracket design.
- Analysis, design and detailing will in general conform to the stipulations of relevant IRC codes and good engineering practice.

## IV. Superstructure

# Design of PSC T Beam and Slab (Precast Girder and in-situ slab)

- The design of such type of structure is very much dependent on the construction sequence. The structure is in iso-static condition upto the stage of casting of deck slab and diaphragm and after developing proper bond with girder, the structure behave as composite section.
- The design therefore will be done with only the girder section being effective upto the stage of casting of deck slab and diaphragm and composite section will be considered for all subsequent loads (i,e for SIDL and live loads).
- The deck structure will be analyzed using grillage analogy method for SIDL and Live Loads. Self weight of girder and Dead Load of slab will be applicable on girder section alone and hence the design forces for DL and SW will be calculated separately and results superimposed. The superstructure will be idealised into a criss cross set of discrete members which are able to resist the loads applied in a plane perpendicular to the plane of assemblage, through bending shear and torsional rigidities of the members.
- The minimum dimension of various elements will be provided conforming to the latest IRC codes and standards. The minimum deck slab thickness will be kept as not less than 200mm. The minimum web thickness for the longitudinal girders will be not less than 200mm plus the sheath diameter of prestressing cable. Thickness of cross girders will not be less than the thickness of longitudinal girder. There will be

at least three cross girders in any beam and slab type structure (i.e one at the centre and two at the ends.).

- For obtaining maximum shear stress, the section at a distance equal to effective depth from the face of the support will be checked and the shear reinforcement calculated at the section will be continued up to the support.
- The design of deck slab supported transversely on the precast girder will be carried out assuming un-yielding support at the girder points.
- Effect of differential shrinkage and creep between precast girder and in-situ slab will be considered.

# Design of RCC T Beam and Slab (Precast Girder and in-situ slab)

- The design of such type of structure economical for smaller spans only.
- The design therefore will be done with only the girder section being effective upto the stage of casting of deck slab and diaphragm and composite section will be considered for all subsequent loads (i,e for SIDL and live loads).
- The deck structure will be analyzed using grillage analogy method for SIDL and Live Loads. Self weight of girder and Dead Load of slab will be applicable on girder section alone and hence the design forces for DL and SW will be calculated separately and results superimposed. The superstructure will be idealised into a criss cross set of discrete members which are able to resist the loads applied in a plane perpendicular to the plane of assemblage, through bending shear and torsional rigidities of the members.
- The minimum dimension of various elements will be provided conforming to the latest IRC codes and standards. The minimum deck slab thickness will be kept as not less than 200mm.
- For obtaining maximum shear stress, the section at a distance equal to effective depth from the face of the support will be checked and the shear reinforcement calculated at the section will be continued up to the support.
- The design of deck slab supported transversely on the precast girder will be carried out assuming un-yielding support at the girder points.
- Effect of differential shrinkage and creep between precast girder and in-situ slab will be considered.

# 5.5.3 Seismic Design & Detailing

# I. Seismic Analysis & Design

The project corridor falls under seismic zone -v, which is a high seismic zone. In general, Seismic analysis of the bridge structure is proposed to be carried out in 2 steps.

<u>Step-1</u>: To carry out single mode analysis to obtain the fundamental vibration period of the bridge in two orthogonal directions (i.e. longitudinal & transverse direction).

<u>Step-2</u>: To estimate seismic forces using the spectrum response, defined in IRC:6.

The calculation for fundamental period can be done either by using the simplified expression given in Appendix - D of IRC:6-2014 or else by modeling the structure in STAAD/Pro and carrying out dynamic analysis.

Vertical seismic coefficient will be taken as "half" of the horizontal seismic coefficient. The vertical seismic will be combined with the horizontal seismic in any one direction. The seismic combination to be considered are as follows:

- $\pm SX \pm SY$
- $\pm SZ \pm SY$

Where SX & SZ are seismic forces in 'longitudinal' & 'transverse' direction respectively while SY is the seismic force in vertical direction.

## II. Seismic Detailing

<u>Superstructure</u>

- The superstructure will be designed for the design seismic forces for the load combinations as specified in IRC:6
- Under simultaneous action of horizontal and vertical accelerations, the superstructure will have a factor of safety of at least 1.5 against overturning. In this calculation, the forces to be considered on the superstructure will be the maximum elastic forces generated in the superstructure.
- The superstructure will be secured, to the substructure (particularly in this project which falls under seismic zones IV), through vertical hold-down devices and/or antidislodging elements in horizontal direction as specified below. These vertical holddown devices and/or anti-dislodging elements may also be used to secure the suspended spans, if any, with the restrained portions of the superstructure.
- However, the frictional forces will not be relied upon in the design of these holddown devices or anti-dislodging elements.
- Vertical Hold-Down Devices

Vertical hold-down devices will be provided at all supports (or hinges in continuous structures), where resulting vertical force U due to the maximum elastic horizontal and vertical seismic forces (combined as per IRC:6) opposes and exceeds 50% of the dead load reaction D.

Where vertical force U, due to the combined effect of maximum elastic horizontal and vertical seismic forces, opposes and exceeds 50%, but is less than 100%, of the

dead load reaction D, the vertical hold-down device will be designed for a minimum net upward force of 10% of the downward dead load reaction that would be exerted if the span were simply supported.

If the vertical force U, due to the combined effect of maximum horizontal and vertical seismic forces, opposes and exceeds 100% of the dead load reaction D, then the device will be designed for a net upward force of 1.2(U-D); however, it will not be less than 10% of the downward dead load reaction that would be exerted if the span were simply supported.

Anti-Dislodging Elements in the Horizontal Direction

Anti-dislodgement elements (thrust blocks) will be provided to prevent dislodgement of deck between adjacent sections of the superstructure at supports and at expansion joints within a span. The thrust blocks are to be provided for both transverse as well as longitudinal seismic force.

The thrust blocks will be designed for, at least, twice the seismic force as calculated based on IRC:6 provisions.

Shock Transmission Units

Multi-span bridges with continuous superstructure may be provided with restrained bearings over only one pier/abutment. In order to distribute the seismic forces generated by the superstructure to other pier(s)/abutment(s), STUs' may be introduced after adequate testing, between superstructure and other pier(s)/abutment(s) where free/guided bearings are used. However, specialist literature will be consulted for the details of such STUs and for their design in bridges subjected to seismic effects. STUs should also facilitate the breathing of the bridge due to thermal and shrinkage effects.

# <u>Bearings</u>

- Elastomeric bearings if used for transferring in--plane horizontal forces will be checked using minimum frictional value and minimum vertical load, including combined effects of horizontal and vertical component of earthquake. Anchored elastomeric bearings may be used in case it is not possible to satisfy the above criteria.
- For spans more than 25m, Pot cum PTFE bearings will preferably be used. For using elastomeric bearings for more than 25m span, special analysis will be carried out by modeling complete bridge to calculate actual seismic coefficient.

# Substructure & Foundation

• The scour to be considered for design will be based on mean design flood. In the absence of detailed data the scour to be considered for design will be 0.9 times the maximum design scour depth. The designer is cautioned that the maximum seismic scour case may not always be governing design condition in case of deep

foundations as the time period of the structure greatly reduces with the reduction in the free standing length of piles.

- In loose sands or poorly graded sands with little or no fines, vibrations due to earthquake may cause liquefaction or excessive total and differential settlements. For the bridges of this project, which is in seismic zones IV and V, liquefaction potential will be assessed. If found necessary, remedial measures may be undertaken to mitigate liquefaction potential. For liquefaction analysis specialist literature may be referred.
- Ductile detailing specification

Considering high seismic zone for the project corridor, following ductile detailing specifications will be adopted for the substructure of all the bridges. The detailing rules given have been chosen with the intention that reliable plastic hinges should form at the top and bottom of each pier column, or at the bottom only of a single stem pier under horizontal loading and that the bridge should remain elastic between the hinges. The aim is to achieve a reliable ductile structure. Design strategy to be used is based on assumption that the plastic response will occur in the substructure. However, in case of a wall type substructure, the nonlinear behaviour may occur in the foundation-ground system. Repair of plastic hinges is relatively easy.

• Minimum grade of concrete should be M25 (fck = 25 MPa).

Steel reinforcement of grade Fe 500, having elongation more than 14.5 percent and conforming to other requirements of IS 1786 : 1985 may be used for the reinforcement.

- The use of circular column is preferred for better plastic hinge performance and ease of construction.
- The bridge must be proportioned and detailed by the designer so that plastic hinges occur only at the controlled locations (e.g., pier column ends) and not in other uncontrolled places (e.g. foundation).
- The area of the longitudinal reinforcement will not be less than 0.8 percent nor more than 6 percent, of the gross cross section area Ag. Splicing of flexural region is not permitted in the plastic hinge region. Lap will not be located within a distance of 2 times the maximum column cross-sectional dimension from the end at which hinging can occur.
- Transverse Reinforcement

The transverse reinforcement for circular columns will consist of spiral or circular hoops. Continuity of these reinforcements should be provided by either:

• Welding, where the minimum length of weld should be 12 bar diameter, and the minimum weld throat thickness should be 0.4 times the bar diameter

 $\circ$  Lapping, where the minimum length of lap should be 30 bar diameters and each end of the bar anchored with 135° hookswith a 10 diameter extension into the confined core

Fig. 5.21: Transverse Reinforcement in Column

Splicing of the spiral reinforcement in the plastic hinge region should be avoided.

In rectangular columns, rectangular hoops may be used. A rectangular hoop is a closed stirrup, having a  $135^{\circ}$  hook with a 10 diameter extension at each end that is embedded in the confined core. When hoop ties are joined in any place other than a corner the hoop ties will overlap each other by a length 40 bar diameter of the reinforcing bar which makes the hoop ties with hooks as specified above.

Joint portion of hoop ties for both circular and rectangular hoops should be staggered.

• Special Confining Reinforcement:

Special confining reinforcement will be provided at the ends of pier columns where plastic hinge can occur. This transverse reinforcement should extend for a distance from the point of maximum moment over the plastic hinge region over a length 10. The length 10 will not be less than,

• 1.5 times the column diameter or 1.5 times the larger cross sectional dimension where yielding occurs

- 1/6 of clear height of the column for frame pier (i.e when hinging can occur at both ends of the column)
- 1/4 of clear height of the column for cantilever pier (i.e when hinging can occur at only one end of the column)
- o 600 mm
- Spacing of Transverse Reinforcement
  - o The spacing of hoops used as special confining reinforcement will not exceed
  - o 1/5 times the least lateral dimension of the cross section of column,
  - o 6 times the diameter of the longitudinal bar,
  - o 150 mm

The parallel legs of rectangular stirrups will be spaced not more than 1/3 of the smallest dimension of the concrete core or more than 350 mm centre to centre. If the length of any side of the stirrups exceeds 350 mm, a cross tie will be provided. Alternatively, overlapping stirrups may be provided within the column.

Amount of Transverse Steel to Be Provided

The area of cross section, Ash, of the bar forming circular hoops or spiral, to be used as special confining reinforcement, will not be less than

$$A_{sh} = 0.09SD_k \left[ \frac{A_g}{A_c} - 1.0 \right] \frac{f_{ck}}{f_y}$$

or,

$$A_{sh} = 0.024SD_k \frac{f_{ck}}{f_y}$$

whichever is the greater, where

Ash = area of cross-section of bar forming rectangular hoop

S = pitch of spiral or spacing of hoops in mm

Dk = Diameter of core measured to the outside of the spiral or hoops in mm

fck = characteristic compressive strength of concrete

fy = yield stress of steel (of circular hoops or spiral)

Ag = gross area of the column cross section

Ac = Area of the concrete core =  $\frac{\pi}{4}D_k^2$ 

The total area of cross-section of the bar forming rectangular hoop and cross ties, Ash to be used as special confining reinforcement will not be less than :

$$A_{sh} = 0.24Sh \left[ \frac{A_g}{A_c} - 1.0 \right] \frac{f_{ck}}{f_y}$$
 or,

$$A_{sh} = 0.096Sh \frac{f_{ck}}{f_{v}}$$

where

h = longer dimension of the rectangular confining hoop measured to its outer face. It should not exceed 300 mm

Ak = Area of confined core concrete in the rectangular hoop measure to its outer side dimensions.

Note: Crossties where used should be of the same diameter as the peripheral hoop bar and Ak will be measured as the overall core area, regardless the hoop area. The hooks of crossties will engage peripheral longitudinal bars.

## 5.5.4 Bearings

Bridge bearing must be designed to transmit all the loads and appropriate horizontal forces. From the material point of view, these bearings can be made from metal, rubber, metal and elastomer and even concrete. However following two types of bearings are recommended to be used on this project.

## Elastomeric Bearings

Elastomeric bearing can accommodate translation movements in any direction and rotational movements in any axis by elastic deformation. They should not be used in tension or when rotation is high and vertical load small. The basis of design is that the elastomer is an elastic material, the deflection of which under a compressive load is influenced by its shape (shape factor). Reinforcing plates should be bonded to the elastomer to prevent any relative movement at the steel/elastomer interface. The dimension and the number of internal layers of elastomer chosen will satisfy the following clauses of IRC: 83(Part-II).

Design Criterion	Clause no of IRC: 83 (Part-II)
Dimensional	916.3.3
Translational	916.3.4
Rotational	916.3.5
Frictional	916.3.6

IRC: 83 (Part-II) recommends that chloroprene (CR) only will be used in the manufacture of bearing. The elastomer will conform to all the properties specified in table 1 of IRC: 83 (Part-II), and tolerances in dimensions specified in table2 of IRC: 83 (Part-II).

# **POT/PTFE Bearings**

Due to initial low cost, easy availability, maintenance free and easy replacement, for simply supported structures elastomeric bearing will be used. Wherever it is unavoidable POT/ PTFE bearings will be used. However for continuous structure POT/ PTFE bearing will be used.

The design of the POT/ PTFE bearing will be done by the manufacturer conforming the provisions of material as well as design parameters IRC: 83(part-III) and will be got approved by the engineer. However the forces, movements and rotation etc will be provided by the designer of the project on the format given in appendix -1 of IRC: 83 (part-III). In support of quality assurance, acceptance specification given in clause 928 of IRC: 83(part-III) will be followed.

## 5.5.5 Loading

# Superimposed dead load

Loads corresponding to the dimensions given for bridge furniture details in item 5.0 will be considered as SIDL for design of structure.

# Differential Settlement

If the riding quality permits, clause 706.3.2.1 of IRC:78 specify that the calculated differential settlement between the foundations of simply supported span will not exceed 1 in 400 of the distance between the foundations, where 1 is distance between two foundations. In case of structure sensitive to differential settlement such as continuous structures the value of differential settlement will be taken as 10 mm.

# Temperature Gradient

Effective bridge temperature will be taken as 34°C estimated from the isothermal of shade air temperature given in fig 8 and fig 9 of IRC: 6. Difference in temperature between the top surface and other levels through the depth of the structure, where ever applicable will be taken in accordance with clause :218.3 of IRC:6.

# Other Loads

The loads which are not mentioned in this Clause, will be as per IRC:6.

## 5.5.6 Cover

Minimum clear cover to any reinforcement bar closest to concrete surface for different component will be as follows.

Component	Minimum Cover in mm
Superstructure	40
Substructure	40
Foundation	75
Pre-stressing cable duct	75
Pre-cast elements	35

## 5.5.7 Minimum Diameter of Bar

Diameter if any reinforcing bar including transverse ties, stirrups etc. will not be less than 10 mm. Diameter of any longitudinal reinforcement bars in columns/ vertical member will not be 12 mm. However diameter of the reinforcing bars will not exceed 25 mm in slabs and 32 mm in other member.

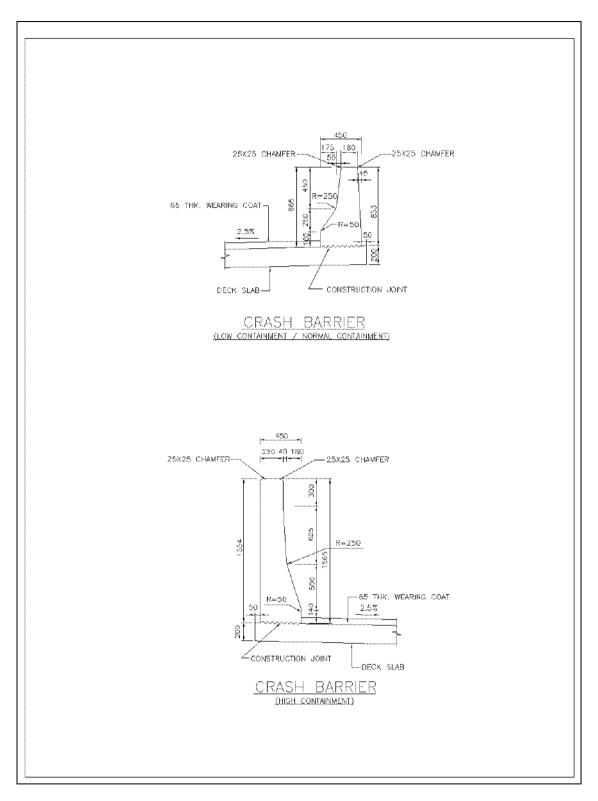
## 5.5.8 Bridge Furniture Details

## Crash Barriers

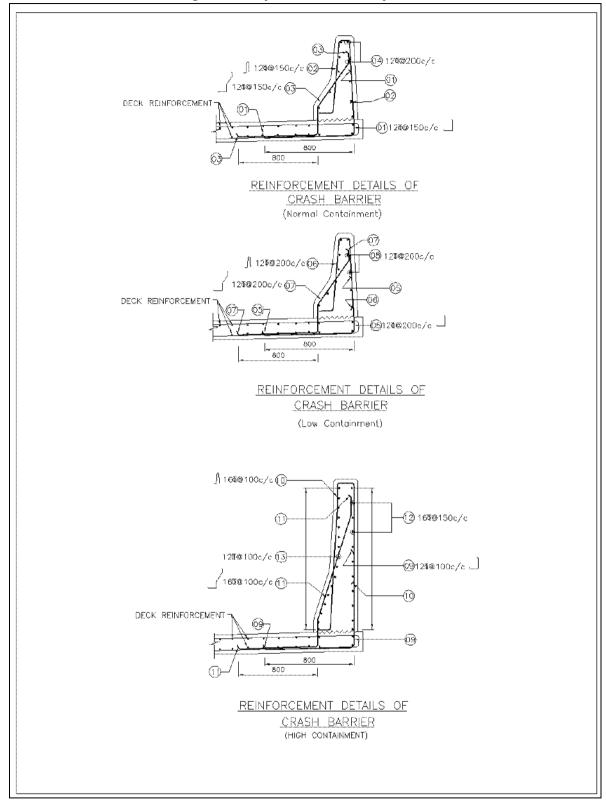
The type of crash barriers is provided according to their applications summarised below.

