DESIGN OF SUBMERSIBLE BRIDGE ACROSS AYAD RIVER ON FATEHPURA BHUWANA ROAD

PREAMBLE

Type of Bridge

The bridge shall be a submersible bridge having HFL as 102.00 m. and deck level as 101.50 m.

The deck slab shall be anchored to the pier with anchor bars; the detail of deck slab anchorage is shown in drawing TEJ-01 enclosed herewith.

This anchorage is in accordance to IRC guidelines given is the paper on submersible bridges there is no standard codal provision is available for deck slab anchorage.

Decking Arrangement

The location of proposed road is 18^0 39' 51" skew to the direction of flow as measured at field please refer Survey Plan enclosed.

However standard RCC Solid Slab Superstructure (30^0 Skew) with right effective span 10 M with footpath shall be provided in accordance to the Ministry of Surface Transport (Roads Wing), New Delhi drawing numbers SD/151, SD/153, SD/156, SD/157 & SD/176.

It is proposed to construct two adjacent slabs of these standard drawings with Expansion Joint in between them at median.

As per requirement of use in two adjacent slabs with median the deviation with respect to these drawings shall be as follows:-

1. Right Pier Cap Width 1500 mm [In the reference drawing the pier cap width is 800 mm]. Due to this change the skew length of the slab shall be 12820 mm (centre to centre over piers). In reference drawings this is shown as 12009 mm.

2. Carriage way width = 7000 mm instead of 7500 mm

3. Footpath & Railing: - The total width of footpath & railing shall be 1500 mm instead of 2250 mm. The footpath & railing towards median side shall be substituted by 487.5 mm wide Kerb. The total width of each slab shall be 8987 mm instead of 12000 mm.

4. Reinforcement Detailing: - The reinforcement detailing is suitably modified as required for the modifications referred above in points 1 to 3.

The proposed decking arrangement is shown in Drawing – UIT01 titled as Decking arrangement.

Design Loads

The following roads have been considered in the design deck slab:-

a) One lane of IRC class 70R or two lanes of IRC Class A on carriage way, whichever governs?

b) Footpath land of 5KN/Sqm.

c) Wearing coat land of 2 Kg/Sqm.

Safe Bearing Capacity

The detailed sub soil investigation report is enclosed.

The foundation rock is Greywacke which is safe against the eroding effects of the water flow and other climatic conditions.

As per detailed subsoil investigation the lowest safe bearing capacity is 1.9 N/ Sq mm which is Equal to 1900 kN/ Sq M; However the adopted Safe Bearing Capacity is 500 kN/ Sq M.

[Please Refer Page 16 of the Report by M/s Rahul Engineers for details.]

Depth of Foundation / Founding Level

The hard rock is available in 5 m to 7 m depth form river bed level and as per codal provisions the foundation is to be embedded in 1.2 m depth however it is proposed to embed the foundation 1.5 m in the rock.

Scour Depth

The computation of scour depth provided in the design is a part of formal design steps and when hard rock is encountered there is no need to embed the foundation in accordance to the scour depth.

Annular Space Filling Around Foundation Footing

As per the suggestion given for protection of footing (Ref. Hand book for Bridge Engineer copy enclosed as (Annexure TEJ04) the annular space around footing shall be filled with PCC 1:3:6 upto the rock level.

The provision is in accordance to there suggestions.

Detailed Structural Analysis for Skew Effect

The location of proposed road is 18^0 39' 51" skew to the direction of flow as measured at field please refer Survey Plan enclosed.

However standard RCC Solid Slab Superstructure (30^0 Skew). The effect is computed for stability analysis as per IRC 6-1966 Clause 213.5

Revised live land calculation for check of stability of pier is unclosed for scrutiny. Ref. Annexure TEJ-02

Reinforcement Detail & other Detail of Deck slab

Ministry of surface transport details drainage No. SD/151, SD/152, SD/153, SD/156, SD/157,SD/158,SD/159 & SD/160,SD/175 & SD/176 are enclosed which contains miscellaneous details of deck slab including reinforcement drawing.

The right effective span of the proposed bridge is 10 m. The Skew length along the centre line of road between pier centers is 12.82 m.

The deck slab pertaining to 10 m. right effective span shall be provided as given in MOST drawing No. SD/176.

In the drawing No. SD/176 the clear right span is 9600 mm. The proposed bridge shall have clear right span as 9600 mm conforming to the standard drawing adopted.

Bearing detail

Tar paper bearing shall be providing on top of pier cap & abutment cap.

Approach slab

The detail of approach slab is enclosed as drawing TEJ-03.

Pier Cap Detail

Pier cap drawing is enclosed as annexure TEJ-05.

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Project :- (DESIGN OF PIER CAP SUBMERSIBLE BRIDGE ACROSS AYAD RIVER ON FATEHPURA BHUWANA ROAD

DESIGN OF PIER CAP :-

D.L./ M Width along bridge

DL. Of Slab =	0.975	x	9	x.	2.4 =	21.06 T
D.L. of Wearing coat =	0.075	x	9	x.	2.4 =	1.62 T
					TOTAL	22.68 T

D.L. of Slab & Wearing coat on half of the pier = 22.68 / 2 = 11.34 T

L.L. on Pier cap including impact along bridge = 82.50 x 1.1375 = 93.84 T

(Refer Live Load Computation)

Dispersion width across the span for 70 T TRACKED VEHTCLE = 6.695 M

(Refer Solid slab design page SS-16)

Live Load u.d.l. on Pier Per M width = 93.84 / 6.695 = 14.02 T

Total Load on Half of pier along bridge = 11.34 + 14.02 = 25.36 T Per M width

Effective depth of slab =75-2.5-2.5/2 = 71.25 cm

Placement of the live load at effective depth from the support (taking support width 750 mm)

Eccentricity = 71.25 -75/2 = 33.75 cm = 0.34 M

Bending Moment along the bridge = 25.36 x 0.34 = 8.56 T - M/M width

This moment is too small hence it will not/be the governing B.M.

