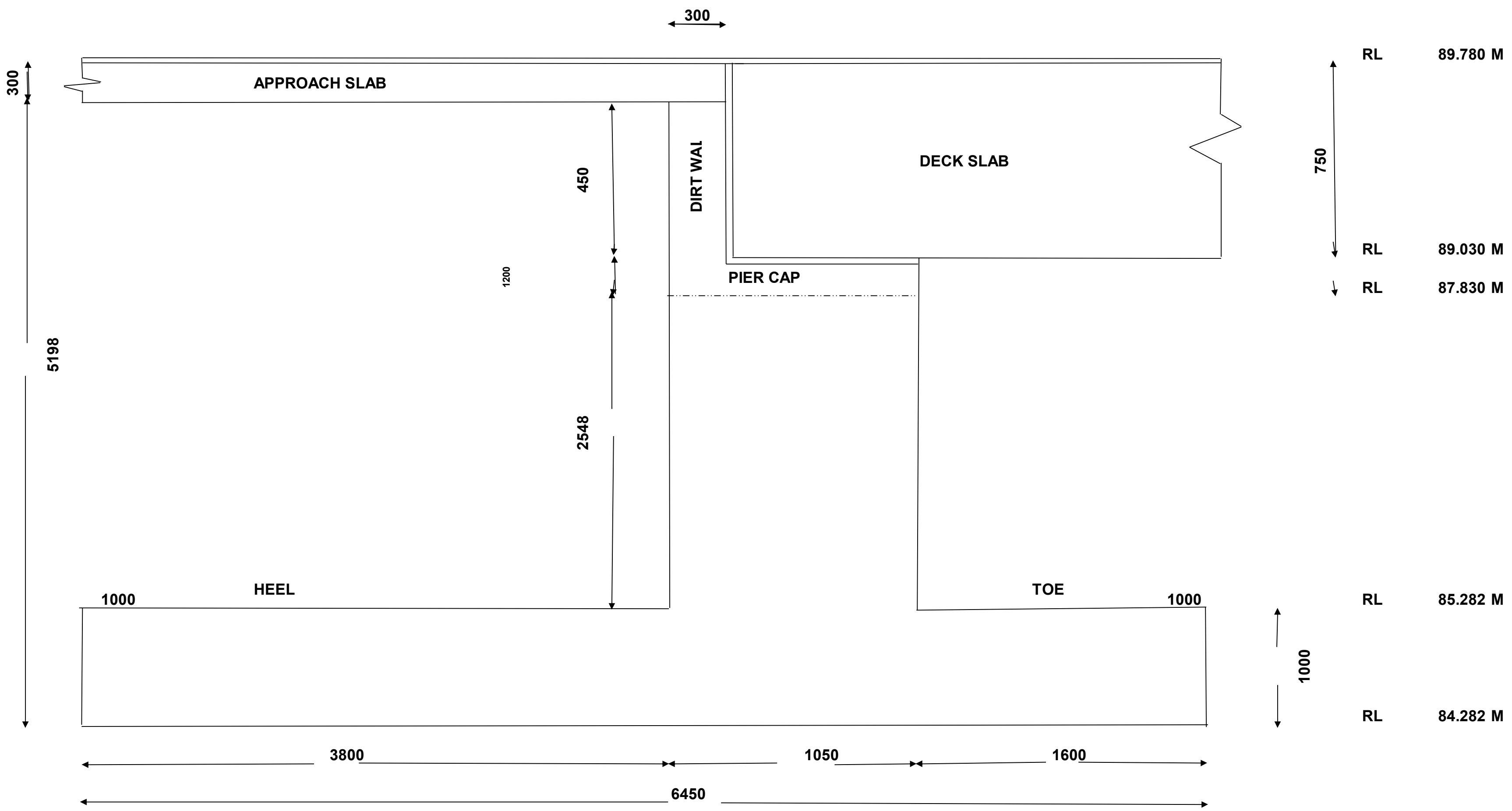
HIGH LEVEL BRIDGE - ACROSS SIRVAL RIVER

Deck Level	89.780 M			
Foundation Level	84.282 M			
Thickness of Deck Slab	750 mm			
Thickness of Approach Slab	300 mm			
Height below Approach Slab	5198 mm			
Length of Heel projection	3800 mm	Offset	1000 mm	
Length of Toe projection	1600 mm	Offset	1000 mm	
Width of Stem	1050 mm			
Thickness of Abutment Cap	1200 mm			
Thickness of Dirt Wall	300 mm			
Depth of Footing	1000 mm			

VARIANTS

187.68	kN/m2	0
0.44	kN/m2	0



TYPICAL SECTION OF THE ABUTMENT TYPABUT-01

Design of ABUTMENT

HIGH LEVEL BRIDGE - ACROSS SIRVAL RIVER

(a) Data

Preliminary dimensions	: Assumed as in Fig. **TYPABUT-01**	
Superstructure	: RCC Slab Bridge Total Width of Slab =	8.40 M
	overall length = 8.80 m	
Type of abutment	: Reinforced concrete	
Loading	: As for National Highway	
Back fill	: Gravel with angle of repose Φ =	35 °
	Unit weight of back fill, w =	18 kN/m3
	Angle of internal friction of soil on wall, z =	17.5 °
Approach slab	: R.C. slab 300 mm thick, adequately reinforced	

Load from superstructure per running foot of abutment wall:

Dead load = 72.72 kN/m

Live load = 93.84 kN/m

(Refer Stability Analysis for sub structure. The above two values are obtained from the calculations for superstructure, and are taken to act over a width of 15 m).

