

SCHEDULES

For

Construction of Iconic Hybrid Cable Stayed and Suspension Bridge Across Krishna River on NH -167K (Design Chainage km 87+360 to km 88+437) in the States of Telangana and Andhra Pradesh on Engineering, Procurement and Construction (EPC) Basis

**BID DOCUMENT
VOLUME-III**

**Ministry of Road Transport & Highways
(MoRT&H)**

December, 2025

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SCHEDULE-A

(See Clauses 2.1 and 8.1)

SITE OF THE PROJECT

1 The Site

- 1.1 Site of the Project Highway shall include the land, buildings, structures and road works as described in **Annex-I** of this Schedule-A.
- 1.2 The dates of handing over the Right of Way to the Contractor are specified in **Annex-II** of this Schedule-A.
- 1.3 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 Clause 8.2(i) of this Agreement.
- 1.4 The plan and profile of the Project Highway are specified in **Annex-III**. The proposed profile of the project highways shall be followed by the contractor with minimum FRL as indicated in the plan and profile. The contractor, however, shall improve/upgrade the Road Profile as indicated in **Annex-III** based on site/design requirement.
- 1.5 The status of the environment clearances obtained or awaited is given in **Annex-IV**.
- 1.6 The details of the existing utilities are given in **Annex-I** to Schedule-A.

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Annex-I
(Schedule-A)

Site

1. Site

- 1.1. Currently there is no connectivity between two banks of the river near Somasila. The proposed bridge on Krishna River starts at km 87+360 and ends at km. 88+437 by connecting Telangana State (near Malleswaram/ Somasila village) and Andhra Pradesh State (near Sangameshwaram Temple). The Start co-ordinate of the project is 213018.394 E and 1774457.478 N. The End co-ordinate is 213903.503 E and 1773844.462 N. The land, carriageway and structures comprising the Site are described below.
- 1.2. The High Flood Level (HFL) of 270.880 m indicated in the General Arrangement Drawing (GAD) is based on secondary data and is provided for reference purposes. The Contractor shall, at its own cost, verify and confirm this level through independent investigations and reliable hydrological and topographical data sources prior to commencement of the design. Notwithstanding such verification, the HFL of 270.880 m shall be treated as the minimum design HFL, and under no circumstances shall the Contractor adopt or consider a lower HFL for the purposes of design and construction.

2. Land

At present no existing road/ structure.

3. Carriageway

The details of carriageway width - Nil

4. Major Bridge

Sl. No.	Existing Chainage (km)	Type of Structure			No. of Spans with span length (m)	Overall Width (m)
		Foundation	Sub-structure	Super-structure		
Nil						

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

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

Sl. No.	Chainage (km)	Type of Structure		No. of Spans with span length (m)	Width (m)	ROB/ RUB
		Foundation	Superstructure			
NIL						

6. Grade Separators

The Site includes the following grade separators:

Sl. No.	Chainage (km)	Type of Structure		No. of Spans with span length (m)	Width (m)
		Foundation	Superstructure		
NIL					

7. Minor Bridges

The existing project road includes the following minor Bridges and Low-level Causeways. The details of minor bridges are listed below.

Sl. No.	Existing Chainage (km)	Type of Structure			No. of Spans with span length (m)	Overall Width (m)
		Foundation	Sub-structure	Super-structure		
Nil						

7.1. Low Level Causeways

Sl. No.	Existing Chainage (km)	Type of Structure			No. of Spans with span length (m)	Overall Width (m)
		Foundation	Sub-structure	Super-structure		
Nil						

8. Railway level crossings

The Site includes the following railway level crossings:

Sl. No.	Existing Chainage (km)	Railway Chainage (km)	Level Crossing No	Remarks
NIL				

9. Underpasses (vehicular, non-vehicular)

The Site includes the following underpasses:

Sl. No.	Chainage (km)	Type of Structure	No. of Spans with span length (m)	Width (m)
NIL				

10. Culverts

The details of the existing Culverts in the project road are tabulated below:

Sl. No.	Existing Survey Chainage (km)	Type of Structures (Pipe / Slab/ Box/ Arch)	Span Arrangement and Total Vent way	
			(No. x Length) (m)	Width (m)
Nil				

11. Bus Bays

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

Bus Shelter (LHS)		Bus Shelter (RHS)	
Sl. No.	Existing Chainage	Sl. No.	Existing Chainage
NIL			

12. Truck Lay Bye

The details of truck lay byes are as follows:

Sl. No.	Chainage (km)	Length (m)	Left Hand Side	Right Hand Side
NIL				

13. Roadside drains

The details of the roadside drain along the project road as follows:

Sl. No.	Design Chainage (km)		Length (km)	Side	Type	
	From	To			Masonry/ cc (Pucca)	Earthen (Kutcha)
	NIL					

14. Major Junctions

The details of major junctions are as follows:

S. No.	Location		At grade	Separated	Category of Cross Road			
	From km	To km			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:

Sl. No	Existing Chainage (Km)	Type	Side	Name of the Road Crossing
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Sl. No	Existing Chainage (Km)	Type	Side	Name of the Road Crossing
Nil				

16. Bypasses

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

Sl. No.	Name of bypass(town)	Chainage (km) From km to km	Length (in Km)
NIL			

17. Other structures: -NIL

18. Utilities

Sl. No.	Type of Utilities	Units	Description
Nil			

Annex-II
(Schedule-A)

Dates for Providing Right of Way

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:

Sl. No.	Design Chainage (Km)		Length (m)	Width (m)	Date of Providing ROW
	From	To			
1	2	3	4	5	6
i) Full Right of Way (Full Width)	87+360	87+405	44.54	60	On Appointed Date
ii) Full Right of Way (Full Width)	87+405	87+466	61.46	45	
iii) Full Right of Way (Full Width)	87+466	88+330	864.00	60	
iv) Full Right of Way (Full Width)	88+330	88+391	61.00	45	
v) Full Right of Way (Full Width)	88+391	88+437	46.00	60	
Total Length			1077		

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Annex-III

(Schedule-A)

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. 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.
- 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 on site/design requirement as per the relevant specifications/IRC Codes/Manual.

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Annex-IV

(Schedule-A)

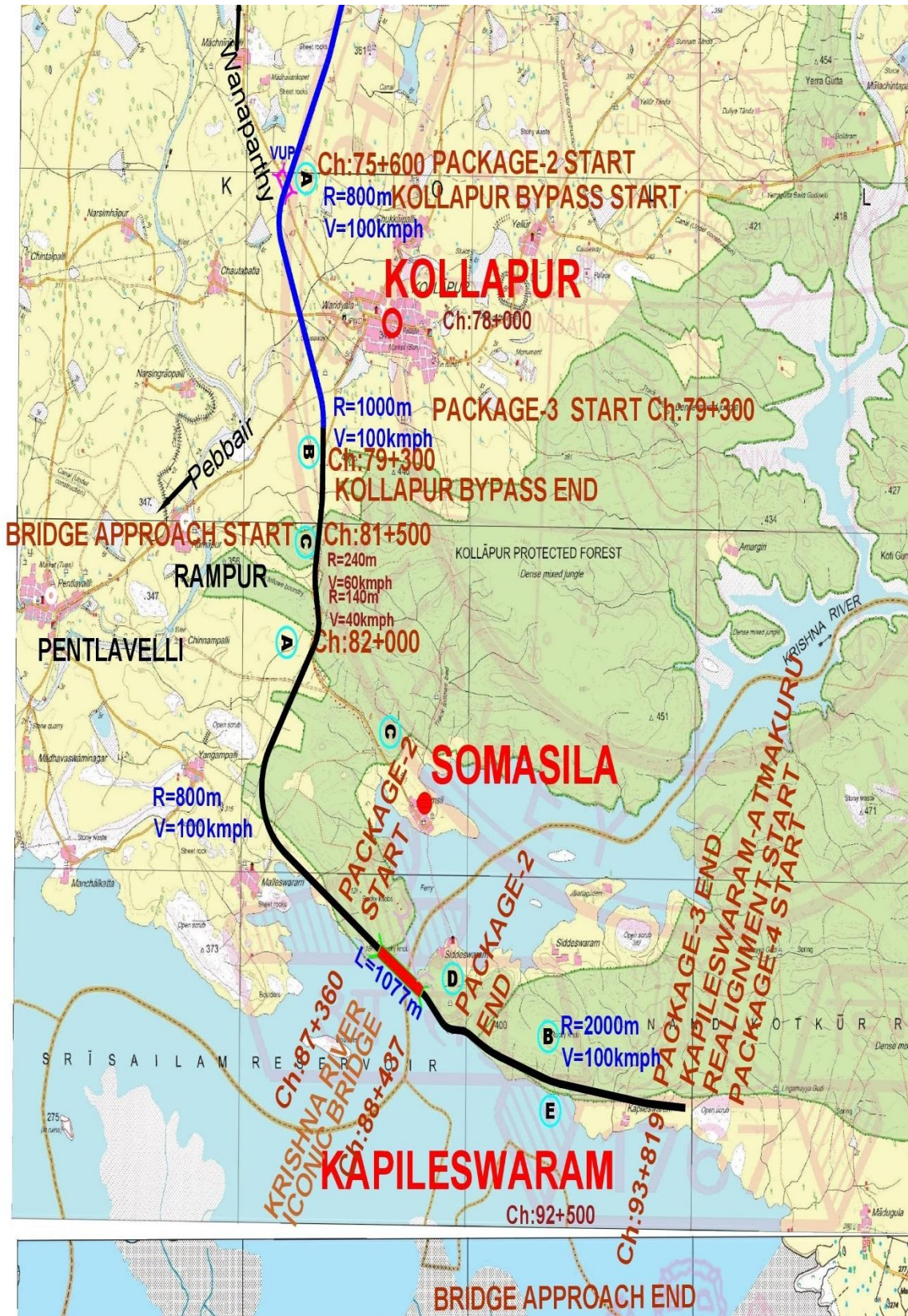
Environmental Clearances

The project highway/ Bridge is passing through green field alignment. The Project Highway / Bridge is less than 100km length and the Right of Way or land acquisition is less than 60m on new alignment. Therefore, as per the amendments issued to EIA Notification, 2006 amended vide Notification S.O 2559(E), Dt. 22.08.2013, environmental and forest clearance is obtained by the client / clearance will be given within 90 days from the date of appointment

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Appendix-A1

INDEX MAP



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SCHEDULE-B

(See Clauses 2.1)

DEVELOPMENT OF THE PROJECT HIGHWAY/BRIDGE

1 Development of the Project Highway/Bridge

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

2 Rehabilitation and augmentation

Nil

3 Specifications and Standards

The Project Highway/Bridge shall be designed and constructed in conformity with the Specifications and Standards specified in Annex-I of Schedule-D.

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Annex-I
(Schedule-B)

Description of Iconic Bridge on Krishna River

The green field stretch from Somasila (Telangana State) to Sangameswaram (Andhra Pradesh State) (Iconic bridge across River Krishna) is proposed for development to 4L+PS standards (from Km 87+360 to km 88+437). The 4-lane cable stayed and suspension (hybrid) major bridge (192+480+192 = 864m length) with 9m dual carriageway having 1.5m wide median, arch type structural, steel superstructure, consists of 2 Pylons, 2 Suspension Cable Anchorage arrangement. For Walkway of 12.9 m including central 6m glass floor and 3.45m concrete floor on either side on bottom deck, 4 Nos emergency staircase at pylons, rams at both ends, road safety provisions, approaches on both side, Highway lighting, facade lighting, walkway illumination, Master Information Delivery Plan (MIDP)/ BIM Execution Plan (as detailed in Article 10, clause 10.10.) etc. completed as per the scope described in schedule B (Annex I, II & III) & Schedule – C and in accordance with manual and standard specified in scheduled D (Annex – I, II, III, IV, V & VI).

1. WIDENING OF THE EXISTING HIGHWAY/BRIDGE

1.1. The Project Highway shall follow the new alignment. Geometric deficiencies, if any, in the new horizontal and vertical profiles shall be corrected as per the prescribed standards for Plain terrain to the extent land is available.

1.2. Width of Carriageway

1.2.1. Four-Lane with paved shoulder (2 x 9m carriageway) shall be undertaken for the entire length. The paved shoulder shall be 2x1.5m wide in accordance with the typical cross sections as specified in the schedule B. Provided that the width of carriageway shall be as specified in the following table.

Sr. No	Design Chainage		Length (m)	Carriageway Width (m)	Type of Typical Cross section
	From	To			
1	87+360	87+405	44.54	Main carriageway 2x7.5m+ Paved Shoulder 2x1.5m+ Median 1.5m+ Metal beam Crash barrier (0.25x2) +Footpath 2x (0 to 2.750m) + covered gallery ramp footpath 2 x 6 m	TCS-1 (Approach towards Telangana)
2	87+405	87+466	61.46	Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m + Crash barrier (0.45x2) +Service Footpath 2x2.3m + Railing with safety Grills +Covered Ramp gallery footpath 2 x 6m	TCS-4A (Approaches & Anchorage)

Sr.	Design Chainage		Length	Carriageway Width (m)	Type of
3	87+466	88+330	864.00	Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m+Rigid Crash Barrier 2x0.45m+ Service Footpath 2x 2.3 + Stainless Steel railing with safety grill (2Nos)	TCS-2 (Bridge Proper)
4	88+330	88+391	61.00	Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m + Crash barrier (0.45x2) +Service Footpath 2x2.3m + Railing with safety Grills +Covered Ramp gallery footpath 2 x 6m	TCS-4B (Approaches & Anchorage)
5	88+391	88+437	46.00	Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m+ Footpath [1x (0 to 3.0m) (LHS) & 1x (0 to 3.0m (RHS))] + Covered Ramp gallery footpath 2 x 6m + 1x1.8m Covered drain (LHS)	TCS-3 (Approaches Towards Andhra Pradesh)

Note:

- Cross-section at Major Bridge approaches is to be followed matching to adjoining cross-sections with suitable transition.
- The entire Cross-sectional elements shall be accommodated in proposed ROW. If required, suitable retaining / slope protection structures shall be provided to accommodate the highway cross section within proposed ROW and same shall not constitute a change of scope.

1.3. Design Chainage corresponding to Existing Chainage

- 1.3.1. This Project is a part of NH-167K starting at Kalwakurthy in Telangana and connecting through Kollapur in Telangana, to Nandyal, Atmakur in Andhra Pradesh, and terminating at Jammamudugu in Andhra Pradesh. This particular bridge project is in greenfield alignment and as such no reference Kilometre stones are existing in entire length of the project highway. During topography survey with Total Station, observations are made and after finalization of alignment by improving the existing geometry the chainage has been referred to "Design Chainage". The longitude, latitude, are given in Plan and Profile drawings.
- 1.3.2. The Iconic Major Bridge is to be constructed to connect two States i.e., Telangana and Andhra Pradesh over Krishna River and green field alignment is adopted.

Sr. No	Existing Chainage		Design Chainage		Remarks
	From	To	From	To	
1	-		87+360		Start of the project in State of Telangana

Sr. No	Existing Chainage		Design Chainage		Remarks
	From	To	From	To	
2	-	-	87+360	87+405	Bridge approach in State of Telangana
3	-	-	87+405	87+466	Approach of the Bridge & Anchor Blocks in the State of Telangana
4	-	-	87+466	88+330	Main/ Bridge Proper
5	-	-	88+330	88+391	Approach of the Bridge & Anchor Blocks in the in State of Andhra Pradesh
6	-	-	88+391	88+437	Bridge approach in the in State of Andhra Pradesh
7	-		88+437		End of the project in the State of Andhra Pradesh

2. GEOMETRIC DESIGN AND GENERAL FEATURES

2.1. General

2.1.1. Geometric design and general features of the Project Highway shall be in accordance with Section 2 of the Manual (IRC: SP:84-2019).

2.1.2. Horizontal and vertical alignment shall be designed satisfying intermediate site distance (ISD).

2.2. Design speed

The design speed shall be 100 kmph (ruling speed) in plain/ rolling terrain and 80 kmph at A2 approach.

2.3. Improvement of the existing road geometries

In the following sections, where improvement of the existing road geometrics to the prescribed standards is not possible, the existing road geometrics shall be improved to the extent possible within the given right of way and proper road signs and safety measures has been provided. The details geometric improvement is given below.

Sl. No.	Stretch (m)		Length (m)	Type of deficiency	Remarks
	From (km)	To (km)			
1	NIL				

2.4. Right of Way

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

2.5. Type of Shoulders

2.5.1. In following sections, footpaths/fully paved shoulders, walkway, service footpath shall be provided in the following stretches:

Sr. No.	Design Chainage		Length (m)	TCS Type	Width (m)		
	From (km)	To (km)			Paved shoulder	Footpath (As per TCS)	Service Footpath/ Utility Corridor (As per TCS)
1	87+360	87+405	44.54	TCS-1 (Approaches)	2 X 1.50	2 X (0 to 2.75 & 2 x 6m (Covered Ramp gallery footpath))	-
2	87+405	87+466	61.46	TCS-4 A (Approaches & Anchorage)	2 X 1.50	2 x 6m (Covered Ramp gallery footpath)	2x2.3
3	87+466	88+330	864.00	TCS-2 (Proper Bridge)	2 X 1.50		2x2.3
4	88+330	88+391	61.00	TCS-4 B (Approaches & Anchorage)	2 X 1.50	2 x 6m (Covered Ramp gallery footpath)	2x2.3
5	88+391	88+437	46.00	TCS-3 (Approach towards Andhra Pradesh)	2 x 1.50	1x [0 to 3.0m (LHS)] + 1x [0 to 3.0m (RHS)] + 2 x 6m (Covered Ramp gallery footpath)	

2.5.2. Paved shoulders of 1.5m wide shall be provided as per TCS.

2.5.3. Service footpath shall be provided as per TCS.

2.5.4. Foot path shall be provided as per TCS.

2.6. Lateral and vertical clearances at underpasses

2.6.1. Lateral and vertical clearances at underpasses and provision of guardrails/crash barriers shall be as per paragraph 2.10 of the Manual. - **Nil**

2.6.2. *Lateral clearance:* The width of the opening at the underpasses shall be as follows:

Sl. No.	Location [Design. Chainage (km)]	Span/ Opening (m)	Vertical clearance (m)	Remarks
Nil				

2.7. Lateral and vertical clearances at overpasses

2.7.1. Lateral and vertical clearances at overpasses shall be as per paragraph 2.11 of the Manual. - **Nil**

2.7.2. *Lateral clearance:* The width of the opening at the overpasses shall be as follows: **Nil**

2.8. Service roads

Service Roads as per the details given in TCS shall be constructed at the locations and for the lengths indicated below.

Sl. No.	Design Chainage (km)		LHS/ RHS/ BOTH	Service road Length (Km)	TCS Type	Carriageway Width (m)	Remarks
	From	To					
Nil							

2.9. Grade Separated Structures

2.9.1. Grade separated structures shall be provided as per paragraph 2.13 of the Manual. The requisite particulars are given below:

Sl. No.	Location (Design Ch.) (km)	Span/ Opening (m)	Vertical Clearance	Approach Gradient	Remarks, if any
Nil					

2.10. Pedestrian underpass / overpass/Walkway

2.10.1. Walkway below the carriageway shall be provided as per TCS in following locations.

Sl. No.	Location		Length (m)	Width (m)	Remark
	From	To			
1	87+405	87+466	61.46	2x3.45 (concrete slab with 25mm Chequered tiles) + 6m (toughened glass)	TCS 4A
2	87+466	88+330	864.00	2x3.45 (concrete slab with 25mm	TCS 2

				Chequered tiles) + 6m (toughened glass)	
3	88+330	88+391	61.00	2x3.45 (concrete slab with 25mm Chequered tiles) + 6m (toughened glass)	TCS 4B
		Total	986.46		

Facilities to be provided for walkway area:

- Total width of walkway is 12.9m (3.45m Concrete+6m Glass+3.45 Concrete)
- Provide railing of 2.2 m height stainless steel (SS-304) outer side the walkway as shown in TCS 2, 4A & 4B.
- Provided railing of 1.05m height of stainless steel (SS-304) and Glass as shown in drawing.
- 4-seater Bench of stainless steel (SS-304) all along the bottom deck on both sides of walkway for entire length at 100 m c/c in staggered pattern as shown in TCS/Drawing shall be provided.
- Provided Dustbin of stainless steel (SS-304) with suitable interval @ 300m c/c all along the walkway on both sides as shown in TCS/Drawing/ as directed by Authority/ Authority Engineer.
- Glass walkways shall have concrete cross over of 6.0m wide at every 60.0 c/c

g. Opening for Walkway (Gallery) (At Anchor Block Location)

Opening for Walkway at both end of walkway shall be provided as per TCS in following locations.

Sl. No.	Location	Length (m)	Width (m)	Remark
1	87+473	25	12	As per GAD
2	88+337	25	12	As per GAD
	Total	50		

2.11. Typical cross-sections of the Proposed Highway/Bridge

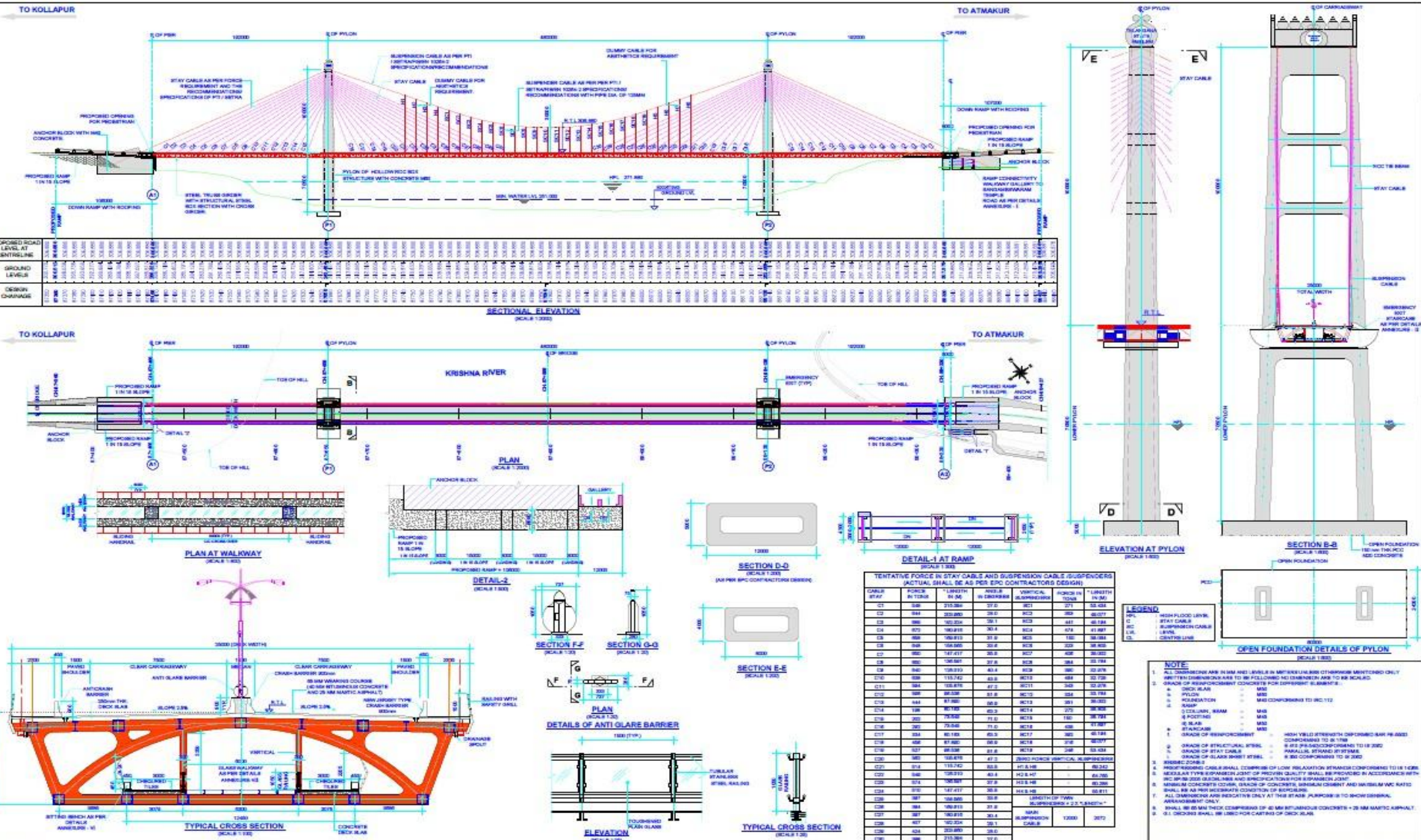
Applicable typical cross-sections for the project highway in different segments of four Lane with paved shoulders and four lane divided carriage way are given below.

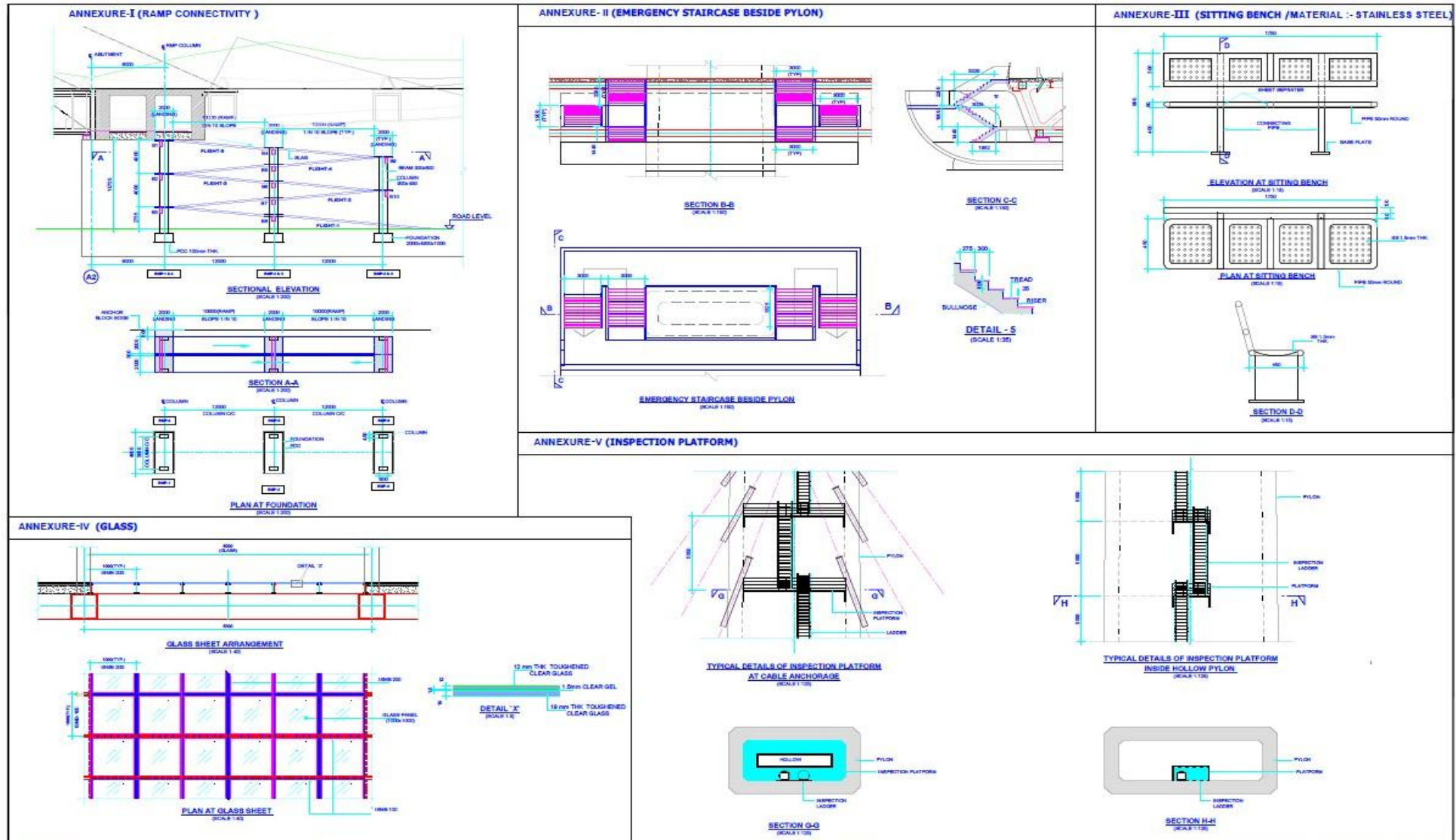
Sr. No	Design Chainage (km)		Length (m)	Carriageway Width (m)		Type of Typical Cross section
	From	To				
1	87+360	87+405	44.54	Main carriageway 2x7.5m+ Paved Shoulder 2x1.5m+		TCS-1 (Approach)

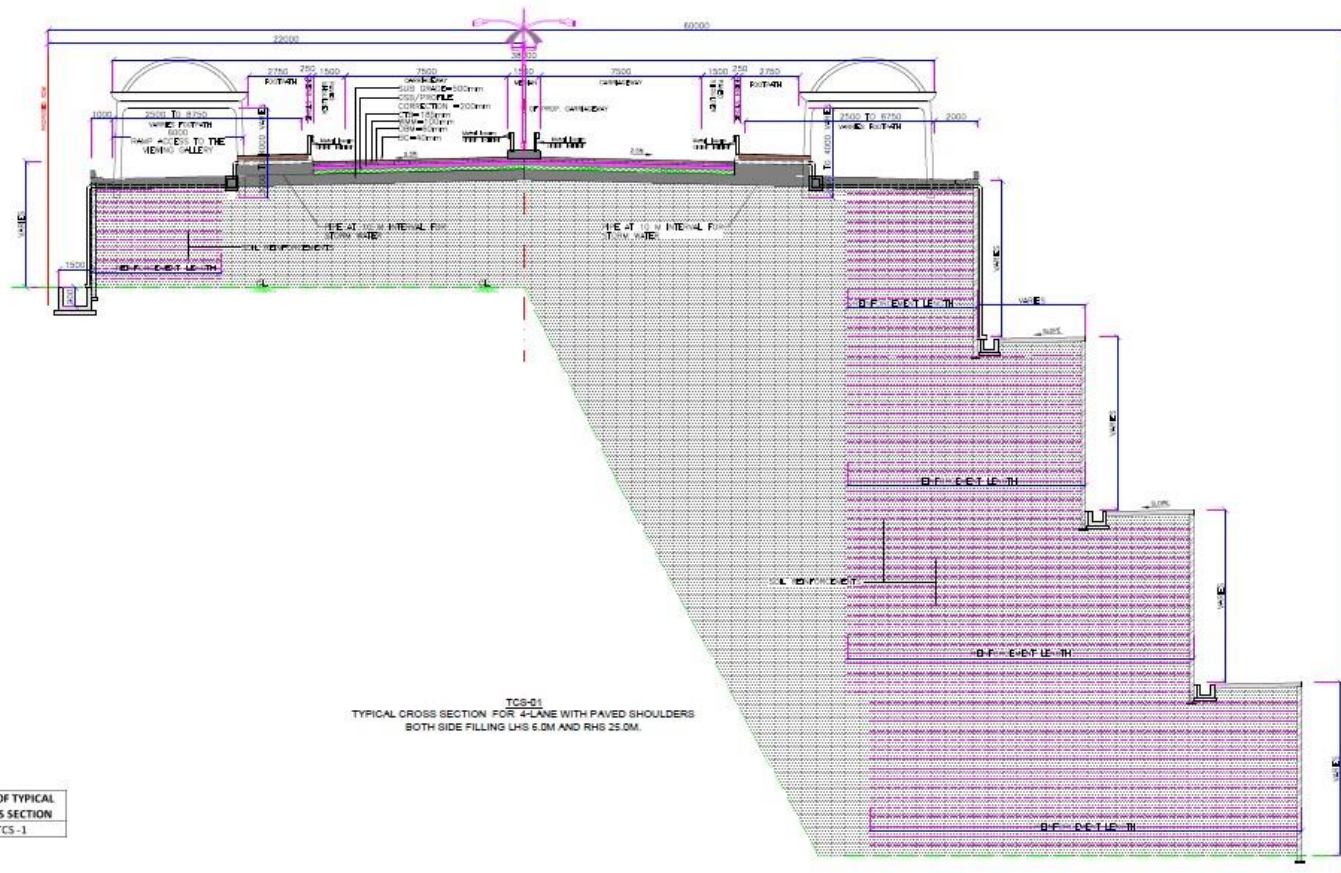
Sr. No	Design Chainage (km)		Length (m)	Carriageway Width (m)	Type of Typical
				Median 1.5m+ Metal beam Crash barrier (0.25x2) +Footpath 2x (0 to 2.750m) + covered gallery ramp footpath 2 x 6 m	towards Telangana)
2	87+405	87+466	61.46	Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m + Crash barrier (0.45x2) +Service Footpath 2x2.3m + Railing with safety Grills +Covered Ramp gallery footpath 2 x 6m	TCS-4A (Approaches & Anchorage)
3	87+466	88+330	864.00	Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m+Rigid Crash Barrier 2x0.45m+ Service Footpath 2x 2.3 + Stainless Steel railing with safety grill (2Nos)	TCS-2 (Bridge Proper)
4	88+330	88+391	61.00	Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m + Crash barrier (0.45x2) +Service Footpath 2x2.3m + Railing with safety Grills +Covered Ramp gallery footpath 2 x 6m	TCS-4B (Approaches & Anchorage)
5	88+391	88+437	46.00	Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m+ Footpath [1x (0 to 3.0m) (LHS) & 1x (0 to 3.0m) (RHS)] + Covered Ramp gallery footpath 2 x 6m + 1x1.8m Covered drain (LHS)	TCS-3 (Approaches Towards Andhra Pradesh)

Type of TCS	Description	Length (m)
TCS 1	4-Lane with divided Carriageway, 2x1.5 Paved shoulder, + Footpath 2x (0 to 2.750m), 1.5 median & Covered gallery footpath 2 x 6m	44.54
TCS 2	4-Lane with divided Carriageway, 1.5 median, 2x1.5 Paved	864.00

Type of TCS	Description	Length (m)
	Shoulder & 2x2.3 m Service footpath.	
TCS 3	4-Lane with divided carriageway with 2x1.5 Paved Shoulder, 1.5m Median, 2x7.5m Footpath & 2x 2.3 Service Footpath	46.00
TCS 4A	4-Lane with divided Carriageway, 2x1.5 Paved shoulder, 1x (0 to 2.945m(LHS)) & 1x (0 to 2.997(RHS)) Footpath, 1.5 median & Covered gallery footpath 2 x 6m	61.46
TCS-4B	4-Lane with divided Carriageway, 2x1.5 Paved shoulder, 1x (0 to 3.0m (LHS)) & 1x (0 to 3.0m (RHS)) Footpath, 1.5 median & Covered gallery footpath 2 x 6m	61.00
	Total Length	1077



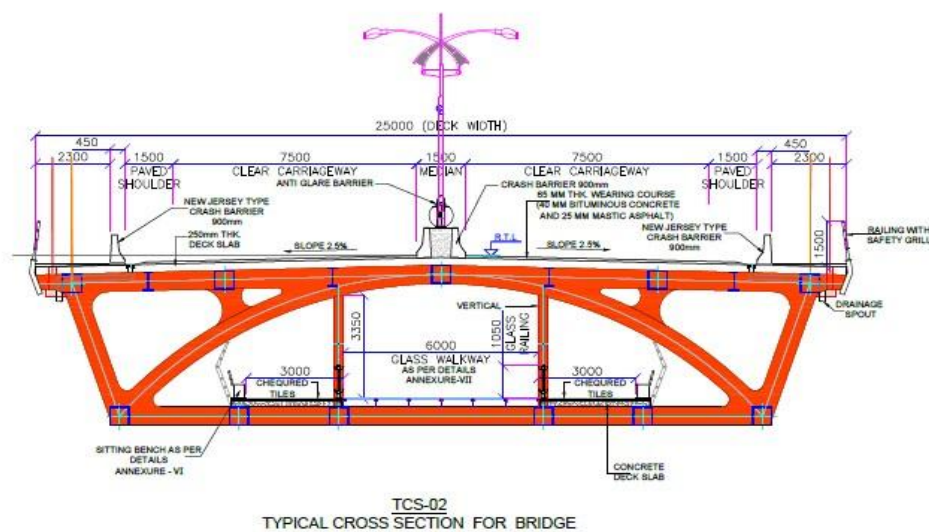




Sr. NO.	CHAINAGE		LENGTH (M)	TYPE OF TYPICAL CROSS SECTION
	FROM	TO		
1	87+360	87+405	44.54	TCS-1

NOTES:

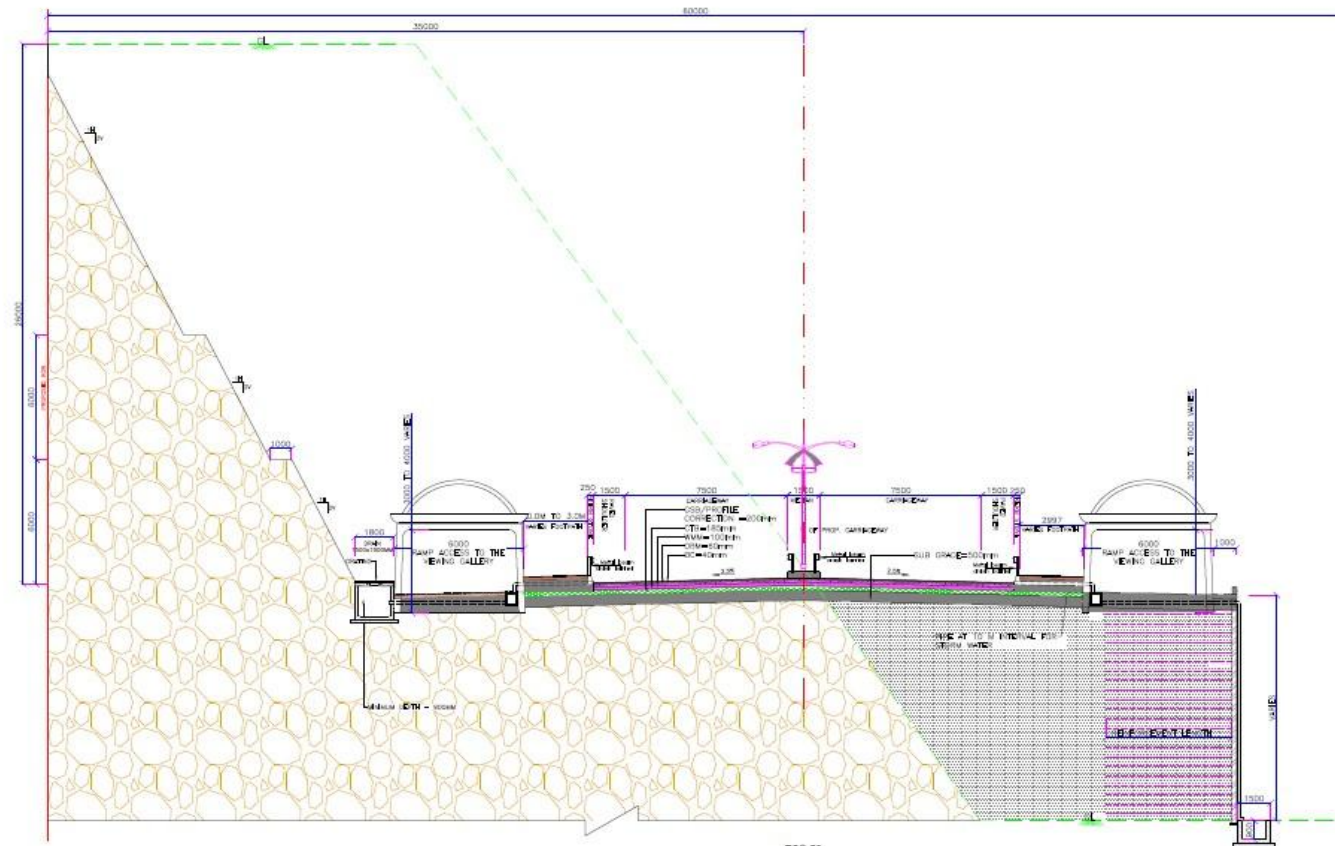
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. FOR KERB AND DRAIN DETAILS REFER SEPARATE DRAWING.
3. RE WALL IS TO BE CONSTRUCTED WHERE EMBANKMENT HEIGHT AND ROW IS CONSTRAINT.
4. SLOPE PROTECTION MEASURES SHOULD BE DESIGNED AS PER STANDARDS AND SITE CONDITION DURING EXECUTION.
5. FOR RAMP ACCESS TO VIEWING GALLERY AND ITS COMPONENTS, KINDLY REFER TO STRUCTURAL DRAWINGS (GAD)
6. DRAIN TO BE TAKEN UPTO NEAREST OUTFALL.



