DESIGN OF PIER AND CHECK FOR STABILITY- SUBMERSIBLE BRIDGE

Name Of Work :- Construction of Submersible Bridge on ON KHERWARA - JAWAS - SUVERI ROAD IN KM 9/000, ACROSS RIVER SOM

DESIGN DATA

1	RIGHT EFFECTIVE SPAN	=	7.60	M		
2	SPAN C/C OF PIERS	=	8.80	M		
3	OVERALL WIDTH OF PIER CAP	=	8.40	M		
4	H.F.L.	=	100.60	M		
5	BUOYANCY					
6	AT FOOTING LEVEL	=	100.00	%		
7	AT PIER LEVEL	=	100.00	%		
8	AQUEDUCT FALLS UNDER ZONE-II SO SEISMIC CASE IS NOT GOVERNING HERE.					
9	FLOOD DISCHARGE	=	**899.93**	**CUMECS**		
10	RIVER BED SLOPE	=	1	IN	960	
11	DESIGN VELOCITY	=	1.84	m/sec		
12	BED LEVEL OF THE HEIGHEST PIER	=	96.47	M		
13	SAFE BEARING CAPACITY	=	**20.00**	**t/m2**	**200.00**	**kN/m^2**
14	TOP LEVEL OF FOUNDING ROCK	=	93.47	M		
15	EMBEDMENT OF PIER IN HARD ROCK	=	1.50	M		
16	FOUNDATION LEVEL OF THE HIGHEST PIER	=	91.970	M		
17	DECK LEVEL OF THE BRIDGE	=	101.600	M		
18	TOP LEVEL OF THE PIER CAP	=	100.775	M		
19	LEVEL DIFFERENCE OF PIER CAP TOP AND FOUNDING LEVEL	=	8.81	M		

CHECKING STABILITY OF PIER AT R.L.91.97 M FOOTING LEVEL

A DEAD LOAD CALCULATION

SUPER STRUCTURE

Self Weight of Slab	=	8.80	x	8.40	x	0.75	x	24.00 =	1330.56 kN
Self Weight of Wearing Coat	=	8.80	x	8.40	x	0.075	x	24.00 =	133.06 kN
TOTAL									**1463.62 kN**

SUB STRUCTURE

Pier Cap

Pier Cap	=	1.50	x	8.40	x	0.60	x	24.00		=	181.440 kN
Flared Portion Sides	=	0.50	x	0.15	x	0.60	x	8.40 x	2.00 x	24.00 =	18.144 kN
	=	0.50	x	0.15	x	0.60	x	3.14 x	1.20 x	24.00 =	4.069 kN
Flared Portion u/s & d/s Sides	=	0.60	x	0.60	x	1.50	x	24.00		=	12.960 kN
	=	3.14	/	4.00	x	1.20	x	1.20 x	0.60 x	24.00 =	16.278 kN
TOTAL											**232.891 kN**

Pier

Flared Portion Top	=	**0.50**	x	0.15	x	0.60	x	8.40 x	**2** x	24.00 =	18.144 kN
	=	**0.50**	x	0.15	x	0.60	x	**3.14** x	1.20 x	24.00 =	4.069 kN
Pier Rectangular portion	=	1.20	x	7.50	x	5.96	x	24.00		=	1286.280 kN
Pier Curved portion	=	**3.14**	/	4	x	1.20	x	1.20 x	5.96 x	24.00 =	161.557 kN
Flared Portion bottom	=	0.50	x	0.60	x	0.30	x	24.00		=	2.160 kN

		=	**3.14**	/	4	x	1.20	x	1.20	x	0.60	x	24.00	= 16.278 kN
	TOTAL													**1493.914 kN**
	Weight of Pier Above H.F.L.	=												**0.000 kN**
	Weight of Pier Below H.F.L.	=	1493.91	-	0.00								=	**1493.914 kN**
	Weight of Sub Structure with 15% Buoyancy	=	0.00	+ (	1493.91	x	22.50	/	24.00	)			=	**1400.544 kN**

Footing		SIZE	12.00	M x	3.80	M x	1.00	M				
Weight without Buoyancy	=	12.00	x	3.80	x	1.00	x	24.00			=	1094.400 kN
Weight with 100% Buoyancy	=	12.00	x	3.80	x	1.00	x	**14.00**			=	638.400 kN

