Schedules

Schedule-A

(See Clauses 2.1 and 8.1)

Site of the Project

1 The Site

(i) Site of the Project Highway "Construction of New Two-lane Bridge (Parallel to the Existing Naranarayan Setu) from km 0.000 to km 4.385 including approach road 50 m on Jogighopa side & 1990 m on Guwahati side across river Brahmaputra on NH-17 at Jogighopa in the State of Assam" shall include the land, buildings, structures, and road works as described in Annex-I of this Schedule-A.

(ii) The dates of handing over the Right of Way to the Contractor are specified in Annex-II of this Schedule-A.

(iii) An inventory of the Site including the land, buildings, structures, road works, trees and any other immovable property on, or attached to, the Site shall be prepared jointly by the Authority Representative and the Contractor, and such inventory shall form part of the memorandum referred to in Clause 8.2 (i) of this Agreement.

(iv) The alignment plans of the Project Highway are specified in Annex-III. In the case of sections where no modification in the existing alignment of the Project Highway is contemplated, the alignment plan has not been provided. Alignment plans have only been given for sections where the existing alignment is proposed to be upgraded. The proposed profile of the Project Highway shall be followed by the contractor with minimum FRL as indicated in the alignment plan. The contractor shall however, improve/upgrade the Road Profile as indicated in Annexure-III based on site/design requirement.

(v) The status of environment clearances obtained or awaited is given in Annex IV.

Annex – I

(Schedule-A)

Annex-I: Site

1. Site

The Site of the Project Highway "Construction of New Two-lane Bridge (Parallel to the Existing Naranarayan Setu) including approach road 50 m on Jogighopa side & 1990 m on Guwahati side across river Brahmaputra on NH-17 at Jogighopa" commencing from Km 0.000 of NH-17 (North Bank) to Km 4.385 of NH-17 (South Bank) in the state of Assam. The location map the Project Highway is presented below in Figure-1.

All the chainages/location referred to in Schedule-A are existing chainages. The comparison of existing and design chainages is given below.

Existing KM Stone	Design Chainage in km
20+385	0+000
21+345	1+000
22+315	2+000
23+265	3+000
24+215	4+000
24+600	4+385

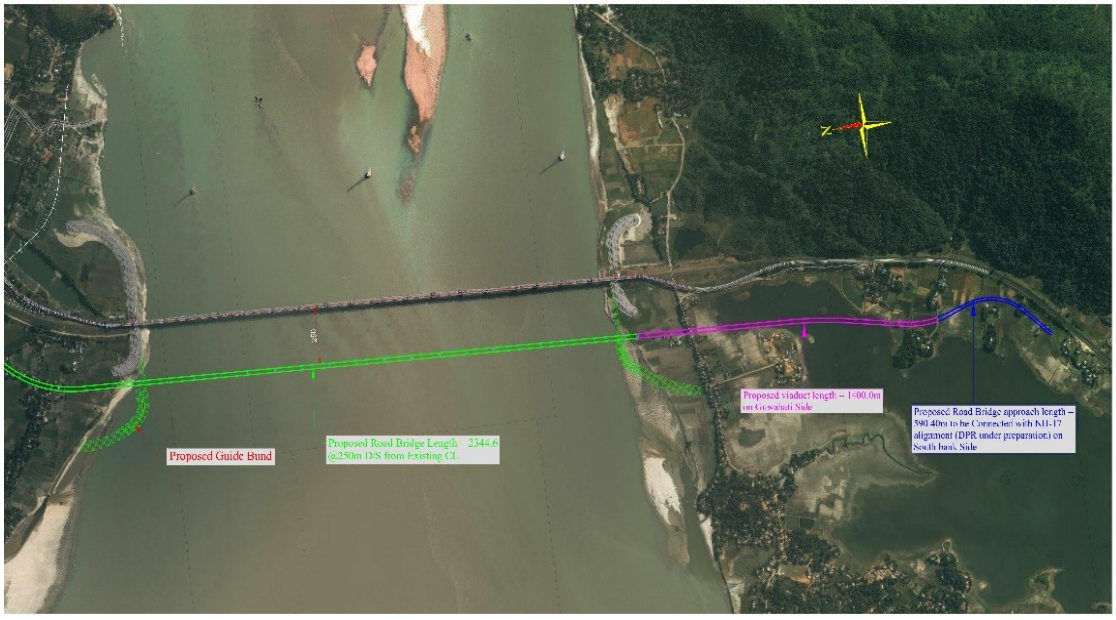


Figure 1: Location Map of Project Highway

2. Land

The Site of the Project Highway is green field alignment, so the existing right of way is not available. However, the project highway passes through mostly with government land.

Sl. No.	Design Chainage (Km)		Right of Way (m)	Remarks
	From	To		
1	0/000	0/050	18	Brahmaputra River
2	0/050	2/395	18	
3	0/095	0/120	400	Guide Bund
4	2/325	2/350	453	
5	2/395	4/385	18-24	

3. Carriageway

The existing carriageway and pavement type is descried below.

S. No.	Existing Chainage in km		Carriageway	Pavement type	Remark
	From	To			
1	20.385	22.669	2 lane	Wearing coat on Bridge	Naranarayan Setu Bridge

4. Major Bridges

(i) The site includes the existing major bride – Naranarayan Setu between existing Chainage from Km 20.385 to Km 22.669 of NH-17 in the State of Assam.

(ii) The details of existing Naranarayan Setu are as below: -

S. No.	Chainage (Km)	Type of Structure			No. of Spans with span length (m)	Width (m)	Remarks
		Foundation	Sub-Structure	Super Structure			
1	Existing Naranarayan Setu	Well	RCC Portal Frame	Steel Truss	(2x32.6m+ 17x125m+ 1x94.6 m) = 2284.8m	11.0	Rail cum Road Bridge

5. Road over-bridges (ROB)/ Road under-bridges (RUB)

The Site includes the following ROB (road over railway line):

S. No.	Chainage (Km)	Type of Structure		No. of Spans with span length (m)	Width (m)
		Foundation	Super Structure		
Nil					

6. Grade separators

The Site includes the following grade separators:

S. No.	Chainage (Km)	Type of Structure		No. of Spans with span length (m)	Width (m)
		Foundation	Super Structure		
NIL					

7. Minor bridges

The Site includes the following minor bridges on the Service Roads:

S. No.	Chainage (Km)	Type of Structure			No. of Spans with span length (m)	Width (m)
		Foundation	Sub-Structure	Super Structure		
Nil						

8. Railway level crossings

The Site includes the following railway level crossings:

S. No.	Location (km)	Remarks
Nil		

9. Underpasses (vehicular, non-vehicular

The Site includes the following underpasses:

S. No.	Chainage (Km)	Type of Structure		No. of Spans with span length (m)	Width (m)	Remark
		Foundation	Super Structure			
Nil						

10. Culverts

The Site has the following culverts:

S. No.	Chainage (Km)	Type of Culvert	Span /Opening with span length (m)	Width (m)	Remarks
Nil					

11. Bus bays

The details of bus bays on the Site are as follows:

S. No.	Chainage (km)	Length (m)	Left Hand Side	Right Hand Side
Nil				

12. Truck Lay byes

The details of truck lay byes are as follows:

S. No.	Chainage (km)	Length (m)	Left Hand Side	Right Hand Side
Nil				

13. Road-side drains

The details of the roadside drains are as follows:

S. No.	Location		Type	
	From km	to km	Masonry/cc (Pucca)	Earthen (Kutcha)
NIL				

14. Major junctions

The details of major junctions are as follows:

S. No.	Chainage (Km)	At grade	Separated	Category of Cross Road			
				NH	SH	MDR	Others
NIL							

(NH: National Highway, SH: State Highway, MDR: Major District Road)

15. Minor junctions

The details of the minor junctions are as follows:

S. No.	Chainage (Km)	Type	Side	Cross road detail (leading to)
Nil				

16. Bypasses

The details of the existing road sections proposed to be bypassed are as follows:

S. No.	Name of bypass (town)	Chainage (km) From km to km	Length (in Km)
Nil			

Annex - II

(As per Clause 8.3 (i))

(Schedule-A)

Annex-II: Dates for providing Right of Way of Construction Zone

The dates on which the Authority shall provide Right of Way of Construction Zone to the Contractor on different stretches of the Site are stated below:

S. No.	**From Km to Km**		**Length (m)**	**Width (m)**	**Date of providing ROW***
(1)	**(2)**		**(3)**	**(4)**	**(5)**
i) **Full Right of Way (full width) (At Existing Bridge)**					Appointed Date
(a) Stretch (Via Duct)	0/000	0/050	50	18	
(b) Stretch (Major Bridge)	0/050	2/395	2345	18	
(c) Stretch (Via Duct & Approach road)					
(d) Stretch (Guide Bund-North Bank)					
(e)Stretch (Guide Bund-South Bank)					
(ii) **Part Right of Way (part width)**					Appointed Date
(a) Stretch (Via Duct)					
(b) Stretch (Major Bridge)					
(c) Stretch (Via Duct & Approach road)					
(d) Stretch (Guide Bund-North Bank)	0/095	0/120	25	282	
(e)Stretch (Guide Bund-South Bank)	2/325	2/350	25	332	
(iii) **Balance Right of Way (width)**					Appointed Date
(a) Stretch (Via Duct)					
(b) Stretch (Major Bridge)					
(c) Stretch (Via Duct & Approach road)	2/395	4/385	485	18-24	
(d) Stretch (Guide Bund-North Bank)	0/095	0/120	25	118	
(e)Stretch (Guide Bund-South Bank)	2/325	2/350	25	121	

Annex - III

(Schedule-A)

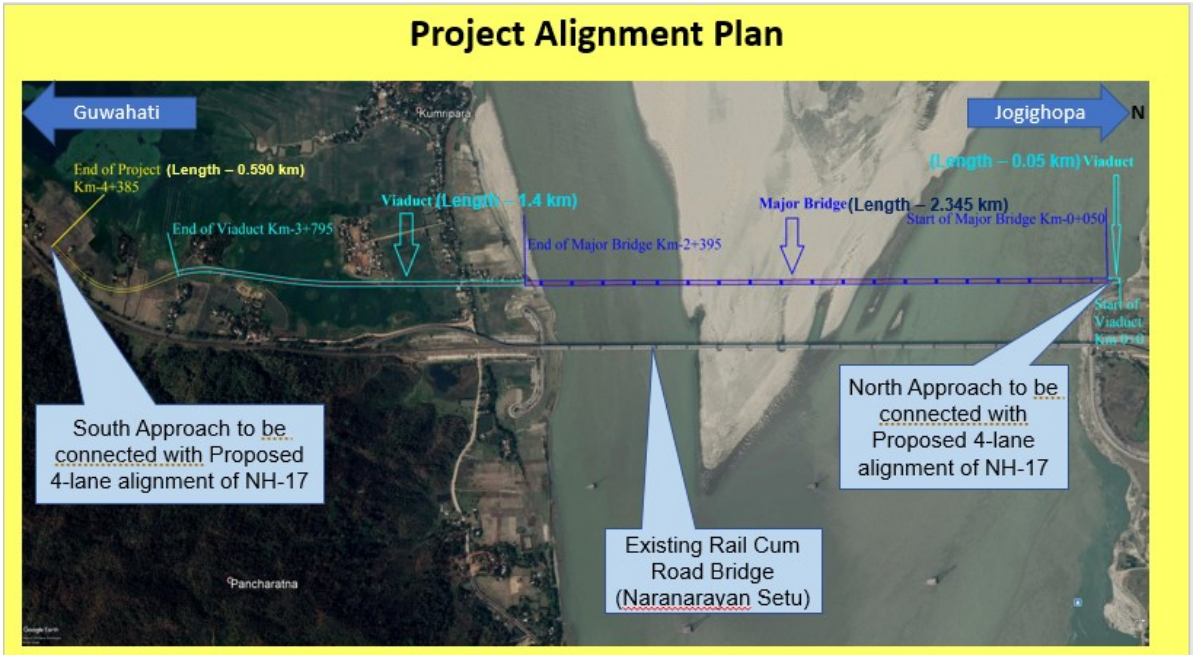
Annex-III: Alignment Plans

The existing alignment of the Project Highway shall be modified in the following sections as per the alignment plan indicated below:

(i) The alignment of the Project Highway is enclosed in Alignment Plan in digital form. Finished road level indicated in the alignment plan shall be followed by the contractor as minimum FRL. In any case, the finished road level of the project highway shall not be less than those indicated in the alignment plan. The contractor shall, however, improve/upgrade the Road profile as indicated in Annex-III based on site/design requirement. For ease of reference the key plan is given Figure-2 below.

(ii) Traffic Signage plan of the Project Highway showing numbers & location of traffic signs is enclosed. The contractor shall, however, improve/upgrade upon the traffic signage plan as indicated in Annex-III based onsite/design requirement as per the relevant specifications/IRC Codes/Manual.

Figure 2: Alignment Plan



Annex - IV

(Schedule-A)

Annex-IV: Environment Clearances

The status of environment and forest clearances activity for the Project Highway is given below:

(i) Environmental Clearance (EC):

The project involves construction of 1,28,827 square meters covered area in terms of:

Length and width of the proposed bridge is 2345m & 19.5m respectively and covered area involves of 1,28,827sqm (2345mx19.5m) i.e., 12.882 Ha.

Hence, the Environmental Clearance (EC) is not required for the Project Highway under Schedule 7(f) as per S.O. 2559 (E), MoEF Notification of 22nd August 2013 (as amendment of 14th September 2006) i.e., Expansion of National Highways greater than 100 km involving additional right of way or land acquisition greater than 40m on the existing alignments and 60m on re-alignment or f bypasses.

The project falls under category of 8 'b' as per NGT order dated 12th February 2015 and as per S.O. 5733(E) dt under schedule 8(b) 14th November 2018 and as per S.O. 5736(E) under schedule 8(b) dt 15th November 2018. Construction of Bridge or similar activity covering a buildup area >=1,50,000 sqm and /or covering an area of >50 Ha. would be covered under Entry 8(b) of schedule to the Regulations of 2006" Naranarayan Setu Built-up area Approx. 1,28,827 sqm and 12.882 Ha. Hence, less than 1,50,0000 sqm built-up area and less than covering area 50 Ha.

(ii) Forest Clearance (FC):

Proposed project does not fall under any protected/Reserve forest and hence forest Clearance is not required.

(iii) IWAI Clearances (FC):

The Bridge is across River Brahmaputra and is falling in the Navigation Waterway 1 (NW-1). The proposal for obtaining the NOCs from IWAI has been applied to Concern Authority.

[To be published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section(ii)]

MINISTRY OF ENVIRONMENT AND FORESTS
NOTIFICATION

New Delhi, the 22nd August, 2013

S.O. 2559 (E).- Whereas by notification of the Government of India in the Ministry of Environment and Forests vide number S.O.1533(E), dated the 14th September, 2006 issued under sub-section (1) and clause (v) of sub-section (2) of section (3) of the Environment (Protection) Act, 1986 read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government directed that on and from the date of its publication, the required construction of new projects or activities or the expansion or modernization of existing projects or activities listed in the Schedule to the said notification entailing the capacity addition with change in process or technology and or product mix shall be undertaken in any part of India only after prior environmental clearance from the Central Government or as the case may be, by the State level Environment Impact Assessment Authority, duly constituted by the Central Government under sub-section (3) of section 3 of the said Act, in accordance with the procedure specified therein;

And whereas the Government of India in the Ministry of Environment and Forests had constituted a High Level Committee under the Chairmanship of Member (Environment and Forests and Science and Technology), Planning Commission, vide OM No.21-270/2008-IA.III dated the 11th December, 2012 to review the provisions of Environmental Impact Assessment Notification, 2006 relating to granting Environmental Clearances for Roads, Buildings and Special Economic Zone projects and provisions under the OM dated the 7th February, 2012 issued by the Ministry of Environment and Forests regarding guidelines for High Rise Buildings;

And whereas one of the terms of reference (ToR) of the Committee was to review the requirement of Environmental Clearance for highway expansion projects upto the right of way of 60 meters and length of 200 kms under Environmental Impact Assessment notification;

And whereas the Committee has submitted its report to the Ministry and on this ToR, the Committee has recommended exempting highway expansion projects from the requirement of scoping and that Environmental Impact Assessment or Environment Management Plan for highway expansion projects may be prepared on the basis of model ToRs to be posted on Ministry's website and in respect of requirement of environmental clearance, the Committee has recommended that expansion of National Highway projects up to 100 kms involving additional right of way or land acquisition upto 40 mts on existing alignments and 60 mts on re-alignments or by-passes may be exempted from the preview of the notification;

Schedule - B

(See Clause 2.1)

Development of the Project Highway

1. Development of the Project Highway

Development of the Project Highway shall include design and construction of the Project Highway as described in this Schedule-B and in Schedule-C.

2. Rehabilitation and augmentation

Nil

3. Specifications and Standards

The Project Highway shall be designed and constructed in conformity with the Specifications and Standards specified in Annex-I, Annex-II & Annex-III of Schedule-D.

Annex – I

(Schedule-B)

Annex-I Description of Project Highway

This project includes the Construction of 2345 m long two-lane major bridge and its approaches of 50m long viaducts on Jogighopa side and 1400m on Guwahati side with 590m on embankment including SVUP of 7.0 m at 250m downstream of the existing 2-lane existing Naranarayan Setu (Rail cum road bridge). The span arrangement was proposed in the way that existing bridge pier and proposed bridge pier is in same alignment. The proposed 2-lane bridge is having 20 spans of extradosed bridge (Precast Segmental PSC Box girder of 3.5m depth) as per GAD enclosed Dwg. No. NHIDCL/Jogighopa/ Extradosed Bridge/R0_001 to 07. The new bridge shall have minimum navigational requirement of 100 m for horizontal clearance between piers and vertical clearance of 10m above HFL. The navigational clearance shall be secured in consideration of old bridge's piers as well. Total approaches of 2040 m length (50 m on Jogighopa side and 1990 m on Guwahati side) shall be developed as two-lane divided carriageway highway along the project alignment.

The project Highway shall be developed as two-lane carriageway from design km 0/000 to km 4/385 on NH-17. The new two-lane Brahmaputra Bridge and its approaches shall primarily cater both side traffic from Jogighopa to Panchratna and via-s-versa.

1. Construction of New Two-Lane Bridge and its approach as two lane Carriageway

(i) The Project Highway shall follow the 250m downstream of the existing alignment unless otherwise specified by the Authority and shown in the alignment plans specified in Annex III of Schedule-A. Geometric deficiencies, if any, in the existing horizontal and vertical profiles shall be corrected as per the prescribed standards.

(ii) Width of Carriageway: -

(a) Width of carriageway of components shall be as under: -

i. For Approach Roads:

2-lane Approach Road Sections – Both side Toe Wall		
Cross Sectional Elements: Main Carriageway	Lanes width	7.0m = 7.0m
	Paved shoulder	1x2.5 m = 2.5m
	Earthen Shoulder	2x1.5 = 3.0 m
	Total Road Width	**= 12.50m**
2-lane Approach Road Sections – Right side Toe Wall		
Cross Sectional Elements: Main Carriageway	Lanes width	7.0m = 7.0m
	Paved shoulder	1x2.5 m = 2.5m
	Earthen Shoulder	1x1.5 = 1.5 m
	Crash Barrier	1X0.5 = 0.5 m

2-lane Approach Road Sections – Both side Toe Wall		
	Total Road Width	**= 11.50m**

ii. Major Bridge including viaducts:

2-Lane Major Bridge		
Cross Sectional Elements: Bridge	Carriageway width	1X 10.5m = 10.5m
	Steel Barrier	1X0.4m = 0.4m
	Footpath	1X1.5m = 1.5m
	RCC Crash Barrier	2X0.45m = 0.9m
	Space for Pylon portion	2X1.0m = 2.0m
	RCC Handrail	2X0.2m = 0.4m
	Total deck width =	**15.7 m**
Viaduct portion		
Cross Sectional Elements: Viaducts	Carriageway width	1X 10.5m = 10.5m
	Steel Barrier	1X0.4m = 0.4m
	Footpath	1X1.5m = 1.5m
	RCC Crash Barrier	2X0.45m = 0.9m
	Gap	2X0.1m = 0.2m
	Total deck width =	**13.5 m**

iii. For SVUP

Small Vehicular Underpass		
Cross Sectional Elements: SVUP	Carriageway width	1x11m = 11m
	Crash Barrier	2x0.50m = 1.0 m
	Total deck width =	**12.0 m**

(b) Except as otherwise provided in this Agreement, the width of the paved carriageway shall conform to Clause 1 (ii) (a) above.

2. Geometric Design and General Features

(i) General

Geometric design and general features of the Project Highway shall be as specified in Plan and Profile drawings enclosed in Volume IX Drawings (Dwg. No. NHIDCL/Jogighopa/P&P/01-05/R0) provided by the authority and in conformity with the Manuals and Standards for the project.

(ii) Design speed

The design speed shall be 100 km per hr. for plain/rolling terrain.

Design Speed	Ruling (Main alignment)	100 km/hr

(iii) Improvement of the proposed road geometrics

S. No.	Stretch (from Km to Km)	Type of deficiency	Remarks
As per Alignment Plan indicated in the Annexure III of Schedule A.			

(iv) Right of Way

Details of the Right of Way are given in Annex II of Schedule-A.

(v) Type of shoulders

(a) Main Carriageway in Approach Road:

Paved shoulder	As per Typical Cross Sections given in clause 2 (xi) c of Schedule-B
Earthen Shoulder	

(b) In built-up sections, footpaths/fully paved shoulders shall be provided in the following stretches:

NIL

(vi) Lateral and vertical clearances at underpasses

(a) Lateral and vertical clearances at underpasses and provision of crash barriers shall be as per the Manual.

(b) The width of the opening and vertical clearance at the Small Vehicular underpasses shall be as follows:

S. No.	Design Chainage (Km)	Span/Opening (m)	Type	Remarks
1	3+940	1x7x4	RCC Box	New Construction

(vii) Lateral and Vertical Clearances at overpasses

(a) Lateral and vertical clearances at overpasses shall be as per applicable Manual.

(b) Lateral clearance: The width of the opening at the overpasses shall be as follows:

S. No.	Chainage (Km)	Span/Opening (m)	Remarks
Nil			

(viii) Service roads

(a) Service roads shall be constructed at the locations and for the lengths indicated below:

S. No.	Location of Service Road		Right hand side (RHS)/Left hand side (LHS)/ or Both sides	Width (m)	Length (m) of service road
	From (Km)	To (Km)			
Nil					

(ix) Grade separated structures

(a) Grade separated structures shall be provided as per Manual. The requisite particulars are given below:

i. Flyover

Sl. No.	Location of Structure (Chainage (Km))	Length (m)	Number and length of spans (m)	Approach gradient	Width (Excluding Median)
NIL					

ii. Vehicular Underpass (VUP)

Sl. No.	Location of Structure (Chainage (Km))	Length (m)	Number and length of spans (m)	Approach length (RE wall) length in m	Width in m
Nil					

iii. Small Vehicular Underpass (SVUP)

Sl. No.	Design (Chainage (Km))	Length (m)	Number x Clear Span x Clear Height (m)	Approach gradient	Overall Width in m
1	3+940	7	1x7x4.0	0.24%	12.0

(b) In the case of grade separated structures, the type of structure and the level of the Project Highway and the crossroads shall be as follows:

Sl. No.	Location	Type of structure Length (m)	Cross road at			Remarks, if any
			Existing Level	Raised Level	Lowered Level	
Nil						

(x) Cattle and pedestrian underpass /overpass

Cattle and pedestrian underpass/ overpass shall be constructed as follows:

S. No.	Location	Type of crossing
Nil		

(xi) Typical Cross Sections Schedule of the Project Road

(a) Typical Cross Section schedule at various chainages of project highway is as shown below:

TCS-SCHEDULE						
Sr. No.	**Design Chainage in m**		**Length (m)**	**Kms**	**Elevated / Approach**	**Details**
	From	**To**				
1	0.000	50.00	50.00	0.050	Viaduct	**Viaduct**
2	50.00	2395.00	2345.00	2.345	Major Bridge	**Major Bridge**
3	2395.00	3795.00	1400.00	1.400	Viaduct	**Viaduct**
4	3795.00	3910.00	115.00	0.115	TAPPER	Both side toe wall
5	3910.00	3936.50	26.50	0.027	TCS-1	Both side toe wall
6	3936.50	3943.50	7.00	0.007	SVUP	**SVUP**
7	3943.50	4140.00	196.50	0.197	TCS-1	Both side toe wall
8	4140.00	4160.00	20.00	0.020	TAPPER	One side toe wall
9	4160.00	4384.68	224.68	0.225	TCS-2	One side toe wall
TOTAL DESIGN LENGTH			**4385**	**4.385**		

(b) The description of each TCS is given below:

TCS	**Description of TCS**
TCS 1	Two Lane Carriageway with both side Toe wall
TCS 2	Two Lane Carriageway with right side Toe wall

Note:

1) Any increase in FRL and length of approaches indicated in plan layout/detailed drawing or any other place shall not constitute Change of Scope.

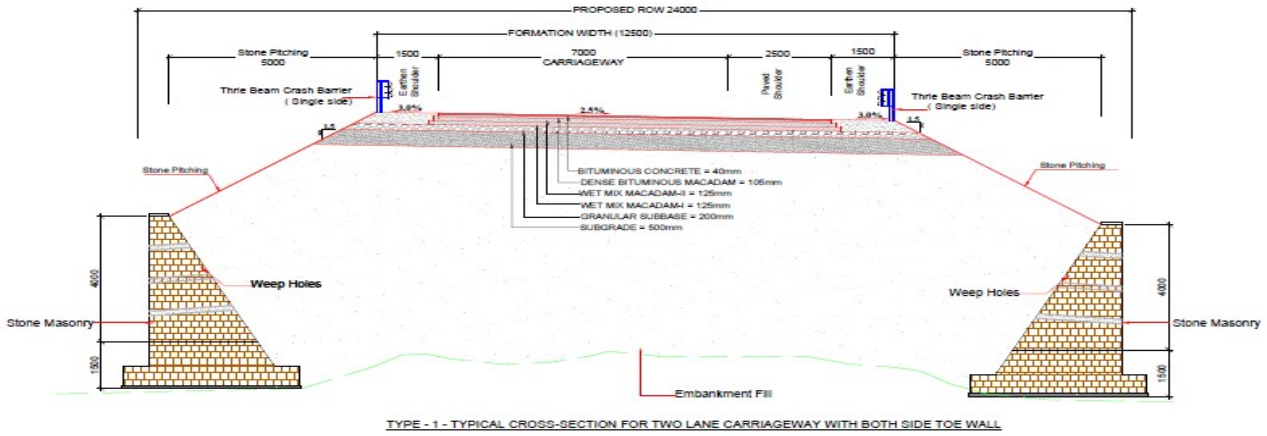
2) Any increase in lengths specified in the above table shall not constitute a Change of Scope, save and except any increase in the length arising out of a

change of scope expressly undertaken in accordance with the provision of Article 13.

3) Cross-section at Major Bridge/Minor Bridge/ROB/Viaduct approaches are to be followed for matching to adjoining cross-sections with suitable transition.

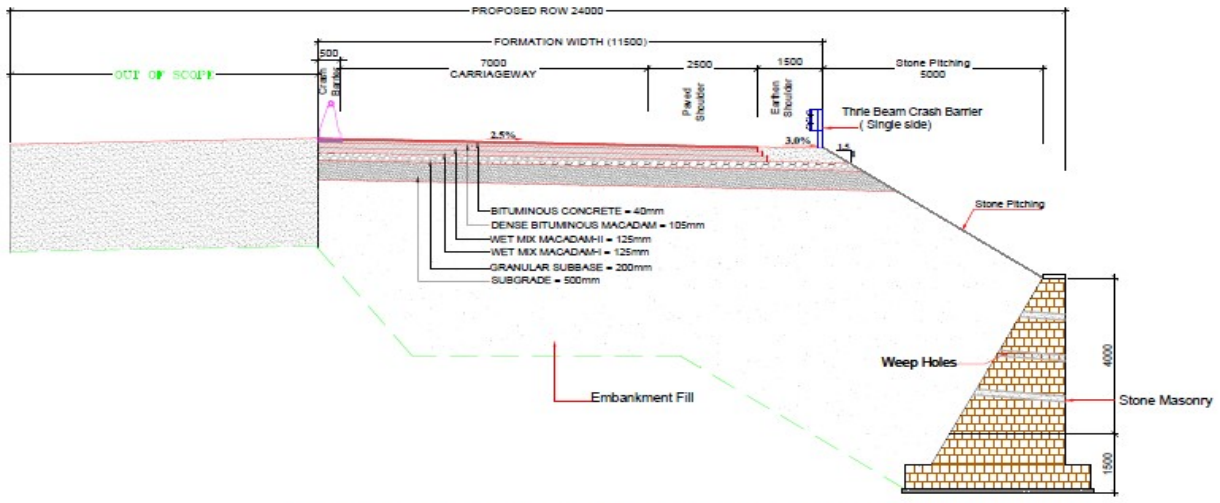
4) The cross-section given in above table is indicative and stretches may increase depending upon geometric design by contractor, and this shall not be treated as change of scope.