Sr. NO.	CHAINAGE		LENGTH (M)	TYPE OF TYPICAL CROSS SECTION
	FROM	TO		
1	87+466	88+330	864	TCS-2

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. FOR KERB AND DRAIN DETAILS REFER SEPARATE DRAWING.
3. SLOPE PROTECTION MEASURES SHOULD BE DESIGNED AS PER STANDARDS AND SITE CONDITION DURING EXECUTION.

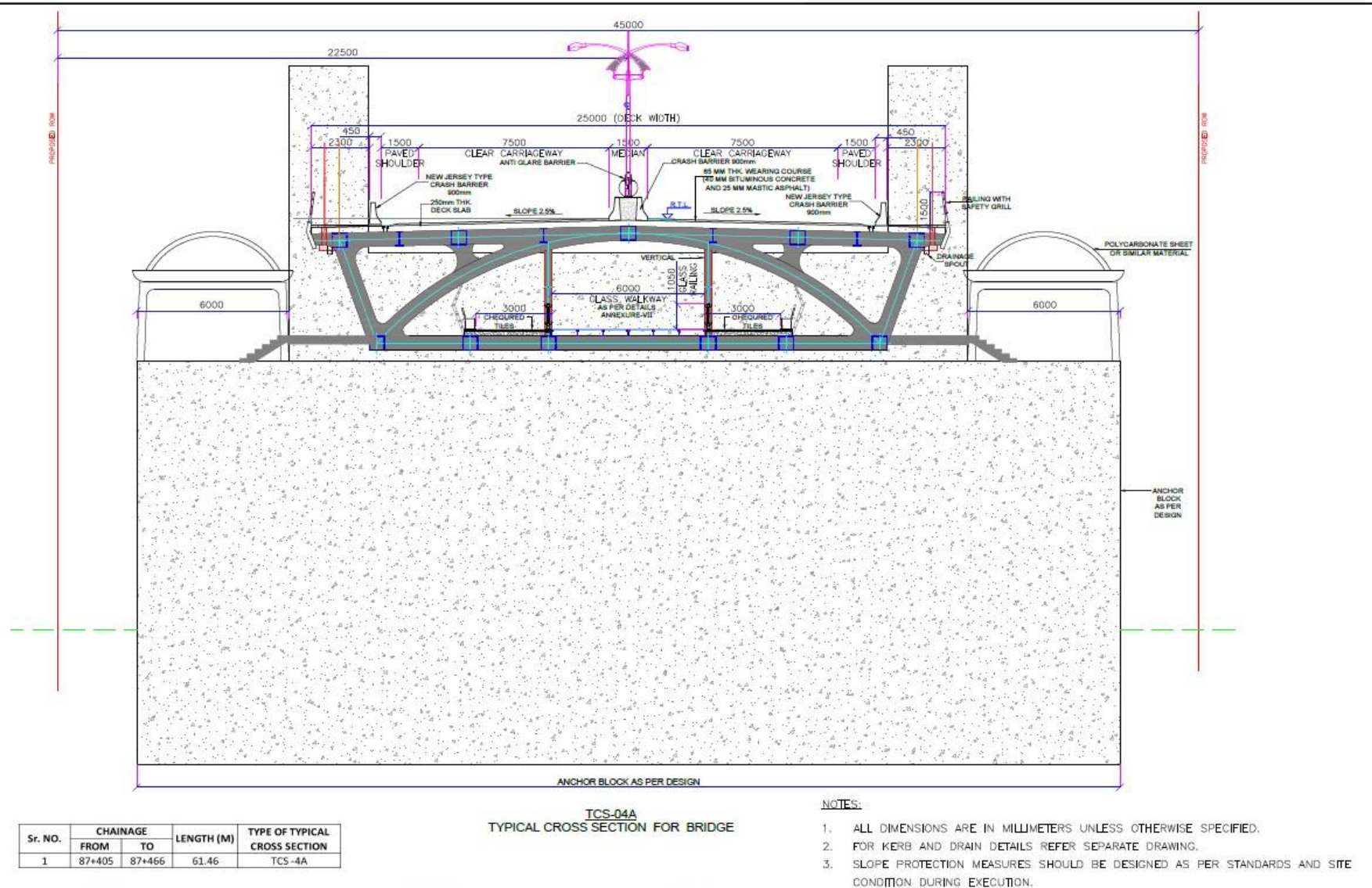


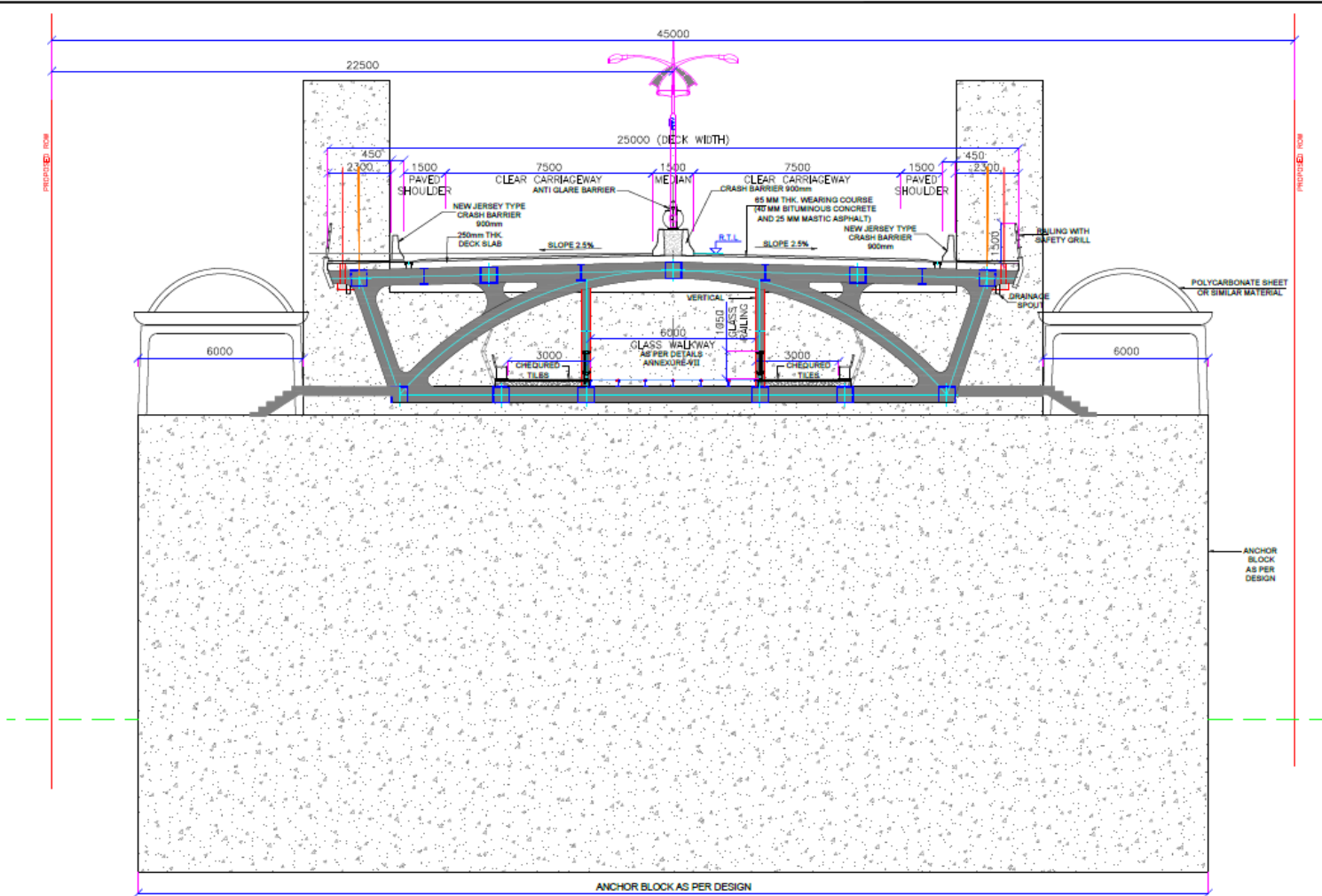
TCS-03
TYPICAL CROSS SECTION FOR 4-LANE WITH PAVED SHOULDERS
LHS CUTTING UPTO 14.0M AND RHS FILLING UPTO 5.0M.

Sr. NO.	CHAINAGE		LENGTH (M)	TYPE OF TYPICAL CROSS SECTION
	FROM	TO		
1	88+391	88+437	46	TCS-3

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. FOR KERB AND DRAIN DETAILS REFER SEPARATE DRAWING.
3. SLOPE PROTECTION MEASURES SHOULD BE DESIGNED AS PER STANDARDS AND SITE CONDITION DURING EXECUTION.
4. FOR RAMP ACCESS TO VIEWING GALLERY AND ITS COMPONENTS, KINDLY REFER TO STRUCTURAL DRAWINGS (GAD).
5. DRAIN TO BE TAKEN UPTO NEAREST OUTFALL.



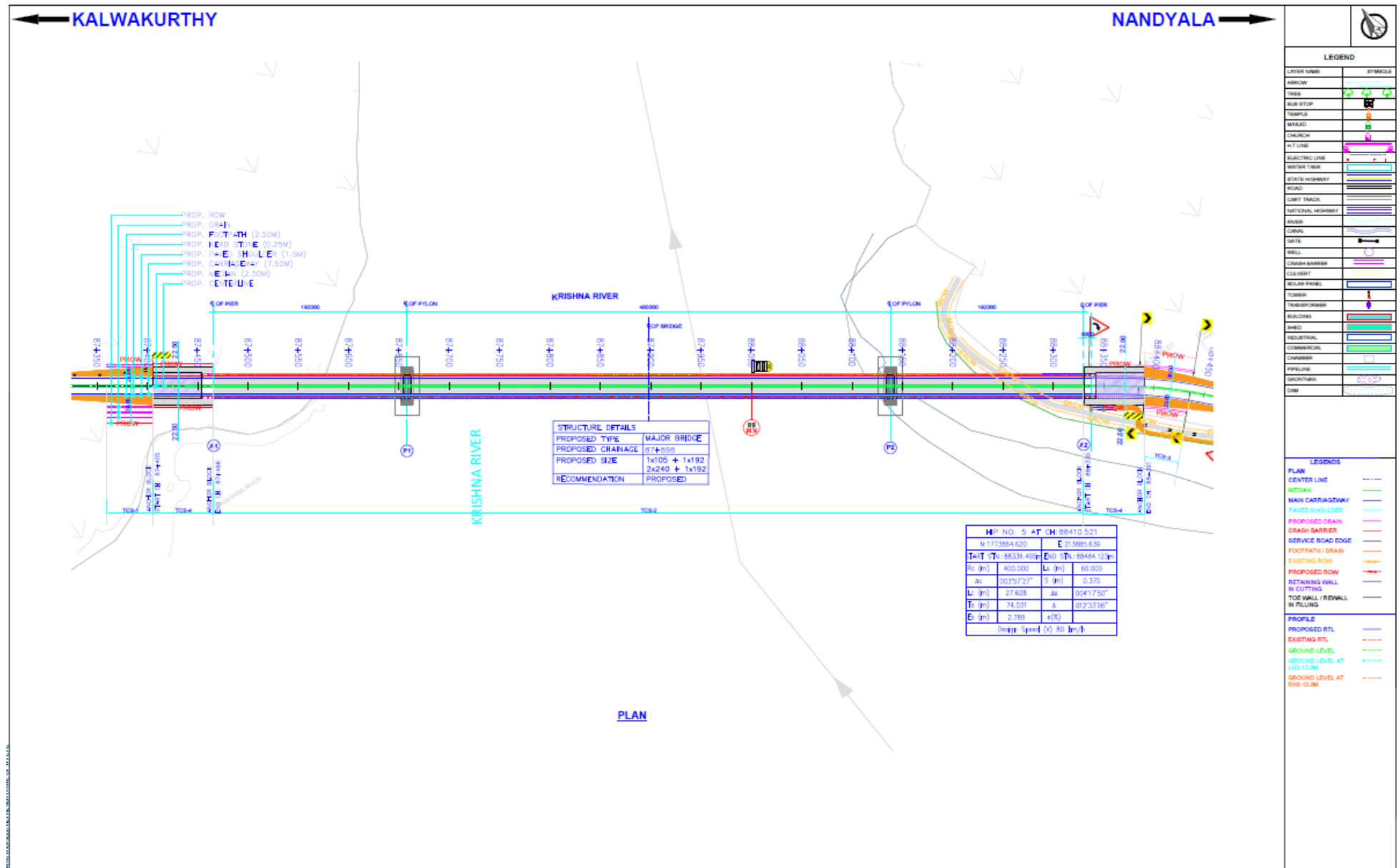


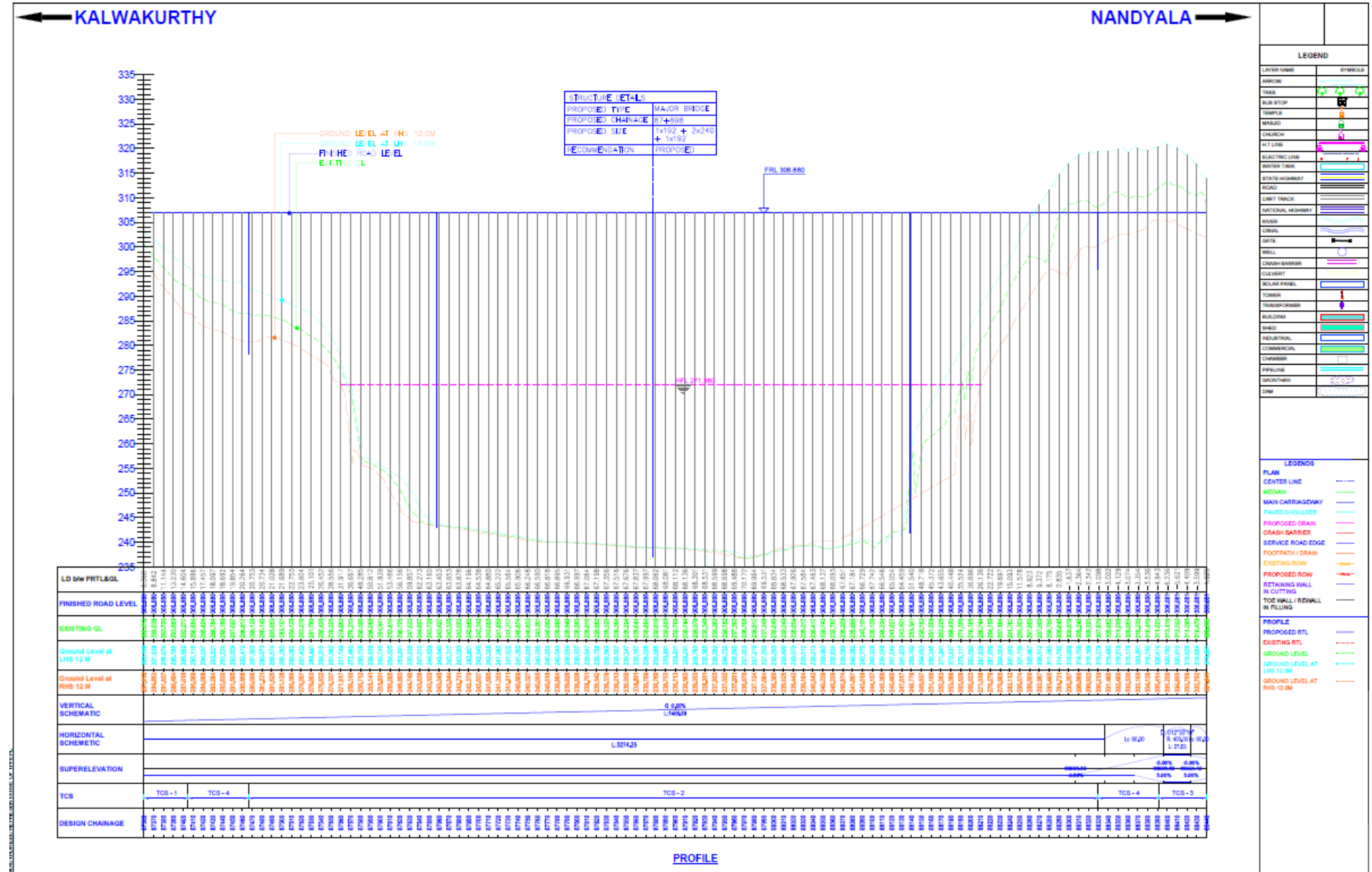
TCS-04B
TYPICAL CROSS SECTION FOR BRIDGE

Sr. NO.	CHAINAGE		LENGTH (M)	TYPE OF TYPICAL CROSS SECTION
	FROM	TO		
1	88+330	88+391	61	TCS -4B

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. FOR KERB AND DRAIN DETAILS REFER SEPARATE DRAWING.
3. SLOPE PROTECTION MEASURES SHOULD BE DESIGNED AS PER STANDARDS AND SITE CONDITION DURING EXECUTION.





3. INTERSECTIONS AND GRADE SEPARATORS

All intersections and grade separators shall be as per Section 3 of the Manual.

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

3.1 At-grade intersections

3.1.1 Major Intersections

The following Major junctions shall be developed/ improved to NH standards as per relevant IRC codes / Manuals and plans provided.

Sl. No.	Existing Chainage	(Design Chainage)	Type of intersection	Other features
Nil				

3.1.2 Minor Intersections

Minor junctions are to be developed / improved with suitable turning radius, channelizers, road markings etc. within available land as per the directions of Authority Engineer at the following locations along the project highway.

Sl. No.	Existing Chainage	Design Chainage	Type of Junction		Side	Village
			X	T		
Nil						

3.2 Grade separated intersection with/without ramps

3.2.1 The Grade separated structure shall be provided as per provision of the relevant Manual. The requisite particulars are given below:

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

Note: The Existing Junctions with other roads below VUP's shall be improved to NH standards.

4 ROAD EMBANKMENT AND CUT SECTION

4.1 Widening and 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.

The existing road shall be raised in the following sections: [Refer attached drawing volume]

Sl. No.	Section (km)		Side	Length (m)	Extend of raising (top of finished road level)
	From	To			
1.	87+360	87+405	BHS	44.54	As per required gradient shown in the drawing/TCS-01
2.	88+391	88+437	RHS	46.00	As per required gradient shown in the drawing/TCS-03

4.2 The Cut sections along the project road shall be as follows: [Refer attached drawing volume]

Sl. No.	Section (km)		Side	Length (m)	Extend of raising (top of finished road level)
	From	To			
1.	88+391	88+437	RHS	46.00	As per required gradient shown in the drawing/TCS-03

4.3. Bypasses / Realignment/New Alignment

Bypasses/New Alignment shall be provided in the following sections:

Name of Village / Town	District	Design Chainage		Length (m)	Remarks
		From (km)	To (km)		
Somasila	Nagar Kurnool, Telangana	87+360	87+466	106	Bridge approach in Telangana State
Krishna River	Connecting two States i.e. Telangana State & Andhra Pradesh State	87+466	88+330	864	Proper/ main Bridge on Krishna River
Sangameswaram	Nandyal, Andhra Pradesh	88+330	88+437	107	Bridge approach in Andhra Pradesh State

5 PAVEMENT DESIGN

Pavement design shall be carried out in accordance with the provision of Section 5 of Manual. Crust composition and pavement layers thickness shown in typical cross sections for highway are the minimum to be provided.

5.1 Type of pavement

- 5.1.1. Flexible Pavement is to be designed in accordance with the IRC-37-2018.
- 5.1.2. The pavement shall be flexible type for entire length of approach to bridge, including paved shoulders.

5.2. Design Period and strategy

Flexible pavement for new pavement or for widening and strengthening of the existing pavement shall be designed for a minimum design period of 15 years. Stage construction shall not be permitted.

5.3. Design Traffic

Notwithstanding anything to the contrary contained in this Agreement or the Manual, the Project Highway (Main Carriageway) shall be designed for a design traffic of 45 Million Standard Axles (MSA) from Km. 87+360 to Km 88+437. The EPC contractor has to conduct traffic surveys before designing and in case if there is excess traffic, the same shall be adopted and the increase in crust thickness as mentioned in TCS on the account this will not consider as change of scope.

5.4. Design Requirements

Pavement design shall be as per paragraph 5.4, 5.9 and 5.10 of the Manual, subject to minimum Crust thickness as detailed below:

Main Carriageway crust for New Construction of bridge approaches:

Sl. No.	Description	Thickness (mm)
1	Bituminous Concrete (Grade-II)	40
2	Dense Bituminous Macadam (Grade-I)	60
3	Wet Mix Macadam	100
4	Cement Treated crushed stone Base	185
5	Granular Sub-base (Grade-I)	200
6	Subgrade (CBR>10%)	500
Total Thickness(mm)		1085

Note: VG-40 grade bitumen will be used in DBM layer with Resilient Modulus of 3000 MPa. The lower DBM layer will be made fatigue resistant with $V_a = 3.0\%$ & $V_b = 11.5\%$ as per clause 9.2 of IRC: 37-2018 for two-layer DBM construction.

i. ~~Deleted.~~

ii. ~~Deleted.~~

Note:

Design Subgrade CBR: Notwithstanding anything to the contrary contained in this Agreement or the Manual, the Contractor shall design the pavement for minimum subgrade CBR of 10%.

5.5. Reconstruction of sections –

Nil

6. ROADSIDE DRAINAGE

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

Roadside RCC M25 covered drain cum footpath (Minimum 1.50m wide x 1.50m Outer dimensions) and RCC M25 Open drain (Minimum 1.50m wide x 0.90m Outer dimensions) shall conform to the typical cross-sectional features and other details specified as per typical section 2.11 in this schedule and shall be provided in following location as per given table below.

6.1. RCC Covered drain shall be provided at locations listed below.

Sl. No	Drain		TCS Type	Total Length (m)	Remarks
	From (km)	To (km)			
1	88+391	88+437	TCS-03	46.5	On Left Side

- Grating (300mm x 100mm x 10mm structural steel) shall be provided at 3m C/C in drain to drain off the runoff water.
- Weep holes shall be provided at every 1m interval.
- The wall and cover slab shall not be less than 0.15m thick.
- The drain shall be taken up to the nearest fallout as decided by the Authority's Engineer and the increase in in the length on the account this will not be constitute as change of scope.
- Collection and discharge arrangement of Storm Water from Main Carriageway to Open drain shall be provided as per the provision of the Manual and the collection

pipe shall have sufficient diameter and minimum at 10m interval and as approved by Authority's Engineer.

6.2. RCC Open drain shall be provided at locations listed below.

Sl. No	Drain		TCS Type	Total Length (m)	Remarks
	From (km)	To (km)			
1	87+360	87+405	TCS-01	44.54	On Both Side
2	88+391	88+437	TCS-03	46.00	On Right Side

- The wall shall not be less than 0.15m thick.
- The drain shall be taken up to the nearest fallout as decided by the Authority's Engineer and the increase in in the length on the account this will not be constitute as change of scope.
- Collection and discharge arrangement of Storm Water from Main Carriageway to Open drain shall be provided as per the provision of the Manual and the collection pipe shall have sufficient diameter and minimum at 10m interval and as approved by Authority's Engineer.

7. DESIGN OF STRUCTURES

7.1 General

7.1.1 All bridges, culverts and structures shall be designed and constructed in accordance with Section 7 of the Manual and cross-sectional features shall be confirmed to the cross sectional of the manual specified in Schedule B/ the GADs provided in the agreement. The scope of work includes the reconstruction/ new construction/ widening of the bridges and structures.

The proposed bridge shall have two levels of serviceability for users i.e. top deck four lane with paved shoulder for vehicular traffic with median and footpath. Below deck level 12.9m walkway consisting of 6m glass walkway at centre and 3.45m side concrete walkway with 25mm thick Chequered tiles on either side.

7.1.2 The following structures shall be provided with footpath:

Sl. No.	Bridge Length	Deck Width (outer to outer) Cross Sectional Features as per GAD & Cross section	Type of Bridge/ TCS	Span Arrangement	Remarks / Type of improvement
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Sl. No.	Bridge Length	Deck Width (outer to outer) Cross Sectional Features as per GAD & Cross section	Type of Bridge/ TCS	Span Arrangement	Remarks / Type of improvement
1	Bridge proper 864m	25m [Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m+Rigid Crash Barrier 2x0.45m+ Service Footpath 2x 2.3 + Stainless Steel railing with safety grill (2Nos)]	Major Bridge TCS -2	192m + 480m + 192m = 864m	hybrid-cable stayed & suspension bridge as per GAD and other detailed drawings
2.	End anchorage (61.46m + 61.00m)	38.750m [Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m + Crash barrier (0.45x2) +Service Footpath 2x2.3m + Railing with safety Grills +Covered Ramp gallery footpath 2 x 6m]	Major Bridge TCS -4A & 4B	61.46m + 61.00m = 122.46m	Anchor Blocks for suspension cable

7.1.3 All bridges shall be high level bridges.

7.1.4 The following structures shall be designed to carry utility services specified in table below:

Sl. No.	Location (km)		Remarks
	From	To	
1.	87+405	87+466	Anchorage portion (Telangana side)
2.	87+466	88+330	Major bridge (Middle portion)
3.	88+330	88+391	Anchorage portion (Andhra Pradesh side)

Note: 0.5t/m² should be considered in the design of superstructure on service footpath at deck level

7.1.5 Cross-section of the new culverts and bridges at deck level for the Project Highway shall conform to the typical cross-sections given in Schedule B.

7.2 Culvert

7.2.1 Reconstruction of Existing Culverts

Sl.	Design	Existing Culvert Details	Proposed Culvert Details	TCS
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No.	Chainage (Km)	Type	Span Arrangement (No x Vent)	Width (m)	Type	Span Arrangement (No x Vent(m))	Width (m)	Type
Nil								

7.2.2 Widening of Existing culverts

The following pipe culverts shall be widened.

Sl. No.	Design Chainage (Km)	Existing Culvert Details			Proposed Culvert Details		
		Type of Culvert	Span Arrangement	Width (m)	Type of Culvert	Span Arrangement	Width (m)
			(No x Vent)			(No x Vent(m))	
Nil							

7.2.4. New Construction of Culverts

Sl. No.	Design Chainage (Km)	Proposed Culvert Details		Roadway Width (m)	Remarks
		Type of Culvert	Span Arrangement (No x Vent)		
Nil					

7.2.5. Reconstruction of Culverts to Slab Culverts

The following pipe culvert shall be reconstructed as slab culvert.

Sl. No.	Design Chainage (Km)	Existing Culvert Details		Proposed Culvert Details		Roadway Width (m)
		Type of Culvert	Span Arrangement (No x Vent)	Type of Culvert	Span Arrangement (No x Vent)	
Nil						

7.2.6. New Construction of Slab Culverts

Sl. No.	Design Chainage (Km)	Proposed Culvert Details		Minimum Length of Culvert (m)	Remarks
		Type of Culvert	Span Arrangement (No x Vent)		
Nil					

7.3. Bridges

7.3.1. New Bridges

New bridges at the following locations on the Project Highway shall be constructed. GADs for the new bridges are attached in the drawings folder.

Sl. No.	Existing Chainage (km)	Existing structure	Design Chainage (km)	Proposed in DPR			Remarks
				Type of Structures (Bridge)	Span Arrangement (No. x Span) m	Width (m)	
1	-	-	87+466 to 88+330	Hybrid structure – Cable stayed and Suspension cable with structural steel type trusses for superstructure with two Pylons	192.00+480.00+192.00=864	25	Refer GAD, TCS – 2 for structural and other details
2	-	-	87+405 to 87+466 & 88+330 to 88+391	Bridge Portion at location of Anchor Blocks	61.46+61.00=122.46	38.75	Refer GAD, TCS – 4A & 4B for structural and other details

Note: -

1. The Hybrid Suspension & Cable stayed iconic bridge as per GAD shall be provided. The General Arrangement of Proposed bridge like span arrangement, height of Pylon, shape & structure of Pylon, Bridge Deck's structural arrangement, Arch type steel trusses, and the one's mentioned in this chapter etc. shall not deviate from the Design Intent and Tender Drawings. Provision made for number of vertical suspenders shown in the tender drawing are mandatory and shall not be deviated. The additional dummy cable (equally on both sides) shall be provided as shown in the tender drawing from aesthetic viewpoint. This bridge should be Hybrid of cable stay bridge and suspension bridge, both in terms of Structural requirements and Aesthetics. Design should not eliminate or reduce the number of cables or suspenders as shown in the drawings. They both should look integrated into a perfect Hybrid bridge.
2. The bottom/ Soffit of superstructure shall be 29.515m from the HFL-of 271.880.
3. The top RCC deck shall be supported on Rolla deck sheet as shuttering and wooden / normal steel sheets are not permitted. The carriageway and other details for vehicular traffic shall be provided over top deck.
4. The bottom deck shall be supported on Rolla deck sheet as shuttering and wooden / normal steel sheets are not permitted. For walkways (2 x 3.45m) and middle walkway (6m width) shall be provided with toughened glass as per

specifications given in Schedule D.

5. The truss structure shall be with structural steel and the entire structure shall be designed for bottom deck with pedestrian facilities, top deck allows vehicular traffic and other facilities as shown in TCS, GAD for class A / 70R/ special vehicle/ seismic / wind loads as per relevant IRC codes / design standards specified in Schedule-D.
6. Aluminium cladding shall be provided for complete length and full width of curve portion of semicircular shape or Arch of pedestrian walkway

Aluminium composite cladding with skin material 0.5 mm thick aluminium sheet cover material natural polyethylene aluminium cladding panel fixed with extruded aluminium basis frame (50x25x1.5mm) angle cleats, weather sealants, rivets, GI brackets all as approved, using suitable bolts on structural steel work including necessary accessories complete in all respects including all labour charges etc., complete for finished item of work but excluding cost of structural steel fabrication, scaffolding charges, if any, ACP Cladding - 4 mm thick shall be provided for Pedestrian Walkway Arch throughout the length.

7. Glass used for Glass flooring in walkway shall-be as per codal provision in code GB/T 38784-2020.
8. The cable stayed [(C1 to C30 x 2) x2], vertical suspenders (2 x 19), vertical hangers (2x 8) shall be provided as per actual design by EPC Contractor: Anticorrosive treatment to the cable system shall be provided.
9. The type of proposed Major Bridge shall be of Hybrid Cable-Stayed and Suspension type. Adoption of this structural system is mandatory, and the EPC Contractor shall not make any deviations or modifications to the bridge design in the proposal & also during the construction stage. Any proposal of deviation from the specified hybrid structure and the General Arrangement Drawing (GAD) enclosed in this tender document shall be rejected outrightly. Contractor would not be given any freedom to change the design and construction sequence decided by the PMC Consultant/ Authority Engineer. The Contractor would however have freedom to choose his options of methodology, machinery and equipment required for implementation of work.