Bearing : Tar Paper Bearings

(C) Self weight of abutment

Treating the section as composed of 6 elements as shown in Fig. 1the weight of each element and moment about the point O on the front toe are computed as in Table 1

(d) Longitudinal forces

(i) Force due to braking

Force due to 70 R wheeled vehicle = 0.2 x 1000 = 200 kN

This force acts at 1.2 m above the road level(Clause 214.3).

Force on one abutment wall = 200 / 2 = 100 kN

Horizontal force per m of wall = 100 / 8.40 = 11.91 kN/ m

(ii) Force due to temperature variation and shrinkage

Assuming moderate climate, variation in temperature is taken as + 17 oC as per Clause 218.5 of Bridge Code.

Coefficient of Thermal expansion = 1.17E-05 /^{o}C

Strain due to temperature variation = 17 x 1.17E-05 = 1.99E-04

From Clause 220.3, strain due to concrete shrinkage = 2.00E-04

Total strain due to temperature and shrinkage = 1.99E-04 + 2.00E-04 = 3.99E-04

Horizontal deformation of deck due to temperature and shrinkage affecting one abutment = 3.99E-04 x 11200 /2 = 2.23E+00 mm

Modulus of Elasticity Ec = 5000x fck$^{1/2}$ = 31220.19 N/mm2

Horizontal Stress due to strain in longitudinal direction at bearing level = 3.99E-04 x 31220.19 = 12.45 N/mm2

Horizontal Force due to strain in longitudinal direction at bearing level (For 1 m width of Slab) =

1.25E+01 x 750 = 9340.30 N/m

= 9.34 kN/m

(iii) Vertical reaction due to braking

$$\text{Vertical reaction at one abutment} = \frac{200(1.2 + 0.975)}{11.10 \times 15} = 2.61 \text{ kN/m}$$

(d)Earth pressure

Active earth pressure $P = 0.5\ wh^2\ K_a$

where K_a is obtained from Equation (3.5)

$K_a = \sec\Theta \sin(\Theta-\Phi)/[(\sin(\Theta+z))^{1/2} + \{\sin(\Phi+z) \sin(\Phi-\delta)/\sin(\Theta-\delta)\}^{1/2]}$

Where P= Total active pressure, acting at a height of 0.42 h inclined at z to the normal to the wall on the earth side

w = unit weight of earth fill

h = height of wall

Θ = Angle subtended by the earthside wall with thw horizontal on the earth side

Φ = Angle of internal friction of the earthfill

z = angle of friction of the earthside wall with the earth

δ = Inclination of earthfill surface with the horizontal

$\Theta = 90^0$ $\Phi = 35^0$

$z = 17.5^0$ $\delta = 0^0$

Substituting values in Equation (3.5), we get K_a = 0.496 Coefficient

Height of backfill below approach slab = 5.20 m

Active earth pressure =

$0.5 \times 18 \times 5.20^2 \times 0.496$

= 120.62 kN/m

Height above base of centre of pressure = 0.42 x 5.20 = 2.19 m

Passive pressure in front of toe slab is neglected.

(e) Live load surcharge and approach slab

Equivalent height of earth for live load surcharge as per clause 714.4 is 1.20 m

Horizontal force due to L.L. surcharge =1.2 x 18 x 0.496 x 9.20 = 55.69 kN/m

Horizontal force due to approach slab = 0.3 x 24 x 0.496 x 9.20 = 18.57 kN/m

Total 74.26 kN/m

The above two forces act at **2.599 m above the base.**

Vertical load due to L.L. surcharge and approach slab

= (1.2 x 18 + 0.3 x 24) x 3.8 = 109.44 kN/m

(f) Weight of earth on heel slab

Vertical load = 18 x3.8x (5.198 - 1) = 75.57 kN/m

(g) Check for stability - overturning

The forces and their position are as shown in Fig. 1

The forces and moments about the point O at toe on the base are tabulated as in Table 1 Two cases of lading condition are examined (i) Span loaded condition and (ii) Span unloaded condition.