Total Weight of Substructure Without Buoyancy

= 232.89 + 1493.91 + 1094.40 = **2821.205 kN**

Total Weight of Substructure With Buoyancy

= 232.89 + 1400.54 + 638.40 = **2271.835 kN**

B LIVE LOAD CALCULATION

Maximum Reaction due Live Load including Impact

= 788.27 x 1.00 = **788.27 kN**

Refer Live load Computation sheet showing maximum reaction

= 78.83 T which is = 788.27 kN

Haunch	0.60	M
PCC Offset	0.20	M
Length Variant	1.00	M
Width Variat	0.50	M

TOTAL LONGITUDINAL MOMENT DUE TO LIVE LOAD & BREAKING FORCE

Maximum Longitudinal moment due to Live Load including Impact and Breaking Force

= 122.13 x 2.00 = **244.25 kN-m**

Refer Live load Computation sheet showing maximum reaction

= 12.21 T- m

which is = 122.13 kN-m

137.30	Stress
60.92	

TOTAL TRANSVERSE MOMENT DUE TO LIVE LOAD & BREAKING FORCE

Maximum Transverse moment due to Live Load including Impact and Breaking Force

= 1123.94 x 2.00 = **2247.88 kN-m**

Refer Live load Computation sheet showing maximum reaction

= 112.39 T- m

which is = 1123.94 kN-m

C LOADS DUE TO WATER CURRENT

WATER CURRENT IN LONGITUDINAL DIRECTION (ALONG THE BRIDGE)

As per IRC- II (6-1966) clause 213.5 For V= 1.84 m/sec

Since the bridge is at Zero Degrees skew from the direction of current as per IRC- II (6-1966) clause 213.5 it should be designed for (20+0) =20 Degrees or (20-0) = 20 Degrees whichever gives higher quantum of water current forces.

Obstructed Velocity = V Sin 20 ^{0}	=	**1.84 x**	**Sin 20 ^{0}**				
	=	0.63					
$2v^2$	=	0.79					
Total SUBMERGED Height	=	7.13 M	0.79	0.68	0.67	0.00	

FORCE ON DECK SLAB BETWEEN Deck Level 101.6 M to Soffit Level 100.775 M

$2v^2$	= (	0.79	+		0.68	) /2	=	0.73						
Area Obstructed	=	12.00	x		0.00	=		0.00	Sqm					
Force on Pier	=	52.00	x	k	x		v^2	x	Area Obstructed					
	=	52.00	x		1.50	x	0.73	x	0.00 / 100	=	**0.00 kN**	at R.L.	101.185	M
Moment @ R. L.		93.57	M =		0.00	x	7.62	=	**0.00 kN-m**					
Moment @ R. L.		92.97	M =		0.00	x	8.22	=	**0.00 kN-m**					
Moment @ R. L.		91.97	M =		0.00	x	9.22	=	**0.00 kN-m**					

FORCE ON PIER CAP BETWEEN 100.775 M to Soffit Level 100.175 M

$2v^2$	= (	0.68	+		0.67	) /2	=	0.67						
Area Obstructed	=	12.00	x		0.60	=		7.20	Sqm					
Force on Pier	=	52.00	x	k	x		v^2	x	Area Obstructed					
	=	52.00	x		1.50	x	0.67	x	7.20 / 100	=	**3.78 kN**	at R.L.	96.373	M
Moment @ R. L.		93.57	M =		3.78	x	2.80	=	**10.59 kN-m**					
Moment @ R. L.		92.97	M =		3.78	x	3.40	=	**12.86 kN-m**					
Moment @ R. L.		91.97	M =		3.78	x	4.40	=	**16.64 kN-m**					

FORCE ON PIER BETWEEN 100.175 M to 93.47 M

$2v^2$	= (	0.67	+		0.00	) /2	=	0.33						
Area Obstructed	=	7.33	x		8.70	=		63.81	Sqm					
Force on Pier	=	52.00	x	k	x		v^2	x	Area Obstructed					
	=	52.00	x		1.50	x	0.33	x	63.81 / 100	=	**16.57 kN**	at R.L.	96.073	M
Moment @ R. L.		93.57	M =		16.57	x	2.50	=	**41.48 kN-m**					
Moment @ R. L.		92.97	M =		16.57	x	3.10	=	**51.42 kN-m**					
Moment @ R. L.		91.97	M =		16.57	x	4.10	=	**67.99 kN-m**					