Construction sequence shall be given by PMC Consultant as part of the bridge to facilitate EPC Contractor to plan the execution of work accordingly. Any change in the sequence of the construction shall only be with the approval of the PMC Consultant / Authority Engineer. Further in case of any discrepancy / error in the design of hybrid bridge as proposed

by the PMC and substantial change of the scope involving financial implication, appropriate action will be taken against PMC Consultant / Authority Engineer in line with the Contractual Obligations and responsibilities of the PMC Consultants.

Wind tunnel test and Fatigue Test shall be conducted by EPC Contractor on Stay cable and suspension cables through one of the laboratories as mentioned below:

Sr. No.	Name of Test	Name of Laboratory
1.	Fatigue	1. Chicago Testing Laboratory (CTL), Chicago, USA 2. Empa, Switzerland 3. Technical University of Wein (TU Wein), Austria
2.	Wind Tunnel	1. Rowan Williams Davies & Irwin Inc. (RWDI) Canada 2. Windtech Consultant, Canada 3. FORCE Technology, Kgs. Denmark
Note: 1. The each of the above-mentioned tests shall be witnessed by the five (05) technical persons of the Authority, and two (02) technical persons of the consultant, as per the list approved by MORT&H. All the necessary arrangements for the same has to be made by the Contractor and cost of visit, including to and fro travel, stay arrangements and travel shall be borne by the Contractor. 2. Conducting fatigue test on stay cables is mandatory. It should be conducted on at least 3 cables, equal to longest, shortest and mid length of cables to be used in the project. The test shall also be conducted on suspension cable. The test shall be conducted in India if such facility / laboratory is available in India subject to approval from Authority		

Acceptance of Prior Tests of Stay Cables

A reference of a fatigue test and a water tightness test passed successfully as per above specifications shall be submitted to the AE at the design approval stage.

Any previous test, conducted for a previous project as per the present specifications based on fib bulletin 30[4] on specimens similar to those recommended for this project, may be proposed to the AE as the basis for stay cable system approval.

Anchorage tests conducted for previous projects according to the specifications of Chapter 6.2.1 of fib bulletin 30[4] are not acceptable except for approval of system.

Wind Tunnel Testing of Model

The test reports of the full-scale Wind Tunnel test of approved model as per latest relevant International Standards as recommended by AE shall be submitted by the agency at the design approval stage.

Strand (Galvanised)

The main tensile elements of PSS stays are coated strands to the requirements of NF A 35--035(Edition 2001) @ [2] with the following characteristics:

- nominal diameter: 15.2 mm (TI 5.2 strands);
- nominal resisting section: 140 mm²;
- nominal linear mass of the bare strand: 1.093 kg/m;
- protective metal coating according to section 2.3. of the present specifications.
- strength class fGUTS = 1860 MPa (maximal load F_{me} = 260 kN, 0,1^o proof load l_p 230 KN);
- strain under maximum load A_{gt} at least 3.5%;
- modulus of elasticity of the bundle of parallel strands of 195 GPa 5^oo: very low relaxation: no more than 2.5% at 1000 hours at 0.7 F_{me} (at 20°C).
- The strands shall comply with category B of (2), i.e. MTES with special capacities meeting the following test conditions:
 - a) fatigue strength: 2 million cycles with maximum stress of 0,45 toe and stress variation of 300 MPa. This characteristic shall be verified on strand anchored with the same wedge as the one used in the anchorage on the structure. After Fatigue loading the strand shall develop a minimum 95% of the minimum specified tensile strength.
 - b) deflected tensile strength coefficient of no more than 20% or a "One Pin test" with minimum tensile force of 80% of the actual ultimate tensile strength

The curvature of strand shall be as follows: when a length of strand is lying free on a flat surface, the maximum bow height from a basic line of 1-meter length, measured inside the curve. shall not exceed 25 mm. The strand lengths may have welds made on individual rods before drawing, but may not be welded during or after drawing.

9. **The Aesthetics of the bridge** shall be as shown in the drawings/ GAD. Suitable painting shall be provided to the structures matching the aesthetics of surrounding and as approved by Authority's Engineer.

- 10. Videography:** Recording shall be done of all construction operations and shall be furnished to the Authority, every month on or before 5th of each month covering all activities, all hidden components, excavated work, finished levels of foundation etc, and as and when required to be furnished by Authority or Authority's Engineer.

11. Bearings

Spherical bearings to be provided for Cable Stayed Portion. The design of such bearings shall conform to IRC: 83 (Part IV) and shall be designed as per actual design of EPC Contractor. The item includes arrangements for ladders, steps for platform to reach for maintenance, inspection for the bearings

12. Wearing Coat

Wearing coat shall be 65 mm thick comprising of 40 mm bituminous concrete overlaid with 25 mm mastic asphalt as specified in section 2702.1 Type-2 of MORTH Standard Specification Fifth Edition

13. Expansion joint:

Modular strip seal expansion joint shall be provided.

- 14. Inspection** Ladder with platform shall be provided in consultation with Authority's engineer.

- 15. Covered Ramps** for entry to gallery (bottom deck) (4 Nos.) shall be provided. 2m wide ramp connection with M50 grade concrete for slab / M45 grade concrete for column shall be provided A2 side on RHS from ground level to gallery level (bottom deck).

- 16.** Anticorrosive treatment of Metalizing shall be provided for entire structural steel components. Technical Specification & requirements shall be as per Schedule-D and as approved by Authority's Engineer.

7.3.2. Existing minor bridges to be re- constructed.

- (i) The existing minor bridges at the following locations shall be re-constructed a new Structures:

Sl. No.	Existing Chainage (km)	Design Chainage (km)	Existing		Proposed in DDPR				TCS Type
			Type of Structures (Bridge)	Span Arrangement (No. x Span) (m)	Width (m)	Type of Structures (Bridge)	Span Arrangement (No. x Span) (m)	Width (m)	

Sl. No.	Existing Chainage (km)	Design Chainage (km)	Existing		Proposed in DDPR				TCS Type
			Type of Structures (Bridge)	Span Arrangement (No. x Span) (m)	Width (m)	Type of Structures (Bridge)	Span Arrangement (No. x Span) m	Width (m)	
Nil									

7.3.3. Temporary Diversion for Bridges

Sl. No.	Location		Minimum Length of Diversion Road (m)	Remarks
	From (km)	To (km)		
Nil				

7.3.4. The following narrow bridges shall be widened and repairs to be undertaken as below.

Sl. No.	Location (km)	Existing Width (m)	Extent of Widening (m)	Cross-section at Deck level for Widening	Remarks
Nil					

7.3.5. The Following bridges are to be retained with minor repairs like replacement of railings/parapets of the existing bridges shall be undertaken as follows.

Sl. No.	Existing Chainage (km)	Design Chainage (km)	Type of Structures (Bridge)	Span Arrangement (No. x Span) m	Width (m)	Repairs to be done
Nil						

7.3.6. Additional new bridges - NIL

7.3.7. The railings of existing bridges shall be replaced by crash barriers at the following locations:

Sl. No.	Location (km)	Remarks
Nil		

7.3.8. Drainage system for bridge decks

An effective drainage system for bridge decks shall be provided as specified in paragraph 7.20 of the Manual (IRC: SP 84-2019). The arrangement shall take away the runoff water away from the super structure and sub-structure to avoid corrosion.

7.4. Rail-road Bridges- Nil

7.5. Grade Separated Structures

[Refer to paragraph 7.19 of the Manual]

The grade separated structures shall be provided at the locations and of the type and length specified in 2.9 of this Annex-I.

Sl. No.	Location [Design. Chainage (km)]	Span/Opening (m)	Remarks
Nil			

7.6. Repairs and strengthening of bridges and structures.

A. Bridges

The following existing bridges which are to be repaired or strengthened.

Sl. No.	Location of bridge/ Design Chainage (km)	Nature and extent of repairs /strengthening to be carried out
Nil		

B. ROB / RUB- NIL

C. Overpasses / Underpasses and Other Structures-NIL

7.7. List of Major Bridges and Structures

Sl. No.	Bridge Length	Deck Width (outer to outer) Cross Sectional Features as per GAD & Cross section	Type of Bridge/ TCS	Span Arrangement	Remarks / Type of improvement
1	Bridge proper 864m	25m [Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m+Rigid Crash Barrier 2x0.45m+ Service Footpath 2x 2.3 + Stainless Steel railing with safety grill (2Nos)]	Major Bridge TCS -2	192m + 480m + 192m = 864m	hybrid-cable stayed & suspension bridge as per GAD and other detailed drawings

Sl. No.	Bridge Length	Deck Width (outer to outer) Cross Sectional Features as per GAD & Cross section	Type of Bridge/ TCS	Span Arrangement	Remarks / Type of improvement
2.	End anchorage (61.46m + 61.00m)	38.750m [Main carriageway 2x7.5m + Paved Shoulder 2x1.5m + Median 1.5m + Crash barrier (0.45x2) +Service Footpath 2x2.3m + Railing with safety Grills +Covered Ramp gallery footpath 2 x 6m]	Major Bridge TCS -4A & 4B	61.46m + 61.00m = 122.46m	Anchor Blocks for suspension cable

8. TRAFFIC CONTROL DEVICES AND ROAD SAFETY WORKS

8.1 Traffic control devices and road safety works shall be provided in accordance with Section 9 of the Manual. All the pavement marking (2.5mm thick), Rumble strips (15 mm thick), Road signs, Hazard markers, Reflective raised pavement markers (Road Studs), Thrie-Beam crash barrier etc. shall be scrupulously provided as per the manual.

- a. **Traffic signs:** Traffic signs include roadside signs, overhead signs and kerb mounted signs along the entire project highway. Minimum 2 number of Overhead and 2 Nos of Cantilever Gantries shall be provided.

Signages, Informatory signboards shall be provided in pedestrian walkway as per the directions of the Authority/Authority Engineer.

- b. **Pavement Marking:** Pavement marking shall cover road marking (as per IRC: SP:73-2018, para9.3, IRC: SP: 84 -2019) for the entire project highway.
- c. **Safety Barriers:** “Thrie” type metal beam/ New Jersey type Crash Barriers shall be provided at high embankments, sharp curves and at roadside hazardous objects (Graveyards, schools and religious structures, bridge approaches, median in built up locations & curve radius <450m), and sections as per TCS.

Rigid Crash Barrier/New Jersey type crash barrier:

Rigid crash barrier is to be provided in a minimum length of 3.944 Km (2x1.972km) along the Project Highway at high embankment, approaches to Structure and as per site requirement in consultation with Authority Engineer. Location of Rigid Crash Barrier as per below table.

Chainage(km)	Side	Length	Remarks
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From	To		(m)	
87+466	88+330	BHS	864.00	At median Refer TCS 02 / GAD
87+466	88+330	BHS	864.00	New Jersey type crash barrier at between service footpath & carriageway, Refer TCS 02/ GAD
87+405	87+466	BHS	61.46	At median Refer TCS 04 / GAD
87+405	87+466	BHS	61.46	At between service footpath & carriageway, Refer TCS 04/ GAD
88+330	88+391	BHS	61.00	At median Refer TCS 04 / GAD
88+330	88+391	BHS	61.00	At between service footpath & carriageway, Refer TCS 04/ GAD
Total Length (m)			1972.92	

Thrie-Beam metal crash barrier:

Thrie-Beam metal crash barrier are to be provided in a minimum length of 0.364 km (2x182.08m) along the Project Highway at high embankment, approaches to Structure and as per site requirement in consultation with Authority Engineer. Location of Thrie-Beam Crash Barrier as per below table.

Thrie-Beam metal Crash Barrier:				
Chainage(km)		Side	Length (m)	Remarks
From	To			
87+360	87+405	BHS	44.54	At median Refer TCS 1 / GAD
87+360	87+405	BHS	44.54	At between footpath & Paved Shoulder, Refer TCS 1/ GAD
87+391	87+437	BHS	46.00	At median Refer TCS 3 / GAD
87+391	87+437	BHS	46.00	At between footpath & Paved Shoulder, Refer TCS 3/ GAD
Total Length (m)			181.08	

d. Specifications of the reflective sheeting shall be as per IRC: SP: 84:2019

e. Provision of Pedestrian Guard rail (1.50m height) (stainless steel of grade SS-304) shall be provided on the outer side of the deck slab footpath for a minimum length of 1.972 (2x0.986) Km.

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+466	88+330	BHS	864.00	At outer edge of Deck slab Refer TCS 02 / GAD
87+405	87+466	BHS	61.46	At outer edge of Deck slab Refer TCS 04 A/ GAD

88+330	88+391	BHS	61.00	At outer edge of Deck slab Refer TCS 04 B/ GAD
Total Length (m)			986.46	

- f. **Provision of Railing with Safety Grill (2.2m height) shall be provided on walkway of stainless steel of grade SS-304 the length of walkway is 1.972 km (2x0.986). It shall be designed in such a way that crossing over by the pedestrian is prevented.**

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+466	88+330	BHS	864.00	At outer edge of below Deck slab Refer TCS 02 / GAD
87+405	87+466	BHS	61.46	At outer edge of Deck slab Refer TCS 04 A/ GAD
88+330	88+391	BHS	61.00	At outer edge of Deck slab Refer TCS 04 B/ GAD
Total Length (m)			986.46	

- g. **Provision of Railing with Safety Grill (1.05m height) shall be provided on walkway of stainless steel of grade SS-304 frame with glass fitting (as per drawing/ as per direction of Authority/ Authority's Engineer) the length of walkway is 1.972km.**

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+466	88+330	BHS	864.00	At outer edge glass walkway and below the Deck slab Refer TCS 02 / GAD
87+405	87+466	BHS	61.46	At outer edge glass walkway and below the Deck slab Refer TCS 04 / GAD
88+330	88+391	BHS	61.00	At outer edge glass walkway and below the Deck slab Refer TCS 04 / GAD
Total Length (m)			986.46	

- h. **Locations with median**

Sl. No.	Design Chainage		Length (m)	Median width (m)	Remarks
	From	To			
1.	87+466	88+330	864.00	1.5	TCS-2
2	87+405	87+466	61.46	1.5	TCS-4A
3	88+330	88+391	61.00	1.5	TCS-4B
4	88+391	88+437	46.00	1.5	TCS-3
5	87+360	87+405	44.54	1.5	TCS-1
6	Total Length (m)		1077.00		

Note: Antiglare devices of height 1.50m shall be provided in the central median.

9. ROADSIDE FURNITURE

Roadside furniture shall be provided in accordance with the provisions of section 9 & 11 of IRC: SP:84: 2019 and as per Schedule-C

1. Kilometre and Hectometre stones along the entire Project Highway.
2. Road Boundary Stones: Shall be provided along the entire project Highway. Certain precautions shall be taken by the Contractor to ensure protection of ROW from encroachments where provision of eccentric bypass has been provided.
3. Pedestrian Facilities shall be provided as per IRC: SP: 84: 2019 para 9.8 and refer Schedule B, typical cross section & Clause 2.11 of Schedule-B, IRC: SP :103: 2012 for disabled person. Pedestrian facilities for disabled persons as per IRC 103:2012 shall be provided.
4. **Overhead Gantry:** Minimum 2 nos. full overhead gantry & 2 nos. cantilever traffic signs shall be provided for the project stretch.

Note: The exact location of Signs and size shall be finalized as per provisions in Manual and as per site conditions. Overhead traffic Signs (locations & sizes) shall conform to the Manual of Specifications, (IRC SP-84:2019), IRC: 67 and also as per MORTH specification. Micro prismatic sheeting of Type XI is preferred for gantry mounted overhead signs.

10. COMPULSORY AFFORESTATION

Compulsory afforestation should be provided as per IRC: SP:21-2009 and as per demand of forest department as per Forest Conservation Act.

11. Hazardous Locations

Hazardous markers, retroreflective plates, cat-eyes shall be provided as per direction of Authority.

The safety barriers shall also be provided at the following hazardous locations:

Sl. No.	Location stretches from (km) to (km)	LHS/RHS
This shall be Provided at High Embankment, Bridge Approaches and at Sharp curve locations as per section 2 of schedule C		

12. Retaining Walls, Toe walls and RE walls

12.1 Retaining walls shall be provided at locations where the proposed road passes through hill sides. The details of the locations are as follows.

Chainage(m)		Length	Structure (m)	Effective Length (m)	Side
From	To				
Nil					

12.2 RE walls are provided at bridge locations. The details of the locations are as follows.

Chainage(m)		Length (m)	Structure (m)	Effective Length (m)	Side
From	To				
87+360	87+405	44.54	RE Wall	44.54 m	BHS
88+391	88+437	46.00	RE Wall	46.00 m	RHS

Note:

Stepped RE wall as per TCS-1 shall be provided. Reinforced earth with synthetic geogrid shall be provided for width in as shown in TCS shall be provided.

Any additional length and/or Height of RE wall required as per site requirement shall not constitute as Change of Scope, save and except any variations arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article13.

The EPC Contractor shall take the necessary action for slope protection to ensure its stability. The contractor may adopt technology for the same in consultation of AE. For avoidance of doubts, it is clarified that the EPC contractor shall be responsible for adopting suitable technology for slope protection and stabilization. It's part of this scope of work without any additional compensation.

13. **Sliding Handrail/ Telescoping ladder:** The sliding Handrail/ Telescoping ladder as per GAD shall be provided at 60m interval as per Drawing or as per instruction by Authority/ Authority Engineer At walkway.

Sr. No	Design Chainage		Side	Length (m)	Remarks
	From	To			
1	87+466	88+330	BHS	864	TCS -2/ GAD

Note: Additional scope/ Length will not be treated as change of scope.

14. Footpaths and Separators:

Footpaths Separators shall be provided at Major and Minor junctions all along the project highway and the details are given below.

Sl. No	Chainage	Area in sqm	
		Separator	Island
Nil			

15. Cast in Situ cement concrete M20 Kerb:

Cast in Situ cement concrete M20 Kerb (at Medians, Footpaths / Separators, etc.) shall be provided (As per TCS) at locations as per authority instructions.

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+360	87+405	BHS	44.54	At median Refer TCS 1 / GAD
87+360	87+405	BHS	44.54	At between footpath & Paved Shoulder, Refer TCS 1/ GAD
88+391	88+437	BHS	46.00	At median Refer TCS 3 / GAD
88+391	88+437	BHS	46.00	At between footpath & Paved Shoulder, Refer TCS 3/ GAD
		Total Length (m)		181.08

Note: Any additional length of Cast in Situ cement concrete M20 Kerb is required as per site requirement shall not constitute as Change of Scope

16. Special requirement for Hill roads -NIL

17. Change of Scope

The length of Structures and bridges specified here in above shall be treated as a minimum requirement. 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.

18. Special Technical requirement and aesthetics of the bridges shall be as per specifications mentioned in the schedule-D

Annex-II
(Schedule-B)

Additional Specifications for Bridge Health Monitoring:

1. Proposal for instrumentation and digital twin

- 1.1. The iconic bridge on completion will be required to be continuous monitored for the parameters considered during the design stage and during operations / service. As the bridge is in the remote location, the monitoring of the bridge will be difficult. The present system of monitoring of the bridge periodically over the specified period will not meet the requirement to get status of the bridge and will lead to accumulation of defects and failure of the structure.
- 1.2. Therefore, there is requirement of preparation of the **digital twin** of the cable stay bridge which is subjected to instrumentation for continuous monitoring of the design and in-service parameters. The digital twin will be based on the reduced based finite element modelling for faster and accurate data analysis. One of the major benefits of dynamic monitoring is the possibility to exploit the recorded data for the application of vibration-based damage identification techniques which are extremely helpful for early-stage damage identification.
- 1.3. The instrumentation with digital twin provides a versatile platform for remote monitoring of structures on a wide range of structural quantities; examples include but not limited to; strain (stress), vibration, tilt, inclination, temperature, humidity etc.

2. Data to be Recorded

- 2.1. Automatic Bridge monitor system using wireless sensors network is proposed. The system collects the data from sensors and status is collected by the controller and transferred to wireless node. This data at transmitter node is sent to the receiver node and is analyzed by the system. Analysed data is sent to the management center for integration with the digital twin.
- 2.2. The following data will be recorded by the system.

2.2.1. Environmental Factors

- 2.2.1.1. Environmental conditions at the top of the pylon will be recorded by a weather station which will measure ambient temperature, relative humidity, precipitation levels, barometric pressure, as well as wind speed and direction. Wind speed and direction will also be measured at deck level, by an ultrasonic sensor.
- 2.2.1.2. Factors affecting specific structural members will also be assessed. Relative humidity and temperature inside the hollow sections of the deck structure will be

measured by four hygrometers, and the level of corrosion in the pylon base structure will be monitored by means of embedded chloride ion and corrosion sensors.

2.2.1.3. In addition, seismic events, which could have a serious impact on the entire structure, will be measured at the pylon base using 3D high-definition accelerometers in each leg plinth.

2.2.2. Load Factors

2.2.2.1 Natural vibrations will be measured by eight 3D-accelerometers, which will be capable of relocation along the length of the structure to provide total coverage on a cyclical basis.

2.2.2.2. Traffic data will be recorded by laser analysers, enabling lane usage, average lane speed and vehicle classification are to be determined.

2.2.2.3. Traffic congestion, accidents and other anomalies will be captured by a video surveillance unit featuring colour cameras, capable of recording 30 frames per second and night-time usage.

2.2.3. Bridge Structural Response

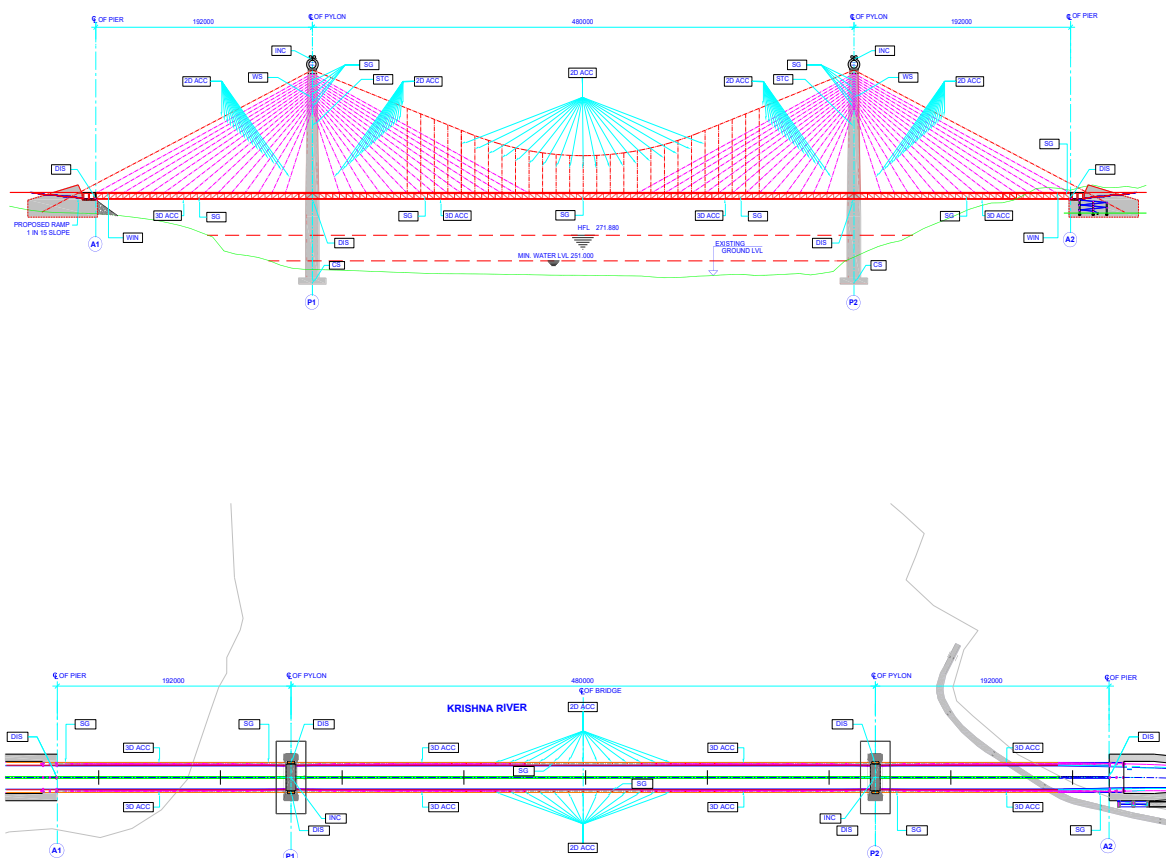
2.2.3.1. Strain in the pylon, compensated for temperature, will be measured by welded strain gauges, while strain in the deck girders, also temperature compensated, will be measured by bolted strain gauges.

2.2.3.2. Stay cable forces will be measured by electromagnetic sensors, weatherproof and telecommunications shielded, on the longest, shortest and medium length cables of each set of cables – two sets on the main span and one on the back span.

2.2.3.3. Cable vibrations will be recorded by 3D-accelerometers, which will be detachable to allow relocation during and after the construction phase to assist in calculation and verification of damping, as well as assessment of changes in harmonics during operation.

2.2.3.4. Tilt of the deck on each span and of the pylon (above and below the elbow) will be measured by inclinometers, and displacement of the deck by strain gauges at the expansion joints.

Refer figure below:



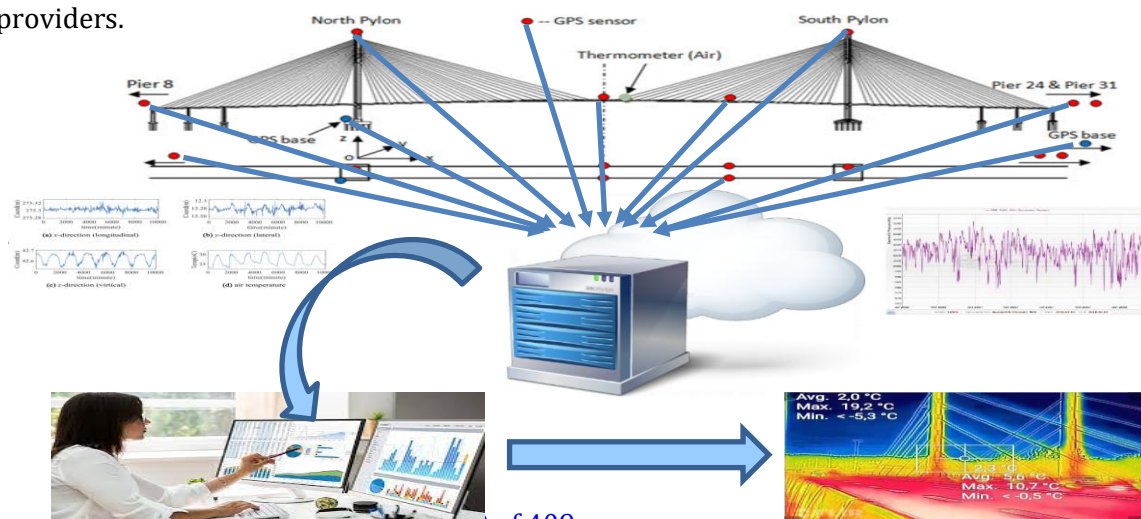
Sr. No	Description of item	Codes	Quantity
1	Inclinometer (inc)	INC	2 NOS
2	Displacement sensors (dis)	DIS	6 NOS
3	2d accelerometer (2dacc)	2DACC	176 NOS
4	3d accelerometer (3dacc)	3DACC	8 NOS
5	Strain Gauge (static)	STATIC	30 NOS
6	Optical strain sensor on cable (ofs)	OFS	24 NOS
7	Temperature sensor (ws)	WS	5 NOS
8	Weather station (ws)	WS	2 NOS
9	Speed trap cameras (stc)	STC	2 NOS
10	Weigh in motion camera (win)	WIN	4 NOS.
11	Corrosion sensors (cs)	CS	4 NOS
12	Data acquisition system (dau)	DAU	2 NOS

Note: The above quantities mentioned are indicative, however final quantities shall be based on Contractor's own design with approval from the Authority's Engineer.

SENSOR	PURPOSE	LOCATION
Tri-axial Accelerometer	Natural frequencies and vibration of the Bridge element	Bridge deck or at the top of pylon for cable stayed bridge
Displacement Sensor	To measure linear displacement at a location	Expansion joints, bearings
Strain Gauge	Strain Measurement	Pier, Bridge deck
GPS	Location Measurement	Top of pylon
Inclinometer	Inclination of Pyre, Pylon	Pier, pylon
Temperature Sensor	Temperature of concrete and steel structure	Pier, deck, pylon
Corrosion Sensor	Amount of corrosion	Deck, pier and pylon
Weather Monitoring Station	To measure ambient temperature, humidity, wind speed, wind direction and amount of rainfall	Top of arch/ pylon
Level Monitoring Prisms	To measure level of pier caps and bridge deck	Pier, pylon
Weigh in Motion Camera	Used to measure traffic intensity and axel to axle distance of Vehicles	Bridge deck
CCTV Camera	Traffic monitoring	Bridge deck

3. Data Transfer from the Master Station to the Local Data Server

3.1. The data connection between the master station on the bridge and the bridge operator's control room is by means of a wireless LAN bridge using a private static IP. This can operate over a distance of four to five kilometers. This system enables real-time data transmission, independent of mobile telecommunication service providers.



- 3.2. Data presentation is controlled by a local monitoring data server in an office of the client's choice. Since the server is connected to the internet and the data transfer from the master station on the bridge to the server is wireless, the location can be freely chosen.
- 3.3. All data received from the master station is stored permanently on two independent hard discs to prevent data loss in case of disc failure.
- 3.4. The server is also capable of processing, managing and presenting data from any other permanent monitoring system that might be connected in the future.

4. Web User Interface

- 4.1. The user interface enables an authorized user to log on to the system, and view any data which may be of interest, for any period of time during which measurements were made (Figures 5 to 7). It also enables the user to input condition and event values and, if necessary, instructions for personnel.
- 4.2. Information is presented in a user-friendly and simply understandable format. High frequency data is displayed in clear graphics (e.g. mimic panel format).
- 4.3. The user can also instruct the system to provide an alarm if predefined threshold values of any variable are exceeded. Such alarms can take the form of a visual notification on a monitor, or an email or SMS to a selected person. This user interface is accessible at any time, from anywhere in the world with an internet connection.

5. Report Generation

- 5.1. A data file with summarized results is automatically generated and stored on the hard disc at the end of each month. This report file summarizes the month's data on environmental conditions, bridge behaviour and bridge performance. If desired, the reporting period can be adjusted to cover shorter or longer intervals.
- 5.2. The generated reports are presented in PDF format, and are password protected for security. For each report, two emails are sent to a previously defined list of recipients - one with the report and the other with the corresponding password.

6. Delivery of the Monitoring System

- 6.1. Smooth delivery, installation and operation of the system are ensured by several measures. First, the system will be pre-assembled in the factory to enable a test of every component and of the whole system to be carried out. This also includes the

initial calibration of the sensors, the creation of quality control documentation and final updates of pre-installed PC and server operating systems.

- 6.2. Following installation of the system (taking approximately 16 weeks), final calibration of all sensors and a function test of the complete system are carried out. This includes, for example, checking of the horizontal fixation of tilt sensors, subtraction of static offset values of accelerometers and similar tasks. It also includes the initial operation of the operator's workstations.
- 6.3. Operation and maintenance training is then carried out, in relation to the monitoring system on the bridge, the web interface and the user interface in the monitoring office. Maintenance tasks performed by the bridge owner's personnel include, for example, software updates, replacement of batteries and general visual inspection of components. The operation and maintenance manual define the relevant tasks.
- 6.4. Finally, a comprehensive maintenance package is included, for a period of five years from completion of installation.

7. Digital Twin

- 7.1. The digital twin will be prepared using reduced based finite element analysis for real time monitoring of the forces structural members by using software like **Akselos or equivalent**. The data from the calibrated instrumentation will be integrated with the digital twin to record and compare the response of the structural members thereby bridge in particular.

8. Maintenance of BHMS System:

- 8.1. BHMS system should be maintained for 10 years. The contractor should assign dedicated person for monitoring, collection and record of all data from time to time. Data does obtained should be maintained throughout the maintenance period (10 years) and handover everything to the Authority at the end of the Maintenance period.

Annex-III
(Schedule-B)

Additional Specifications for Bridge Facade lighting

1. Bridge Aesthetic Lighting

1.1. Flood light fixtures: 550-600W, LED, RGBW, IP 66

The housing in light weight, made of high strength die cast aluminium. Protection screen in ultra-white tempered glass with high impact resistance (=>IK08). High precision dial ensures precision angle adjustment. Premium thermal management by high heat conductivity aluminium alloy and thermal fins. Pure Polyester powder coating in Standard Grey Colour. Precise structure and multi-protection silicon rubber seal guarantees the fixture IP66 rated. Power LED Module with high efficacy LED's (CREE/ OSRAM), on Printed Circuit Board with metal core plate. Electronic Power Supply for LED Module, which offers Protection against Short Circuit, Over-Voltage & Over – Current, with in-built surge protection. Light fixture should be standard DMX512, DALI, DMX-RDM wireless protocol compatible, the DMX decoder function should be inbuilt the light fixture. Each light fixture should be individually addressable & should be able to operate with any standard DMX512 equipment. Automatic and master-slave mode with RFU (remote firmware update), Lens made of PC which should offer minimum 4 different beam angles 9deg./13deg./25deg./35deg. to serve different lighting needs. Estimated LED Lifetime is L70-100,000 hours minimum. LM80 report from LED Manufacturer should be submitted. BIS safety test report with manufacturer name neri same as brand proposed, as per IS10322 from Intertek/ UL lab & BIS Certificate with manufacturer name neri NFL same as brand proposed, should be submitted. Minimum Light fixture Lumen output is 45600 Lumens @ full power.

1.2. Flood light fixtures: 275-300W, LED, RGBW, IP 66

The housing in light weight, made of high strength die cast aluminium. Protection screen in ultra-white tempered glass with high impact resistance (=>IK08). High precision dial ensures precision angle adjustment. Premium thermal management by high heat conductivity aluminium alloy and thermal fins. Pure Polyester powder coating in Standard Grey Colour. Precise structure and multi-protection silicon rubber seal guarantees the fixture IP66 rated. Power LED Module with high efficacy LED's (CREE /OSRAM), on Printed Circuit Board with metal core plate. Electronic Power Supply for LED Module, which offers Protection against Short Circuit, Over-Voltage & Over- Current, with in-built surge protection. Light fixture should be standard DMX512, DALI, DMX-RDM wireless protocol compatible, the DMX decoder function should be inbuilt the light fixture. Each light fixture should be individually addressable & should be able to operate with any standard DMX512 equipment. Automatic and master-slave mode with RFU (remote firmware update), Lens made

of PC which should offer minimum 4 different beam angles 9deg./13deg./25deg./35deg. to serve different lighting needs. Estimated LED Lifetime is L70-100,000 hours minimum. LM80 report from LED Manufacturer should be submitted. BIS safety test report with manufacturer name neri same as brand proposed, as per IS10322 from Intertek/ UL lab & BIS Certificate with manufacturer name neri NFL same as brand proposed, should be submitted. Minimum Light fixture Lumen output is 22800 Lumens @ full power. Sample Should be submitted for concerned engineer incharge for approval of light fixture.