The P-1: Normal Containment type is provided on the Bridges (major and minor). The Crash barrier has been provided according to IRC: 5-1998.

Typical shape and dimensional details of crash barrier and their locations on the bridges decks with or without footpaths are shown in *Fig. 5.22*. The reinforcement details are shown in *Fig. 5.23*.







#### Fig.5.23: Reinforcement Details of Crash Barrier

## 5.5.9 Expansion joints

The Ministry's Interim Specification circulated vide letter RW/NH/33059/1/95 S & R, dated 28th June 1996 will be followed.

These will conform to Section 2600 Technical Specification of MORTH.

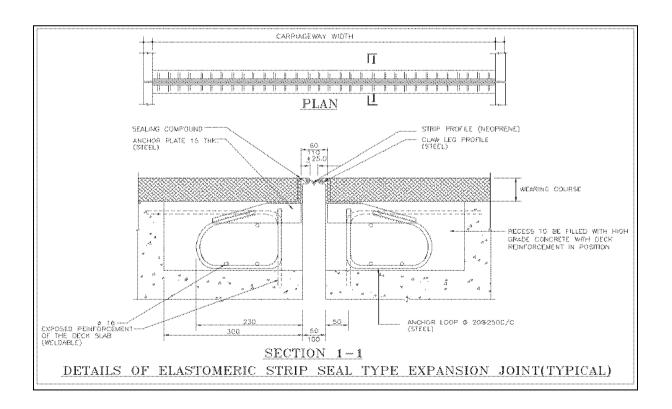
Types of Expansion joints based upon the length of the span and movements are given in *Table 5.3.* 

Sr. No.	Span	Expansion Joints		
(i).	For RCC slabs upto 11 m span only	Buried type expansion joints		
(ii).	For all other bridges having span longer than 11 m and where movements are upto $\pm$ 70mm	Elastomeric Single Strip Seal type expansion joints		
(iii).	Superstructure having movements more than $\pm$ 70mm.	Modular Strip Seal expansion joints		

Table 5.3: Type of Expansion Joints

Typical dimensional details of expansion joints are shown in Fig. 5.24

# Fig. 5.24: Details of Expansion Joints



### 5.5.10 Wearing course

Asphaltic concrete wearing course, 65 mm thick, as per the latest circular issued by MORTH/NHAI for National Highways, will be provided. It will comprise of 50 mm thick asphaltic concrete laid in two layers of 25 mm each with an overlay of 15 mm thick mastic asphalt.

### 5.5.11 Edge treatment

A drip course of 25mm will be provided at the edge and bottom of the cantilever of the superstructure to barricade the flow into the base of superstructure.

Typical shape and dimensional details of Edge Treatment are shown in Fig. 5.25.

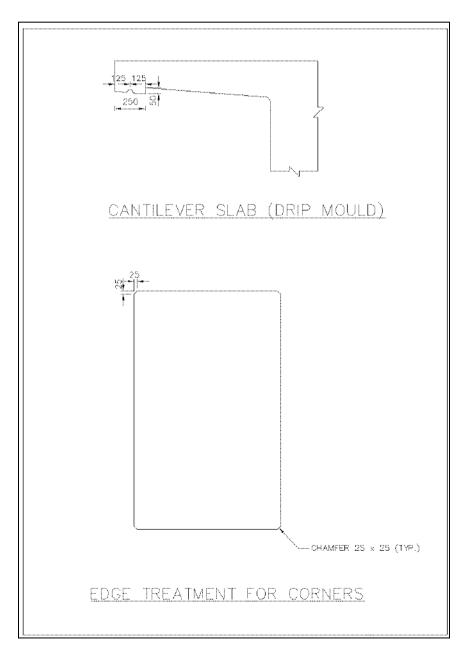
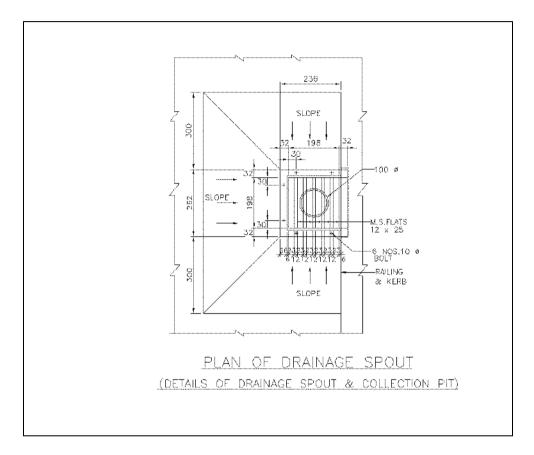


Fig. 5.25: Details of Edge Treatment

## 5.5.12 Drainage spouts

Drainage spouts will be provided in accordance with MORTH standard. The minimum spacing will be kept preferably as 5.0m c/c which may be adjusted to suit span length. The drainage spouts at nallah/canal Bridge are proposed with free down fall.

Typical shape and dimensional details drainage spouts are shown in Fig. 5.26.



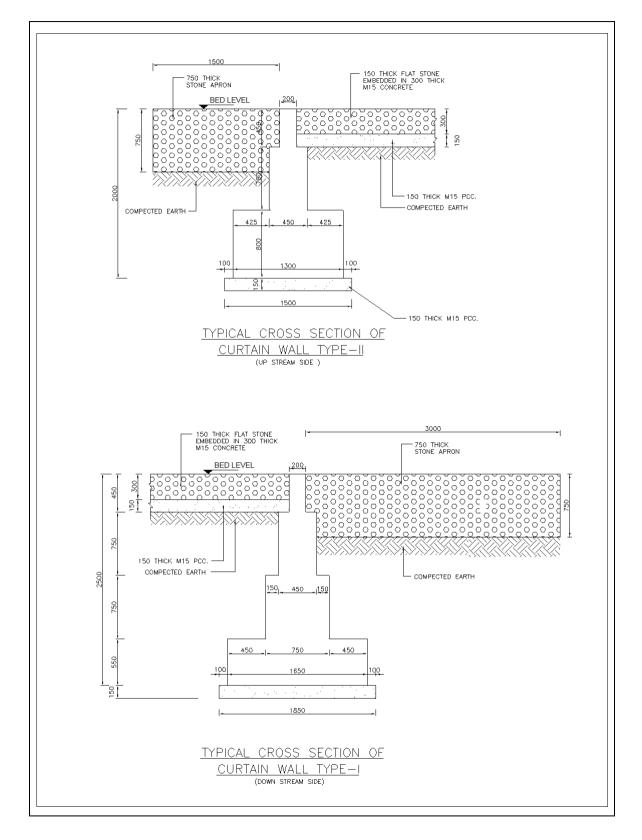


### 5.5.13 Protection works

For bridges with open or raft foundation protective flooring, curtain wall and apron will be provided both up-stream and down-stream.

Typical dimensional details of protection works are shown in *Fig.5.27*.

Fig.5.27: Details of Protection Works



#### 5.6 APPROACHES

The approaches on the either side of the Bridges would have slope protection in the form stone pitching and turfing will be provided on the embankment slopes.

#### 5.7 LAMP POST FIXTURES

#### 5.7.1 Fixtures Details

The standard fixture details will be used from the cantilever slab protruding from the crash barrier.

#### 5.7.2 Utilities

100mm dia pipes will be provided in the raised footpath or in crash barrier to facilitate the utilities running along the bridge.

#### 5.7.3 Approach slab

Reinforced concrete approach slabs, 3.5 m long and 300 mm thick, in M30 grade concrete at either end of the bridge, will be provided. One end will be supported on the reinforced concrete bracket projecting from the dirt wall and the other end resting over the soil, in accordance with the guidelines issued by MORTH.

A levelling course, 10 cm thick, in M-15 grade concrete will be laid under the approach slabs.

Typical shape and dimensional details Approach slab are shown in *Fig.5.28*. The reinforcement details of approach slab are shown in *Fig.5.29*.

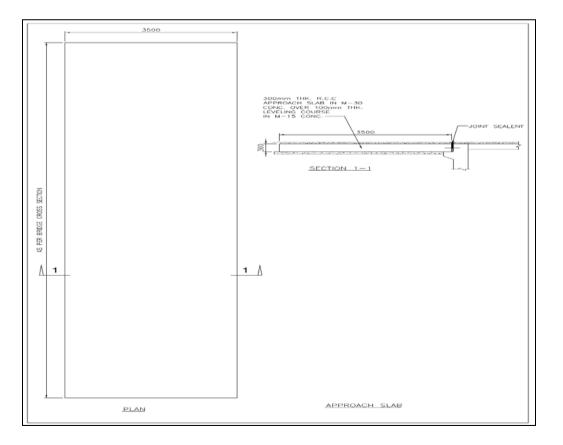
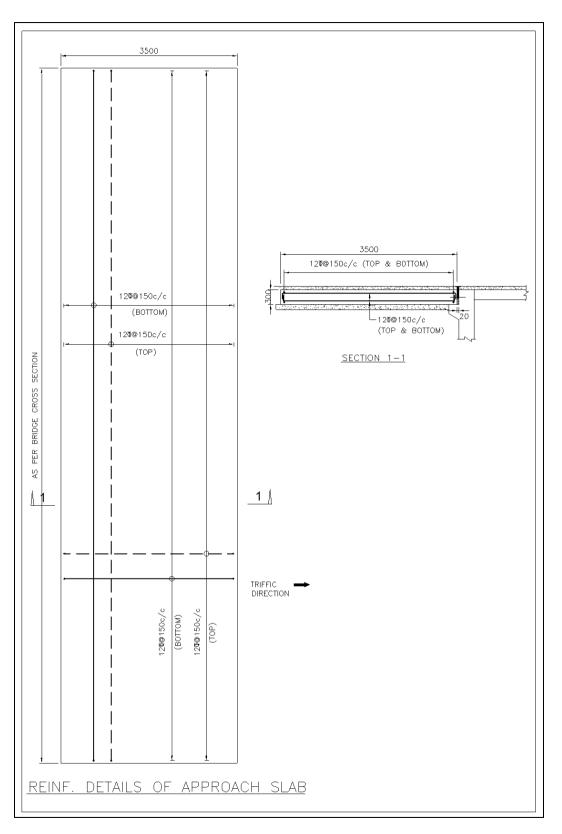


Fig.5.28: Dimensional Details of Approach Slab





**Chapter 6** 

Improvement Proposals and Preliminary Design

# 6: IMPROVEMENT PROPOSALS AND PRELIMINARY DESIGN

#### 6.1 GENERAL

The preliminary assessment of data collected from the surveys and investigations carried out, and the results derived from the analysis of the data have formed the basis for preliminary engineering designs, which were developed within the parameters of the design criteria and standards adopted for the project.

The design criteria / method applied for important components of the project are as follows:

Structure Design	:	IRC Bridge Standards and MORTH Manual & circulars on Structures
Geometric Design	:	IRC Standards and MORTH Manual & circulars on National Highways.
Pavement Design	:	New Pavement
		- IRC 37 and AASHTO Design guide for design of flexible pavement
		- IRC 58 for Design of Rigid Pavement
Road Furniture & Road side Facilities	:	Related standards of IRC & MORTH publications

The basic data used for preliminary design of various components of the project road are indicated in *Table 6.1*.

Sl. No.	Project Component	Basic Data for Design	Out come
1	Bridges	<ul> <li>Design standards</li> <li>Inventory and condition survey of bridges</li> <li>Suitability of location for new bridges</li> <li>Hydrological and hydraulic study</li> </ul>	<ul> <li>Replacement of sub- standard bridges by new ones</li> <li>Location of New Bridge</li> <li>Span and Foundation</li> </ul>
		Geotechnical Investigations	
2	Road alignment and profile	<ul> <li>Geometric design standards</li> <li>Road Inventory and condition survey</li> <li>Type of area, rural or urban including available ROW and roadside developments</li> <li>Suitability of location for new bridges</li> </ul>	<ul> <li>Location of widening of carriageway</li> <li>Improvement to substandard alignment and sections with steep-gradient</li> <li>Realignments</li> </ul>

Table 6.1 Basic Data for Design

SI. No.	Project Component	Basic Data for Design	Out come
3	Pavement design new pavement and shoulders	<ul> <li>Traffic loading in terms of cumulative standard axles for design lane</li> <li>Soaked laboratory CBR of soil samples from prospective borrow areas</li> <li>Initial design life and stage development strategy</li> </ul>	Thickness and composition of various pavement courses
4	Design culverts	<ul> <li>Inventory and condition survey of culverts</li> </ul>	<ul> <li>Details of widening of existing culverts</li> <li>Replacement of sub- standard culverts by new ones</li> </ul>
5	Road furniture and safety measures	<ul> <li>Road inventory</li> <li>Alignment plans</li> <li>Locations of intersections</li> </ul>	<ul> <li>Identification of different types of signs on linear plans</li> <li>Identification of locations for installation of crash barriers and pedestrian guard rails</li> <li>Pavement marking details</li> </ul>
6	Roadside Drains	• Results from drainage study	• Location, type and size of roadside drains to be provided

## 6.2 ALIGNMENT PROPOSAL

To accommodate the requirement for 2 lane carriageway with earthen shoulders configuration of the project as per cross sectional requirements provided in Chapter5, the Consultant has optimized the various requirements and tried to accommodate the proposed bridge location along with approaches within the existing ROW. The available ROW varies from 30m to 70m along the project road. Geometric improvements / realignments for approaches have been proposed within available ROW. Except at few bridges, new bridges have been proposed at same locations of existing steel bridges. At few locations bridge locations has been shifted to improve the geometrics of the project road. Alignment has been proposed keeping in view of existing alignment deficiencies and available Right of Way and traffic diversion at the time of construction. Atfirst bridge near Indian/Myanmar border, Proposed Integrated Check Post at Moreh (Proposed Bypass for Moreh) along Indo-Myanmar Border by Ministry of External Affairs.

#### 6.3 CROSS SECTION OF BRIDGES AND BRIDGE APPROACH

The cross section adopted for Bridges are presented in *Table 6.2* 

Sl. No.	Particulars	CW (m)	Foot Path (m)	Crash Barrier (m)	Railing (m)	Raised Safety Kerb (m)	Total Width (m)
1	Two lane bridge with footpath in Plain and Rolling Terrain.	10.50	2x1.50	2x0.45	2x0.20	-	14.80
2	Two lane bridge without footpath in Plain and Rolling Terrain.	10.50	-	2x0.45	-	2x0.75	12.90
3	Two lane bridge without footpath in Hilly Terrain	7.50	-	2x0.45	-	2x0.80	10.0

### Table 6.2: Cross Section for Bridges

Proposed typical cross section details are provided in **Chapter 5** and detail of applicable cross sections are given in the *Table 6.3* 

Sl.	Bridge	Design Ch	ainage (m)	Length	TCS
No.	No.	From	То	( <b>m</b> )	105
1		70	95	25	TCS - 12
2		95	120	25	TCS - 8
3		120	130	10	TCS – 13a
4	1	130	210	80	Br. Section-1
5		210	215	5	TCS - 15
6		215	360	145	TCS - 1
7		360	480	120	TCS - 2
8		4635	4860	225	TCS - 1
9	2	4860	4900	40	Br. Section-2
10		4900	5045	145	TCS - 1
11		10655	10850	195	TCS - 1
12	3	10850	10910	60	Br. Section-2
13		10910	11065	155	TCS - 1
14		11800	11990	190	TCS - 1
15	4	11990	12010	20	Br. Section-2
16		12010	12200	190	TCS - 1
17	5	13410	13725	315	TCS - 1
18	5	13725	13755	30	Br. Section-2

Table 6.3: Details of Proposed applicable Cross Sections as per Design Chainage

Sl.	Bridge	Design Ch	ainage (m)	Length	TCS
No.	No.	From	То	(m)	105
19		13755	13940	185	TCS - 1
20		15470	15750	280	TCS - 1
21	6	15750	15770	20	Br. Section-2
22		15770	15945	175	TCS - 1
23		17880	18203	323	TCS - 1
24	7	18203	18278	75	Br. Section-2
25		18278	18530	253	TCS - 1
26		19350	19565	215	TCS - 1
27	8	19565	19585	20	Br. Section-2
28		19585	19790	205	TCS - 1
29		22270	22455	185	TCS - 1
30	9	22455	22485	30	Br. Section-2
31		22485	22670	185	TCS - 1
32		24870	24900	30	TCS - 1
33		24900	25120	220	TCS - 1A
34	10	25120	25140	20	Br. Section-2
35		25140	25280	140	TCS - 1A
36		25280	25370	90	TCS - 1
37		27140	27260	120	TCS - 1
38		27260	27320	60	Br. Section-2
39		27320	27715	395	TCS - 1
40		27715	27735	20	Br. Section-2
41	11 & 12	27735	27800	65	TCS - 1
42		27800	27830	30	TCS – 12
43		27830	27870	40	TCS - 2
44		27870	27965	95	TCS – 14a
45		27965	27980	15	TCS – 14b
46		30870	31010	140	TCS - 1
47	13	31010	31070	60	Br. Section-2
48		31070	31320	250	TCS - 1
49	14	34500	34585	85	TCS - 1