(c) The indicative TCSs are presented in the following pages, the TCS with broader view are enclosed in Plan & Profile specified as Annex-III of Schedule-A



TYPE - 1 - TYPICAL CROSS-SECTION FOR TWO LANE CARRIAGEWAY WITH BOTH SIDE TOE WALL

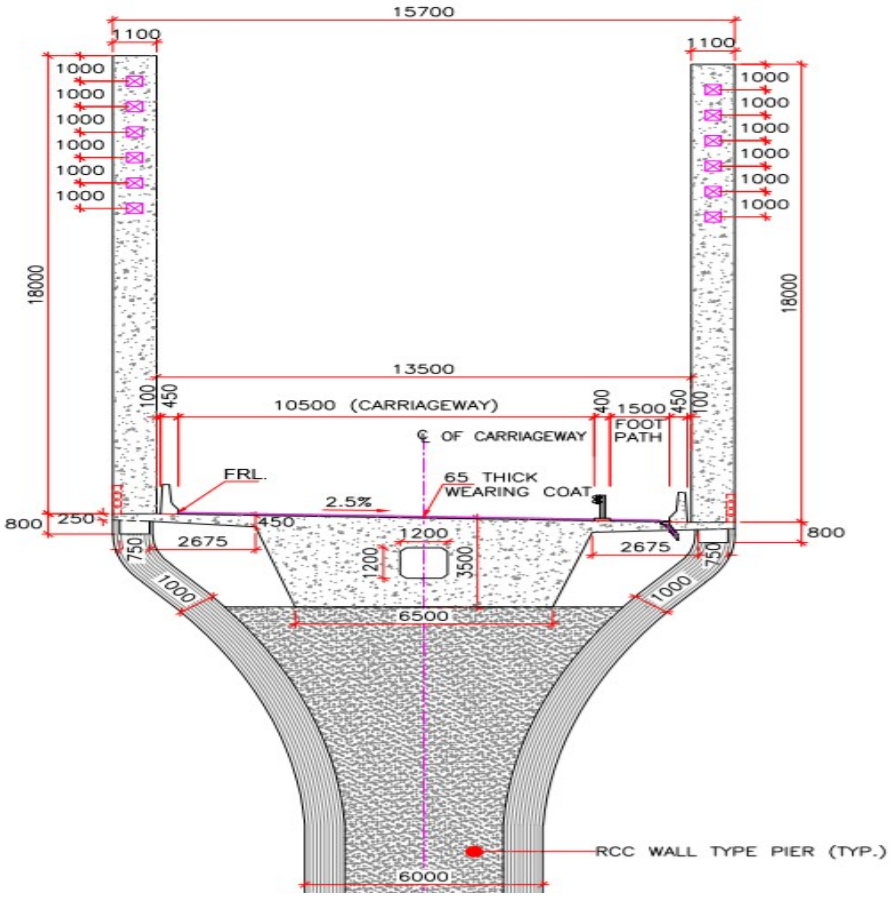
Type-1 -Typical Cross Section for Two Lane Carriageway with Both Side Toe Wall



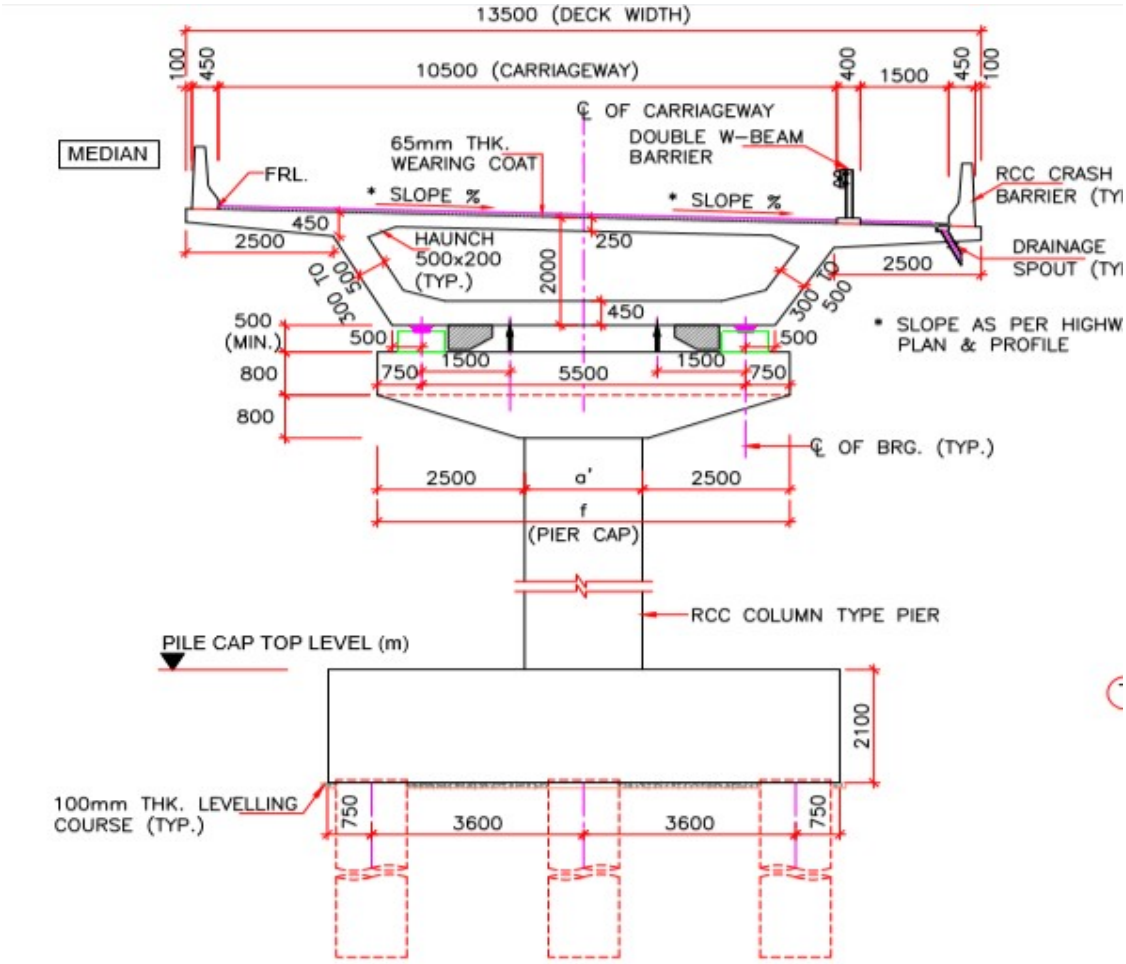
TYPE - 2- TYPICAL CROSS-SECTION FOR TWO LANE CARRIAGEWAY WITH RIGHT SIDE TOE WALL

Type-2 -Typical Cross Section for Two Lane Carriageway with Right Side Toe Wall

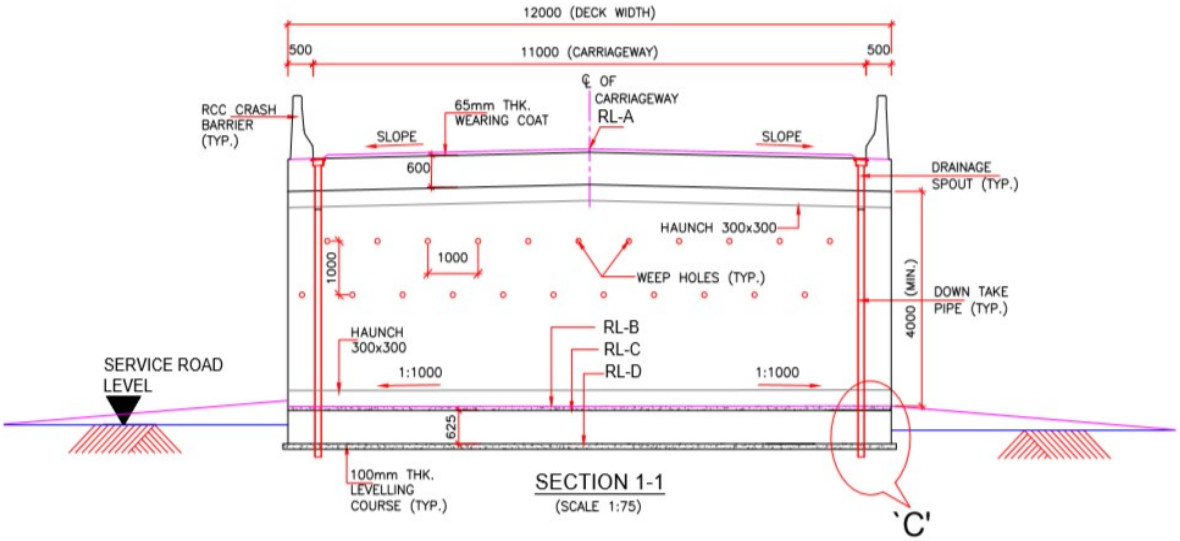
Longitudinal Section of Proposed 2 Lane Major Bridge



Cross Section of Proposed 2 Lane Major Bridge



Cross Section of Proposed Viaduct



Cross Section of Proposed SVUP

3. Intersections and Grade Separators

All intersections and grade separators shall be as per Section 3 of the Manual. Existing intersections which are deficient shall be improved to the prescribed standards.

Properly designed intersections shall be provided at the locations and of the types and features given in the tables below:

(i) At-grade intersections

Sr. No.	Location of intersection	Type of intersection	Other features	Type of Road/Remarks
Nil				

(ii) Grade separated intersection with/without ramps

Sr. No.	Location	Salient features	Minimum length of viaduct to be provided	Road to be carried over/under the structures
Nil				

(iii) Minor junctions with Service Road

Sr. No.	Chainage (Km)	Type	Side	Cross road detail (leading to)
Nil				

4. Road Embankment and Cut Section

(i) Improvement of the existing road embankment/cuttings and construction of new road embankment/ cuttings shall conform to the Specifications and Standards given in Section 4 of the Manual and the specified cross-sectional details. Deficiencies in the plan and profile of the existing road shall be corrected.

(ii) Raising of the existing road shall be as per paragraph 4.2.1 of the Manual.

5. Pavement Design

(i) Pavement design shall be carried out in accordance with Section 5 of the Manual. Further, as per Ministry Circular No. RW/NH-35072/05/2018-S&R (P&B) dated 24.08.2018, only VG-40 Grade of the bitumen shall be used for DBM layers and modified bitumen (using polymer/crumbed rubber/natural rubber) or VG-40 grade of bitumen shall be used for wearing coat of BC layer.

(ii) Type of pavement:

Flexible pavement shall be provided for the entire project highway.

Design requirements:

(a) Design Period and strategy

Flexible pavement shall be designed for a minimum design period of 20 years and minimum CBR of subgrade should be 8%. Stage construction shall not be permitted.

(b) Design Traffic

Notwithstanding anything to the contrary contained in this Agreement or the Manual, the Contractor shall design the pavement for minimum design traffic as given below.

i. Minimum pavement composition of flexible pavement for main carriageway should be adopted for new pavement/reconstruction of road as below:

Sections	Design Traffic	Pavement Composition (mm)			
		BC	DBM	WMM	GSB
Entire section of Approach road	40 MSA	40	105	250	200

ii. For Service Roads and up/down entry/exit ramps along Main Carriageway in Approaches of Main Bridge:

Sections	Design Traffic	Pavement Composition (mm)			
		BC	DBM	WMM	GSB
Nil					

iii. For Service Road along the Main Bridge: NIL

(iii) Reconstruction of stretches

The following stretches of the existing road shall be reconstructed. These shall be designed as new pavement.

Sr. No.	Stretch From km to km	Remarks
Nil		

6. Roadside Drainage

Drainage system including surface and subsurface drains for the Project Highway shall be provided as per Section 6 of the Manual.

(i) The surface drainage along the main carriageway in RE Wall portions shall be provided with necessary channels, drain pipes sufficiently so that the runoff water shall drain off quickly in order to avoid hydroplaning.

(ii) RCC covered drain shall be provided at the following stretches of built-up areas:

Sr. No.	Location of RCC Covered Drain		Side	Length (m)
	From (Km)	To (Km)		
Nil				

7. Design of Structures

(i) General

(a) All bridges, culverts and structures shall be designed and constructed in accordance with Section 7 of manual and shall conform to the cross-sectional features and other details specified therein unless otherwise mentioned in this document.

(b) The total width of new Four lane extra dosed bridge and other structures shall have the minimum requirement as follows:

2-Lane Major Bridge		
Cross Sectional Elements: Bridge	Carriageway width	1X 10.5m = 10.5m
	Steel Barrier	1X0.4m = 0.4m
	Footpath	1X1.5m = 1.5m
	RCC Crash Barrier	2X0.45m = 0.9m
	Space for Pylon portion	2X1.0m = 2.0m
	RCC Handrail	2X0.2m = 0.4m
	Total deck width =	**15.7 m**
Viaduct portion		
Cross Sectional Elements: Viaducts	Carriageway width	1X 10.5m = 10.5m
	Steel Barrier	1X0.4m = 0.4m
	Footpath	1X1.5m = 1.5m
	RCC Crash Barrier	2X0.45m = 0.9m
	Gap	2X0.1m = 0.2m
	Total deck width =	**13.5 m**
Small Vehicular Underpass (SVUP)		
Cross Sectional Elements: SVUP	Carriageway width	1x11m = 11m
	Crash Barrier	2x0.50m = 1.0 m
	Total deck width =	**12.0 m**

(c) The following structures shall be provided with footpaths:

Sr. No.	Location at Km		Length in Km	Remarks
	From	To		
1	0+000	0+050	0+050	Viaduct
2	0+050	2+395	2+345	Bridge
3	2+395	3+795	1+400	Viaduct

(d) All bridges shall be high-level bridges.

The main bridge shall meet the horizontal and vertical clearances as per IWAI guidelines, AAI norms and IRC Provisions.

(e) The following structures shall be designed to carry utility services specified in table below:

Sl. No.	Bridge at Km	Utility service to be carried	Remarks
1	Km 0+050 to Km 02+395 of NH-17	Electric Cable, OFC Cable and Water supple pipe line etc.	New 2-lane bridge (2345m)

Note: The provision of utility services specified in above table are minimum requirements, the Contractor must finalise the actual requirement of any particular utility service provision based on site conditions and in consultation with Authority Engineer.

(f) Cross-section of the new culverts and bridges at deck level for the Project Highway shall conform to the typical cross-sections given Section 7 of the Manual unless otherwise mentioned in this document.

(ii) Culverts

(a) Overall width of all culverts shall be equal to the roadway width of the approaches.

(b) Reconstruction of existing culverts:

S. No.	Culvert location	Span/Opening (m)	Type	TCS
NIL				

(c) Widening of existing culverts:

All existing culverts which are not to be reconstructed shall be widened tothe roadway width of the Project Highway as per the typical cross section given Section 7 of the Manual. Repairs and strengthening of existing structures where required shall be carried out.

Sl. No.	Culvert location	Type, span, height and width of existing culvert (m)	Repairs to be carried out
Nil			

(d) Additional new culverts shall be constructed as per particulars given in the table below:

S. No.	Culvert location	Span/Opening (m)	Type	TCS
NIL				

(e) Repairs/replacements of railing/parapets, flooring and protection works of the existing culverts shall be undertaken as follows:

S. No.	Culvert location	Type	Type of repair required
NIL			

(f) Floor protection works shall be as specified in the relevant IRC Codes and Specifications.

(iii) Bridges

(a) Existing bridges to be re- constructed/widened/retained

i. The existing bridges at the following locations shall be re-constructed as new Structures:

S. No.	Bridge Location (Km)	Salient details of existing bridge	Adequacy or otherwise of the existing waterway, vertical clearance, etc	New Span Arrangement	Remarks
NIL					

ii. The following narrow bridges shall be widened:

S. No.	Location (Km)	Existing width (m)	Extent of Widening (m)	Cross-section at deck level for widening@
Nil				

iii. The following bridges shall be retained, and necessary repair and re-habitation shall be carried out as per mentioned below respective tables:

S. No.	Location (Km)	Existing span (m)	Width (m)	Remarks
NIL				

(b) Additional new bridges Structures

New bridges at the following locations on the Project Highway shall be constructed.

S. No.	Location (km)	Total Length (m)	Remarks, if any
1	Km 0+050 to Km 02+395 of NH-17	2345m	It is (1x62.5m+14x125m+1x94.6m+3x125m +1x62.5m) spans 4-lane bridge with total length of 2345m having profile as per Dwg. No. NHIDCL/Jogighopa/ Extradosed Bridge /01 to 07/R0

Note (*): -

1. Tentative GADs for the Two-lane bridges in Figure-3 is given below, for the tentative GADs of other bridges are included in Alignment Plan specified in Annex-III of Schedule-A.

2. The Two-lane bridge with 20 main spans (1x62.5m+14x125m+1x94.6m+3x125m+1x62.5m) shall be provided between chainage Km 0+050 to Km 02+395. The proposed bridge is having Extradosed

Bridge type with integral PSC Box girder. The detail of Superstructure is as under-

3. Discharge shall be considered as 90500 cumecs at proposed bridge for the design of bridge.

4. The safe bearing capacity for well foundation found out at RL (-) 43.73 is 135t/sqm. This SBC shall be reduced by 1 t/sqm when the founding level is up and increase by 1 t/sqm when the founding level will be decrease from the RL (-43.73) m.

5. The pile depth shall be terminated minimum upto where the good quality of rock shall be found.

6. The Expansion Joints in the proposed 2-lane bridge shall be provided as per attached GAD. The Expansion Joints shall be of modular type. The tentative drawing is shown in Fig 3 on next page.

7. No major change in the span arrangement given in tentative GAD shall be entertained unless it is required as per any constraint(s) and approved by Authority. Any financial implication due to require such changes shall be borne by the EPC Contractor.

8. The navigational Channel in proposed bridge is considered as per the present span of existing Naranarayan Setu navigational channel. Considering the guidelines of IWAI (Class VII type river as per the Gazette of India January 20, 2007 (PAUSA 30, 1928), Part-III, Section-4, IWAI), i.e., minimum requirement of 100m for horizontal clearance between piers and vertical clearance (bottom/soffit of girder) of 10m above HFL

9. The bridge gradient shall be 1 in 50 so that it causes minimum discomfort to pedestrians and cyclists.

10. Pile Integrity test shall be carried out at pile foundation as per procedures given in IRC:78-2014 Appendix-7 part-2. Number of tests shall be decided by engineer to the project.

11. For extradosed/cable supported bridge portion, minimum concrete grade for Pylon, substructure etc. will be M- 60.

12. Both banks of river shall be protected by Guide bund / protection work along the abutment as per codal and /or design requirement and specification.

13. Certificates for Wind load stability and Earthquake resistance design shall be given by construction agency and checked by proof consultant and approved by Authority Engineer and client.

14. 65 mm wearing coat shall be provided on main bridge.

15. Reinforced Cement Concrete (RCC) Crash Barrier & Metal Beam Crash Barrier shall be provided in accordance with IRC: 5-2015 and relevant provision.

16. Lightning arrester shall be installed on top of all Pylons.

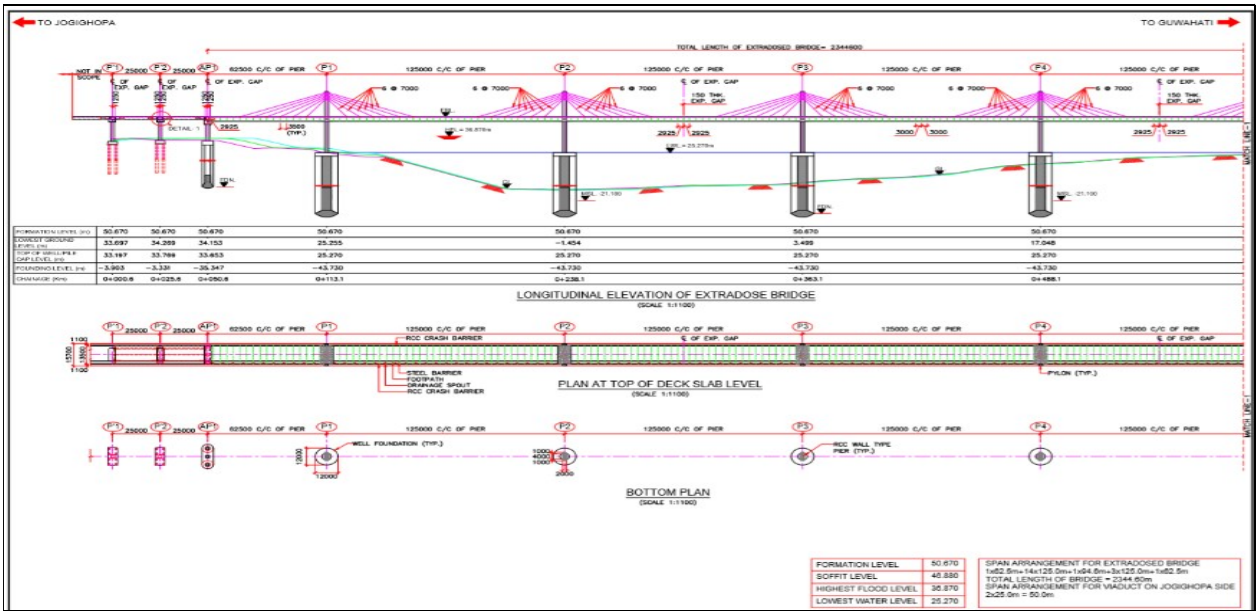


Figure 3A: GAD New 2 Lane Bridge (0+050 to Km 2+395 of NH-17)

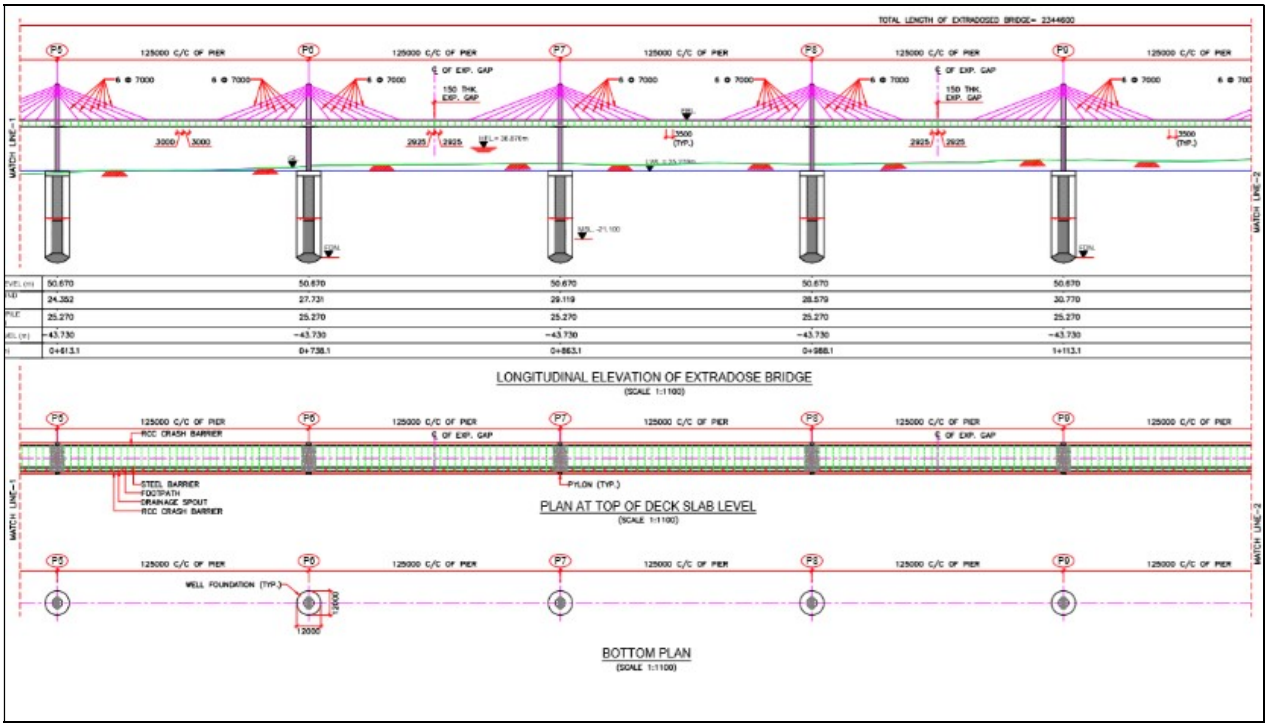


Figure 3B: GAD New 2 Lane Bridge (0+050 to Km 2+395 of NH-17)

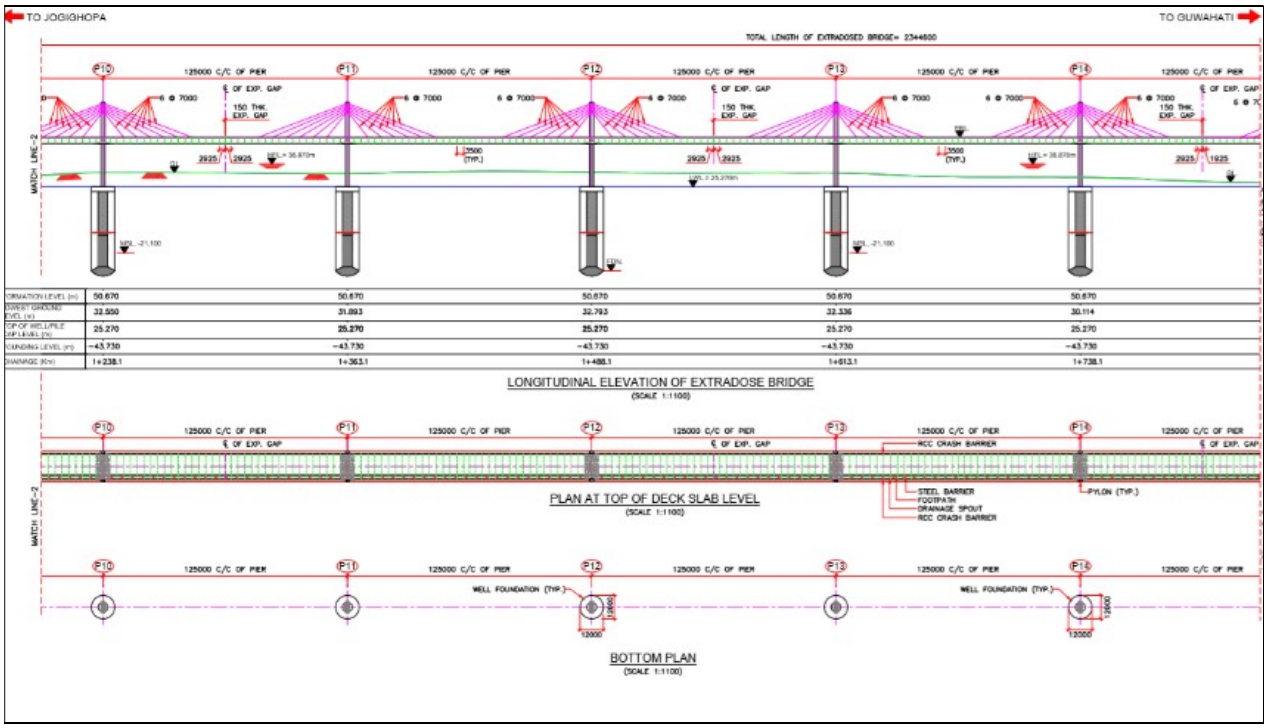


Figure 3C: GAD New 2 Lane Bridge (0+050 to Km 2+395 of NH-17)

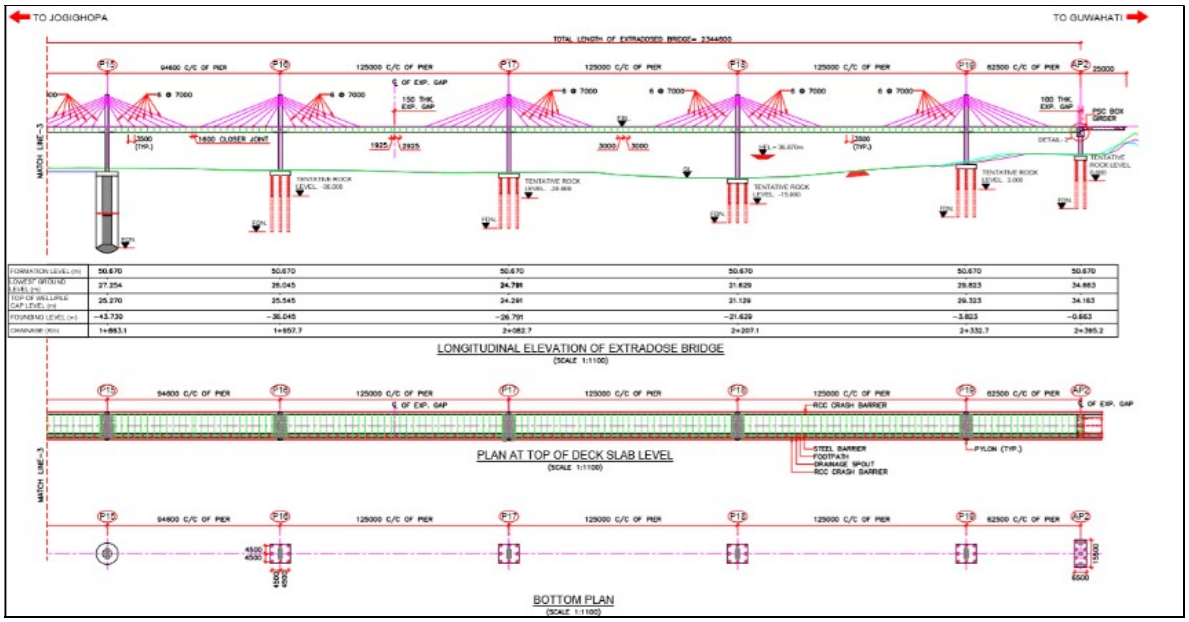


Figure 3D: GAD New 2 Lane Bridge (0+050 to Km 2+395 of NH-17)

(c) The railings of existing bridges shall be replaced by crash barriers at the following locations:

Sr. No.	Location at km	Remarks
Nil		

(d) Repairs/replacements of railing/parapets of the existing bridges / Viaducts / ROBs shall be undertaken as follows:

Sr. No.	Location at km	Remarks
Nil		

(e) Drainage system for bridge decks

An effective drainage system for bridge decks shall be provided as specified in paragraph 7.20 of the Manual.

(f) Deleted

(iv) Rail-road bridges

(a) Design, construction and detailing of ROB/RUB shall be as specified in the Manual.