Case (i) Span loaded condition

See Row 15 of Table 12.3

Overturning moment about toe =	558.10 kN-m			
Restoring moment about toe =	1869.75 kN-m			
Factor of safety against overturning =	1869.75 /	558.10 =		**3.35**
Location of Resultant from O				**> 1.5 Hence Safe**

$X_0 = (M_V - M_H) / V= (1740.9 - 623.1) / 691.4 = 1.62$ m

=(1869.748 - 558.099) / 606.677) = 2.16 m

Eccentricity of resultant

e_{max} = B/6 =	6.45 /6 =	1.08 m		
e = (B/2 -$X_{0)}$ = 0.78 m < 0.80 m	3.23 -	2.16 =	1.07 m	
		<	1.08 m	

Case (ii) Span unloaded condition

See Row 11 of Table 12.3

Overturning moment about toe =	501.53 kN-m			
Restoring moment about toe =	1679.24 kN-m			
Factor of safety against overturning =	1679.24 /	501.53 =	**3.35**	
Location of Resultant from O			**> 1.5 Hence Safe**	

X_0 = (M_V - M_H) / V=

=(1679.238 - 501.526) / 510.223) = 2.31 m

(h)Check for stresses at base

For Span loaded condition

Total downward forces = 606.68 kN

606.68 6 x 0.78

Extreme stresses at base =

Maximum Stress = 606.677/(6.45x1)(1 +(6x1.07/6.45))	=	187.68	kN/m2
Minimum Stress = 606.677/(6.45x1)(1 -(6x1.07/6.45))	=	0.44	kN/m2

Table 1 Forces and Moments About Base for Abutment.

Sl. No.	Details	Force, kN		Moment about O, kn-m		
		V	H	Arm m	Mv	M_H
1.	D.L. from superstructure	72.72	-	1.98	144.000	-
2.	Horizontal force due to temperatre and shrinkage	0	9.34	4.75	-	44.366
3.	Active earth pressure	0	120.62	2.19	-	264.158
4.	Horizontal force due to L.L surcharge and approach slab	0	74.26	2.599	-	193.002
5.	Vertical load due to L.L. surcharge and approach slab	109.44	-	4.55	497.952	-
6.	Self weight - part 1 6.45x1x 24 =	154.80	-	3.225	499.23	-
7.	Self weight - part 2 2.548x1.05x 24 =	64.21	-	2.13	136.767	-
8.	Self weight - part 3 1.2x1.05x 24 =	30.24	-	1.68	50.8032	-
9.	Self weight - part 4 0.3x0.45x 24 =	3.24	-	2.05	6.642	-
10.	Weight of earth on heel slab part 1 Rectangular Portion 1 x 4.198 x 18=	75.57	-	4.55	343.844	-
11.	**Items 1 to 10 (Span unloaded condition)**	**510.22**			**1679.24**	**501.53**
12.	L.L. from Superstructure Class 70 R wheeled vehicle	93.84	-	1.975	185.336	-
13.	Vertical force due to braking	2.61	-	1.98	5.173	-
14.	Horizontal force due to braking	0.00	11.91	4.75		56.5725
15.	**Items 11 to 14 (Span loaded condition)**	**606.68**	**216.13**	**-**	**1869.75**	**558.10**

NET LONGITUDINAL MOMENT	1869.75 -	558.10 =	1311.65

Maximum pressure =	187.68 kN/m2 <	200.00	kN/m2 permissible HENCE OK.	
Minimum pressure =	0.44 kN/m2 >0 (No tension) HENCE OK.			

(i) Check for sliding

See Row 15 of Table 1				
Sliding force =	216.13 kN			
Force resisting sliding =	0.6 x	606.68 =		364.01 kN
Factor of Safety against sliding =	364.01 /	216.13 =	**1.68**	
			> 1.5 Hence Safe	

(j) Summary

The assumed section of the abutment is adequate.