1.3. Projector light fixtures: 180W-200W, LED, RGBW, IP 66

The housing in light weight, made of high strength die cast aluminium and coated by static powder making it weather resistant. Protection screen in ultra-white tempered glass with high impact resistance (=>IK08). High precision dial ensures precision angle adjustment. Premium thermal management by high heat conductivity aluminium alloy and thermal fins. Pure Polyester powder coating in Standard Grey Colour. Precise structure and multi-protection silicon rubber seal guarantees the fixture IP66 rated. Power LED Module with high efficacy LED's (CREE/ OSRAM), on Printed Circuit Board with metal core plate., Electronic Power Supply for LED Module, which offers Protection against Short Circuit, Over- Voltage & Over- Current, with in-built surge protection. Light fixture should be standard DMX512, DALI, DMX-RDM wireless protocol compatible, the DMX decoder function should be inbuilt the light fixture. Each light fixture should be individually addressable & should be able to operate with any standard DMX512 equipment. Automatic and master-slave mode with RFU (remote firmware update), Lens made of PC which should offer minimum 4 different beam angles 9deg./13deg./25deg./35deg. to serve different lighting needs. Estimated LED Lifetime is L70-100,000 hours minimum. LM80 report from LED Manufacturer should be submitted. BIS safety test report with manufacturer name neri same as brand proposed, as per IS10322 from Intertek/UL lab & BIS Certificate with manufacturer name neri NPL same as brand proposed, should be submitted. Minimum Light fixture Lumen output is 14400 Lumens @ full power. Sample Should be submitted for concerned engineer incharge for approval of light fixture.

1.4. Linear Wall Washer: 50-60W, LED, RGBW, IP 66.

The housing in light weight, made of high strength aluminium and coated by static powder making it weather resistant. Protection screen in ultra-white tempered glass with high impact resistance (=>IK08). High precision dial ensures precision angle adjustment. Pure Polyester powder coating in Standard Grey Colour. Precise structure and multi-protection silicon rubber seal guarantees the fixture IP66 rated. Power LED Module with high efficacy LED's (CREE/ OSRAM), on Printed Circuit Board with metal core plate. Electronic Power Supply for LED Module, which offers Protection against Short Circuit, Over- Voltage & Over- Current, with in-built surge

protection. Light fixture should be standard DMX512, DALI, DMX-RDM wireless protocol compatible, the DMX decoder function should be inbuilt the light fixture. Each light fixture should be individually addressable & should be able to operate with any standard DMX512 equipment. Automatic and master-slave mode with RFU (remote firmware update). Lens made of PC which should offer minimum 3 different beam angles 12deg., 35deg. & 25deg.x45deg. to serve different lighting needs. Estimated LED Lifetime is L70-100,000 hours minimum. LM80 report from LED Manufacturer should be submitted. BIS test report with manufacturer name neri same as brand proposed as per IS10322 from Intertek/UL lab & BIS Certificate with manufacturer name neri NWWL same as brand proposed should be submitted. Minimum Light fixture Lumen output is 3450Lumens @ full power. Sample Should be submitted for concerned engineer in charge for approval of light fixture.

1.5. DMX Splitter: 4 Port industrial grade

DMX Splitter (Din rail Mountable) with following features & specifications: The DMX splitters boost an incoming DMX signal and provide it on four output ports. This allows for safely going beyond the 32 devices limit of the DMX standard, as well as for building star topologies. The splitters also act as repeaters, and thus they may be used for transporting a DMX signal across larger distances. DMX signals often get disturbed by the environment or even by the devices connected to the signal line. A splitter may completely clear the disturbances if it is connected at a location where the signal is still “readable”. Providing four individually optically isolated outputs, as well as an optically isolated input, the splitters may prevent harmful voltages applied to a given port from affecting the other ports and damaging the connected equipment. The bidirectional splitters work within DMX/RDM environments, as well as in pure DMX environments. Features - DMX splitter booster, DMX repeater, Input optically isolated, Each output individually optically isolated, RDM support, Rugged metal housing & Built-in termination. Applications- Boost/repeat DMX signals, Regenerate/clean DMX signals, prevent reflection issues, Split DMX signals and build star topologies, connect a large number of fixtures to a single universe & protect expensive equipment. Specification - Weight-0.4Kgs. Ambient temperature - -30 - +55°C, Power consumption 4 W, DC power input -10 - 48 V DC, DMX-ANSI E1.11, RDM-ANSI E1.20 & Signal ports-EIA-485.

1.6. DMX controller - 5 Universe microprocessor based.

Microprocessor-based system specifically designed for control of lighting in an architectural application. Personal computer running emulation software shall not be acceptable. Store show-data in non-volatile solid-state memory. This memory shall be removable for purposes of backup or disaster-recovery. Show-data must be downloaded from a remote personal computer over an Ethernet or USB connection. Capacity of 512/1024 output control channels of pharos either DMX512 with RDM

or eDMX protocols, including Art-Net II, KiNet, sACN and Path port. Support multiple timelines, crossfades and effects running concurrently. A multi-mode full-duplex RS232 / half-duplex RS485 serial port. Receive DMX512 for triggering and 8 local inputs capable of digital, analogue or contact closure operating modes. A MIDI input and a MIDI output interface for use in triggers and for MIDI timecode. Support multiple remote devices connected via Ethernet for support of additional show control interfaces, such as contact closures, analogue inputs, relay outputs, serial, audio input, linear timecode, MIDI and DALI. Internal watchdog feature to restart the unit in the event of program failure. The Controller shall support conditional logic and execute user-defined Lua scripts to support advanced show control operations. Enclosure and mounting shall comply with DIN43880 and EN60715 (35/7.5) respectively.

2. Underdeck Walkway Lighting -

2.1. Surface Downlight fixtures: LED, 18 W +/-10% (>= 1800 Lumens)

Back lit LED Down Light Surface mounting round with housing made of Powder coated Pressure die cast aluminium housing with extended heat sink, with Protruded high efficiency diffuser, with wide operating voltage range, Power factor > 0.9, Surge protection: > 2KV, System efficacy of >100 lumens/watt, CCT: 3000K - 6500K as desired by the department and as per IS, CRI >80, and THD is less than 15% etc.

2.2. Strip light fixtures: 5W/m, LED, 3000K

Outdoor Linear LED strip neri light mounted in aluminium profile with Opal diffuser screen, of 5W/m, IP67, 3000K, minimum 450lm/w, including outdoor rated driver NLS, profile for enclosure and diffusion with complete accessories.

2.3. Up light fixtures: 12-15W, LED, 3000K

Single Emission Diffuser up lights, IP65 Wall mounted neri, 12-15W, LED, minimum 800lm, narrow beam NWL. Housing shall be extruded and die cast aluminium body.

3. The following Codes and Standards shall be applicable for continuous performance of all electrical equipment's to be supplied, delivered at site, erected, tested and commissioned. The Electrical equipment's offered shall comply with the relevant Indian Standard Specifications, Fire Insurance Regulations, Tariff Advisory Committee's Regulations, and in particular to Indian Electricity Rules in all respects with all its latest amendments up - to - date.

For guidelines, few of the Indian Standards are indicated below shall be included but not be limited to :-

Codes	Description
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Codes	Description
IS 8084 / 1976	Interconnecting bus-bars for A.C. voltage above 1 KV up to & including 36 KV.
IS 1919 /	General and Safety requirements for light fittings
IS 1944/ 1970	Code of practice for lighting public thoroughfares
IS 3528	Waterproof electric lighting fittings
IS 3553	Water tight electric lighting fittings
IS 1239	M.S. Tubular and other wrought steel pipe fittings
IS 2149	Luminaries for street lighting
IS 13032 / 1991	A.C. miniature circuit breaker board for voltage not exceeding 1000V specification.
IS 732/ Part 2/ 1982 IS 3043 / 1987	Code of practice for earthing.
IS 3427 / 1997	A. C. metal enclosed switchgear & control gears for rated voltage above 1KV up to & including 52 KV.
IS 3837 / 1977	Accessories for rigid steel conduits for electrical wiring.
IS 13947 / Part 3 / 1993	Specification for low voltage switchgear & control gear.
IS 4615 / 1968	Switch socket outlets (Non – Interlocked type).
IS 5216 / Part1, 2 / 1982	Guide for safety procedure & practices in electric work.
IS 5578 / 1984	Guide for marking of insulated conductors.
IS 5820 / 1970	Specification for pre cast concrete cable covers.
IS 6381 / 1972	Specifications for construction & testing of electrical apparatus with type of protection's'.
IS 10322 / Part1, 2 / 1982	Specification of luminaries.
IS 10322 / Part3, 4 /1984	Specification of luminaries.
IS 10322 / Part5 (Sec 1, 2) /1985	Specification of luminaries.
IS 13022 / Part 5 (Sec3 to 5) / 1987	Specification of luminaries.
IS 13947 / Part1 / 1993	Specification for low-voltage switchgear & control gear.
IS 13703 / Part4 / 1993	Specification for low voltage fuses for voltages not exceeding 1000V AC or 1500 V DC.
IS 2551 / 1982	Danger notice plates.
IS 732 / 1989	Code of practice for electrical wiring installation.
IS 3854 / 1997	Switches for domestic & similar purpose.
IS 2309 / 1989	Code of practice for lightning protection
IS 2418 / Part 1 to 3 / 1977	Tubular florescent lamps for general lighting

Codes	Description
	service.
IS 13032 /1991	AC miniature circuit breaker board for voltage not exceeding 1000V.
IS 2706 / Part 1 to 5 / 1992	Current transformers.
IS 15086 / Part1 / 2001	Surge arresters.
IS 13925 / Part1 / 1998	Shunt capacitors for AC power systems having a rated voltage above 1000V.
IS 13118 / 1991	Specification for HVAC circuit breakers.
IS 374 / 1979	Ceiling fans.
IS 5578 / 1984	Guide for marking for insulated conductors.
IS 418 / 1978	Tungsten filament general service electrical lamp.
IS 694 / 1990	PVC insulated cable & cords for power / lighting.
IS 13010 / 2002	A.C. watt –hour meters.
IS 732 / 1989	Electrical wiring installation (up to 650V).
IS 10870 / 1984	Code of safety for hexane.
IS 1248 / Part 1 / 1993	Direct acting indicating instruments & their accessories.
IS 1248 / Part 2 / 1983	Direct acting indicating instruments & their accessories.
IS 1248 / Part 7 / 1984	Direct acting indicating instruments & their accessories.
IS 1248 / Part 9 / 1983	Direct acting indicating instruments & their accessories.
IS 1293 / 1988	3 pin plugs & socket outlets.
IS 1554 / Part1 to 3/1988	PVC insulated cables – heavy duty.
IS 13947/Part 1 to 5 /1993	Low voltage switchgear & control gear.
IS 1651 / 1991	Lead acid cell batteries.
IS 9537 / Part 5 / 2000	Conduits for electrical installation.
IS 2082/ 1993	Stationary storage type water heaters
IS 16242(PART 1)/ 2014	UPS/ Inverters of rating <= 5 KVA
IS 13252(PART 1)/ 2010	CCTV cameras/ CCTV recorders
IS 1391(PART 1 & PART 2)/ 1992	Room air conditioners – PART 2 split air conditioners
IS 10617(PART 1)/ 1983	Water cooler – hermetically sealed type suction cooled compressor with overload protection
IS 1475(PART 1)/ 2001	Self-contained drinking water coolers
IS 14724/ 1999	Water purifiers with UV disinfection
IS 10000/ 1980	Methods of tests for IC engines
IS 4722/ 2001	Rotating electrical machines
IS 1180(Part-1):2014, Level-2	Distribution transformers

SCHEDULE - B1

(See 15 of Annex-I to Schedule-B)

Utility Shifting

1. 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 is attached in **Annex-I** to Schedule-B1. The Contractor has to verify & shift all the utilities on the Project Site under the supervision of Utility Department / Agency.
2. All the Utilities which affects the execution of EPC work or Maintenance of Project highway in accordance with Article-9 of EPC Agreement.

Annex-I
(Schedule-B1)

Utility Shifting

Shifting of obstruction existing utilities indicated in Schedule-A to an appropriate location in accordance with the standards and specification of concerned utilities owning department is part of the scope of work of the contractor / Concessionaire. The bidder may visit the site along with Authority's representative and Utility Department / agency representative and assess & verify the quantum of shifting of utilities for the projects before submission of their bid. The specifications of concerned utility owning department shall be applicable and followed.

The Details of the Utilities requiring to be shifted is given as under:

NIL

SCHEDULE-C

(See Clauses 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:

- A. Toll plaza;
- B. Roadside furniture / Traffic control Devices / Road safety devices;
- C. Pedestrian facilities;
- D. Tree plantation;
- E. Truck lay-byes;
- F. Bus-bays and Bus shelters;
- G. Utility Corridor;
- H. Street Lighting; and
- I. Bridge Health monitoring System (BHMS)
- J. Mobile Bridge Inspection Unit (MBIU)
- K. Security
- L. Emergency Staircase
- M. Facility for Authority
- N. Provision of Boats.
- O. Training of personnel.

2 Description of Project Facilities

Each of the Project Facilities is described below:

A. Toll Plaza

Sl. No.	Design Chainage (Km)		Length (m)	Location	Remarks, if any
	From	To			
Nil					

B. Roadside Furniture / Traffic control Devices / Road safety devices

Each of the Project Facilities is described below:

(i) Traffic signs.

Traffic control devices and road safety works shall be provided in accordance with section 9 of the manual IRC SP: 73-2018, IRC SP: 84-2019 and IRC:67-2012. Locations of the sign boards (roadside signs, overhead signs and curb mounted signs) shall be finalized with the consultation of Authority/ Authority

Engineer. Traffic signs include roadside signs, overhead signs and kerb mounted signs along the entire project highway.

(ii) **Pavement Markings.**

Pavement markings shall cover road marking (2.5mm thick) for the entire Project Highway as per Manual IRC: SP: 84-2019 and IRC: 35-2015. Locations of the different pavement markings shall be finalized with the consultation of Authority Engineer. 15mm thick rumble strips shall also be provided wherever required as per site requirement and as per instructions of Authority Engineers.

(iii) **LED Traffic Blinkers:**

As per the requirement in accordingly with relevant manuals/IRC guidelines shall be provided. Location of installation shall be finalized by the Authority Engineer. Any excess requirement as per site requirements shall be provided and will not constitute as change of scope.

(iv) **Crash barrier:**

Provide Thrie-beam crash barrier along the project highway at all Locations as specified in IRC SP-84: 2019. However Minimum length of Crash barrier shall be provided at the locations provided below:

(v) **Thrie-Beam Crash Barrier**

Thrie-Beam Crash Barrier shall be provided at location as per table below:

(The minimum length of 0.364 Km (2x0.18208 km) along the bridge as per TCS)

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+360	87+405	BHS	44.54	At median Refer TCS 1 / GAD
87+360	87+405	BHS	44.54	At between footpath & Paved Shoulder, Refer TCS 1/ GAD
88+391	88+437	BHS	46.00	At median Refer TCS 3 / GAD
88+391	88+437	BHS	46.00	At between footpath & Paved Shoulder, Refer TCS 3/ GAD
Total Length (m)			181.08	

Note: The length indicated in the above table are minimum and any additional number required as per site requirement shall be provided and will not constitute as change of scope

(vi) Rigid Crash Barrier

The Rigid shall be provided at location as per table below:

(The minimum length of 3.948 Km (2x1.972km) along the bridge as per TCS)

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+466	88+330	BHS	864.00	At median Refer TCS 02 / GAD
87+466	88+330	BHS	864.00	New Jersey type crash barrier at between service footpath & carriageway, Refer TCS 02/ GAD
87+405	87+466	BHS	61.46	At median Refer TCS 04 / GAD
87+405	87+466	BHS	61.46	At between service footpath & carriageway, Refer TCS 04/ GAD
88+330	88+391	BHS	61.00	At median Refer TCS 04 / GAD
88+330	88+391	BHS	61.00	At between service footpath & carriageway, Refer TCS 04/ GAD
Total Length (m)			1972.90	

Note: The length indicated in the above table are minimum and any additional number required as per site requirement shall be provided and will not constitute as change of scope.

(vii) Pedestrian Guard rail

Provision of Pedestrian Guard rail (1.50m height) (stainless steel of grade SS-304) shall be provided outer side the deck slab footpath for a minimum length of 1.972 Km (2X 0.986 km).

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+466	88+330	BHS	864.00	At outer edge of Deck slab Refer TCS 02 / GAD
87+405	87+466	BHS	61.46	At outer edge of Deck slab Refer TCS 04 / GAD
88+330	88+391	BHS	61.00	At outer edge of Deck slab Refer TCS 04 / GAD
Total Length (m)			986.46	

Provision of Railing with Safety Grill (2.2m height) shall be provided on walkway of stainless steel of grade SS-304. The length of walkway is 1.972 km (2x0.986 km). It shall be designed in such a way that crossing over by the pedestrian is prevented.

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+466	88+330	BHS	864.00	At outer edge of below the Deck slab(walkway) Refer TCS 02 / GAD
87+405	87+466	BHS	61.46	At outer edge of below the Deck slab(walkway) Refer TCS 04 / GAD
88+330	88+391	BHS	61.00	At outer edge of Deck slab Refer TCS 04 / GAD
Total Length (m)			986.46	

Provision of Railing with Safety Grill (1.05m height) shall be provided on walkway of stainless steel of grade SS-304 frame with glass fitting (as per drawing/ as per directed by Authority/ Authority Engineer) the length of walkway is 1.972km.

Chainage(km)		Side	Length (m)	Remarks
From	To			
87+466	88+330	BHS	864.00	At outer edge of Deck slab Refer TCS 02 / GAD
87+405	87+466	BHS	61.46	At outer edge of Deck slab Refer TCS 04 / GAD
88+330	88+391	BHS	61.00	At outer edge of Deck slab Refer TCS 04 / GAD
Total Length (m)			986.46	

Pedestrian facilities for persons with disabilities shall be provided as per ministry's circular RW/NH-33044/28/2015/S&R(R) Dated 17.06.2015 and IRC.103:2012, Guidelines for Pedestrian facility shall also be provided along the highway.

- (viii) **Delineators:** Delineators shall be provided as per the provision of relevant manual/IRC guidelines for the entire project highway.
- (ix) **Boundary stones:** Boundary stones shall be provided as per the provision of relevant manual/IRC guidelines for the entire project highway, certain precautions shall be taken by the contractor to ensure protection of ROW & new encroachments where provision of eccentric bypass has been provided.

- (x) **Hectometre/ Kilometre stones stone/fifth kilometre fifth kilometre stone:** Hectometer/ Kilometer stones shall be provided as per the manual for the entire project Highway.

(xi) **Road Studs (Raised Pavement Markers)**

Road studs for the entire Project at the locations as per IRC: SP: 84-2019, IRC 35-2015 shall be provided. The tentative quantities are given in below table.

Sl. No.	Type of Traffic signs	Remarks, if any
1	Road studs (Raised Pavement Markers)	On both ends of bridge and along both edge of carriageway

(xii) **Overhead and Cantilever Gantries.**

The location of these facilities shall be finalized in consultation with Authority Engineers as per site requirement. However minimum 2 numbers of overhead gantry signs shall be provided at starting and end of Project highway, as per instruction of Authority Engineer. Further, 2 nos. of Cantilever gantries shall be provided as per instruction of Authority Engineer

Location of Overhead Gantry signs are as follows.

Sl. No.	Design Chainage (km)	Location	Remarks, if any
1	87+390	Start of Iconic Bridge	
2	88+370	End of Iconic Bridge	

(xiii) **Anti-glare in Median**

Anti-glare shall be installed in the median as mentioned in GAD/TCS.

Necessary signages as per IRC codes including Special Signages for Pedestrians have to be provided wherever necessary.

C. Pedestrian Facilities:

As per Manual para 9.8 and refer schedule-B of Annexure-I, typical cross section, and clause 2.11 of Schedule –B. The pedestrian facilities shall include the provision of the project.

- i. **Pedestrian guardrail:** Provide stainless steel (Grade SS-304) pedestrian guardrail at both side of bridge (1.05m height), stainless steel guardrail (Grade SS-304) both side of walkway (2.20m height) for entire length of the project as per instruction of Authority/ Authority Engineer.

ii. **Pedestrian Crossings:** Provide pedestrian crossing facilities at village/Built-up portions and as per instruction of Authority/ Authority Engineer.

iii. **Footpaths with Chequered tiles** (25mm thick) shall be provided on RCC drains for footpaths and facilities for disabled persons in accordance with IRC 103-2012 shall be provided.

iv. **Stainless steel Benches (4-seater) and dustbin** shall be provided both side of walkway as shown in drawings for both side of walkway for entire length at every 100 m interval in staggered pattern or as directed by Authority/ Authority Engineer.

Drinking water facility shall be provided at both the ends of the pedestrian walk way

v. **Pedestrian facilities for persons with disabilities** shall be provided as per ministry's circular No. RW/NH-33044/28/2015/S&R(R) Dated 17.06.2015 and IRC 103:2012, Guidelines for Pedestrian facility shall also be provided along the highway.

D. Landscaping and Tree Plantation: Nil

E. Truck Lay-byes: Nil

F. Bus bays and Bus Shelters:

The contractor shall provide Bus Bay with Bus Shelters, Bus bays along the project highway at following tentative locations.

Sl. No.	Project Facility	Design Chainage (km)	Location	Side	Remarks
Nil					

G. Utilities/ Utility Corridor

Utilities details shall be provided as per drawing /as per instruction of Authority/ Authority Engineer.

H. Street Lighting, Walkway illumination and Façade lighting:

Lighting shall be provided at the following locations:

- 10 m height double arms poles shall be provided at median centre for Highway Street Lighting as per Manual referred in Schedule D or as indicated by Authority / Authority Engineer.
- The Façade lighting and walkway lighting shall be provided as directed by Authority/ Authority Engineer.

The tentative scope of Street Lighting, Walkway illumination and Façade lighting;

Sr. No	Description	Scope
1	Bridge Aesthetic Lighting	Design, procurement, supply, transportation, installation, testing & commissioning of Façade Lighting of Pylon, Stay Cables, Suspension Ropes 1) DMX Control of lights 2) LT Panel 3) Auto Voltage Regulator 4) LV & HT Cabling, termination 5) HT Substation with metering Cubicle, HT Panels, transformer and distribution panel. 6) Earthing System 7) Lightning Protection System 8) Aviation Obstruction Lighting
2	Underdeck Walkway Lighting	Design, procurement, supply, transportation, installation, testing & commissioning of 1) Internal Lighting 2) Internal Wiring 3) LV cables, termination 4) Earthing System
3	Street Lighting (Bridge)	Design, procurement, supply, transportation, installation, testing & commissioning of 1) Streetlighting 2) LT Panel 3) LV cables, termination 4) Earthing System
4	Lightening arrestor	2 nos. on each Pylon.
Note- The above table has indicative scope and any additional requirement to complete the job shall be verified by the Contractor and submitted to the Client/ consultant for approval for works to be carried out.		

I. Bridge Health Monitoring system (BHMS)

Bridge health monitoring system (BHMS) including its monitoring and control station at the location specified by the authority shall be provided for the major bridge as specified in Schedule B. Maintenance of Bridge Health Monitoring System including Calibration, Service/repair/replacement, inspection etc., should be for 10 years.

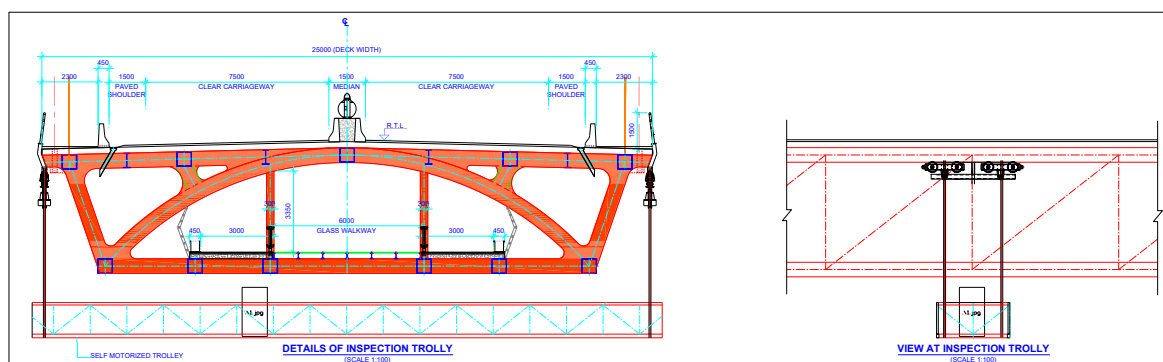
THE EPC CONTRACTOR HAS TO MAKE PROVISION FOR LIVE GENERATION OF REPORT IN BHMS. FURTHER, THE BRIDGE HEALTH IS TO BE MONITORED CONTINUOUSLY AND ANY URGENT REQUIREMENT FOR SAFETY AND

SERVICEABILITY OF BRIDGE IS TO BE ATTENDED IMMEDIATELY BY THE EPC CONTRACTOR AND SAME SHALL BE INTIMATED TO THE AUTHORITY DURING CONSTRUCTION AND MAINTENANCE PERIOD.

J. Mobile bridge Inspection Unit (MBIU)

- a. One mobile bridge inspection unit (MBIU) for inspection shall be provided and maintenance of Stay & suspension cables, their accessories, fixtures, sensors fitted on it, for Pylon (Height of 100 M) by providing manlift, deck etc. shall be provided and kept at the location specified by Authority and shall be maintained properly for entire maintenance period. The detailed specifications and capacity of MBIU shall be as specified in schedule D. Mobile bridge Inspection (MBIU) unit should be operated for 10 years for inspection of bridge and shall be handed over in good working condition to the authority after maintenance period.
- b. A Mechanical/ Electromechanical/ Hydraulic/Electronic system shall be developed and provided for cleaning, maintenance of the glass floor, glass railings, (from all sides) entire walkway, its structural parts. The system shall be in operation throughout the maintenance period. Tentative sketch is as shown below.

3 no' s of trollies are to be provided as shown in the TCS below:



K. Security:

The complete bridge shall be equipped with CCTV cameras to ensure complete surveillance of the Traffic, at both Vehicular and Pedestrian level. This bridge shall be supervised from Security Office.

L. Emergency staircase:

A staircase for emergency exits from walkway to bridge deck level is to be provided at both pylons as shown in GAD and Drawings.

M. Facility for Authority:

The contractor shall remain responsible for providing 2 Nos of vehicle (SUV- Innova or equivalent) for travel up to 4000 Km per month to the Authority including driver, Fuel (diesel) and other lubricants, insurances and commercial taxes applicable, for construction period and running operation & maintenance period thereof.

N. Provision of Boats:

The contractor shall remain responsible for providing 2 nos. motor boats for client/authority engineer for work inspection as and when required basis. The boat shall of minimum 6-person capacity. The boat shall be equipped with all safety measures like life jackets etc., fuel, pilot other lubricants, insurances and commercial taxes applicable, for construction period and running operation & maintenance period thereof. The boats shall be serviced regularly as per manufacture standard & specifications. Further, it is to be ensured that any boat shall not be un-operational for more than 2 days and it is also to be ensured that at any particular time at least 1 boat shall be in working condition.

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SCHEDULE-D

(See Clauses 2.1)

SPECIFICATIONS AND STANDARDS

1 Construction

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

2 Design Standards

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.

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

[Manual of Standards and Specifications for Four Laning of Highways (IRC: SP: 84-2019), referred to herein as the Manual, IRC: SP: 13-2004, IRC: 112-2011]

"The Authority shall appoint a proof check consultant (the "Proof Consultant") before the Appointed Date"

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Annex-I
(Schedule-D)

Specifications and Standards for Construction

1. Specifications and Standards

All Materials, works and construction operations shall conform to the “Manual of Standards and Specifications for Four-Laning of Highways (IRC: SP: 84-2019)”, referred to as the Manual, and “MORTH Specifications for Road and Bridge Works”, specific standards, specifications, international standards specified in this Schedule-D shall be followed scrupulously. 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

- 2.1 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.
- 2.2 Notwithstanding anything to the contrary contained in Paragraph 1 above, the following Specifications and Standards shall apply to the Project Highway, and for purposes of this Agreement, the aforesaid Specifications and Standards shall be deemed to be amended to the extent set forth below.

Sr. No.	Item	Manual Clause Reference	Provision as per Manual	Modified Provision
1	Typical Cross Section of 4 Lane Divided Highway (Bridge)	IRC: SP: 84-2019	Fig. 7.2A	Refer TCS drawings

2.3 Wearing Course over Bridge Deck

Sr. No.	Item	Manual Clause Reference	Provision as per Manual	Modified Provision
1	Wearing Course over Bridge Deck	MoRTH Standard Specification Fifth Edition	Section 2700 Clause No. 2702.1	Wearing coat shall be 65 mm thick comprising of 40 mm bituminous concrete overlaid with 25 mm mastic asphalt as specified in section 2702.1 Type-2 of MORTH Standard Specification Fifth Edition

- 2.4 **Codes for Design of Hybrid Structures for Suspension Cables** – The EPC Contractor is permitted to adopt any one recognized international code/standard for the design and specification of the project structure. The selected code/standard shall be applied consistently throughout the design and shall be subject to the approval of the Authority/Engineer
- 2.5 The circulars, along with any addenda or modifications thereto, issued by the Ministry of Road Transport and Highways (MoRTH) from time to time up to the bid due date, shall be deemed to form an integral part of the project specifications. Their applicability shall be determined by the Authority, whose decision in this regard shall be final and binding.

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Annex-II

(Schedule D)

Design of Hybrid Cable Stayed Bridge

1. Specifications and Standards of Design and construction of Hybrid suspension Cable Stayed Bridge

For, the design purpose of hybrid-cable stayed bridge and other structures, the EPC contractor shall adopt the Indian standards/codal provisions as far as preferable. In case IRC/IRS/BIS standards are silent about certain provisions of the designs, equivalent international standard may be used with prior permission of Authority Engineer. All the relevant loads, specification, analysis & tests shall be taken/carried out as per Indian codes IRC, MORTH and BIS for road and bridge works.

1.1. Codes published by Indian Road Congress (IRC Codes) shall be included but not be limited to

Code No.	Code Description
IRC: 5	Standard Specifications and Code of Practice for Road, Section I – General Features of Design (Seventh Revision).
IRC: 6	Standard Specifications and Code of Practice for Road Bridges, Section II – Loads and Stresses (Revised Edition).
IRC: 22	Standard Specifications and Code of Practice for Road Bridges, Section VI – Composite Construction (Limit States Design).
IRC: 24	Standard Specifications and Code of Practice for Road Bridges, Section V – Steel Road Bridges (Limit State Method).
IRC: 78	Standard Specifications and Code of Practice for Road Bridges, Section VII – Foundations and Substructure (Revised Edition).
IRC: 83 (Part II)	Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part II: Elastomeric Bearings.
IRC: 83 (Part III)	Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part III: POT, POT-CUM-PTFE, Pin and Metallic Guide Bearings.
IRC: 83 (Part IV)	Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part IV: Spherical and Cylindrical Bearings.
IRC: 112	Code of Practice for Concrete Road Bridges
IRC: SP 69	Guidelines and Specifications for Expansion Joints.

Code No.	Code Description
IRC: SP 102	Guidelines design and construction of reinforced soil walls
IRC: SP 114	Guidelines for Seismic Design of Road Bridges.

1.2. Codes published by Bureau of Indian Standards (BIS Codes) shall be included but not be limited to

Code No.	Code Description
IS 16651:17	High Strength Deformed Stainless Steel Bars and Wires for Concrete Reinforcement Specification
IS: 1363 (ALL PARTS)	Black Hexagon Bolts, Nuts & Lock Nuts (Diameter 6 To 39mm) and Black Hexagon Screws (Diameter 6 To 24mm)
IS: 1367 (ALL PARTS)	Technical Supply Conditions for Threaded Steel Fasteners.
IS: 2062	Steel for General Structural Purposes – Specification

Where the Contractor intends to use an alternative to these Standards and Guidelines for delivering an equal or better product, he shall be permitted to use without changing the aesthetics of the proposed bridge such alternative subject to the following conditions:

- (a) He shall demonstrate that the proposed alternative conforms to any of the following International Standards, Codes of Practice, Specifications, Guidelines, etc.
 - i. IRC revised codes or new codes or amendments to existing codes which are effective after the date of calling of bid,
 - ii. American Association of State Highway and Transportation Officials (AASHTO),
 - iii. American Society for Testing of Materials (ASTM),
 - iv. Euro Codes
 - v. National Standards of any of the following countries: United States of America (USA), United Kingdom (UK), France, Germany, Norway, China, Australia and Japan.

Code No.	Code Description
-	Cable-Stayed Bridges- PTI Recommendations for Stay Cable Design, Testing and Installation
-	Setra Cable -Recommendations of French intermenstrual commission on Prestressing
EN 10264-1	Steel wire and wire products - Steel wire for ropes - Part 1: General requirements
EN 10264-2	Steel wire and wire products - Steel wire for ropes - Part 2: Cold drawn non-alloy steel wire for ropes for

Code No.	Code Description
	general applications
GB/T 38784-2020	<i>Suspended floor, stairs, trail and plank road glass</i>
GB/T 36483-2018	Main cable paralleled wire strands for suspension bridge
JT/T 694-2007	Specification of anti-corrosive coating for main-cable systems of suspension bridges
T/ZZB 028-2015	Parallel steel wires cable for suspension bridge

2.0 Special Architectural / Aesthetic and structural stipulations to be followed in this Cable Stayed cum suspension hybrid Iconic bridge across river Krishna on NH-167K between Telangana & Andhra Pradesh.

2.1 Architectural stipulations which are mandatory and are not to be altered without specific written approval of the client:

2.1.1 Bridge Pylon Geometry: The bridge has 2 Pylons, one falling in each state. The Bridge Pylon is conceptually designed by abstracting the geometry of Traditional South Indian temple Gopurams. The Shape, Geometry and the Proportions of the Pylon given in the EPC schedules shall not be changed.

2.1.2 The Lower Section: The Lower section must have a broader and wider cross section, as compared to the upper portion of the Pylon, as shown in the GADs, and shall become the base for the Bridge deck. The Top of this base has a RCC capital like shape as shown in the GADs, that houses the Emergency staircases, connecting the Road level to the Pedestrian walkway level below the deck for the vehicular traffic. The area below the mid-landing of emergency staircase could house electrical rooms, Pedestrian Bridge Security personnel with their CCTV governance etc. The proportionate distinct relief gap as shown in between the Capital and the Lower structure shown in the GADs should not be altered.

2.1.3 Emergency Staircase: This open to Sky Staircase shall be made in RCC, and shall not be visible in elevation, outside this capital like enclosure/ shell. There shall be total of 8 Emergency stairs, on both pylons put together with 2 stairs on each pylon leg, as shown in GADs. Each dog legged stair shall be of minimum 3.0m width, having a stair well of at least 300mm, and with riser not more than 190mm, and Tread width not less than 275mm. The Two stairs on each side of a leg of the pylon, shall be connected by a 3.0m wide RCC slab at its Mid-level, as shown in GADs. The stairs shall be finished with 35 mm thick Flamed / Leather finished Granite on treads with Bull nosing of 25 mm projected, and with polished granite of different colour on risers. There shall be a finishing stone joint only at middle of the tread of the stairs. There shall be SS railings of 1050 mm high, on both side of the stairs as well as the middle of the width of the stair, except at mid-level., The Balusters shall not be spaced more than 4 treads, measured at centre of the treads. The Handrails

and the Mid rails shall be of 50mm dia. SS Pipe and shall be not more than 200mm apart from each other. No portion of the railing shall pass a ball of 200 mm diameter through it. The railings along with the mid-rails, shall be designed for heavy traffic load. The Balusters can be supported either on Top of tread, with a SS base cap over granite, or fixed on the Sides of the tread. The outer edge of the rails shall be in the same plane as that of the outer edge of the stairs.