(b) Road over-bridges

Sr. No.	Chainage	Type of Crossing	Proposed Structure Type	Proposed Span Arrangement	Total Width of the Structure
NIL					

(c) Road under-bridges

Road under-bridges (road under railway line) shall be provided at the following level crossings, as per GAD drawings attached:

Sr. No.	Location of Level crossing (Chainage km)	Number and length of span (m)
Nil		

(v) Grade separated structures/ Viaduct

S. No.	Location (km)	Total Length (m)	Span Arrangement (No. x Length)	Remarks, if any
1	Km 0+000 to Km 0+050 of NH-17	50m	2x25 m	Jogighopa Side (North Bank)
2	Km 2+395 to Km 3+795	1400m	56x25 m	Guwahati Side (South Bank)

(vi) Repairs and strengthening of bridges and structures.

The existing bridges and structures to be repaired / strengthened, and the nature and extent of repairs /strengthening required are given below:

(a) Bridges

Sl. No.	Location of bridge (km)	Nature and extent of repairs /strengthening to be carried out*
NIL		

(b) ROB

Sl. No.	Location of ROB/RUB (km)	Nature and extent of repairs /strengthening to be carried out*
NIL		

(c) Overpasses/Underpasses and other structures

Sl. No.	Location of Structure (km)	Nature and extent of repairs /strengthening to be carried out*
Nil		

(vii) List of Major Bridges and Structures

The following is the list of the Major Bridges and Structures:

Sr. No.	Location at Km		Length in Km	Remarks
	From	To		
1	0+000	0+050	0.050	Viaduct
2	0+050	2+395	2.345	Bridge
3	2+395	3+795	1.400	Viaduct
4	3+937	3+944	0.007	SVUP

8. Traffic Control Devices and Road Safety Works

Traffic control devices and road safety works shall be provided in accordance with the Manual of Specifications and Standards as referred in Schedule "D" and in consultation with the Authority Engineer. The minimum provisions shall be as given below:

(i) Traffic Signs and Pavement Markings:

(a) Traffic signs and pavement markings shall include roadside signs, overhead signs; Kerb mounted signs of retro reflective reflector and road markings of hot applied thermoplastic material with glass reflective reflector along the Project Highway shall be as per IRC 67 & IRC 35. The location shall be finalized in consultation with the Authority Engineer.

(b) Minimum 2 numbers of Overhead signs shall be placed on a structurally sound gantry or cantilever structure made of GI pipes. Its height, lateral and vertical clearance for installation shall be as per guidance provided in IRC 67 and also as per MORTH specifications.

(ii) Reflecting Sheeting shall be as per paragraph 9.3 of the Manual.

(iii) Instrumentation and Monitoring System for Stay Cables shall be put in place for safety during use of cable-stayed bridge as specified in Annexure I of Schedule-C & Annexure II of Schedule-D.

9. Roadside Furniture

(i) Roadside furniture shall be provided in accordance with the provisions of Section 9 of the Manual. Following minimum requirements shall be fulfilled:

(a) Road Marking:

Road marking as per IRC: 35 shall be of hot applied thermoplastic material with glass reflectorizing beads as per relevant specifications, and this shall be provided at edge side, lanes and median side.

(b) Road Delineator:

Circular iron posts of 1.0 m height or concrete or manufacture product with retro reflective reflector as per IRC: 79 shall be provided at necessary locations.

Hazard markers shall be provided as given in IRC: 67. In addition, the objects close to the road shall be painted with black & yellow stripes using the paint conforming to IS: 164.

(c) Reflective Pavement marker (Road Studs):

The reflective pavement markers (RRPM) i.e. road studs shall be provided to improve the visibility in night time and wet weather conditions. These shall be prismatic retro reflective type conforming to ASTM D 4280. This shall be provided throughout the project.

(d) Thrie beam barrier & Concrete barrier shall be provided Minimum 1145 m at the project highway as per section 9 of the manual. It shall be provided at viaduct/bridges/underpass approaches.

10. Compulsory Afforestation

As per environmental guidelines new trees shall be planted, as per guideline of the MOEF.

11. Hazardous Locations:

Sr. No.	Design Length in km		Length (m)	Side
	From	To		
Nil				

(i) Details of Toe Wall/ Retaining Wall Locations:

Sr. No.	Design Chainage in km		Length (m)*	Side
	From	To		
1	3+795	3+910	115	RHS
2	3+910	3+936.5	26.6	BOTH SIDE

3	3+943.5	4+140	196.5	BOTH SIDE
4	4+140	4+160	20	RHS
5	4+160	4+385	225	RHS

- T
  he length provided is minimum only & any change in length shall not be considered as a "change in scope of works**".**

12. (a) Special Requirement for Hill Roads

Nil

(b) Special Requirement of Project Highway

i. The Two lane extradosed bridge shall be designed as architecturally/aesthetically marvellous structure. The EPC contractor shall have design competition for pleasing visual impression of the proposed bridge before finalizing structural design.

ii. Bridge Health Monitoring System (BHMS): -

Nil

iii. The maximum stretch of the proposed project falls in the Brahmputra river land, hence the embankment construction shall be in such a way that it shall be protected from the rise in water level due to rains, floods and monsoon. The embankment protection is an integral part of Embankment construction. The Protection of the riverbank in the Elevated Structure portion shall also be done in proportion to the Construction length of the structure for the safety of the bank in this region. To understand the exact river behaviour throughout the year following points needs to be review:

(a) Observations for Hydrological Data: To establish a data acquisition network in the area to observe water level, velocity and discharge in both the channels so that the studies on certain assumptions/ limitations can be modified to take care of observed data for assessing the hydraulic design parameters accurately for bridge and river training/ protection works during next stage of detailed engineering /construction.

(b) Hydraulic Model Study: Modelling by scaling down the geometrical dimensions of river, structures and other temporary / permanent features to validate them in prototype for hydraulic behaviour of the river, is a convenient method of river behaviour study with and without man's intervention. There are number of complex factors in the design of hydrological structures, therefore, adequate answer to various problems cannot be obtained by analytical methods. Small scale models have, therefore, become effective and handy for hydraulic design engineers as it is possible to impose design condition on the model for any number of times and sufficiently for longer duration to have thorough testing. Physical model study is valuable to arrive at various guidelines for an optimum design of bridge length and river training/protection measures based on the field river configuration and tested on the model.

(c) Recommendation for Hydraulic Model Study: Ideally the hydraulic model (physical model) test should be done to decide the exact location and layout of river training and protection works based on the river configuration during construction. Model should be retained till the construction of bridge for monitoring river behaviour

post monsoon and effects of manmade structures inside the khadir are being undertaken on a yearly basis and timely steps being undertaken to mitigate damage and control erosion to the protection works/banks etc.

iv. Suitable measure to be adopted not to affect the Flora and fauna and disturbance to aquatic life.

v. Any construction material should not be disposed in the Brahmaputra River. All precautions have to be taken by the Contractor, particularly at all stages of construction of the main bridge, that no solid or liquid waste/released material is dumped in the River Zone area. The solid waste shall be properly collected, segregated and disposal as per provision of Solid Waste (Management and Handling) Rules, 2000.

vi. During the construction phase noise pollution should be minimised in the river for the safety of these animals are very sensitive to noise.

vii. All the Environmental mitigation measure is mandatorily to be taken during various stages of construction.

viii. The traffic movements across the river Brahmaputra during the construction shall be managed by State Government through existing Naranarayan Setu or by other means.

ix. After the completion of maintenance period, the illumination shall be done by State Government.

13. Change of Scope

The length of Structures and bridges specified herein above shall be treated as an approximate assessment. The actual lengths as required on the basis of detailed investigations shall be determined by the Contractor in accordance with the Specifications and Standards. Any variations in the lengths specified in this Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 13.

(Schedule B-1)

(ii) The shifting of utilities and felling of trees shall be carried out by the Contractor. The cost of the same shall be borne by the Authority. The details of utilities are as follows:

Sr. No	Type of Utility	Unit	Quantity*	Location/stretch (LHS/RHS)
A	Electrical Utilities			
A1	Electrical Poles	Nos.	5	
A2	Electrical cables	meters	200	
A3	Felling of Trees	Nos.	10	

(*) Note: The quantity given above is indicative, the Contractor has to finalise the actual requirement of shifting of various utilities duly verified by the concerned utility authorities and approved by Authority.

Schedule - C

(See Clause 2.1)

Project Facilities

1. Project Facilities

The Contractor shall construct the Project Facilities in accordance with the provisions of this Agreement. Such Project Facilities shall include:

I. Toll plaza;
II. Roadside furniture;
III. Pedestrian facilities;
IV. Landscaping and tree plantation;
V. Truck lay-bys;
VI. Bus-bays and bus shelters;
VII. Street lighting;
VIII. Traffic aid posts;
IX. Medical aid posts;
X. Vehicle rescue posts;
XI. Telecom system;
XII. Vehicles for Authority:
XIII. Advanced Traffic Management System (ATMS);
XIV. Rainwater Harvesting;
XV. Slope Protection;
XVI. Utility Crossing;
XVII. Decorative lighting , Theme lighting;
XVIII. Monitoring Equipment for Stay Cables;
XIX. Bridge Health Monitoring System (BHMS) and

2. Description of Project Facilities

Each of the Project Facilities is described below:

(i) Toll Plaza:

Design Chainage	No of Lanes	Location	Remarks
NIL			

(ii) Road side furniture:

Roadside furniture such as Metal Beam Crash Barrier at high embankment locations, Boundary Stones, Hectometer / Kilometer Stones and any other road side furniture shall be provided all along the project road in accordance with the Manual of Specifications and Standards as referred in Schedule "D" and in consultation with the Authority Engineer.

(iii) Pedestrian facilities:

Pedestrian Facilities shall be provided in accordance with the Manual of Specifications and Standards as referred in schedule "D". The minimum provisions shall be as given below:

(a) Footpaths: Minimum width of 1.5m footpaths shall be provided as per Schedules-B.

(b) At grade pedestrian crossings shall be provided for all the intersections of cross roads with service roads and entry exit ramps. At grade pedestrian crossing shall be controlled. Controlled form of crossing shall be achieved through provision of Zebra Crossings, whether at signalised intersection or pedestrian actuated signal.

(iv) Truck lay-byes:

Locations for proposed truck lay-byes are as follows:

S. No.	Design Chainage	Side	Remarks
Nil			

(v) Bus bays and Bus Shelters:

Bus bays / Bus Shelter shall be provided at following locations as minimum in accordance with the Manual of Specifications and Standards as referred in schedule "D".

S. No.	Approximate location	Side (Left/Right)	Location	Remark
NIL				

(vi) Street lighting:

The Street Highway/ Bridge lighting shall be provided on the Entire Project Length. in accordance with Manual of Specifications and Standards as referred in schedule "D". The minimum provisions shall be as given below:

(a) Highway & Bridge lighting Double Arm Poles (147 Nos. minimum) and shall be provided at locations as per the TCS in accordance with Manual of Specifications and Standards as referred in schedule "D". Location shall be finalised in consultation with Authority Engineer.

(vii) Traffic Aid Posts:

Nil

(viii) Medical Aid post:

Nil

(ix) Vehicle rescue posts:

Nil

(x) Telecom system:

Emergency call boxes shall be provided at an interval of 2km in accordance with Manual of Specifications and Standards as referred in schedule "D".

(xi) Vehicles for Authority:

Nil.

(xii) Advanced Traffic Management System (ATMS):

Nil

(xiii) Rainwater Harvesting:

As per Ministry of Environment and Forests Notification, New Delhi dated 14.01.1997 (as amended on 13.01.1998, 05.01.1999 & 6.11.2000), the construction of Rainwater, harvesting structure is mandatory in and around Water Crisis area, notified by the Central Ground Water Board.

(xiv) Slope protection:

The slope protection by lawn or any other method using green technology will be provided at locations, where embankment height is more than 1.00 m and in approaches of Viaducts/Flyover/bridges as per Manual and as decided by Authority's Engineer/NHAI.

(xv) Utility Crossing:

Yes

(xvi) Monitoring Equipment for Stay Cables:

The monitoring equipment for Stay Cables should be furnished by the EPC Contractor as per Manufacturers recommendations as mentioned in the 7 (iii) (b) Schedule-B.

The load cells and Bi-directional accelerometers may be installed for permanent monitoring the stay cables.

(xvii) Bridge Health Monitoring System (BHMS):-

Nil

Schedule - D

(See Clause 2.1)

Specifications and Standards

1. Construction

The Contractor shall comply with the Specifications and Standards set forth in Annex-I, Annex-II and Annex-III of this Schedule-D for construction Project Highway.

2. Design Standards

The Project Highway including Project Facilities shall conform to design requirements set out in the following documents:

(a) Manual of Specifications and Standards for Four Laning of Highways (IRC: SP:84-2019) referred to herein as the Manual and all the other latest IRC Codes, specifications and circulars issued by MoRTH /NHAI unless otherwise specified in the schedules of this agreement.

Annex – I

(Schedule-D)

Annex-I: Specifications and Standards for Construction

1. Specifications and Standards

All Materials works and construction operations shall conform to the "Manual of Specifications and Standards Four Laning IRC: SP: 84:2019", as applicable referred to as the Manual (s), and MoRTH Specifications for Road and Bridge Works. Where the specification for a work is not given, Good Industry Practice shall be adopted to the satisfaction of the Authority's Engineer.

2. Deviations from the Specifications and Standards

(i) The terms "Concessionaire", "Independent Engineer" and "Concession Agreement" used in the Manual shall be deemed to be substituted by the terms "Contractor", "Authority's Engineer" and "Agreement" respectively.

(ii) Notwithstanding anything to the contrary contained in the Paragraph (i) above, the following Specifications and Standards shall apply to the Project Highway and for the purposes of this Agreement, the aforesaid Specifications and Standards shall be deemed to be amended to the extent set forth below:

Sr. No.	Clause referred in the Manual	Item	Provision as per Manual	Description of Deviation
1	7.3	Width of Structures (only in Major Bridge)	Fig.7.2A: 4-lane divided Highway	As per Schedule-B (Due to extra-dose bridge, the deck width of proposed Major bridge portion having more than of proposed in IRC (2-lane of 4-lane divided carriageway) to accommodate the pylon.

Annex – II

(Schedule-D)

Annex-II: Specifications and Standards for Construction Extra-dosed Bridge

1. Description

This specification is for the construction of Extradosed Bridge. An Extradosed bridge is frequently described as a blending between a box girder bridge and a cable-stayed bridge. A typical cable stayed bridge has a tower with a height above the deck at least half the span to the next support, since the cables are the vertical support and must come at a relatively high angle. In an extra-dosed bridge, the deck is directly, supported by resting on part of the tower, so that in close proximity to the tower the deck can act as a continuous beam. The cables from a lower tower intersect with the deck only further out, and at a lower angle, so that their tension acts more to compress the bridge deck horizontally than to support it vertically. Thus, stay cables act as prestressing cables for a concrete deck, made of a box girder. The extra-dosed bridge resembles more closely that of a continuous girder bridge with external prestressing. The main characteristic of extra-dosed bridges is the arrangement of external cables, as opposed to placing it inside the girder. The stay cables behave like prestressing cables passing over the pylons that act as deviator thus adding eccentricity to the tendons.

2. Materials

a. Concrete

Construct concrete according to "Section 1700 STRUCTURAL CONCRETE" of MoRTH Specifications for Road and Bridge Works.

b. Reinforcing Steel

Construct reinforcing steel according to "Section 1600 STEEL REINFORCEMENT" of MoRTH Specifications for Road and Bridge Works.

c. Prestressing

Construct prestressing steel according to "Section 1800 PRESTRESSING" of MoRTH Specifications for Road and Bridge Works.

3. Construction

a. General

The Contractor shall be responsible for geometric control of construction such that the completed structure will conform to the lines, grades, and dimensions and cable stresses on the Plans accepted by the Authority's Engineer.

b. Construction requirements

1. The Contractor shall submit to the Authority's Engineer a proposal detailing the construction sequence. The submission shall incorporate detailed methodology, shop and erection drawings of the proposed construction sequence, together with the corresponding complete and checked erection design calculations in every erection step to obtain the correct elevation in the completed bridge. The package shall be submitted at least twelve (12) weeks prior to the commencement of construction of the superstructure for the Authority's Engineer's approval. Include the following to perform prestressing:

2. The program of dimensional survey of all construction works will be subject to the approval of the Authority's Engineer. The Contractor shall employ a suitably qualified Erection Authority's Engineer (Professional engineer), preferably from the company preparing the erection design calculations, and experienced in erection Authority's Engineering and geometry control on a similar bridge project, to review survey data during each individual erection phase, and to determine alignment of the pier form and form traveller and recommend adjustments to geometry necessary to correct any deviations from the planned alignment.

3. Setting points situated at support lines are presented in the Drawings. These points are acting as coordinate points for the bridge structure. When surveying the structure, the required tolerances are to be taken into consideration. In order to find out the standard error and deviation, each survey is to be carried out from a different base point. Positioning surveys and inspection surveys of the completed structure shall be documented. The positioning survey, the standard error and deviation in the measurements of the structure shall be documented.

c. Tolerance

The tolerances define the maximum discrepancies between the theoretical reference dimensions and the dimensions measured in-situ by topographical survey that will be admitted without penalty upon final acceptance of the works.

(a) Bridge and superstructure Deck - Erection tolerances:

The guide pipes for cable anchorages in the deck and in the pylon shall be installed to the following tolerances:

- ✓ Globally in levels: ± 25 mm
- ✓ Laterally relative to the pylon and box girder centre ± 10 mm
- ✓ Vertically relative to the box girder soffit. ± 10 mm

Within 48 hours of completion of each stay stressing operation the Contractor shall provide to the Engineer the following information:

- ✓ Climatic data
- ✓ Stay force and extension, on each side
- ✓ Level of control points situated at mid-segment, on the stay anchorage axis, before stay installation and after the tensioning, for a survey achieved at mid-morning,

- ✓ Pylon top horizontal movement,

In addition, at the time of every two stay installation, the Contractor shall survey the entire deck profile for comparison with theoretical values, taking in account the actual temperature and actual construction loading, for instance the strand coils.

All measurements shall be taken at the time of day when the effects of solar gain (or loss) on the structure are at a minimum (normally, between 9 and 11:00 a.m.)

The maximum deviation from the theoretical deck profile, for any stage of construction, shall not exceed ±25mm.

If the measured deck profile after temperature and other adjustments does not correspond with the theoretical deck profile from the stage by stage analysis by more than the permitted deviation the Contractor shall propose the most appropriate corrective action.

This corrective action shall, subject to the consent of the Engineer, be immediately incorporated into the Contractor's method of working.

The permitted deviation in the actual deck profile from the theoretical deck profile after mid span closure, but prior to the installation of the surfacing and bridge equipment, shall not exceed ±25 mm.

(b) Prestressing

Installation tolerance of deviators for external prestressing tendons shall satisfy the following requirements:

- ✓ Longitudinal direction: not more that L/200 or 10mm
- ✓ Transverse direction: not more than the smallest of L/200, T/80 or 10mm
- ✓ Vertical direction: not more than the smallest of L/200, V/80 or 10mm
- ✓ Angle: not more than 5/100 radian

Where, L=Free length of the cable (mmm)

T=Width of bottom slab (mm)

V=Height of box girder (mm)

d. Superstructure

Situated on the rivers, the segments in concrete part shall be erected the already "traditional" symmetric balanced precast segmental cantilever method, using pairs of Derrick Crane (DC). The deck system consists of a posttensioned precast concrete box girder section, where a structure is built outward from a fixed point to form a cantilever structure, without temporary support, using staged precast segmental construction. When two opposing free cantilever structures are attached as a single structure and erected in the same step, it is known as 'balanced cantilever'. This erection method utilizes derrick crane where box girder sections are lifted up and post-tensioned.

Precasting of segments, Shear keys, epoxy jointing of segments and other process not mentioned herein shall be applied in accordance with MoRTH Specifications for Road and Bridge Works (Fifth Revision 2013).

Steel box girder at the center of main spans is erected by crane. End span shall in principle be erected using temporary fixed false-work.

- ✓ Pier head segments need to be the minimum length required for the installation of derrick crane.
- ✓ Details and computations of the cast-in-place concrete forming system should be submitted to the approval of the Authority's Engineer. This includes maximum loadings and stresses created because of equipment and concrete; deflections during placement and temporary supports; and a detailed step-by-step procedure for placement, stressing, and form advancement.
- ✓ Camber will be monitored at each stage of construction. The constructor should submit a survey plan depicting proper erection to the final grades and cambers.
- ✓ Recommended erection tolerance from the predicted alignment is ±1 in (±25mm)
- ✓ Typical balanced method's cycle is:

1. Installing the derrick crane (DC).
2. Lifting up a precast segment.
3. Post tensioning and pumping the grout into the duct
4. Setting forward DC and installing stay cable for cable anchor segment.
5. Doing the same way for next segment before closure segment

e. Pylon

The pylon is constructed 'in situ' with formwork and falsework.

- ✓ The Contractor shall submit documentation to the satisfaction of the Engineer demonstrating that the proposed mix design(s) will satisfy the strength, durability, and performance requirements.
- ✓ The Contractor shall construct the formwork and falsework in accordance with the submitted Shop Drawings. Variations from the formwork and falsework Shop Drawings will not be permitted unless the Engineer is provided with revised Shop Drawings that have been sealed, signed and dated by the Professional Engineer.
- ✓ Formwork and falsework are both structural systems. Formwork contains the lateral pressure exerted by concrete placed in the forms. Falsework supports the vertical and/or the horizontal loads of the formwork, reinforcing steel, concrete, and live loads during construction.
- ✓ The Contractor shall set falsework, to produce in the finished Structure, the lines and grades indicated in the Contract Plans. The setting of falsework shall allow for shrinkage, settlement, falsework girder camber, and any structural camber the Plans or the Engineer require.

f. Stay Cables

i. Description

Supply, fabricate, deliver, test, store, install, stress, re-stress, adjust, repair and/or replace damaged components (if necessary), and permanently protect stay cables. Stay cables include, but are not limited to, main tensile elements (strands), strand sheathing, complete anchorage components, wedges, bearing plates, sealing components, damping devices, anti-vandalism tubes, temporary and permanent corrosion protection provisions, and components which are part of the structure, such as the anchor pipes/guide pipes, erection devices and equipment, and all incidental materials and labor necessary to construct the stay cables in accordance with the Plans, Standard Specifications, and Special Provisions.

Conform the stay cable system to the following criteria:

a) Install and tension each strand individually (mono-strand tensioning).
b) Protect each strand individually against corrosion. Coat and fill the strands and interstices that are extruded through high density polyethylene (HDPE) sheath with petroleum wax.
c) Ability to remove and replace each strand individually.
d) Prepare the outer sheath using two layers of co-extruded HDPE pipe, un-grouted, inner black layer, outer layer color to be selected by Owner, and double external helical ribs (if necessary).
e) Install anti-vandalism tubes on the lower part of the cables.

Stay cables are to be provided in accordance with the PTI Recommendations for Stay Cable Design, Testing and Installation unless otherwise noted. These Special Provisions are intended to complement the PTI recommendations (PTI DC45.1-12). In cases of disagreements, these Special Provisions for stay cables shall govern over the PTI Recommendations.

ii. Materials

1. General

Provide stay cables that consist of parallel, individually polyethylene coated seven-wire strands, placed inside an external polyethylene stay pipe.

Provide redundant protection against corrosion of the strands, by means of two complementary, nested barriers:

1) Make the first or internal barrier an internal envelope and an intermediate medium between the internal envelope and the main tensile element (MTE) to protect each strand individually. Make the internal envelope completely airtight, watertight and qualified as a corrosion barrier. Maintain the airtight, watertight, and corrosion barrier internal envelope between the end anchorages, or throughout the free length, transition areas and through the pylon. Use an intermediate medium to prevent any water or moisture that might get inside a damaged internal envelope from migrating along the length of the individual MTE's.
2) Use a second or external barrier that is a continuous external stay pipe protecting the internal barrier over the free length of the cable.
3) Additional corrosion protection may be provided by hot dip galvanic coating

applied directly to the wires of the strand over their entire length without interruption. If provided, comply galvanized strand with the French Norm NF A 35-035 and make strand meet or exceed the requirements of ASTM A416.

If the stay cable and anchor heads and/or the individual stay cable strands proposed have different dimensions and/or support details other than those shown on the Plans, re-design the stay cable anchorage areas and details at the box girders such that they are compatible with the remainder of the structure, subject to approval by the Engineer.

2. Strand

Use 15.2mm diameter, Grade 1860, fy = 0.90 f's, weldless grade, low-relaxation seven-wire strand for stay cables. Conform to the requirements of ASTM A416/A416M.

Strand will have relaxation losses of not more than 2.5% when initially loaded to 70% of specified minimum breaking strength, or not more than 3.5% when loaded to 80% of specified minimum breaking strength of the strand after 1000 hours when tested under conditions of ASTM A416/A416M.

Furnish the strand in coils on wooden or steel reels with padded contact areas, wherever possible. Protect each coil with a manufacturer approved method so that a strand has no adhering foreign matter or damage to the corrosion protective coating, including that from ultraviolet exposure. Seal the ends of the strand to prevent intrusion of moisture into the annular space between the seven wires. Make no welds or joints in the finished strand.

Upon delivery, properly store the strand in a weatherproof enclosure. Mark each coil with the order number, coil number and heat number. Also mark the starting end of each coil. When uncoiled, the strand will lay straight with a maximum deviation not exceeding ½-inch offset from a theoretical centerline in any ten feet of length. The Engineer may reject any strands with sharp kinks or short radius bends.

The Engineer may reject any strand represented by test samples that do not meet the requirements of this specification. Replace the strand or, alternatively, strip it of coating, re-clean, recoat and resubmit it for acceptance testing in accordance with the requirements of this specification.

Cut strands using abrasive saws or shear. Do not use flame cutting.

3. Internal Corrosion Barrier

Produce the internal barrier using a high-density polyethylene (HDPE) sheath extruded directly onto the strand, previously coated and filled with petroleum wax.

1) Individual HDPE sheath

Make the individual HDPE sheaths of high density black polyethylene classified PE 80. Do not use recycled materials. Comply with the following physical and mechanical specifications regarding extruded sheath:

Character Specified	Value Specified	Test Method
Density at 23°C	> 950 kg/m3	NF EN ISO 1183
Melt flow Index of 5 kg at 190°C	< 0.25 gram per 10 minutes	NF EN ISO 1133
Flexural modulus	> 800 MPa on average	ISO 178
Tensile stress at yield point at 23°C	18 MPa	NF EN ISO 527
Ultraviolet radiation stability	condition E	ASTM D 3350
Carbon-black content	2.3 ± 0.3% by weight	ISO 6964
Carbon-black dispersion index	< 3	ISO 11420
Carbon-black distribution level	< C2	ISO 11420
Antioxidant content in the final composition of the HDPE	> 1000 ppm	
Melting temperature	> 130°C	ISO 3146
Oxidative induction time at 200°C	> 20 minutes	ISO/TR 10837 or ASTM D 3350
Elongation at fracture at 23°C	500%	NF EN ISO 527
Elongation at fracture at -20°C	100%	NF EN ISO 527
Izod impact strength at 23°C	> 20 kJ/m2	NF EN ISO 180
Stress cracking resistance at stress F 50	> 1000 h	ASTM 1693, condition B
Shore D hardness	> 55 points	ISO 868

Make the thickness of the individual HDPE sheaths greater than 1.5 mm (0.06 inches), and the outer diameter of sheathed seven-wire strands less than 19.5 mm (0.77 inches).

2) Petroleum Wax Filler

Fill the intermediate space among the wires and between the wires and the individual sheath of each stay strand with microcrystalline wax, i.e. a malleable crystallized solid consisting of saturated hydrocarbons which are injected in a liquid state. Do not use grease in the void filler in order to prevent problems of thermal stability and bleed.

Inject the void filler material in the workshop of the strand extrusion facility. Completely fill the internal voids between the constituent wires of the strand and the voids between the wires and the individual sheath. Ensure no voids appear in the intermediate medium, due to thermal shrinkage, creep, setting or aging of the void filler.

Make the filling material continuous and durably stable. Make the weight of filler per unit length between 6 and 12 g/m. For individually sheathed strands, compare weights

of a factory-made strand length before and after cleaning and de-waxing the wires and the HPDE sheath which has been cut longitudinally to allow the operations.

Comply with the following specifications with regard to wax filling material:

Character Specified	Value Specified	Test Method
Pour point	> 77°C	NF T 60-128
Penetration at 25°C	No cracking	NF T 60-119
Viscosity at 100°C	> 20 mm2/s	ASTM D 445
Bleeding at 40°C	At 7 days < 0.5%	NF T 60-191 modified by conducting the test for 7 days without the 100-gram weight
Oxidative resistance 100 hours at 100°C	< 0.03 MPa	ASTM D 942-02
Copper strip corrosion 100 hours at 100°C	Level 1 a (no corrosion)	NF EN ISO 2160
Rust protection Salt fog: 5% NaCl, 168 hours at 35°C ± 1°C Fog: distilled water, 168 hours at 35°C ± 1°C	Pass No corrosion	NF X 41-002 NF X 41-002 modified by replacing the NaCl solution by distilled water

4. Outer Stay Pipe

Thread the strands through the outer casing of a one-piece stay pipe. Do not fill the void within this outer casing.

Use an outer casing of appropriate thickness and chemical composition to ensure good aging performance against environmental degradation including satisfactory resistance to ultraviolet radiation. Ensure that the outer casing withstands the mechanical actions that might be exerted on it, notably the bending and axial force caused by the installation, and the buckling force that could be caused by compression of the pipe under its self-weight when it rests on the bottom anchorage of the stay cable.

The Owner will determine the color of the external sheath, UV stabilized pipe. Submit evidence as to the UV resistance and color stability of the pipe for the approval of the Engineer. Ensure the co-extruded pipe is capable of being joined by fusion welding in accordance with this Special Specification.