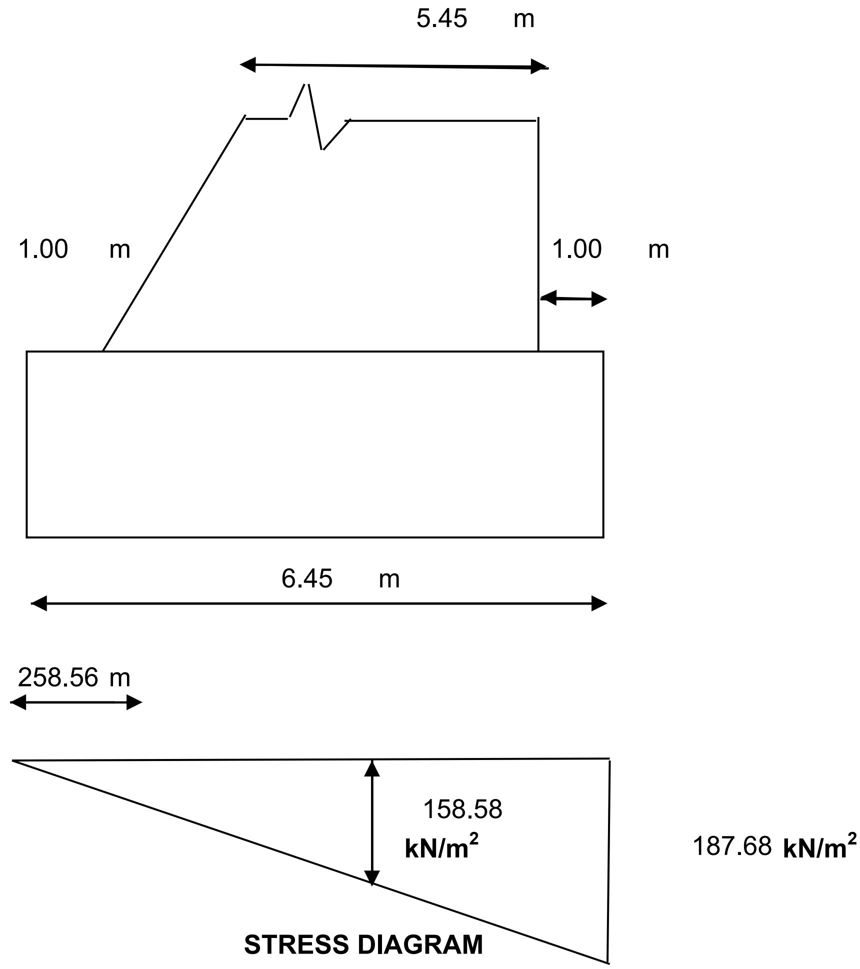
DESIGN OF ABUTMENT FOOTING

HIGH LEVEL BRIDGE - ACROSS SIRVAL RIVER
REDISTRIBUTION OF PRESSURE
FOR WIND AT SERVICE CONDITION

Length of footing	l_f	10.40	m	
Width of Footing	l_b	6.45	m	
Width of Abutment just above footing		4.45	m	
Vertical Load	P	606.68	kN	
Longitudinal Moment	M_e	1311.65	kN-m	
Transverse Moment	M_b	0.00	kN-m	
Area in Tension = y x l_b			0.00 m^2	0.00 %
Maximum Pressure before Redistribution			187.68 kN/m^2	
Maximum Pressure After Redistribution = pxK			187.68 kN/m^2	
Maximum Stress at Edge of Pier			187.68 kN/m^2	
Distance From Face of Pier to the Edge			1.00 m	
Stress at the Edge of Pier			158.58 kN/m^2	
Average Stress on Cantilevered Area			173.13 kN/m^2	
Area of the Cantilever Portion			1.00 m^2	
Distance of Centroid of the Stress in Cantilever Portion			0.51 m	
Moment about the Face of Pier			**88.99 kN-m**	
CONCRETE GRADE			**M-25**	
FOR THIS GRADE σcbc			**10** N/mm2	
m			**9.33**	
σst			**200**	
factor k			0.318	
j			0.894	
R			1.422	
Effective Depth Required			250 mm	
Adopt Total Depth			1000 mm	
Cover			50 mm	
Assume Bar Dia			16 mm	
Keeping A Cover Of 50 mm Effective Depth			942 mm	
Adopt Effective Depth			942 mm	
Steel Required Ast			528 mm^2	
Area Of One Bar			201 mm^2	
Spacing S			380 mm	
Provide Bars Of Dia And Spacing		16 mm	**150** mm	**Adopt spacing as 150 mm**
Area Of Distribution Steel			1884 mm^2	
Dia Of Bar For Distribution Steel			20 mm	
Area Of One Bar In Distribution Reinforcement			314 mm^2	
Using The Bars Spacing Required			167 mm	
Provide Bars Of Dia And Spacing		16 mm	160 mm	**Adopt spacing as 150 mm**
Provide Bars Of Dia And Spacing for Top Main Steel		12 mm	150 mm	
Provide Bars Of Dia And Spacing for Top Distribution Steel		12 mm	150 mm	

CHECK FOR SHEAR (As per IRC 21-1987 Cl. 304.7)

Critical Section is at a distance equal to effective depth from pier face		942 mm	
Section of Shear from end of pier		0.06 m	
Maximum Stress at Edge of Pier		187.68 kN/m^2	
Stress at the Section for Shear Check		158.58 kN/m^2	
Average Stress on Cantilevered Area		173.13 kN/m^2	
Shear Force		10.04 kN	
V=V' + M/d tanB	(B=0) Hence V =V'		
Actual Shear Stress		0.01 N/mm^2	
Percentage Steel	100As/bd	0.14	
Tc		0.23 N/mm^2	
k=1			
Permissble Shear Stress = k Tc		0.23 N/mm^2	
		< Actual Shear Stress hence Shear Reinforcement should be provided	
Dia Of two Legged Stirrups		16 mm	
Area Of One Bar In Distribution Reinforcement		201 mm^2	
Using The Bars Spacing Required s= Asw ts d/V		7541 mm	
Provide Bars Of Dia And Spacing	16 mm	150 mm	**Adopt spacing as 150 mm**