Sl.	Bridge	Design Ch	ainage (m)	Length	TCS
No.	No.	From	То	(m)	105
50		34585	34655	70	Br. Section-2
51		34655	34770	115	TCS - 1
52		36510	36720	210	36510
53		36720	36913	193	36720
54	15	36913	36948	35	36913
55		36948	37200	252	36948
56		37200	37280	80	37200
57		41800	42065	265	TCS - 1
58	16	42065	42085	20	Br. Section-2
59		42085	42300	215	TCS - 1
60		43190	43595	405	TCS - 1
61	17	43595	43665	70	Br. Section-2
62		43665	43960	295	TCS - 1
63		49170	49500	330	TCS - 1
64		49500	49520	20	Br. Section-2
65	18&19	49520	49800	280	TCS - 1
66		49800	49900	100	Br. Section-2
67		49900	50110	210	TCS - 1
68		53510	53835	325	TCS - 1
69		53835	53895	60	Br. Section-2
70	20&21	53895	54090	195	TCS - 1
71		54090	54210	120	Br. Section-2
72		54210	54420	210	TCS - 1
73		55340	55515	175	TCS - 1
74	22	55515	55605	90	Br. Section-2
75		55605	55770	165	TCS - 1
76		59840	60063	223	TCS - 1
77		60063	60088	25	Br. Section-2
78	23&24	60088	60263	175	TCS - 1
79		60263	60288	25	Br. Section-2
80		60288	60560	273	TCS - 1

Sl.	Bridge	Design Ch	ainage (m)	Length	TCS
No.	No.	From	То	(m)	105
81		63910	64120	210	TCS - 1
82	25	64120	64150	30	Br. Section-2
83		64150	64480	330	TCS – 1
84		66200	66395	195	TCS – 1
85	26	66395	66415	20	Br. Section-2
86		66415	66800	385	TCS – 1
87		68770	68985	215	TCS – 1
88	27	68985	69005	20	Br. Section-2
89		69005	69160	155	TCS – 1
90		71960	72190	230	TCS – 1
91	28	72190	72210	20	Br. Section-2
92		72210	72320	110	TCS - 1
93		74710	74888	178	TCS - 1
94		74888	74923	35	Br. Section-2
95	29&30	74923	75313	390	TCS - 1
96		75313	75338	25	Br. Section-2
97		75338	75530	193	TCS - 1
98		80920	81073	153	TCS - 1
99	31	81073	81098	25	Br. Section-2
100		81098	81450	353	TCS - 1
101		89830	89965	135	TCS - 1
102	32	89965	90015	50	Br. Section-2
103		90015	90300	285	TCS - 1
104		90755	90853	98	TCS - 1
105		90853	90888	35	Br. Section-2
106	33&34	90888	91205	318	TCS - 1
107		91205	91225	20	Br. Section-2
108		91225	91480	255	TCS - 1
109		92300	92495	195	TCS - 1
110	35&36	92495	92515	20	Br. Section-2
111		92515	92745	230	TCS - 1

Sl.	Bridge	Design Ch	ainage (m)	Length	TCS
No.	No.	From	То	(m)	
112		92745	92765	20	Br. Section-2
113		92765	92980	215	TCS - 1
114		94620	94820	200	TCS - 1
115	37	94820	94870	50	Br. Section-2
116		94870	95040	170	TCS - 1
117		95920	96153	233	TCS - 1
118		96153	96178	25	Br. Section-2
119	38&39	96178	96515	338	TCS - 1
120		96515	96535	20	Br. Section-2
121		96535	96760	225	TCS - 1
122		97220	97597	377	TCS - 1
123	40	97597	97622	25	Br. Section-2
124		97622	97810	188	TCS - 1
125		98630	98865	235	TCS - 1
126		98865	98895	30	Br. Section-2
127		98895	99195	300	TCS - 1
128	41,42 & 43	99195	99215	20	Br. Section-2
129		99215	99558	343	TCS - 1
130		99558	99593	35	Br. Section-2
131		99593	99740	148	TCS - 1
132		101255	101415	160	TCS - 1
133	44	101415	101435	20	Br. Section-2
134		101435	101660	225	TCS - 1
135		106040	106235	195	TCS - 1
136	45	106235	106285	50	Br. Section-2
137		106285	106420	135	TCS - 1
138		107010	107280	270	TCS - 1
139		107280	107300	20	Br. Section-2
140	46&47	107300	107335	35	TCS - 1
141		107335	107347	12	RCC Br. in approach
142		107347	107707	360	TCS - 1

Sl.	Bridge	Design Ch	ainage (m)	Length	TCS
No.	No.	From	То	(m)	
143		107707	107715	8	RCC Br. in approach
144		107715	107915	200	TCS - 1
145		107915	107945	30	Br. Section-2
146		107945	108110	165	TCS - 1
147		112050	112303	253	TCS - 1
148	48	112303	112338	35	Br. Section-2
149		112338	112500	163	TCS - 1
150		115800	116000	200	TCS - 1
151	49	116000	116020	20	Br. Section-2
152		116020	116200	180	TCS - 1
153		121690	121855	165	TCS - 3
154		121855	121888	33	TCS - 6
155		121888	121913	25	Br. Section-3
156		121913	121930	18	TCS - 6
157		121930	121955	25	TCS - 7
158		121955	122035	80	TCS - 3
159		122035	122100	65	TCS - 7
160		122100	122170	70	TCS - 3
161		122170	122188	18	TCS - 7
162		122188	122213	25	Br. Section-3
163	50,51&52	122213	122235	23	TCS - 7
164		122235	122250	15	TCS - 3
165		122250	122300	50	TCS - 11
166		122300	122320	20	TCS - 3
167		122320	122340	20	TCS - 7
168		122340	122373	33	TCS - 3
169		122373	122398	25	Br. Section-3
170		122398	122430	33	TCS – 13b
171		122430	122515	85	TCS - 3
172		122515	122540	25	TCS - 7
173		122540	122640	100	TCS - 3

Sl.	Bridge	Design Ch	ainage (m)	Length	TOO
No.	No.	From	То	(m)	TCS
174		126350	126728	378	TCS - 3
175		126728	126763	35	Br. Section-3
176	53,&54	126763	126965	203	TCS - 3
177	55,&54	126965	127015	50	Br. Section-3
178		127015	127120	105	TCS - 3
179		127120	127150	30	TCS - 4
180		133205	133230	25	TCS - 4
181		133230	133280	50	TCS - 3
182		133280	133305	25	TCS - 4
183		133305	133315	10	TCS - 3
184		133315	133330	15	TCS - 7
185		133330	133378	48	TCS - 3
186		133378	133403	25	Br. Section-3
187		133403	133430	28	TCS - 3
188		133430	133455	25	TCS - 4
189	56,&57	133455	133480	25	TCS - 3
190		133480	133498	18	TCS - 4
191		133498	133505	7	RCC Br. in approach
192		133505	133550	45	TCS - 3
193		133550	133570	20	TCS - 4
194		133570	133598	28	TCS - 3
195		133598	133623	25	Br. Section-3
196		133623	133650	28	TCS - 7
197		133650	133800	150	TCS - 3
198		134118	134420	302	TCS - 4
199		134420	134448	28	TCS - 3
200	- 58	134448	134473	25	Br. Section-3
201		134473	134480	8	TCS - 3
202		134480	134535	55	TCS - 4
203		134535	134600	65	TCS - 3
204	59	136270	136345	75	TCS - 4

Sl.	Bridge	Design Ch	ainage (m)	Length	TOG
No.	No.	From	То	(m)	TCS
205		136345	136420	75	TCS - 3
206		136420	136448	28	TCS – 13b
207		136448	136473	25	Br. Section-3
208		136473	136640	168	TCS - 3
209		137830	137845	15	TCS - 4
210		137845	137905	60	TCS - 3
211		137905	137975	70	TCS - 4
212		137975	138005	30	TCS - 10
213		138005	138040	35	TCS - 4
214		138040	138070	30	TCS - 3
215		138070	138100	30	TCS - 7
216		138100	138120	20	Br. Section-3
217	60&61	138120	138190	70	TCS - 3
218	00&01	138190	138240	50	TCS - 4
219		138240	138285	45	TCS - 3
220		138285	138320	35	TCS - 7
221		138320	138340	20	TCS - 3
222		138340	138515	175	TCS - 4
223		138515	138535	20	Br. Section-3
224		138535	138555	20	TCS - 7
225		138555	138585	30	TCS - 3
226		138585	138645	60	TCS - 4
227		139230	139280	50	TCS - 3
228		139280	139360	80	TCS - 4
229	62	139360	139370	10	TCS - 3
230		139370	139390	20	Br. Section-3
231		139390	139450	60	TCS - 3
232	63	140110	140180	70	TCS - 4
233		140180	140190	10	TCS - 3
234		140190	140228	38	TCS – 13b
235		140228	140253	25	Br. Section-3
236		140253	140270	18	TCS - 7

Sl.	Bridge	Design Ch	ainage (m)	Length	TCS
No.	No.	From	То	(m)	105
237		140270	140295	25	TCS – 13b
238		140295	140480	185	TCS - 4
239		141240	141305	65	TCS - 4
240		141305	141345	40	TCS - 5
241		141345	141355	10	TCS - 4
242	64	141355	141378	23	TCS - 3
243	04	141378	141403	25	Br. Section-3
244		141403	141480	78	TCS - 7
245		141480	141600	120	TCS - 9
246		141600	141620	20	TCS - 4
247		142700	142735	35	TCS - 4
248		142735	142810	75	TCS - 3
249	65	142810	142830	20	Br. Section-3
250		142830	142860	30	TCS - 3
251		142860	142905	45	TCS - 4
252		145140	145190	50	TCS - 4
253		145190	145308	118	TCS - 3
254		145308	145333	25	Br. Section-3
255	67	145333	145350	18	TCS - 7
256	07	145350	145385	35	TCS - 3
257		145385	145425	40	TCS - 4
258		145425	145490	65	TCS - 3
259		145490	145595	105	TCS - 4
260		146175	146235	60	TCS - 4
261		146235	146245	10	TCS - 10
262		146245	146250	5	TCS - 4
263		146250	146280	30	TCS - 3
264	68&69	146280	146330	50	TCS - 7
265		146330	146350	20	Br. Section-3
266		146350	146370	20	TCS - 3
267		146370	146410	40	TCS - 4
268		146410	146500	90	TCS - 10

Sl.	Bridge	Design Ch	ainage (m)	Length	TCS
No.	No.	From	То	(m)	105
269		146500	146535	35	TCS - 4
270		146535	146580	45	TCS - 3
271		146580	146600	20	Br. Section-3
272		146600	146660	60	TCS - 3
273		146660	146740	80	TCS - 4
274		146740	146760	20	TCS - 3
275		147360	147380	20	TCS - 4
276		147380	147410	30	TCS - 10
277		147410	147450	40	TCS - 3
278		147450	147478	28	TCS - 7
279		147478	147503	25	Br. Section-3
280		147503	147520	18	TCS - 3
281		147520	147640	120	TCS - 4
282		147640	147700	60	TCS - 5
283	70&71	147700	147790	90	TCS - 4
284		147790	147860	70	TCS - 7
285		147860	147880	20	TCS - 4
286		147880	147900	20	TCS - 3
287		147900	147928	28	TCS - 7
288		147928	147953	25	Br. Section-3
289	1	147953	148000	48	TCS - 7
290	1	148000	148075	75	TCS - 10
291		148075	148085	10	TCS - 4

# 6.4 STRUCTURE DESIGN

## 6.4.1 Structure Proposal

Out of 71 existing steel bridges two minor bridges are under construction. Remaining 69 steel bridges which are structurally distressed will be reconstructed. All existing RCC bridges (falling on steel bridge approaches) which are sound in condition but narrower than 7.50 m wide carriageway will be widened and remaining RCC bridges which are in sound condition with 7.50m wide carriageway will be retained.

All steel bridge will be replaced with new Bridges as per circular {Width of bridges on 2 lane National Highways (with or without footpath)} of "Ministry of Road Transport and Highway".

The total width of deck is 12.90m with clear carriageway width of 10.50m, crash barrier of 0.45m and raised kerb of 0.75m on each side in bridge for bridges in plain / rolling terrain . The total width of deck is 10.00m with clear carriageway width of 7.50m, crash barrier of 0.45m and 0.80m raised safety kerb on each side in bridge for bridges in hilly section.

For Bridge no. 1, total width of deck is 14.80m with clear carriageway width of 10.50m, crash barrier of 0.45m railing of 0.20m and footpath of 1.50m on each side in bridge.

Based on geotechnical, simplicity of construction and execution, it is proposed to provide PCC/PSC Girders Superstructures with open/pile foundations. Depends on the waterway discharge and existing ground longitudinal profile the number of spans and span lengths has been decided, these structures briefly detailed as listed below:

### 6.4.2 PSC Girder Superstructures

The PSC Girders are designed as pre cast construction since these are proposed in sites where the construction is possible to do pre cast PSC Girders with deck slab.

### 6.4.3 RC Girder Superstructures

The RC Girders are designed as pre cast construction since these are proposed in sites where the construction is possible to do pre cast PSC Girders with deck slab.

### 6.4.4 RC Substructures

Rectangular type abutment shaft to a width of 14.80m, 12.90m and 10.00m is proposed to cater the soil pressure and retain excess soil slopes to fall in river/stream waterway. The seismic arrestors are designed at abutment cap locations since the area is under high seismic influence as per the seismic map of Myanmar.

### 6.4.5 Foundation

Open foundation and pile foundation is proposed based on soil strata and foundation is adequately protected against scour by providing rigid floor, flexible apron and curtain wall at both upstream and downstream sides of the bridge.

### 6.4.6 RC Crash Barriers

Crash Barriers have been proposed as per Indian Road Congress Standards (IRC:5-1998).

### 6.4.7 Expansion Joints

Strip seal type expansion joints are proposed for all the structures.

#### 6.4.8 Wearing Coat

Asphaltic concrete wearing coat, 65 mm thick comprising of 50 mm thick bituminous concrete laid in 2 layers of 25 mm thickness each / over under layer of 15mm thick mastic asphalt as per MoRTH Standards has been proposed since the proposed bridges fall in high rainfall area.

### 6.4.9 Drainage Spouts

Drainage spouts have been proposed in accordance with MoRTH standards.

### 6.4.10 Approach Slab

Reinforced concrete approach slabs 3.5 m long and 300 mm thick in M30 grade concrete at either end of the bridge has been proposed with one end supported on reinforced concrete bracket projecting out from dirt wall and the other end resting over the soil in accordance with the guidelines issued by MoRTH India. A leveling course in M15 grade concrete has been provided under the approach slab.

### 6.4.11 Concrete grades

The grades of concrete for different bridge components are as follows.

Retaining Wall	-	M35
Deck Slab	-	M45
Pile and Pile cap	-	M35
Substructure	-	M35
Super structure of RCC Bridges	-	M45
Super structure of PSC Bridges	-	M45

### 6.4.12 Reinforcement

Thermo Mechanically Treated Bars (TMT) conforming to IS: 1786 shall be used for reinforcement of super-structure, sub-structure and foundations. The minimum lap length of reinforcement bars shall be kept as 63 times the diameter of bar and not more than 50% of the bars shall be lapped at one location.

## 6.4.13 Bearings

Type of bearings to be adopted depends upon the length of the span, loads, forces, movement and seismic zone in which the project road falls. Since the proposed bridges fall in high seismic hazardous zone, Elastomeric type bearings with longitudinal and transverse seismic arrestors are proposed.

### 6.4.14 Protection Works

There is the requirement of protection to provide adequate protection work against scour. The floor protection work comprises of rigid flooring with curtain wall and flexible apron so as to check scour, washing away or disturbance by pumping action etc. The arrangement of floor protection work shall be as follows:

### Rigid Flooring

The rigid flooring shall be provided under the bridge and it shall extend for a distance of at least 3m on u/s side and 5m on d/s side of the bridge. In case of splayed wing wall the flooring shall extend up to the line connecting the end of wing wall on either side of the bridge.

## Curtain Wall

The rigid flooring shall be enclosed by curtain walls.

### Flexible Apron

Flexible apron, 1m thick comprising of loose stone boulders shall be provided beyond the curtain wall.

Break-up of structures according to length of structures is as under in Table 6.4

S. No.	Tamu - Kyigone –	No. of M	ajor Bridges	No. of Min	Tatal	
S. No.	Kalewa Section	Retained/ Widen	Reconstruct ed	Retained/ Widen	Reconstruc ted	Total
1	Existing Steel Bridges		7		64	71
2	Existing RCC bridges falling on approaches of steel bridges			2	1	3

Table 6.4: Details of Bridges

## 6.4.15 Proposed Major Bridges

There are 7 major bridges along the project length, the type of structure, location and span details are listed in *Table 6.5*.