PIER CAP IS OF M 250 GRADE

σ_{st} =	2000	Kg/Cm2,	Q =	11.049	Kg. Km2,		J =	0.902	
$d_{reqd.}$ =[	8.56	x	100000	/(	11.049	x	100)]$^{1/2}$=	27.83	cm
d_{pro} =	120.00	-	4.00	-	2.00	/	2 =	115.00	cm (OK)

$Ast_{reqd.}$ =[8.56 x 100000 /(2000 x
0.902 x 115.00)] = 4.13 cm^2

Which is too small.

Provide Minimum Steel.

PIER SECTION ACROSS BRIDGE

D.L/M Width across bridge :-

Slab D.L.	0.975	x	9	x.	2.4	=	21.06 T
D.L. of Wearing coat =	0.075	x	9	x.	2.4	=	1.62 T
					TOTAL		22.68 T

D.L. of Slab & Wearing coat on half of the pier = 22.68 / 2 = 11.34 T/ M width

L.L on pier = 64.69 T

(Refer Abutment stability page 4)

Dispersion width along the span for
70 T Tracked vehical = 5.3 M

(Refer Solid slab design page 14)

L.L. . per M width on pier = 64.69 / 5.3 = 12.21 T/ M width

Total D.L. + L.L. on half of Pier across bridge per M width = 11.34 + 12.21 = 23.55 T Per M width

The Live Load is with clearance from the Footpath and kerb. The cantilever portion of pier cap and width of footpath is 1500 mm Hence There is no eccentricity.

Bending Moment across the bridge = 23.55 x 0 = 0.00 T - M/M width

σ_{st} =	2000	Kg/Cm2,	Q =	11.049	Kg. Km2,		J =	0.902	

$d_{reqd.}$ =[0.00 x 100000 /(11.049 x 100)]$^{1/2}$= 0.00 cm

d_{pro} = 120.00 - 2.50 - 2.00 / 2 = 116.50 cm (OK)

$Ast_{reqd.}$ =[0.00 x 100000 /(2000 x 0.902 x 116.50)] = 0.00 cm^2

Provide Minimum steel

Minimum Reinforcement calculation for Pier cap :-

As per clause 116.1, IRC- 78 - 1983, the thickness of pier cap shall be at least 225 mm However the thickness provided of Pier cap here is 1200 MM.

Grade of Concrete M 250

Reiforcement in Pier cap as per clause 716.2.1 - IRC 78 - 1983

= 1% steel assuming cap 225 mm thick
However provide = 1% steel assuming cap 1200 mm thick
= 1/100 x 150 x 22.5 33.75
= 33.75 Cm^2
This steel shall be distributed equally and provided both at top and bottom in two derections.
Provide 25 mm tor reiforcement @ 100 mm c/c (14 Nos.) in top along the pier cap
Provide 16 mm tor reiforcement @ 100 mm c/c (14 Nos.) in bottom along the pier cap

Area of Steel Provided
= (14x 4.91)+ (14x 2.01) = 96.88 Cm2 > 33.75 Cm^2 OK

+ 32.30 Cm^2 > 27 Cm^2

SHEAR CHECK ALONG BRIDGE DIRECTION

V = 23.55 T

Nominal Shear Stress. = 23.55 x 1000 /(100 x 116.50) cm

= 2.02 Kg/ Cm 2

Permissible Shear Stress = K1 x K2 x s

s = 4 Kg/ Cm2 accroding to 304.73.1 ; IRC 21

K1 = 1.14 - 0.7 xdegr > 0.5 ; depr Cm2

= 1.14 - 0.7 x 1.15 > 0.5

= 0.335 < 0.5

= K1 = 0.5

K2 = 0.5 + 0.25 P > 1

$= 0.5 + 0.25 \times \frac{100 \times 32.80}{100 \times 115}$ > 1

0.52 > 1

= K2 = 1

= 0.5 x 1 x 4 = 2 Kg/ Cm^2

No Shear reinforcement is required as per clause 304. - 7.3. 1 -Section- 3 of IRC 21- 1987

Yet

Provide 16 mm tor 2 legged vertical stirrups @ 100 mm centre to centre along the pier cap

Provide 16 mm tor 2 legged horizontal stirrups @ 100 mm centre to centre along the pier cap

SHEAR CHECK ACROSS BRIDGE DIRECTION

V = 20.3 T

Nominal Shear Stress. = 20.3 x 1000 /(100 x 116.50) cm

= 1.74 Kg/ Cm 2

Permissible Shear Stress = K1 x K2 x s

s = 4 Kg/ Cm2 accroding to 304.73.1 ; IRC 21

As Calculation already done above

K1 = 0.5

K2 = 1.0

= 4

= 0.5 x 1 x 4 = 2 Kg/ Cm2

> 1.77 Kg/Cm2

No Shear reinforcement is required as per clause 304. - 7.3. 1 -Section- 3 of IRC 21- 1987

Yet

Provide 16 mm tor 2 legged vertical stirrups @ 100 mm centre to centre along the pier cap

Provide 16 mm tor 2 legged horizontal stirrups @ 100 mm centre to centre along the pier cap