STRESS DIAGRAM

DESIGN OF ABUTMENT FOOTING

DESIGN OF RETURN WALL FOOTING

HIGH LEVEL BRIDGE - ACROSS SIRVAL RIVER
REDISTRIBUTION OF PRESSURE
FOR WIND AT SERVICE CONDITION

BOTTOM WIDTH OF RETURN WALL		0.90	m	
Length of footing	l_f	1.00	m	
Width of Footing	l_b	3.20	m	
Width of Abutment just above footing		1.05	m	
Vertical Load	P	606.68	kN	
Longitudinal Moment	M_e	1311.65	kN-m	
Transverse Moment	M_b	0.00	kN-m	
Area in Tension = y x l_b		0.00	m^2	0.00 %
Maximum Pressure before Redistribution		189.59	kN/m^2	
200.00 kN/m2 permissible HENCE OK.				
Maximum Pressure After Redistribution = pxK		189.59	kN/m^2	
Maximum Stress at Edge of Pier		189.59	kN/m^2	
Distance From Face of Pier to the Edge		1.00	m	
Stress at the Edge of Pier		130.34	kN/m^2	
Average Stress on Cantilevered Area		159.96	kN/m^2	
Area of the Cantilever Portion		1.00	m^2	
Distance of Centroid of the Stress in Cantilever Portion		0.53	m	
Moment about the Face of Return		**84.92**	**kN-m**	
CONCRETE GRADE		**M-25**		
FOR THIS GRADE σcbc		**10**	N/mm2	
m		**9.33**		
σst		**200**		
factor k		0.318		
j		0.894		
R		1.422		
Effective Depth Required		244	mm	
Adopt Total Depth		500	mm	
Cover		50	mm	
Assume Bar Dia		16	mm	
Keeping A Cover Of 50 mm Effective Depth		442	mm	
Adopt Effective Depth		442	mm	
Steel Required Ast		1075	mm^2	
Area Of One Bar		201	mm^2	
Spacing S		187	mm	
Provide Bars Of Dia And Spacing	16 mm	**150**	mm	**Adopt spacing as 150 mm**
Area Of Distribution Steel		884	mm^2	
Dia Of Bar For Distribution Steel		16	mm	
Area Of One Bar In Distribution Reinforcement		200.96	mm^2	
Using The Bars Spacing Required		227	mm	
Provide Bars Of Dia And Spacing	16 mm	220	mm	**Adopt spacing as 200 mm**
Provide Bars Of Dia And Spacing for Top Main Steel	12 mm	150	mm	
Provide Bars Of Dia And Spacing for Top Distribution Steel	12 mm	150	mm	

CHECK FOR SHEAR (As per IRC 21-1987 Cl. 304.7)

Critical Section is at a distance equal to effective depth from pier face		442	mm	
Section of Shear from end of pier		0.56	m	
Maximum Stress at Edge of Pier		189.59	kN/m^2	
Stress at the Section for Shear Check		130.34	kN/m^2	
Average Stress on Cantilevered Area		159.96	kN/m^2	
Shear Force		89.26	kN	
V=V' + M/d tanB	(B=0) Hence V =V'			
Actual Shear Stress		0.20	N/mm^2	
Percentage Steel	100As/bd	0.30		
Tc		0.23	N/mm^2	
k=1				
Permissble Shear Stress = k Tc		0.23	N/mm^2	
		< Actual Shear Stress hence Shear Reinforcement should be provided		
Dia Of two Legged Stirrups		12	mm	
Area Of One Bar In Distribution Reinforcement		113	mm^2	
Using The Bars Spacing Required s= Asw ts d/V		224	mm	
Provide Bars Of Dia And Spacing	12 mm	250	mm	**Adopt spacing as 250 mm**

WIDTH OF RETURN WALL		900 MM	
Footing size	3.20	x	0.5 M

REINFORCEMENT CALCULATION IN CANTILEVER ABUTMENT
HIGH LEVEL BRIDGE - ACROSS SIRVAL RIVER

		R.L.	**85.28**	**M TO**	**87.83**	**M**			
FOR SERVICE CONDITION									
VERTICAL LOADS									
(Span loaded condition)	=			**606.68** kN					
LONGITUDINAL MOMENT									
		Moment @ R. L.	85.28 M =		1311.65 kN-m				
LONGITUDINAL MOMENT Due To				**423.34**	**244.25**				
Braking Force	=			**+**		**=**	**667.59 kN-m**		
TRANSVERSE MOMENT due to				**423.34**	**1123.94**				
Braking Force and water current	=			**+**		**=**	**1547.28 kN-m**		
					One Slab only				
TOTAL TRANSVERSE MOMENT	=			**1547.28**		**=**	**1547.28 kN-m**		
TOTAL LONGITUDINAL MOMENT	=			**1311.65 +**	**667.59 =**		**1979.24 kN-m**		
CONCRETE MIX			M-25						
CHARACTERISTIC STRENGTH OF REINFORCEMENT					415 N/mm2				
PERMISSIBLE STRESSES									
IN STEEL				190					
IN CONCRETE									
CHARACTERISTIC STRENGTH OF									
Concrete			fck	=	30 N/mm2				
Permissible Compressive Stress in									
Bending			σcbc	=	8 N/mm2				
Permissible Compressive Stress in Direct									
Compression			σcc	=	8 N/mm2				
			σct	=	3.6 N/mm2				
Ultimate Axial Load P_U	=			1.5 X	606.68 =		910.0155 kN		
Ultimate Longitudinal Moment M_U	=			1.5 X	1979.24 =		2968.857 kN-m		
Ultimate Transverse Moment M_U	=			1.5 X	1547.28 =		2320.914 kN-m		
INCREASE WHEN WIND CONDITION IS CONSIDERED					33.33 %				
Neglecting area of Cut and Ease water parts Rectangular Section considered is									
			1000 mm x		1050 mm				
		Assume cover as		75					
d^1/d	=			83 /	1050 =		0.0790		
$P_U/(f_{ck}\ b\ d)$	=			910.02 x	1000 / (		30 x	1000 x	1050)
	=			0.0289					
FOR LONGITUDINAL MOMENT									
$Mu/(f_{ck}\ b\ d^2)$	=			2968.86 x	1000000 / (		30 x	1000 x	1050^2)
	=			0.0898					