2.1.4 The Middle Section: This section is made to look likes stories of temple Gopuram, with reducing portions as shown in the drawings. The pylon sizes of this section shall be smaller than the lower section. The proportions of the height of the 3 openings, shall be in the ratio of 1:1:2, with the lower section, that allows the passing of the bridge deck having proportion of 2. The junction between the inclined pylon and the horizontal element of the Pylon shall be curved in elevation and shall be proportionate as per the GADs. There shall be a distinct relief gap as shown in the drawings, between the Middle Section and the Upper section. No plaster works shall be permitted over any RCC surfaces.

2.1.5 The Upper Section: This section shall depict the Top of a Gopuram, and shall be made in Formed finished RCC, in shape like a Barrel with series of 3D domical Finials made out to form finished concrete, similar to the temple finials of Somasila and Someshwara temples, and as shown in the GADs. Kirtimukhas inspired silhouette made in form finished RCC, as shown in the GADs, on two edges and one in centre of the barrel in elevation, would display the Country's Embelum / State Emblem made of 3D overall 100 mm deep letters/ Emblem, in Cement mixed with Recron (manufacturer's specified mix) with additional Steel Reinforcement wherever necessary, on the state in which the pylon falls. This barrel shaped element shall sit on a Form finished Capital, with distinct reliefs above and below the capital, as shown in the GADs. No plaster works shall be permitted on any RCC surfaces. The signages shall be built to withstand the Wind load as calculated for the design of the bridge at that level. A Welcome Signage, ("WELCOME TO TELANGANA", and "WELCOME TO ANDRA PRADESH") both in Regional language and English language shall be made out of Stainless Steel (SS) 3D letters, back lit and shall be placed on each pylon. Each Pylon shall have welcome signage of both states, depending on the Ingress and Egress from the state. The Complete Pylon should have access to every portion of the Pylon for maintenance. The access doors and the ladders should be well hidden/ disguised, so as not to obscure the aesthetics of the structure. All false protection systems, safety elements to be fixed at necessary locations to allow safety of maintenance personnel. But these shall also be placed without compromising the aesthetics of the structure. The complete scheme above shall have to be approved by the Authority Engineer with the consent of the Authority before Execution.

2.1.6 Care has been taken to abstract the geometry, such that it does not directly create an impression of a Temple Gopuram but does it symbolically. No Deity images or

religious figures are to be used on this structure, as is done in actual temple Gopurams, so that it maintains the sanctity of a secular infrastructure with subtle resemblance to the regional architecture.

2.1.7 Pedestrian RCC Bridge: The Bottom flange of the main bridge deck is designed to accommodate the Pedestrian walkway (Footbridge). The Cross Section of the Belly is made into a series of Archways, as shown in GADs, instead of typical Trusses/ Girders. And the Outer Box Section shall be made Trapezoidal, to add some dynamism to the Volume. The Pedestrian Pathway shall be 2 lanes of 3.0m wide spaced 6.0m between apart, to ensure One Way Movement in each direction. Minimum height clearance (head room) of 2.4m shall be maintained throughout the length of the walkway bridge, and No portion of the pathway shall have any obstruction of any sorts. The flooring of the Pathway shall be Heavy duty, Chequered Cement tiles, that can take heavy pedestrian traffic. The colour shall be approved by the Authority's Engineer. Each Side of the Pathway has series of 4-Seater Bench with back rest, ergonomically designed, and spaced at 100m c/c, and shall be manufactured using Stainless Steel 304/316, overall length 1750 mm, width 450 mm and height at back as 900 mm, all with grade matt finished as per design. Stainless Steel sheet/plate shall be of 16 gauge. The seat frame and supports, (spacing between supports not being more than 900mm), made of round pipe shall be of 50/40mm dia and 2mm thickness, square pipe shall be of size 50mm x 50mm/ 40mm x 80mm and 2mm thickness, as required for structural stability of the seat, base plate shall be 8mm thick and Stainless-Steel fastener shall be of size 10mm x 100mm. The punching/ perforation in seating plate and back rest shall be done by Turret punching machine as per approved sample for punching pattern. All fabrication work shall be done on roller machine by CNC Laser cutting and Argon welding. The Argon welding shall be done by TIG (Tungsten inert gas) Arc welding method as per IS:9604. Joints shall be welded under controlled condition to avoid formation of crack and metal flow at welding point by using tungsten electrodes as per IS:13907 and SS304/SS304L/SS316 grade filler material. Welds should be treated with K-2 solution. All the joints shall be finished and polished using automatic polishing machine to match with parent material complete including all accessories as per drawing and approved technical specifications.

2.1.8 Side Rails: There shall be Side railings of full height from the floor level, Outward inclined Lower section, and inward inclined upper section, MS Rails on the edge, designed such that One cannot climb the same and try jumping into the river, as shown in the GADs. The Mid rails shall be minimum of 50mm diameter and the spacing between the Mid rails shall not be less than 200mm. The vertical supports of these rails shall not be spaced more than 2.0m c/c. The Vertical supports should be aesthetically designed and their fixing to the bridge portion to be well hidden.

2.1.9 Pedestrian Glass Bridge: The space between the 2 pathways has been proposed as a 6 m wide Glass pedestrian walkway. This Glass bridge shall have the View of the Krishna River below. This Glass walkway is physically isolated from the RCC pathway by 1050mm high Glass panel railing with 10mm double SS plates with balusters at 2.0m c/c and Top rail of 50mm at 1050mm. These Glass walkways shall have concrete Cross overs of 6.0m wide, at every 60.0 m c/c. In case of any accidents / emergencies / maintenance, the entries can be cordoned off at cross overs with built in sliding rails of 3.0 m long, on either end, placed parallel to the walkway, which can close the cross over entry, as and when necessary. The complete scheme above shall have to be approved by the Authority engineer before Execution.

Glass Floor Specification:

Hermetically Sealed Insulated (IGU) Double Glazed Glass Unit (DGU) with 12 mm and 19 mm thick toughened Clear Glass both sides and hollow aluminium spacer bar frames where frame is bent at 90 degree angle and assembled with only one joint, called a bent frame filled with desiccant of appropriate grade molecular sieve desiccant of adsorption capacity by weight, 20-30% by weight, capacity to dry air down to an extremely low PPMv level, <100 ppm (%RH) fixed to the glasses of specified thickness and quality with primary and secondary sealants of Poly ISO Butylene, or Butyl, primary sealant and Silicone and Polysulfide secondary sealants, to help fixing the IGU at the time of assembly and protect the gas filled spaces from moisture vapor penetration, chemical attack from cleaning fluids and glazing products, and liquid water penetration due to rain or condensation complete for Type I - Dry Air Insulated - Regular IGU, the design of the glass floor including the support system in structural steel shall be designed for pedestrian load as per standards and the design shall be approved from the Authority Engineer. The Size, shape, pattern and shade of the glass shall be approved by the Authority Engineer before purchasing of the material.

The Manufacturing Brands for the Glass Floor may be Saint-Gobain (France), Pilkington (UK / Japan - NSG Group), Guardian Glass (USA), Glas Trösch (Switzerland), Sedak GmbH & Co. (Germany) or similar. The Brand shall be pre-approved by the Authority Engineer.

2.1.10 Entrance gates: Entrance Lobbies shall be created on both ends of the Pedestrian walkway bridge. The Entrance and Exit Points of this Pedestrian walkway bridge at both ends shall open on both sides of the Roads, and also function as underpass. These openings shall also be designed as a Gateway, as shown in the GADs. The complete Gate way element to be done in form finished RCC, without any plaster work. The Extreme end walls here should have a large Art wall that can showcase the Story of the Place of each side of the state, it belongs to. These Artwork shall be permanent in nature, made of appropriate material as per the Theme, and made by a reputed Artist of the state. The Artwork shall be approved by the Authority

Engineer. The Ceiling of the Entrance Lobby shall be free from any False Ceiling. Hence the Slabs shall be designed with aesthetics in mind, Like a Coffered slab/ waffle slab/ ribbed slab, etc. This area shall have warm colours on ceilings/ walls. The complete Entrance lobby scheme shall have to be approved by the Authority Engineer before execution.

2.1.11 Shaded pedestrian ramps: These Bridges are connected to the main road by at least 6.0 m wide Ramps with a maximum gradient of 1:15, with horizontal landings of 6.0m x 6.0m, at every ramp rise, and shall be floor finished with the same finishing material as that of the Pedestrian bridge. These Ramps including the landings, shall be shaded by polycarbonate sheets. The Portals of the polycarbonate sheets are also designed to depict a Gopuram like Entrance Gate, similar to the geometry of the Pylon. The same can be made by using Prefab MS structure with minimum clear height of 6.0m and shall be located only at the mid landings of the ramp.

2.1.12 The Entire Pedestrian bridge shall be Physically challenged friendly, allowing Wheelchair, Electric-cart movement between two ends. Electric charging points shall be provided for such vehicles at both ends.

2.1.13 Anti- glare arrangement on the median of the road carriageway: The Antiglare arrangement on the median is designed to look like the Finial, used on the top of the Pylon, and shall be made as per the GADs. These shall be designed as per IRC codes and other internationally accepted design criteria.

2.1.14 LIGHTING: The Whole bridge is to be illuminated with special façade lighting, to give it a character at Night. The complete Lighting scheme shall be approved by Authority Engineer before execution.

2.1.15 SECURITY: The complete bridge is to be equipped with CCTV cameras to ensure complete surveillance of the Traffic, at both Vehicular and Pedestrian level. This bridge shall be supervised from Security Office.

2.1.16 Necessary signages as per IRC codes including Special Signages for Pedestrians have to be provided wherever necessary.

2.1.17 Dummy Suspension cables: The proposed Hybrid Cable stayed cum Suspension Iconic bridge with structural suspension cables as well as dummy suspension cables indicated from aesthetic considerations as per GADs given in the schedules shall be followed accordingly. The Proposed General Arrangement of the bridge like span arrangement, height of Pylon, shape & structure of Pylon, Bridge Deck's structural arrangement, Arch type steel trusses, proportions and aspect ratios are all decided from integrated aesthetic and structural considerations and as such shall not be changed from those given in GADs without specific written approval of the Authority. The colour scheme for every element of bridge shall be decided by the authority during execution. Provision made for number of vertical suspenders

shown in the GADs are mandatory. The additional dummy suspension cables (equally on both sides) of dia 125mm shall be provided similar to the designed suspenders as per the locations shown in GADs from aesthetic viewpoint. Design should not eliminate or reduce the number of cables or suspenders out of those shown in the GADs. Cable stays and suspenders should both look integrated into a perfect Hybrid bridge as indicated in the GADs.

- 2.1.18. Aluminium cladding shall be provided for complete length and full width of curve portion of semicircular shape or Arch of pedestrian walkway

Aluminium composite cladding with skin material 0.5 mm thick aluminium sheet cover material natural polyethylene aluminium cladding panel fixed with extruded aluminium basis frame (50x25x1.5mm) angle cleats, weather sealants, rivets, GI brackets all as approved, using suitable bolts on structural steel work including necessary accessories complete in all respects including all labour charges etc., complete for finished item of work but excluding cost of structural steel fabrication, scaffolding charges, if any, ACP Cladding - 4 mm thick shall be provided for Pedestrian Walkway Arch throughout the length.

2.2 Structural design stipulations which are mandatory and are not to be altered without specific written approval of the client:

- 2.2.1 Specifications and Standards:** For, the design of hybrid-cable stayed cum suspension bridge and other structures, the EPC contractor shall adopt the Indian standards/ IRC Codal provisions as far as feasible. In case IRC/IRS/BIS standards are silent about certain provisions of the designs, equivalent international standards may be used under intimation to the Authority Engineer. All the relevant loads, specification, analysis & tests shall be taken/carried out as per Indian standards, IRC codes, MORTH specifications and BIS standards for road and bridge works.

2.2.1.1 Codes published by Indian Road Congress (IRC Codes) / BIS include but not be limited to the following.

Code No.	Code Description
IRC: 5	Standard Specifications and Code of Practice for Road, Section I – General Features of Design (Seventh Revision).
IRC: 6	Standard Specifications and Code of Practice for Road Bridges, Section II – Loads and Stresses (Revised Edition).
IRC: 22	Standard Specifications and Code of Practice for Road Bridges, Section VI – Composite Construction (Limit States Design).
IRC: 24	Standard Specifications and Code of Practice for Road Bridges, Section V – Steel Road Bridges (Limit State Method).
IRC: 78	Standard Specifications and Code of Practice for Road Bridges,

Code No.	Code Description
	Section VII – Foundations and Substructure (Revised Edition).
IRC: 83 (Part II)	Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part II: Elastomeric Bearings.
IRC: 83 (Part III)	Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part III: POT, POT-CUM-PTFE, Pin and Metallic Guide Bearings.
IRC: 83 (Part IV)	Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part IV: Spherical and Cylindrical Bearings.
IRC: 112	Code of Practice for Concrete Road Bridges
IRC: SP 69	Guidelines and Specifications for Expansion Joints.
IRC: SP 114	Guidelines for Seismic Design of Road Bridges.

2.2.1.2. Codes published by Bureau of Indian Standards (BIS Codes) shall be included but not be limited to

Code No.	Code Description
IS 16651:17	High Strength Deformed Stainless Steel Bars and Wires for Concrete Reinforcement Specification
IS: 1363 (ALL PARTS)	Black Hexagon Bolts, Nuts & Lock Nuts (Diameter 6 To 39mm) and Black Hexagon Screws (Diameter 6 To 24mm)
IS: 1367 (ALL PARTS)	Technical Supply Conditions for Threaded Steel Fasteners.
IS: 2062	Steel for General Structural Purposes – Specification
IS: 4000	High Strength Bolts in Steel Structures – Code of Practice

2.2.2 Where the Contractor intends to use an alternative to these Standards and Guidelines for delivering an equal or better product, he shall be permitted to use such alternative without changing the aesthetics of the proposed bridge subject to the following conditions:

- (a) He shall demonstrate that the proposed alternative conforms to any of the following International Standards, Codes of Practice, Specifications, Guidelines, etc.
 - i. IRC revised codes or new codes or amendments to existing codes which are effective after the date of inviting bids,
 - ii. The following international standards (latest edition) to be followed shall be included but not limited to

Code No.	Code Description
-	Cable-Stayed Bridges- PTI Recommendations for Stay Cable Design, Testing and Installation
-	Setra Cable -Recommendations of French inter-ministerial commission on Prestressing
-	FIB CEP-FIP Bulletin 89 Recommendations for

Code No.	Code Description
	"Acceptance of cable systems using prestressing steels".
EN 10264-1	Steel wire and wire products - Steel wire for ropes - Part 1: General requirements
EN 10264-2	Steel wire and wire products - Steel wire for ropes - Part 2: Cold drawn non-alloy steel wire for ropes for general applications
GB/T 38784-2020	<i>Suspended floor, stairs, trail and plank road glass</i>
GB/T 36483-2018	Main cable paralleled wire strands for suspension bridge
JT/T 694-2007	Specification of anti-corrosive coating for main-cable systems of suspension bridges
T/ZZB 028-2015	Parallel steel wires cable for suspension bridge

*Detailed design consultant must have design experience of design of Cable Stayed and/or Suspension Bridge (Road or Railway), for same or different project, having span equal to or greater than 480m

2.2.3 Specifications and Standards for Construction of proposed Hybrid-cable stayed cum suspension bridge.

The Bridge superstructure structure should be proposed with Prefabricated Steel Box Sections making it as truss type of structure, with RCC Deck Slabs. Notwithstanding any other stipulations contained in any other Codes / standards, designed sections of truss elements should be limited to interaction ratios as mentioned below:

Section	Maximum Interaction value
Running section	0.9
End section	0.9

2.2.4 Deflections under Live load shall be limited to $L/1200$. Welding shall be allowed for jointed connections provided that the structure shall be fabricated in a workshop / factory / plant approved by Authority Engineer. No in-situ welding shall be permitted. Bolting and riveting will be permitted for onsite erection only. Torquing of all connection bolts shall be done only with automatic torquing machine. No manual torquing is allowed

2.2.5 Notwithstanding any other stipulations contained in any other Codes / standards, designed sections of Pylon should be limited to interaction ratios as mentioned below:

Cross Section	Maximum Interaction value
Pylon base	0.75
Pylon top	0.75

2.2.6 Stay cables and suspension main cable: The proposed hybrid cable stayed cum suspension bridge structure should be analysed in Finite Element Analysis (FEA) based software. The Geometric nonlinear analysis shall be performed for main suspension cable. The cable forces should be finalised for all critical load combinations. Stay Cables & Suspension cables shall be designed in such a way that all forces shall comply with the permissible stress limits for both Serviceability Limit State (SLS) and Ultimate Limit State (ULS) as per PTI/FIB bulletin no 89/ Setra specification or equivalent. Specifically, the Setra Guidelines that the limiting stress value of the cable under SLS is 0.45 times Guaranteed Ultimate Tensile Strength (GUTS), whereas during the construction stage the cables shall be subject to stresses up to 0.5 GUTS shall be strictly followed notwithstanding anything contained in any other codes / stipulations. Duly considering FIB-89, (which stipulates that the permissible stress for the Stay cable for the SLS is considered as 0.5 GUTS), **Notwithstanding any other stipulations contained in any other Codes / standards**, the limiting stresses for SLS shall be adopted as 0.45 GUTS and 0.4 GUTS for the Stay Cables and Suspension Cables/Suspenders respectively.

Annex-III
(Schedule D)

Specifications and Standards for Design & Construction of Hybrid – Cable stayed and Suspension type bridge

1. Specifications and Standards

- 1.1. For, the design purpose of hybrid-cable stayed bridge and other structures, the EPC contractor shall adopt the Indian standards/codal provisions as far as preferable. In case IRC/IRS/BIS standards are silent about certain provisions of the designs, equivalent international standard may be used with prior permission of Authority Engineer. All the relevant loads, specification, analysis & tests shall be taken/carried out as per Indian codes IRC, MORTH and BIS for road and bridge works.
- 1.2. Where the Contractor intends to use an alternative to these Standards and Guidelines for delivering an equal or better product, he shall be permitted to use without changing the aesthetics of the proposed bridge such alternative subject to the following conditions:
 - a. He shall demonstrate that the proposed alternative conforms to any of the following International Standards, Codes of Practice, Specifications, Guidelines, etc.
 - i. IRC revised codes or new codes or amendments to existing codes which are effective after the date of calling of bid,
 - ii. American Association of State Highway and Transportation Officials (AASHTO),
 - iii. American Society for Testing of Materials (ASTM),
 - iv. Euro Codes
 - v. National Standards of any of the following countries: United States of America (USA), United Kingdom (UK), France, Germany, Norway, China, Australia and Japan.
 - b. In case the Concessionaire intends to use any alternative material, technology / method, whether patented or otherwise, that is not specifically covered in the Indian or International Standards as listed above, but the use of which has been permitted on similar projects (similar in category of road, traffic and climatic conditions) as the Project Highway, he would be permitted its use on certification by the owners of such similar projects regarding the continued successful performance of such materials, technologies, methods, procedures or processes for at-least 5 years of the service life of the project. Such a

certification shall be supported with details of critical performance parameters.

- (i) In the project congestion factor as per IRC 06 shall be applied.
- (ii) In the project Special Vehicle (SV) loading as per IRC 06 shall be applied.
- (iii) Exposure condition shall be as per IRC 112 (severe).
- (iv) All tests including full scale Wind Tunnel Test and Model Studies shall be mandatorily carried out.
- (v) The bridge shall be designed for 100 years according to the IRC.
- (vi) In case of load tests for large diameter piles, the contractor shall carryout bi-directional O-load-cell test.

2. Cable stays and Suspension cable

For Cable, Testing and Installation, 6th edition, 2018 of Post Tensioning Institute or Guidelines of SETRA Stay Cable Recommendations for French Inter-ministerial Commission on Prestressing, June 2002 or EN 10264-1 for Cable stays and EN 10264-2 for Suspension cable shall be used.

3. Spherical bearings

Spherical bearings shall be as per the actual design of the EPC Contractor.

4. Bridge and superstructure Deck- Erection tolerances:

- 4.1. 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 truss: ± 10 mm
 - Vertically relative to the truss: ± 10 mm
- 4.2. 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

midmorning,

- Pylon top horizontal movement,
- 4.3. In addition, at the time of every stay pair installation, the Contractor shall survey the entire deck profile for comparison with theoretical values, taking into account the actual temperature and actual construction loading.
- 4.5. The maximum deviation from the theoretical deck profile, for any stage of construction, shall not exceed ± 25 mm.
- 4.6. 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 acceptable to the Authority's Engineer.
- 4.7. This corrective action shall, subject to the consent of the Authority's Engineer, be immediately incorporated into the Contractor's method of working.
- 4.8. 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.

5. Superstructure

- 5.1. The bridge superstructure details are follows:

Clear Carriageway Width : 9.0 m on LHS and RHS of Median as per GAD
/ TCS given in Schedule B.

Overall Deck Width : 25 m

- 5.2. Vibrations analysis should be performed and the output shall be limited to relevant codal provision. Welding shall be allowed for jointed connections provided that the structure shall be fabricated in a workshop/factory/plant approved by Authority Engineer. No in-situ welding shall be permitted. Bolting and riveting will be permitted for onsite erection only. All Bolted connections shall be provided with HSFG bolts. Torquing of all connection bolts shall be done only with automatic torquing machine. No manual torquing is allowed. The walkway deck slab should also be designed for Dead load and pedestrian load as per IRC-6:2017.

6. Stay Cables

6.1. 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 labour necessary to construct the stay cables in accordance with the Plans, Standard Specifications, and Special Provisions.

6.2. 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 colour to be selected by Owner, and double external helical ribs (if necessary).
- e) Install anti-vandalism tubes on the lower part of the cables.

6.3. 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.

7. Materials

7.1. STAY CABLE

7.1.2. DESCRIPTION

- (a) This section covers the supply, fabrication, delivery, testing, installation, stressing and permanent protection of the stay cables and associated components.
- (b) Criteria used for design of the bridge are shown on the Drawings, including modulus of elasticity and tensile strength for the stay cables, fatigue strength in axial tension of the stay cables, drag coefficient and exposed surface area of stay cables.
- (c) The stay cable system shall be such that re-tension or replacement of any cable can be accomplished, either strand by strand or stay by stay as appropriate, at any time during the life of the bridge.

- (d) Stay cable installation and bridge construction procedure shall incorporate requirements and provisions for the assessment and adjustment of stay cable tension. It shall include stipulations for geometric control of stay cables in accordance with applicable provision of this Technical Specifications.
- (e) Tensioning operation may be accomplished either strand by strand or stay by stay as appropriate during the phases of construction with full consideration for geometric control of stay cables in accordance with applicable provisions of this Technical Specifications.
- (f) The adjustments of stay cables tension shall be made in accordance with method(s) proposed by the Contractor and approved by the Engineer.
- (g) Prior to commencement of pylon construction, the Contractor shall verify all details of the stay cable system and provide design calculations including erection stages and Working Drawings to define the reinforcement details and dimensions for concrete and steel structure details to accommodate the stay cable system.

7.4.1. MATERIAL REQUIREMENTS - STRAND STAY CABLES

7.4.1.1. WIRE

- (a) The galvanization of wires shall comply with the following requirements:
 - Zinc with minimum 99.95% purity
 - Galvanizing to the wires shall in average be of a minimum of 280g/m² with an absolute minimum of 220g/m². The galvanization of wires is to be applied uniformly without drops or local thickenings.
- (b) The minimum requirements for bending and torsion testing of galvanized wires shall comply with Type BA in ASTM A421/A421M or equivalent code.
- (c) The adhesive strength of the galvanizing shall be verified by a winding test with minimum 6 whorls of one of the constituents of the coated strands, in accordance with ASTM A421/A421M. After the winding test, the whorls shall not present exfoliations or cracks.
- (d) The Contractor shall be required for the wire supplier to furnish for approval complete mill certificates for the wire including stress-strain curves and modulus of elasticity.

7.4.1.2. STRAND

- (a) The seven wire strands shall comply with the requirements in ASTM A416/A416M with the following properties or equivalent code:

Nominal diameter (mm)	15.70
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Nominal tensile strength (N/mm ²)	1860
Nominal mass (g/m)	1180
Specified permitted deviation on mass (g/in)	±24
Specified cross-sectional area (mm ²)	150
Specified permitted deviation on cross sectional area (mm ²)	±3 (±2%)
Specified characteristic breaking load (kN)	279
Specified characteristic 0.1% proof load (kN)	248
Modulus of elasticity (N/ mm ²)	195000
Minimum elongation measured over a length of min 100 mm	3.5%
Constriction at break	Ductile wire breaks visible to the naked eye
Max. relaxation after 1000 h at 20 °C and 0.7 times effective breaking load	2.5%
Fatigue stress range, 2 million, cycles (MPa) with maximum stress 837 MPa	300, 3059(kgf7cnr)

- (b) The curvature of one strand shall be such that when a full-length strand is lying free on a flat surface, the maximum bow weight from a base line of 1-meter length, measured inside the curve, shall not exceed 25mm.

7.4.1.3. SHEATHING

- (a) The strands shall be protected from corrosion using a system consisting of a High-Density Polyethylene sheathing extruded directly onto the strand, previously coated with a corrosion inhibiting coating material.
- (b) The HDPE sheathing shall comply with the following:
- (c) HDPE material shall meet the specific requirements of ASTM D4976 "Standard Specification for Polyethylene Plastics Moulding and Extrusion Materials" or equivalent Code. The resultant acceptable values of the primary properties for this HDPE material are as follows:

Property	Value	ASTM Test Method
Density (g/cm ³)	0.941-0.965	D 1505
Melt index (g/10 min)	0.2-1.0	D 1238
Flexural modulus (MPa)	550-1100	D790
Tensile strength at yield (MPa)	21-28	D638
Elongation at rupture	500% - 700%	D638

- (d) The material shall be UV stabilized and suffer no property degradation for a minimum of 6 months. In applications where the HDPE sheathed strand may be exposed to UV in excess of 6 months, the HDPE shall meet the requirements for a class C material and it shall be black and contain not less than 2% carbon black.
- (e) HDPE material shall not react with cementitious grout, the prestressing

steel corrosion inhibiting coating material or any other material it is permitted to come in contact with as part of the stay cable sheath and shall be free of water-soluble chloride.

- (f) HDPE material shall be chemically stable without embrittlement or softening over the anticipated exposure temperature and the service life of the strand.
- (g) The use of recycled polyethylene is prohibited.
- (h) The thickness of the individual HDPE sheaths shall be greater than 1.5mm and the outer diameter of sheathed seven-wire strands shall be less than 18.9mm.

7.4.1.4. CORROSION INHIBITING COATING

- (a) A corrosion inhibiting coating material shall be applied in the void between the wires and the sheathing material.
- (b) The corrosion inhibiting material shall have the following properties:
 - (i). Provide corrosion protection to the steel wires
 - (ii). Resist flow from the sheathing within the anticipated temperature range of exposure including the temperature of the manufacturing process of the sheathed strand
 - (iii). Provide a continuous non-brittle film at the lowest anticipated temperature of exposure
 - (iv). Be chemically stable and non-reactive with the prestressing steel and the sheathing material or any other material it is permitted to come in contact with as part of the stay
 - (v). Allow sufficient bond between the strand and the HDPE sheathing so that there is no macroscopic displacement / shrinking of the sheath on the strand, under thermal variation for example
- (c) The coating shall be injected in the workshop of the strand manufacturer and the manufacturing process must completely fill the internal voids between the constituent wires of the strand and the voids between the wires and the individual sheath.
- (d) Moreover, this process shall ensure that no voids will appear throughout the service life for the strand.
- (e) The coating shall be continuous and durably stable, and must retain its protective properties without interruption and continue to protect the steel throughout the service life for the strand.

- (f) Tests for the corrosion inhibiting coating shall meet the requirements of Table 1 of the PTI "Specification for Unbonded Single Strand Tendons" or the provisions of fib Bulletin 30 Section 5.6 and be conducted by an approved testing laboratory. All test data shall be furnished to the Engineer prior to shipment of the strand.

7.4.2. PERFORMANCE TEST

- (a) Performance tests for the strands shall be carried out by an independent laboratory.
- (b) The performance tests shall meet the requirements in section 3.3.9 in "Recommendation for stay cable design, testing and installation", PTI 2012. The contractor shall furnish to the Engineer a test report prepared by the independent laboratory.

7.4.3. ANCHORAGE

- (a) The stay cable anchorages shall be designed to individually anchor each strand by reversible means. The anchorages shall be capable of transmitting the full ultimate tensile force of the strands. The anchorage system shall comprise a deviator system in order to prevent angular deviations of the strand extending to the anchorage head or wedges. Alternatively, to apply a standard deviator system the supplier may prove by testing that other feature of a given anchorage system reduce the bending stresses sufficiently for the system to pass the fatigue test requirements of this specification and thereby apply for the Engineers approval of an anchorage system without a traditional deviator system. The application for approval of alternatives to a standard deviator system shall include reference to other major bridges where the alternative system has been successfully applied.
- (b) Hard material (resin) filling or cement grouting shall not be allowed in the anchorage area that directly contacts the strands.

7.4.4. HDPE SHEATHING PIPE

- (a) A High-Density Polyethylene sheathing pipe (HDPE sheathing) shall be provided for corrosion protection of the stay cables.
- (b) The HDPE sheathing shall comply with the following:
- (c) The HDPE sheaths shall be made of high-density black polyethylene classified PE325433 or PE345444 as defined by table 1 of ASTM D3350 or equivalent Code.
- (d) The resultant acceptable values of the primary properties for this HDPE material are as follows:

Property	Value	ASTM Test Method
Density (g/cm ³)	> 0.940	D 1505
Melt index (g/10 min)	0.35 ~ 1.4	D 1238
Flexural modulus (MPa)	>750	D790
Tensile strength at yield (MPa)	>21	D638
Environmental stress crack resistance, F20, hrs	600	DI693 (Cond C)

- (e) The manufacturer shall submit test evidence of the coloured HDPE sheathing's resistance against ultraviolet degradation and colour change prior to commencement of sheathing manufacture. The sheathing shall be weather resistant and it shall on the outside be light grey or blue in colour. This shall be achieved by co-extruding coloured polyethylene over black HDPE. The black HDPE shall contain not less than 2% carbon black.
- (f) The stability of the colour over duration of 30 years shall be demonstrated.
- (g) The HDPE material shall not react with any cementitious grout, pre-stressing steel, Corrosion inhibiting coating or any other material it is permitted to come in contact with, as part of the stay cable and shall be free of water-soluble chloride. The contractor shall furnish to the Engineer a certified test report covering the quality of polyethylene pipe performed by an approved laboratory. Samples for quality testing shall consist of one 1.8m length of pipe per size per 1000m.
- (h) The maximum Standard Dimension Ratio (SDR) shall be 18 for grouted systems, and 32 for ungrouted systems. The minimum thickness shall be 6mm.
- (i) The use of recycled polyethylene is prohibited.
- (j) Resistance to the environment of the pipe shall be demonstrated by the stay cable supplier. The pipe shall be designed for a lifetime corresponding to the design life for the Stay Cables.

7.4.5. STAY CABLES

- (a) All materials and components shall be ordered from and produced by manufacturers and suppliers with proven and documented experience of producing materials to the codes and standards required by this Contract. A list of proposed manufacturers and suppliers together with documentary proof of their ability to meet the required standards shall be submitted for the Engineer's approval.
- (b) Stay cables and associated components delivered for incorporation in the

works shall be identified by marking. The marking shall enable the material to be clearly identified and checked against the documentation which must include details of origin, methods of production, content of material, inspection report and test certificates.

- (c) Modulus of elasticity for the stay cables shall be 195,000 MPa $\pm$ 5%.
- (d) The anchorage system shall comprise a deviator system in order to manage deviations up to 30 miliradian and to prevent angular deviations of the strand extending to the anchorage head or wedges. Alternatively, to applying a standard deviator system the supplier may prove by testing that other feature of a given anchorage system reduce the bending stresses.
- (e) sufficiently for the system to pass the fatigue test requirements of this specification and thereby apply for the Engineer's approval of an anchorage system without a traditional deviator system. The application for approval of alternatives to a standard deviator system shall include reference to other major bridges where the alternative system has been successfully applied.

7.4.6. DOCUMENTATION

- (a) Materials for all component described in section 2.1 to 2.5 shall be delivered with a certificate type inspection report in accordance with ISO 404. The contractor's representative and his scope of work in respect of certification according to ISO 404 are subject to acceptance by the Engineer.
- (b) For steel products the certificate shall give details and results of each test carried out in accordance with requirements stated in the technical specification and general specification for steel work. It shall appear from certificate that all tests specified have been completed with a satisfactory result. Copies of the certificates shall be submitted to the Engineer.

7.1. CONSTRUCTION REQUIREMENTS - STRAND STAY CABLES

7.1.1. INSPECTION AND TESTING

7.1.1.1. GENERAL

It is the Contractor's responsibility by inspections and testing to ensure that work on the stay cables complies with the requirements specified.

7.1.1.2. WIRE AND STRAND

- (a) Wire and strand testing during production shall be in accordance with NF A 35-035, category B. Tensile test, test of mass, test of resistance to reverse bending, test of the galvanizing and control of straightness shall be carried out as described in NF A 35-035 clause 9.0.

- (b) The frequency of testing shall be at least one test per wire coil delivered to the strand fabrication site or at least 4 tons of wire whichever is more frequent. If the test specimen fails, the test shall be repeated on two further specimens from the same end of the coil as the original specimen. If any re-test is unsatisfactory the coil may be subdivided and the subdivided coils resubmitted for approval. Such subdivided coils must satisfy the specified requirements on one test at each end of the coils.
- (c) For fatigue testing of the strands, one 5 m long wire sample shall be taken from every 20 tons or portion thereof produced from each batch of wires. A batch of wires is any quantity of wires of the same type, size and grade, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time.
- (d) All prestressing wires and derived test samples shall be marked in such a manner as to ensure traceability during production, transit, storage and testing. One fatigue test in accordance with NF A 35-035 shall be performed on a test specimen from each sample to verify the requirements specified in section 2.1 and 2.2. If any specimen should fail within the anchorage zone, the test shall be discarded and another specimen shall be used from the same sample. In case the first valid test specimen from each sample fails the test, two additional tests shall be made on test specimens from the same sample. If further failures occur, the wire quantity represented by the sample shall be rejected.

7.1.1.3. STAY CABLE

- (a) The tensile and fatigue strength of the stay cables shall be demonstrated by testing as a verification of the stay cable design and fabrication. The testing laboratory shall be approved by the Engineer.
- (b) Stay specimens shall have a minimum length of 5.0m and shall be tested including all load bearing appurtenances. They shall include one active and one passive anchorage and with all corrosion protection material in place. Strand deviations shall be representative of the actual installed stay cable deviations.
- (c) The tensile strength and the fatigue strength shall be documented for all stay cables.
- (d) When instructed by the Engineer, the Contractor shall carry out tensile and fatigue tests on stay cables with diameters representing various size stay cable as specified on the Drawings. The tests shall be representative of the conditions experienced during operation. The tests shall be performed with technically identical elements and composition of the anchorage system proposed for this project. The submission shall include certified test report in English language.