				Type of S	tructure		Span	Length	Total	
Sl.	Design	Existing	Super	Sub st	ructure		arrange-	of	Width of	
No.	Chainage	Str. No.	structure	Abut- ment	Pier	Foundation	ment	Bridge (m)	Structure (m)	
			Precast PSC I	RCC	RCC	Pile	25+30+			
1	0.170	1/1	Girder+ Deck	Wall	Circular	Foundation	25+30+	80	14.80	
			Slab	type	type	Foundation	23			
			Precast PSC I	RCC	RCC	Open				
2	18.240	12/1	Girder+ Deck	Wall	Circular	Foundation	3x25	75	12.90	
			Slab	type	type	Foundation				
			Precast PSC I	RCC	RCC	Open	20+30+			
3	34.620	22/1	Girder+ Deck	Wall	Circular	Foundation 20		70	12.90	
			Slab	type	type		20			
			Precast PSC I	RCC	RCC	Pile	20+30+			
4	43.630	28/1	Girder+ Deck	Wall	Circular	_	Foundation	20+30+	70	12.90
			Slab	type	type	roundation	20			
			Precast PSC I	RCC	RCC	Pile				
5	49.850	32/2	Girder+ Deck	Wall	Circular	Foundation	4x25	100	12.90	
			Slab	type	type	Foundation				
			Precast PSC I	RCC	RCC	Pile				
6	54.150	34/2	Girder+ Deck	Wall	Circular	Foundation	4x30	120	12.90	
			Slab	type	type	roundation				
			Precast PSC I	RCC	RCC	Pile				
7	55.560	35/1	Girder+ Deck	Wall	Circular	Foundation	3x30	90	12.90	
			Slab	type	type	1 Junuarion				

Table 6.5: Details of Major Bridges

## 6.4.16 Proposed Minor Bridges

There are 62 minor bridges along the project length. The type of structure, location and span details are listed in *Table 6.6*.

			r	Гуре of	Structure		n	Length	Total
Sl.	Design	Existing	G	Sub s	tructure		Span	of	Width of
No.	(CH)	Str. No.	Super structure	Abut-	Pier	Foundation	arrange- ment	Bridge	Structure
				ment				(m)	( <b>m</b> )
			Precast PSC I	RCC	RCC	Open			
1	4.880	4/1	Girder+ Deck	Wall	Circular	Foundation	2x20	40	12.90
			Slab	type	type	1 0 0 11 0 0 11 0 11			
			Precast PSC	RCC	RCC	Pile			
2	10.880	7/1	I Girder+	Wall	Circular	Foundation	2x30	60	12.90
			Deck Slab	type	type	roundation			
			Precast PSC	RCC		Open			
3	12.000	8/1	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		Toundation			
			Precast PSC	RCC		Open			
4	13.740	9/1	I Girder+	Wall	-	Foundation	1x30	30	12.90
			Deck Slab	type		Toundation			
			Precast PSC	RCC		Open			
5	15.760	10/2	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		Toundation			
			Precast PSC	RCC		Open			
6	19.575	13/2	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		Toundation			
			Precast PSC	RCC		Open			
7	22.470	15/1	I Girder+	Wall	-	Foundation	1x30	30	12.90
			Deck Slab	type		Toundation			
			Precast PSC	RCC		Open			
8	25.130	16/2	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		Toundation			
			Precast PSC	RCC	RCC	Open			
9	27.290	18/1	I Girder+	Wall	Circular	Foundation	2x30	60	12.90
			Deck Slab	type	type	Toulidation			
			Precast PSC	RCC		Open			
10	27.725	18/2	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		Toundation			
			Precast PSC	RCC	RCC	Open			
11	31.040	20/2	I Girder+	Wall	Circular	Foundation	2x30	60	12.90
			Deck Slab	type	type	roundation			
			Precast	RCC	RCC				
12	12 36.930	24/1	RCC I	Wall	Circular	Open	$2 \times 17.5$	35	12.90
12	50.950	24/1	Girder+			Foundation	2x17.5	35	12.90
			Deck Slab	type	type				
			Precast PSC	RCC		Open			
13	42.075	27/1	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		roundation			

## Table 6.6: Details of Minor Bridges

	Design (CH)	Existing			Structure				
	0			Sub ef	tructure		Span	Length of	Total Width of
		Str. No.	Super	Abut-		Foundation	arrange-	Bridge	Structure
	(- )		structure	ment	Pier	1 oundation	ment	( <b>m</b> )	( <b>m</b> )
			Precast PSC	RCC					
14 4	49.510	32/1	I Girder+	Wall	-	Open	1x20	20	12.90
11	17.510	52/1	Deck Slab	type		Foundation	1//20	20	12.70
			Precast PSC	RCC	RCC	_			
15 5	53.850	34/1	I Girder+	Wall	Circular	Open	2x30	60	12.90
			Deck Slab	type	type	Foundation			
			Precast PSC	RCC	J1	0			
16 6	60.075	38/1	I Girder+	Wall	-	Open	1x25	25	12.90
			Deck Slab	type		Foundation			
			Precast PSC	RCC		0			
17 6	60.275	38/2	I Girder+	Wall	-	Open Foundation	1x25	25	12.90
			Deck Slab	type		Foundation			
			Precast PSC	RCC		Orer			
18 6	64.135	41/1	I Girder+	Wall	-	Open Foundation	1x30	30	12.90
			Deck Slab	type		Foundation			
			Precast PSC	RCC		Open			
19 6	66.405	42/1	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		Foundation			
			Precast PSC	RCC		Open			
20 6	68.995	44/1	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		Toundation			
			Precast PSC	RCC		Open			
21 7	72.200	46/1	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type		Toundation			
			Precast	RCC	RCC				
22 7	74.905	47/3	RCC I	Wall	Circular	Open	2x17.5	35	12.90
	/ 11/00	.,,e	Girder+	type	type	Foundation			12.00
			Deck Slab		-7 F -				
	75.005	40/1	Precast PSC	RCC		Open	1 05	25	12.00
23 7	75.325	48/1	I Girder+	Wall	-	Foundation	1x25	25	12.90
			Deck Slab	type					
	01.007	<b>~ 1</b> / 1	Precast PSC	RCC		Open	1 05	25	12.00
24 8	81.085	51/1	I Girder+	Wall	-	Foundation	1x25	25	12.90
			Deck Slab	type	DCC				
25 8	89.990	57/1	Precast PSC	RCC	RCC	Open	225	50	12.90
25 8	89.990	57/1	I Girder+	Wall	Circular	Foundation	2x25	50	12.90
			Deck Slab	type	type				
			Precast RCC I	RCC	RCC	Onon			
26 9	90.870	57/2	Girder+	Wall	Circular	Open Foundation	2x17.5	35	12.90
			Deck Slab	type	type	Foundation			
			Precast PSC	RCC					
27 9	91.215	57/3	I Girder+	Wall	_	Open	1x20	20	12.90
	1.213	5115	Deck Slab	type	_	Foundation	1720	20	12.70
			Precast PSC	RCC					
28 9	92.505 58/1 I Girder+ Wall	_	Open	1x20	20	12.90			
20 2	12.505	J 0/ 1	Deck Slab	type	_	Foundation	1720	20	12.70
			Precast PSC	RCC		Open			
29 9	92.755	58/2	I Girder+	Wall	-	Foundation	1x20	20	12.90

			,	Type of	Structure			Length	Total
SI.	Design	Existing			tructure		Span	of	Width of
No.	(CH)	Str. No.	Super	Abut-		Foundation	arrange-	Bridge	Structure
			structure	ment	Pier	1 oundation	ment	(m)	( <b>m</b> )
			Deck Slab	type					
• •			Precast PSC	RCC	RCC	Open			
30	94.845	60/1	I Girder+	Wall	Circular	Foundation	2x25	50	12.90
			Deck Slab	type	type				
31	96.165	61/1	Precast PSC I Girder+	RCC Wall		Open	1x25	25	12.90
51	90.105	01/1	Deck Slab	type	-	Foundation	1777	23	12.90
			Precast PSC	RCC					
32	96.525	61/2	I Girder+	Wall	_	Open	1x20	20	12.90
	/		Deck Slab	type		Foundation			
			Precast PSC	RCC		0			
33	97.610	61/3	I Girder+	Wall	-	Open Foundation	1x25	25	12.90
			Deck Slab	type		Foundation			
			Precast PSC	RCC		Open			
34	98.880	62/1	I Girder+	Wall	-	Foundation	1x30	30	12.90
-			Deck Slab	type		1 0 0 11 0 0 11 0 11			
25	00.005	(0)	Precast PSC	RCC		Open	1 00	20	12.00
35	99.205	62/2	I Girder+ Deck Slab	Wall	-	Foundation	1x20	20	12.90
			Precast	type					
			RCC I	RCC	RCC	Open			
36	99.575	63/1	Girder+	Wall	Circular	Foundation	2x17.5	35	12.90
			Deck Slab	type	type	1 0 0 11 0 0 11 0 11			
-			Precast PSC	RCC		Oman			
37	101.425	64/1	I Girder+	Wall	-	Open Foundation	1x20	20	12.90
			Deck Slab	type		Foundation			
			Precast PSC	RCC	RCC	Open			
38	106.260	67/1	I Girder+	Wall	Circular	Foundation	2x25	50	12.90
-			Deck Slab	type	type				
39	107.290	68/1	Precast PSC I Girder+	RCC Wall		Open	1x20	20	12.90
39	107.290	00/1	Deck Slab	type	-	Foundation	1X20	20	12.90
			Precast PSC	RCC					
40	107.930	68/2	I Girder+	Wall	_	Open	1x30	30	12.90
			Deck Slab	type		Foundation			
			Precast		RCC				
41	112.320	71/1	RCC I	RCC Wall	Circular	Open	2x17.5	35	12.90
41	112.320	/ 1/ 1	Girder+	type	type	Foundation	2817.5	55	12.90
			Deck Slab		type				
10	110010	<b>50/1</b>	Precast PSC	RCC		Open	1.00	20	12.00
42	116.010	73/1	I Girder+	Wall	-	Foundation	1x20	20	12.90
			Deck Slab	type PCC					
43	121.900	77/1	Precast PSC I Girder+	RCC Wall		Open	1x25	25	10.00
	121.900	///1	Deck Slab	type	_	Foundation	1723	23	10.00
			Precast PSC	RCC		6			
44	122.200	77/2	I Girder+	Wall	-	Open Foundation	1x25	25	10.00
			Deck Slab	type		Foundation			

			,	Type of :	Structure			Length	Total
Sl.	Design	Existing					Span	of	Width of
No.	(CH)	Str. No.	Super		tructure	Foundation	arrange-	Bridge	Structure
110.	(СП)	50.100	structure	Abut- ment	Pier	roundation	ment	(m)	(m)
			Precast PSC	RCC					
45	122.385	77/3	I Girder+	Wall	_	Open	1x25	25	10.00
	1221000	1110	Deck Slab	type		Foundation			10100
			Precast		Daa				
10	106 745	00/1	RCC I	RCC	RCC	Open	0 17 5	25	10.00
46	126.745	80/1	Girder+	Wall	Circular	Foundation	2x17.5	35	10.00
			Deck Slab	type	type				
			Precast PSC	RCC	RCC	Open			
47	126.990	80/2	I Girder+	Wall	Circular	Foundation	2x25	50	10.00
			Deck Slab	type	type	Foundation			
			Precast PSC	RCC		Open			
48	133.390	83/2	I Girder+	Wall	-	Foundation	1x25	25	10.00
			Deck Slab	type		Toundation			
			Precast PSC	RCC		Open			
49	133.610	84/1	I Girder+	Wall	-	Foundation	1x25	25	10.00
			Deck Slab	type					
	10110	0.7.11	Precast PSC	RCC		Open			10.00
50	134.460	85/1	I Girder+	Wall	-	Foundation	1x25	25	10.00
			Deck Slab	type					
<b>C</b> 1	126.460	0.6/1	Precast PSC	RCC		Open	1.05	25	10.00
51	136.460	86/1	I Girder+	Wall	-	Foundation	1x25	25	10.00
			Deck Slab Precast PSC	type RCC					
52	138.110	86/2	I Girder+	Wall		Open	1x20	20	10.00
52	136.110	00/2	Deck Slab		-	Foundation	1820	20	10.00
			Precast PSC	type RCC					
53	138.525	87/1	I Girder+	Wall	_	Open	1x20	20	10.00
55	130.323	07/1	Deck Slab	type	_	Foundation	1720	20	10.00
			Precast PSC	RCC		_			
54	139.380	87/2	I Girder+	Wall	-	Open	1x20	20	10.00
_			Deck Slab	type		Foundation			
			Precast PSC	RCC		0			
55	140.240	88/1	I Girder+	Wall	-	Open	1x25	25	10.00
			Deck Slab	type		Foundation			
			Precast PSC	RCC		Orean			
56	141.390	88/2	I Girder+	Wall	-	Open Foundation	1x25	25	10.00
			Deck Slab	type		Foundation			
			Precast PSC	RCC		Open			
57	142.820	89/1	I Girder+	Wall	-	Foundation	1x20	20	10.00
			Deck Slab	type		Toundation			
			Precast PSC	RCC	RCC	Open			
58	145.320	90/1	I Girder+	Wall	Circular	Foundation	1x25	25	10.00
			Deck Slab	type	type	- canaation			
			Precast PSC	RCC	RCC	Open			10.0-
59	146.340	91/1	I Girder+	Wall	Circular	Foundation	1x20	20	10.00
			Deck Slab	type	type				
~	146 500	01/2	Precast PSC	RCC	RCC	Open	1 00	20	10.00
60	146.590	91/3	I Girder+	Wall	Circular	Foundation	1x20	20	10.00
			Deck Slab	type	type				

			r	Structure	Snan	Length	Total		
Sl.	Design	Existing	Super	Sub st	ructure		Span arrange-	of Bridge (m)	Width of
No.	(CH)	Str. No.	structure	Abut- ment	Pier	Foundation	ment		Structure (m)
61	147.490	92/1	Precast PSC I Girder+ Deck Slab	RCC Wall type	RCC Circular type	Open Foundation	1x25	25	10.00
62	147.940	92/2	Precast PSC I Girder+ Deck Slab	RCC Wall type	RCC Circular type	Open Foundation	1x25	25	10.00

# 6.4.17 Details of Minor Bridges in Approaches

The existing RCC Bridge at Ch.107.341 falling in the approach is proposed for reconstruction. The type of structure, location and span details are listed in *Table 6.7*.

Sl. l No.		Existing Str. No.	<b>Type of Structure</b>				Span	Length	Total
	Design		Super	Sub structure			arrange- ment	of Bridge	Width of
	(CH)		structure Abut-	Pier	Foundation	Structure			
			501 40041 0	ment	1 101			( <b>m</b> )	( <b>m</b> )
			RCC I	RCC		Onan			
1	107.341	68/1	Girder +	Wall	-	Open Foundation	1x12.0	12	12.90
			Deck Slab	type		roundation			

Existing RCC bridges at Ch. 107.711 and Ch. 133.502 are proposed to retain. The type of structure, location and span details are listed in *Table 6.8* 

Table	<i>6.8</i> :	Details	of	Retained	Minor	Bridges
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	Design	Existin g Str.		Type of Stu	Span	Length	Total			
Sl.			Super	Sub struc	Sub structure		arrange	of	Width of	
No.	(CH)	No.	structure	Abut-	Pier	Foundation	-ment	Bridge (m)	Structure (m)	
				ment	1 101			(III)	( <b>m</b> )	
1	107.711	68/2	Slab	RCC Wall	-	Open	1x7.40	7.4	8.10	
				type		Foundation				
2	133.502	83/4	RCC Slab	RCC Wall type	-	Open Foundation	1x6.30	6.6	12.00	

# 6.4.18 Detail of Bridges under Construction

The following two minor bridges are under construction and the details are shown in Table 6.9

Sl.No.	DesignExisting(Chainage)Structure No.		Remarks
1	143.270	89/2	Under Construction
2	131.520	82/1	Under Construction

Table 6.9: Detail of Under Construction Bridges

### 6.4.19 Culverts

There are total 59 numbers of culverts consisting of 44 Slab, 6 Arch and 9 Hume Pipe culverts. The condition of most of these CD structures is fair to good. Location and Proposal details of Culvert are listed in *Table 6.10*, *Table 6.11* and *Table 6.12* 

SL. No.	Chainage	Type of culvert	Proposed	Proposed Span	Type of culvert
1	17.892	Pipe	Retain	1x1.2	Pipe
2	43.778	Pipe	Widen	1x1.2	Pipe
3	68.800	Pipe	Widen	1x1.0	Pipe
4	122.097	Pipe	Widen	1x1.0	Pipe
5	136.326	Pipe	Reconstruction	1x1.2	Pipe
6	136.627	Pipe	Reconstruction	1x1.2	Pipe
7	145.250	Pipe	Reconstruction	1x1.2	Pipe
8	145.378	Pipe	Reconstruction	3x1.2	Pipe
9	147.667	Pipe	Reconstruction	1x1.2	Pipe

 Table 6.10: Details of HP Culvert

## Table 6.11: Details of Arch Culvert

SI. No.	Chainage	Type of culvert	Proposed	Proposed Span	Type of culvert
1	92.375	Arch	Retain	1x1.0	Arch
2	98.707	Arch	Widen	1x4.0	Slab
3	99.269	Arch	Reconstruction	1x2.0x2.0	Box
4	106.404	Arch	Retain	2x1.0	Arch
5	107.568	Arch	Widen	1x2.0	Slab
6	107.798	Arch	Reconstruction	1x1.5x1.5	Box

 Table 6.12: Details of Slab Culvert

SI. No.	Chainage	Type of culvert	Proposed	Proposed Span	Type of culvert
1	0.075 (Left)	Slab	Abandoned	1x2.5x2.5	
2	0.075 (Right)	Slab	Abandoned	1x2.5x2.5	
3	4.645	Slab	Retain	1x1.1	Retain
4	13.51	Slab	Widen	1x3.0	Slab
5	13.909	Slab	Widen	1x4.0	Slab
6	22.615	Slab	Widen	1x4.0	Slab
7	34.71	Slab	Widen	1x5.8	Slab
8	34.77	Slab	Retain	1x2.0	Slab
9	36.574	Slab	Widen	1x3.2	Slab
10	37.1	Slab	Reconstruction	1x6.0	Slab
11	64.35	Slab	Retain	1x1.8	Slab

SI. No.	Chainage	Type of culvert	Proposed	Proposed Span	Type of culvert
12	66.638	Slab	Widen	1x2.0	Slab
13	72.311	Slab	Retain	1x2.0	Slab
14	74.834	Slab	Reconstruction	1x1.5x1.5	Box
15	75.051	Slab	Widen	1x1.0	Slab
16	75.122	Slab	Widen	1x1.0	Slab
17	90.15	Slab	Widen	1x1.0	Slab
18	90.257	Slab	Widen	1x2.0	Slab
19	91.358	Slab	Widen	1x6.0	Slab
20	91.386	Slab	Widen	1x3.2	Slab
21	92.918	Slab	Widen	1x1.0	Slab
22	96.6	Slab	Reconstruction	1x1.5x1.5	Box
23	112.119	Slab	Retain	1x1.2	Slab
24	122.532	Slab	Reconstruction	1x1.5x1.5	Box
25	122.633	Slab	Widen	1x1.3	Slab
26	126.526	Slab	Reconstruction	1x1.5x1.5	Box
27	126.6	Slab	Reconstruction	1x1.5x1.5	Box
28	133.208	Slab	Retain	1x2.0	Slab
29	133.237	Slab	Widen	1x1.0	Slab
30	133.549	Slab	Widen	1x1.0	Slab
31	133.693	Slab	Reconstruction	1x1.5x1.5	Box
32	134.168	Slab	Widen	1x1.6	Slab
33	134.268	Slab	Widen	1x1.0	Slab
34	134.363	Slab	Widen	1x1.0	Slab
35	138.165	Slab	Widen	1x3.1	Slab
36	138.302	Slab	Widen	1x1.0	Slab
37	138.397	Slab	Widen	1x1.7	Slab
38	139.244	Slab	Widen	1x2.0	Slab
39	141.558	Slab	Widen	1x1.0	Slab
40	145.452	Slab	Widen	1x1.0	Slab
41	145.568	Slab	Widen	1x1.1	Slab
42	146.219	Slab	Widen	1x1.0	Slab
43	146.503	Slab	Widen	1x1.0	Slab
44	147.595	Slab	Widen	1x2.3	Slab

## 6.4.20 New Culvert

Details of New Proposal of Box culverts are listed in *Table 6.13* 

SL. No.	Chainage	Type of culvert	Proposed	Proposed Span
1	0.075 (Left)	Slab	New Box	1x2.5x2.5
2	0.075 (Right)	Slab	New Box	1x2.5x2.5

 Table 6.13: Details of New Culvert

## 6.5 GEOMETRIC DESIGN

Geometric design involves the design of the visible elements such as horizontal alignment, vertical alignment and the cross-section of the project road. The design is governed by the design speed fixed up taking into account site conditions including the terrain in which the project road traverses.