TOTAL LONGITUDINAL MOMENT DUE TO WATER CURRENT

Moment @ R. L.	93.57	M =	0.00	+	10.59		
				+	41.48	=	**52.07 kN-m**
Moment @ R. L.	92.97	M =	0.00	+	12.86		
				+	51.42	=	**64.28 kN-m**
Moment @ R. L.	91.97	M =	0.00	+	16.64		
				+	67.99	=	**84.63 kN-m**

WATER CURRENT IN TRANSVERSE DIRECTION (ACROSS THE BRIDGE)

As per IRC- II (6-1966) clause 213.5 **For V= 1.84 m/sec** **Maximum velocity being 1.414 x mean velocity** (1.414= Root of 2)

Obstructed Velocity = V Cos 20 0 = **1.84 x Cos 20 0**

= 1.72

2v2 = 5.95

Total Height = 7.13 M 5.95 5.14 5.03 0.00

FORCE ON DECK SLAB BETWEEN Deck Level 101.6 M to Soffit Level 100.775 M

$2v^2$	= (	5.95	+		5.14	) /2	=	5.54						
Area Obstructed	=	8.80	x		0.000	=		0.00	Sqm					
Force	=	52.00	x	k	x		v^2	x	Area Obstructed					
	=	52.00	x		1.50	x	5.54	x	0.00 / 100	=	**0.00 kN**	at R.L.	101.185	M
Moment @ R. L.		93.57	M =		0.00	x	7.62	=	**0.00 kN-m**					
Moment @ R. L.		92.97	M =		0.00	x	8.22	=	**0.00 kN-m**					

Moment @ R. L.		91.97	M =		0.00	x		9.22	=	**0.00**	**kN-m**			
FORCE ON PIER CAP BETWEEN 100.775 M to Soffit Level 100.175 M														
$2v^2$	= (	5.14	+		5.03	) /2	=	5.08						
Area Obstructed	=	1.50	x		0.60	=		0.90	Sqm					
Force on Pier	=	52.00	x	k	x		v^2	x	Area Obstructed					
	=	52.00	x		1.50	x	5.08	x	0.90 / 100	=	**3.57 kN**	at R.L.	96.373	M
Moment @ R. L.		93.57	M =		3.78	x	2.80	=	**10.59**	**kN-m**				
Moment @ R. L.		92.97	M =		3.78	x	3.40	=	**12.86**	**kN-m**				
Moment @ R. L.		91.97	M =		3.78	x	4.40	=	**16.64**	**kN-m**				
FORCE ON PIER BETWEEN 100.175 M to 93.47 M														
$2v^2$	= (	5.03	+		0.00	) /2	=	2.52						
Area Obstructed	=	7.33	x		1.20	=		8.80	Sqm					
Force on Pier	=	52.00	x	k	x		v^2	x	Area Obstructed					
	=	52.00	x		1.50	x	2.52	x	8.80 / 100	=	**17.28 kN**	at R.L.	96.073	M
Moment @ R. L.		93.57	M =		16.57	x	2.50	=	**41.48**	**kN-m**				
Moment @ R. L.		92.97	M =		16.57	x	3.10	=	**51.42**	**kN-m**				
Moment @ R. L.		91.97	M =		16.57	x	4.10	=	**67.99**	**kN-m**				
TOTAL TRANSVERSE MOMENT DUE TO WATER CURRENT														
Moment @ R. L.		93.57	M =		0.00	+	10.59	=						
						+	41.48		**52.07**	**kN-m**				
Moment @ R. L.		92.97	M =		0.00	+	12.86	=						
						+	51.42		**64.28**	**kN-m**				
Moment @ R. L.		91.97	M =		0.00	+	16.64	=						
						+	67.99		**84.63**	**kN-m**				

D SEISMIC CONDITION

According to clause 222.1 of IRC : 6- 1966 the Aqueduct is situated in the standard Zone- II ; therefore the aqueduct need not to be designed for Seismic Forces.