- (e) Each tensile test shall establish the load/extension relationship for the specimen both between the anchorages and over a gauge length centred on the parallel part of the stay itself. Measurements and observations of draw-in at the anchorages shall be made. Tensile specimens shall be loaded to failure which shall occur away from the socket, within the central part of the stay cable specimen. The fatigue specimens shall be equipped with all relevant accessories to be fully representative of stay cable in service. Anchorage shall be filled with the material registered in the stay cable system documentations. Filler can be removed in the cap area to allow for installation of sensors during the test.
- (f) The fatigue specimens shall be subjected to cyclic axial loading for 2 million cycles and then loaded to breaking. The specimens shall be tested at an upper bound stress of 837MPa and a stress range of 200MPa. At the same time the cable shall deviate sinusoidally from the anchorage centred-line as described for Category B in CIP Recommendations on cable stays, 20 June 2002, Clause 11.2.2.2 or equivalent.
- (g) During fatigue testing, not more than 2% of the number of individual wires (rounded to the nearest whole number) may fail. No failure shall occur in the anchorages during the fatigue tests.
- (h) After fatigue testing, the test specimen shall be reloaded and shall develop a minimum tensile force equal to 92% of the actual ultimate breaking load of the test cable or 95% of the specified minimum breaking load of the test cable, whichever is greater. The actual ultimate breaking load of the test cable shall be calculated from the results of the tensile tests carried out on the individual wires. Any failure at the anchorages during the static test shall be cause for rejection of the stay cable.
- (i) After testing, all tensile and fatigue specimens shall be examined closely and the nature of failure and any other damage shall be reported.
- (j) The Contractor shall provide for the Engineer the opportunity to witness the tests and examine the specimens and all test procedures and results. Alternative test details as described in fib standard may also be accepted.
- (k) Failure of any of the tensile or fatigue test specimens to comply with the specified acceptance criteria is cause for rejection of stay cables with the concerned diameter.
- (l) The stay cable design shall be reconsidered and modified if necessary and a new test shall be carried out.
- (m) A water-tightness test shall be carried out to demonstrate that there is no ingress of water through the HDPE sheathing and that the connection between the HDPE sheathing and the anchorage areas is watertight.
- (n) The test shall be carried out as described in CIP Recommendations on cable

stays, 20 June 2002, Clause I 1.3 or equivalent on one full-size specimen. Coloured water shall be used in the test and the test is deemed positive if no trace of colouring water is found inside the HDPE sheathing pipe.

- (o) The Contractor shall submit a fully detailed description of the test to be approved by the Engineer before setting up the test rig. Alternative test details as described in fib standard may also be accepted.
- (p) The Contractor shall give notice to the Engineer two weeks in advance of starting to carry out the test and access shall be provided for the Engineer to inspect the testing during all stages of preparation and testing.

7.1.1.4. ANTI VIBRATION MEASURES (INCLUDING DAMPER)

- (a) The design of the stay cable system shall include the following countermeasures:
 - The surface of the stay cables shall be treated in such a way that rain and wind-induced vibrations are suppressed. Such surface textures might constitute dimples or helical fillets. The contractor shall design and submit the surface texture configuration to the Engineer for approval.

Provision of dampers

- The damping ratio of stay cable equipped with the damping device shall exceed 4% log decrements, before the stay cable vibration amplitude reaches the minimum of the HDPE stay pipe diameter or the cable length divided by $k \times 1000$.
 - Damping device shall not be damaged at exceptional large cable amplitude of at least 3 times HDPE pipe diameter.
- (b) The dampers shall be robust with a lifetime of at least 30 years completely accessible for maintenance operations, easy to inspect and exchangeable.
 - (c) test reports of at least 1 full-scale test performed on the type of damping device intended to be used on the structure, of comparable size as intended to be used on the structure, performed under well-defined conditions, shall be submitted to the Engineer for approval.
 - (d) The actual damper performance shall be validated on site by testing of the vibration behaviour of cables of representative sizes without and with installed/ activated damping devices. Such measurements shall consist of recording the free response of the damped cable under initial excitation of the first mode of vibration. These tests shall be performed under favourable climatic conditions (no rain, benign wind speed) in order to prevent uncontrolled excitation of higher modes.

- (e) The measurements on site shall be performed on three different stay cables including the longest one, each without and with installed/activated damping device, for three first modes for each of the stay cables considered.
- (f) The Specialist Contractor shall submit the detailed test procedure for approval to the Engineer prior to site testing.
- (g) Damper with hydraulic system has problem (or possibility) of oil leakage. Therefore it is not suggested for use, but if it is required (or necessary) then supplier should make plans to prevent leakage that is approved by Engineer.
- (h) The Specialist Contractor shall submit the test report of the site testing with all test results of all individual tests, for approval to the Engineer. The test report shall declare the measured intrinsic damping of the cable without damping device and measured additional damping ratio with the installed/activated damping device.

7.1.2. WORKMANSHIP

7.1.2.1. PLANNING

- (a) The contractor is responsible for installing stay cable material that conforms to the Project Documents in an undamaged condition. In order to assure that only conforming material is introduced into the work the contractor shall develop a comprehensive Quality Control Program (QCP) that covers the procurement, packaging, transport, and delivery of all stay cable materials and components of the stay cables.
- (b) This program shall include, but not be limited to all procedures and practices necessary for the final installation of stay cables that meet the requirements in the project documents without residual damage to any component of the stay cable system.
- (c) The Quality Control Program shall be submitted to the Engineer for approval prior to procuring any stay cable materials. Permanent records shall be established and maintained by the Contractor for all procurement, inspection, sampling, testing and installation in accordance with the Project Requirements.
- (d) Prior to commencement of the works and placing of final orders to the supply of temporary items and equipment, a method statement for fabrication, transportation and erection of the stay cables shall be submitted for the Engineer's approval.
- (e) The fabrication, transportation and erection operations shall be documented among other things by preparation of descriptions, drawings and calculations according to the program and time schedule. Procedures to ensure that the stay cable components will not be damaged during

fabrication, transportation and installation shall be included in the documentation and Method Statement.

- (f) The shop work shall be planned in such a way that the items are completed well in advance of the erection. The Contractor shall submit as a minimum (but not limited to) the following documents to the Engineer for approval before materials are ordered:
- Description of the manufacturing procedures for strands and stay cables and proposals for testing.
 - Full documentation for the design of the prefabricated strands and the final stay cables including anchorages, guide system and dampers.
 - Shop drawings for anchorages, guide system and dampers and general information about proposed repair procedures.
 - Shop drawings for fabricated items and general information about welding procedures.
 - Description of measures taken during transportation and storage of all items.

7.1.2.2. FABRICATION

- (a) Stay cables strands shall be protected from corrosives, heat, abrasion and other harmful effects throughout fabrication.
- (b) Each strand shall be in a continuous length, free from welds.
- (c) The Contractor shall design and detail the anchorages, guide system and dampers for the stay cables. The HDPE sheathing shall be sealed properly at both ends towards the anchorages to ensure that water will not enter the anchorage zones. All anchorage parts shall be capable of resisting the actual breaking load of the stay cable.
- (d) All castings shall be fit for their intended purpose. Acceptance standards shall be established and agreed with the Engineer before the commencement of fabrication. In general, no linear crack-like or tear defects are acceptable.
- (e) All threads on anchorages shall be thermally sprayed with zinc, thickness 60 microns. All smooth surfaces on the anchorages shall be coated with the same system as for externally exposed structural steel. In the completed bridge the externally exposed thread on the anchorage shall be covered and the gap between the cover and the thread shall be filled with a corrosion inhibiting compound to be approved by the Engineer.
- (f) At the low point of the lower stay cable anchorages the Contractor shall

design, fabricate and install holes, groves or similar to allow for future drainage of water accumulated in the interior of the stay cable anchorage tubes. The Contractor shall submit the proposed arrangement for the approval.

7.1.2.3. HANDLING, TRANSPORTATION, AND INSTALLATION

- (a) Handling and transportation of stay cable strands shall be so that the assemblies are not damaged in any way.
- (b) The stay cable strands shall be protected from corrosives, heat, abrasion, salt water and other harmful effects throughout handling, transportation, and installation.
- (c) The stay cable strands shall not be stored in direct contact with the ground.
- (d) Coiled prefabricated strands shall be coiled, stored, and uncoiled at temperatures and in such a manner that permanent deformation or cracking of the polyethylene sheathing is avoided. The coiling diameter shall not be less than 25 times the outside diameter of the HDPE pipe.
- (e) When uncoiled, the polyethylene sheathing shall be inspected for any permanent deformations and damage. Any deformation or damage, inconsistent with its function, shall be repaired in a manner proposed by the Contractor and subject to approval of the Engineer. Otherwise, the prefabricated strand shall be replaced.
- (f) All steel surfaces on anchorages shall be inspected for any physical damage or corrosion. If any physical damage, coating defects or corrosion is observed it shall be repaired in a manner proposed by the Contractor and subject to approval by the Engineer.
- (g) Spreader bars, slings or other appropriate devices shall be used to handle all prefabricated strands. The minimum bending radius for the prefabricated strands shall be 50 times the outside diameter of the HDPE pipe or such larger radius as may be necessary to prevent damage to the strand including sheathing.
- (h) Any damage to strands or components thereof shall be evaluated and remedied prior to installation of the stay cable. Damage to non-load carrying components shall be repaired prior to installing the stay cables. All equipment for handling the strands shall have padded contact areas.
- (i) The anchorage of the stay cables shall be centred on the anchor plate holes to a tolerance of 5 mm.
- (j) The minimum bending diameter for the HDPE pipe during fabrication, transport, storage or erection of stay cables shall be 25 times the outer diameter.

- (k) The theoretical lengths of the stay cables are based on the dimensions specified on the project drawings corresponding to the bridge reference condition. Before erection of the bridge deck starts, the Contractor shall furnish to the Engineer dead load computations based on weights and geometry from approved shop drawings to verify the final dead load and stay cable lengths calculated by the Contractor.
- (l) The final length of the stay cables shall be determined based on the actual position of the anchorages in the tower and the back span as constructed.
- (m) Due consideration shall be given to the actual environmental conditions.
- (n) Prior to commencement of the stay cable installation erection stage analysis for all erection stages shall be carried out based on the actual erection loads to determine the geometry of the completed structure. The calculations shall include tables containing values of anticipated stay cable lengths and tensions in each stay cable at a corresponding erection stage.
- (o) A procedure for multiple step adjustment shall be included in the Method Statement.
- (p) A pair of stay cables (i.e. two stay cables connecting to the same erection section) shall be tensioned simultaneously and force and movements for both jacks shall be watched and operated from a common control unit. It shall be possible to adjust the forces in the stay cables with increments of maximum 1% of the stay cable force.
- (q) Immediately after erection of a pair of stay cables, the Contractor shall measure the length of and tension in the stay cables. The Contractor shall ascertain that the lengths of the stay cables are as anticipated and the tensions in the stay cables shall be within $\pm 5\%$ of the values calculated for that erection. All such records shall be submitted to the Engineer. If the specified tolerances are exceeded, adjustment procedures shall be developed and carried out by the Contractor subject to the prior approval of the Engineer.
- (r) Promptly after erection the stay cables shall be stabilized and sealed at the ends towards the anchorage at top and bottom anchorages. Stabilization and sealing shall be either permanent as specified in the project documents or provisional according to the Contractor's proposal. Detailed procedures for installation of permanent or provisional stabilization and sealing shall be approved by the Engineer.
- (s) The erection stage calculations shall be updated after erection of a pair of stay cables (2 nos.) based on an updated survey of the bridge and the actual erection loads and conditions at the time of the stay cable installation. The surveys shall comprise the bridge deck and pylon. Survey points shall be weather resistant points incorporated into the structure. Surveys shall be

carried out in the pre-dawn hours to minimize temperature effects.

- (t) Permanent records shall be established and submitted to the Engineer for each stay cable installation. Such records shall include survey records; date, time, and ambient temperatures; stay cable lengths; stay cable forces; jack extension measurement; shim pack or lock-nut setting; deck loading conditions and all other special records necessary and sufficient to establish the conditions under which the stay cable shall be installed.
- (u) Jacks and gauges for stay cable installation shall be calibrated using a load cell or calibrated static load machine within one month prior to the beginning of stay cable installation, and every one month thereafter, for the duration of the stay cable installation.
- (v) The one month re-calibration may be performed using a master gauge, provided that the master gauge is calibrated with the field gauges at the time of initial jack, calibration.
- (w) Adjustment of the stay cables shall be performed with a precision of $\pm 5\%$ of elongation or shortening relative to the marks of L0 and $\pm 3\%$ on the measurement of the tension load in the stay cable.
- (x) The stays shall be equipped with sufficient threading of the anchorage or other means to allow compensation for construction tolerances, both in tension and de-tension. 200mm adjustment capacity shall be provided as a minimum.
- (y) Prior to forming the closure in the main spans the suspended sides of the joints shall be brought into vertical alignment with each other by jacking or counter weighting, and/or adjusting selected stay cables as indicated on the Contractor's erection scheme and approved by the Engineer.
- (z) At completion of the erection works (i.e. before application of certain permanent loads like wearing surface, barriers, lighting etc.) a check of the stay cable lengths and forces shall be made by the Contractor and submitted to the Engineer. The stay cable forces shall be within $\pm 5\%$ of the theoretical values when the geometry is within the specified tolerances. If the specified tolerances are exceeded, adjustment procedures shall be developed and carried out by the Contractor subject to the prior approval of the Engineer.
- (aa) At completion of the bridge a check of the stay cable lengths and forces under the bridge reference condition shall be made by the Contractor and submitted to the Engineer. The stay cable forces shall be within $\pm 5\%$ of the theoretical values when the geometry is within the specified tolerances. If the specified tolerances are exceeded, adjustment procedures shall be developed and carried out by the Contractor subject to the prior approval of the Engineer.
- (ab) Permanent records shall be prepared by the Contractor and include the as-

built vertical alignment of the deck along the centre line of the deck and along a line adjacent to each stay cable plane as well as the deflection of the pylon. The records shall be compared by the Contractor with the construction vertical alignment and if the specified tolerances are exceeded adjustment procedures shall be developed and carried out by the Contractor subject to the approval of the Engineer.

- (ac) If necessary, during all stages of installation restraints such as collar rings or ropes tied around individual stay cables and anchored to the deck shall be employed to control stay cable vibration. Such measures must not damage the HPDE sheathing or the stay cable itself.

7.1.2.4. TOLERANCE

- (a) Length measurement and marking of each strand forming the stay cable with length L0 shall be carried out. The length L0 is equal to the unstressed length of the stay cable.
- (b) The length measurement and marking shall be carried out under well defined uniform temperature conditions under cover or at night. During the operation of length measurement and marking the stay cable shall be continuously supported without sag and under a tension equivalent to 5% of the breaking load of the stay cable.
- (c) When carrying out the length measurement and marking compensation shall be made for the tension in the stay cable. Allowance shall be made for anticipated deformation at the anchorages. The marks shall be well-defined.
- (d) The length L0 shall be corrected with the following tolerance:
$$\Delta L0 = \pm (L0/2000 + 5\text{mm}); \text{ Max } 20\text{mm}; L0 \text{ in mm}$$
- (e) The lengths of the thread on the sockets shall allow for a future adjustment of minimum $\pm 0.08 \%$ of the length of the stay cable or 100mm, whichever is greater.

7.1.2.5. DURABILITY AND CORROSION PROTECTION

- (a) Materials and methods of construction shall be chosen which achieve the design life and maintenance criteria detailed below and have a proven record of durability in similar conditions to the marine environment of the Site.
- (b) Stay cables shall be provided with a corrosion protection system consisting of galvanizing of the wires extruded HDPE sheathing on the individual strands and an external HDPE sheathing pipe, which is capable of protecting them from corrosion for the design life of the cables. The HDPE sheathing for the strands and the HDPE sheathing pipe shall be watertight. At the

connection between the HDPE sheathing pipe and the anchorages a watertight sealing shall be provided.

- (c) A comprehensive approach to protection for the complete stay cable system shall be developed by the Contractor taking into account design life, material life, accessibility, maintenance and replacement. The supplier shall assess the durability of the corrosion protection system proposed for the cable system by a review of the corrosion protection and expected materials of each protected component with reference to tests, previous experience, and corrosion life data.
- (d) The durability and design life of the corrosion protection system shall be defined by considering the environmental conditions.
- (e) The Contractor shall propose and implement the corrosion protection system including type and thickness of HDPE sheathing, which shall be submitted for the Engineers approval. The Contractor shall provide evidence of the satisfactory use of the protection system in a similar environment and life requirement.
- (f) Any corrosion inhibiting coating material used as intermediate medium between the wires and the HPDE and in the inter-wire voids within the strands shall be approved by the Engineer. The inhibitor shall not contain substances that are harmful to the materials it will be in contact with.
- (g) A method statement for replacement of stay cables, including a description of required temporary works, shall be submitted for the Engineers approval.
- (h) During the stay cable replacement operation, it shall be assumed that the shoulder adjacent to the stay cable being replaced is closed to traffic. The method shall be so that no objects can be dropped onto the carriage way.
- (i) Temporary corrosion protection shall be provided if the permanent corrosion protection system is not installed at the time of the stay cable fabrication. Any partially completed stay assemblies shall be stored such that no damage or deterioration of the stay cable can occur.
- (j) The anchorage components which are not accessible for maintenance operation in-situ after installation in the bridge shall be designed with a corrosion protection system that will remain effective during the design life without maintenance.
- (k) Corrosion protection systems shall be compatible with regards to galvanic corrosion process.
- (l) The use of cementitious grout is not permitted.
- (m) During component assembly, the corrosion protection of the threads shall not be damaged.
- (n) A detailed maintenance manual for the stay cables shall be provided after

cable installation for facilitating future maintenance.

- (o) The manual shall cover among others the following aspects:
- (i). Description of how to monitor the stay cables for excessive wind-induced vibration regularly during major wind events.
 - (ii). Description of how to maintain the clampers applied at deck or pylon anchorages.
 - (iii). Description of how to inspect and ensure that the dampers applied at deck or pylon anchorages are functioning.
 - (iv). Description of how to inspect the cable anchorage hidden within the anchorage tube (inspection using an endoscope).
 - (v). Description of how to inspect and maintain the HDPE coating of the stay cables.
 - (vi). Principles of how to measure the stay cable forces.
 - (vii). The contents of the manual shall include, but not be limited to the following parts:
 - (viii). How to use the manual
 - (ix). Periodic inspection and maintenance
 - (x). Exceptional inspection
 - (xi). Component description
 - (xii). Partial or complete replacement of a stay cable
 - (xiii). Re-stressing and de-stressing
 - (xiv). Repair of corrosion protection

7.4.7. Suspension cable

- 7.4.7.1. The wires shall be Class A coated wire in accordance with EN 10264-2 and have the following properties:

Nominal diameter (mm)	5.75
Deviation on diameter (mm) (See Note 1)	-0.05/+0.08
Nominal tensile strength (MPa)	1960 – 2210 (1960 -0/+250)
Minimum 0.2% proof load (MPa)	1470
Modulus of elasticity (MPa)	min. 190000 max. 210000 The stress range for the MoE shall be 196-1176MPa
Fatigue resistance (See Note 2)	Min 2 x 10 ⁶ cycles with a stress range 400 - 750 MPa without failure.

Minimum elongation measured over a length of 250 mm	4%
Constriction at break	Ductile break visible to the naked eye (a clear cup and cone failure)
Wrapping test on coated wire	Min. 6 closed coiled turns around a mandrel with a diameter of 3 times the nominal wire diameter. No fracture or cracks of the wire
Torsion test on coated wire	14 full rotations in a length of 100 times the nominal wire diameter at a speed of 18 – 22 rpm.
Sulphur and phosphor	The content of S and P shall be less than 0.025 % as determined by ladle analysis
Coating (g/m ²), min.	300
Wire straightness	See Clause 4.2.1

Note 1

- (a) The average diameter over the total quantity for each cable shall be within the tolerance of ± 0.01 mm.
- (b) The wires shall be drawn from steel made by the basic oxygen or electric process. Wire rod shall be rolled on a rod mill and coiled for shipment to the wire mill. Rods, bright wire and galvanized wire shall be marked and kept segregated for identification of heat and serial number during manufacture.

Note 2

- (a) This test can be substituted by adequate documentation from similar tests on similar wires.

7.4.7.2. Coating

- (a) The wires shall be hot-dipped galvanized. The coating material shall be Zinc.
- (b) The galvanization of the wires shall comply with the following requirements:
 - Zinc Grade Z2 with minimum 99.99 % purity as defined in EN 1179.

7.4.7.3. Marking

In addition to EN 10264-1, Section 8, each material cast shall be identified by a unique reference number. A metal label shall be attached to every coil and on it shall be stamped a unique serial number for the coil and the cast number. The serial number shall also be attached to any specimen cut from the coil.

7.4.7.4. Sockets

- (a) The Contractor shall design the sockets on the basis of the requirements to loads and displacements etc. given on the Design Drawings.
- (b) The sockets shall be designed by the Contractor. The shop drawings shall state the tolerances on the dimensions.
- (c) The documentation and shop drawings shall be submitted for approval

before commencement of the work.

- (d) The material shall be cast steel grade G20Mn5+QT or G24Mn6+QT2 according to EN 10340 with the following properties:

	G20Mn5+QT	G24Mn6+QT2
Nominal tensile strength (MPa)	500-650	650-800
Nominal 0.2% proof load (MPa)	300	500
Minimum elongation (%)	22	15
Impact test Charpy-V, (Joule)	60 (RT)	27 (-30° C)
Harness Brinel (HB)	152-190	152-190

- (e) The properties shall be required also for structural parts thicker than 100 mm.
- (f) The following additional requirements shall apply to the steel castings:
- (i). Any required rectification shall be proposed to the Employer. Rectification by welding shall comply with EN 1090-2 and EN 1011 or equivalent. Welding procedures shall be qualified by pre-production tests.
 - (ii). Castings shall be identified by a cast-on unique reference system, which shall be varied for each cast/heat treatment batch.
 - (iii). The identification number shall be visible after the socketing and installation of the main cables
 - (iv). The test blocks shall be an integrated part of the casting.
 - (v). The test blocks shall only be separated from the casting after the heat treatment.
 - (vi). Full traceability shall be maintained for all components.
 - (vii). The sockets shall be with surface treatment in accordance with Technical Specification, Volume 4.2.

7.4.7.5. Cable Cell

The wire lengths may have welds made on individual rods before drawing but shall not be welded during or after drawing.

7.4.7.5.1. Formation of Cable Cell

- (a) The shop fabrication of Prefabricated Parallel Wire Strands (PPWS) shall account for the angle changes occurring at cable saddles and within the cable geometry as shown on the drawings. Wire length within a strand shall be calculated according to the radius that they are assigned. The length shall be calculated for the centre wire and all the wires in a strand shall have the same length.
- (b) The wires shall be laid up and banded into 127 wire hexagonal profile strands. Each individual wire shall be free from welded or other types of

- splices and there shall be no kinks or twists in the wires in a strand. One external wire in the formation shall be marked with a continuous coloured acrylic paint to act as an inspection wire (datum wire) to detect any subsequent twisting of the strand.
- (c) This wire shall be accurately measured and used to determine the length of all the other wires in the strand.
 - (d) It shall be demonstrated that the acrylic paint is suitably durable and adheres to the galvanized wire without any detrimental effects.
 - (e) The location of the tower saddles and splay saddles shall be accurately marked on the datum wire under agreed temperature and load conditions.
 - (f) Circumferential marks on the strand shall be applied to the outer wires according to the marking on the datum wire.
 - (g) The cable wires shall be arranged parallel with each other within a strand and there shall be no wire crossings. The strand shall be free of loose wires, flaws or other defects.
 - (h) Seizing bands shall be applied at approximately 1.5 m intervals. The bands shall be so designed that they will break under the action of the cable compacting machine. The bands shall be made of a material which will not cause corrosion of the zinc-coated steel wires. Means shall be taken to randomly vary the relative position of the bands on the different strands so that there will be no concentration of bands that would cause local increases in the diameter of the compacted cable.
 - (i) The uniformity of the wires in a strand shall be controlled during manufacture and it shall be demonstrated to the Employer that strand length, uniformity and parallelism of wires are strictly controlled by maintaining consistent tensions in all 127 wires during the strand manufacturing process. Wire tensions during the strand manufacturing process shall be regulated by accurately controlling the braking force on each un-coiler to maintain a constant tension with a standard deviation corresponding to a vertical spread of less than 150 mm. This shall be demonstrated before strand fabrication commence.

7.4.7.5.2. Transport

- (a) For transportation and erection, the strands shall be wound onto reels with a diameter large enough to ensure that there is no excessive displacement of the formation and that no damage occurs to the strand. In winding, the strand shall be slightly twisted not to introduce improper tension into outer wires hence avoid outer wires getting into the strand. The twist is applied to each turn alternately, to avoid accumulated twist in the strand. To demonstrate the adequacy of the reels and the reeling and unreeling procedures, one strand shall be wound on and off, to the approval of the

Employer.

- (b) For transportation the reels shall be protected so as to avoid any damage or corrosion to the strands and sockets by using soft fabric straps and covering of the reel by waterproof sheet. Furthermore, it shall be secured that the humidity inside the covered reel is kept to an acceptable level to avoid the formation of white rust.
- (c) Sockets shall be placed inside the reel edges and be securely fixed to the reel; particular care being taken to ensure that the sockets cannot move and damage the strands.

7.4.7.6. Wrapping Wire

- (a) The wrapping wire shall be round wires as described below.
- (b) The round wrapping wires shall be annealed wires and have the following properties:

Nominal tensile strength (MPa)	≥ 570 (-0/+50 MPa)
Minimum elongation	Min. 8% measured over a length of 250 mm
Dimension (mm)	3.5 mm
Tolerance on dimensions of galvanized wire (mm)	± 0.07
Zinc coating (g/m ²), min.	265
Torsion test on coated wire	35 twists over a length of 100 times the diameter of the wire
Wrapping test on uncoated wire	8 wrappings around its own diameter (on and off) without crack
Wire straightness	No kinks found by visual observation

- (c) The galvanization of the wires shall comply with the following requirements:
 - Zinc Grade Z2 with minimum 99.99 % purity as defined in EN 1179

7.4.7.7. Socketing

- (a) Socketing shall be carried out in accordance with EN 13411-4 with the following additions:
 - (i). Each wire shall be completely surrounded by socketing material.
 - (ii). There shall be no voids in the socketing material.
 - (iii). No wire shall be in contact with the inside of the casting.
- (b) The socketing material shall be zinc based alloy.

7.4.7.8. Inspection and Testing of Materials and Assemblies for Cable Works

7.4.7.8.1. Main Cables

7.4.7.8.1.1. Wires

Test Type	Reference Standard	Frequency of Testing
Diameter	EN 10218	Each end of each coil
Tensile test	EN 10264-1	Each end of each coil
Proof stress and stress/ strain curve	EN 10264-1	One end of each 10th coil
Modulus of Elasticity	EN 10264-1	One end of each 10th coil
Fatigue resistance	-	20 tests evenly distributed through the production
Elongation	EN 10264-1	One end of each 10th coil
Wrapping test on coated wire	EN 10218	One end of each 10th coil
Torsion test on coated wire	EN 10264-1	One end of each coil
Sulphur and phosphor	EN 10021	Each batch
Weight of coat	EN 10244	One end of each 10th coil
Uniformity of zinc coat	-	One end of each 10th coil
Adhesion of zinc coat by wrapping test	EN 10218	One end of each coil
Visual inspection of zinc coating	-	Each coil
Wire straightness	EN 10218	One end of each 10th coil

- 7.4.7.8.1.2.** Where the wire is manufactured from two or more rods **joined by welding, the wire mill shall tension test the weld** to demonstrate that the weld, after the wire drawing operation, develops the minimum specified strength and ductility as the wire produced from the base rod. The wire mill shall produce test evidence from a minimum of 20 tests performed in the past, attesting to the record of performance of the welding procedure. In addition, the Contractor shall conduct a minimum of 9 tests on welded joints on the drawn wire, using the proposed welding procedure.
- 7.4.7.8.1.3.** All 9 tests shall produce the minimum specified properties for yield strength, ultimate strength, percent elongation and torsional ductility.
- 7.4.7.8.1.4.** If any weld fails to produce the minimum specified properties, the wire manufacturer shall stop wire drawing production, investigate the cause of the low-strength weld, correct the welding process and perform additional testing before resuming the wire drawing production. The batch of wire manufactured from the last successful test to the stoppage of production shall be quarantined until proof is submitted that the wire does meet the requirements.
- 7.4.7.8.1.5.** The minimum number of tests to be carried out for the wires is as follows:
If failure occurs, the test frequency shall be increased to double the stated frequency until the cause of the failures has been rectified.
- 7.4.7.8.1.6. Tensile Testing**
- (i) The wire shall be tested in an accepted mechanically operated tensile testing machine which shall be verified as a Class 1 machine in accordance with EN ISO 7500. The gauge length is to be 250 mm and the extensometer used shall give the true extension to the nearest 0.125 mm. The load shall be applied steadily and the rate of separation of the machine jaws shall not be greater than 100 mm/minute.

- (ii) For determination of elongation, tests in which the fracture occurs outside the central 200 mm of the gauge length shall be discarded and the test repeated until the fracture is obtained within the central 200 mm. The broken parts of the test length shall be carefully reassembled to ensure proper contact and the distance between the gauge marks shall be measured and recorded.
- (iii) One tensile test in every 10th coil or minimum each cast shall be carried out to obtain a stress strain curve. Extensometer readings shall be taken from a load of 4 KN up to a load of 36 KN at intervals of 2 KN and from 36 KN up to failure at intervals of 1 KN. The stress strain curve readings can be terminated at 44 KN.

7.4.7.8.1.7. Sulphur and Phosphor Content

The Sulphur content and the phosphor content shall be stated on the mill certificate.

7.4.7.8.1.8. Wire Straightness

- (i) The coated wire is to be such that, when uncoiled, a 30 m length in free suspension under a tension of 1300 N shall not show any kinks, bends or wavy condition.
- (ii) A turn of the wire laid on the floor shall have a free cast diameter of not less than 5 m and a lift of one end of less than 150 mm.

7.4.7.8.1.9. Coating

- (i) The determination of the zinc mass shall be by the gravimetric method in accordance with EN 10244-2.
- (ii) The test for the uniformity of the zinc coating shall be the dipping test in accordance with EN 10244-2.
- (iii) In addition to this test, uniformity of galvanizing shall be visually inspected on finished coils and coils shall be rejected if there are misses in the zinc coating.

7.4.7.8.2. Sockets

Test Type	Reference Standard	Frequency of Testing
Chemical composition	EN 10340, Table 1	Each cast
Mechanical properties	EN 10340, Table 2	Each cast and each heat treatment batch
Hardness test	EN 10340	Each heat treatment batch
Visual inspection		Each cast item
Ultrasonic or X-ray inspection	EN 12680 EN 12681	Each cast item
Crack detection by magneto flux		Each cast item

Test Type	Reference Standard	Frequency of Testing
Dimensional check, rough surfaces	EN ISO 8062	Each cast item
Dimensional check, machined surfaces	EN ISO 8062	Each cast item
Welded repairs		100 %

(Other codes equivalent EN are acceptable)

7.4.7.8.2.1. Ultrasonic and X-ray Inspection

- (i) All cast items shall be subject to crack detection at all accessible fillets and changes in sections.
- (ii) Acceptance standards shall be established and agreed with the Employer before commencement of manufacture.
- (iii) In general, no linear crack-like or tear defects are acceptable, but a limited number of minor isolated rounded defects would be acceptable.

7.4.7.8.2.2. Tensile Testing of Strands

- (i) One strand from each successive 20 strands shall be selected by the Engineer's Representative for tensile testing and shall be made with an overlength such that, after cutting, the excess material will provide a test specimen at least 3.5 m long.
- (ii) The Engineer's Representative shall advise the Contractor which strands have been randomly selected for testing sufficiently well in advance of the production for the Contractor to plan the overlength of the strand.
- (iii) The test samples shall be socketed and tested to destruction in an approved tensile testing machine verified as Class 1 machine in accordance with EN ISO 7500-1 (EN ISO 7500) to determine the modulus of elasticity and breaking strength of the cable strand. The sockets shall be identical to those specified for the permanent cable strands. Failure shall occur by fracture of the wires between the sockets and not by pull-out from or failure by the sockets.
- (iv) The first three tensile tests from production strands shall also determine the load/extension relationship for the strand over the range of loading from 500 KN to 3500kN in 250 KN increments.
- (v) The sockets used in the tests shall not be incorporated in the permanent works.
- (vi) **Socketing Procedure Testing** - Before any permanent socketing, three tests to destruction shall be carried out on a sample length of strand, complete with two sockets identical to those specified for the permanent cables, in accordance with Clause 8.7. The sockets are to be attached using exactly the same procedure to be used for the permanent sockets.

- (vii) For a satisfactory procedure, failure shall not occur by pulling out of the strand from the socket.
- (viii) After the test the two sockets, each socket shall be sectioned in three places to demonstrate that each wire is completely surrounded by zinc and that the cone is completely filled with zinc and that there are not excessive voids in the zinc.
- (ix) No wire shall be in contact with the casting.
- (x) After socketing, the following requirements shall be checked:
 - (a) The alloy quantity poured into the socket (filling rate) shall not be less than 90 % of the theoretical quantity.
 - (b) The back of the socketed material shall be pressed into the socket with a load of not less than 40% of the breaking load of the strand applied by a suitable diameter jacking head, the pressure being maintained for 5 minutes. During the jacking the displacement of the strand shall be measured and shall not be greater than 6 mm.
- (xi) Proposals for jacking force and jacking head diameters shall be submitted to the Employer for review.
 - (a) Axis of the strand and the front surface of the socket shall be at a right angle in any direction, with a tolerance of 0.5°.
- (xii) Every socket shall be checked in accordance with the above items. If the requirements are not met, the alloy shall be re-melted, and the socketing shall be redone with the approval of the Employer.

7.4.7.8.2.3. Length Measurement of Strands

- (i) Strands shall be cut to length and socketed, and circumferential paint marks applied at the reference plane positions of the tower saddles.
- (ii) The length of the strand can be determined by marking the span length to and between saddle marks on the datum wire, at well-defined uniform temperature with the wire strung out on an even surface and tensioned to a specific load proposed by the manufacturer prior to the fabrication.
- (iii) During fabrication of the strand the marks from the datum wire shall be transferred to the circumferential paint marks.
- (iv) The length of the socketed strand and the span length to and between saddle marks, at datum temperature, shall be correct to within a tolerance of:
 - (a) $\pm 1/15000 L_g$ (caused by gauge wire)
 - (b) $\pm 5\text{mm}$ (caused by socketing)

7.4.7.8.3. Wrapping Wire

- 7.4.7.8.3.1. Trials of the complete cable protection, including wrapping wire and protection system shall be carried out early in a simulation on a short length

of the exterior of a parallel wire cable in accordance with Technical Specification, Volume 4.2.

- 7.4.7.8.3.2. The following tests shall be carried out on the round wrapping wire with the stated frequencies:

Test Type	Reference Standard	Frequency of Testing
Tensile test	EN 10264-1	One end of each coil
Dimensions		One end of each coil
Elongation	EN 10264-1	One end of each coil
Weight of coating	EN 10244	One end of each 10th coil
Torsion test on coated wire	EN 10218	One end of each 10th coil
Wrapping test on uncoated wire	EN 10218	One end of each 10th coil
Wire straightness		100%

- 7.4.7.8.3.3. If failure occurs, the test frequency shall be increased until the cause of the failures has been rectified.