(If necessary) Manufacture the outer stay pipe with a surface carrying relief, for example two helically wound ribs at 180° apart around the cable, with a demonstrated efficiency against rain and wind induced vibration. Make any such ribs the same color as the external sheath.

1) Material Specifications

Make the outer stay pipe a co-extruded high-density polyethylene (HDPE) pipe, with a coloured external layer and a black internal layer.

Manufacture the stay pipe with high density polyethylene classified PE 344433 C (if black), or PE 344434 E (if other than black) as per ASTM D3350. Comply with the following physical and mechanical specifications regarding the pipe:

Character Specified	Value Specified	Test Method
Density at 23°C	> 941 kg/m^3	ASTM D 1505
Melt flow index of 5 kg at 190°C	< 0.15 gram per 10 minutes	NF EN ISO 1133
Flexural modulus	> 800 MPa on average	ISO 178
Tensile stress at yield point at 23°C	21 MPa	NF EN ISO 527
Ultraviolet radiation stability	Condition E	ASTM D 3350
Carbon-black content (inner layer only in the case of a co-extruded color stay pipe)	2.3 ± 0.3% by weight	ISO 6964
Carbon-black dispersion index	< 3	ISO 4437
Carbon-black distribution level	< C2	ISO 4437
Antioxidant content in the final composition of the HDPE	> 1000 ppm	
Thermal stability	> 220°C for 20 minutes	ASTM D 3350
Oxidative induction time at 200°C	> 20 minutes	ISO/TR 10837 or ASTM D 3350
Elongation at fracture	350%	NF EN ISO 527
Izod impact strength at 23°C	> 20 kJ/m^2	NF EN ISO 180
Stress cracking resistance at stress F 50	> 1000 h	ASTM 1693, condition B
Shore D hardness	> 55 points	ISO 868

Do not use recycled polyethylene. The stay pipe supplier will be a quality management organization in accordance with the NF EN ISO 9001 standard.

In addition to the above requirements, make stay pipe thickness at least $Ø_{ext}/32$ (SDR 32) or 6 mm (0.24 inches), whichever is greater, where $Ø_{ext}$ is the stay pipe outside diameter.

2) Fusion Welds

Obtain the required pipe length for each cable by continuous extrusion or by fusion welding of standard-length sections of pipe. When the stay pipe is made up of sections assembled end-to-end, assemble the sections by butt fusion welding (hot-plate welding in accordance with ASTM D2657). Make the cut ends of sections of the joined pipe perpendicular to the pipe axis. Make the strength of a joint more than 90% of the intact pipe. Perform proposed welds on a test section of polyethylene pipe for the cable cross section used on the project and perform the necessary tests to ensure that the weld develops the required strength and that the joint is hydrostatically sealed. Submit the

results of fusion weld tests to the Engineer for approval. Do not weld the pipe when the stay strands are in the pipe.

3) Expansion Sleeves

Design and provide a polyethylene pipe system that can accommodate the full range of thermal expansion and contraction for the temperature range specified in the Plans. Provide an overlapping expansion system that prevents water from entering the stay pipe. Submit the expansion system to the Engineer for approval along with adequate evidence that demonstrates the ability of the system in preventing water from entering the stay pipe.

5. Cable Stay Anchorages

The anchors for the cable stay system shown on the Plans are schematic. The Manufacturer will supply for review and approval by the Engineer all material specifications not specified herein or on the Plans.

Use an anchorage device capable of transmitting the full ultimate tensile force of the cable. Use all other components such as bearing plates, guide pipes, and deviators shown on the drawings of suitable type and sufficient strength for the intended use.

Use material for filling the void between the strand bundle and the anchors that will permit monitoring and replacement of individual strands during the entire service life of the bridge. Do not use hard material filling or cement grouting in the anchorage area.

1) Stay Anchor Assembly

Supply anchorage components that meet the requirements as specified herein. Use anchorage components specified by the vendor furnishing the anchorages at the time of acceptance testing of the stay cable. Supply stay anchor assemblies consisting of an externally threaded steel socket, anchor head, tension ring, load bearing ring nut, protective cap and filler. Ensure the anchorage assembly allows for complete de-tensioning of the stay and subsequent removal for the anchorage components (except the load bearing nut) through the guide pipe. Furnish all material and testing specifications to the Engineer for review and approval. Ensure each component of the assembly, including wedges, has an AASHTO ASTM, or EN material and test specification.

Make the threaded portion of the anchorage of sufficient length for the installation of the cable and for the future force adjustment of (±) 2.5%of the guaranteed ultimate tensile strength (GUTS) of the stay cable. Make this tension adjustment by means of a threaded tube and ring nut assembly. Do not use shims for stay tension adjustments.

Submit shop drawings to the Engineer for approval showing all dimensions, materials and operations for fabrication of the anchor assembly. Develop and submit to the Engineer for approval detailed procedures for installing all assembly components, insertion of the strands, installation of wedges, and stressing the assembly. Submit

complete shop drawings with supporting calculations showing all equipment (jack, stressing chair, etc.) and procedures required for stay force adjustments and for complete de-tensioning. Sign and seal all shop drawings by a Professional Engineer registered in Engineering Council of India (ECI). No approval will be given to any portion of the stay anchor assembly or procedures until all required submittals are made and found acceptable. If the vendor's patented anchorage requires stripping of the HDPE sheath within the anchorage zone, use filler that provides adequate corrosion protection in accordance with these Special Specifications.

All other components such as bearing plates, wedges, protective caps, extension pipes, tension rings, etc. shown on the Plans, but not specified herein, are only shown schematically. Provide these in suitable type and sufficient strength suitable for the intended use. Submit material specifications, calculations and detail drawings for the sizes, types and materials for such components to the Engineer for review and approval.

A. Filtering Out Angular Deviations

Comprise the anchorage with cable guide systems in order to prevent significant bending stresses due to angular deviations of the strand to extend to the anchorage device or wedges. Make the anchorages capable of accepting static angular deviations in excess of the installation tolerances of the connecting parts.

Account for in the design of the cable guide system transverse and flexural forces resulting from: deck and pylon anchorage rotation under live loads, inaccuracy of anchorage placing and shuttering tube misalignment, permanent angles due to the fanning out of the strands, and bending of strand in the anchorage head due to manufacturing tolerances of anchorage parts.

Do not use guide deviators placed in the transition area, which impose a transverse force on the structure ahead of the stay anchorage in the above cases. Make the anchorage capable of handling by itself the following combination of deviation angles, as a minimum, without damaging the cable:

(i) ± 20 milliradians (Mrad) static angle or the installation tolerances of the connecting parts (shuttering tube misalignment), whichever is greater.
(ii) ± 10 milliradians dynamic angle.
i. Document the efficiency of such means to satisfy the following criteria:
(iii) The angle of deviation of any strand in the anchorage or transition zones will not exceed 25 milliradians.
(iv) The bending stresses in each strand will be less than 250 MPa in the transition zone at the entrance of the anchorage under a deviation of 30 milliradians and a load of 45% GUTS.
(v) The bending stress in each strand at the anchorage will be less than 50 MPa.
i. Calculate the bending stress with the maximum service tension in the cable.
ii. If the anchorages require a deviator to be placed at the guide tube to reduce the

deviation induced bending stresses at the anchorages, do not substitute any device to dampen the cable for the deviator. Keep the deviator to provide a fixed point to avoid deviation induced bending stresses from reaching the anchorage.

B. Protection Against Corrosion

Extend the two complementary internal corrosion-protection barriers, defined for the stay strand, continuously through the free length of the stay and entire anchorage transition zones.

If the external anti-corrosion barrier is replaced by a local casing in the anchorage, inject it with an appropriate blocking medium. Ensure this blocking medium is a flexible material.

Protect the anchor assemblies and components at all times against corrosion, particularly the wedge and wedge holes. Show corrosion protection measures on the shop drawings. At the end of the stay cable, close the outer casing with a watertight cap attached to the anchorage head and cover at least the entire area of the strand terminations. Ensure this cap is removable for inspection of the strand terminations and is injected with a corrosion protective material that does not induce hydrogen embrittlement. Protect the strand tails and the exposed threaded area of the anchor with the corrosion protective material. Heavily coat the threaded area exposed inside the bearing plate/guide pipe with a corrosion inhibiting material. Obtain approval of the Engineer for the corrosion protective material.

Ensure this integrity and continuity of the waterproofing is consistent with the other functions of the anchorage and maintain under all service conditions (vibration, movement, aging, temperature variations, etc.). The water tightness at the entrance of the strand into the anchorage is a key factor.

C. Protection Against Wear

To prevent fretting corrosion and fatigue, do not allow steel to steel contact between the strand and the parts of the transition zone.

Take steps to prevent fretting corrosion and fatigue at critical points: at each deviation of the strand, where the strand enters the anchorage head, etc.

In order to avoid an accumulation of causes of fatigue (axial and flexural action effects) at the anchorage head, take steps to guide lateral displacement of strands.

2) Stay Anchor/Guide Pipe & Bearing Plate

Conform the stay anchor pipe and guide pipe attached to the longitudinal box girders at deck level for the anchorage assembly to the requirements of ASTM

A500/A500M, Grade C with a minimum thickness shown on the Plans. Fabricate bearing plates from ASTM A709/A709M, Grade 50 with a minimum thickness as shown on the Plans.

iii. Qualification and Testing

1. Individually Sheathed Polyethylene Strand

1) Performance Tests

Furnish to the Engineer, a test report prepared by an independent laboratory documenting compliance with items a through f below. Ensure HDPE sheathed strand meet the following requirements:

A. Chemical resistance test – Evaluate the chemical resistance of the sheathing in accordance with ASTM G20 "Standard Test Method for Chemical Resistance of Pipeline Coatings, by immersing coated strands in each of the following: a 3M (Molar) aqueous solution of $CaCl_2$, a 3M (Molar) aqueous solution of NaOH, and a solution saturated with $Ca(OH)_2$. In addition, to simulate cementitious grout, utilize an aqueous solution of potassium hydroxide and an aqueous solution of sodium hydroxide for this test. Perform tests at 24±2°C with specimens without damage to the sheathing and specimens with intentional 6 mm diameter holes drilled through the sheathing. Perform the test for a minimum of 45 days. Verify the polyethylene is not soft, cracked, or visually deteriorated.

B. Chloride permeability test – Measure, using the methods outlined in FHWA-RD-74-018, "Non-metallic coatings for Reinforcing Bars," the chloride permeability characteristics of the films of cured coating having the minimum thickness as proposed for use. Perform the test at 24±2°C for 45 days. Verify the accumulative concentration of chloride ion permeating through the film is less than 1 x 10-4M.

C. Impact test – Determine the resistance of a strand sheathing to mechanical damage by using the falling weight test. Use a test apparatus similar to that described in ASTM G14 "Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)", along with a 1.8kg tup. Ensure impact occurs on the crown areas on the sheathed strand. Perform the test at room temperature. With an impact of 9 N-m, ensure no shattering or cracking, of the sheathing occurs except at the impact area, that is, the area permanently deformed by the tup.

D. Abrasion resistance test – Determine the resistance of the strand sheathing to abrasion by using the falling sand method of ASTM D968 "Standard Test Method for Abrasion Resistance of Organic Coatings by Falling Abrasive" adopted for testing sheathed strand. Do not exceed net loss of sheathing by 0.25 mm per 1,000 L of abrasive.

E. Salt spray (fog) test – Tension sheathed strand specimens to 70% of the minimum ultimate tensile strength and expose to salt fog for 3,000 hours in accordance with ASTM B117. Take care to protect the end anchorage used from salt fog or corrosion so as not to influence the test results. Make observations for signs of corrosion and record every 250 hours. After 3,000 hours of exposure, ensure no evidence of corrosion is present, and the specimen is holiday free. After the salt spray (fog) test is completed, perform a tensile test on the specimen in conformance with ASTM

A416. Do not allow any cracks visible to the unaided eye in the HDPE or HDPP up to an elongation of 1 percent (yield point).

F. Water tightness test – Propose a water tightness test for the approval of the Engineer. Carry out one test of the void filling manufacturing process of the sheathed strand as per the approved test procedure per production run or portion thereof.

2) Quality Control Tests

Furnish test reports to the Engineer for each inspection unit of strand documenting compliance of the material properties in Section 3.2.2.1 of the PTI "Recommendations for Stay Cable Design, Testing and Installation", 6th edition. Include in the inspection unit for sampling, the unit of production composed of coated products (wires or seven-wire strands) coming from the same factory and of the same grade and nominal diameter, manufactured according to the same process. Define this unit either by cast or by batch, the mass of each inspection unit being no more than 20 tons. Take three samples when the number of coils in an inspection unit is lower than 3. Take one sample per coil when the number of coils in an inspection unit is greater than 3. The maximum number of samples is limited to 12.

A. Standard Properties - On each sample, complete one series of tests to document compliance with the following:
   - Minimum ultimate tensile stress;
   - Minimum yield stress;
   - Elastic modulus.

B. Particular Properties - Carry out the following tests on one sample per inspection unit or fraction thereof:
   - One-Pin Test for ductility;
   - Fatigue strength.

Perform tests as outlined in Section 3.2.2.1 of the PTI "Recommendations for Stay Cable Design, Testing and Installation", 6th edition. Select 3 samples for each test. If the test on the first sample fails, carry out two more tests. If either of the two additional tests fails, reject the quantity of strands represented by the three samples.

2. HDPE Stay Pipe

Furnish a certificate of analysis to the Engineer for each shipment of pipe stating the material supplied meets this Special Specification and showing the results of the tests performed by an approved independent laboratory.

3. Anchorage Assembly and Fully Assembled Stay Cable

Qualification and acceptance testing of the stay cable system based on fatigue and ultimate strength tests of the stay system and leak tests of the anchorage assembly in accordance with Sections 4.2 and 4.1.6, respectively, of the PTI "Recommendations for Stay Cable Design, Testing and Installation", 6th edition, is not required. Submit evidence of previous tests conducted for previous projects on specimens similar in stay size, design, and details to those proposed for this project to the Engineer for

acceptance. Only stay cable systems having previously passed such testing witnessed by a third party are qualified. Perform quality control tests outlined above for the sheathed strand to establish that the prestressing steel supplied for this project has fatigue characteristics comparable to the prestressing steel used in the acceptance tests of the stay cable specimens in the previous project. Demonstrate with shop drawings that the stay anchorage hardware proposed is the same as in the previous tests.

iv. Construction

1. Construction Analysis

Submit detailed step-by-step construction analyses consistent with actual loads, sequences, schedules, material properties, cable forces, and all aspects of construction of the bridge. Prepare and sign/seal all computations by a Professional Engineer registered in the ECI, with demonstrated experience in the design and construction of extradosed bridges.

2. Installation

Install stay cables in accordance with the procedures prescribed by the stay cable supplier. Submit to the Engineer for review and approval, a method statement which describes the installation operations, including a description of the main items of the equipment required, as well as an engineered cable installation program that prescribes the cable force and elongation of each stay cable.

Stay cable procedure will be compatible with the bridge construction sequence with cables generally erected in-situ. Prefabrication may be considered provided specific procedures are developed to ensure the strands remain parallel, equally stressed and that no damage to any elements of the system is permitted.

3. Handling

Develop procedures to assure that stay cable components will not be damaged during handling.

Protect stay cable components from corrosion, heat, abrasion and other harmful effects throughout the fabrication, shipping, delivery, storage and installation.

The minimum bending diameter for the HDPE outer casing is 50 times its outside diameter during fabrication, transport, storage or erection of stay cables.

Evaluate and remedy all damage to stay cables or components thereof prior to installation of the stays. Replace any damaged strand. Repair damage to non load-carrying components to the Engineer's satisfaction prior to the installation of the stays.

4. Strand-by-Strand Erection

Take appropriate measures to prevent the leading end of the strand from damaging the stay pipe or the sheaths of the strands installed previously.

Fit all the special features of the stay cable (anchorages, guidance systems, etc.) with protection to avoid damaging the individual protection of strands.

Ensure the strands are parallel throughout their length and that they pass through matching holes in the two anchorage heads.

5. Stressing

Calibrate jacks and gauges for stay cable installation with reference to a standard pressure gauge or load cell within one month prior to the beginning of the cable installation, and every 6 months thereafter, or for 500 strands, for the duration of cable installation.

The standard gauge should have a relative accuracy of at least 0.5% and should itself be gauged by an appropriate laboratory at least once per year.

In-situ erected parallel strand stay cables may be tensioned one-by-one provided that it can be demonstrated, to the satisfaction of the Engineer, that the final tension and elongation of each strand is equalized within a range of +/-1.25% GUTS.

Record all stressing automatically with a computer system connected to load cells. In case of length measurement of all the strands before erection, place in a straight, confined and covered area, at a controlled temperature and protected from any damage.

Use stay cables that are capable of being tensioned, de-tensioned and re-tensioned more than once during the construction of the structure. These operations may be carried out either by full jacking of the live anchorage and adjusting the ring nut setting, or strand by strand. If de-tensioning cables strand by strand in such way that the "gripping" zone is incorporated in the stressed portion of the stay, do not leave a "gripped" zone permanently on the stressed portion of the stay.

6. Corrosion Protection During Erection

If the strand corrosion protection system is not put in place at the time the cable is installed on the structure, apply an appropriate temporary corrosion-protection system.

7. Monitoring & Adjustment

Monitor strands extending through the cable stay saddles for any possible slippage during construction and adjust if needed in accordance with procedures prescribed by the stay cable supplier.

At some intermediate stage of superstructure erection, which the Engineer will designate depending on the approved construction sequence, check the tension in each stay cable with a full head lift off to ensure it is within the anticipated range. Adjust any stay cable as required at this stage using approved stressing procedures.

Adjust stay cables in the final dead load condition such that each individual cable does not deviate from the stay cable dead load force values shown on the Plans by ±5%.

Perform force verification with full head lift off tests. It is possible that one individual cable may have to be adjusted to lesser tolerances to prevent stress in other cables from exceeding the ±5% tolerance.

8. Finishing

After the final cable tension adjustment has been completed, and subjected to the Engineer's approval, carry out the finishing of the anchorage and transition zones (permanent corrosion protection, installation of dampers, etc.).

Submit a detailed procedure for these operations for the approval of the Engineer.

9. Fire Resistance of Stay Cables

As per FIB CEB-FIP bulletin 30 guidelines Cl.3.1.2 extradosed bridges shall be designed considering failure of one stay cables with suitable impact factor in the event of fire.

4. Maintenance and Replacement

Maintenance Manual detailing the inspection program and maintenance procedures of stay cables shall be submitted by the stay cable supplier and manufacturers.

4.1 Inspections

The inspection program shall comprise at least:

a) routine inspection operations at a frequency proposed by the stay cable supplier to the Engineer;

b) If necessary replacement of one representative strand on stay cables (in the main span) to check corrosion protection every 10 years.

4.2 Maintenance Procedures

The maintenance procedures shall include at least:

a) procedures for minor and major maintenance operations foreseen during the 100 year design lifetime of the stay cables;

b) frequencies of minor and major inspection and maintenance operations; and

c) the replacement procedure for a single strand and a full cable.

The water tightness of the anchorages shall be inspectable during the maintenance program and shall be easily reinstated without dismantling any major components.

5. Monitoring of the Stay Cable

The monitoring of stay cables shall be submitted by the stay cable supplier.

The monitoring equipment of stay cables may include:

The stay cable force monitoring system operating modes shall be as On-line monitoring or Offline monitoring.

6. Pile Integrity Test

Pile Integrity test shall be carried out as per procedures given in IRC:78-2014 Appendix-7 part-2. Number of tests shall be decided by engineer to the project.

Schedule - E

(See Clauses 2.1 and 14.2)

Maintenance Requirements

1. Maintenance Requirements

(i) The Contractor shall, at all times maintain the Project Highway in accordance with the provisions of this Agreement, Applicable Laws and Applicable Permits.

(ii) The Contractor shall repair or rectify any Defect or deficiency set forth in Paragraph 2 of this Schedule-E within the time limit specified therein and any failure in this behalf shall constitute non-fulfilment of the Maintenance obligations by the Contractor. Upon occurrence of any breach hereunder, the Authority shall be entitled to effect reduction in monthly lump sum payment as set forth in Clause 14.6 of this Agreement, without prejudice to the rights of the Authority under this Agreement, including Termination thereof.

(iii) All Materials, works and construction operations shall conform to the MORTH Specifications for Road and Bridge Works, and the relevant IRC publications. Where the specifications for a work are not given, Good Industry Practice shall be adopted.

(iv) The maintenance of the new 4-lane extradosed bridge is an important aspect for ensuring safety and long life span of the bridge. Maintenance Manual for the bridge shall be furnished by the construction agency as per Manufacturers recommendations using latest technology and adopting best international practise and to the satisfaction of proof consultant and duly approved by Authority Engineer.

2. Repair/rectification of Defects and deficiencies

The obligations of the Contractor in respect of Maintenance Requirements shall include repair and rectification of the Defects and deficiencies specified in Annex - I of this Schedule-E within the time limit set forth therein.

3. Other Defects and deficiencies

In respect of any Defect or deficiency not specified in Annex - I of this Schedule-E, the Authority's Engineer may, in conformity with Good Industry Practice, specify the permissible limit of deviation or deterioration with reference to the Specifications and Standards, and any deviation or deterioration beyond the permissible limit shall be repaired or rectified by the Contractor within the time limit specified by the Authority's Engineer.

4. Extension of time limit

Notwithstanding anything to the contrary specified in this Schedule-E, if the nature and extent of any Defect or deficiency justifies more time for its repair or rectification than the time specified herein, the Contractor shall be entitled to additional time in conformity with Good Industry Practice. Such additional time shall be determined by

the Authority's Engineer and conveyed to the Contractor and the Authority with reasons thereof.

5. Emergency repairs/restoration

Notwithstanding anything to the contrary contained in this Schedule-E, if any Defect, deficiency or deterioration in the Project Highway poses a hazard to safety or risk of damage to property, the Contractor shall promptly take all reasonable measures for eliminating or minimizing such danger.

6. Daily inspection by the Contractor

The Contractor shall, through its engineer, undertake a daily visual inspection of the Project Highway and maintain a record thereof in a register to be kept in such form and manner as the Authority's Engineer may specify. Such record shall be kept in safe custody of the Contractor and shall be open to inspection by the Authority and the Authority's Engineer at any time during office hours.

7. Pre-monsoon inspection / Post-monsoon inspection

The Contractor shall carry out a detailed pre-monsoon inspection of all bridges, culverts and drainage system before [1st June] every year in accordance with the guidelines contained in IRC: SP35. Report of this inspection together with details of proposed maintenance works as required on the basis of this inspection shall be sent to the Authority's Engineer before the [10th June] every year. The Contractor shall complete the required repairs before the onset of the monsoon and send to the Authority's Engineer a compliance report. Post monsoon inspection shall be done by the [30th September] and the inspection report together with details of any damages observed and proposed action to remedy the same shall be sent to the Authority's Engineer.

8. Repairs on account of natural calamities

All damages occurring to the Project Highway on account of a Force Majeure Event or wilful default or neglect of the Authority shall be undertaken by the Authority at its own cost. The Authority may instruct the Contractor to undertake the repairs at the rates agreed between the Parties.

9. Additional Guidelines for maintenance of main extradosed bridge: Annex - II

Annex – I

(Schedule-E)

Annex-I : Repair/rectification of Defects and deficiencies

The Contractor shall repair and rectify the Defects and deficiencies specified in this Annex-I of Schedule-E within the time limit set forth in the table below.

1. Table -1: Maintenance Criteria for Pavements:

Asset Type	Performance Parameter	Level of Service (LOS)		Frequency of Inspection	Tools/Equipment	Standards and References for Inspection and Data Analysis	Time limit for Rectification/Repair	Maintenance Specifications
		Desirable	Acceptable					
Flexible Pavement (Pavement of MCW, Service Road, approaches of Grade	Potholes	Nil	< 0.1 % of area and subject to limit of 10 mm in depth	Daily	Length Measurement Unit like Scale, Tape, odometer etc.	IRC 82: 2015 and Distress Identification Manual for Long Term Pavement Performance Program, FHWA 2003 (http://www.tfhrc.com/pavement/lttp/reports/03031/)	24-48 hours	MORT&H Specification 3004.2
	Cracking	Nil	< 5 % subject to	Daily			7-15 days	MORT&H Specification

Asset Type	Performance Parameter	Level of Service (LOS)		Frequency of Inspection	Tools/Equipment	Standards and References for Inspection and Data Analysis	Time limit for Rectification/Repair	Maintenance Specifications
		Desirable	Acceptable					
structure, approaches of connecting roads, slip roads, lay byes etc. as applicable)			limit of 0.5 sqm for any 50 m length					3004.3
	Rutting	Nil	< 5 mm	Daily	Straight Edge		15 -30 days	MORT&H Specification 3004.2
	Corrugations and Shoving	Nil	< 0.1 % of area	Daily	Length Measurement Unit like Scale, Tape, odometer etc.		2-7 days	IRC:82-2015
	Bleeding	Nil	< 1 % of area	Daily			3-7 days	MORT&H Specification 3004.4

Asset Type	Performance Parameter	Level of Service (LOS)		Frequency of Inspection	Tools/Equipment	Standards and References for Inspection and Data Analysis	Time limit for Rectification/Repair	Maintenance Specifications
		Desirable	Acceptable					
	Ravelling/ Stripping	Nil	< 1 % of area	Daily			7-15 days	IRC:82-2015 read with IRC SP 81
	Edge Deformation/ Breaking	Nil	< 1 m for any 100 m section and width < 0.1 m at any location, restricted to 30 cm from the edge	Daily			7- 15 days	IRC:82-2015
	Roughness BI	2000 mm/km	2400 mm/km	Bi-Annually	Class I Profilometer	Class I Profilometer : ASTM E950 (98) :2004 –Standard Test Method for measuring Longitudinal Profile of Travelled Surfaces	180 days	IRC:82-2015

Asset Type	Performance Parameter	Level of Service (LOS)		Frequency of Inspection	Tools/Equipment	Standards and References for Inspection and Data Analysis	Time limit for Rectification/Repair	Maintenance Specifications
		Desirable	Acceptable					
	Skid Number	60SN	50SN	Bi-Annually	SCRIM (Sideway-force Coefficient Routine Investigation Machine or equivalent)	with Accelerometer Established Inertial Profiling Reference ASTM E1656 -94: 2000- Standard Guide for Classification of Automatic Pavement Condition Survey Equipment	180 days	BS: 7941-1: 2006
	Pavement Condition Index	3	2.1	Bi-Annually			180 days	IRC:82-2015
	Other Pavement Distresses			Bi-Annually			2-7 days	IRC:82-2015
	Deflection/ Remaining Life			Annually	Falling Weight Deflectometer	IRC 115: 2014	180 days	IRC:115-2014
Rigid Pavement	Roughness BI	2200mm /km	2400mm/	Bi-Annually	Class I Profilometer	ASTM E950 (98) :2004 and ASTM E1656 -94: 2000	180 days	IRC:SP:83-2008

Asset Type	Performance Parameter	Level of Service (LOS)		Frequency of Inspection	Tools/Equipment	Standards and References for Inspection and Data Analysis	Time limit for Rectification/Repair	Maintenance Specifications
		Desirable	**Acceptable**					
(Pavement of MCW, Service Road, Grade structure, approaches of connecting roads, slip roads, lay byes etc. as applicable)			km					
	Skid	Skid Resistance no. at different speed of vehicles **Minimum SN** / **Traffic Speed (Km/h)** 36 / 50 33 / 65 32 / 80 31 / 95 31 / 110		Bi-Annually	SCRIM (Sideway-force Coefficient Routine Investigation Machine or equivalent)	IRC:SP:83-2008	180 days	IRC:SP:83-2008
Embankment/ Slope	Edge drop at shoulders	Nil	40mm	Daily	Length Measurement	IRC	7-15 days	MORT&H Specification

Asset Type	Performance Parameter	Level of Service (LOS)		Frequency of Inspection	Tools/Equipment	Standards and References for Inspection and Data Analysis	Time limit for Rectification/Repair	Maintenance Specifications
		Desirable	Acceptable					
					Unit like Scale, Tape, odometer etc.			408.4
	Slope of camber/cross fall	Nil	<2% variation in prescribed slope of camber /cross fall	Daily			7-15 days	MORT&H Specification 408.4
	Embankment Slopes	Nil	<15 % variation in prescribe side slope	Daily			7-15 days	MORT&H Specification 408.4
	Embankment Protection	Nil	Nil	Daily	NA		7-15 days	MORT&H Specification

Asset Type	Performance Parameter	Level of Service (LOS)		Frequency of Inspection	Tools/Equipment	Standards and References for Inspection and Data Analysis	Time limit for Rectification/Repair	Maintenance Specifications
		Desirable	Acceptable					
	Rain Cuts/ Gullies in slope	Nil	Nil	Daily Specially During Rainy Season	NA		7-15 days	MORT&H Specification

In addition to the above performance criterion, the contractor shall strictly maintain the rigid pavements as per requirements in the following table

2. Table -2: Maintenance Criteria for Rigid Pavements:

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
CRACKING						
1	**Single Discrete Cracks Not intersecting with any joint**	w = width of crack L = length of crack d = depth of crack D = depth of slab	0	Nil, not discernible	No Action	Not applicable
			1	w < 0.2 mm. hair cracks		
			2	w = 0.2 - 0.5 mm, discernible from slow-moving car	Seal without delay	Seal, and stitch if L > lm.
			3	w = 0.5 - 1.5 mm, discernible from fast-moving car		Within 7days
			4	w = 1.5 - 3.0 mm	Seal, and stitch if L > lm.	Staple or Dowel Bar Retrofit, FDR for affected portion.
			5	w > 3 mm.	Within 7 days	