E WIND FORCE

Slab												
Area	=	11.10	x	0.98						=	10.82	Sqm
height of C.G. above Bed level	=	101.19	-	96.47	=		4.72	m				
According to Clause 212.3 IRC -6 -1966		Wind pressure	=	85.37	Kg/Sqm	=		0.85	kN/Sqm			
Wind Force	=	10.82	x	0.85						=	**9.24**	**kN**
Moment @ R. L.		93.57	M =	9.24	x		7.62	=	**70.36**	**kN-m**		
Moment @ R. L.		92.97	M =	9.24	x		8.22	=	**75.90**	**kN-m**		
Moment @ R. L.		91.97	M =	9.24	x		9.22	=	**85.14**	**kN-m**		
Pier Cap												
Area A1	=	1.50	x	0.60						=	0.90	Sqm
Area A2	=	1.35	x	0.60						=	0.81	Sqm
										Total	**1.71**	**Sqm**
$\bar{Y}$	= (	0.90	x	0.90	)+ (		0.81	x	0.30	) / 1.71	0.62	M
height of C.G. above Bed level	=	96.37	-	96.47	=		-0.10	m				
According to Clause 212.3 IRC -6 -1966		Wind pressure	=	74.79	Kg/Sqm	=		0.75	kN/Sqm			
Wind Force	=	1.71	x	0.75						=	**1.28**	**kN**

	Moment @ R. L.	93.57	M =	1.28	x	2.80	=	**3.58**	**kN-m**						
	Moment @ R. L.	92.97	M =	1.28	x	3.40	=	**4.35**	**kN-m**						
	Moment @ R. L.	91.97	M =	1.28	x	4.40	=	**5.63**	**kN-m**						
(I)	**Pier from R.L.**	**100.775**	**to**	**96.47**	**M**										
	Area	=	1.20	x	4.31					=		5.17	Sqm		
	height of C.G. above Bed level	=	98.62	-	96.47	=	2.15	m							
	According to Clause 212.3 IRC -6 -1966	Wind pressure	=	79.74	Kg/Sqm	=		0.80	kN/Sqm						
	Wind Force	=	5.17	x	0.80					=		**4.12**	**kN**		
	Moment @ R. L.	93.57	M =	4.12	x	5.05	=	**20.81**	**kN-m**						
	Moment @ R. L.	92.97	M =	1.28	x	5.65	=	**7.23**	**kN-m**						
	Moment @ R. L.	91.97	M =	1.28	x	6.65	=	**8.51**	**kN-m**						

TOTAL TRANSVERSE MOMENT DUE TO WIND FORCE

Moment @ R. L.	93.57	M =	70.36	+	3.58	+	20.81	+							
								=	94.75	**kN-m**					
Moment @ R. L.	92.97	M =	75.90	+	4.35	+	7.23	+							
								=	87.48	**kN-m**					
Moment @ R. L.	91.97	M =	85.14	+	5.63	+	8.51	+							
								=	99.28	**kN-m**					

BASE PRESSURE CALCULATION

CASE- 1 FOR SERVICE CONDITION AT R. L.91.97 M

VERTICAL LOADS

DEAD LOAD CALCULATION

SUPER STRUCTURE	=	**1463.62**	**kN**	
SUB STRUCTURE	=	**2821.21**	**kN**	**Without Buoyancy**
SUB STRUCTURE	=	**2271.84**	**kN**	**With Buoyancy**
LIVE LOAD	=	**788.27**	**kN**	
Total Load without Buoyancy	=	**5073.09**	**kN**	
Total Load with Buoyancy	=	**4523.72**	**kN**	
Total LONGITUDINAL MOMENT	=	**84.63**	**+**	**244.25** **=** **328.88** **kN-m**
Total TRANSVERSE MOMENT	=	**84.63**	**+**	**2247.88** **=** **2332.51** **kN-m**

C.S.A.	=	12.00		x	3.80					=	45.60	m^2				
I_{xx}	=	1/6x	12.00		x	3.80	^{2}			=	28.88	m^3				
I_{yy}	=	1/6x	12.00	^{2}		x	3.80			=	91.20	m^3				
STRESS with Buoyancy	= (	4523.72	/		45.60	)+ / - (	328.88	/	28.88	)+ / - (	2332.51	/	91.20	)		
	=	99.20		+ / -	11.39	+ / -	25.58									
P_{max}	=	99.20		+	11.39	+	25.58									
	=	**136.17**	**kN/m^2**													
		< 250 kN/m2 Hence O.K.														
P_{min}	=	99.20		-	11.39	-	25.58									
	=	**62.24**	**kN/m^2**													
		> 0 Hence O.K.														
STRESS without Buoyancy	= (	5073.09	/		45.60	)+ / - (	328.88	/	28.88	)+ / - (	2332.51	/	91.20	)		
	=	111.25		+ / -	11.39	+ / -	25.58									
P_{max}	=	111.25		+	11.39	+	25.58									
	=	**136.22**	**kN/m^2**													
		< 250 kN/m2 Hence O.K.														
P_{min}	=	111.25		-	11.39	-	25.58									

= **74.29** **kN/m²**

> 0 Hence O.K.