7.4.7.8.4. Tensile Testing

The wire shall be tested in an accepted mechanically operated tensile testing machine which shall be verified as a Class 1 machine in accordance with EN ISO 7500. The gauge length is to be 150 mm and the extensometer used shall give the true extension to the nearest 0.125 mm. The load shall be applied steadily and the rate of separation of the machine jaws shall not be greater than 100 mm/minute. For determination of elongation, tests in which the fracture occurs outside the central 100 mm of the gauge length shall be discarded and the test repeated until the fracture is obtained within the central 100 mm. The broken parts of the test length shall be carefully reassembled to ensure proper contact and the distance between the gauge marks shall be measured and recorded.

7.4.7.8.5. Coating

- (i) The determination of the coating mass shall be by the gravimetric method in accordance with EN 10244-2.
- (ii) The test for the uniformity of the coating shall be the dipping test in accordance with EN 10244-2.
- (iii) In addition to this test, uniformity of galvanizing shall be visually inspected on finished coils and coils shall be rejected if there are misses in the zinc coating.

7.4.7.9. Stay Anchor/Guide Pipe & Bearing Plate

- 7.4.7.9.1. 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

7.4.7.9.2. Installation of suspension cables

Detail suspension cable Installation Method Statement should be submitted and subjected to approval from the Engineer before any commencement of the cable installation works.

7.4.8. 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.

7.4.8.1. 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.

7.4.8.2. 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.
- 7.4.8.3. The water tightness of the anchorages shall be inspectable during the maintenance program and shall be easily reinstated without dismantling any major components.

7.4.9. Monitoring of the Stay Cable

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

7.4.9.2. 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.

11. Corrosion protection of All Structural Steel works shall be carried out by metallizing in accordance with the below mentioned codes and standards shall be included but not be limited to.

Code	Description
IRC24:2010	Table "D-2(b), Page No-185 " for all structural steel.

IRS B1-2001	Appendix-VIII, Page no-35 & Page No-17 for Structural Steel.
IS 5905-1989	Sprayed Aluminum & Zinc coatings on Iron & Steel specifications.
IS: 9954-1981	Pictorial surface preparation standards for painting of steel surfaces.
IS 104:1979 & IS 51:1998	Zinc Chrome primer.
IS: 2339: 1963	Specifications for Aluminium Paint

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Annex-IV
(Schedule-D)

Additional Specifications for Bridge Facade lighting

The following Codes and Standards shall be applicable for continuous performance of all electrical equipments to be supplied, delivered at site, erected, tested and commissioned. The Electrical equipments offered shall comply with the relevant Indian Standard Specifications, Fire Insurance Regulations, Tariff Advisory Committee's Regulations, and in particular to Indian Electricity Rules in all respects with all its latest amendments up - to - date.

For guidelines, few of the Indian Standards are indicated below shall be included but not be limited to : -

Codes	Description
IS 8084 / 1976	Interconnecting bus-bars for A.C. voltage above 1 KV up to & including 36 KV.
IS 1919 /	General and Safety requirements for light fittings
IS 1944/ 1970	Code of practice for lighting public thoroughfares
IS 3528	Waterproof electric lighting fittings
IS 3553	Water tight electric lighting fittings
IS 1239	M.S. Tubular and other wrought steel pipe fittings
IS 2149	Luminaries for street lighting
IS 13032 / 1991	A.C. miniature circuit breaker board for voltage not exceeding 1000V specification.
IS 732/ Part 2/ 1982 IS 3043 / 1987	Code of practice for earthing.
IS 3427 / 1997	A. C. metal enclosed switchgear & control gears for rated voltage above 1KV up to & including 52 KV.
IS 3837 / 1977	Accessories for rigid steel conduits for electrical wiring.
IS 13947 / Part 3 / 1993	Specification for low voltage switchgear & control gear.
IS 4615 / 1968	Switch socket outlets (Non – Interlocked type).
IS 5216 / Part1, 2 / 1982	Guide for safety procedure & practices in electric work.
IS 5578 / 1984	Guide for marking of insulated conductors.
IS 5820 / 1970	Specification for pre cast concrete cable

Codes	Description
	covers.
IS 6381 / 1972	Specifications for construction & testing of electrical apparatus with type of protection's'.
IS 10322 / Part1, 2 / 1982	Specification of luminaries.
IS 103222 / Part3, 4 /1984	Specification of luminaries.
IS 10322 / Part5 (Sec 1, 2) /1985	Specification of luminaries.
IS 13022 / Part 5 (Sec3 to 5) / 1987	Specification of luminaries.
IS 13947 / Part1 / 1993	Specification for low-voltage switchgear & control gear.
IS 13703 / Part4 / 1993	Specification for low voltage fuses for voltages not exceeding 1000V AC or 1500 V DC.
IS 2551 / 1982	Danger notice plates.
IS 732 / 1989	Code of practice for electrical wiring installation.
IS 3854 / 1997	Switches for domestic & similar purpose.
IS 2309 / 1989	Code of practice for lightning protection
IS 2418 / Part 1 to 3 / 1977	Tubular florescent lamps for general lighting service.
IS 13032 /1991	AC miniature circuit breaker board for voltage not exceeding 1000V.
IS 2706 / Part 1 to 5 / 1992	Current transformers.
IS 15086 / Part1 / 2001	Surge arresters.
IS 13925 / Part1 / 1998	Shunt capacitors for AC power systems having a rated voltage above 1000V.
IS 13118 / 1991	Specification for HVAC circuit breakers.
IS 374 / 1979	Ceiling fans.
IS 5578 / 1984	Guide for marking for insulated conductors.
IS 418 / 1978	Tungsten filament general service electrical lamp.
IS 694 / 1990	PVC insulated cable & cords for power / lighting.
IS 13010 / 2002	A.C. watt –hour meters.
IS 732 / 1989	Electrical wiring installation (up to 650V).
IS 10870 / 1984	Code of safety for hexane.
IS 1248 / Part 1 / 1993	Direct acting indicating instruments & their accessories.
IS 1248 / Part 2 / 1983	Direct acting indicating instruments & their accessories.
IS 1248 / Part 7 / 1984	Direct acting indicating instruments & their accessories.
IS 1248 / Part 9 / 1983	Direct acting indicating instruments & their accessories.
IS 1293 / 1988	3 pin plugs & socket outlets.
IS 1554 / Part1 to 3/1988	PVC insulated cables – heavy duty.

Codes	Description
IS 13947/Part 1 to 5 /1993	Low voltage switchgear & control gear.
IS 1651 / 1991	Lead acid cell batteries.
IS 9537 / Part 5 / 2000	Conduits for electrical installation.
IS 2082/ 1993	Stationary storage type water heaters
IS 16242(PART 1)/ 2014	UPS/ Inverters of rating <= 5 KVA
IS 13252(PART 1)/ 2010	CCTV cameras/ CCTV recorders
IS 1391(PART 1 & PART 2)/ 1992	Room air conditioners – PART 2 split air conditioners
IS 10617(PART 1)/ 1983	Water cooler – hermetically sealed type suction cooled compressor with overload protection
IS 1475(PART 1)/ 2001	Self-contained drinking water coolers
IS 14724/ 1999	Water purifiers with UV disinfection
IS 10000/ 1980	Methods of tests for IC engines
IS 4722/ 2001	Rotating electrical machines
IS 1180(Part-1):2014, Level-2	Distribution transformers

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Annex-V
(Schedule D)

Additional Specifications for Mobile Bridge Inspection Unit (MBIU)

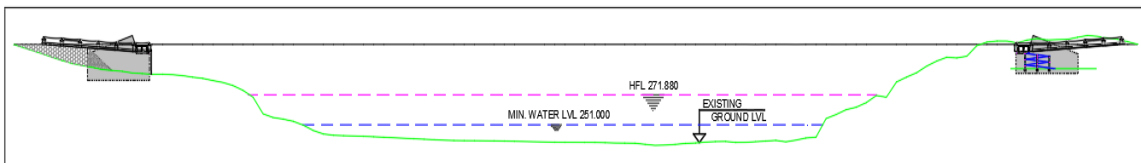
1. One unit of Mobile Elevating steel work platform shall be provided for the project having specifications as –
 - a) Folding type / scissor type ladder / lift – hydraulic / mechanical
 - b) Platform capacity 4 person / 400 kg
 - c) Height – can be work / inspect the bridge components of height / depth up to 100m.
 - d) Fitted on truck
 - e) Lift can be operated on batteries
 - f) Platform shall have proper railings / grills for safety of workers & inspecting person.
2. The unit shall be provided before completion of project and shall be maintained till the end of maintenance period and shall be handed over to client in good working condition on completion of maintenance period. All operating, maintaining expenses including manpower (driver, operator), software, hardware, if any, fuel, oil charges shall be borne by concessionaire for full period of maintenance. The unit shall be ready at any time (within 4 hours of notice from client) for inspection & maintenance. The unit shall be kept near bridge in maintenance yard or at the location suggested by client. Safety of vehicle & manpower, equipment, machinery, its insurance, taxes etc. will be concessionaire's responsibility.

Annex-VI
(Schedule-D)

Construction Methodology

1.1 Phase 1: Site Preparation and Earthworks on Both Banks

- Preparation of both riverbanks to establish stable foundation zones.
- Excavation, leveling, and soil stabilization to create firm working platforms for construction.
- Construction of earth-retaining structures and slope protection measures near abutment zones, wherever required.
- Provision of adequate surface drainage to prevent water accumulation during construction activities.
- Development of access roads and working platforms to ensure safe movement of cranes, transport vehicles, and material handling equipment.



1.2 Phase 2: Construction of Open Foundations and Abutments

Open Foundations:

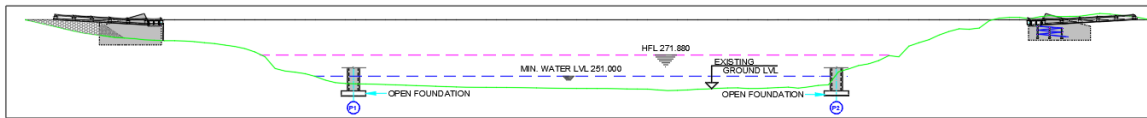
- Excavation is carried out in dry or controlled dewatered conditions.
- Foundation pits are excavated to the required depth and width to reach competent strata as per design.
- A levelling course is placed at the base before reinforcement placement.
- Concreting of open foundation blocks is done with proper formwork and compaction.

Abutments and Anchorage Blocks:

- Reinforced concrete abutments are constructed on both banks to anchor the bridge deck and resist horizontal forces.
- Anchorage blocks are integrated within the abutments to receive stay cable loads during and after construction.

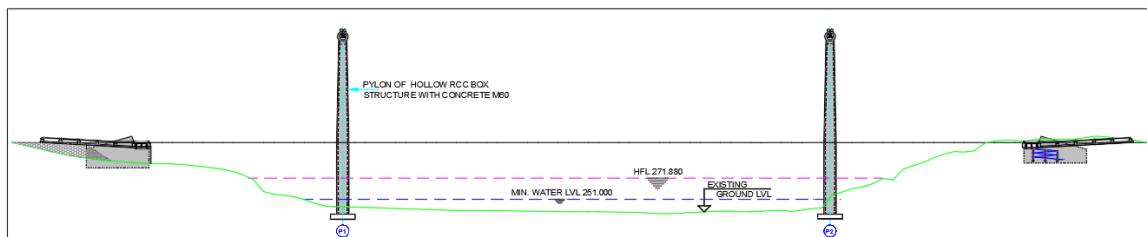
Temporary Supports:

- Temporary piers or falsework are installed where required to support early deck assembly and launching.
- These supports maintain deck alignment and ensure structural stability during construction operations.



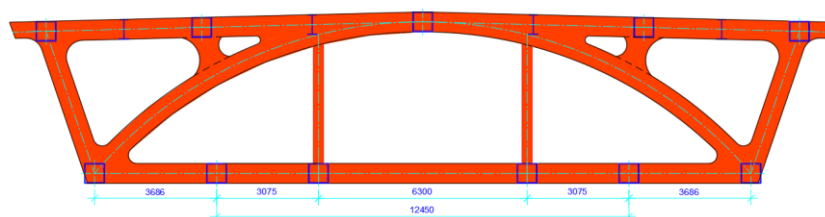
1.3 Phase 3: Erection of Pylons and Preparation for Superstructure

- Construction of pylons begins after the completion of foundations using climbing or jump-formwork systems.
- Reinforcement and embedded anchor boxes for stay cable connections are fixed and cast at designated levels.
- Each lift of the pylon is closely monitored for verticality and geometric alignment.
- Bearings and temporary staging are installed on side piers and abutments to receive the initial truss deck segments.



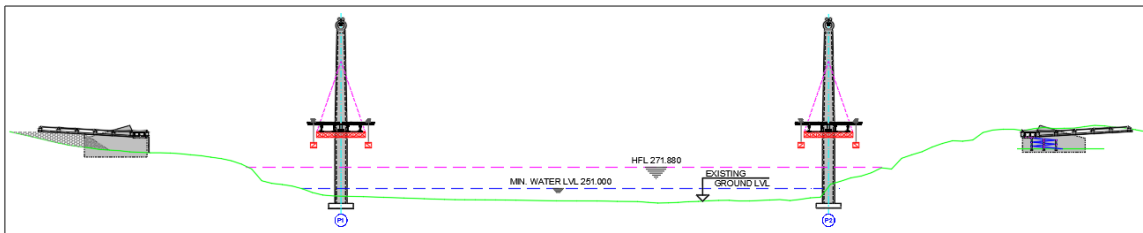
1.4 Phase 4: Fabrication and Assembly of Steel Truss Segments

- Steel truss segments are fabricated in a controlled workshop environment to maintain dimensional accuracy and high-quality welding standards.
- Each segment consists of upper and lower chords, diagonals, and cross-girders, forming a rigid panel assembly.
- Segments are shop-assembled and trial-fitted to verify alignment and fit-up before dispatch.
- After fabrication, all steel surfaces are blast-cleaned and coated with an anti-corrosive protective system.
- Finished segments are transported to the site using heavy-duty trailers or barges, depending on size and accessibility.
- Segments are stored on designated assembly platforms at the site, ready for lifting and erection.



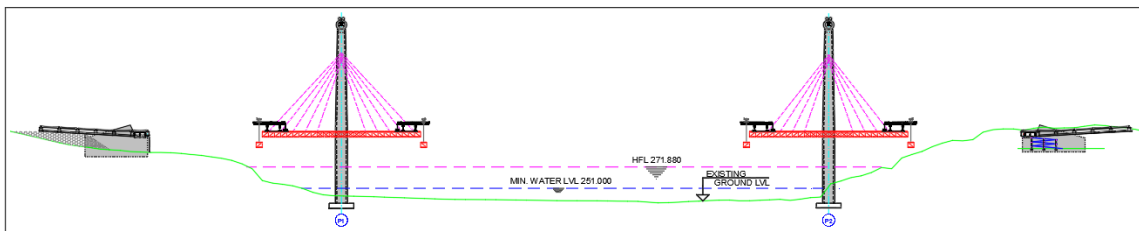
1.5 Phase 5: Launching and Initial Assembly of Truss Deck

- A girder erection crane is first installed at the pylon to support the subsequent deck assembly operations.
- Truss deck panels are progressively advanced over the mid-span and back span using the deck erection crane.
- Continuous monitoring ensures correct deck alignment, level, and geometry during launching.
- Cables are anchored in pylon saddles and connected to deck nodes via gusseted anchor assemblies.



1.6 Phase 6: Cantilever Erection of Main Span and Back Span Truss Segments

- After initial stabilization, construction of the main span and back span proceeds using the balanced cantilever method.
- Steel truss segments are lifted and connected at the free end of the previously erected section, extending progressively toward the center and towards the abutment.
- Each newly added segment is immediately supported by a corresponding stay cable, which is tensioned in stages to maintain the desired geometry and camber.
- Erection proceeds symmetrically from both pylons to minimize torsional effects and maintain overall balance.

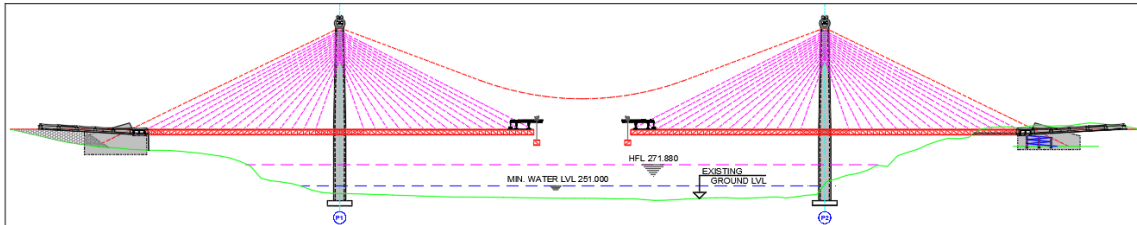


1.7 Phase 7: Closure of Central Span and Structural Continuity

As the cantilever arms from both pylons extend toward each other, the final closure segment is lifted into position using a suspension cable crane and carefully installed to bridge the gap.

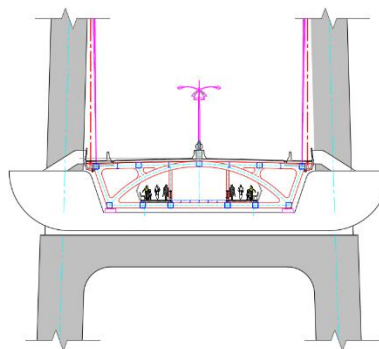
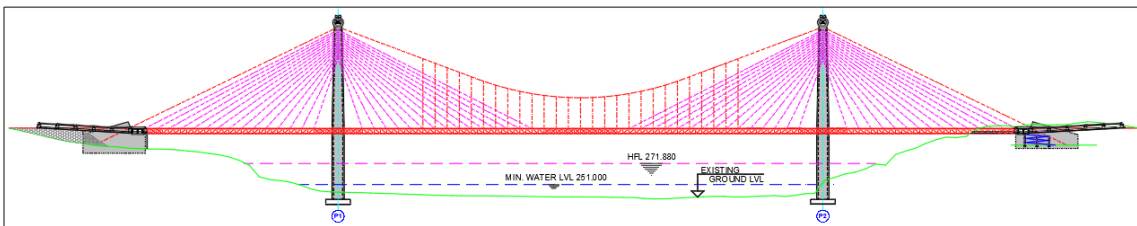
- Precise alignment and leveling are carried out before final bolting or welding to ensure perfect fit and structural integrity.

- stay cables are installed to provide temporary stability and support to the closure segment during the final adjustments.
- Once installed, the final stay cables are tensioned, and deck alignment is adjusted to match the designed profile.
- This stage completes the main structural assembly, resulting in a continuous steel truss deck fully supported by the stay cables.



1.8 Phase 8: Deck Finishing and Ancillary Works

- After structural completion, slabs are installed over the truss top chords.
- A waterproofing layer and bituminous wearing course are applied to create the running surface.
- Expansion joints, bearings, drainage systems, crash barriers, parapets, and lighting fixtures are subsequently installed.
- Final stress adjustments of the stay cables are carried out, and alignment verification is performed.
- The bridge then undergoes load testing and inspection before being opened to traffic.



Note: The above-mentioned construction methodology / sequence is indicative and for reference purpose.

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Schedule-E

(See Clauses 2.1 and 14.2)

Maintenance Requirements

1. Maintenance Requirements

- 1.1 The Contractor shall, at all times maintain the Project Highway in accordance with the provisions of this Agreement, Applicable Laws and Applicable Permits.
- 1.2 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.
- 1.3 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.

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 willful 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. Maintenance Module of Software

The Contractor shall prepare Module software, so as to capture real time maintenance requirement and reporting of its rectification. Access of the Authority to such module through user ID/Password will be provided, so as to monitor the standard of maintenance. Such module shall be ready for use at the time of submission of maintenance programme.

10. Maintenance Methodology

A detailed methodology shall be prepared by the contractor and approved by the Authority's Engineer in concurrence of Authority to be adopted to address maintenance and Defect Liability Obligation of the Contractor.

11. Recovery against failure to Maintenance.

~~Recovery shall be made against EPC Contractor in case of failure in satisfactory Maintenance requirement during Construction period (for keeping the project in traffic worthy conditions) / DLP period. Recovery Rate shall be 0.003% of the Contract value per day.~~

12. Payment for Bridge health Monitoring System (BHMS):

Only 70% of the total estimated cost of the BHMS has been provisioned in the Schedule-H for payment on completion of work after installation and Testing. The remaining 30%, as calculated by proportionality, shall be made during maintenance period per year equally on pro rata basis.

For Avoidance of doubt, an amount of ₹ 3,99,95,500.00 (excl. GST) is the estimated cost of BHMS in the DPR. However, in the cost put to tender, an amount of ₹ 2,79,97,000.00 (excl. GST), (70% of 3,99,95,500.00), has been taken for payment on completion, as per Schedule-H. The remaining payment for an amount of Rs. ₹1,19,98,500.00 (excl GST) [=3,99,95,500.00-2,79,97,000.00] shall be made during maintenance period per year equally on pro rata basis. However, the same shall be adjusted as per Tender Premium / Discount.

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Annex-I
(Schedule-E)

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.

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 structure, approaches of connecting	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 reports / 03031 /)	24-48 hours	MORT&H Specification 3004.2
	Cracking	Nil	< 5 % subject to limit of 0.5 sqm for any 50 m length	Daily			7-15 days	MORT&H Specification 3004.3
	Rutting	Nil	< 5 mm	Daily	Straight Edge		15 -30 days	MORT&H Specification 3004.2

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					
roads, slip roads, lay byes etc. as applicable)	Corrugations and Shoving	Nil	< 0.1 % of area	Daily	Length Measurement Unit like		2-7 days	IRC:82-2015
	Bleeding	Nil	< 1 % of area	Daily	Scale, Tape, odometer etc.		3-7 days	MORT&H Specification 3004.4
	Ravelling / Stripping	Nil	< 1 % of area	Daily			7-15 days	IRC:82-2015 read with IRC SP81
	Edge Deformation / Breaking	Nil	< 1 m for any 100 m section and width <0.1 m at any location, restricted to 30cm 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	180 days	IRC:82-2015
	Skid Number	60SN	50SN	Bi-	SCRIM (Sideway-force Coefficient	Test Method for measuring Longitudinal Profile of	180 days	BS: 7941-1:2006

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					
				Annually	Routine Investigation Machine or equivalent)	Travelled Surfaces with Accelerometer Established Inertial Profiling Reference ASTM E1656 -94: 2000-Standard Guide for Classification of Automatic Pavement Condition Survey Equipment		
	Pavement Condition Index	3	2.1	Bi-Annually			180 days	IRC:82-2015
	Other Pavement Distresses						2-7 days	IRC:82-2015
	Deflection / Remaining Life			Annually	Falling Weight Deflectometer	IRC 115: 2014	180 days	IRC:115-2014
Rigid Pavement (Pavement of MCW, Service Road, Grade structure, approaches of	Roughness BI	2200m m / km	2400mm / km	Bi-Annually	Class I Profilometer	ASTM E950 (98) :2004 and ASTM E1656 -94: 2000	180 days	IRC:SP:83-2008
	Skid	Skid Resistance no. at different speed of vehicles		Bi-Annually	SCRIM (Sideway-force Coefficient Routine	IRC:SP:83-2008	180 days	IRC:SP:83-2008
		Minimum	Traffic Speed (Km /					

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					
connecting roads, slip roads, lay byes etc. as applicable)		SN	h)		Investigation Machine or equivalent)			
		36	50					
		33	65					
		32	80					
		31	95					
		31	110					
Embankment / Slope	Edge drop at shoulders	Nil	40mm	Daily	Length Measurement Unit like Scale, Tape, odometer etc.	IRC	7-15 days	MORT&H Specification 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 prescribed side slope	Daily			7-15 days	MORT&H Specification 408.4

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					
	Embankment Protection	Nil	Nil	Daily			7-15 days	MORT&H Specification
	Rain Cuts / Gullies in slope	Nil	Nil	Daily Specially During Rainy Season			7-15 days	MORT&H Specification

[Note: Where necessary, the Authority may modify the time limit for repair / rectification, or add to the nature of Defect or deficiency before issuing the bidding document, with the approval of the competent authority.]

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

Table -2: Maintenance Criteria for Rigid Pavements:

Sl. 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	w = width of crack L = length of crack d = depth of crack D =	0	Nil, not discernible	No Action	Not applicable
	1		$w < 0.2$ mm. hair cracks			
	Not intersecting with any joint		2	$w = 0.2 - 0.5$ mm, discernible from	Seal without delay	Seal, and stitch if L

Sl. No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case $d < D / 2$	For the case $d > D / 2$
		depth of slab		slow-moving car		>1m. Within 7days
			3	w = 0.5 - 1.5 mm, discernible from fast-moving car		
			4	w = 1.5 - 3.0 mm	Seal, and stitch if L > 1 m.	Staple or Dowel Bar Retrofit, FDR for affected portion.
			5	w > 3 mm.	Within 7 days	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
			5	w > 6 mm, usually associated with spalling, and / or slab rocking under traffic	Not Applicable, as it may be full depth	reconstruct affected. Portion with norms 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, discernible from slow moving vehicle	Seal with epoxy, if L > 1 m. Within 7 days	Staple or dowel bar retrofit. Within 15days

Sl. 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 = 0.5 - 3.0 mm, discernible from fast vehicle	Route seal and stitch, if L > 1 m. 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 -
4	Multiple Cracks intersecting with one or more joints	w = width of crack	0	Nil, not discernible	No Action	-
			1	w < 0.2 mm, hair cracks	Seal, and stitch if L > 1 m.	
			2	w = 0.2 - 0.5 mm. discernible from slow vehicle	Within 15 days	
			3	w = 0.5 - 3.0 mm, discernible from fast vehicle	Full depth repair within 15 days	Dismantle, Reinstatement 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

Sl. 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	three or four corners broken		
6	Punchout (Applicable to Continuous Reinforced Concrete Pavement (CRCP) only)	w = width of crack L = length (m / m2)	0	Nil, not discernible		No Action
			1	w < 0.5 mm; L < 3 m / m2	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 / m2		
			3	w > 1.5 mm and L < 3 m / m2		
			4	w > 3 mm, L < 3 m / m2 and deformation		
			5	w > 3 mm, L > 3 m / m2 and deformation		
Surface Defects						
7	Ravelling or	r = area damaged	0	Nil, not discernible	Short Term	Long Term

Sl. No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case $d < D / 2$	For the case $d > D / 2$
	Honeycomb type surface	surface / total surface of slab (%) h = maximum depth of damage			No action.	Not Applicable
			1	$r < 2 \%$	Local repair of areas	
			2	$r = 2 - 10 \%$	damaged and liable to be damaged. Within 15 days	
			3	$r = 10-25\%$	Bonded Inlay, 2 or 3	
			4	$r = 25 - 50 \%$	slabs if affecting.	
					Within 30 days	
			5	$r > 50\%$ and $h > 25 \text{ mm}$	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	
		2	$r = 2 - 10 \%$	damaged and liable to be damaged. Within 7days		
			3	$r = 10 - 20\%$		Bonded Inlay within 15
		4	$r = 20 - 30 \%$	days		
		5	$r > 30 \%$ and $h > 25 \text{ mm}$	Reconstruct slab within30 days		
9	Polished Surface / Glazing	t = texture depth, sand patch test	0		No action.	Not Applicable
			1	$t > 1 \text{ mm}$		
			2 '	$t = 1 - 0.6 \text{ mm}$	Monitor rate of deterioration	
			3	$t = 0.6 - 0.3 \text{ mm}$		
			4	$t = 0.3 - 0.1 \text{ mm}$		

Sl. 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	$t < 0.1 \text{ mm}$	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	$d < 50 \text{ mm}; h < 25 \text{ mm}; n < 1 \text{ per } 5 \text{ m}^2$	No action.	Not Applicable
			1	$d = 50 - 100 \text{ mm}; h < 50 \text{ mm}; n < 1 \text{ per } 5 \text{ m}^2$	Partial depth repair 65 mm deep. Within 15 days	
			2	$d = 50 - 100 \text{ mm}; h > 50 \text{ mm}; n < 1 \text{ per } 5 \text{ m}^2$		
			3	$d = 100 - 300 \text{ mm}; h < 100 \text{ mm } n < 1 \text{ per } 5 \text{ m}^2$	Partial depth repair 110 mm i.e. 10 mm more than the depth of the hole. Within 30 days	
			4	$d = 100 - 300 \text{ mm}; h > 100 \text{ mm}; n < 1 \text{ per } 5 \text{ m}^2$		
			5	$d > 300 \text{ mm}; h > 100 \text{ mm}; n > 1 \text{ per } 5 \text{ m}^2$	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
			1	Discernible, $L < 25\%$ but of little immediate consequence with regard to ingress of water or trapping incompressible material.	Clean joint, inspect later.	

Sl. 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	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 in compressible material	Clean, widen and reseal the joint. Within 7 days	
12	Spalling of Joints	w = width on either side of the joint L = length of spalled portion (as % joint length)	0	Nil, not discernible	No action.	Not Applicable
			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 . Within 30 days	
13	Faulting (or Stepping)	f = difference of level	0	not discernible, < 1 mm	No action.	No action.
	in Cracks or Joints		1	$f < 3$ mm		
			2	$f = 3 - 6$ mm	Determine cause and observe, take action for	Replace the slab as appropriate. Within

Sl. No.	Type of Distress	Measured Parameter	Degree of Severity	Assessment Rating	Repair Action	
					For the case $d < D / 2$	For the case $d > D / 2$
					diamond grinding	30days
			3	$f = 6 - 12 \text{ mm}$	Diamond Grinding	
			4	$f = 12 - 18 \text{ mm}$	Raise sunken slab.	Replace the slab as
			5	$f > 18 \text{ mm}$	Strengthen subgrade and sub-base by grouting and raising sunken slab	appropriate. Within 30days
14	Blow-up or Buckling	h = vertical displacement from normal profile	0	Nil, not discernible	Short Term	Long Term
			1	$h < 6 \text{ mm}$	No Action	
			2	$h = 6 - 12 \text{ mm}$	Install Signs to Warn Traffic	
			3	$h = 12 - 25 \text{ mm}$	within 7 days	
			4	$h > 25 \text{ mm}$	Full Depth Repair. Within 30 days	
			5	shattered slabs, i.e 4 or more pieces	Replace broken slabs. Within 30 days	
15	Depression	h = negative vertical displacement from normal profile L=length	0	Not discernible, $h < 5 \text{ mm}$	No action.	Not Applicable
			1	$h = 5 - 15 \text{ mm}$		
			2	$h = 15 - 30 \text{ mm}$, Nos $< 20\%$ joints	Install Signs to Warn	
			3	$h = 30 - 50 \text{ mm}$	Traffic within 7 days	
			4	$h > 50 \text{ mm}$ or $> 20\%$ joints	Strengthen subgrade. Reinstate pavement at normal level	

Sl. 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	$h > 100$ mm	if $L < 20$ m. Within 30 days	
16	Heave	h = positive vertical displacement from normal profile. L = length	0	Not discernible. $h < 5$ mm	Short Term	Long Term
					No action.	scrabble
			1	$h = 5 - 15$ mm	Follow up.	
			2	$h = 15 - 30$ mm, Nos<20% joints	Install Signs to Warn	
			3	$h = 30 - 50$ mm	Traffic within 7 days	
			4	$h > 50$ mm or $> 20\%$ joints	Stabilise subgrade.	
			5	$h > 100$ mm	Reinstate pavement at normal level if length< 20 m. Within 30 days	
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 Shoulder Dropoff	f = difference of level	0	Nil, not discernible< 3mm	Short Term	Long Term
					No action.	
			1	$f = 3 - 10$ mm	Spot repair of shoulder	
			2	$f = 10 - 25$ mm	within 7 days	

Sl. 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	f = 25 - 50 mm	Fill up shoulder	
			4	f = 50 - 75 mm	within 7 days	For any 100 m stretch Reconstruct shoulder, if affecting 25% or more of stretch. Within 30days
			5	f > 75 mm		
Drainage						
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 / Frequent10 - 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 due to blockage of drains	0-2	No discernible problem	No action.	
			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-	

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

Asset Type	Performance Parameter	Level of Service (LOS)			Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
Highway	Availability of Safe Sight Distance	As per IRC SP :84-2014, a minimum of safe stopping sight distance shall be available throughout.			Monthly	Manual Measurements with Odometer along with video / image backup	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.	IRC:SP84-2014	
		Design Speed, kmph	Desirable Minimum Sight Distance (m)	Safe Stopping Sight Distance (m)					
		100	360	180					
		80	260	130					
Pavement Marking	Wear	<70% of marking remaining			Bi- Annually	Visual Assessment as per Annexure-F of IRC:35-2015	Re - painting	Cat-1 Defect – within 24 hours Cat-2 Defect - within 2 months	IRC:35-2015
	Day time Visibility	During expected life Service Time Cement Road -130mcd / m ² / lux Bituminous Road - 100mcd / m ² / lux			Monthly	As per Annexure-D of IRC:35-2015	Re - painting	Cat-1 Defect – within 24 hours Cat-2 Defect – within 2 months	IRC:35-2015
	Night Time	<u>Initial and Minimum</u>			Bi-Annually	As per Annexure-E	Re - painting	Cat-1 Defect –	IRC:35-2015

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Visibility	<u>Performance for Dry Retro reflectivity during night time:</u>		of IRC:35-2015		within 24 hours Cat-2 Defect – within 2 months	
		Design (RL) Retro Reflectivity Speed (mcd / m2 / lux)					
		Initial (7 days) Minimum Threshold level (TL) & warranty period required up to 2 years					
		Up to 65 200 80					
		65 - 100 250 120					
		Above 100 350 150					
		<u>Initial and Minimum Performance for Night Visibility under wet condition (Retro reflectivity):</u>					
		Initial 7 days Retro reflectivity: 100 mcd / m2 / lux Minimum					

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
		Threshold Level: 50mcd / m ² / lux					
	Skid Resistance	Initial and Minimum performance for Skid Resistance: Initial (7days): 55BPNMin. 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	IRC: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
	Retro reflectivity	As per specifications in IRC:67-2012	Bi-Annually	Testing of each	change of signboard	boards 48 hours in case of Mandatory	RC:67-2012
				signboard using Retro Reflectivity Measuring Device. In accordance with ASTM D4956-09.		Signs, 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 m	Use of distance Reassuring tape H	raising Kerb eight	Within 1 Month	RC 86:1983
	Kerb Painting	<u>Functionality</u> : Functioning of Kerb painting as intended	Daily	Visual with video / image K 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:84-2014 and IRC:35-2015, unless specified in Schedule-B.	Daily	Counting	New Installation	Within 2 months	IRC:SP:84-2014, IRC:35-2015
	Pedestrian Guardrail	<u>Functionality</u> : Functioning of guardrail as intended	Daily	Visual with video / image backup	Rectification	Within 15 days	IRC:SP:84-2014
	Traffic Safety Barriers	<u>Functionality</u> : Functioning of Safety Barriers as intended	Daily	Visual with video / image backup	Rectification	Within 7 days	IRC:SP:84-2014,

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
							IRC:119-2015
	End Treatment of	<u>Functionality:</u> Functioning of End Treatment as intended	Daily	Visual with video / image backup	Rectification	Within 7 days	IRC:SP:84-2014,
	Traffic Safety Barriers						IRC:119-2015
	Attenuators	<u>Functionality:</u> Functioning of Attenuators as intended	Daily	Visual with video / image backup	Rectification	Within 7 days	IRC:SP-2014, IRC:119-2015
	Guard Posts and Delineators	<u>Functionality:</u> 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	<u>Functionality:</u> Functioning of Traffic Blinkers as intended	Daily	Visual with video / image backup	Rectification	Within 7 days	IRC:SP:84-2014
	Walkway Flooring	<u>Floor shall be cleaned, even, plain, dry.</u>	Daily	Visual with video / image backup	Rectification	24 hours	
	Glass Flooring & Glass Railing	<u>Glass shall be cleaned, transparent, without cracks.</u>	Daily	Visual with video / image backup	Rectification	24 hours	
		If found damaged shall be reported to Authority and replace immediately and shall be barricaded immediately.	Daily	Visual with video / image backup	Rectification	Immediately	
	Pedestrian	Shall be maintained properly	Daily	Visual with video /	Rectification	Within 7 Days	

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	Facilities	and ready for use through the maintenance period		image backup			
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:84-2014, schedule D
		No major failure in the lighting system	Daily	-	Rectification of failure	24 hours	IRC: SP:84-2014, schedule D
		No minor failure in the lighting system	Monthly	-	Rectification of failure	8 hours	IRC: SP:84-2014, schedule D
	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:84-2014
		No major / minor failure in the lighting system	Daily	-	Rectification of failure	8 hours	IRC: SP:84-2014, schedule D
	Walkway lighting	Minimum 100 Lux illumination on the walkway	Daily	The illumination level shall be measured with luxmeter	Improvement in Lighting System	24 hours	IRC: SP:84-2014, schedule D

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
		No major / minor failure in the lighting system	Daily	-	Rectification of failure	8 hours	IRC: SP:84-2014, schedule D
	Facade lighting	Colours and Lux illumination on the structure	Daily	The illumination level shall be measured with luxmeter	Improvement in Lighting System	24 hours	As per Schedule D
		No major / minor failure in the lighting system	Daily	-	Rectification of failure	8 hours	As per Schedule D
	CC TV	Recording shall be continued 24 X 7 and with Backup of 30 days.	Daily	-	Rectification of failure	8 hours	As per Schedule D
		No major / minor failure in the lighting source of CCTV Cameras	Daily	-	Rectification of failure	8 hours	IRC: SP:84-2014, schedule D
Trees and Plantation including median plantation	Obstruction in a minimum headroom 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:84-2014

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specifications and Standards
	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:84-2014
	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 84-2014
	Defects in electrical, water and sanitary installations	-	Daily	-	Rectification	24 hours	
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 84-2014

Table 4: Maintenance Criteria for Structures and Culverts:

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specification s 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
	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					

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specification s and Standards
		length					
	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 approach embankment	15 days	MORT&H Specification 3004.2 & 2811.
	User safety (condition of	No damaged or missing stretch of crash barrier or	Daily	Visual inspection and detailed	Repairs and replacement of safety	3days	IRC: 5-1998, IRC SP: 84-2014 and

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specification s and Standards
	crash barrier and guard rail)	pedestrian hand railing		condition survey as per IRC SP: 35-1990.	barriers as the case may be		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 Inspection Unit	All the corroded reinforcement shall need to be thoroughly cleaned from rusting and applied with anti-corrosive coating before carrying out the repairs to affected concrete portion with epoxy mortar / concrete	15 days	IRC SP: 40-1993 and MORTH Specification 1600.
	Spalling of concrete	Not more than 0.50 sq.m					
	Delamination	Not more than 0.50 sq.m					
	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.
	Rainwater seepage through deck slab	Leakage – nil	Quarterly	Detailed condition survey as per IRC SP: 35-1990 using Mobile Bridge	Grouting of deck slab at leakage areas, waterproofing, repairs to drainage spouts	1 months	MORTH specifications 2600 & 2700

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specification s and Standards
				Inspection Unit			
	Deflection due to permanent loads and live loads	Within design limits.	Once in every 10 years for spans more than 40m	Load Test Method	Carry out major rehabilitation works on bridge to retain original design loads capacity	6 months	IRC SP: 51-1999.
	Rusting of structural members	Within design and specification limits.	Every month	Corrosion meters	Remove rust immediately.	7 days	
	Stay and suspension Cables and system	No change of stresses beyond acceptable limits specified in approved designs.	As soon as monitoring system highlights the stress.	Online monitoring system.	Replacement/addition/ modification of cables, if needed.	7 days	
	Bolt joints Connections	No loose connections/ damaged connections	Daily	Visual inspection as per IRC SP:35-1990	Torquing of bolts to be done with automatic torquing machine. Damaged bolts to replaced and torqued as per design	Immediate.	IRC: 24-2010.
	Gauges / Sensors/ BHMS	Shall be online 24/7/365.	Online – all the time.	Online – all the time.	Shall be replaced in case of not being online.	Immediate.	
	Vibrations in bridge deck due	Frequency of vibrations shall not be more than 5 Hz	Once in every 5 years for spans	Laser displacement sensors or laser	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	Specification s and Standards
	to moving trucks		more than 30m and every 10 years for spans between 15 to 30m	vibro-meters			
	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	MORTHspecifications2600 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.
	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	3 days	MORTHspecification2700.