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
						Within 15days
2	**Single Transverse (or Diagonal) Crack intersecting with one or more joints**	w = width of crack L = length of crack d = depth of crack D = depth of slab	0	Nil, not discernible	No Action	
			1	w < 0.2 mm, hair cracks	Route and seal with epoxy. Within 7 days	Staple or Dowel Bar Retrofit. Within 15days
			2	w = 0.2 - 0.5 mm, discernible from slow vehicle		
			3	w = 0.5 - 3.0 mm, discernible from fast vehicle	Route, seal and stitch, if L > 1 m. Within 7 days	
			4	w = 3.0 - 6.0 mm	Dowel Bar Retrofit. Within 15 days	Full Depth Repair Dismantle and reconstruct affected. Portion with norms

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
			5	w > 6 mm, usually associated with spalling, and/or slab rocking under traffic	Not Applicable, as it may be full depth	and specifications - See Para 5.5 & 9.2 Within 15days
3	**Single Longitudinal Crack intersecting with one or more joints**	w = width of crack L = length of crack d = depth of crack D = depth of slab	0	Nil, not discernible	No Action	
			1	w < 0.5 mm, discernable from slow moving vehicle	Seal with epoxy, if L > 1 m. Within 7 days	Staple or dowel bar retrofit. Within 15days
			2	w = 0.5 - 3.0 mm, discernible from fast vehicle	Route seal and stitch, if L > l m.	-

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
					Within 15 days	
			3	w = 3.0 - 6.0 mm	Staple, if L > 1 m. Within 15 days	Partial Depth Repair with stapling. Within 15 days
			4	w = 6.0 - 12.0 mm, usually associated with spalling	Not Applicable, as it may be full depth	
			5	w > 12 mm, usually associated with spalling, and/or slab rocking under traffic		Full Depth Repair Dismantle and reconstruct affected portion as per norms and specifications - See Para 5.6.4 Within 15 days
4	**Multiple Cracks**	**w = width of crack**	0	Nil, not discernible	No Action	-

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
	intersecting with one or more joints		**1**	w < 0.2 mm, hair cracks	Seal, and stitch if L > l m. Within 15 days	
			2	w = 0.2 - 0.5 mm. discernible from slow vehicle		
			3	w = 0.5 - 3.0 mm, discernible from fast vehicle	Full depth repair within 15 days	Dismantle, Reinstate subbase, Reconstruct whole slab as per specifications within 30 days
			4	w = 3.0 - 6.0 mm panel broken into 2 or 3 pieces		
			5	w > 6 mm and/or panel broken into more than 4 pieces		
5	**Corner Break**	w = width of crack L = length of crack	0	Nil, not discernible	No Action	-
			1	w < 0.5 mm; only 1 corner broken	Seal with low viscosity	Seal with epoxy seal

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
			2	w < 1.5 mm; L < 0.6 m, only one corner broken	epoxy to secure broken parts Within 7 days	with epoxy Within 7days
			3	w < 1.5 mm; L < 0.6 m, two corners broken	Partial Depth (Refer Figure 8.3 of IRC:SP: 83-2008) Within 15 days	Full depth repair
			4	w > 1.5 mm; L > 0.6 m or three corners broken		
			5	hree or four corners broken		Reinstate sub-base, and reconstruct the slab as per norms and specifications within 30days
6	**Punchout**	w = width of crack	0	Nil, not discernible		No Action

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
	(Applicable to Continuous Reinforced Concrete Pavement (CRCP) only)	L = length (m/m2)	1	w < 0.5 mm; L < 3 m/m^2	Not Applicable, as it may be full depth	Seal with low viscosity epoxy to secure broken parts. Within 15days
			2	either w > 0.5 mm or L < 3 m/m^2		
			3	w > 1.5 mm and L < 3 m/m^2		
			4	w > 3 mm, L < 3 m/m^2 and deformation		Full depth repair - Cut out and replace damaged area taking care not to damage reinforcement. Within 30days
			5	w > 3 mm, L > 3 m/m^2 and deformation		

<table>
<tr><th rowspan="2">S.No.</th><th rowspan="2">Type of Distress</th><th rowspan="2">Measured Parameter</th><th rowspan="2">Degree of Severity</th><th rowspan="2">Assessment Rating</th><th colspan="2">Repair Action</th></tr>
<tr><th>For the case d < D/2</th><th>For the case d > D/2</th></tr>
<tr><td colspan="7">Surface Defects</td></tr>
<tr><td rowspan="5">7</td><td rowspan="5">Ravelling or Honeycomb type surface</td><td rowspan="5">r = area damaged surface/total surface of slab (%)
h = maximum depth of damage</td><td>0</td><td>Nil, not discernible</td><td>Short Term
No action.</td><td>Long Term</td></tr>
<tr><td>1</td><td>r < 2 %</td><td rowspan="3">Local repair of areas damaged and liable to be damaged.
Within 15 days</td><td rowspan="4">Not Applicable</td></tr>
<tr><td>2</td><td>r = 2 - 10 %</td></tr>
<tr><td>3</td><td>r = 10-25%</td><td rowspan="2">Bonded Inlay, 2 or 3 slabs if affecting.</td></tr>
<tr><td>4</td><td>r = 25 - 50 %</td></tr>
</table>

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
					Within 30 days	
			5	r > 50% and h > 25 mm	Reconstruct slabs, 4 or more slabs if affecting. Within 30 days	
8	**Scaling**	r = damaged surface/total surface of slab (%) h = maximum depth of damage	0	Nil, not discernible	**Short Term**	**Long Term**
					No action.	Not Applicable
			1	r < **2 %**	Local repair of areas damaged and liable to be damaged. Within 7days	
			2	r = 2 - 10 %		

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
			3	r = 10 - 20%	Bonded Inlay within 15 days	
			4	r = 20 - 30 %		
			5	r > 30 % and h > 25 mm	Reconstruct slab within 30 days	
9	**Polished Surface/Glazing**	t = texture depth, sand patch test	0		No action.	Not Applicable
			1	t > 1 mm		
			2 '	t = 1 - 0.6 mm	Monitor rate of deterioration	
			3	t = 0.6 - 0.3 mm		
			4	t = 0.3 - 0.1 mm		

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
			5	t < 0.1 mm	Diamond Grinding if affecting 50% or more slabs in a continuous stretch of minimum 5 km. Within 30 days	
10	**Pop out (Small Hole), Pothole Refer Para 8.4**	n = number/m^2 d = diameter h = maximum depth	0	d < 50 mm; h < 25 mm; n < 1 per 5 m^2	No action.	Not Applicable
			1	d = 50 - 100 mm; h < 50 mm; n < 1 per 5 m^2	Partial depth repair 65 mm deep. Within 15 days	
			2	d = 50 - 100 mm; h > 50 mm; n < 1 per 5 m^2		

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
			3	d = 100 - 300 mm; h < 100 mm n < 1 per 5 m^2	Partial depth repair 110mm i.e.10 mm more than the depth of the hole. Within 30 days	
			4	d = 100 - 300 mm; h > 100 mm; n < 1 per 5 m^2		
			5	d > 300 mm; h > 100 mm: n > 1 per 5 m^2	Full depth repair. Within 30 days	
Joint Defects						
11	**Joint Seal Defects**	loss or damage L = Length as % total joint length	0	Difficult to discern.	**Short Term**	**Long Term**
					No action.	Not Applicable

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
			1	Discernible, L< 25% but of little immediate consequence with regard to ingress of water or trapping incompressible material.	Clean joint, inspect later.	
			3	Notable. L > 25% insufficient protection against ingress of water and trapping incompressible material.	Clean and reapply sealant in selected locations. Within 7 days	
			5	Severe; w > 3 mm negligible protection against ingress of water and trapping incompressible material.	Clean, widen and reseal the joint. Within 7 days	
12	**Spalling of Joints**	w = width on either	0	Nil, not discernible	No action.	Not Applicable

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
		side of the joint L = length of spalled portion (as % joint length)	1	w < 10 mm	Apply low viscosity epoxy resin/ mortar in cracked portion. Within 7 days	
			2	w = 10 - 20 mm, L < 25%		
			3	w = 20 - 40 mm, L > 25%	Partial Depth Repair. Within 15 days	
			4	w = 40 - 80 mm, L > 25%	30 - 50 mm deep, h = w + 20% of w, within 30 days	
			5	w > 80 mm, and L > 25%	50 - 100 mm deep repair. H = w + 20% of w.	

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
					Within 30 days	
13	**Faulting (or Stepping) in Cracks or Joints**	f = difference of level	0	not discernible, < 1 mm	No action.	No action.
			1	f < 3 mm		
			2	f = 3 - 6 mm	Determine cause and observe, take action for diamond grinding	Replace the slab as appropriate. Within 30days
			3	f = 6 - 12 mm	Diamond Grinding	
			4	f= 12 - 18 mm	Raise sunken slab.	Replace the slab as appropriate. Within 30days
			5	f> 18 mm	Strengthen subgrade and sub-base by grouting and	

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
					raising sunken slab	
14	**Blow up or Buckling**	h = vertical displacement from normal profile			**Short Term**	**Long Term**
			0	Nil, not discernible	No Action	
			1	h < 6 mm		
			2	h = 6 - 12 mm	Install Signs to Warn Traffic within 7 days	
			3	h = 12 - 25 mm		
			4	h > 25 mm	Full Depth Repair. Within 30 days	

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
			5	shattered slabs, ie 4 or more pieces	Replace broken slabs. Within 30 days	
15	**Depression**	h = negative vertical displacement from normal profile L =length	0	Not discernible, h < 5 mm	No action.	Not Applicable
			1	h = 5 - 15 mm		
			2	h = 15-30 mm, Nos <20% joints	Install Signs to Warn Traffic within 7 days	
			3	h = 30 - 50 mm		
			4	h > 50 mm or > 20% joints	Strengthen subgrade. Reinstate pavement at normal level if L < 20 m.	
			5	h > 100 mm		

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
					Within 30 days	
16	**Heave**	h = positive vertical displacement from normal profile. L = length	0	Not discernible. h < 5 mm	**Short Term** No action.	**Long Term** scrabble
			1	h = 5 - 15 mm	Follow up.	
			2	h = 15 - 30 mm, Nos <20% joints	Install Signs to Warn Traffic within 7 days	
			3	h = 30 - 50 mm		
			4	h > 50 mm or > 20% joints	Stabilise subgrade. Reinstate pavement at normal level if length < 20 m. Within 30 days	
			5	h > 100 mm		

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	**For the case d > D/2**
17	**Bump**	h = vertical displacement from normal profile	0	h < 4 mm	No action	
			1	h = 4 - 7 mm	Grind, in case of new construction within 7 days	Construction Limit for New Construction.
			3	h = 7 - 15 mm	Grind, in case of ongoing Maintenance within 15 days	Replace in case of new construction. Within 30days
			5	h > 15 mm	Full Depth Repair. Within 30 days	Full Depth Repair. Within 30days
18	**Lane to**	f = difference of	0	Nil, not discernible	**Short Term**	**Long Term**

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
	Shoulder Drop off	level		< 3mm	No action.	
			1	f = 3 - 10 mm	Spot repair of shoulder within 7 days	
			2	f = 10 - 25 mm		
			3	f = 25 - 50 mm	Fill up shoulder within 7 dayss	
			4	f = 50 - 75 mm		For any 100 m stretch Reconstruct shoulder, if affecting 25% or more of stretch. Within 30days
			5	f > 75 mm		
Drainage						

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
19	**Pumping**	quantity of fines and water expelled through open joints and cracks Nos	0	not discernible	No Action	
			1 to 2	slight/ occasional Nos < 10%	Repair cracks and joints Without delay.	Inspect and repair sub-drainage at distressed sections and upstream.
			3 to 4	appreciable/ Frequent 10 - 25%	Lift or jack slab within 30 days.	
		Nos/100 m stretch	5	abundant, crack development > 25%	Repair distressed pavement sections. Strengthen subgrade and subbase. Replace slab. Within 30 days	
20	**Ponding**	Ponding on slabs	0-2	No discernible problem	No action.	

S.No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case d < D/2	For the case d > D/2
		due to blockage of drains	3 to 4	Blockages observed in drains, but water flowing	Clean drains etc within 7 days, Follow up	Action required to stop water damaging foundation within 30 days.
			5	Ponding, accumulation of water observed	-do-	

3. Table -3: Maintenance Criteria for Safety Related Items and Other Furniture Items:

<table>
<tr><th>Asset Type</th><th>Performance Parameter</th><th>Level of Service (LOS)</th><th>Frequency of Measurement</th><th>Testing Method</th><th>Recommended Remedial measures</th><th>Time limit for Rectification</th><th>Specifications and Standards</th></tr>
<tr><td>Highway</td><td>Availability of Safe Sight Distance</td><td>As per IRC SP :84-2019, a minimum of safe stopping sight distance shall be available throughout.
<table><tr><th>Design Speed, kmph</th><th>Desirable Minimum Sight Distance (m)</th><th>Safe Stopping Sight Distance (m)</th></tr><tr><td>100</td><td>360</td><td>180</td></tr><tr><td>80</td><td>240</td><td>120</td></tr></table></td><td>Monthly</td><td>Manual Measurements with Odometer along with video/ image backup</td><td colspan="2">Removal of obstruction within 24 hours, in case of sight line affected by temporary objects such as trees, temporary encroachments.

In case of permanent structure or design deficiency:
Removal of obstruction/improvement of deficiency at the earliest
Speed Restriction boards and suitable traffic calming measures such as transverse bar marking, blinkers, etc. shall be applied during the period of rectification.</td><td>IRC SP :84-2019</td></tr>
<tr><td>Pavement Marking</td><td>Wear</td><td><70% of marking remaining</td><td>Bi-Annually</td><td>Visual Assessment as per Annexure-F of IRC:35-2015</td><td>Re - painting</td><td>Cat-1 Defect – within 24 hours
Cat-2 Defect - within 2 months</td><td>IRC:35-2015</td></tr>
</table>

<table>
<tr><th>Asset Type</th><th>Performance Parameter</th><th>Level of Service (LOS)</th><th>Frequency of Measurement</th><th>Testing Method</th><th>Recommended Remedial measures</th><th>Time limit for Rectification</th><th>Specifications and Standards</th></tr>
<tr><td rowspan="2"></td><td>Day time Visibility</td><td>During expected life Service Time
Cement Road - 130mcd/m²/lux
Bituminous Road - 100mcd/m²/lux</td><td>Monthly</td><td>As per Annexure-D of IRC:35-2015</td><td>Re - painting</td><td>Cat-1 Defect – within 24 hours
Cat-2 Defect – within 2 months</td><td>IRC:35-2015</td></tr>
<tr><td>Night Time Visibility</td><td><u>Initial and Minimum Performance for Dry Retro reflectivity during night time:</u>
<table>
<tr><td>Design Speed</td><td colspan="2">(RL) Retro Reflectivity (mcd/m²/lux)</td></tr>
<tr><td></td><td>Initial (7 days)</td><td>Minimum Threshold level (TL) & warranty period required up to 2 years</td></tr>
<tr><td>Up to 65</td><td>200</td><td>80</td></tr>
<tr><td>65 - 100</td><td>250</td><td>120</td></tr>
<tr><td>Above 100</td><td>350</td><td>150</td></tr>
</table>
<u>Initial and Minimum Performance for Night Visibility under wet condition (Retro reflectivity):</u>
Initial 7 days Retro reflectivity: 100</td><td>Bi-Annually</td><td>As per Annexure-E of IRC:35-2015</td><td>Re - painting</td><td>Cat-1 Defect – within 24 hours
Cat-2 Defect – within 2 months</td><td>IRC:35-2015</td></tr>
</table>

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
		mcd/m²/lux Minimum Threshold Level: 50 mcd/m²/lux					
	Skid Resistance	Initial and Minimum performance for Skid Resistance: Initial (7days): 55BPN Min. Threshold: 44BPN *Note: shall be considered under urban/city traffic condition encompassing the locations like pedestrian crossings, bus bay, bus stop, cycle track intersection delineation, transverse bar markings etc	Bi-Annually	As per Annexure-G of IRC:35-2015		Within 24 hours	IRC:35-2015
Road Signs	Shape and Position	Shape and Position as per IRC:67-2012. Signboard should be clearly visible for the design speed of the section.	Daily	Visual with video/image backup	Improvement of shape, in case if shape is damaged. Relocation as per requirement	48 hours in case of Mandatory Signs, Cautionary and Informatory Signs (Single and Dual post signs) 15 Days in case of Gantry/Cantilever Sign boards	IRC:67-2012
	Retro reflectivity	As per specifications in IRC:67-2012	Bi-Annually	Testing of each signboard	Change of signboard	48 hours in case of Mandatory Signs,	RC:67-2012

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
				using Retro Reflectivity Measuring Device. In accordance with ASTM D 4956-09.		Cautionary and Informatory Signs (Single and Dual post signs) 1 Month in case of Gantry/Cantilever Sign boards	
Kerb	Kerb Height	As per IRC 86:1983 depending upon type of Kerb	Bi-Annually	Use of distance measuring tape	Raising Kerb Height	Within 1 Month	RC 86:1983
	Kerb Painting	Functionality: Functioning of Kerb painting as intended	Daily	Visual with video/image backup	Kerb Repainting	Within 7-days	RC 35:2015
Other Road Furniture	Reflective Pavement Markers (Road Studs)	Numbers and Functionality as per specifications in IRC SP :84-2019and IRC:35-2015, unless specified in Schedule-B.	Daily	Counting	New Installation	Within 2 months	IRC SP :84-2019, IRC:35-2015
	Pedestrian Guardrail	Functionality: Functioning of guardrail as intended	Daily	Visual with video/image backup	Rectification	Within 15 days	IRC SP :84-2019
	Traffic Safety Barriers	Functionality: Functioning of Safety Barriers as intended	Daily	Visual with video/image backup	Rectification	Within 7 days	IRC SP :84-2019, IRC:119-2015
	End Treatment of Traffic Safety Barriers	Functionality: Functioning of End Treatment as intended	Daily	Visual with video/image backup	Rectification	Within 7 days	IRC SP :84-2019, IRC:119-2015

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Attenuators	Functionality: Functioning of Attenuators as intended	Daily	Visual with video/image backup	Rectification	Within 7 days	IRC SP :84-2019, IRC:119-2015
	Guard Posts and Delineators	Functionality: Functioning of Guard Posts and Delineators as intended	Daily	Visual with video/image backup	Rectification	Within 15 days	IRC: 79 - 1981
	Overhead Sign Structure	Overhead sign structure shall be structurally adequate	Daily	Visual with video/image backup	Rectification	Within 15 days	IRC:67-2012
	Traffic Blinkers	Functionality: Functioning of Traffic Blinkers as intended	Daily	Visual with video/image backup	Rectification	Within 7 days	IRC SP :84-2019
Highway Lighting System	Highway Lights	Illumination: Minimum 40 Lux illumination on the road surface	Daily	The illumination level shall be measured with luxmeter	Improvement in Lighting System	24 hours	IRC SP :84-2019
		No major failure in the lighting system	Daily	-	Rectification of failure	24 hours	IRC SP :84-2019
		No minor failure in the lighting system	Monthly	-	Rectification of failure	8 hours	IRC SP :84-2019
	Toll Plaza Canopy Lights	Minimum 40 Lux illumination on the road surface	Daily	The illumination level shall be measured with luxmeter	Improvement in Lighting System	24 hours	IRC SP :84-2019
		No major/minor failure in the lighting system	Daily	-	Rectification of failure	8 hours	IRC SP :84-2019

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
Trees and Plantation including median plantation	Obstruction in a minimum head-room of 5.5 m above carriageway or obstruction in visibility of road signs	No obstruction due to trees	Monthly	Visual with video/image backup	Removal of trees	Immediate	IRC SP :84-2019
	Deterioration in health of trees and bushes	Health of plantation shall be as per requirement of specifications & instructions issued by Authority from time to time	Daily	Visual with video/image backup	Timely watering and treatment. Or Replacement of Trees and Bushes.	Within 90 days	IRC SP :84-2019
	Vegetation affecting sight line and road structures	Sight line shall be free from obstruction by vegetation	Daily	Visual with video/image backup	Removal of Trees	Immediate	IRC SP :84-2019
Rest Areas	Cleaning of toilets	-	Daily	-	-	Every 4 hours	
	Defects in electrical, water and sanitary installations	-	Daily	-	Rectification	24 hours	

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
Other Project Facilities and Approach roads	Damage or deterioration in Approach Roads, pedestrian facilities, truck lay-bys, bus-bays, bus-shelters, cattle crossings, Traffic Aid Posts, Medical Aid Posts and other works		Daily	-	Rectification	15 days	IRC SP :84-2019

4. Table -4: Maintenance Criteria for Structures:

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
Pipe/box/slab culverts	Free waterway/unobstructed flow section	85% of culvert normal flow area to available.	2 times in a year (before and after rainy season)	Inspection by Bridge Engineer as per IRC SP: 35-1990 and recording of depth of silting and area of vegetation.	Cleaning silt up soils and debris in culvert barrel after rainy season, removal of bushes and vegetation, U/s of barrel, under barrel and D/s of barrel before rainy season.	15 days before onset of monsoon and within 30 days after end of rainy season.	IRC 5-2015, IRC SP:40-1993 and IRC SP:13-2004
	Leak-proof expansion joints if any	No leakage through expansion joints	Bi-Annually	Physical inspection of expansion joints as per IRC SP: 35-1990 if any, for leakage strains on walls at joints.	Fixing with sealant suitably	30 days or before onset of rains whichever comes earlier	IRC SP:40-1993 and IRC SP:69-2011

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Structurally sound	Spalling of concrete not more than 0.25 sqm	Bi-Annually	Detailed inspection of all components of culvert as per IRC SP:35-1990 and recording the defects	Repairs to spalling, cracking, delamination, rusting shall be followed as per IRC:SP:40-1993.	15 days	IRC SP 40-1993 and MORTH Specifications clause 2800
		Delamination of concrete not more than 0.25 sq.m.					
		Cracks wider than 0.3 mm not more than 1m aggregate length					

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Protection works in good condition	Damaged of rough stone apron or bank revetment not more than 3 sqm, damage to solid apron (concrete apron) not more than 1 sqm	2 times in a year (before and after rainy season)	Condition survey as per IRC SP:35-1990	Repairs to damaged aprons and pitching	30 days after defect observation or 2 weeks before onset of rainy season whichever is earlier.	IRC: SP 40-1993 and IRC:SP:13-2004.
Bridges including ROBs Flyover etc. as applicable	Riding quality or user comfort	No pothole in wearing coat on bridge deck	Daily	Visual inspection as per IRC SP:35-1990	Repairs to BC or wearing coat	15 days	MORT&H Specification 2811
Bridge -Super Structure	Bumps	No bump at expansion joint	Daily	Visual inspection as per IRC SP:35-1990	Repairs to BC on either side of expansion joints, profile correction course on approach slab in case of settlement to	15 days	MORT&H Specification 3004.2 & 2811.

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
					approach embankment		
	User safety (condition of crash barrier and guard rail)	No damaged or missing stretch of crash barrier or pedestrian hand railing	Daily	Visual inspection and detailed condition survey as per IRC SP: 35-1990.	Repairs and replacement of safety barriers as the case may be	3days	IRC: 5-1998, IRC SP :84-2019 and IRC SP: 40-1993.
	Rusted reinforcement	Not more than 0.25 sq.m	Bi-Annually	Detailed condition survey as per IRC SP: 35-1990 using Mobile Bridge	All the corroded reinforcement shall need to be thoroughly cleaned from rusting and	15 days	IRC SP: 40-1993 and MORTH Specification 1600.
	Spalling of concrete	Not more than 0.50 sq.m					

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Delamination	Not more than 0.50 sq.m		Inspection Unit	applied with anti-corrosive coating before carrying out the repairs to affected concrete portion with epoxy mortar / concrete.		
	Cracks wider than 0.30 mm	Not more than 1m total length	Bi-Annually	Detailed condition survey as per IRC SP: 35-1990 using Mobile Bridge Inspection Unit	Grouting with epoxy mortar, investigating causes for cracks development and carry out necessary rehabilitation.	48 Hours	IRC SP: 40-1993 and MORTH Specification 2800.

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Rainwater seepage through deck slab	Leakage - nil	Quarterly	Detailed condition survey as per IRC SP: 35-1990 using Mobile Bridge Inspection Unit	Grouting of deck slab at leakage areas, waterproofing, repairs to drainage spouts	1 months	MORTH specifications 2600 & 2700.
	Deflection due to permanent loads and live loads	Within design limits.	Once in every 10 years for spans more than 40 m	Load test method	Carry out major rehabilitation works on bridge to retain original design loads capacity	6 months	IRC SP: 51-1999.
	Vibrations in bridge deck due to moving trucks	Frequency of vibrations shall not be more than 5 Hz	Once in every 5 years for spans more than 30m and every 10 years for spans between 15 to 30 m	Laser displacement sensors or laser vibro-meters	Strengthening of super structure	4 months	AASHTO LRFD specifications

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Leakage in Expansion joints	No damage to elastomeric sealant compound in strip seal expansion joint, no leakage of rain water through expansion joint in case of buried and asphalt plug and copper strip joint.	Bi-Annually	Detailed condition survey as per IRC SP:35-1990 using Mobile Bridge Inspection Unit	Replace of seal in expansion joint	15 days	MORTH specifications 2600 and IRC SP: 40-1993.
	Debris and dust in strip seal expansion joint	No dust or debris in expansion joint gap.	Monthly	Detailed condition survey as per IRC SP:35-1990 using Mobile Bridge Inspection Unit	Cleaning of expansion joint gaps thoroughly	3 days	MORTH specifications 2600 and IRC SP: 40-1993.

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Drainage spouts	No down take pipe missing/broken below soffit of the deck slab. No silt, debris, clogging of drainage spout collection chamber.	Monthly	Detailed condition survey as per IRC SP: 35-1990 using Mobile Bridge Inspection Unit	Cleaning of drainage spouts thoroughly. Replacement of missing/broken down take pipes with a minimum pipe extension of 500mm below soffit of slab. Providing sealant around the drainage spout if any leakages observed.	3 days	MORTH specification 2700.

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Bearings	Delamination of bearing reinforcement not more than 5%, cracking or tearing of rubber not more than 2 locations per side, no rupture of reinforcement or rubber	Bi-Annually	Detailed condition survey as per IRC SP: 35-1990 using Mobile Bridge Inspection Unit	In case of failure of even one bearing on any pier/abutment, all the bearings on that pier/abutment shall be replaced, in order to get uniform load transfer on to bearings.	3 months	MORTH specification 2810 and IRC SP: 40-199.
Bridge Foundations	Scouring around foundations	Scouring shall not be lower than maximum scour level for the bridge	Bi-Annually	Condition survey and visual inspection as per IRC SP: 35-1990 using Mobile Bridge Inspection Unit.	Suitable protection works around pier/abutment	1 month	IRC SP: 40-1993, IRC 83-2014, MORTH specification 2500

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
				In case of doubt, use Underwater camera for inspection of deep wells in major Rivers.			
	Protection works in good condition	Damaged of rough stone apron or bank revetment not more than 3 sq.m, damage to solid apron (concrete apron) not more than 1 sq.m	2 times in a year (before and after rainy season)	Condition survey as per IRC SP:35-1990	Repairs to damaged aprons and pitching.	30 days after defect observation or 2 weeks before onset of rainy season whichever is earlier.	IRC: SP 40-1993 and IRC:SP:13-2004.

Note: Any Structure during the entire contract period which is found that does not complies with all requirements of this Table will be prepared, rehabilitated or even reconstructed under the scope of the contractor.

5. Table 5: Maintenance Criteria for Hill Roads

In addition to above, for hill roads the following provisions for maintenance is also to done.

Hill Roads		
(i)	Damage to Retaining wall/ Breast wall	7 (Seven) days
(ii)	Landslides requiring clearance	12 (Twelve) hours
(iii)	Snow requiring clearance	24 (Twenty-Four) hours

Note: For all tables 1 to 5 above, latest BIS & IRC standards (even those not indicated herewith) along with MoRTH specifications shall be binding for all maintenance activities.

Annex-II

(Schedule-E)

Annex-II: Tentative guidelines for maintenance of Cable stayed bridge

Maintenance may be defined as measurements to guarantee the continuous performance of a structure at its capacity level. For bridges, maintenance can be defined as ensuring the safe, unrestrained passage of people, and vehicles as specified in the construction. This is a combination of planned maintenance, refurbishment, inspection, replacement and the repair of accidental damage. In another point of view, maintenance work could be regarded as the action taken to prolong the useful life of a bridge at a minimum cost with least interference to its operational function. The structural components composing the bridge are subject to a number of potential hazards that can be categorised into:

- Environmental hazards: Earthquake, strong wind, soil erosion, flooding etc.
- Accidents & incidents: ship or vehicle collision, overloading, fire etc.
- Degradation of materials: fatigue, erosion corrosion, cracking, aging, etc.
- Structural accommodation and construction non conformities

The bridge maintenance activities include repairing bent or damaged steel beams, coating removals & coatings, cracked or spalled concrete, damaged expansion joints, bent or damaged railings. These activities can entail operation of support vehicles and equipment, pavement repair, welding and grinding operations, associated pollutants, environmental stewardship practices under paving, structural pavement failure (dig outs), pavement grinding, concrete slab, spall repairs etc. .

The life cycle cost based study of bridge maintenance and rehabilitation is very limited. It is necessary and urgent to develop appropriate maintenance and rehabilitation strategies that not only meet serviceability criteria but also consider the life-cycle cost optimization. Maintenance and rehabilitation are necessary to maintain the safety, serviceability and sustainability of these bridge structures. In order to optimize maintenance and rehabilitation interventions and achieve a cost-effective life-cycle performance for in-service cable supported bridges, it is necessary and urgent to establish sound life-cycle based maintenance and rehabilitation strategies.

Preventative bridge maintenance avoids larger scale work in both natural and financial resources. Preventive maintenance is defined as a planned strategy of cost-effective treatments applied at the proper time to preserve and extend the useful life of a bridge. Preventive maintenance activities eligible for funding include sealing or replacing leaking joints; applying deck overlays that will significantly increase the service life of the deck; painting the structural steel; and applying electrochemical chloride extraction treatments to decks and substructure elements.