CASE- 2 FOR IDLE CONDITION AT R. L.91.97 M **(WHEN THERE IS NO LIVE LOAD)**

SUPER STRUCTURE	=	**1463.62**	**kN**	**A CHECK OF STABILITY DUE TO BUOYANCY EFFECT**
SUB STRUCTURE	=	**2821.21**	**kN**	**Without Buoyancy**
SUB STRUCTURE	=	**2271.84**	**kN**	**With Buoyancy**
LIVE LOAD	=	**0.00**	**kN**	
Total Load without Buoyancy	=	**4284.82**	**kN**	
Total Load with Buoyancy	=	**3735.45**	**kN**	

STRESS with Buoyancy = (3735.45 / 45.60)+ / - (84.63 / 28.88)+ / - (84.63 / 91.20)

= 81.92 + / - 2.93 + / - 0.93

P_{max} = 81.92 + 2.93 + 0.93

= **85.78** **kN/m²**

< 250 kN/m2 Hence O.K.

P_{min} = 81.92 - 2.93 - 0.93

= **78.06** **kN/m²**

> 0 Hence O.K.

STRESS without Buoyancy = (4284.82 / 45.60)+ / - (84.63 / 28.88)+ / - (84.63 / 91.20)

= 93.97 + / - 2.93 + / - 0.93

P_{max} = 93.97 + 2.93 + 0.93

= **97.82** **kN/m²**

< 250 kN/m2 Hence O.K.

P_{min} = 93.97 - 2.93 - 0.93

= **90.11** **kN/m²**

> 0 Hence O.K.

CASE- 3 FOR WIND FORCE AT SERVICE CONDITION AT R. L.91.97 M

SUPER STRUCTURE	=	**1463.62**	**kN**	
SUB STRUCTURE	=	**2821.21**	**kN**	**Without Buoyancy**
SUB STRUCTURE	=	**2271.84**	**kN**	**With Buoyancy**
LIVE LOAD	=	**788.27**	**kN**	
Total Load without Buoyancy	=	**5073.09**	**kN**	
Total Load with Buoyancy	=	**4523.72**	**kN**	
Total LONGITUDINAL MOMENT	=	**84.63**	**+**	**244.25** **= 328.88** **kN-m**
Total TRANSVERSE MOMENT	=	**84.63**	**+**	**99.28** **+** **2247.88** **= 2431.79** **kN-m**

STRESS with Buoyancy = (4523.72 / 45.60)+ / - (328.88 / 28.88)+ / - (2431.79 / 91.20)

= 99.20 + / - 11.39 + / - 26.66

P_{max} = 99.20 + 11.39 + 26.66

= **137.26** **kN/m²**

< 250 kN/m2 Hence O.K.

P_{min} = 99.20 - 11.39 - 26.66

= **61.15** **kN/m²**

> 0 Hence O.K.

STRESS without Buoyancy = (5073.09 / 45.60)+ / - (328.88 / 28.88)+ / - (2431.79 / 91.20)

= 111.25 + / - 11.39 + / - 26.66

P_{max} = 111.25 + 11.39 + 26.66

= **137.30 kN/m²**

< 250 kN/m2 Hence O.K.

P_{min} = 111.25 - 11.39 - 26.66

= **73.20 kN/m²**

> 0 Hence O.K.

CASE- 4 FOR WIND FORCE AT IDLE CONDITION AT R. L.91.97 M **[NO LIVE LOAD]**

SUPER STRUCTURE	=	**1463.62 kN**	
SUB STRUCTURE	=	**2821.21 kN**	**Without Buoyancy**
SUB STRUCTURE	=	**2271.84 kN**	**With Buoyancy**
LIVE LOAD	=	**0.00 kN**	
Total Load without Buoyancy	=	**4284.82 kN**	
Total Load with Buoyancy	=	**3735.45 kN**	
Total LONGITUDINAL MOMENT	=	84.63 **kN-m**	
Total TRANSVERSE MOMENT	=	**84.63 +**	**99.28 = 183.91 kN-m**

STRESS with Buoyancy = (3735.45 / 45.60)+ / - (84.63 / 28.88)+ / - (183.91 / 91.20)

= 81.92 + / - 2.93 + / - 2.02

P_{max} = 81.92 + 2.93 + 2.02

= **86.86 kN/m²**

< 250 kN/m2 Hence O.K.