Refer Chart 31 & 32 of Design Aids for Reinforced concrete SP-16 the point lies below the range of applicability. Hence provide minimum percentage of steel.

The point lies below the range of applicability. Hence provide minimum percentage of steel
CRITERIA 1 FOR MINIMUM STEEL Pt = 0.8 % OF CROSS SECTION AREA OF COLUMN REQUIRED FOR COMPRESSION

Area Required due to Compression = 910.02 x 1000 / 8
= 113752 mm^2
Area of steel @ 0.8% = 0.8 x 113752 / 100
= **910 mm^2**

CRITERIA 2 FOR MINIMUM STEEL Pt = 0.3 % OF GROSS SECTION AREA OF COLUMN
Area of steel @ 0.3% = 0.3 x 1000 x 1050 / 100
= **3150 mm^2**
PROVIDE STEEL AREA = **3150 mm^2**
NO. OF 16 MM BARS = 16 Nos.
SPACING = 260 MM
FOR TRANSVERSE MOMENT

$Mu/(f_{ck}\ b\ d^2)$ = 2320.91 x 1000000 / (30 x 1000 x 1050^2)
= 0.0702

Refer Chart 31 & 32 of Design Aids for Reinforced concrete SP-16 the point lies below the range of applicability. Hence provide minimum percentage of steel.

TRANSVERSE REINFORCEMENT
Shear Force to be resisted by the pier In Accordance to IS 1893
2320.91 / 4.50 = 515.99 kN

Check for Shear

Nominal Shear Stress = 515.99 x 1000 / (1000 x 1050)
= 0.49 N/mm^2
Pt 0.30
Permissible Shear Stress = 0.40 N/mm^2 Refer table 61
Nominal Shear Reinforcement will suffice
According to IRC 21-1987 Clause 306.3
Dia of Transverse Reinforcement = 16 / 4 = 4 mm
Provide 12 mm dia rings
Pitch of the Transverse should be least of
a) Least lateral Dimension = 1050 mm
b) 12 d = 12 x 12 = 144 mm
c) 300 mm = 300 mm
d) As per IS IS 13920:1993 Cl. 7.4.6 < or = 100 mm
Provide 12 mm dia rings @ 100 mm c/c.
This spacing is in accordance to IS 13920:1993 Cl. 7.4.6

CODE OF PRACTICE FOR DUCTILE DETAILING OF REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES

Check for Size of Hoop Reinforcement **Refer IS 13920:1993 Cl. 7.4.8**

Ash= 0.18 Sh (Fck/Fy)x(Ag/Ak-1)

S	=	100.00	mm	
h	=	300.00	N/mm^2	(Spacing of long. bars+ effective cover) or 300 mm whichever is less
Fck	=	30.00	N/mm^2	**Cover 75 mm to main reinforcement**
Fy	=	415.00	N/mm^2	
Ag	=	1050.00	mm^2	Considering 1 mm Wide Pier
Ak	=	940.00	mm^2	Considering 1 mm Wide Pier Effective
Hence Ash	=	45.68	mm^2	
Ash ProvideD	=	113.04	mm^2	Which is OK

d) As per IS IS 13920:1993 Cl. 7.4.6 < or = 100 mm

Provide 12 mm dia rings @ 100 mm c/c.

This spacing is in accordance to IS 13920:1993 Cl. 7.4.6

CODE OF PRACTICE FORDUCTILE DETAILING OF REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES

ABSTRACT

LONGITUDINAL REINFORCEMENT	**16**	**MM BARS**	**260**	**MM**	**However Adopt spacing as 250 mm**
TRANSVERSE REINFORCEMENT	**12mm dia rings @100mm c/c.**				