The project road traverses through plain/rolling and hilly terrain and a design speed of 100/80 kmph &50/40kmph has been provided. However the minimum values have been applied only where serious restrictions are placed by technical or economic considerations. At few locations design speed has been reduced due to unavoidable circumstances. General effort has been made to exceed the design speed on safer side.

The entire geometric design has been based on the ground modelling by highway design software MOSS/MX Road.

### 6.5.1 Horizontal Alignment

The proposed design of all curves has been made as per the desired design standards and specifications given in *Chapter-5*. Except at few locations, generally project road has been designed for a speed of 100/80 kmph in Plain/ Rolling area and 50/40kmph in hilly areas. The super elevation and the length of transition curves have been finalized with maximum super-elevation of 7%. No hair pin bends have been proposed. Details of horizontal alignment curve details are provided in *Table 6.14* 

### 6.5.2 Vertical Alignment / Gradient

Generally the project road has been designed for ruling gradient. However, the "limiting gradients" have been adopted 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 has been kept as short as possible. Details of vertical alignment curve details are provided in *Table 6.15* 

HIP Northing V Ls Ts Lc Side of **R** (m) **D** (°) e (%) Chainage Easting (X) Sl. No. Es (m) **(Y)** (km/h)Curve (m) (**m**) (m) (m) Bridge No. - 1 57.015 631911.889 2681286.702 25.869 15 39.67 48.21 3.717 5.08 LHS 140 40 1 2 359.246 631884.382 2680985.092 800 80 7.172 30 65.13 70.13 1.619 3.56 LHS Bridge No. - 2 632172.515 2676771.190 2000 100 111.97 0.784 LHS 4642.695 3.208 56.00 1 -\_ 2 170 50 25.221 40 4795.767 632164.388 58.11 34.83 4.602 6.54 RHS 2676617.624 Bridge No. - 4 630443.601 137.73 11900.047 2669808.675 2000 100 3.946 68.89 1.186 LHS 1 --2 12066.222 630414.313 2669645.064 2.735 47.74 95.45 2000 100 0.570 RHS --Bridge No. - 5 13417.751 630085.225 2668339.329 5000 100 0.517 22.58 45.15 0.051 RHS -\_ 2 13829.392 629963.679 2667946.041 5000 100 0.597 26.05 52.10 0.068 RHS --Bridge No. - 6 15804.622 629692.550 2665996.174 2000 100 1.140 19.90 39.80 0.099 RHS -\_ Bridge No. - 7 17918.830 629564.128 2663894.751 1200 80 4.304 45.09 90.14 0.847 LHS 1 -\_ 100 50 57.426 30.23 RHS 18115.099 629567.633 2663692.852 70 90.75 16.346 7.00 2 3 18372.433 629343.912 2663544.391 150 50 52.546 45 96.81 92.56 17.905 7.00 LHS Bridge No. - 9 22408.946 627531.665 2660097.416 1200 50 3.405 35.67 71.31 0.530 RHS 1 --35 2 627513.960 2659930.572 50 34.048 78.81 83.85 9.437 5.56 22574.831 200 RHS Bridge No. - 10 24975.644 625977.388 2658092.418 600 12.983 35 85.78 100.96 3.962 RHS 80 4.74 1 2 625754.620 2657922.529 600 80 13.352 35 87.74 104.82 4.187 4.74 LHS 25255.172

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Sl. No.	HIP Chainage (m)	Easting (X)	Northing (Y)	<b>R</b> (m)	V (km/h)	<b>D</b> (°)	Ls (m)	Ts (m)	Lc (m)	Es (m)	e (%)	Side of Curve
Bridge I	No 12											
1	27657.419	624518.356	2655890.255	1200	80	4.029	-	42.21	84.39	0.742	-	LHS
2	27871.119	624411.957	2655704.613	1500	80	9.136	-	119.84	239.17	4.779	-	LHS
Bridge I	No 13											
1	30956.254	622990.469	2653164.511	300	50	11.726	25	43.31	36.40	1.668	3.70	LHS
2	31216.124	623042.709	2652898.316	80	40	77.562	55	92.94	53.30	24.650	7.00	RHS
Bridge I	No 15											
1	36645.660	621695.160	2647856.840	400	80	23.596	55	111.11	109.73	8.959	7.00	LHS
2	36845.679	621770.492	2647670.132	600	80	7.791	35	58.36	46.59	1.480	4.74	RHS
3	37123.668	621846.057	2647371.105	135	50	90.419	55	164.39	158.04	57.940	7.00	RHS
Bridge I	No 16											
1	42136.315	619838.300	2643128.212	5000	80	0.827	-	36.06	72.12	0.130	-	LHS
Bridge I	No17											
1	43393.356	619725.003	2641948.638	150	50	48.196	45	89.83	81.18	14.934	7.00	RHS
2	43808.175	619599.531	2641545.952	150	50	41.614	45	79.70	63.94	11.064	7.00	RHS
Bridge I	No18 & 19											
1	49417.202	617066.032	2636687.353	600	80	8.026	35	59.60	49.05	1.565	4.74	LHS
2	49644.158	616968.105	2636482.518	1200	80	3.257	-	34.11	68.21	0.485	-	LHS
3	50058.478	616810.919	2636099.162	5000	100	0.700	-	30.52	61.05	0.093	-	RHS
Bridge I	No20 &21											
1	53810.376	616831.078	2632400.693	125	50	52.427	55	89.50	59.38	15.455	7.00	RHS
2	54285.477	616452.776	2632102.640	200	65	32.071	60	87.68	51.95	8.877	7.00	LHS
Bridge I	No22											
1	55683.708	616555.164	2630741.160	320	65	15.442	40	63.41	46.24	3.140	5.87	LHS
Bridge I	No23 & 24											
1	59957.737	617729.202	2626725.733	125	50	55.582	55	93.87	66.26	17.440	7.00	LHS

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Sl. No.	HIP Chainage (m)	Easting (X)	Northing (Y)	<b>R</b> (m)	V (km/h)	<b>D</b> (°)	Ls (m)	Ts (m)	Lc (m)	Es (m)	e (%)	Side of Curve
2	60421.374	618115.239	2626449.410	125	50	54.380	55	92.19	63.64	16.665	7.00	RHS
Bridge N	Bridge No25											
1	54057.589	617443.124	2622988.227	3000	100	1.0622	-	27.81	55.62	0.129	-	RHS
2	64361.748	617334.296	2622703.671	300	65	19.030	40	70.32	59.64	4.408	6.26	LHS
Bridge N	Bridge No26											
1	66336.231	616885.589	2620850.189	3000	100	1.810	-	47.40	94.78	0.374	-	RHS
2	66686.561	616690.933	2620558.663	900	80	10.044	30	94.09	127.77	3.508	3.16	LHS
Bridge N	No27											
1	68894.476	616181.547	2618435.631	600	80	7.703	35	57.90	45.66	1.448	4.74	RHS
2	69119.879	616131.582	2618215.767	1000 0	80	0.256	-	22.34	44.68	0.025	-	RHS
Bridge N	No28											
1	72131.285	615351.246	2615323.341	3000	80	1.828	-	47.85	95.69	0.382	-	LHS
Bridge N	No31											
1	80931.026	615147.947	2606669.265	1000	100	16.478	50	169.81	237.59	10.530	4.44	RHS
2	81313.814	615114.713	2606285.797	310	80	23.963	75	103.43	54.65	7.680	7.00	LHS
Bridge N	No32											
1	89912.435	614543.322	2598270.958	150	50	32.274	45	66.04	39.49	6.735	7.00	RHS
2	90154.705	614489.536	2598026.598	200	65	50.807	60	125.32	117.35	22.238	7.00	LHS
Bridge N	No33 & 34											
1	90959.470	614509.598	2597289.342	220	65	40.236	60	110.82	94.49	15.019	7.00	LHS
2	91360.638	614658.317	2596905.614	215	65	50.119	60	130.84	128.07	23.114	7.00	RHS
Bridge N	No35 & 36				-		-		-			
1	92424.829	614068.436	2596025.073	200	65	25.187	60	74.83	27.92	5.699	7.00	LHS
2	92721.068	613996.934	2595736.658	500	65	6.960	25	42.91	35.74	0.974	3.76	LHS
3	92957.587	613968.253	2595501.843	1200	80	1.330	-	13.92	27.85	0.081	-	LHS

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Sl. No.	HIP Chainage (m)	Easting (X)	Northing (Y)	<b>R</b> (m)	V (km/h)	<b>D</b> (°)	Ls (m)	Ts (m)	Lc (m)	Es (m)	e (%)	Side of Curve
Bridge N	No37											
1	94758.998	613433.834	2593834.462	200	65	34.071	60	91.49	58.93	9.962	7.00	LHS
Bridge N	No38 & 39											
1	96261.315	613372.195	2592374.070	250	65	25.587	50	81.85	61.64	6.795	7.00	LHS
2	96437.069	613384.294	2592196.485	200	65	28.425	60	80.82	39.22	7.089	7.00	RHS
3	96629.167	613303.198	2592018.762	170	65	35.220	70	89.29	34.50	9.617	7.00	LHS
Bridge M	No 40											
1	97349.430	613157.266	2591369.230	200	65	34.094	60	91.53	59.01	9.975	7.00	LHS
2	97711.804	613170.276	2591004.059	200	65	26.540	60	77.32	32.64	6.257	7.00	RHS
Bridge M	No 41, 42 &	43										
1	98717.311	612943.802	2590023.268	400	80	1.931	55	61.85	13.48	1.761	7.000	LHS
2	98997.495	612959.035	2589742.930	250	65	19.234	50	67.42	33.92	3.989	7.00	RHS
3	99149.095	612916.531	2589595.900	200	65	26.431	60	77.12	32.26	6.211	7.00	LHS
4	99339.164	612951.050	2589406.093	200	65	33.095	60	89.62	55.52	9.423	7.00	RHS
5	99656.641	612827.364	2589112.669	900	80	1.596	30	42.55	25.07	0.461	3.16	RHS
Bridge N	No 44											
1	101381.227	612329.081	2587513.327	170	65	39.715	70	96.78	47.84	12.023	7.00	LHS
Bridge N	No 45											
1	106339.019	612506.566	2582618.119	2000	80	2.506	-	43.75	87.49	0.479	-	RHS
Bridge N	No 46 & 47											
1	107331.247	612384.266	2581641.201	1200	80	2.640	-	27.65	55.29	0.318	-	RHS
2	107430.354	612366.443	2581543.701	1200	80	2.671	-	27.97	55.93	0.326	-	LHS
3	107860.557	612308.882	2581117.359	3000	80	1.351	-	35.38	70.75	0.209	-	RHS
Bridge N	No 48											
1	112230.694	613658.261	2577449.229	150	65	49.711	80	110.22	50.14	17.275	7.00	RHS

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Sl. No.	HIP Chainage (m)	Easting (X)	Northing (Y)	<b>R</b> (m)	V (km/h)	<b>D</b> (°)	Ls (m)	Ts (m)	Lc (m)	Es (m)	e (%)	Side of Curve
Bridge No 49												
1	115799.093	613796.381	2574091.679	700	80	6.964	35	60.10	50.08	1.365	4.06	LHS
2	115911.527	613813.711	2573980.528	1200	80	2.379	-	24.92	49.83	0.259	-	RHS
3	116126.667	613838.006	2573766.722	3000	80	3.848	-	100.79	201.50	1.693	-	LHS
Bridge I	Bridge No 50, 51 & 52											
1	121782.740	616088.718	2569359.538	200	40	57.123	15	116.40	184.40	27.769	3.56	RHS
2	122097.018	616400.050	2569448.546	100	40	23.711	20	31.02	21.38	2.353	7.00	LHS
3	122198.923	616482.297	2569516.746	60	40	64.660	35	55.96	32.71	12.013	7.00	RHS
4	122296.290	616574.952	2569473.552	125	40	20.491	15	30.11	29.70	2.107	5.69	LHS
5	122423.942	616702.533	2569463.504	150	40	12.430	15	23.84	17.54	0.947	4.74	RHS
6	122484.174	616760.283	2569445.921	150	40	12.121	15	23.43	16.73	0.903	4.74	LHS
7	122564.603	616842.186	2569439.026	90	40	42.293	25	47.42	41.43	6.809	7.00	RHS
Bridge I	No 53 & 54											
1	126437.110	618474.830	2570803.835	60	40	73.367	35	62.78	41.83	15.878	7.00	LHS
2	126618.127	618385.975	2570975.252	90	40	60.743	25	65.40	70.42	14.652	7.00	RHS
3	126842.328	618516.999	2571174.394	125	40	65.460	15	87.89	127.81	23.687	5.69	RHS
4	127042.435	618723.634	2571142.395	300	40	5.079	-	13.31	26.60	0.295	-	LHS
Bridge I	No 56 & 57											
1	133251.922	621214.388	2568706.143	80	30	16.641	15	19.22	8.24	0.972	5.00	RHS
2	133312.235	621213.477	2568645.300	120	30	24.994	15	34.11	37.35	2.994	3.33	LHS
3	133388.495	621244.968	2568575.020	170	30	20.189	-	30.27	59.90	2.673	-	RHS
4	133454.285	621249.532	2568508.880	80	30	21.237	15	22.52	14.65	1.516	5.00	LHS
5	133518.519	621277.012	2568450.440	60	30	21.226	15	18.77	7.23	1.207	6.67	RHS
6	133663.945	621287.076	2568304.969	70	30	23.788	15	22.27	14.06	1.669	5.71	RHS
7	133720.620	621267.528	2568250.761	60	30	36.346	15	27.24	23.06	3.318	6.67	LHS

KD4 :Draft Feasibility cum Preliminary design Report

Sl. No.	HIP Chainage (m)	Easting (X)	Northing (Y)	<b>R</b> (m)	V (km/h)	<b>D</b> (°)	Ls (m)	Ts (m)	Lc (m)	Es (m)	e (%)	Side of Curve
Bridge No 58												
1	134174.342	621397.599	2567821.334	80	40	33.237	25	36.47	21.41	3.832	7.00	RHS
2	134288.508	621389.217	2567706.713	500	40	0.842	-	3.67	7.34	0.013	-	RHS
3	134397.569	621379.602	2567597.337	125	40	29.347	15	40.25	49.03	4.297	5.69	RHS
4	134538.028	621299.755	2567480.596	100	40	21.093	20	28.65	16.81	1.891	7.00	LHS
Bridge I	Bridge No 59											
1	136338.949	621996.291	2566542.774	60	40	51.063	35	46.52	18.47	7.435	7.00	RHS
2	136548.387	622203.193	2566596.488	125	40	41.020	15	54.29	74.49	8.545	5.69	LHS
Bridge I	Bridge No 60 & 61											
1	137874.512	623256.511	2566709.010	130	40	14.516	15	24.06	17.94	1.121	5.47	RHS
2	137962.063	623352.174	2566711.603	45	30	84.092	25	53.57	41.05	16.378	7.00	LHS
3	138126.350	623373.156	2566987.083	39	30	151.169	30	170.38	72.90	121.511	7.00	RHS
4	138232.884	623460.498	2566795.215	50	30	28.614	20	22.82	4.97	1.941	7.00	LHS
5	138300.584	623515.232	2566754.103	80	30	27.799	15	27.32	23.81	2.537	5.00	RHS
6	138415.171	623565.761	2566647.162	110	30	49.702	15	58.49	80.42	11.324	3.64	LHS
7	138522.073	623675.357	2566617.781	40	30	65.805	25	38.76	20.94	8.416	7.00	RHS
8	138593.530	623687.377	2566543.464	50	30	33.909	20	25.33	9.59	2.617	7.00	LHS
Bridge I	Bridge No 62											
1	139245.748	624190.352	2566235.226	500	40	2.276	-	9.93	19.86	0.099	-	RHS
2	139337.833	624280.761	2566215.671	90	40	25.915	25	33.27	15.71	2.649	7.00	LHS
Bridge No 63												
1	140132.186	625030.726	2566334.072	300	40	8.207	-	21.52	42.97	0.771	-	RHS
2	140196.920	625087.216	2566366.657	60	30	30.926	15	24.14	17.39	2.419	6.67	LHS
3	140285.694	625139.797	2566461.141	30	30	115.131	30	64.05	30.28	28.266	7.00	RHS
4	140397.101	625218.507	2566351.896	100	30	55.915	15	60.62	82.59	13.314	4.00	LHS