Bridge maintenance encompasses:

- Cleaning activities including water flush of all decks, drains, bearings, joints, pier caps, abutment seats, concrete rails, and parapets.

- Preventive maintenance activities such as painting, coating, sealant applications for routine, minor deck patching and railing repairs.

- Technical and specialized repairs including jacking up the structures, crack repairs, epoxy injection, repairing or adjusting bearing systems, repair and sealing of expansion joints, repair or reinforcement of main structural members to include stringers, beams, piers, pier and pile cap, cables, abutments and footings, underwater repairs, major deck repairs, major applications of coatings, sealants.

- Stream channel maintenance including debris removal, stabilizing banks and correcting erosion problems.

To maintain and repair bridges, establishing procedures are necessary for early detection of problems, timely repair, good preventative maintenance and consideration of long term effectiveness.

The evaluated urgency of repair, the life-cycle costs, user costs, and minimum requirements of structural performance, structural risks, traffic and other operational requirements, aesthetics, environmental risks and ecological pressures can be taken into account for multiple-attribute planning on all hierarchical levels of the system. The life-cycle analysis and optimization module involves the data applications for studying the economy of the life cycle and cost-effectiveness of optional maintenance, repair and rehabilitation strategies.

In order to conserve fiscal and natural resources and ensure safety, investing in bridge inspection for preventative maintenance on such "smart bridge" is essential. The "smartest" bridge to date is considered in terms of density of sensors, contains sensors, data-collection boxes, and a central data processing unit. It will count on the investment to help to make smaller, less costly repairs while problems are still manageable. Engineering data collection will be able to be correlated with continuous environmental data collection on-site. Some of the bridge maintenance activities that provide the biggest benefit for the smallest level of investment generally include - Eliminating deck joints, Repairing or installing new expansion dams on bridge decks, Repairing bridge decks, Maintaining proper deck drainage, Restoring or replacing bridge bearings, Repairing or replacing bridge approach slabs, Repairing bridge beam ends and beam bearing areas, Bridge painting etc.

Maintaining Activities: -

Effective bridge deck drainage is important because deck structure and reinforcing steel is susceptible to corrosion from de-icing salts; moisture on bridge decks freezes before surface roadways, hydroplaning can occur more easily; and drainage occurs over environmentally sensitive areas.

Bridge Cleaning

Bridge cleaning consists of cleaning all bridge components that are susceptible to dirt, debris, bird dropping and de-icing salts. Drainage systems and components subject to dirt or bird droppings accumulation need to be cleaned regularly by hand tools, air blasting or preferably water flushing.

Bridge painting/coating/sealing covers all protective and preventative maintenance activities designed to prevent deterioration of structure components. Components made of non-weathering steel are generally painted with a multicoated paint system to protect the steel from rust and corrosion. Bridges painted earlier typically used lead, chromium, or cadmium pigmented paints, which must be removed according to the guidelines and disposed of as a hazardous waste.

As an alternative to removal, some toxic based paint is in a condition that permits an over coating of paint to effectively contain the toxic material and protect the steel. Critical variables which determine the success or failure of an over coating job include: the condition of the existing paint, the extent of corrosion on the substrate, the level of surface cleanliness achieved, and the environment of exposure.

The removal of lead-containing paint considered the relative cost increases associated with changing regulations that deal with removal and handling of hazardous debris during bridge maintenance painting operations. The relative cost of paint material is almost always insignificant when viewed in terms of the overall cost of the bridge maintenance job. The advantage in the relative durability of the better coating systems often far outweighs the nominally increased cost of these materials at the time of application. In general, for moderately to severely corrosive environments, the most durable options in the coating material and in the surface preparation system will be the optimum choices from a life-cycle cost standpoint.

Metallizing is a term used to describe thermal sprayed metal coatings. For corrosion control coatings on steel structures, metallizing refers to the thermal spraying of zinc or aluminium alloys as a coating directly onto steel surfaces. Metallized coatings provide corrosion protection to steel by sacrificial and barrier protection. The coating itself provides a barrier between the environment and the steel surface, especially when applied in combination with conventional sealers as topcoats. Due to the electrochemical reaction between steel and zinc or aluminium in an aqueous and salt-contaminated environment, these coatings tend to "sacrifice" themselves to protect the steel at the site of any damage in the coating. This sacrificial protection is similar to the protection provided by zinc-rich primers or galvanizing. The project can be considered successful and equipment advances enabled metallizing to be done much faster than in the past. Under life-cycle costing, metallizing can be advantageous despite its cost.

Deterioration in cable stayed bridge

The major hazards of in-service cable supported bridges, including fatigue cracking of orthotropic steel decks, deterioration of cables, damage of main cables, hangers and expansion joints etc. Advanced maintenance and rehabilitation tools are introduced to

save the life-cycle cost, acoustic emission monitoring technique and cold retrofit technique are detailed studied. A framework is provided for the strategies of maintenance and rehabilitation based on life-cycle cost. The framework takes into account of the safety, serviceability and sustainability during the lifetime of cable supported bridges. The Cable supported bridges are subject to Fatigue and fracture, Durability, Life-cycle cost, Maintenance and rehabilitation, Cold retrofit technique, Sustainability.

Life-Cycle Cost Based Maintenance and Rehabilitation Strategies for Cable Supported Bridges, Problems mainly include fatigue failure of the orthotropic steel deck, fracture or deterioration of main cables and hangers, as well as wear and damage of expansion joints, due to wheel loading, harsh environments and natural hazards. Consequences of traffic closure or even traffic capacity reduction may lead to inconvenience for users and thus result in significant losses of society and economy. Therefore, sound maintenance and rehabilitation strategies for cable supported bridges are important for the purpose of providing an acceptable standard of safety and serviceability, as well as meeting the sustainability and low carbon energy requirements during their operation service time.

Fatigue Cracking of Orthotropic Steel Decks Orthotropic steel decks (OSDs) have been widely used in cable supported bridges for several decades in parts of the world for they are considerably lighter, thus allow longer spans to be efficiently designed.

The complex configurations and direct exposure to repeated vehicular loading lead to relatively high levels of stress concentration. Many details of OSDs are fatigue-sensitive. Recently, more and more engineers, researchers, as well as bridge owners pay more attention to the fatigue problem of the OSDs since a large number of fatigue cracks have been found. Hundreds of fatigue cracks have been detected in the steel decks.

Stay cables are made of high strength steel strands and are susceptible to corrosion with the presence of humidity and oxygen. Under the action of repeated vehicle load, stay cables may initiate fatigue cracks and in the meanwhile, the buffeting and fluttering vibrations caused by wind and rain would increase the stress in the stay cables and make the fatigue.

Test Deterioration of stay cables mainly refers to damage in the cover, corrosion of steel wires, fatigue of cable and cable anchor systems, and other damages caused by excessive vibration. The corrosion of stay cables includes uniform corrosion, dent corrosion, crack corrosion, stress corrosion and corrosion fatigue. Anti-corrosion measures should be made on a case-by-case basis since each bridge is different in production, transportation, storage, erection and maintenance. Commonly used PE protective cover of stay cables may deteriorate due to damages such as transverse cracks, longitudinal cracks, scratches, corrugations and indentations. After these, corrosion of the steel wire may accelerate. In addition, the actions of wind and rain, or the vibration of the bridge tower and deck, vibrations such as wake galloping, vortex-induced vibration, rain vibration, parametric-induced vibration as well as buffeting may occur. Some of these vibrations' amplitudes are not big, but the frequency is

relatively larger while others amplitudes may be big. Such vibrations of the stay cables are the main cause of fatigue in the vicinity of the anchorages of cable-stayed bridges and may also damage the corrosion protection system of cables or even lead to the failure of stay cables.

The main cables and hangers are essential elements of a suspension bridge and they are also the most difficult components to maintain. Thus, more attention should be paid to their maintenance and rehabilitation. A main cable's damage has always been associated with corrosion. The damage of hangers has always been associated with corrosion. The vibrations such as buffeting, galloping and rain vibration or a combination of these.

As the temperature changes, the girder of cable supported bridges will experience expansion and contraction which may lead to longitudinal strain in the girder. In the meanwhile, the bridge deck will produce longitudinal displacements under vehicle loads. In order to meet the requirements of such strain and deformation, it is necessary to set expansion joints between the bridge girder and the abutment or between hinged joints. As expansion joints are repeatedly subjected to vehicle loads, even a very small unevenness can cause a great impact. Expansion joints have been recognized as weak components in cable supported bridges for a long time. In addition, along with the rapid increase of traffic volume and the unavoidable phenomenon of overload, the impact of expansion joints increases. This may accelerate the wear and damage of expansion joints and cause both economic and social problems in maintenance and rehabilitation during the operation service time.

Dehumidification System Steel corrosion is a recognized cause for deterioration in bridge cables and girders. There were several cases worldwide where rehabilitation and replacement had to be done due to corrosion problems and these led to enormous costs of bridge maintenance. Traditional anti-corrosion protection systems for components such as main cables and steel girder cannot totally prevent corrosion, but merely slow it down. The invention and application of dehumidification systems have proven to be able to totally prevent corrosion. Generally, dehumidification systems can be designed and installed in components such as main cable, cables saddles and anchor houses of suspension bridges and also at steel girders.

The cost of maintenance and rehabilitation depends on the reliability level for when the maintenance and rehabilitation work is to be applied. Thus, formulating a reasonable reliability level after maintenance and rehabilitation is important to provide an acceptable level of safety and serviceability during operation service over the entire life cycle.

Major hazards of in-service cable supported bridges, including fatigue cracking of orthotropic steel decks, deterioration of cables, damage of main cables, hangers and expansion joints are analysed in operation condition.

Advanced maintenance and rehabilitation tools are introduced to save the life-cycle cost, acoustic emission monitoring technique and cold retrofit technique.

Bridge Management Systems (BMS)

The growth of the bridge stock and the availability of computers have led to the development of bridge management systems (BMS) for managing the bridges. It is important that bridge management is brought into consideration at the very beginning of the bridge design stage. Recent experience has shown that the durability and maintenance should also be addresses along with safety and serviceability at the design stage itself. It is accepted fact that many parts of the bridges from bearings, expansion joints, surfacing, etc. to hangers, cable stays and external prestressing tendons all have to be replaced. Some of these replacements are more than once during the design lifetime of the bridge. Account should be taken at the design stage so that replacements can be carried out with ease and with minimum intervention to traffic.

Bridge structures need to maintain from time to time to brought into service and the people who are responsible for maintenance are different from those who carry out the design. Therefore, the maintaining parties need to have a full set of the drawings and maintenance schedules that indicate the frequency of inspection & maintenance. The maintenance plan should also highlight areas where something has gone wrong during construction & which need special monitoring.

Once the bridge is completed, it starts to be exposed under the impaction of both traffic & the environment. A comprehensive bridge management system is an integrated set of formal procedure for directing / controlling all activities related to bridges. A bridge management system should incorporate:-

- A set of data that describes the physical and operating condition of the bridge at any given time.
- A procedure for predicting changes in the bridge condition caused by future deterioration and improvement work.

A number of BMS are now being developed, which may comprising of three main modules – recommendations, optimization and improvement. It is designed only for bridges. It covers only routine maintenance and deterioration part of the highway bridge management activities.

The bridge management system is necessary to ensure a rational study of a bridge from conception to the end of useful life. The bridge is planned to be inspected as per requirement. The cables will have a monitoring system which may consists of laser vibrometer to monitor structural of the cables. It measures the cables under excitation, or prevailing wind conditions. The vibrometer allows the evaluators to target more than one cable from a single setup. For maintenance, the type of cable is most important in dealing with corrosion protection and cable anchorage. The option to protect the cable from corrosion is using polyethylene pipe to enclose epoxy coated cables.

The long term condition assessment of cable & bridge decks on the structural health monitoring techniques shall improve predictions of deterioration over the service life and guide future decision making on bridge maintenance & repair.

The Routine/Regular inspections & other activities of the bridge & its components shall be carried out as per IRC SP-18, IRC-SP-35, IRC-SP-52 and relevant guidelines issued by MoRTH from time to time. The contractor shall hand over two complete & durable sets of 'as built 'drawings & designs duly signed by contactor & Authority Engineer to the Authority at the time of issue of completion certificate. The contractor shall carry out NDT on each & every components of bridge before opening to traffic and furnish the same to the Authority. Based on these data, 'Principal /Detail 'inspections shall be done an interval of 5 years or twice in the defect liability period.

Maintenance of Cable Stay Bridge Components:

The Contractor shall prepare a manual providing information about the basic demands on the components used in the bridge, the construction of the bridge, and suggestions about the inspection procedures based on recommendations of suppliers and manufacturers. The major inspection should include the following:-

- Cable enclosure: A careful examination of the main cables is necessary to ensure that their protective covering is in good condition. Cracking and unsoundness are the main problems of the cable enclosure.
- Damping system: Damping system should be inspected to ensure that they are performing as the original design required. The operation and adjustment of the damping system should be executed according to the suggestions by the manufacturer and should be part of the maintenance procedures of the structure. The damping system may need to be replaced if the dampers are seriously deformed. The maintenance of the damping system should base on the manual of the manufacturer.
- Cable anchorages: The anchorages should be inspected for water tightness; drainage between guide transition pipes; and corrosion protection of the anchor system.
- Cables: To accurately determine the load – carry – capacity of the main cables, non-destructive testing is required. First the alignment is inspected. The strength of the stay is kept under the deign value.
- Cables: If the steel cables are wrapped inside a grout pipe, no maintenance is possible. Maintaining of the protection means maintain the cable inside. Periodic maintenance of a cable-stayed bridge includes repainting of cable enclosures or rewrapping of polyethylene cable enclosures. Painting of metal enclosures is about every 15 to 20 years but the time varies depending on the environmental and site conditions. Repairing should be compatible to the original paint system. The wrapping tape should be rewrapped every 5 to 7 years.
- Anchorage Protection: The waterproofing system at the connection is crucial to the cable and any defect in this part should be repaired immediately. Again, the recoating should conform to the original coating of the system.
- Cable-stayed force adjustments: Maintenance should include the measurement of the forces distributed on the cables to ensure no single cable is experiencing abnormal excess force. If the long-term behaviour of the bridge is differs from that assumed in the design, cable-stay force adjustments may be required. Any readjustment of stay forces should be performed by experienced technicians based on the original design.

- Vibration adjustment: Vibration should be measured at constant time intervals and should be compared to the operational manual. Excessive vibration of the cable could result in damage to the whole bridge. The main forces inducing vibration are the wind forces and water dropping on the cables. If vibrations are excessive, adjustments to the damping system should be made. Solution to the problem is correction on the damping system. Again, corrective measurements should be performed by professionals.
- Cable protection: Cable protection protects the cable not only from moisture but also temperature variations, ultraviolet attack, and environmental corrosions. Protection has the tendency to put more importance on the grout or oil surrounding the stays. They are crucial in extending the life expectancy of the cables.
- Retensioning of cables: The retensioning procedure for cable-stayed should be incorporated to the original design. Actually, retensioning of the cables should be required as a design requirement. Variations during construction, differences between expected and actual material properties all require re-examine of the tension of the cable stays and retensioning is often needed. Retensioning should be executed only under experienced engineers and under a proper designed maintenance program.
- **Cable replacement:** In modern cable-stayed bridge designs, complete cable replacement under traffic is required in the design stage. The cable replacement is a major rehabilitation work of the bridge should also be investigated as part of the rehabilitation program.

Inspection Procedures

- Abutments: Footings should be checked for the potential of scour or undercutting. The inspection should normally be done at the season of the lowest water level. Scour or undercutting of a pier on piles can be quite serious, and hence exposed piles should be properly inspected. Exposed concrete should be examined for the presence and severity of cracks and visual signs of deterioration. Tops of piers and abutments are particularly vulnerable to de-icing chemical attack. Steel partially encased in substructure concrete should be inspected at exposed faces for deterioration and movement. If any movement or settlement is suspected, piers and abutments should be observed and compared with previous records.
- Piles: The piles in the splash zone and below the water surface should be checked for corrosion and deterioration. All submerged piles should be checked for deterioration and section loss, with special attention to exposed piles. Corrosion of exposed piles can be more severe at the terminus of concrete encasement, at the waterline and at the middle.
- Bearings: Bearings should be re-examined after unusual events such as traffic damage, earthquake, or battering from flood debris. The inspection should focus on the physical condition of bearing pads, including any abnormal flattering, bulging, or splitting that may result in uneven distribution of loads. The concrete at bearing seats should be checked for cracks and spalls.

Maintenance and rehabilitation:

- Foundation settlement: Uneven settlements usually lead to cracking of the substructure. Uniform settlement may leave the unit intact and result in a change of bridge elevations or a tilt of the substructure elements. Tilting of the substructure often contributes to either closure or opening of the deck joints over the tilted substructure, making joint replacement necessary.

- **Scour:** Protective materials to be placed around a scoured foundation must be sufficient stable to resist the hydraulic forces causing the scouring in the first place. The most commonly used repair methods include dump riprap**,** hand-laid riprap bagged concrete and cofferdams.
- Pile repair: Although prestressed concrete piles show better resistance to the chemical because of their dense, high-quality concrete cast under controlled conditions and the fact is that the concrete is under compression. They are not immune to deterioration. A jackets built over the deteriorated area is the most common method adapted while pile deteriorated.
- Prestressed Concrete: Prestressed concrete offers many advantages as a material for bridge construction such as better durability. Like steel, or any other material for that matter, prestressed concrete requires a thorough and attentive maintenance program to ensure that the structure serves its function at a high level of performance.

Inspection procedures of Prestressed Concrete Structure:

Basic features or conditions which should be identified by the inspector can be defined as: cracking, wet spots, spalling, and excessive deflection, presence of efflorescence, scaling and settlement or uplift of the structure. Of particular concern is the condition of the prestressing tendons. Advanced methods based on non-destructive evaluation, such as ultrasonic, electrical, and radiographic techniques can be used to indicate possible delaminations in the concrete or corrosion to the prestressing steel. Anchorage zones and beam ends should then be constantly inspected. These areas are particularly susceptible to joint leakage and the intrusion of water at the anchorage. In addition to moisture, anchorage zones are also susceptible to cracking due to high stress at this location.

- Deterioration of prestressed concrete: Provided below is an outline of some of the major forms of deterioration prestressed Concrete members are subject to:
  1. Cracking
  2. Deterioration of prestressing steel
  3. Another source of deterioration is the deck joint leakage

- Rehabilitation of prestressed concrete: These both protect and repair a prestressed concrete structure. One basic step is to repair and replace the deficient joints. A preliminary assessment of damage should include a brief analysis of the approximate strength of the member and then a complete capacity analysis should follow to articulate stress levels in the damage section. Discussed below are some basic methods to repair damage to prestressed concrete members:

  1. Patching. For small, localize areas of deterioration, patching offers a quick low cost remedial measure. If the patch is located in an area that is normally in compression, the member should be preloaded to simulate the effects of live load on the structure.
  2. Crack injection: When an element is subjected to an overload condition which induces cracking, the injection of epoxy resin is often a suitable repair method. On the other hand, if the crack is subjected to constant loads, then the crack injection is not recommended since the crack is likely to reappear.
  3. Permanent formwork: If the prestressed concrete member has suffered from accidental damage which caused the exposure of the prestressing steel,

permanent formwork is often used. Sometimes jacketing of the damaged area with concrete is used. In essential, both of these repairs are similar to patch.

4. Sealers: Concrete sealers are used to protect the underlying concrete from being intruded by moisture.
5. Strengthening: Methods include bonded external reinforcement, tendon replacement and external posttensioning.

- ***Influence of maintenance on the design of highway structures:***

The design considerations could help a bridge serviceable at a minimum cost throughout its operational life.

Low-maintenance design:

To design a low maintenance bridge, the designs must be realistic and pragmatic of the parts that have directly contact with the traffic. Hence, all such parts should be designed to be inspected and replaced easily and rapidly. This means every part of the bridge should be designed for rapidly inspection and reparation. The best way to ensure rapid defect identification and reparation is to provide easy access to every part of the bridge for future maintenance workers. Serious loss of strength exacerbated because the economical use of materials and excessive deflections can ensue, leading to troublesome and expensive maintenance operations. In most optimistic cases, the time-dependent properties should be studied to decide maintenance procedures afterwards. It should be stressed that maintenance as well aesthetics should be considered in the design stage of bridges. An expensive bridge that will cheap to maintenance and will last for a longer time must be shown in the long run cheaper than a cheaper bridge in construction but cost a lot to maintenance and last a much shorter time.

- Practical design considerations

1. Elimination of roadway irregularities: As all the joints must be brought up to the surface as well as the joints often shorter life span than other parts of the bridge, the best way to eliminate such joint-related problems is to have as few joints as possible. Changes of level often occur in the point where approach meets bridge. Firstly, different compaction of the pavement will be prevented if the full depth of paving is carried from the approach on to the bridge without reduction. Secondly, approach embankments should be constructed in advance, to preload the ground and the consolidation could be prevent after the pavement is constructed. Thirdly, abutments and wing walls should be designed so that compaction machinery could operate effectively.
2. ***Design for parts accessible to traffic:*** The functions of joints, surfacing drainage, parapets, lighting and traffic aids merely assist to traffic for safely & smoothly. They contribute substantially to the service a bridge provides to the traffic passing through and should be designed based on the consideration of low maintenance cost.
3. ***Joints: Volume*** changes may be caused **by** temperature variations, **loss of** prestress, and shrinkage. **A** typical bridge may be approximately 1 in longer per **100 ft** of length in the summer than in the winter. Forces, such as centrifugal and longitudinal vehicle force, traction, earthquake, wind, earth pressure, and ice loads all cause movements in the conjunction. **AASHTO** stipulates that thermal movement must be provided for at the rate of ***1.25*** in/100 ***ft.*** Types of joints developed for this purpose vary from open joints, simple planes or weakness, and elastic joints to sliding bar joints. The joints must be represent the state-of-the-art approach to accommodating the complex movements in a bridge. Deterioration of expansion joints from continuous use must be accepted. Designing multi-span bridges as continuous and reducing the number of

joints. To evenly distribute the movement, restrainer belts across joints could redistribute the movement to other joints. The joint should be designed to carry traffic impact without appreciable defection. In a desirable condition for low-maintenance design, joints should have a life expectancy the same as the roadway deck. Some suggested guidelines for joints are summarized as follows:

Seating's should be provided to support the joints where joints have to be used. Joint seals could then base on solid concrete rather than on mortar that is likely to break under traffic. Use more holding-down bolts than theoretically necessary to ensure that the joints are firmly embedded in strong structural concrete. Provide the minimum number of expansion joints possible, consistent with the concept of integral bridges. Continuous bridges with integral abutments are the most practical method. Use oversized expansion joints to accommodate anticipated movements. The movement should include creep and shrinkage effects. A conservative factor of design is 1.25. Detail a joint to limit deflection under traffic loads and prevent failure of the anchorage system. Enhance joint water tightness: With open joints, use deflector plates to protect the bearings. Because joints are open to damage from debris and dirt, make provisions for maintenance and cleaning. If the joint design is the contractor's responsibility, introduce performance specifications. Although cost may be increased, this would improve performance. Provide relief joints at the bridge ends 30 to 50 ft. away from the bridge ends to reduce force from pavement growth. Include quality control of all materials, process, and fieldwork, and specify appropriate non-destructive inspection and testing procedures. Prepare instructions and specifications for the installation of the expansion joint devices. Finally, joint seal anchor bolts can be fixed with nuts tightened to tension the anchor bolts to simplify the operation of replacing the joints when it has to be replaced the day it wears out.

Mechanical and electrical equipment:

Operation parts normally require ongoing maintenance and repair. This means that a preventive maintenance program must be developed for equipment such as Parapets, lighting and traffic aids should be designed easy to move and replace and at the same time, be constructed of corrosion-resistant material. Electric supplies should be ducted, with draw pits and inspection chambers.

4. ***Bearings:*** Bearings in a bridge transmit the various vertical and horizontal forces from the superstructure to the substructure. Bearings must be designed for both the static loads from the dead weights of the structure and the dynamic loads generated **by** passing vehicles, wind, temperature variations, tractive forces, and earthquakes. The bearings are expected to function without maintenance for a long period of time. Therefore, they must be properly inspected at regular intervals because the stability and integrity of the entire structure depend on this. Monitoring of the movement of the structure and observing the substructure and superstructure members for signs of distress still is the best way to detect bearing dysfunctions.
5. ***Durable*** concrete*:* The durability of concrete is determined by four factors: cement content, compaction, cover and curing. Practically, strength requirements for concrete can be achieved using concrete insufficient for durability. Concrete quality may be further enhanced by the use of air-entraining. Durable concrete may be obtained with the use of proper aggregates and vibration to ensure placement without voids or rock pockets, and by following acceptable curing procedures. Adequate cover can be assured by choosing a design with allowance for site errors.

6. **Substructures** ***and foundations:***

The major bridge failures worldwide, more than 45 percent of these bridge related incidents are attributed to scour. This suggests that measures to reduce the severity of this problem should be considered in the planning stage by selecting a bridge site to minimize scour action. A review of substructure history of existing bridges in the same vicinity and waterway may provide useful data and guidelines with regard to the best protective philosophy.

7. Concrete bridge decks:

It appears that the deterioration of concrete bridge decks is the most frequently mentioned problem. The main cause being salt-induced corrosion of the reinforcing steel. For reducing concrete deck maintenance, the following are recommended:

1. Emphasize the importance of quality control and place of reinforcing steel on plans and in the specifications. Specify a water-cement ratio no greater than 0.4 combined with air entrainment. Also, specify a minimum clear cover to the top steel of 2 inch.
2. Specify epoxy-coated bars in all decks to be subjected to salt applications. All reinforcing steel in the deck should be coated to prevent formation of corrosion.
3. Specify high-density, low-slump concrete or latex-modified concrete with low permeability for overlays. Past experience and research indicate that chloride intrusion will continue but at a reduced rate.
4. In addition to the requirements specified above, use epoxy-coated bars on particular vulnerable structures, such as segmental bridges, and on bridges carrying high volume traffic.

8. ***Reinforced* and prestressed concrete:** To improve maintenance, a number of recommendations for detailing of reinforced concrete are listed below:

1. Ensure that areas of secondary reinforcement provided are sufficient to cope with early thermal cracking.
2. Provide suitable reinforcement at member junctions so that the actual restraints are recognized, as opposed to the perhaps more pessimistic assumptions about mutual restraints made in the design of the individual elements themselves.
3. Consider to use deeper but less heavily reinforced members.
4. Ensure adequate concrete cover to anchorages.
5. Ensure adequate cover to ducts along their whole lengths.
6. Take all possible steps in detailed design to ensure adequate grouting of ducts.
7. For both pre- and post-tension construction, ensure that anti-bursting steel in anchorage zones is adequate and well detailed to avoid congestion.
8. For large segmental bridges, it may be necessary to modify the prestress force after construction. Additional prestressing may also be dictated at a later date to correct for unanticipated creep or for additional loads such as a new wearing surface. The recommendation is to provide for the installation of additional prestress of about 10 percent of the initial prestress. Since the tendon anchorage for the spare ducts are inside the box girder and generally located at the web flange fillet, they are easily accessible. If future prestressing becomes necessary, it can be provided by inserting the required tendon in the duct, jacking it to the design loads, anchoring and grouting it.

Tools & Plants:

The contactor shall ensure the availability of all tools & plants at site/camp to carry out maintenance of Cable Stayed Bridge during DLP:

i. Hand tools
ii. Power tools
iii. Power tools cleaning to bare metal,
iv. Blast Cleaning tools,
v. Shrouded Power Tools,
vi. Proper lighting network
vii. MBIU
viii. Remote Sensing Drones
ix. Cable Dehumidifiers on anchor nodes: The main cables dehumidification involves injecting dry air into the cables micro-environment & allowing the air permeate into the interstitial spaces (voids) between the individual cable wires. It addresses root causes of corrosion by removing water and therefore control the humidity within the cable.
x. Fire Extinguisher System
xi. All safety accessories for workers
xii. Lift/elevators
xiii. Specialised Inspection vehicles
xiv. Rescue navigational system
xv. Others tools tec. Decided by Authority Engineer

Scheduling Maintenance and Repair:

There are times of the year when the effects of pollution from bridge maintenance and repair would cause the most damage and times when the damage would be minimal. The exact timing depends upon the site and the species involved. Schedule bridge maintenance to avoid egg incubation, juvenile rearing and downstream migration periods of fish. Using prefabricated bridge elements and systems makes construction less disruptive for the environment. Bats are primary predators of vast numbers of insect pests that are extremely costly to farmers and foresters. The successful control of pollution from bridge maintenance and repair involves minimizing the potential sources of pollutants from the outset.

Conclusions:

Initial cost is mainly considered in constructing a bridge in the past, whereas future payments such as the cost of strengthening or rehabilitation were neglected. This situation has brought numerous economic as well as social problems due to the lack of rational maintenance and rehabilitation strategies. Thus, it is necessary and urgent to develop appropriate bridge maintenance and rehabilitation strategies that not only meet serviceability criteria but also consider the life-cycle cost (LCC) optimization. As for bridge management, new technologies such as **GIS** and Imaging Technologies have immense potential in implementing BMS objects. Non-destructive evaluation will also gain more importance in determine bridge status. Besides these new developed technologies, probability is crucial in determine total cost of a bridge and should be combined with other engineering information to give the best results. These methods give the BMS lots of space to be discovered. The concept of maintenance is sure to get more and more consequence and it really deserves engineers today to pay more attention especially on long life structure.