REINFORCEMENT CALCULATION IN CANTILEVER RETURNS
HIGH LEVEL BRIDGE - ACROSS SIRVAL RIVER

R.L. 85.28 M TO 87.83 M
PROPOSED BOTOM WIDTH 1000 MM

FOR SERVICE CONDITION

VERTICAL LOADS

(Span loaded condition) = **606.68** kN

LONGITUDINAL MOMENT

Moment @ R. L. 85.28 M = 1311.65 kN-m

One Slab only

TOTAL LONGITUDINAL MOMENT = 1311.65 + 0.00 = 1311.65 kN-m

CONCRETE MIX M-25

CHARACTERISTIC STRENGTH OF REINFORCEMENT 415 N/mm2

PERMISSIBLE STRESSES

IN STEEL 190

IN CONCRETE

CHARACTERISTIC STRENGTH OF Concrete fck = 30 N/mm2

Permissible Compressive Stress in Bending σcbc = 8 N/mm2

Permissible Compressive Stress in Direct Compression σcc = 8 N/mm2

σct = 3.6 N/mm2

Ultimate Axial Load P_U = 1.5 X 606.68 = 910.0155 kN

Ultimate Longitudinal Moment M_U = 1.5 X 1311.65 = 1967.474 kN-m

INCREASE WHEN WIND CONDITION IS CONSIDERED 33.33 %

Neglecting area of Cut and Ease water parts Rectangular Section considered is

1000 mm x 1000 mm

Assume cover as 75

d^1/d = 81 / 1000 = 0.0810

$P_U/(f_{ck}\ b\ d)$ = 910.02 x 1000 / (30 x 1000 x 1000)

= 0.0303

FOR LONGITUDINAL MOMENT

$Mu/(f_{ck}\ b\ d^2)$ = 1967.47 x 1000000 / (30 x 1000 x 1000^2)

= 0.0656

Refer Chart 31 & 32 of Design Aids for Reinforced concrete SP-16 the point lies below the range of applicability. Hence provide minimum percentage of steel.

The point lies below the range of applicability. Hence provide minimum percentage of steel

CRITERIA 1 FOR MINIMUM STEEL Pt = 0.8 % OF CROSS SECTION AREA OF COLUMN REQUIRED FOR COMPRESSION

Area Required due to Compression = 910.02 x 1000 / 8

	=		113752 mm^2		
Area of steel @ 0.8% =		0.8 x		113752 /	100
	=		**910** $\mathbf{mm^2}$		

CRITERIA 2 FOR MINIMUM STEEL Pt = 0.3 % OF GROSS SECTION AREA OF COLUMN

Area of steel @ 0.3% =		0.3 x		1000 x	1000 /	100
	=		**3000** $\mathbf{mm^2}$			
PROVIDE STEEL AREA	=		**3000** $\mathbf{mm^2}$			
NO. OF		12 MM BARS	=	27 Nos.		
SPACING	=		**150** MM			

FOR TRANSVERSE MOMENT

$Mu/(f_{ck}\ b\ d^2)$	=	1967.47 x	1000000 / (		30 x
			1000 x	1000^2)	
	=	0.0656			

Refer Chart 31 & 32 of Design Aids for Reinforced concrete SP-16 the point lies below the range of applicability. Hence provide minimum percentage of steel.

TRANSVERSE REINFORCEMENT

Shear Force to be resisted by the pier In Accordance to IS 1893

1311.65 / 4.50 = 291.61 kN

Check for Shear

Nominal Shear Stress =	291.61	x	1000	/ (	1000	x	1000)
	=		0.29 N/mm^2				
Pt	0.30						
Permissible Shear Stress =		0.40 N/mm^2	Refer table 61				

Nominal Shear Reinforcement will suffice

According to IRC 21-1987 Clause 306.3

Dia of Transverse Reinforcement	=	12 /	4 =	3 mm	
Provide	12 mm dia rings				

Pitch of the Transverse should be least of

a) Least lateral Dimension =		1000 mm		
b) 12 d =		12 x	12 =	144 mm
c) 300 mm =		300 mm		
d) As per IS IS 13920:1993 Cl. 7.4.6	< or =	100 mm		
Provide		12 mm dia rings @	100 mm c/c.	

This spacing is in accordance to IS 13920:1993 Cl. 7.4.6

CODE OF PRACTICE FOR DUCTILE DETAILING OF REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES

Check for Size of Hoop Reinforcement **Refer IS 13920:1993 Cl. 7.4.8**

Ash= 0.18 Sh (Fck/Fy)x(Ag/Ak-1)

S	=	100.00	mm	
h	=	300.00	N/mm^2	(Spacing of long. bars+ effective cover) or 300 mm whichever is less
Fck	=	30.00	N/mm^2	**Cover 75 mm to main reinforcement**

Fy	=	415.00	N/mm^2	
Ag	=	1000.00	mm^2	Considering 1 mm Wide Pier
Ak	=	886.00	mm^2	Considering 1 mm Wide Pier Effective
Hence Ash	=	50.23	mm^2	
Ash ProvideD	=	113.04	mm^2	Which is OK

d) As per IS IS 13920:1993 Cl. 7.4.6 < or = 100 mm

Provide 12 mm dia rings @ 100 mm c/c.