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Sl. No.	HIP Chainage (m)	Easting (X)	Northing (Y)	<b>R</b> (m)	V (km/h)	<b>D</b> (°)	Ls (m)	Ts (m)	Lc (m)	Es (m)	e (%)	Side of Curve
Bridge No 64												
1	141306.750	625970.694	2566136.969	50	30	72.665	20	47.00	43.41	12.476	7.00	LHS
2	141406.305	626066.470	2566186.614	90	30	51.573	15	51.03	66.01	10.064	4.44	RHS
3	141555.155	626205.727	2566124.109	100	30	31.888	15	36.09	40.66	4.094	4.00	LHS
Bridge I	Bridge No 65											
1	142909.399	627525.217	2566090.511	70	30	42.932	10	32.55	42.45	5.282	5.71	LHS
Bridge I	Bridge No 67											
1	145208.813	629345.660	2565159.979	125	40	31.129	15	42.34	52.91	4.841	5.69	LHS
2	145275.800	629401.919	2565198.037	300	40	9.347	-	24.52	48.94	1.001	-	RHS
3	145361.356	629479.808	2565233.912	60	30	20.737	15	18.50	6.72	1.159	6.67	RHS
4	145408.237	629526.829	2565237.194	70	30	17.965	15	18.58	6.95	1.001	5.71	LHS
5	145464.511	629580.599	2565258.873	40	30	51.536	25	32.08	10.98	5.138	7.00	RHS
6	145534.944	629643.887	2565222.953	80	30	33.835	15	31.87	32.24	3.744	5.00	LHS
Bridge I	No 68 & 69											
1	146229.674	630195.869	2565460.569	100	30	23.983	15	28.76	26.86	2.323	4.00	LHS
2	146372.651	630280.812	2565576.288	60	30	25.002	15	20.83	11.18	1.621	6.67	LHS
3	146433.945	630292.860	2565636.703	400	30	9.174	-	32.09	64.05	1.285	-	LHS
4	146497.194	630295.186	2565700.002	300	40	7.069	-	18.53	37.01	0.572	-	RHS
5	146565.751	630307.367	2565775.438	40	40	85.954	25	50.34	35.01	15.561	7.00	RHS
6	146637.924	630387.061	2565768.287	200	30	5.560	-	9.71	19.41	0.236	-	LHS
7	146754.291	630505.110	2565769.177	310	40	28.768	-	79.50	155.65	10.032	-	LHS
Bridge No 70 & 71												
1	147476.763	631081.512	2566159.512	55	30	128.075	20	123.56	102.94	71.317	7.00	RHS
2	147579.799	631182.955	2566040.037	40	30	51.646	25	32.13	11.06	5.159	7.00	LHS
3	147657.172	631262.965	2566042.802	60	30	41.805	15	30.47	28.78	4.398	6.67	RHS
4	147719.962	631312.303	2566001.658	90	30	25.794	15	28.13	25.52	2.432	4.44	LHS

KD4 :Draft FeasibilityConsultancy Services for Preparation of Feasibility Report for Construction of Bridges including Approaches on Tamu – Kyigone – Kalewa Road Section from<br/>km 0.00 to km 149.70 in Myanmar

Sl. No.	HIP Chainage (m)	Easting (X)	Northing (Y)	<b>R</b> (m)	V (km/h)	<b>D</b> (°)	Ls (m)	Ts (m)	Lc (m)	Es (m)	e (%)	Side of Curve
5	147785.530	631376.441	2565985.628	60	30	22.060	15	19.22	8.10	1.292	6.67	LHS
6	147858.038	631448.733	2565995.824	100	30	23.951	15	28.73	26.80	2.317	4.00	LHS
7	147943.417	631523.842	2566042.720	40	30	62.713	25	37.23	18.78	7.603	7.00	RHS
8	148042.547	631612.598	2565989.949	50	30	46.762	15	29.19	25.81	4.680	7.00	LHS

Table 6.15: Details of vertical alignments							
VIP Chainage (m)	VIP Level (m)	In Grade (%)	Out Grade (%)	Curve Length (m)	Type of Curve		
Bridge - 1	•		•				
115.000	186.100	-4.500	0.000	50	Sag		
272.651	186.100	0.000	2.650	100	Sag		
Bridge - 2	•	•	·	•	•		
4815.000	174.167	-1.345	0.000	50	Sag		
4970.000	174.167	0.000	0.859	50	Sag		
5043.331	174.797	0.859	-1.418	60	Summit		
Bridge - 3			•				
10715.136	174.451	-2.575	1.000	100	Sag		
11009.106	177.391	1.000	-0.318	60	Summit		
Bridge - 4	•	•	·	•	·		
11867.475	176.833	-0.295	0.800	60	Sag		
11955.000	177.533	0.800	0.000	60	Summit		
12045.000	177.533	0.000	-0.800	60	Summit		
12144.099	176.740	-0.800	0.234	60	Sag		
Bridge - 5					· · · · · ·		
13486.193	182.000	1.017	0.000	100	Summit		
13790.000	182.000	0.000	0.545	60	Sag		
13887.547	182.532	0.545	-0.143	60	Summit		
Bridge - 6							
15542.412	174.578	0.363	-3.000	100	Summit		
15695.000	170.000	-3.000	0.000	100	Sag		
15810.000	170.000	0.000	2.000	60	Sag		
15892.077	171.642	2.000	0.989	50	Summit		
Bridge - 7	•	L	•		•		
18005.252	166.549	-0.549	1.500	100	Sag		
18375.965	172.109	1.500	-0.573	100	Summit		
Bridge - 8	•	•	·	•	·		
19416.901	156.446	-1.398	2.000	100	Sag		
19525.000	158.608	2.000	0.000	70	Summit		
19620.000	158.608	0.000	-0.500	60	Summit		
19711.102	158.152	-0.500	1.948	100	Sag		
Bridge - 9	•	•	·	•	· – –		
22304.168	167.397	-0.736	2.500	50	Sag		
22425.000	170.418	2.500	0.000	50	Summit		
22520.000	170.418	0.000	0.785	50	Sag		
22601.740	171.060	0.785	0.548	50	Summit		
Bridge - 10							
24963.378	166.332	1.192	-2.000	110	Summit		
25085.000	163.900	-2.000	0.000	60	Sag		
25246.695	163.900	0.000	2.000	70	Sag		
25323.707	165.440	2.000	0.997	30	Summit		
Bridge - 11 & 1					•		
27210.000	163.050	-3.152	-1.000	95	Sag		
27378.238	161.368	-1.000	3.258	110	Sag		
27555.977	167.159	3.258	-0.562	130	Summit		
27675.000	166.490	-0.562	1.800	70	Sag		
27770.000	168.200	1.800	3.791	65	Sag		
27909.767	173.499	3.791	2.874	50	Summit		
2/909./6/	1/5.499	5./91	2.8/4	50	Summit		

## Table 6.15: Details of vertical alignments

VIP Chainage	VIP Level	In Grade	Out Grade	Curve	Type of
(m)	(m)	(%)	(%)	Length (m)	Curve
27967.421	175.155	2.874	0.857	30	Summit
Bridge - 13					
30918.703	175.870	-0.618	-1.419	50	Summit
30980.000	175.000	-1.419	0.000	50	Sag
31100.000	175.000	0.000	3.000	60	Sag
31214.618	178.439	3.000	0.649	90	Summit
Bridge - 14					
34546.017	175.754	-1.405	-2.600	50	Summit
34702.506	171.685	-2.600	0.695	90	Sag
Bridge - 15					
36613.517	173.996	-0.326	-0.072	50	Sag
36667.557	173.957	-0.072	-0.940	50	Summit
36880.000	171.960	-0.940	0.000	50	Sag
37090.000	171.960	0.000	0.654	50	Sag
37228.120	172.864	0.654	0.331	50	Summit
Bridge - 16					
41829.140	168.360	0.218	1.423	50	Sag
41912.368	169.544	1.423	-2.945	100	Summit
42035.000	165.933	-2.945	0.000	60	Sag
42140.000	165.933	0.000	3.212	60	Sag
42198.471	167.811	3.212	0.238	50	Summit
42253.180	167.942	0.238	-0.775	50	Summit
Bridge - 17					
43237.520	176.266	-1.241	-3.858	50	Summit
43346.003	172.081	-3.858	0.000	120	Sag
43700.000	172.081	0.000	0.946	60	Sag
43779.658	172.835	0.946	3.535	50	Sag
43847.305	175.226	3.535	0.735	60	Summit
43910.408	175.690	0.735	2.331	50	Sag
Bridge - 18 & 1			•		
49249.416	179.262	-3.989	-0.093	130	Sag
49361.481	179.157	-0.093	2.499	70	Sag
49450.000	181.370	2.499	0.000	90	Summit
49664.600	181.370	0.000	1.000	60	Sag
49760.000	182.324	1.000	0.000	60	Summit
49950.000	182.324	0.000	-2.500	90	Summit
50046.102	179.921	-2.500	0.915	90	Sag
Bridge - 20 & 2					
53534.366	191.152	-0.459	-2.170	40	Summit
53623.348	189.221	-2.170	-0.573	60	Sag
53701.360	188.774	-0.573	2.500	60	Sag
53800.000	191.240	2.500	0.000	60	Summit
53925.000	191.240	0.000	-0.166	50	Summit
54070.000	191.000	-0.166	1.600	60	Sag
54230.000	193.560	1.600	3.000	50	Sag
54367.935	197.698	3.000	4.670	60	Sag
Bridge - 22					
55390.000	193.027	1.142	0.000	50	Summit
55635.000	193.027	0.000	1.339	50	Sag
55691.194	193.779	1.339	0.360	50	Summit

VIP Chainage	VIP Level	In Grade	Out Grade	Curve	Type of
(m)	(m)	(%)	(%)	Length (m)	Curve
Bridge - 23 & 2	4				
60025.000	168.800	-2.594	0.000	70	Sag
60125.000	168.800	0.000	-0.900	60	Summit
60225.000	167.900	-0.900	0.000	60	Sag
60315.000	167.900	0.000	0.779	50	Sag
60512.184	169.436	0.779	3.049	50	Sag
Bridge - 25					6
63968.792	185.226	-0.206	2.500	60	Sag
64070.000	187.756	2.500	0.000	90	Summit
64190.000	187.756	0.000	-2.000	70	Summit
64287.896	185.798	-2.000	1.023	80	Sag
64353.533	186.469	1.023	-0.083	50	Summit
64434.922	186.402	-0.083	-0.849	50	Summit
Bridge - 26					1
66265.000	179.391	0.438	0.000	60	Summit
66470.000	179.391	0.000	-1.131	60	Summit
66607.636	177.835	-1.131	0.956	80	Sag
66691.247	178.634	0.956	-0.545	60	Summit
Bridge - 27	I	I			1
68860.945	193.170	1.263	-1.935	110	Summit
68950.000	191.447	-1.935	0.000	60	Sag
69100.000	191.447	0.000	1.775	60	Sag
Bridge - 28	I				6
72001.429	207.203	-0.188	-1.710	50	Summit
72065.934	206.100	-1.710	0.000	60	Sag
72275.283	206.100	0.000	-1.208	50	Summit
Bridge - 29 & 3	0	I			1
74850.000	226.996	1.131	0.000	60	Summit
74970.000	226.996	0.000	-2.300	90	Summit
75053.019	225.087	-2.300	-0.006	65	Sag
75128.921	225.082	-0.006	1.480	50	Sag
75226.744	226.530	1.480	0.000	60	Summit
75375.000	226.530	0.000	-1.300	60	Summit
75466.249	225.344	-1.300	2.901	80	Sag
Bridge - 31					
80968.507	178.783	-0.635	0.341	50	Sag
81040.000	179.027	0.341	0.000	50	Summit
81140.000	179.027	0.000	-2.200	75	Sag
81211.908	177.445	-2.200	0.049	60	Sag
81319.204	177.497	0.049	0.693	50	Sag
81377.069	177.898	0.693	0.257	50	Summit
Bridge – 32	•	•			·
89872.881	155.747	-1.459	0.000	50	Sag
90077.495	155.747	0.000	1.998	50	Sag
90134.680	156.889	1.998	1.503	50	Summit
90240.780	158.484	1.503	2.319	50	Sag
Bridge - 33 & 3	4			-	<del>-</del>
90808.448	159.697	-0.923	0.000	60	Sag
90925.000	159.697	0.000	-1.586	60	Summit

VID Chainaga	VIP Level	In Grade	Out Grade	Curve	Type of
VIP Chainage (m)	(m)	(%)	(%)	Length (m)	Type of Curve
	· · · ·	` ´	. ,	0	
90987.297	158.709	-1.586	-0.378	50	Sag
91175.000	158.000	-0.378	0.000	50	Sag
91281.286	158.000	0.000	2.084	70	Sag
91371.997	159.890	2.084	-0.432	50	Summit
91440.259	159.595	-0.432	0.408	50	Sag
Bridge - 35 & 3		0.420	2(((	70	G
92353.622	158.359	0.428	-2.666	70	Summit
92449.878	155.792	-2.666	0.000	70	Sag
92550.000	155.792	0.000	-1.500	60	Summit
92655.800	154.205	-1.500	0.000	100	Sag
92795.000	154.205	0.000	-0.221	50	Summit
92924.926	153.918	-0.221	-2.925	60	Summit
Bridge – 37					
94689.133	144.673	0.478	-0.688	80	Summit
94761.972	144.172	-0.688	0.000	60	Sag
94905.000	144.172	0.000	-1.240	60	Summit
94991.283	143.102	-1.240	-0.084	50	Sag
Bridge - 38 & 3					
95920.246	149.252	-0.240	2.097	20	Sag
95977.224	150.447	2.097	0.933	50	Summit
96115.000	151.732	0.933	0.000	60	Summit
96215.000	151.732	0.000	-1.000	60	Summit
96286.274	151.019	-1.000	1.224	60	Sag
96402.401	152.440	1.224	-2.500	80	Summit
96480.000	150.500	-2.500	0.000	60	Sag
96568.000	150.500	0.000	-2.500	80	Summit
96702.981	147.125	-2.500	-0.429	60	Sag
Bridge – 40					
97256.035	145.651	0.847	2.360	40	Sag
97348.684	147.838	2.360	1.501	50	Summit
97461.732	149.534	1.501	-1.001	120	Summit
97565.000	148.500	-1.001	0.000	60	Sag
97655.000	148.500	0.000	0.227	60	Sag
97749.026	148.714	0.227	0.993	50	Sag
Bridge - 41, 42	& 43				
98772.023	142.478	1.716	0.000	140	Summit
98940.000	142.478	0.000	-2.000	80	Summit
99036.450	140.549	-2.000	0.000	80	Sag
99372.850	140.549	0.000	2.000	70	Sag
99485.000	142.792	2.000	0.000	80	Summit
99630.000	142.792	0.000	-1.700	60	Summit
99688.116	141.804	-1.700	-0.242	50	Sag
Bridge – 44	111001	1.,00	0.212		545
101317.714	142.889	-0.830	2.000	50	Sag
101317.714	144.135	2.000	0.000	50	Summit
101530.000	144.135	0.000	-1.700	60	Summit
101530.000	144.133	-1.700	-0.715	50	Sag
Bridge – 45	172.000	-1./00	-0./13	50	Sag
106144.742	128.337	-0.192	0.000	50	Sag
106144.742	128.337	0.000	-1.200	50	
100313.000	120.33/	0.000	-1.200	50	Summit

VIP Chainage	VIP Level	In Grade	Out Grade	Curve	Type of
(m)	(m)	(%)	(%)	Length (m)	Curve
106370.889	127.666	-1.200	-0.002	50	Sag
Bridge - 46 & 4					8
107010.000	133.412		0.617		
107086.363	133.883	0.617	-1.800	90	Summit
107172.696	132.329	-1.800	0.000	60	Sag
107345.000	132.329	0.000	-2.400	90	Summit
107524.945	128.010	-2.400	0.845	240	Sag
107716.121	129.625	0.845	0.553	50	Summit
107880.000	130.532	0.553	0.000	50	Summit
107980.000	130.532	0.000	-1.500	60	Summit
108045.675	129.547	-1.500	0.655	60	Sag
Bridge - 48	127.347	-1.500	0.055	00	Bag
112102.776	132.976	0.928	-0.067	50	Summit
112102.770	132.970	-0.067	2.000	60	Sag
112187.342	132.919	2.000	0.000	70	Summit
112200.000	134.368	0.000	2.815	70	
	134.308	2.815		50	Sag
112448.329	130.332	2.813	1.864	50	Summit
Bridge – 49	12(049	1 400	1 400	100	C:+
115848.649	126.948	1.400	-1.400	100	Summit
115950.000	125.529	-1.400	0.000	60	Sag
116060.000	125.529	0.000	-1.500	50	Summit
116147.669	124.214	-1.500	-1.259	50	Summit
Bridge - 50, 51			• • • • •	<u> </u>	~
121749.775	113.889	-0.438	2.000	60	Sag
121850.000	115.894	2.000	0.000	60	Summit
122068.176	115.894	0.000	1.700	60	Sag
122150.000	117.285	1.700	0.000	60	Summit
122260.000	117.285	0.000	-0.912	40	Summit
122335.000	116.601	-0.912	0.000	40	Sag
122420.000	116.601	0.000	2.300	40	Sag
122527.221	119.067	2.300	0.034	60	Summit
Bridge - 53 & 5	4				•
126413.284	124.962	1.752	-4.000	75	Summit
126555.046	119.291	-4.000	0.000	100	Sag
126790.000	119.291	0.000	-1.000	40	Summit
126874.100	118.450	-1.000	0.000	30	Sag
127106.714	118.450	0.000	1.200	30	Sag
Bridge - 56 & 5	7				
133158.940	116.536	-1.498	0.121	30	Sag
133190.453	116.574	0.121	-1.000	30	Summit
133246.403	116.015	-1.000	1.520	35	Sag
133311.224	117.000	1.520	0.000	40	Summit
133415.000	117.000	0.000	2.000	20	Sag
133449.964	117.699	2.000	-0.556	30	Summit
133488.138	117.487	-0.556	0.290	20	Sag
133537.887	117.631	0.290	-1.499	50	Summit
133580.000	117.000	-1.499	0.000	20	Sag
133703.914	117.000	0.000	2.600	30	Sag
133731.529	117.718	2.600	0.461	20	Summit
133765.418	117.874	0.461	1.027	20	Sag
155705.710	TT/.0/T	0.401	1.027	20	Jag