Schedule - F

(See Clause 4.1 (vii)(a))

Applicable Permits

1. Applicable Permits

(i) The Contractor shall obtain, as required under the Applicable Laws, the following Applicable Permits:

(a) Permission of the State Government for extraction of boulders from quarry;

(b) Permission of Village Panchayats and Pollution Control Board for installation of crushers;

(c) Licence for use of explosives;

(d) Permission of the State Government for drawing water from river/reservoir;

(e) Licence from inspector of factories or other competent Authority for setting up batching plant;

(f) Clearance of Pollution Control Board for setting up batching plant;

(g) Clearance of Village Panchayats and Pollution Control Board for setting up asphalt plant;

(h) Permission of Village Panchayats and State Government for borrow earth; and

(i) Permission of the IWAI (inland Waterway Authority of India) for construction on River steams.

(j) Any other permits or clearances required under Applicable Laws.

(ii) Applicable Permits, as required, relating to environmental protection and conservation shall have been procured by the Authority in accordance with the provisions of this Agreement.

Schedule – G

(See Clauses 7.1 and 19.2)

Annex-I

(See Clause 7.1)

Annex-I : Form of Bank Guarantee

[Performance Security/Additional Performance Security]

To,
Managing Director,
National Highways & Infrastructure Development Corporation Ltd.
PTI Building, 3rd Floor,
4, Parliament Street
New Delhi – 110001

WHEREAS:

(A) _____[name and address of contractor] (hereinafter called the "**Contractor**") and [name and address of the authority], (hereinafter called the **"Authority"**) have entered into an agreement (hereinafter called the "**Agreement**") for the construction of the ***** section of [National Highway No. **] on Engineering, Procurement and Construction (the "**EPC**") basis, subject to and in accordance with the provisions of the Agreement

(B) The Agreement requires the Contractor to furnish a Performance Security for due and faithful performance of its obligations, under and in accordance with the Agreement, during the {Construction Period/ Defects Liability Period and Maintenance Period} (as defined in the Agreement) in a sum of Rs….. cr. (Rupees ……..….. crore) (the "**Guarantee Amount**").

(C) We, …….. through our branch at ……. (the "**Bank**") have agreed to furnish this bank guarantee (*hereinafter called the* **"Guarantee**") by way of Performance Security.

NOW, THEREFORE, the Bank hereby, unconditionally and irrevocably, guarantees and affirms as follows:

1. The Bank hereby unconditionally and irrevocably guarantees the due and faithful performance of the Contractor's obligations during the {Construction Period/ Defects Liability Period and Maintenance Period} under and in accordance with the Agreement, and agrees and undertakes to pay to the Authority, upon its mere first written demand, and without any demur, reservation, recourse, contest or protest, and without any reference to the Contractor, such sum or sums up to an aggregate sum of the Guarantee Amount as the Authority shall claim, without the Authority being required to prove or to show grounds or reasons for its demand and/or for the sum specified therein.

2. A letter from the Authority, under the hand of an officer not below the rank of [General Manager in the National Highways & Infrastructure Development Corporation Limited], that the Contractor has committed default in the due and faithful performance of all or any of its obligations under and in accordance with the Agreement shall be conclusive, final and binding on the Bank. The Bank further agrees that the Authority shall be the sole judge as to whether

the Contractor is in default in due and faithful performance of its obligations during and under the Agreement and its decision that the Contractor is in default shall be final and binding on the Bank, notwithstanding any differences between the Authority and the Contractor, or any dispute between them pending before any court, tribunal, arbitrators or any other authority or body, or by the discharge of the Contractor for any reason whatsoever.

3. In order to give effect to this Guarantee, the Authority shall be entitled to act as if the Bank were the principal debtor and any change in the constitution of the Contractor and/or the Bank, whether by their absorption with any other body or corporation or otherwise, shall not in any way or manner affect the liability or obligation of the Bank under this Guarantee.

4. It shall not be necessary, and the Bank hereby waives any necessity, for the Authority to proceed against the Contractor before presenting to the Bank its demand under this Guarantee.

5. The Authority shall have the liberty, without affecting in any manner the liability of the Bank under this Guarantee, to vary at any time, the terms and conditions of the Agreement or to extend the time or period for the compliance with, fulfillment and/ or performance of all or any of the obligations of the Contractor contained in the Agreement or to postpone for any time, and from time to time, any of the rights and powers exercisable by the Authority against the Contractor, and either to enforce or forbear from enforcing any of the terms and conditions contained in the Agreement and/or the securities available to the Authority, and the Bank shall not be released from its liability and obligation under these presents by any exercise by the Authority of the liberty with reference to the matters aforesaid or by reason of time being given to the Contractor or any other forbearance, indulgence, act or omission on the part of the Authority or of any other matter or thing whatsoever which under any law relating to sureties and guarantors would but for this provision have the effect of releasing the Bank from its liability and obligation under this Guarantee and the Bank hereby waives all of its rights under any such law.

6. This Guarantee is in addition to and not in substitution of any other guarantee or security now or which may hereafter be held by the Authority in respect of or relating to the Agreement or for the fulfillment, compliance and/or performance of all or any of the obligations of the Contractor under the Agreement.

7. Notwithstanding anything contained hereinbefore, the liability of the Bank under this Guarantee is restricted to the Guarantee Amount and this Guarantee will remain in force for the period specified in paragraph 8 below and unless a demand or claim in writing is made by the Authority on the Bank under this Guarantee all rights of the Authority under this Guarantee shall be forfeited and the Bank shall be relieved from its liabilities hereunder.

8. The Guarantee shall cease to be in force and effect on ****[$]. Unless a demand or claim under this Guarantee is made in writing before expiry of the Guarantee, the Bank shall be discharged from its liabilities hereunder.

9. The Bank undertakes not to revoke this Guarantee during its currency, except with the previous express consent of the Authority in writing, and declares and warrants that it has the power to issue this Guarantee and the undersigned has full powers to do so on behalf of the Bank.

10. Any notice by way of request, demand or otherwise hereunder may be sent by post addressed to the Bank at its above referred branch, which shall be deemed to have been duly authorised to receive such notice and to effect payment thereof forthwith, and if sent by post it shall be

[$] Insert date being 2 (two) years from the date of issuance of this Guarantee (in accordance with Clause 7.2 of the Agreement).

deemed to have been given at the time when it ought to have been delivered in due course of post and in proving such notice, when given by post, it shall be sufficient to prove that the envelope containing the notice was posted and a certificate signed by an officer of the Authority that the envelope was so posted shall be conclusive.

11. This Guarantee shall come into force with immediate effect and shall remain in force and effect for up to the date specified in paragraph 8 above or until it is released earlier by the Authority pursuant to the provisions of the Agreement.

12. This guarantee shall also be operatable at our…….. Branch at New Delhi, from whom, confirmation regarding the issue of this guarantee or extension / renewal thereof shall be made available on demand. In the contingency of this guarantee being invoked and payment thereunder claimed, the said branch shall accept such invocation letter and make payment of amounts so demanded under the said invocation.

13. Bank Guarantee has been sent to authority's bank through SFMS gateway as per the details below:-

S.No.	Particulars	Details
1.	Name of the Beneficiary	National Highways & Infrastructure Development Corporation Limited
2.	Beneficiary Bank Account No.	90621010002659
3.	Beneficiary Bank Branch	IFSC SYNB0009062
4.	Beneficiary Bank Branch Name	Transport Bhawan, New Delhi
5.	Beneficiary Bank Address	Canara Bank (erstwhile Syndicate Bank), Transport Bhawan, 1st Parliament Street, New Delhi - 110001

Signed and sealed this ……. day of ……..., 20…… at …….. SIGNED, SEALED AND DELIVERED

For and on behalf of the Bank by:
(Signature)
(Name)
(Designation)
(Code Number)
(Address)

NOTES:

(i) The bank guarantee should contain the name, designation and code number of the officer(s) signing the guarantee.

(ii) The address, telephone number and other details of the head office of the Bank as well as of issuing branch should be mentioned on the covering letter of issuing branch.

Annex – II

(Schedule - G)

(See Clause 19.2)

Annex-II: Form for Guarantee for Advance Payment

To,
Managing Director,
National Highways & Infrastructure Development Corporation Ltd.
PTI Building, 3rd Floor,
4, Parliament Street
New Delhi - 110001

WHEREAS:

(A) [name and address of contractor] (hereinafter called the "**Contractor**") has executed an agreement (hereinafter called the "**Agreement**") with the [name and address of the authority], (hereinafter called the "**Authority**") for the construction of the ***** section of [National Highway No. **] on Engineering, Procurement and Construction (the "**EPC**") basis, subject to and in accordance with the provisions of the Agreement

(B) In accordance with Clause 19.2 of the Agreement, the Authority shall make to the Contractor an interest bearing *@Bank Rate + 3%* advance payment (herein after called "**Advance Payment**") equal to 10% (ten per cent) of the Contract Price; and that the Advance Payment shall be made in two installments subject to the Contractor furnishing an irrevocable and unconditional guarantee by a scheduled bank for an amount equivalent to 110% (one hundred and ten percent) of such installment to remain effective till the complete and full repayment of the installment of the Advance Payment as security for compliance with its obligations in accordance with the Agreement. The amount of {first/second} installment of the Advance Payment is Rs. ------ cr. (Rupees ------ crore) and the amount of this Guarantee is Rs. ------- cr. (Rupees ------ crore) (the **"Guarantee Amount")**[$]**.**

(C) We, …….. through our branch at ……. (the "**Bank"**) have agreed to furnish this bank guarantee (*hereinafter called the* **"Guarantee"**) for the Guarantee Amount.

NOW, THEREFORE, the Bank hereby, unconditionally and irrevocably, guarantees and affirms as follows:

1. The Bank hereby unconditionally and irrevocably guarantees the due and faithful repayment on time of the aforesaid instalment of the Advance Payment under and in accordance with the Agreement, and agrees and undertakes to pay to the Authority, upon its mere first written demand, and without any demur, reservation, recourse, contest or protest, and without any reference to the Contractor, such sum or sums up to an aggregate sum of the Guarantee Amount as the Authority shall claim, without the Authority being required to prove or to show grounds or reasons for its demand and/or for the sum specified therein.

A letter from the Authority, under the hand of an officer not below the rank of [General

[$] The Guarantee Amount should be equivalent to 110% of the value of the applicable instalment.

Manager in the National Highways & Infrastructure Development Corporation Limited], that the Contractor has committed default in the due and faithful performance of all or any of its obligations for the repayment of the instalment of the Advance Payment under and in accordance with the Agreement shall be conclusive, final and binding on the Bank. The Bank further agrees that the Authority shall be the sole judge as to whether the Contractor is in default in due and faithful performance of its obligations during and under the Agreement and its decision that the Contractor is in default shall be final and binding on the Bank, notwithstanding any differences between the Authority and the Contractor, or any dispute between them pending before any court, tribunal, arbitrators or any other authority or body, or by the discharge of the Contractor for any reason whatsoever.

2. In order to give effect to this Guarantee, the Authority shall be entitled to act as if the Bank were the principal debtor and any change in the constitution of the Contractor and/or the Bank, whether by their absorption with any other body or corporation or otherwise, shall not in any way or manner affect the liability or obligation of the Bank under this Guarantee.

3. It shall not be necessary, and the Bank hereby waives any necessity, for the Authority to proceed against the Contractor before presenting to the Bank its demand under this Guarantee.

4. The Authority shall have the liberty, without affecting in any manner the liability of the Bank under this Guarantee, to vary at any time, the terms and conditions of the Advance Payment or to extend the time or period of its repayment or to postpone for any time, and from time to time, any of the rights and powers exercisable by the Authority against the Contractor, and either to enforce or forbear from enforcing any of the terms and conditions contained in the Agreement and/or the securities available to the Authority, and the Bank shall not be released from its liability and obligation under these presents by any exercise by the Authority of the liberty with reference to the matters aforesaid or by reason of time being given to the Contractor or any other forbearance, indulgence, act or omission on the part of the Authority or of any other matter or thing whatsoever which under any law relating to sureties and guarantors would but for this provision have the effect of releasing the Bank from its liability and obligation under this Guarantee and the Bank hereby waives all of its rights under any such law.

5. This Guarantee is in addition to and not in substitution of any other guarantee or security now or which may hereafter be held by the Authority in respect of or relating to the Advance Payment.

6. Notwithstanding anything contained hereinbefore, the liability of the Bank under this Guarantee is restricted to the Guarantee Amount and this Guarantee will remain in force for the period specified in paragraph 8 below and unless a demand or claim in writing is made by the Authority on the Bank under this Guarantee all rights of the Authority under this Guarantee shall be forfeited and the Bank shall be relieved from its liabilities hereunder.

7. The Guarantee shall cease to be in force and effect on ****.[$] Unless a demand or claim under this Guarantee is made in writing on or before the aforesaid date, the Bank shall be discharged from its liabilities hereunder.

8. The Bank undertakes not to revoke this Guarantee during its currency, except with the previous express consent of the Authority in writing, and declares and warrants that it has the power to issue this Guarantee and the undersigned has full powers to do so on behalf of the Bank.

9. Any notice by way of request, demand or otherwise hereunder may be sent by post addressed to the Bank at its above referred branch, which shall be deemed to have been duly authorised to

[$] Insert a date being 90 (ninety) days after the end of one year from the date of payment of the Advance payment to the Contractor (in accordance with Clause 19.2 of the Agreement).

receive such notice and to effect payment thereof forthwith, and if sent by post it shall be deemed to have been given at the time when it ought to have been delivered in due course of post and in proving such notice, when given by post, it shall be sufficient to prove that the envelope containing the notice was posted and a certificate signed by an officer of the Authority that the envelope was so posted shall be conclusive.

10. This Guarantee shall come into force with immediate effect and shall remain in force and effect up to the date specified in paragraph 8 above or until it is released earlier by the Authority pursuant to the provisions of the Agreement.

11. This guarantee shall also be operatable at our…….. Branch at New Delhi, from whom, confirmation regarding the issue of this guarantee or extension / renewal thereof shall be made available on demand. In the contingency of this guarantee being invoked and payment thereunder claimed, the said branch shall accept such invocation letter and make payment of amounts so demanded under the said invocation.

12. Bank Guarantee has been sent to authority's bank through SFMS gateway as per the details below:-

S.No.	Particulars	Details
1.	Name of the Beneficiary	National Highways & Infrastructure Development Corporation Limited
2.	Beneficiary Bank Account No.	90621010002659
3.	Beneficiary Bank Branch	IFSC SYNB0009062
4.	Beneficiary Bank Branch Name	Transport Bhawan, New Delhi
5.	Beneficiary Bank Address	Canara Bank (erstwhile Syndicate Bank), Transport Bhawan, 1st Parliament Street, New Delhi - 110001

Signed and sealed this ……. day of ……., 20…… at …….. SIGNED, SEALED AND DELIVERED

For and on behalf of the Bank by:
(Signature)
(Name)
(Designation)
(Code Number)
(Address)

NOTES:

(i) The bank guarantee should contain the name, designation and code number of the officer(s) signing the guarantee.

(ii) The address, telephone number and other details of the head office of the Bank as well as of issuing branch should be mentioned on the covering letter of issuing branch.

Schedule - H

See Clauses10.1 (iv) and 19.3

Contract Price Weightages

1. Contract Price Weightages

1.1 The Contract Price for this Agreement is Rs……

1.2 Proportions of the Contract Price for different stages of Construction of the Project Highway shall be as specified below:

Item no.	Weightage in percentage to the Contract Price	Stage for Payment	Percentage Weightage
Road works including culverts, widening and repair of culverts.	**0.638%**	**B.1- Reconstruction/ New 2-lane realignment/ bypass (Flexible pavement)**	
		1) Earthwork up to top of Sub-grade	49.443%
		2) Sub-Base Course	15.309%
		3) Non-Bituminous Base Course	13.849%
		4) Bituminous Base Course	15.282%
		5) Wearing Coat	6.117%
		6) Widening and repair of culverts	0.000%
		D) Re-Construction and New culverts on existing road, realignments, bypasses:	
		Culverts (length < 6 m)	0.000%
Minor Bridges/ Under passes/ Overpasses/Viaduct	**0.21%**	**B.2- New underpasses/ overpasses**	
		(1) Foundation +Sub-Structure: On completion of the foundation work including foundations for wing and return walls, abutments, piers up to the abutment/pier cap.	39.258%
		(2) Super-structure: On completion of the super-structure in all respects including wearing coat, bearings, expansion joints, handrails, crash barriers, road signs & markings, tests on completion etc. complete in all respect.	10.312%

Item no.	Weightage in percentage to the Contract Price	Stage for Payment	Percentage Weightage
		Wearing Coat (a) in case of Overpass- wearing coat including expansion joints complete in all respects as specified and (b) in case of underpass- rigid pavement including drainage facility complete in all respects as specified as specified.	2.248%
		(3) Approaches: On completion of approaches including Retaining walls/ Reinforced Earth walls, stone pitching, protection works complete in all respect and fit for use.	48.182%
Major Bridge (length >60 m) works and ROB/ RUB/ elevated sections/flyovers including viaducts, if any	**97.377%**	**A.2- New Major Bridges**	
		1) Foundation	41.792%
		2) Sub-structure	2.906%
		3) Super-structure (including bearings)	31.581%
		4) Wearing Coat including expansion joints	0.459%
		5) Miscellaneous Items like handrails, crash barriers, road markings etc.)	0.738%
		6) Wing walls/return walls	0.000%
		7) Guide Bunds, River Training works etc.	0.000%
		8) Approaches (including Retaining walls, stone pitching and protection works)	0.000%
		C.2-New Elevated Section/ Flyovers/Grade Separators/Viaduct	
		1) Foundation	9.954%
		2) Sub-structure	2.789%
		3) Super-structure (including bearings)	8.767%
		4) Wearing Coat including expansion joints	0.396%
		5) Miscellaneous Items like handrails, crash barriers, road markings etc.)	0.316%
		6) Wing walls/return walls	0.000%
		7) Approaches (including Retaining walls, stone pitching and protection works)	0.303%
Other Works	**1.776%**	1) Toll Plaza	0.000%
		2) Road side drains	0.000%

Item no.	Weightage in percentage to the Contract Price	Stage for Payment	Percentage Weightage
		3) Road signs, markings, km stones safety device...	8.261%
		4) Project Facilities	0.000%
		a) Rainwater Harvesting	0.117%
		b) Truck lay byes	0.000%
		c) Bus Bays	0.000%
		d) Rest Area	0.000%
		e) Roadside plantation	3.520%
		5) Junctions	0.000%
		6) High Mast Lighting & Electric Pole	15.040%
		7) Protection works RCC Retaining Wall RR Toe Wall excluding structures	72.183%
		8) Safety and traffic management during construction	0.879%

1.3 Procedure of estimating the value of work done.

1.3.1 Road works:

Procedure for estimating the value of road work done shall be as follows:

Table 1.3.1

Stage of Payment	Percentage -weightage	Payment Procedure
A-Widening and strengthening of existing road (1) Earthwork up to top of the sub-grade	[**]	Unit of measurement is linear length. Payment of each stage shall be made on pro rata basis on completion of a stage in a length of not less than 5(five) percent of the total length.
(2) Sub-Base Course	[**]	
(3) Non-Bituminous Base Course	[**]	
(4) Bituminous Base Course	[**]	
(5) Wearing Coat	[**]	
(6) Widening and repair of culverts	[**]	Cost of completed culverts shall be determined pro rata basis with respect to the total no. of culverts. The payment shall be made on the completion of at least five

Stage of Payment	Percentage -weightage	Payment Procedure
		culverts.
B.1- Reconstruction/New 2-lane realignment/bypass (Flexible pavement) (1) Earthwork up to top of the sub-grade	49.443%	Unit of measurement is linear length. Payment of each stage shall be made on pro rata basis on completion of a stage in full length or 0.5 (half) km. length, whichever is less.
(2) Sub Base Course	15.309%	
(3) Non-Bituminous Course	13.849%	
(4) Bituminous Base Course	15.282%	
(5) Wearing Coat	6.117%	
D- Re-Construction and New culverts on existing road, realignments, bypasses: (1) Culverts (length < 6m)	[**]	Cost of each culvert shall be determined on pro rata basis with respect to the total number of culverts. Payment shall be made on the completion of atleast five culverts.

@. For example, if the total length of bituminous work to be done is 100 km, the cost per km of bituminous work shall be determined as follows:

Cost per km = P x weightage for road work x weightage for bituminous work x (1/L)

Where P= Contract Price

L = Total length in km

Similarly, the rates per km for other stages shall be worked out accordingly.

Note: The length affected due to law and order problems or litigation during execution due to which the Contractor is unable to execute the work, may be deducted from the total project length for payment purposes. The total length calculated here is only for payment purposes and will not affect and referred in other clauses of the Contract Agreement.

1.3.2 Minor Bridges and Underpasses/Overpasses:

Procedure for estimating the value of Minor bridge and Underpasses/Overpasses shall be as stated in table 1.3.2:

Table 1.3.2

Stage of Payment	Weightage	Payment Procedure
1	2	3
A.1-Widening and repair of minor bridges (length > 6m and < 60m)		Cost of each minor bridge shall be determined on pro rata basis with respect to the total linear length of the minor bridges. Payment shall be made on the completion of widening & repair works of a minor bridge.
Minor Bridges	[**]	
B.2- New Underpasses/ Overpasses: **(i) Foundation +Sub-Structure:** On completion of the foundation work including foundations for wing and return walls, abutments, piers up to the abutment/pier cap.	**39.258%**	(i) **Foundation +Sub-Structure:** Cost of each minor bridge shall be determined on pro-rata basis with respect to the total linear length (m) of the minor bridges. Payment against foundation shall be made on pro-rata basis on completion of a stage i.e. Not less than 25% of the scope of foundation of each bridge. In case where load testing is required for foundation, the trigger of first payment shall include load testing also where specified.
(ii) **Super-structure:** On completion of the super-structure in all respects including wearing coat, bearings, expansion joints, handrails, crash barriers, road signs &markings, tests on completion etc. complete in all respect. Wearing Coat (a) in case of Overpass- wearing coat including expansion joints complete in all respects as specified and (b) in case of underpass- rigid pavement including drainage facility complete in all respects as specified as specified.	**10.312%** **2.248%**	(ii)**Super-structure:** Payment shall be made on pro-rata basis on completion of a stage i.e. completion of super structure of at least one span in all respects as specified in the column of "Stage of Payment"; in this sub-clause. In case of structures where pre-cast girders have been proposed by the Contractor, 50% of the stage payment shall be due and payable on casting of girders for each span and balance 50% of the stage payment shall be made on completion of stage specified as above.
(iii) **Approaches**: On completion of approaches including Retaining walls/ Reinforced Earth walls, stone pitching, protection works complete in all respect and fit for use.	**48.182%**	(iii) **Approaches:** Payment shall be made on pro-rata basis on completion of a stage i.e. completion of approaches in all respect as specified.

1.3.3 Major Bridge works, ROB/RUB and Structures:

Procedure for estimating the value of Major Bridge works, ROB/RUB and Structures shall be as stated in table 1.3.3:

Table 1.3.3

Stage of Payment	Weightage	Payment Procedure
1	2	3
A.2- New Major Bridges (i) Foundation	**41.792%**	(i) **Foundation:** Cost of each Major Bridge shall be determined on pro-rata basis with respect to the total linear length (m) of the Major Bridge. Payment against foundation shall be made on pro-rata basis on completion of a stage i.e. not less than 25% of the scope of foundation of the major Bridge. In case where load testing is required for foundation, the trigger of first payment shall include load testing also where specified. (iii) **Substructures**: - Payment against sub-structure shall be made on pro-rata basis on completion of a stage i.e. not less than 25% of the scope of sub- structure of major bridge. iii) **Super-structure: -** Payment shall be made on pro-rata basis on completion of a stage i.e. completion of super- structure including bearings of at least one span in all respects as specified. In case of structures where pre-cast girders have been proposed by the Contractor,50% of the stage payment shall be due and payable on casting of girders for each span and balance 50% of the stage payment shall be made on completion of stage specified as above.
(ii) Sub-structure	**2.906%**	
(iii) Super-structure (including bearings)	**31.581%**	
(iv) Wearing Coat including expansion joints	0.459%	**(iv Wearing Coat:** Payment shall be made on completion ofwearing coat including expansion joints complete in all respects as specified
(v) Miscellaneous Items like hand rails, crash barriers, road markings etc.	0.738%	(v) **Miscellaneous:** Payments shall be made on completion of all miscellaneous works like handrails, crash barriers, road markings etc. completein all respects as specified.
(vi) Wing walls/return walls	[**]	(vi) **Wing walls/return walls:** Payments shall be made on completion of all wing walls/return walls complete in all respects as specified.

Stage of Payment	Weightage	Payment Procedure
(vii) Guide Bunds, River Training works etc.		(vii) **Guide Bunds, River Training works:** Payments shall be made on completion of all guide bunds/rivertraining works etc.complete in all respectsas specified.
(viii) Approaches (including Retaining walls, stone pitching and protection works)	0.000%	**(viii) Approaches**: **Approaches**: Payments shall be made on pro-rata basis on completion of 10% of the scope of each stage.
C.2 -New Elevated Section/Flyovers/ Grade Separators (i) Foundation	9.954%	(i) **Foundation:** Cost of each Major Bridge shall be determined on pro-rata basis with respect to the total linear length (m) of the Major Bridge. Payment against foundation shall be made on pro-rata basis on completion of a stage i.e. not less than 25% of the scope of foundation of the major Bridge. In case where load testing is required for foundation, the trigger of first payment shall include load testing also where specified.
(ii) Sub-structure	2.789%	**(ii) Sub-Structure:** Payment against Sub-structure shall be made on pro-rata basis on completion of a stage i.e. not less than 25% of the scope of sub-structure of the structure.
(iii) Super-structure (including bearings)	8.767%	(iii) **Super-structure:** Payment shall be made on pro-rata basis on completion of a stage i.e. completion of super-structure including bearings of at least one span in all respects as specified. In case of structures where pre-cast girders have been proposed by the Contractor,50% of the stage payment shall be due and payable on casting of girders for each span and balance 50% of the stage payment shall be made on completion of stage specified as above.

Stage of Payment	Weightage	Payment Procedure
(iv) Wearing Coat including expansion joints	0.396%	**(iv) Wearing Coat:** Payment shall be made on completion of wearing coat including expansion joints complete in all respects as specified.
(v) Miscellaneous Items like hand rails, crash barriers, road markings etc.	0.316%	(v) **Miscellaneous:** Payments shall be made on completion of all miscellaneous works like handrails, crash barriers, road markings etc. complete in all respects as specified.
(vi) Wing walls/return walls	0.000%	(vi) **Wing walls/return walls:** Payments shall be made on completion of all wing walls/return walls complete in all respects as specified.
(vii) Approaches (including Retaining walls/Reinforced Earth wall, stone pitching and protection works)	0.303%	**(vii) Approaches**: Payments shall be made on pro-rata basis on completion of 20% of the total area.

Note: (1) In case of innovate Major Bridge projects like cable suspension/cable stayed/ Extra Dozed and exceptionally long span bridges, the schedule may be modified as per site requirements before bidding with due approval of Competent Authority.

(2) The Schedule for exclusive tunnel projects may be prepared as per site requirements before bidding with due approval of Competent Authority.

1.3.4 Other works:

Procedure for estimating the value of other works done shall be as stated in table 1.3.4.

Table 1.3.4

Stage of Payment	Weightage	Payment Procedure
(i) (a) Toll plaza	[**]	Unit of measurement is each completed toll plaza. Payment of each toll plaza shall be made on pro rata basis with respect to the total of all toll plazas.
(ii) Roadside drains	[**]	Unit of measurement is linear length.

Stage of Payment	Weightage	Payment Procedure
(iii) Road signs, markings, km stones, safety devices, etc.	8.261%	Payment shall be made on pro-rata basis on completion of a stage in a length of not less than 5% (five percent) of the total length.
(iv) Project Facilities a) Bus bays/Bus shelters b) Truck lay-byes c) Rest areas d) Rainwater Harvesting	 [**] [**] [**] 0.117%	Payment shall be made on pro rata basis for completed facilities.
(v) Toe wall/ Retaining wall	72.183%	Unit of measurement is linear length. Payment shall be made on pro rata basis on completion of a stage in a length of not less than 5% (five per cent) of the total length.
(vi) Roadside Plantation	3.520%	
(vii) Street Lighting/ Theme Lighting	15.040%	
(viii) Safety and traffic management during construction	0.879%	Payment shall be made on pro rata basis every six months.

2. Procedure for payment for Maintenance

2.1 The cost for maintenance shall be as stated in Clause 14.1.1.

2.2 Payment for Maintenance shall be made in quarterly instalments in accordance with the provisions of Clause 19.7.

Schedule - I

(See Clause 10.2 (iv))

Drawings

1. Drawings

In compliance of the obligations set forth in Clause 10.2 of this Agreement, the Contractor shall furnish to the Authority's Engineer, free of cost, all Drawings listed in Annex-I of this Schedule-I.

2. Additional Drawings

If the Authority's Engineer determines that for discharging its duties and functions under this Agreement, it requires any drawings other than those listed in Annex-I, it may by notice require the Contractor to prepare and furnish such drawings forthwith. Upon receiving a requisition to this effect, the Contractor shall promptly prepare and furnish such drawings to the Authority's Engineer, as if such drawings formed part of Annex-I of this Schedule-I.

Annex – I

(Schedule - I)

Annex-I List of Drawings

A broad list of the drawings of the various components/elements of the Project Highway and project facilities required to be submitted by the Contractor is given below:

a) Horizontal & vertical alignment with details of reference pillars, Horizontal intersection points, vertical intersection points, elements of curves and sight distances, and roadway super elevation details. It should also show the beginning and end of all structures.

b) Cross section at 50m interval along the alignment with ROW, and all underground and above ground utilities.

c) Typical cross section with details of pavement structures and embankments.

d) Detailed drawings for individual Bridge (including fabrication drawings) & Structures.

e) Detailed drawings for individual culverts.

f) Detailed layout drawings for intersections, rotaries, loops & ramps.

g) Drawings for Road sign, marking, Toll plazas, Bus stops, Parking areas, Truck lay-bys.

h) Detailed layout drawings for traffic circulation for service roads.

i) Detailed layout drawings for Telecom system and traffic signals.

j) Detailed drawings for Museum.

k) Detailed layout drawings for Street lighting and variable message signs.

l) Detailed layout drawings for Landscaping & Tree plantation.

m) Detailed layout drawings for Vehicle rescue post.

n) Traffic management drawings for safety in construction zones.

o) Detailed drawings of road side furniture and safety structures.

p) Detailed drawing of guide bunds and protection works.

q) Detailed drawings of Drainage including RCC covered drains and chute drains.

r) Detailed drawings of Launching and/or erection scheme/scaffolding details for individual Bridge & Structures and river channel protection during construction.

s) Detailed drawings of proposed Mahatma Gandhi Museum.