P_{min} = 81.92 - 2.93 - 2.02

= **76.97 kN/m²**

> 0 Hence O.K.

P_3 = 81.92 + 2.93 - 2.02

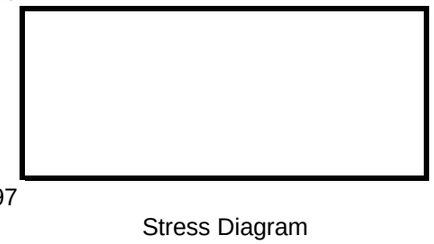
= **82.83 kN/m²**

< 250 kN/m2 Hence O.K.

P_4 = 81.92 - 2.93 + 2.02

= **81.00 kN/m²**

> 0 Hence O.K.



Stress Diagram

STRESS without Buoyancy = (4284.82 / 45.60)+ / - (84.63 / 28.88)+ / - (183.91 / 91.20)

= 93.97 + / - 2.93 + / - 2.02

P_{max} = 93.97 + 2.93 + 2.02

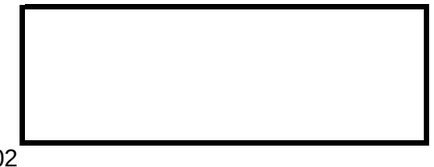
= **98.91 kN/m²**

< 250 kN/m2 Hence O.K.

P_{min} = 93.97 - 2.93 - 2.02

= **89.02 kN/m²**

> 0 Hence O.K.



Stress Diagram

CASE- 5 FOR ONE SPAN DISLODGED CONDITION AT R. L.91.97 M

SUPER STRUCTURE	=	**731.81 kN**	
SUB STRUCTURE	=	**2821.21 kN**	**Without Buoyancy**
SUB STRUCTURE	=	**2271.84 kN**	**With Buoyancy**
LIVE LOAD	=	**0.00 kN**	
Total Load without Buoyancy	=	**3553.01 kN**	
Total Load with Buoyancy	=	**3003.64 kN**	

Total LONGITUDINAL MOMENT = **84.63 kN-m**

Total TRANSVERSE MOMENT = **84.63 +** **99.28 =** **183.91 kN-m**

STRESS with Buoyancy = (3003.64 / 45.60)+ / - (84.63 / 28.88)+ / - (183.91 / 91.20)

= 65.87 + / - 2.93 + / - 2.02

P_{max} = 65.87 + 2.93 + 2.02

= **70.82 kN/m²**

< 250 kN/m2 Hence O.K.

P_{min} = 65.87 - 2.93 - 2.02

= **60.92 kN/m²**

P_3 = 65.87 + 2.93 - 2.02

= **66.78 kN/m²**

P_4 = 65.87 - 2.93 + 2.02

= **64.96 kN/m²**

Stress Diagram

STRESS without Buoyancy = (3553.01 / 45.60)+ / - (84.63 / 28.88)+ / - (0.00 / 91.20)

= 77.92 + / - 2.93 + / - 0.00

P_{max} = 77.92 + 2.93 + 0.00

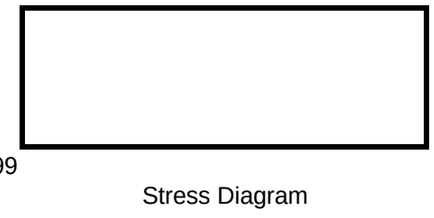
= **80.85 kN/m²**

P_{min} = 77.92 - 2.93 - 0.00

= **74.99 kN/m²**

P_3 = 77.92 + 2.93 - 0.00

= **80.85 kN/m²**



Stress Diagram

P_4 = 77.92 - 2.93 + 0.00

= **74.99 kN/m²**

CASE- 6 FOR SERVICE CONDITION AT R. L.92.97 M

VERTICAL LOADS

DEAD LOAD CALCULATION

SUPER STRUCTURE = **1463.62 kN**

SUB STRUCTURE = **1726.81 kN** **Without Buoyancy**

SUB STRUCTURE = **1633.44 kN** **With Buoyancy**

LIVE LOAD = **788.27 kN**

Total Load without Buoyancy = **3978.69 kN**

Total Load with Buoyancy = **3885.32 kN**

Total LONGITUDINAL MOMENT = **52.07 +** **244.25 =** **296.32 kN-m**

Total TRANSVERSE MOMENT = **52.07 +** **2247.88 =** **2299.95 kN-m**

C.S.A. = 12.00 x 1.20 = 14.40 m^2

I_{xx} = 1/6x 12.00 x 1.20 ^{2} = 2.88 m^3

I_{yy} = 1/6x 12.00 ^{2} x 1.20 = 28.80 m^3

STRESS with Buoyancy = (3885.32 / 14.40)+ / - (296.32 / 2.88)+ / - (2299.95 / 28.80)