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specification s and Standards
					500mm below soffit of slab. Providing sealant around the drainage spout if any leakages observed.		
Bridge-substructure	Cracks / spalling of concrete / rusted steel	No cracks, spalling of concrete and rusted steel	Bi-Annually	Detailed condition survey as per IRC SP: 35-1990 using Mobile Bridge Inspection Unit	All the corroded reinforcement shall need to be thoroughly cleaned from rusting and applied with anti-corrosive coating before carrying out repairs to substructure by grouting / guniting and micro concreting depending on type of defect noticed	30 days	IRC SP: 40-1993 and MORTH specification 2800.
	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	3 months	MORTH specification 2810 and IRC SP: 40-199.

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specification s and Standards
					on to bearings.		
	Joints	Malfunctioning of joints	Daily	Visual inspection as per IRC SP:35-1990	Repairs/ Replace to damaged components	15 days	IRC: SP:69-2011
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. In case of doubt, use Underwater camera for inspection of deep wells in major Rivers.	Suitable protection works around pier / abutment	1 month	IRC SP: 40-1993, IRC83-2014, MORTH specification 2500
	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 2Weeks before onset of rainy season whichever is	IRC: SP 40-1993 and IRC: SP:13-2004.

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specification s and Standards
						earlier.	
Bridges including ROBs Flyover etc. as applicable	Aesthetic Painting	Any defects/ deficiency not covered above but pointed out by Authority/ Engineer	Monthly	Visual inspection as per IRC SP:35-1990	All the damaged area shall need to be thoroughly cleaned from then painted	Immediate	
Bridges including ROBs Flyover etc. as applicable		Any other defects/ deficiency not covered above but pointed out by Authority/ Engineer	Daily	Visual inspection as per IRC SP:35-1990	Repairs/ Replace to damaged components	3 Days	

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

All lighting (Roadway lighting, Façade lighting and walkway lighting), BHMS, MBIU, CCTV, Pedestrian facilities shall be maintained for 10 years in good and running condition for complete maintained period at contractor's cost.

Stay and suspension cables, its accessories shall be maintained as per manufactures specifications, Schedule D Thought out the maintenance period at contractor's cost.

Asset Type	Performance Parameter	Level of Service (LOS)	Frequency of Measurement	Testing Method	Recommended Remedial measures	Time limit for Rectification	Specification s and Standards
The superstructure, walkway shall be cleaned and coloured yearly at Contractor's cost. The MBIU shall be maintained in good working condition at site/location suggested by Client throughout the maintenance period with required manpower, Fuel, lubricants etc for operation of inspection and maintenance of the bridge and record of use of the machinery shall be maintain in register with video / image backup.							

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Annex-II
(Schedule-E)

Tentative guidelines for maintenance of Cable stayed bridge

1. 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
2. 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.
3. 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.
- 4., 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.

5. Bridge maintenance encompasses:

- 5.1. Cleaning activities including water flush of all decks, drains, bearings, joints, pier caps, abutment seats, concrete rails, and parapets.
- 5.2. Preventive maintenance activities such as painting, coating, sealant applications for routine, minor deck patching and railing repairs.
- 5.3. 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.
- 5.4. Stream channel maintenance including debris removal, stabilizing banks and correcting erosion problems.
- 5.5. 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.
- 5.6. 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.
- 5.7. 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.

6. Maintaining Activities: -

- 6.1. 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.

7. Bridge Cleaning

- 7.1. 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.

- 7.2. 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.
- 7.3. 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.
- 7.4. 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.
- 7.5. 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.

8. Deterioration in cable stayed bridge

- 8.1. 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.

- 8.2. 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.
- 8.3. 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.
- 8.4. 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.
- 8.5. 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.
- 8.6. 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.

- 8.7. 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.
- 8.8. 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.
- 8.9. 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.
- 8.10. 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.
- 8.11. 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.
- 8.12. Advanced maintenance and rehabilitation tools are introduced to save the life-cycle cost, acoustic emission monitoring technique and cold retrofit technique.
- 9. Bridge Management Systems (BMS)**
- 9.1. 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.

- 9.2. 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.
- 9.3. 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.
- 9.4. 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.
- 9.5. 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.
- 9.6. 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 contractor & 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.

10. Maintenance of Cable Stay and Suspension Cable Bridge Components:

10.1. 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 deigns 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 rewinding 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 corruptions. 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.

11. Inspection Procedures

- 11.1. 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.
- 11.2. 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.
- 11.3. 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 flattening, bulging, or splitting that may result in uneven distribution of loads. The concrete at bearing seats should be checked for cracks and spalls.

12. Maintenance and rehabilitation:

- 12.1. 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.

- 12.2. 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.
- 12.3. 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.
- 12.4. 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.

13. Inspection procedures of Prestressed Concrete Structure:

- 13.1. 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.
- 13.2. Deterioration of prestressed concrete: Provided below is an outline of some of the major forms of deterioration prestressed Concrete members are subject to:
 - (a) Cracking
 - (b) Deterioration of prestressing steel
 - (c) Another source of deterioration is the deck joint leakage
- 13.3. 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:
 - (i). 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.

- (ii). 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.
- (iii). 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.
- (iv). Sealers: Concrete sealers are used to protect the underlying concrete from being intruded by moisture.
- (v). Strengthening: Methods include bonded external reinforcement, tendon replacement and external posttensioning.
- (vi). Influence of maintenance on the design of highway structures:
- (vii). The design considerations could help a bridge serviceable at a minimum cost throughout its operational life.

14. Low-maintenance design:

- 14.1. 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.

15. Practical design considerations

- 15.1. 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.

- 15.2. 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.
- 15.3. 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 deflection. 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:
- 15.4. 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.

16. Mechanical and electrical equipment:

- 16.1. 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.
- 16.2. 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.
- 16.3. 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.

16.3.1. 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.

16.3.2. 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:

- (a) 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.
- (b) 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.
- (c) 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.

- (d) 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.

16.2.3. 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.

17. Tools & Plants:

17.1. The contractor 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

18. 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.

19. 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

1.1 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) License for use of explosives;
- (d) Permission of the State Government for drawing water from river / reservoir;
- (e) License 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) Any other permits or clearances required under Applicable Laws.

1.2 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.

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Schedule-G
(See Clauses 7.1 and 19.2)

Annex-I
(See Clause 7.1)

Form of Bank Guarantee
[Performance Security / Additional Performance Security]

To

Regional Officer,
Hyderabad, MoRTH

WHEREAS:

- (a) _____ [name and address of contractor] (hereinafter called the “Contractor”) and **Ministry of Road Transport & Highways, Govt. of India represented by Regional Officer, Hyderabad, MoRTH** (hereinafter called the “Authority”) have entered into an agreement (hereinafter called the “Agreement”) for “**Construction of Iconic Hybrid cable stayed and suspension bridge across Krishna River on NH -167K (Design Chainage 87+360 to 88+437) in the State of Telangana and Andhra Pradesh on EPC Mode**” 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 Authority of India], 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, fulfilment 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 fulfilment, 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 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.

Signed and sealed this day of, 22..... at

SIGNED, SEALED AND DELIVERED

For and on behalf of the Bank by:

(Signature)

(Name)

(Designation)

(Code Number)

(Address)

NOTES:

1. The bank guarantee should contain the name, designation and code number of the officer(s) signing the guarantee.
2. 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.

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

Annex-II

(Schedule - G)

(See Clause 19.2)

Form for Guarantee for Advance Payment

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Annex-III

(See Clause 7.1)

Form of Insurance Surety Bonds

[Performance Security / Additional Performance Security]

To

The Regional Officer
Hyderabad, MoRTH, Govt. of India

WHEREAS:

- (a) _____ [name and address of contractor] (hereinafter called the “**Contractor**”) has undertaken, in pursuance of Letter of Acceptance (LOA) No. _____ dated _____ for Construction of “**Construction of Iconic Hybrid cable stayed and suspension bridge across Krishna River on NH - 167K (Design Chainage 87+360 to 88+437 in the State of Telangana and Andhra Pradesh on EPC Mode**” (hereinafter called the “**Contract**”).
- (b) AND WHEREAS the Contract requires the Contractor to furnish an {Performance Security / Additional Performance Security} for due and faithful performance of its obligations, under and in accordance with the Contract, during the {Construction Period / Defects Liability Period and Maintenance Period} (as defined in the Agreement) in a sum of Rs..... cr. (Rupees crore) (the “**Surety Bond Amount**”).
- (c) We,through our branch at (the “**Surety Insurer**”) have agreed to furnish this Surety Bond by way of Performance Security.

NOW, THEREFORE, the **Surety Insurer** hereby, unconditionally and irrevocably, guarantees and affirms as follows:

1. The **Surety Insurer** 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 **Surety Bond** 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 Authority of India], 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 **Surety Insurer**. The **Surety Insurer** 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 **Surety Insurer**, 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 **Surety Bond**, the Authority shall be entitled to act as if the **Surety Insurer** were the principal debtor and any change in the constitution of the Contractor and / or the **Surety Insurer**, 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 **Surety Insurer** under this **Surety Bond**.
4. It shall not be necessary, and the **Surety Insurer** hereby waives any necessity, for the Authority to proceed against the Contractor before presenting to the **Surety Insurer** its demand under this **Surety Bond**.
5. The Authority shall have the liberty, without affecting in any manner the liability of the **Surety Insurer** under this **Surety Bond**, 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 **Surety Insurer** 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 **Surety Insurer** from its liability and obligation under this **Surety Bond** and the **Surety Insurer** hereby waives all of its rights under any such law.
6. This **Surety Bond** is in addition to and not in substitution of any other **Surety Bond** 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 **Surety Insurer** under this **Surety Bond** is restricted to the **Surety Bond** Amount and this **Surety Bond** 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 **Surety Insurer** under this **Surety Bond** all rights of the Authority under this **Surety Bond** shall be forfeited and the **Surety Insurer** shall be relieved from its liabilities hereunder.

8. The **Surety Bond** shall cease to be in force and effect on ****\$. Unless a demand or claim under this **Surety Bond** is made in writing before expiry of the **Surety Bond**, the **Surety Insurer** shall be discharged from its liabilities hereunder.
9. The **Surety Insurer** undertakes not to revoke this **Surety Bond** 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 **Surety Bond** and the undersigned has full powers to do so on behalf of the **Surety Insurer**.
10. Any notice by way of request, demand or otherwise hereunder may be sent by post addressed to the **Surety Insurer** 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 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 **Surety Bond** 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.

Signed and sealed this day of, 20..... at

SIGNED, SEALED AND DELIVERED

For and on behalf of the **Surety Insurer** by:

(Signature)

(Name)

(Designation)

(Code Number)

(Address)

NOTES:

3. The **Surety Bond** should contain the name, designation and code number of the officer(s) signing the **Surety Bond**.
4. The address, telephone number and other details of the head office of the **Surety Insurer** as well as of issuing branch should be mentioned on the covering letter of issuing branch.

\$ Insert date being 2 (two) years from the date of issuance of this **Surety Bond** (in accordance with Clause 7.2 of the Agreement).

Annex-IV

(Schedule - G)

(See Clause 19.2)

Form of Surety Bond for Advance Payment

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Schedule-H

(See Clauses 10.1.4 and 19.3)

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:

Bill No	Item	Weightage in percentage to the Contract Price	Stage for Payment	Percentage Weightage
1	2	3	4	5
1	I. Road works including culverts, widening and repair of culverts.	Nil		Nil
2	II. Minor Bridges/ Underpasses / Overpasses	Nil		Nil
3	III. Major Bridge (length h > 60 m.) and ROB/RUB/elevated sections/flyovers including viaducts, if any.	96.16%	C - New major bridges.	
			(1) Foundation: on completion of the foundation work of pylon.	5.58%
			(2) Sub-structure: On completion of Lower Pylon upto Deck level, Anchor Block, etc.	
			(a) Lower pylons up to deck soffit level	8.94%
			(b) Anchor Blocks	7.76%
			(3) Super-structure:	
			3.a) Supply & Erection of Suspension Cable, Suspenders, Stay cable and Accessories	
			a.1) Providing and installation of Stay Cable system comprising of Galvanized Strand, HDPE sheathing, Recess pipe with Bearing Plate and exit pipe, including Fabrication, Delivery, Testing, Permanent Protection including saddles	5.67%
			a.2) Providing and installation of Suspension Cable (Including Suspenders and Dummy Cables) system comprising of Anchorages, Galvanized Strand, HDPE sheathing, Recess pipe with Bearing Plate and exit pipe, including Fabrication, Delivery, Testing, Permanent Protection including saddles	19.85%

Bill No	Item	Weightage in percentage to the Contract Price	Stage for Payment	Percentage Weightage
1	2	3	4	5
			3.b) Supplying and fabrication of superstructure elements	
			b.1) supply, fabrication and erection of structural steel (incl. Metallisation of Steel Segments, cladding, support system for glass pedestrian walkway & emergency staircase at both pylons)	36.09%
			b.2) Concrete of structure including reinforcement (Deck sheet/form work and concreting for deck slab for bridge, walkway, cross over at walkway, etc.)	3.29%
			b.3) Aluminium composite Cladding	0.07%
			<u>3.c) Erection of superstructure elements and other deck fixtures</u>	
			c.1) Super structure element including reinforcement at both pylons (pylon above soffit level including Tie Beam)	8.67%
			c.2) Spherical Bearing including arrangement/steps/ladders/platform for inspection	0.46%
			<u>3.d) Walkway</u>	
			d.1) Glass walkway with SS with Glass railing	0.94%
			d.2) Walkway Entrance System: SS 4-seater Benches & Openings for walkway, Ramp connecting to walkway and Ramp at A2 connecting Service Road	0.03%
			d.3) Misc. items for walkway (SS railing for outer edge, dust-bin, chequered tiles for flooring etc.)	1.11%
			4) Wearing Coat including expansion joints	0.44%
			5) Miscellaneous items Like Approach slab, Hand Rails, Crash barriers, road markings, road sign and other safety items etc. (incl. chequered tiles, Kerb, Drainage Spout, anti-glare devices)	0.30%
			(6) Approaches & Pedestrian Ramps [including Foundation, Sub-structure, super structure, flooring, railing etc. for ramps and foundation, retaining walls/Reinforced Earth wall, embankment with geogrid, filter media etc., stone pitching, footpath, separator, pavement layer works, road safety items, crash barrier, drain work for approaches]	0.80%

Bill No	Item	Weightage in percentage to the Contract Price	Stage for Payment	Percentage Weightage
1	2	3	4	5
4	IV. Other Engineering Works (BHMS, Electrical Works)	3.84%	(1) Road Side Drains - RCC Box Drain with Footpath including Concrete tile Flooring & roofing of poly carbonate sheet including support system for glass pedestrian walkway & emergency staircase)	8.32%
			(2) Road markings for Approaches, road stud, kerb, Metal beam Crash Barrier, painting, etc.	1.36%
			(3) Illumination work (Streetlighting, and Façade Lighting)	
			i. Bridge Façade lighting (RGBW)	63.05%
			ii. Underdeck walkway lighting	8.86%
			iii. Street lighting	1.96%
			(4) Bridge Health Monitoring System including MBIU.	16.45%
		100%		

1.3 Procedure of estimating the value of work done

1.3.1. Major Bridges (Length > 60m)

Procedure for estimating the value of Major Bridges (Length > 60m) shall be as stated in table 1.3.1:

Table 1.3.1

Sr. No.	Stage of Payment	Percentage - weightage	Payment Procedure
A.2	New Major Bridges	96.16%	
1	(1) Foundation: on completion of the foundation work of pylon.	5.58%	Payment shall be made on pro rata basis on completion of minimum 25% of total depth of each foundation / minimum 25 % of No. of piles.
			In case where load testing is required for foundation, the trigger of first payment shall include load testing also where specified.
2	(2) Sub-structure: On completion of Lower Pylon upto Deck level, Anchor Block, etc.		
	(a) Lower pylons up to deck soffit level	8.94%	Payment shall be made on pro rata basis on completion of minimum 15% of total height of each pylon as per the weightage given in this table

Sr. No.	Stage of Payment	Percentage - weightage	Payment Procedure
	(b) Anchor Blocks	7.76%	Payment shall be made on pro rata basis on completion of minimum 15% of total height of each Anchor Block as per the weightage given in this table
3	Super-structure completion		
	3.a) Supply & Erection of Suspension Cable, Suspenders, Stay cable and Accessories		
	a.1) Providing and installation of Stay Cable system comprising of Galvanized Strand, HDPE sheathing, Recess pipe with Bearing Plate and exit pipe, including Fabrication, Delivery, Testing, Permanent Protection including saddles	5.67%	Payment for supply and installation of stay cables shall be made on pro-rata basis on completion of stage as per following weightage: 45% payment shall be made for the material brought on site, after satisfactory completion of fatigue & other tests, 45% payment shall be made after installation of all the cable along with its accessories as described below: Payment for this shall be made on pro rata basis on completion of minimum 12 Nos. of stay cables. Payment for the suspenders/ dummy cable shall be made on pro rata basis on installation of minimum 05 nos. suspenders/ dummy cable 10% payment shall be made after final successful load test of the Bridge.
	a.2) Providing and installation of Suspension Cable (Including Suspenders and Dummy Cables) system comprising of Anchorages, Galvanized Strand, HDPE sheathing, Recess pipe with Bearing Plate and exit pipe, including Fabrication, Delivery, Testing, Permanent Protection including saddles	19.85%	
	3.b) Supplying and fabrication of superstructure elements		
	b.1) supply, fabrication and erection of structural steel (incl. Metallisation of Steel Segments, cladding, support system for glass pedestrian walkway & emergency staircase at both pylons)	36.09%	Payment for the works shall be made on pro-rata basis , corresponding to the completion of the respective stages of work for a minimum of 5% of the total linear length of the superstructure, as per the percentages specified herein: a) Fifty-five percent (55%) of the payable amount shall be released upon supply of materials and completion of fabrication and assembly of the truss segments at site , in accordance with the approved drawings and as per the applicable specifications. b) Forty percent (40%) of the payable amount shall be released upon successful erection and positioning of the truss segments in their final location , including completion of all required tests, checks, and certifications as per the specifications and approved erection methodology.

Sr. No.	Stage of Payment	Percentage - weightage	Payment Procedure
			Note: 1) The maximum payment at any time against un-erected or un-launched, finished fabricated segments brought and assembled at site shall not exceed twenty-five percent (25%) of the total number of segments or corresponding linear length proposed to be launched. 2) The balance five percent (5%) of the payable amount shall be released upon successful completion of the final load test of the bridge , to the satisfaction of the Engineer-in-Charge.
	b.2) Concrete of structure including reinforcement (Deck sheet/form work and concreting for deck slab for bridge, walkway, cross over at walkway, etc.)	3.29%	Payment shall be made on pro rata basis on completion of minimum 10% of total length of deck slab as per the weightage given in this table
	b.3) Aluminium composite Cladding	0.07%	Payment shall be made on the completion of whole work as per the weightage given in this table
	3.c) Erection of superstructure elements and other deck fixtures		
	c.1) Super structure element including reinforcement at both pylons (pylon above soffit level including Tie Beam)	8.67%	Payment shall be made on pro rata basis on completion of minimum 15% of total height of each pylon as per the weightage given in this table
	c.2) Spherical Bearing including arrangement/steps/ladders/platform for inspection	0.46%	Payment shall be made on the completion of whole work as per the weightage given in this table
	3.d) Walkway		
	d.1) Glass walkway with SS with Glass railing	0.94%	Payment shall be made on the completion of whole work as per the weightage given in this table
	d.2) Walkway Entrance System : SS 4 seater Benches & Openings for walkway, Ramp connecting to walkway and Ramp at A2 connecting Service Road	0.03%	Payment shall be made on the completion of whole work as per the weightage given in this table.
	d.3) Misc. items for walkway (SS railing for outer edge, dust-bin, chequered tiles for flooring etc.)	1.11%	Payment shall be made on the completion of whole work as per the weightage given in this table
4	4) Wearing Coat including expansion joints	0.44%	Payment shall be made on the completion of wearing coat including expansion joints complete in all respects as specified

Sr. No.	Stage of Payment	Percentage - weightage	Payment Procedure
5	5) Miscellaneous items Like Approach slab, Hand Rails, Crash barriers, road markings, road sign and other safety items etc. (incl. chequered tiles, Kerb, Drainage Spout, anti-glare devices)	0.30%	Payment shall be made on the completion of all miscellaneous works like Approach slab, Hand Rails, Crash barriers, road markings, road sign and other safety items etc. (incl. chequered tiles, Kerb, Drainage Spout, anti-glare devices) complete in all respects as specified
6	(6) Approaches & Pedestrian Ramps [including Foundation, Sub-structure, super structure, flooring, railing etc. for ramps and foundation, Retaining walls/Reinforced Earth wall, embankment with geogrid, filter media etc., stone pitching, footpath, separator, pavement layer works, road safety items, crash barrier, drain work for approaches]	0.80%	Payment shall be made on the completion of both Pedestrian Ramp and Approaches [including Foundation, Sub-structure, super structure, flooring, railing etc. for ramps and foundation, retaining walls/Reinforced Earth wall, embankment with geogrid, filter media etc., stone pitching, footpath, separator, pavement layer works, road safety items, crash barrier, drain work for approaches] etc. complete in all respects as specified

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

Sr. No.	Stage of Payment	Percentage - weightage	Payment Procedure
	Other Works	3.84%	
1	(1) Road Side Drains - RCC Box Drain with Footpath including Concrete tile Flooring & roofing of poly carbonate sheet including support system for glass pedestrian walkway & emergency staircase)	8.32%	Payment shall be made on the completion of whole works as per the weightage given in this table
2	(2) Road markings for Approaches ,road stud, kerb, Metal beam Crash Barrier, painting, etc.	1.36%	Payment shall be made on the completion of whole works as per the weightage given in this table
3	(3) Illumination work (Streetlighting, and Façade Lighting)		Payment shall be made on the completion of whole works after successful testing as per the weightage given in this table
	i. Bridge Façade lighting (RGBW)	63.05%	
	ii. Underdeck walkway lighting	8.86%	
	iii. Street lighting	1.96%	
4	(4) Bridge Health Monitoring System including MBIU.	16.45%	Payment shall be made after installation, Testing and submission of First Report of Bridge Health Monitoring System (BHMS) / MBIU

@ For calculation of payment stage for main carriageway the project length shall be converted into equivalent 2 lane length. For example, if the total length of 4 lane main carriageway is 100 km, then the equivalent length for calculation of payment stage will be 2 x 100 km. Now, 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:

$$\text{Cost per km} = P \times \text{weightage for road work} \times \text{weightage for bituminous work} \times (1 / L)$$

Where

P = Contract Price

L = Total equivalent 2-Lane length in km as defined above

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 including the length not handed over to the Contractor under clause 8.3 of this Contract Agreement 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

2. Procedure for payment for Maintenance

- (a) **The cost for maintenance shall be as stated in Clause 14.1.1.**
- (b) **Payment for Maintenance shall be made in accordance with the provisions of Clause 19.7.**

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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.

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Annex – I
(Schedule - I)

List of Drawings

- i) Detailed Geotechnical report
- ii) Drawings of horizontal alignment, vertical profile and cross sections at 20 m interval
- iii) Drawings of road furniture items including traffic signage, markings, safety barriers, traffic calming measures, rumble strips, pedestrian railing etc.
- iv) Drawings of traffic control measures
- v) General arrangement drawing for Hybrid cable stayed cum suspension bridge
- vi) Details of foundations, substructure and superstructure for Hybrid cable suspension bridge including temporary structures
- vii) Drawings of typical details slope protection measures
- viii) Drawings of Retaining/Breast walls
- ix) Drawings of pedestrian crossings
- x) Drawings of street lighting
- xi) Drawings of project facilities provided

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Schedule-J

(See Clause 10.3 (ii))

Project Completion Schedule

1. Project Completion Schedule – 36 months (1095 Days) from appointed date.

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

- 2.1 Project Milestone-I shall occur on the date falling on the 383rd day [35% of the Scheduled Construction Period] day from the Appointed Date (the “Project Milestone- I”).
- 2.2 Prior to the occurrence of Project Milestone-I, the Contractor shall have commenced construction of the Project Highway and submitted to the Authority duly and validly prepared Stage Payment Statements for an amount not less than 10% (ten per cent) of the Contract Price.

3. Project Milestone-II

- 3.1 Project Milestone-II shall occur on the date falling on the 657th day [60%of the Scheduled Construction Period] day from the Appointed Date (the “Project Milestone- II”).
- 3.2 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 per cent) of the Contract Price and should have started construction of all bridges.

4. Project Milestone-III

- 4.1. Project Milestone-III shall occur on the date falling on the 931st day [85% of the Scheduled Construction Period] day from the Appointed Date (the “Project Milestone- III”).
- 4.2. 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 per cent) of the Contract Price and should have started construction of all project facilities.

5. Scheduled Completion Date

5.1 The Scheduled Completion Date shall occur on the 1095th day [Scheduled Construction Period] from the Appointed Date.

5.2 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

- 1.1 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.
- 1.2 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

- 2.1 **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 [***].
- 2.2 **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 equipment's and the maximum permissible roughness for purposes of this Test shall be [2,000 (two thousand)] mm for each kilometre.
- 2.3 **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.

Span Load Test - The span load test shall be conducted as per IRC:SP:51-2015 "Guidelines for load testing of Bridges"

- 2.4 **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.
- 2.5 **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.
- 2.6 **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) NSV shall be conducted (as per guidelines of Ministry) before issue of provisional/final completion certificate, & at every six months after completion of work till the end of DLP/maintenance period.
2	Roughness of	Network Survey	At least twice a year (As per

Sr. No.	Key metrics of Asset	Equipment to be used	Frequency of condition survey
	pavement	Vehicle (NSV)	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.

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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 Iconic Hybrid cable stayed and suspension bridge across Krishna River on NH -167K (Design Chainage 87+360 to 88+437) in the State of Telangana and Andhra Pradesh under EPC Mode"** (the "Project 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 of20.....

SIGNED, SEALED AND
DELIVERED

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

(Signature)

(Name)

(Designation)

(Address)

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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

- 1.1. Monthly lump sum payments for maintenance shall be reduced in the case of noncompliance with the Maintenance Requirements set forth in Schedule-E.
- 1.2. 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.
- 1.3. 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

- 2.1. The following percentages shall govern the payment reduction:

Sl. No.	Item / Defect / Deficiency	Percentage
(a)	Carriageway / Pavement	
(i)	Potholes, cracks, other surface defects	10%
(ii)	Repairs of Edges, Rutting	2%
(b)	Bridges	
(i)	Cleaning - Vegetation growth, flooring, Glass flooring, parapets, wearing course, walkway, railings, footpaths, benches, staircase areas.	12%
(ii)	Any Defects in superstructures, bearings and sub-structures	10%
(iii)	Painting, repairs / replacement - Kerbs, railings, parapets, guideposts / crash barriers/ walkway glass/ vertical glass of walkway/Benches/Staircase	16%
(c)	Roadside Drains	
(i)	Cleaning and repair of drains	3%
(d)	Road Furniture	
(i)	Cleaning, painting, replacement of road signs, delineators, road markings, 200 m / km / 5th km stones	2.5%
(e)	Miscellaneous Items	
(i)	Removal of dead animals, broken down / accidented vehicles, road blockades or malfunctioning of mobile crane & MBIU	5%
(ii)	Any other Defects in accordance with paragraph 1.	2.5%

Sl. No.	Item / Defect / Deficiency	Percentage
(f)	Defects in Other Project Facilities, lighting etc.	5%
(g)	Bridge Health Monitoring System (BHMS)	30%
(h)	CCTV inside walkway	2%

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

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

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

- 1.1 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.
- 1.2 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

- 2.1 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.

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Annex – I
(Schedule - N)

Terms of Reference for Authority's Engineer

1. Scope

- 1.1 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 Iconic Hybrid cable stayed and suspension bridge across Krishna River on NH -167K (Design Chainage 87+360 to 88+437 in the State of Telangana and Andhra Pradesh under EPC Mode**", and a copy of which is annexed hereto and marked as Annex-A to form part of this TOR.
- 1.2 The TOR shall apply to construction and maintenance of the Project Highway.

2. Definitions and interpretation

- 2.1 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.
- 2.2 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.
- 2.3 The rules of interpretation stated in Article 1 of the Agreement shall apply, mutatis mutandis, to this TOR.

3. General

- 3.1 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.
- 3.2 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.

- 3.3 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.
- 3.4 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.
- 3.5 The Authority's Engineer shall aid and advise the Authority on any proposal for Change of Scope under Article 13.
- 3.6 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

- 4.1 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.
- 4.2 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.
- 4.3 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.

- 4.4 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.
- 4.5 Deleted.
- 4.6 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.
- 4.7 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.
- 4.8 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.
- 4.9 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 quality management. For purpose of this paragraph 4 (ix), the tests specified in the MoRTH Specifications for Road and Bridge Works and respective Indian Roads Congress Standards/ Guidelines/Manuals, together with any other Indian/International Standards mentioned therein including any modifications/substitutions thereof shall be deemed to be tests confirming to Good Industry Practice for quality Management.
- 4.10 The Authority's Engineer shall witness all the quality control tests carried out by the Contractor at its laboratory/main site laboratory/field/plants. These include tests for all materials, products, mixes, etc. Authority's Engineer shall also witness all tests of finished products like bearing in the manufacturers' laboratory as respective mandated standards. Authority's Engineer will also conduct review of quality control documents in of factory respect manufactured materials /finished products, etc. as per IRC: SP:112
- 4.11 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 accordance with the MORTH specifications for Road & Bridge works and respective Indian Roads Congress Standards/ Guidelines/Manuals other together with any Indian/International Standards referred thereto. The tests shall be undertaken on 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.

- 4.12 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.
- 4.13 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.
- 4.14 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.
- 4.15 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.
- 4.16 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.
- 4.17 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.
- 4.18 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

- 5.1 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.
- 5.2 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.
- 5.3 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.
- 5.4 In respect of any defect or deficiency referred to in Paragraph 3 of Schedule- E, the Authority's Engineer shall, in conformity with Good 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.
- 5.5 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

- 6.1 The Authority's Engineer shall determine the costs, and / or their reasonableness, that are required to be determined by it under the Agreement.
- 6.2 The Authority's Engineer shall determine the period of Time Extension that is required to be determined by it under the Agreement.
- 6.3 The Authority's Engineer shall consult each Party in every case of determination in accordance with the provisions of Clause 18.5.

7. Payments

- 7.1 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).

7.2 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.

7.3 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.

7.4 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

9.1 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.

9.2 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.

9.3 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.

- 9.4 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.
- 9.5 The Authority's Engineer shall inform the Authority and the Contractor of any event of Contractor's Default within one week of its occurrence.

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Schedule-0

(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

1.1 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.

1.2 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

3.1 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. [*****]

3.2 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.

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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 Iconic Hybrid cable stayed and suspension bridge across Krishna River on NH - 167K (Design Chainage 87+360 to 88+437) in the State of Telangana and Andhra Pradesh under EPC Mode"** (the "Project Highway") 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 *****