VIP Chainage	VIP Level	In Grade	Out Grade	Curve	Type of
(m)	(m)	(%)	(%)	Length (m)	Curve
Bridge – 58					
134118.000	121.750		-1.630		
134152.777	121.183	-1.630	0.033	20	Sag
134183.697	121.193	0.033	-0.643	20	Summit
134214.080	120.998	-0.643	0.149	20	Sag
134252.192	121.055	0.149	-1.596	50	Summit
134291.125	120.434	-1.596	-0.934	20	Sag
134366.975	119.725	-0.934	-0.357	30	Sag
134430.000	119.500	-0.357	0.000	30	Sag
134490.000	119.500	0.000	0.899	20	Sag
Bridge – 59	119.500	0.000	0.899	20	Sag
136303.266	116.307	-0.939	-2.999	20	Summit
136363.516	114.500	-2.999	0.000	30	Summe
					U
136494.013	114.500	0.000	2.620	30	Sag
136600.496	117.290	2.620	1.158	20	Summit
Bridge - 60 & 6			5.041		
137830.000	121.467	5.041	5.041	25	Cit
137861.538	123.057	5.041	2.021	25	Summit
137954.204	124.929	2.021	0.235	40	Summit
138057.559	125.172	0.235	1.600	20	Sag
138083.848	125.593	1.600	0.000	30	Summit
138143.848	125.593	0.000	-2.000	30	Summit
138189.890	124.672	-2.000	-0.134	20	Sag
138503.848	124.250	-0.134	0.000	20	Sag
138563.848	124.250	0.000	-3.500	40	Summit
138608.347	122.693	-3.500	-0.866	30	Sag
Bridge – 62					
139300.000	113.650	-0.418	-1.000	20	Summit
139350.000	113.150	-1.000	0.000	30	Sag
139415.367	113.150	0.000	0.175	20	Sag
Bridge – 63		1			
140107.336	114.314	-2.635	-3.000	0	Summit
140187.793	111.900	-3.000	0.000	60	Sag
140300.855	111.900	0.000	0.901	30	Sag
140377.514	112.591	0.901	3.721	35	Sag
140437.025	114.805	3.721	-2.995	35	Summit
Bridge – 64			•		•
141283.360	118.932	0.285	-5.000	65	Summit
141350.000	115.600	-5.000	-2.000	50	Sag
141422.317	114.154	-2.000	-3.900	30	Summit
141535.643	109.734	-3.900	-0.262	40	Sag
141602.330	109.559	-0.262	2.712	20	Sag
Bridge – 65					
142742.333	104.985	-2.446	1.500	40	Sag
142790.000	105.700	1.500	0.000	30	Summit
142851.257	105.700	0.000	3.630	30	Sag
142897.327	107.372	3.630	2.149	20	Summit
Bridge - 67		•			•
145165.399	104.221	-0.029	0.000	20	Sag
145446.489	104.221	0.000	-3.096	60	Summit

VIP Chainage (m)	VIP Level (m)	In Grade (%)	Out Grade (%)	Curve Length (m)	Type of Curve
145499.153	102.590	-3.096	-0.206	25	Sag
Bridge - 68 & 6	9				
146175.173	98.973	-2.166	-0.434	20	Sag
146244.136	98.674	-0.434	3.000	40	Sag
146310.000	100.650	3.000	0.000	30	Sag
146370.000	100.650	0.000	2.576	30	Sag
146412.935	101.756	2.576	-1.500	50	Summit
146507.986	100.330	-1.500	2.000	40	Sag
146559.987	101.370	2.000	0.000	30	Summit
146620.000	101.370	0.000	-3.299	30	Summit
146655.992	100.183	-3.299	-0.848	30	Sag
146706.776	99.752	-0.848	1.755	50	Sag
Bridge - 70 & 7	1				
147409.954	101.187	-0.290	3.000	40	Sag
147455.000	102.538	3.000	0.000	30	Summit
147525.000	102.538	0.000	-3.000	30	Summit
147575.742	101.016	-3.000	-1.889	20	Sag
147658.685	99.449	-1.889	1.256	40	Sag
147711.383	100.111	1.256	0.101	20	Summit
147774.669	100.175	0.101	-0.294	20	Summit
147850.545	99.951	-0.294	2.501	40	Sag
147905.000	101.313	2.501	0.000	30	Summit
147975.000	101.313	0.000	-2.500	30	Summit
148037.607	99.748	-2.500	-1.807	20	Sag

# 6.6 PAVEMENT DESIGN

## 6.6.1 General

The general design procedure is based on the prevalent practices. The design of pavement has been carried out as per IRC Guide lines and TOR. The design of new pavement has been based on IRC-37:2012 for flexible pavement.

## 6.6.2 Factor considered for Pavement Design

The principal factors that will govern the design of pavements are :

- i. Design Period
- ii. Traffic loads that the pavement has to withstand during its design life
- iii. Condition of the existing pavement
- iv. Strength and other engineering characteristics of the sub-grade soil

## 6.6.3 Design Period

The design period for the pavement has been considered as 15 years. The Construction period has been considered as 36 months (3.0 years). As per the IRC: 37-2012, the minimum design period is defined as 15 years with a provision of stage construction satisfying the following design requirements;

a) The thickness of sub-base and the base of pavement section are designed for full design period and the initial bituminous surfacing for a minimum design period of 15 years.

# 6.6.4 Design Traffic

The detailed traffic surveys for the project road have been conducted in April, 2014. The survey data and analysis for the project road are provided in Traffic Report.

## Average Daily Traffic:

Based on the traffic survey data, the project road has been divided into two homogeneous sections as shown in *Table 6.16*.

		AADT Commercial Vehicles				
Section Chainage (km)		Bus	LGV	2 axle truck	3 axle Truck	MAV
1	Km 0.000 to km 121.690	22	15	54	5	23
2	Km 121.690 to km 149.700	45	40	86	14	73

Table 6.16: Homogeneous Traffic Sections

Based on the traffic projections and the Vehicle Damage Factor (VDF) (refer *Table 6.17*) of various types of commercial vehicles, Cumulative standard Axles (CSA) during the period of design life have been computed for the homogeneous sections.

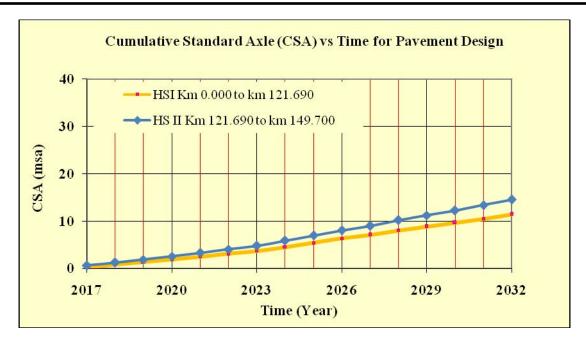
Mode	Km 12.5	Km 122.5
LGV	0.45	0.49
2 axle Truck	3.24	3.27
3 Axle Truck	3.81	3.84
MAV	2.59	2.95

The computations of CSAs for the 2-lane carriageways of the traffic homogenous sections are given in *Annexure 6.1*. The trend of CSA growth over the design life of pavement is given in *Figure 1.2*. Based on CSA computations, the design traffic (msa) adopted for 15 years of pavement life for the four/six sections of the project road are given in *Table 6.18*.

 Table 6.18: Design Traffic for 15 Years (after opening of traffic)
 Image: Comparison of traffic opening of traffic)

Homogeneous Section	From km to km	Estimated Traffic (msa)	Adopted Traffic (msa)
HS 1	Km 0.000 to km 121.690	11.4	20
HS 2	Km 121.690 to km 149.700	14.53	20

Figure 6.1: CSA Growth over the Design Life of Pavement



## 6.6.5 Characteristics of the Subgrade Soil

Based on the results from investigations of the Subgrade soils, following CBR values have been adopted for the pavement design and are given in *Table 6.19*.

Based on the results from investigations of the borrow area soils, following effective CBR values have been adopted as per IRC-37 2012 for the sub-grade material selected for the pavement given in *Table 6.19*.

 Table 6.19: CBR values for Subgrade Materials

Section	Effective CBR Adopted
Tamu To Kalewa	7%

## 6.6.6 Design of Flexible Pavement

The detailed calculations for design traffic loading in term of million standard axles (msa) for 15 years have been computed and are presented in *Table 6.19*. Following the design methodology described above, the flexible pavements for new carriageways have been designed for the design period as stated above. The pavement composition as evaluated from IRC: 37, 2012 for the different sections of the project road are summarized in *Table 6.20* 

 Table 6.20: Pavement Composition for New Construction

Homogeneous Sections	CBR	Design	Pavement Composition (mm)				
(KM)	(%)	Traffic (msa)	BC	DBM	WMM	GSB	Sub- grade
Km 0.000 to km 121.690	7%	20	40	90	250	230	500
Km 121.690 to km 149.700	7%	20	40	90	250	230	500

\*BC: Bituminous Concrete, WMM: Wet Mix Macadam; GSB: Granular Sub base.

## 6.6.7 Design of Shoulders

## 6.6.7.1 Design for Earthen Shoulder

The following criteria are desirable in the borrow material used in construction of earthen shoulders:

- (a) It should have a minimum soaked CBR value of 10%-12%.
- (b) The plasticity Index (PI) of the material used should not exceed 8-12.
- (c) The GSB layer will be extended to the entire width of the embankment. Shoulders should be covered with 150mm thick layer of granular material. The remainder of the thickness between this layer and the GSB below will be filled with filler type material qualifying the specifications provided in MOSRT&H (Section 309.3.2 & Table 300.3).

## 6.7 ROADSIDE DRAINAGE DESIGN

## 6.7.1 Design Methodology

Adequate drainage is a primary requirement for maintaining the structural soundness and functional efficiency of the road. Hence the main emphasis of surface drainage is to quickly drain out the rain water from road surface and its surroundings. Rain water falling on the road surface shall be taken off quickly by providing a camber to the road surface.

Water shall be collected from the carriageway through the top surface in unlined drains. Water thus collected shall be conveyed through the drains and the drains shall be connected to the nearest natural water course such as rivers, streams, etc. at the location of culverts/bridges. Drainage system is designed as per IRC: SP-42and SP-50 – Guidelines on road drainage. Drainage on high embankment and steep grade, designed outlet by kerbs, gutterand chutes along the side slope of embankment will be included to prevent erosion.

Storm water will be directed away from bridge deck, in case the bridge is in longitudinal grade, with kerb and gutter on the approaches beyond bridge proper and carried by chute to the roadside channels avoiding embankment erosion. Berms may also be proposed for height of embankment more than 6.0 m and that will effectively act as velocity break Design capacity of the drains is identified based on hydrologic analysis. Since the surface drains are having a well-defined catchments and the area of catchment is much less than 50 Sq.km, "Rational Method" shall be adopted in estimating the run off.

Peak Run-off in Cum/Sec  $(Q) = 0.028 \times P \times A \times Ic$ 

P - Coefficient of run-off for the catchment characteristics

A - Area of catchment in Hectares

Ic - Critical Intensity of rainfall in cm/hr. for the selected frequency and for the duration equal to the time of concentration

Coefficient of runoff depends on large number of factors, even for a single storm. Factors affecting it are porosity of soil, type of ground cover, catchment area, slope and initial state of wetness and duration of storm. To get the maximum discharge, value of "P" as it exists at the end of design period of storm is considered. Values of "P" used in this analysis are the ones suggested in IRC SP-42. Following values of "P" in the *Table 6.22* are used in this analysis:

Sl. No.	Surface	Coefficient of Runoff (P)
1	Steep bare rock and water tight pavement surface (concrete or bitumen)	0.9
2	Steep rock with some vegetative cover	0.8

Table6.21: Suggestive values of Coefficient of Run-off

Sl. No.	Surface	Coefficient of Runoff (P)
3	Plateau areas with light vegetative cover	0.7
4	Bare stiff clayey soils (impervious soils)	0.6
5	Stiff clayey soils (impervious soils) with vegetative cover and uneven paved road surfaces	0.5
6	Loam lightly cultivated, covered and macadam or gravel roads	0.4
7	Loam largely cultivated or turfed	0.3
8	Sandy soil, light growth, park, gardens, lawns and meadows	0.2
9	Sandy soil covered with heavy bush or wooded/ forest areas	0.1

Runoff is calculated using the rational formula, using the rainfall intensity of the identified storm, catchment areas and the corresponding time of concentration. Once the discharge is fixed from the above, hydraulic design of the drain section shall be carried out to fix the drain section. Length of continuous drain for each location shall be identified after studying the terrain, ground slope and the discharge points. The drain section is finalised using Manning's formula for open channels;

Discharge of the drain in cum/sec (Q) = 1/n \* A \* R2/3 \* S1/2

Velocity of flow in the drain in m/sec (V) = 1/n \* R2/3 \* S1/2

Where, n –Manning's roughness coefficient

R - Hydraulic mean radius in "m" which is area of flow cross-section divided by wettedperimeter

S - Energy slope of the channel, which is roughly taken as the slope of the drain bed

A - Area of flow cross section in "Sqm"

Drain section and slopes shall be varied to get optimum designs.

#### 6.7.2 Design Rainfall intensity

IRC SP-42 recommends a storm recurrence interval of 25 years for the design purpose. The 25 year - 24 hour rainfall has been taken from plate 8 of Flood estimation report for North Brahmaputra basin (sub zone 2a).

## 6.7.3 Storm Duration

The Drains are designed for the duration of storm based on the concentration time for the stretch of the Drains. Drains are to be designed for the peak rainfall expected for the time of concentration (tc). Peak rainfall for a storm is inversely proportional to the time duration of the storm. In order to find the intensity of rain fall for a particular duration of storm, from the one hour storm, following equation given in IRC SP 13 & IRC SP 42 shall be used.

i = F/T \* (T+1)/(t+1)

i - Intensity of rainfall within a shorter period "t" hrs. within a storm

F - Total rainfall in a storm in "cm" falling in duration of storm of "T" hours

T - Duration of storm t - smaller time interval of "t" hrs during a storm of "T" hrs

## Hydrologic discharge Calculation: a) Determination of runoff coefficient (P):

$$\mathsf{P} = \frac{W_1 P_1 + W_2 P_2 + W_3 P_3 + W_4 P_4 + W_5 P_5 + W_6 P_6}{W_1 + W_2 + W_3 + W_4 + W_5 + W_6}$$

Where,

W1 = Width of Main Carriageway in m.

W2 = Width of Paved shoulder

W3 = Width of Earthen shoulder in m

- W4 = Width of Embankment in m
- W5 = Width of the drain in m
- W6 = Remaining width till ROW in m has been considered
- P1 = Run off coefficient of Main Carriageway
- P2 = Run off coefficient of Paved shoulder
- P3 = Run off coefficient of Earthen shoulder
- P4 = Run off coefficient of Embankment
- P5 = Run off coefficient of drain

P6 = Run off coefficient of width till ROW has been considered

# b) Determination of Time of Concentration (tc):

Time of Concentration (tc) =Entry time + Time of flow in drain

$$= \left[\frac{(W_1 + W_2 + W_3 + W_4 + W_5 + W_6)}{V_1} + \frac{L}{V_2}\right] \times \frac{1}{60} \text{ minutes}$$
$$V_2 = \frac{1}{n} x R^{2/3} \times S^{1/2}$$

V1= Assumed Velocity = 0.75 m/s for unlined drain and 6.0 m/s for lined drain.

# c) Determination of Catchment area (A):

Catchment Area(A) = W x L Where, W= W1 + W2 + W3 + W4 + W5

# d) Determination of Rainfall Intensity (Ic):

Maximum One hour rainfall for the selected frequency of 25 year = 19 cm/hr Rainfall intensity for a shorter duration equal to the time of concentration (tc),

$$lc = \frac{F}{T}x \left[\frac{T+1}{tc+1}\right]$$

Where, F = Total Rainfall within a shorter period of t hrs. within a storm tc = Smaller time interval in hrs.as explained in (b) above within the storm duration of T hours.

# e) Determination of Design Storm Discharge:

Q = 0.028 P. Ic.A Where,

Q = Discharge (Peak run-off) in cum/sec

P = Coefficient of Runoff for the catchment characteristics

A = Area of catchment in hectares Ic = Critical intensity of rainfall in cm per hour for the selected frequency and for duration equal to the time of concentration.