Note: Fabrication drawings and shop drawings should be submitted after designed drawings are approved.

Schedule - J

(See Clause 10.3 (ii))

Project Completion Schedule

1. Project Completion Schedule

During Construction period, the Contractor shall comply with the requirements set forth in this Schedule-J for each of the Project Milestones and the **Scheduled Completion Date**. Within 15 (fifteen) days of the date of each Project Milestone, the Contractor shall notify the Authority of such compliance along with necessary particulars thereof.

2. Project Milestone-I

(i) Project Milestone-I shall occur on the date falling on the 320th (Three Hundred and Twentieth) Day from the Appointed Date (the "**Project Milestone- I**").

(ii) Prior to the occurrence of Project Milestone-I, the Contractor shall have commenced construction of the Project Highway submitted to the Authority duly and validly prepared Stage Payment Statements for an amount not less than 10% (Ten percent) of the Contract Price and should have started construction of main Brahmaputra Bridge.

3. Project Milestone-II

(i) Project Milestone-II shall occur on the date falling on the 548th (Five Hundred Forty Eighth) Day from the Appointed Date (the "**Project Milestone- II**").

(ii) Prior to the occurrence of Project Milestone-II, the Contractor shall have continued with construction of the Project Highway and submitted to the Authority duly and validly prepared Stage Payment Statements for an amount not less than 35% (Thirty Five percent) of the Contract Price and should have started construction of all other Bridges and Structures.

4. Project Milestone-III

(i) Project Milestone-III shall occur on the date falling on the 776th (Seven Hundred Seventy Sixth) Day from the Appointed Date (the "**Project Milestone- III**").

(ii) Prior to the occurrence of Project Milestone-III, the Contractor shall have continued with construction of the Project Highway and submitted to the Authority duly and validly prepared Stage Payment Statements for an amount not less than 70% (Seventy percent) of the Contract Price and should have started construction of all project facilities.

5. Scheduled Completion Date

(i) The Scheduled Completion Date shall occur on the 913th (Nine Hundred Thirteenth) Days from the Appointed Date.

(ii) On or before the Scheduled Completion Date, the Contractor shall have completed construction in accordance with this Agreement.

6. Extension of time

Upon extension of any or all of the aforesaid Project Milestones or the Scheduled Completion Date, as the case may be, under and in accordance with the provisions of this Agreement, the Project Completion Schedule shall be deemed to have been amended accordingly.

Schedule - K

(See Clause 12.1 (ii))

Tests on Completion

1. Schedule for Tests

(i) The Contractor shall, no later than 30 (thirty) days prior to the likely completion of construction, notify the Authority's Engineer and the Authority of its intent to subject the Project Highway to Tests, and no later than 10 (ten) days prior to the actual date of Tests, furnish to the Authority's Engineer and the Authority detailed inventory and particulars of all works and equipment forming part of Works.

(ii) The Contractor shall notify the Authority's Engineer of its readiness to subject the Project Highway to Tests at any time after 10 (ten) days from the date of such notice, and upon receipt of such notice, the Authority's Engineer shall, in consultation with the Contractor, determine the date and time for each Test and notify the same to the Authority who may designate its representative to witness the Tests. The Authority's Engineer shall thereupon conduct the Tests itself or cause any of the Tests to be conducted in accordance with Article 12 and this Schedule-K.

2. Tests

(i) Visual and physical test: The Authority's Engineer shall conduct a visual and physical check of construction to determine that all works and equipment forming part thereof conform to the provisions of this Agreement. The physical tests shall include [***].

(ii) Riding quality test: Riding quality of each lane of the carriageway shall be checked with the help of a Network Survey Vehicle (NSV) fitted with latest equipments and the maximum permissible roughness for purposes of this Test shall be [2,000 (two thousand)] mm for each kilometre.

(iii) Tests for bridges: All major and minor bridges shall be subjected to the rebound hammer and ultrasonic pulse velocity tests, to be conducted in accordance with the procedure described in Special Report No. 17: 1996 of the IRC Highway Research Board on Non destructive Testing Techniques, at two spots in every span, to be chosen at random by the Authority's Engineer. Bridges with a span of 15 (fifteen) metres or more shall also be subjected to load testing.

(iv) Other tests: The Authority's Engineer may require the Contractor to carry out or cause to be carried additional tests, in accordance with Good Industry Practice, for determining the compliance of the Project Highway with Specifications and Standards, except tests as specified in clause 5, but shall include measuring the reflectivity of road markings and road signs; and measuring the illumination level (lux) of lighting using requisite testing equipment.

(v) Environmental audit: The Authority's Engineer shall carry out a check to determine conformity of the Project Highway with the environmental requirements set forth in Applicable Laws and Applicable Permits.

(vi) Safety Audit: The Authority's Engineer shall carry out, or cause to be carried out, a safety audit to determine conformity of the Project Highway with the safety requirements and Good Industry Practice.

3. Agency for conducting Tests

All Tests set forth in this Schedule-K shall be conducted by the Authority's Engineer or such other agency or person as it may specify in consultation with the Authority.

4. Completion Certificate

Upon successful completion of Tests, the Authority's Engineer shall issue the Completion Certificate in accordance with the provisions of Article 12.

5. The Authority Engineer will carry out tests with following equipment at his own cost in the presence of contractor's representative.

Sr. No.	Key metrics of Asset	Equipment to be used	Frequency of condition survey
1	Surface defects of pavement	Network Survey Vehicle (NSV)	At least twice a year (As per survey months defined for the state basis rainy season)
2	Roughness of pavement	Network Survey Vehicle (NSV)	At least twice a year (As per survey months defined for the state basis rainy season)
3	Strength of pavement	Falling Weight Deflectometer (FWD)	At least once a year
4	Bridges	Mobile Bridge Inspection Unit (MBU)	At least twice a year (As per survey months defined for the state basis rainy season)
5	Road signs	Retro-reflectometer	At least twice a year (As per survey months defined for the state basis rainy season)

The first testing with the help of NSV shall be conducted at the time of issue of Completion Certificate.

Schedule - L

(See Clause 12.2)

Completion Certificate

1 I, ……. (Name of the Authority's Engineer), acting as the Authority's Engineer, under and in accordance with the Agreement dated …… (the "**Agreement**"), for Construction of New Two-Lane Bridge (Parallel to existing Naranarayan Setu) from Design CH. Km 0+000 to Design CH. Km 4+385 including two-lane bridge of length of 2345 m across River Brahmaputra and Approaches towards Jogighopa of 50 m (Viaduct) & approaches towards Guwahati of 1990 m (Viaduct – 1400 m & embankment - 590 m) NH-17 at Jogighopa in the State of Assam on (the "**Project Bridge/Highway**") on Engineering, Procurement and Construction (EPC) basis through ……. (Name of Contractor), hereby certify that the Tests in accordance with Article 12 of the Agreement have been successfully undertaken to determine compliance of the Project Highway with the provisions of the Agreement, and I am satisfied that the Project Highway can be safely and reliably placed in service of the Users thereof.

2 It is certified that, in terms of the aforesaid Agreement, all works forming part of Project Highway have been completed, and the Project Highway is hereby declared fit for entry into operation on this the …… day of …… 20….. , Scheduled Completed Date for which was the …… day of ……20…..

SIGNED, SEALED AND DELIVERED

For and on behalf of the Authority's Engineer by:

(Signature)

(Name)

(Designation) (Address)

Schedule - M

(See Clauses 14.6, 15.2 and 19.7)

Payment Reduction for Non-Compliance

1. Payment reduction for non-compliance with the Maintenance Requirements

(i) Monthly lump sum payments for maintenance shall be reduced in the case of non-compliance with the Maintenance Requirements set forth in Schedule-E.

(ii) Any deduction made on account of non-compliance with the Maintenance Requirements shall not be paid even after compliance subsequently. The deductions shall continue to be made every month until compliance is done.

(iii) The Authority's Engineer shall calculate the amount of payment reduction on the basis of weightage in percentage assigned to non-conforming items as given in Paragraph 2.

2. Percentage reductions in lump sum payments on monthly basis

(i) The following percentages shall govern the payment reduction:

S. No.	Item/Defect/Deficiency	Percentage
(a)	**Carriageway/Pavement**	
(i)	Potholes, cracks, other surface defects	15%
(ii)	Repairs of Edges, Rutting	5%
(b)	**Road, Embankment, Cuttings, Shoulders**	
(i)	Edge drop, inadequate cross fall, undulations, settlement, potholes, ponding, obstructions	10%
(ii)	Deficient slopes, raincuts, disturbed pitching, vegetation growth, pruning of trees	5%
(c)	**Bridges and Culverts**	
(i)	Desilting, cleaning. vegetation growth, damaged pitching, flooring, parapets, wearing course, footpaths, any damage to foundations	40%
(ii)	Any Defects in superstructures, bearings and sub-structures	25%
(iii)	Painting, repairs/replacement kerbs, railings, parapets, guideposts/crash barriers	5%

S. No.	Item/Defect/Deficiency	Percentage
(d)	**Roadside Drains**	
(i)	Cleaning and repair of drains	5%
(e)	**Road Furniture**	
(i)	Cleaning, painting, replacement of road signs, delineators, road markings, 200 m/km/5th km stones	5%
(f)	**Miscellaneous Items**	
(i)	Removal of dead animals, broken down/accidented vehicles, fallen trees, road blockades or malfunctioning of mobile crane	10%
(ii)	Any other Defects in accordance with paragraph 1.	5%
(g)	**Defects in Other Project Facilities**	5%

ii. The amount to be deducted from monthly lump-sum payment for non-compliance of particular item shall be calculated as under:

$$R = {}^{P}/_{100} \times (M1 \text{ or } M2) \times {}^{L1}/_{L}$$

Where,

P= Percentage of particular item/Defect/deficiency for deduction

M1= Monthly lump-sum payment in accordance para 1.2 above of this Schedule

M2= Monthly lump-sum payment in accordance para 1.2 above of this Schedule

L1= Non-complying length L = Total length of the road,

R= Reduction (the amount to be deducted for non-compliance for a particular item/Defect/deficiency

The total amount of reduction shall be arrived at by summation of reductions for such items/Defects/deficiency or non-compliance.

For any Defect in a part of one kilometer, the non-conforming length shall be taken as one kilometer.

Schedule - N

(See Clause 18.1 (i))

Selection of Authority's Engineer

1. Selection of Authority's Engineer

(i) The provisions of the Model Request for Proposal for Selection of Technical Consultants, issued by the Ministry of Finance in May 2009, or any substitute thereof shall apply for selection of an experienced firm to discharge the functions and duties of an Authority's Engineer.

(ii) In the event of termination of the Technical Consultants appointed in accordance with the provisions of Paragraph 1.1, the Authority shall appoint another firm of Technical Consultants forthwith and may engage a government-owned entity in accordance with the provisions of Paragraph 3 of this Schedule-N.

2. Terms of Reference

The Terms of Reference for the Authority's Engineer (the "**TOR**") shall substantially conform with Annex 1 to this Schedule N.

3. Appointment of Government entity as Authority's Engineer

Notwithstanding anything to the contrary contained in this Schedule, the Authority may in its discretion appoint a government-owned entity as the Authority's Engineer; provided that such entity shall be a body corporate having as one of its primary functions the provision of consulting, advisory and supervisory services for engineering projects; provided further that a government-owned entity which is owned or controlled by the Authority shall not be eligible for appointment as Authority's Engineer.

Annex – I

(Schedule - N)

Annex-I : Terms of Reference for Authority's Engineer

1. Scope

(i) These Terms of Reference (the "**TOR**") for the Authority's Engineer are being specified pursuant to the EPC Agreement dated ..... (the "**Agreement**), which has been entered into between the [name and address of the Authority] (the "**Authority**") and ..... (the "**Contractor**")# for Construction of New Two-Lane Bridge (Parallel to existing Naranarayan Setu) from Design CH. Km 0+000 to Design CH. Km 4+385 including two-lane bridge of length of 2345 m across River Brahmaputra and Approaches towards Jogighopa of 50 m (Viaduct) & approaches towards Guwahati of 1990 m (Viaduct – 1400 m & embankment - 590 m) NH-17 at Jogighopa in the State of Assam on Engineering, Procurement, Construction (EPC) basis, and a copy of which is annexed hereto and marked as Annex-A to form part of this TOR.

- In case the bid of Authority's Engineer is invited simultaneously with the bid of EPC project, then the status of bidding of EPC project only to be indicated

(ii) The TOR shall apply to construction and maintenance of the Project Highway.

2. Definitions and interpretation

(i) The words and expressions beginning with or in capital letters and not defined herein but defined in the Agreement shall have, unless repugnant to the context, the meaning respectively assigned to them in the Agreement.

(ii) References to Articles, Clauses and Schedules in this TOR shall, except where the context otherwise requires, be deemed to be references to the Articles, Clauses and Schedules of the Agreement, and references to Paragraphs shall be deemed to be references to Paragraphs of this TOR.

(iii) The rules of interpretation stated in Article 1 of the Agreement shall apply, mutatis mutandis, to this TOR.

3. General

(i) The Authority's Engineer shall discharge its duties in a fair, impartial and efficient manner, consistent with the highest standards of professional integrity and Good Industry Practice.

(ii) The Authority's Engineer shall perform the duties and exercise the authority in accordance with the provisions of this Agreement, but subject to obtaining prior written approval of the Authority before determining:

(a) any Time Extension;

(b) any additional cost to be paid by the Authority to the Contractor;

(c) the Termination Payment; or

(d) issuance of Completion Certificate or

(e) any other matter which is not specified in (a), (b), (c) or (d) above and which creates a financial liability on either Party.

(iii) The Authority's Engineer shall submit regular periodic reports, at least once every month, to the Authority in respect of its duties and functions under this Agreement. Such reports shall be submitted by the Authority's Engineer within 10 (ten) days of the beginning of every month.

(iv) The Authority's Engineer shall inform the Contractor of any delegation of its duties and responsibilities to its suitably qualified and experienced personnel; provided, however, that it shall not delegate the authority to refer any matter for the Authority's prior approval in accordance with the provisions of Clause 18.2.

(v) The Authority's Engineer shall aid and advise the Authority on any proposal for Change of Scope under Article 13.

(vi) In the event of any disagreement between the Parties regarding the meaning, scope and nature of Good Industry Practice, as set forth in any provision of the Agreement, the Authority's Engineer shall specify such meaning, scope and nature by issuing a reasoned written statement relying on good industry practice and authentic literature.

4. Construction Period

(i) During the Construction Period, the Authority's Engineer shall review and approve the Drawings furnished by the Contractor along with supporting data, including the geo-technical and hydrological investigations, characteristics of materials from borrow areas and quarry sites, topographical surveys, and the recommendations of the Safety Consultant in accordance with the provisions of Clause 10.1 (vi). The Authority's Engineer shall complete such review and approval and send its observations to the Authority and the Contractor within 15 (fifteen) days of receipt of such Drawings; provided, however that in case of a Major Bridge or Structure, the aforesaid period of 15 (fifteen) days may be extended upto 30 (thirty) days. In particular, such comments shall specify the conformity or otherwise of such Drawings with the Scope of the Project and Specifications and Standards.

(ii) The Authority's Engineer shall review and approve any revised Drawings sent to it by the Contractor and furnish its comments within 10 (ten) days of receiving such Drawings.

(iii) The Authority's Engineer shall review and approve the Quality Assurance Plan submitted by the Contractor and shall convey its comments to the Contractor within a period of 21 (twenty one) days stating the modifications, if any, required thereto.

(iv) The Authority's Engineer shall complete the review and approve of the methodology proposed to be adopted by the Contractor for executing the Works, and convey its comments to the Contractor within a period of 10 (ten) days from the date of receipt of the proposed methodology from the Contractor.

(v) The Authority's Engineer shall grant written approval to the Contractor, where necessary, for interruption and diversion of the flow of traffic in the existing lane(s) of the Project Highway for purposes of maintenance during the Construction Period in accordance with the provisions of Clause 10.4.

(vi) The Authority's Engineer shall review the monthly progress report furnished by the Contractor and send its comments thereon to the Authority and the Contractor within 7 (seven) days of receipt of such report.

(vii) The Authority's Engineer shall inspect the Construction Works and the Project Highway and shall submit a monthly Inspection Report bringing out the results of inspections and the remedial action taken by the Contractor in respect of Defects or deficiencies. In particular, the Authority's Engineer shall include in its Inspection Report, the compliance of the recommendations made by the Safety Consultant.

(viii) The Authority's Engineer shall conduct the pre-construction review of manufacturer's test reports and standard samples of manufactured Materials, and such other Materials as the Authority's Engineer may require.

(ix) For determining that the Works conform to Specifications and Standards, the Authority's Engineer shall require the Contractor to carry out, or cause to be carried out, tests at such time and frequency and in such manner as specified in the Agreement and in accordance with Good Industry Practice for quality assurance. For purposes of this Paragraph 4 (ix), the tests specified in the IRC Special Publication-11 (Handbook of Quality Control for Construction of Roads and Runways) and the Specifications for Road and Bridge Works issued by MORTH (the "Quality Control Manuals") or any modification/substitution thereof shall be deemed to be tests conforming to Good Industry Practice for quality assurance.

(x) The Authority's Engineer shall test check at least 50 (fifty) percent of the quantity or number of tests prescribed for each category or type of test for quality control by the Contractor.

(xi) The timing of tests referred to in Paragraph 4 (ix), and the criteria for acceptance/ rejection of their results shall be determined by the Authority's Engineer in accordance with the Quality Control Manuals. The tests shall be undertaken on a random sample basis and shall be in addition to, and independent of, the tests that may be carried out by the Contractor for its own quality assurance in accordance with Good Industry Practice.

(xii) In the event that results of any tests conducted under Clause 11.10 establish any Defects or deficiencies in the Works, the Authority's Engineer shall require the Contractor to carry out remedial measures.

(xiii) The Authority's Engineer may instruct the Contractor to execute any work which is urgently required for the safety of the Project Highway, whether because of an accident, unforeseeable event or otherwise; provided that in case of any work required on account of a Force Majeure Event, the provisions of Clause 21.6 shall apply.

(xiv) In the event that the Contractor fails to achieve any of the Project Milestones, the Authority's Engineer shall undertake a review of the progress of construction and identify potential delays, if any. If the Authority's Engineer shall determine that completion of the Project Highway is not feasible within the time specified in the Agreement, it shall require the Contractor to indicate within 15 (fifteen) days the steps proposed to be taken to expedite progress, and the period within which the Project Completion Date shall be achieved. Upon receipt of a report from the Contractor, the Authority's Engineer shall review the same and send its comments to the Authority and the Contractor forthwith.

(xv) The Authority's Engineer shall obtain from the Contractor a copy of all the Contractor's quality control records and documents before the Completion Certificate is issued pursuant to Clause 12.2.

(xvi) Authority's Engineer may recommend to the Authority suspension of the whole or part of the Works if the work threatens the safety of the Users and pedestrians. After the Contractor has carried out remedial measure, the Authority's Engineer shall inspect such remedial measures forthwith and make a report to the Authority recommending whether or not the suspension hereunder may be revoked.

(xvii) In the event that the Contractor carries out any remedial measures to secure the safety of suspended works and Users, and requires the Authority's Engineer to inspect such works, the Authority's Engineer shall inspect the suspended works within 3 (three) days of receiving such notice, and make a report to the Authority forthwith, recommending whether or not such suspension may be revoked by the Authority.

(xviii) The Authority's Engineer shall carry out, or cause to be carried out, all the Tests specified in Schedule-K and issue a Completion Certificate, as the case may be. For carrying out its functions under this Paragraph 4 (xviii) and all matters incidental thereto, the Authority's Engineer shall act under and in accordance with the provisions of Article 12 and Schedule-K.

5. Maintenance Period

(i) The Authority's Engineer shall aid and advise the Contractor in the preparation of its monthly Maintenance Programme and for this purpose carry out a joint monthly inspection with the Contractor.

(ii) The Authority's Engineer shall undertake regular inspections, at least once every month, to evaluate compliance with the Maintenance Requirements and submit a Maintenance Inspection Report to the Authority and the Contractor.

(iii) The Authority's Engineer shall specify the tests, if any, that the Contractor shall carry out, or cause to be carried out, for the purpose of determining that the Project Highway is in conformity with the Maintenance Requirements. It shall monitor and review the results of such tests and the remedial measures, if any, taken by the Contractor in this behalf.

(iv) In respect of any defect or deficiency referred to in Paragraph 3 of Schedule- E, the Authority's Engineer shall, in conformity with G ood Industry Practice, specify the permissible limit of deviation or deterioration with reference to the Specifications and Standards and shall also specify the time limit for repair or rectification of any deviation or deterioration beyond the permissible limit.

(v) The Authority's Engineer shall examine the request of the Contractor for closure of any lane(s) of the Project Highway for undertaking maintenance/repair thereof, and shall grant permission with such modifications, as it may deem necessary, within 5 (five) days of receiving a request from the Contractor. Upon expiry of the permitted period of closure, the Authority's Engineer shall monitor the reopening of such lane(s), and in case of delay, determine the Damages payable by the Contractor to the Authority under Clause 14.5.

6. Determination of costs and time

(i) The Authority's Engineer shall determine the costs, and/or their reasonableness, that are required to be determined by it under the Agreement.

(ii) The Authority's Engineer shall determine the period of Time Extension that is required to be determined by it under the Agreement.

(iii) The Authority's Engineer shall consult each Party in every case of determination in accordance with the provisions of Clause 18.5.

7. Payments

(i) The Authority's Engineer shall withhold payments for the affected works for which the Contractor fails to revise and resubmit the Drawings to the Authority's Engineer in accordance with the provisions of Clause 10.2 (iv) (d).

(ii) Authority's Engineer shall -

(a) within 10 (ten) days of receipt of the Stage Payment Statement from the Contractor pursuant to Clause 19.4, determine the amount due to the Contractor and recommend the release of 90 (ninety) percent of the amount so determined as part payment, pending issue of the Interim Payment Certificate; and

(b) within 15 (fifteen) days of the receipt of the Stage Payment Statement referred to in Clause 19.4, deliver to the Authority and the Contractor an Interim Payment Certificate certifying the amount due and payable to the Contractor, after adjustments in accordance with the provisions of Clause 19.10.

(iii) The Authority's Engineer shall, within 15 (fifteen) days of receipt of the Monthly Maintenance Statement from the Contractor pursuant to Clause 19.6, verify the Contractor's monthly statement and certify the amount to be paid to the Contractor in accordance with the provisions of the Agreement.

(iv) The Authority's Engineer shall certify final payment within 30 (thirty) days of the receipt of the final payment statement of Maintenance in accordance with the provisions of Clause 19.16.

8. Other duties and functions

The Authority's Engineer shall perform all other duties and functions as specified in the Agreement.

9. Miscellaneous

(i) A copy of all communications, comments, instructions, Drawings or Documents sent by the Authority's Engineer to the Contractor pursuant to this TOR, and a copy of all the test results with comments of the Authority's Engineer thereon, shall be furnished by the Authority's Engineer to the Authority forthwith.

(ii) The Authority's Engineer shall retain at least one copy each of all Drawings and Documents received by it, including 'as-built' Drawings, and keep them in its safe custody.

(iii) Within 90 (ninety) days of the Project Completion Date, the Authority's Engineer shall obtain a complete set of as-built Drawings, in 2 (two) hard copies and in micro film form or in such other medium as may be acceptable to the Authority, reflecting the Project Highway as actually designed, engineered and constructed, including an as-built survey illustrating the layout of the Project Highway and setback lines, if any, of the buildings and structures forming part of Project Facilities; and shall hand them over to the Authority against receipt thereof.

(iv) The Authority's Engineer, if called upon by the Authority or the Contractor or both, shall mediate and assist the Parties in arriving at an amicable settlement of any Dispute between the Parties.

(v) The Authority's Engineer shall inform the Authority and the Contractor of any event of Contractor's Default within one week of its occurrence.

Schedule - O

(See Clauses 19.4 (i), 19.6 (i), and 19.8 (i))

Forms of Payment Statements

1. Stage Payment Statement for Works

The Stage Payment Statement for Works shall state:

(a) the estimated amount for the Works executed in accordance with Clause 19.3 (i) subsequent to the last claim;

(b) amounts reflecting adjustments in price for the aforesaid claim;

(c) the estimated amount of each Change of Scope Order executed subsequent to the last claim;

(d) amounts reflecting adjustment in price, if any, for (c) above in accordance with the provisions of Clause 13.2 (iii) (a);

(e) total of (a), (b), (c) and (d) above;

(f) Deductions:

i. Any amount to be deducted in accordance with the provisions of the Agreement except taxes;

ii. Any amount towards deduction of taxes; and

iii. Total of (i) and (ii) above.

(g) Net claim: (e) – (f) (iii);

(h) The amounts received by the Contractor upto the last claim:

i. For the Works executed (excluding Change of Scope orders);

ii. For Change of Scope Orders, and

iii. Taxes deducted

2. Monthly Maintenance Payment Statement

The monthly Statement for Maintenance Payment shall state:

(a) the monthly payment admissible in accordance with the provisions of the Agreement;

(b) the deductions for maintenance work not done;

(c) net payment for maintenance due, (a) minus (b);

(d) amounts reflecting adjustments in price under Clause 19.12; and

(e) amount towards deduction of taxes

3. Contractor's claim for Damages

Note: The Contractor shall submit its claims in a form acceptable to the Authority.

Schedule - P

(See Clause 20.1)

Insurance

1. Insurance during Construction Period

(i) The Contractor shall effect and maintain at its own cost, from the Appointed Date till the date of issue of the Completion Certificate, the following insurances for any loss or damage occurring on account of Non Political Event of Force Majeure, malicious act, accidental damage, explosion, fire and terrorism:

(a) insurance of Works, Plant and Materials and an additional sum of [15 (fifteen)] per cent of such replacement cost to cover any additional costs of and incidental to the rectification of loss or damage including professional fees and the cost of demolishing and removing any part of the Works and of removing debris of whatsoever nature; and

(b) insurance for the Contractor's equipment and Documents brought onto the Site by the Contractor, for a sum sufficient to provide for their replacement at the Site.

(ii) The insurance under sub para (a) and (b) of paragraph 1(i) above shall cover the Authority and the Contractor against all loss or damage from any cause arising under paragraph 1.1 other than risks which are not insurable at commercial terms.

2. Insurance for Contractor's Defects Liability

The Contractor shall effect and maintain insurance cover of not less than 15% of the Contract Price for the Works from the date of issue of the Completion Certificate until the end of the Defects Liability Period for any loss or damage for which the Contractor is liable and which arises from a cause occurring prior to the issue of the Completion Certificate. The Contractor shall also maintain other insurances for maximum sums as may be required under the Applicable Laws and in accordance with Good Industry Practice.

3. Insurance against injury to persons and damage to property

(i) The Contractor shall insure against its liability for any loss, damage, death or bodily injury, or damage to any property (except things insured under Paragraphs 1 and 2 of this Schedule or to any person (except persons insured under Clause 20.9), which may arise out of the Contractor's performance of this Agreement. This insurance shall be for a limit per occurrence of not less than the amount stated below with no limit on the number of occurrences.

The insurance cover shall be not less than: Rs. [*****]

(ii) The insurance shall be extended to cover liability for all loss and damage to the Authority's property arising out of the Contractor’s performance of this Agreement excluding:

(a) the Authority's right to have the construction works executed on, over, under, in or through any land, and to occupy this land for the Works; and

(b) damage which is an unavoidable result of the Contractor's obligations to execute the Works.

4. Insurance to be in joint names

The insurance under paragraphs 1 to 3 above shall be in the joint names of the Contractor and the Authority.

Schedule-Q

(See Clause 14.10)

Tests on Completion of Maintenance Period

1. Riding Quality test:

Riding quality test: Riding quality of each lane of the carriageway shall be checked with the help of a calibrated bump integrator and the maximum permissible roughness for purposes of this Test shall be 2,200 (two thousand and two hundred only) mm for each kilometre.

2. Visual and physical test:

The Authority's Engineer shall conduct a visual and physical check of construction to determine that all works and equipment forming part thereof conform to the provisions of this Agreement. The physical tests shall include measurement of cracking, rutting, stripping and potholes and shall be as per the requirement of maintenance mentioned in Schedule-E.

Schedule-R

(See Clause 14.10)

Taking Over Certificate

I, …….. (Name and designation of the Authority's Representative) under and in accordance with the Agreement dated …….. (the "**Agreement**"), for Construction of New Two-Lane Bridge (Parallel to existing Naranarayan Setu) from Design CH. Km 0+000 to Design CH. Km 4+385 including two-lane bridge of length of 2345 m across River Brahmaputra and Approaches towards Jogighopa of 50 m (Viaduct) & approaches towards Guwahati of 1990 m (Viaduct – 1400 m & embankment - 590 m) NH-17 at Jogighopa in the State of Assam on Engineering, Procurement and Construction (EPC) basis through …….. (Name of Contractor), hereby certify that the Tests on completion of Maintenance Period in accordance with Article 14 of the Agreement have been successfully undertaken to determine compliance of the Project Highway with the provisions of the Agreement and I hereby certify that the Authority has taken over the Project highway from the Contractor on this day.....

SIGNED, SEALED AND DELIVERED

(Signature)

(Name and designation of Authority's Representative)

(Address)

******* End of the Document *******