This spacing is in accordance to IS 13920:1993 Cl. 7.4.6

CODE OF PRACTICE FORDUCTILE DETAILING OF REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES

ABSTRACT

LONGITUDINAL REINFORCEMENT	**12**	**MM BARS**	**150**	**MM**	**However Adopt spacing as 150 mm**
TRANSVERSE REINFORCEMENT	**12mm dia rings @100mm c/c.**				

DESIGN OF Abutment CAP HIGH LEVEL BRIDGE

HIGH LEVEL BRIDGE - ACROSS SIRVAL RIVER

DESIGN OF Abutment CAP :-

D.L./ M Width along bridge				
DL. Of Slab =	0.975 x	15 x.	2.4 =	35.10 T
D.L. of Wearing coat =	0.075 x	12 x.	2.4 =	2.16 T
			TOTAL	**37.26 T**
D.L. of Slab & Wearing coat on half of the Abutment	=			
		37.26 /	2 =	18.63 T
L.L. on Abutment 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 Abutment	=	93.84 /	6.695 =	14.02 T
Per M width				
Total Load on Half =	18.63 +	14.02	=	32.65 T
of Abutment along bridge				Per M width
Effective depth of slab =90-2.5-2.5/2 =	86.25 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 =				
	32.65 x	0.34		11.02 T - M/M width
=				
	11.02 x	10.00 =	**110.2 kN-M/M width**	
This moment is too small hence it will not/be the governing B.M.				
Moment in Abutment cap		**110.20 kN-m**		
CONCRETE GRADE		**M30**		
FOR THIS GRADE σcbc		**10** N/mm2		
m		**9.33**		
σst		**200**		
factor k		0.318		
j		0.894		
R		1.422		
Effective Depth Required		278 mm		
Adopt Total Depth		1200 mm		
Cover		50 mm		
Assume Bar Dia		25 mm		
Keeping A Cover Of 50 mm Effective Depth		1138 mm		
Adopt Effective Depth		1137.5 mm		
Steel Required Ast		542 mm^2		
Area Of One Bar		491 mm^2		
Spacing S		905 mm		
Provide Bars Of Dia And Spacing	25 mm	**100** mm	**Adopt spacing as 100 mm**	
Provide Bars Of Dia And Spacing for Top Main Steel	25 mm	100 mm		
Provide Bars Of Dia And Spacing for Bottom Steel	16 mm	100 mm		
Abutment SECTION ACROSS BRIDGE				
DEAD LOAD MOMENT PER METRE Width across bridge :-				
Slab D.L.	0.975 x	15 x.	2.4 =	35.10 T
D.L. of Wearing coat =	0.075 x	12 x.	2.4 =	2.16 T
			TOTAL	**37.26** T

D.L. of Slab & Wearing coat on half of the Abutment		=			
		37.26 /	2 =	18.63 T/ M width	
L.L on Abutment		=		64.69 T	
Dispersion width along the span for					
70 T Tracked vehical	=	5.3 M			
L.L. . per M width on Abutment =		64.69 /	5.3 =	12.21 T/ M width	
Total D.L. + L.L. on half of Abutment across		18.63 +	12.21 =	30.84 T	
bridge per M width				Per M width	

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

Bending Moment across the bridge =

30.84 x	0	0.00 T - M/M width	

Provide Minimum steel

Minimum Reinforcement calculation for Abutment cap :-

As per clause 710.8.2, IRC- 78 - 2000, the thickness of Abutment
cap shall be at least 200 mm However the thickness
of Abutment cap here is 1200 MM.
Grade of Concrete M 30

Minimum Shrinkage and Temperature reinforcement required as per Clause 305.10 IRC 21-2000
in any RC structure is 250 Sq mm per m in each direction. Allowable maximum spacing is 300 mm.

Shrinkage and Temperature reinforcement required = 250 x 1.2 = 300 mm^2

Provide 25 mm tor reiforcement @ 100 mm c/c (14 Nos.) in top along the Abutment cap
Provide 16 mm tor reiforcement @ 100 mm c/c (14 Nos.) in bottom along the Abutment cap

Area of Steel Provided at top				
= (14x 491)	=	6874 mm^2	> 300 mm^2	OK
Area of Steel Provided at bottom				
= (14x 201)	=	2814 mm^2	> 300 mm^2	OK

CHECK FOR SHEAR ALONG BRIDGE DIRECTION

V =		30.84 T		
Shear Force			308.40 kN	
V=V' + M/d tanB	(B=0) Hence V =V'			
Actual Shear Stress			0.27 **N/mm^2**	
Percentage Steel	100As/bd		0.25	
Tc			0.23 **N/mm^2**	
k=1				
Permissble Shear Stress = k Tc			0.23 **N/mm^2**	
			< Actual Shear Stress hence Shear Reinforcement should be provided	
Dia Of two Legged Stirrups			16 mm	
Area Of One Bar In Distribution Reinforcement			201 mm^2	
Using The Bars Spacing Required s= Asw ts d/V			296 mm	
Provide Bars Of Dia And Spacing		16 mm	100 mm	**Adopt spacing as 100 mm**

HOWEVER
Provide 16 mm tor 2 legged vertical stirrups @ 100 mm centre to centre along the Abutment cap
Provide 16 mm tor 2 legged horizontal stirrups @ 100 mm centre to centre along the Abutment cap

SHEAR CHECK ACROSS BRIDGE DIRECTION

V = 20.3 T