# e) Determination of Design drain discharge:

Width of trapezoidal drain = b in m Depth of trapezoidal drain = h in m

Side slope of drain = s Manning's coefficient, n = 0.015 for Lined drain n = 0.022 for Unlined drain Actual depth of water = d Cross sectional area, A = (b + sd) x d

Perimeter,  $P = b + 2 \overline{x \sqrt{d^2 + s}d^2}$ 

Hydraulic Mean Depth, R = A/PLongitudinal bed slope of drain = S

Velocity of flow in drain,  $V = \frac{1}{n} x R^{2/3} x S^{1/2}$ 

Discharge capacity,  $Q = A \times V$ 

If the designed drain discharge capacity is greater than designed storm discharge capacity then the size of the drain is sufficient.

The detailed calculation is given in Annexure 6.2

# 6.8 **PROTECTIVE WORKS**

Project road is passing through Plain/Rolling and Hilly Terrain. Following structures have been proposed to effectively retain cut and fill slopes and to ensure a stable road:

- Retaining wall
- Breast Wall
- Parapet, Railing and edge stones

Proposed locations of retaining walls are provided in Table 6.22

	Left Side			Right Side		
Bridge No.	From	То	Length (m)	From	То	Length (m)
1	95	130	35	210	215	5
	121855	121888	33	121855	121887.5	32.5
	121913	121930	17	121912.5	121955	42.5
				122035	122100	65
50-51-52				122170	122187.5	17.5
				122212.5	122235	22.5
				122320	122340	20
	122398	122430	32	122515	122540	25
56.57				133315	133330	15
56-57				133623	133650	27
59	136420	136447.5	27.5			
				137975	138005	30
(0, (1				138065	138100	35
60-61				138285	138320	35
				138535	138555	20

Table 6.22: Details of Retaining wall

	Left Side			<b>Right Side</b>	2	
Bridge No.	From	То	Length (m)	From	То	Length (m)
62-63	140190	140227.5	37.5	139230	139250	20
02-03				140252.5	140270	17.5
64				141402.5	141600	197.5
67	145370	145385	15	145332.5	145350	17.5
07				145535	145590	55
				146175	146180	5
68-69				146235	146245	10
08-09				146280	146330	50
				146410	146500	90
	147465	147478	13	147380	147410	30
				147450	147478	28
70-71				147790	147860	70
				147905	147928	23
				147953	148075	122

## 6.8.1 Breast walls

The uphill slopes and the slopes cutting would affect the stability of the road. Provisions have, therefore, been made for the breast walls for the stretches wherever there is a likelihood of a slip or slide on the road. A standard design of breast wall of 2 m and 3m in height in stone masonry with cement mortar has been adopted for the present study.

Table	<i>6.23</i> :	Details	of Breast wal	l
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Left		Left Si	de	Right Side		
Bridge No.	From	to	Length (m)	From	to	Length (m)
12	27870	27965	95	27870	27980	110
50-51-52	122250	122310	60			
60-61	138450	138515	65			

## 6.8.2 Parapets

For defining the edge of the road and for safety of traffic, parapets are required on the valley side. Parapet wall of 0.45m thick of stone masonry in cement mortar in length of 2m to 6m with 0.75m gaps have been proposed. The proposed height of parapet wall is 0.6m.

#### 6.8.3 Crash barrier

The Crash barrier has been provided on the valley side where the height is more than 3.0 m from the ground level.

## 6.9 ROAD FIXTURES

The provision of following road fixtures has been considered for the project road;

- Kilometre Stones
- 5<sup>th</sup> Km Stones
- 200m Stones
- Boundary pillars and guard posts
- Information Sign Board

- Mandatory Signs
- Cautionary Signs
- Road Delineators
- Solar lights/Blinkers/Road Studs

## 6.10 LAND ACQUISITION

Available ROW along the Project corridor varies from 30 to 70m.Mostly alignment has been proposed concentric and new bridges have been proposed at same locations of existing bridges. At four locations new bridges have been proposed adjacent to existing steel bridges.

At first bridge near Indian/ Myanmar border, realignment has been proposed on right side of existing steel bridge considering direct connectivity to Proposed Integrated Check Post at Moreh (Proposed Bypass for Moreh) along Indo -Myanmar Border by Ministry of External Affairs.

Only 0.69Ha Land need to be acquired for Bridge number 1(Km.0.170) and no additional land will be required for the other bridges as proposed bridges and approaches are within the existing ROW.Alignment plans of all bridges are presented in Volume IVA: Drawings- Highway. Additional land required for the bridge and approaches at Km.0.170 is shown in *Annexure 6.3*.

## 6.11 UTILITY RELOCATION

Widening and geometric improvements of approaches of 69 steel bridges of Tamu-Kyigone – Kalewa section will effect various utility services located along the road. The main type of utility located along the project section is electric poles.

The widening of the approaches will be normally taking place on either side of the road and the utility services on both sides of the road will be required to be shifted and relocated to the extreme boundary. This work will required to be interacted with concerned service departments and owners of the utility lines.

List of electric poles required relocation are shown in *Table 6.24* 

Elect	ric pole			
Left	Right			
-	-			
4	-			
-	-			
-	-			
-	-			
-	-			
-	-			
-	-			
-	-			
-	-			
-	-			
20				
28	-			
	Elect Left -			

# Table 6.24: Electric poles required relocation

On Approach of Bridge No.	Electric pole		
of Bridge 140.	Left	Right	
7	-	-	
8	-	-	
9	-	-	
10	-	-	
11	-	-	
12	-	-	
43	-	-	
44	-	-	
45	-	4	
46	11	6	
47	11	U	
48	-	-	
49	-	-	

On Approach of Bridge No.	Electric pole		
of bridge 100.	Left	Right	
20	12	2	
21	13	3	
22	-	-	
23	-	-	
24	-	-	
25	-	26	
26	-	-	
27	20	-	
28	-	-	
29	-	-	
30	-	-	
31	-	-	
32	-	-	
33	-	-	
34	-	-	
35	-	-	
36	-	-	
37	-	-	
38	-	-	
39	-	-	
40	1	2	
41	-	-	
42	-	-	

On Approach of Bridge No.	Electric pole		
of Bridge 140.	Left	Right	
50			
51	7	21	
52			
53	1	7	
54		7	
55	Under C	onstruction	
56		14	
57	-	14	
58	-	8	
59	-	6	
60	-	3	
61	-	6	
62	-	12	
63	-	16	
64	-	20	
65	5	3	
66	Under C	onstruction	
67	-	14	
68	-	14	
69	-	14	
70		31	
71	-	51	

**Chapter 7** 

# Environment and Social Impact Assessment

# 7. ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT

#### 7.1 BACKGROUND OF THE E & SIA REPORT

Environmental & Social Impact Assessment (EIA) report including Environmental Management Plan (EMP) is prepared as a part of feasibility study for the proposed bridges & its approaches.

## 7.2 SALIENT FEATURES OF THE PROJECT

The Salient features of the project are as under:

- 1. The road is generally in good condition except the bridges which are old steel bridges of single lane width and are proposed to be replaced by two lane wide bridges for Class 70 R loading
- 2. The trees along the bridges stretch are Gulmoher (Delonix Regia), Teak (Techtona Grandis), Amaltash (Cassia fistula), Mango (MangiferaIndica), Pipal (Ficusreligiosa) and Bamboo (Dendrocalamusstrictus). The density of the trees along the bridges &its approaches is less and total 158 trees are going to be affected.
- 3. Only 0.69 Ha Land need to be acquired for Bridge number 1 and no additional land will be required for the other bridges as proposed bridges and approaches are within the existing RoW.
- 4. The existing ROW passes through a number of villages along the stretch, No Major town located along the proposed section except Tamu and Kalewa which are located at the start and at the end of the section respectively.
- 5. Settlements/Villages falling all along the present section are given in *Table7.1*.

Sr. no.	Location	Name of Settlement/Villages	
	(in Km)		
1	0.0	Tamu Town	
2	9.6	Htan Ta Pin Village	
3	10.5	Man Maw Village	
4	13.5	Pan Tha Village	
6	20.2	Nan Mon Tar Village	
5	18.6	KhonMonn Non Village	
7	20.2	Yen Alin Fin	
8	27.7	Witoke Village	
9	31.4	Tit Tit Yan	
10	33.6	YantinAung	
11	36.2	Tywan Village	
12	38.6	Boken Village	
13	46.3	TheinZin	
14	52.3	Ka ma Kyee Village	
15	53.4	Kanan Village	
16	56.3	Khampat Town	
17	63.2	Nan katate Village	
18	66.8	Nan KhotKhotVilage	
20	74.8	KyunnDaw Yay Shin Village	
19	72.9	Phatyaryashin	
21	76.0	Saw Bwa Yay Shin	

 Table 7.1 – List of Settlement/Villages along the Project Road

Sr. no.	Location	Name of Settlement/Villages	
	(in Km)	U	
22	81.6	YanmyoAung	
23	86.9	Kaontha	
24	89.4	Khontar	
25	95.6	Kanhla	
26	99.8	Kanoo	
27	101.1	SonelarMying	
28	103.1	KanTharYar	
29	107.9	Nann Han Nwe	
30	108.8	Sakhangyi	
31	113.3	Nanbaho	
32	115.9	Maw Like Kalay	
33	117.0	In DaingKalay	
34	118.5	In DaingGyi	
35	121.7	Kyi Gone	
36	128.1	Itaya Site Khin	
37	130.4	Nat Kyi Gone	
38	132.0	Yanan Chang	
39	134.6	KyaukKar	
40	136.2	KbayaeMyaing	
41	139.6	Chaung Chin	
42	140.8	Doe Pin Chaut	
43	142.5	ThitChaut	
44	144.2	NwarSwe	
45	146.0	Nat Tet	
46	150.0	Kalewa Town	

# 7.3 SUMMARY OF THE BRIDGES FEATURES

The details of the bridges on the project section are:

Steel Bridges-69 nos.Under Construction-2 nos.Existing RCC bridges on approaches - 3 nosOther Bridges-72 nos. (Not in scope)

## 7.4 SIGNIFICANT FINDINGS

The E & SIA report was prepared after thorough interaction with the engineering section of the consultants so that the negative impacts on the environment and human population could be avoided as far as possible. Some of the important findings of the study are as follows: -

- 1. There will be no loss of bio-diversity as no rare plant or animal species are going to be affected by the present project.
- 2. No Sanctuary or National Park is located within 10 km radius of the bridges.
- 3. No historical monuments are located near the bridges.
- 4. The most important factors, which need continuous attention and assessment during the construction phase, are the ambient air quality, the water quality and the noise level. The ambient air quality of the study area is good. The quality of the ground water is good for

drinking as well as other daily use purpose. Noise levels in the area, particularly at crossing points and in the urban settlement, exceed the limits.

5. The proposed alignment of the bridges and their approaches would be such that it has minimum impact on physical and social environment. Approximately 158 numbers of trees may be cut down due to the proposed approach roads connecting bridges. No forest area will be diverted.

## 7.5 SCOPE OF THE E &SIA STUDY

The scopes of the E &SIA study are: -

- Baseline status of environmental parameters.
- Identification of the potential impacts during pre-construction, construction and operation phases.
- Developing mitigative measures to sustain and maintain the environmental scenario.
- Providing compensatory developments wherever necessary, including plans for highway side tree plantation.
- Designing and monitoring the Environmental Management Plan.
- Suggesting the Environmental Enhancement Scheme and its monitoring.
- Screening, scoping and consultations with public, experts in various fields, non-government organization (NGOs), etc.
- Review of policies and legal framework.

## 7.6 BASELINE ENVIRONMENTAL STATUS

The baseline environmental parameters were monitored during May,2014. The ambient air quality was monitored at four locations and all the parameters are well within the standards in India .The data is compared with Indian standards as there are no such ambient standards in Myanmar. The Noise levels are also very low as study area is devoid of commercial activities. The water quality of the study area is good and fit for drinking except for coliform in surface water. The soil quality in the study area is generally good for agriculture. The land use in the study area is mainly agricultural.

## 7.7 PUBLIC CONSULTATION

Public consultation at all stages of planning and implementation of a project is necessary. It helps in making the project more environment-friendly and easy to implement. Public consultation in this project is done by field-testing of questionnaires for various environmental / socio-economic parameters.

# 7.8 ENVIRONMENT MANAGEMENT & MONITORING PLAN

The Environmental Management Plan is prepared for avoidance, mitigation and management of the negative impacts of the project. It also covers remedial measures require to be taken for hot spots. EMP includes the list of all the project related activities, their impacts at different stages of project during pre-construction phase / design phase, construction phase and operational phase on environment and remedial measures to be undertaken to mitigate these impacts.

The Environmental Monitoring Programs are suggested to provide information on which management decisions may be taken during construction and operational phase. The objectives of these programs are:-

To evaluate the efficiency of mitigation and enhancement measures, updating the actions & impacts of baseline data and adaptation of additional mitigation measures (if the present measures are insufficient) and generation of the data that may be incorporated in the environmental management plan in future projects.

## 7.9 POTENTIAL IMPACTS AND MITIGATION

The finding of E & SIA indicates that project is unlikely to cause any significant adverse environmental impacts. While some of the impacts are negative, there are many bearing benefits to the area. Most of the impacts are likely to occur during construction stage and are temporary in nature. Anticipated minor impacts will be mitigated through the implementation of mitigation measures summarized in the Environmental Management Plan.

Factors contributing to minimal impacts due to proposed bridges & their approaches confined within the available ROW, presence of no sensitive environmental issue like wildlife sanctuary, national park, bio reserve, with 10 km from the proposed bridges & their approaches, water body crossing road are non-perennial in nature. However, some of the impacts are unavoidable. These impacts with mitigation measures are indicated below:

- About 158 trees need to be cut due to making approach roads along the new bridges Compensatory Tree plantation on the basis of 1:5 will be made to compensate this loss. Preventive measures shall be taken into consideration during construction phase especially in rainy months, to prevent soil erosion because of tree cutting and alteration of ground flora.
- Air Pollution due to construction activities and operation of hot mix plant will be controlled through adoption of dust suppression measures and provision of high stack for good dispersion of gaseous emission from hot mix plant.
- Noise levels may increase during the construction phase due to operation of construction machineries. All the construction equipment and DG set will be well maintained and fitted with silencers.
- Waste materials will be generated during construction phase may contaminate soil, surface and ground water resources. Waste shall be segregated and reused or disposed off in environmentally acceptable manner.
- The social issues need to be addressed through public participation during design and construction stages.

## 7.10 RECOMMENDATIONS

Adequate mitigations shall be taken up both during construction and operation stages of the project to avoid/minimize adverse environmental impacts due to the proposed activity as suggested in E & SIA. Effective EMP implementation is essential for elimination or minimization of the identified impacts. The Project proponent shall ensure that EMP and forms part of bid document and civil works contract. The same shall be revised if necessary during project implementation or if there is any change in the project design.

Project Proponent needs capacity building and practical exposure. Adequate training shall be imparted as proposed under environmental management plan to enhance the capability of concerned officials.

# Chapter 8

**Project Cost Estimate** 

# 8. PROJECT COST ESTIMATE AND IMPLEMENTATION SCHEDULE

#### 8.1 GENERAL

The cost estimates for the project are extremely important as its entire viability and implementation depends on the project cost. Therefore, cost estimates and rate analysis of the items have been carried out with due care. The project cost estimates have been prepared considering various items of works and based on the rates calculated as per standard Data Book for analysis of rates (MoRTH) and rates based on the Tamu Region (Myanmar) and Manipur (India) Schedule of rates and prevailing market rates in the project vicinity.

#### 8.2 ESTIMATION OF QUANTITIES

The quantities of major items of work for the Project road have been estimated on the basis of Pavement design, geometric design and structural design as presented in drawing Volume IV of the Project Report.

The quantities of the following major items of works has been estimated separately.

- Site Clearance
- Earth Works
- Granular Sub-base and Base Courses
- Bituminous Courses
- Bridges, Culverts and Retaining Walls etc.
- Kerbs, Drainage and Protective Works
- Road Furniture and Safety Works
- Traffic Management and Miscellaneous.

## 8.3 SITE CLEARANCE

Site clearance quantity is estimated, as overall area requires clearance for construction of road. It includes the cutting of trees etc and reuse/re-fixing of usable material.

## 8.4 EARTH WORKS

Earthwork quantities are calculated using the "MX Roads" software package. The earthwork is calculated based on the amount of cut or fill with respect to the datum line defined in the template and the existing ground profile, which in turn is obtained from the DTM surface developed by the software. The volumes of earthwork as well as materials have been calculated with the areas obtained at 10m intervals.

## 8.5 PAVEMENT MATERIAL (FLEXIBLE)

The pavement work includes construction of proposed carriageway. The flexible pavement includes Bituminous Concrete (BC), Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM), Granular Sub-base (GSB), Subgrade and other related items like prime coat and tack coat etc. over road formation. The quantities of bituminous course are calculated for full width of carriageway.

#### 8.6 CROSS DRAINAGE STRUCTURES

The construction of bridges and culverts are assessed on proposed length and the earthwork, pavement and shoulders for bridge approaches have been included as appropriate roadwork items. The other items like RCC and PCC work of bridges and culverts are calculated as per design and drawings.

#### 8.7 DRAINAGE AND PROTECTIVE WORKS

Drainage and protective works provides for the roadside drains in the plain, rolling and hilly terrain, drainage chutes and crash barriers for the embankments more than 3.0 m high and retaining and breast walls where necessary.

#### 8.8 ROAD FURNITURE AND SAFETY WORKS

Provisions for road safety measures road signs, markings, road appurtenant have been made.

The cost estimate for works item are presented in *Table 8.1*.

Bill No.	Description of Item	Amount
1	Site Clearance	33704059
2	Earth Work	99741706
3	Sub-Base And Base Courses	338453038
4	Bituminous Works	249567085
5	Culverts	36677715
6	Road Markings & Sign Boards	26893765
7	Drainage And Protection Works	345384839
8	Bridges	1530507777
9	Miscellaneous	141124915
	Sub Total	2802054898

#### Table 8.1: Project Cost Estimate