= 269.81 + / - 102.89 + / - 79.86

P_{max} = 269.81 + 102.89 + 79.86

= **452.56** **kN/m^2**

< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.

P_{min} = 269.81 - 102.89 - 79.86

= **87.07** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.

STRESS without Buoyancy = (3978.69 / 14.40)+ / - (296.32 / 2.88)+ / - (2299.95 / 28.80)

= 276.30 + / - 102.89 + / - 79.86

P_{max} = 276.30 + 102.89 + 79.86

= **459.05** **kN/m^2**

< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.

P_{min} = 276.30 - 102.89 - 79.86

= **93.55** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.

CASE- 7 FOR IDLE CONDITION AT R. L.92.97 M

SUPER STRUCTURE = **1463.62** **kN**

SUB STRUCTURE = **1726.81** **kN** **Without Buoyancy**

SUB STRUCTURE = **1633.44** **kN** **With Buoyancy**

LIVE LOAD = **0.00** **kN**

Total Load without Buoyancy = **3190.42** **kN**

Total Load with Buoyancy = **3097.05** **kN**

STRESS with Buoyancy = (3097.05 / 14.40)+ / - (52.07 / 2.88)+ / - (52.07 / 28.80)

= 215.07 + / - 18.08 + / - 1.81

P_{max} = 215.07 + 18.08 + 1.81

= **234.96** **kN/m^2**

< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.

P_{min} = 215.07 - 18.08 - 1.81

= **195.19** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.

STRESS without Buoyancy = (3190.42 / 14.40)+ / - (52.07 / 2.88)+ / - (52.07 / 28.80)

= 221.56 + / - 18.08 + / - 1.81

P_{max} = 221.56 + 18.08 + 1.81

= **241.44** **kN/m^2**

< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.

P_{min} = 221.56 - 18.08 - 1.81

= **201.67** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.

CASE- 8 FOR WIND FORCE AT SERVICE CONDITION AT R. L.92.97 M

SUPER STRUCTURE = **1463.62** **kN**

SUB STRUCTURE = **1726.81** **kN** **Without Buoyancy**

SUB STRUCTURE = **1633.44** **kN** **With Buoyancy**

LIVE LOAD = **788.27** **kN**

Total Load without Buoyancy = **3978.69** **kN**

Total Load with Buoyancy = **3885.32** **kN**

Total LONGITUDINAL MOMENT = **52.07** **+** **244.25** **=** **296.32** **kN-m**

Total TRANSVERSE MOMENT = **52.07** + **94.75** + **2247.88** = **2394.70** **kN-m**

STRESS with Buoyancy = (3885.32 / 14.40)+ / - (296.32 / 2.88)+ / - (2394.70 / 28.80)

= 269.81 + / - 102.89 + / - 83.15

P_{max} = 269.81 + 102.89 + 83.15

= **455.85** **kN/m^2**

< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.

P_{min} = 269.81 - 102.89 - 83.15

= **83.78** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.

STRESS without Buoyancy = (3978.69 / 14.40)+ / - (296.32 / 2.88)+ / - (2394.70 / 28.80)

= 276.30 + / - 102.89 + / - 83.15

P_{max} = 276.30 + 102.89 + 83.15

= **462.34** **kN/m^2**

< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.

P_{min} = 276.30 - 102.89 - 83.15

= **90.26** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.

CASE- 9 FOR WIND FORCE AT IDLE CONDITION AT R. L.92.97 M

SUPER STRUCTURE = **1463.62** **kN**

SUB STRUCTURE = **1726.81** **kN** **Without Buoyancy**

SUB STRUCTURE = **1633.44** **kN** **With Buoyancy**

LIVE LOAD = **788.27** **kN**

Total Load without Buoyancy = **3978.69** **kN**

Total Load with Buoyancy = **3885.32** **kN**

Total LONGITUDINAL MOMENT = **52.07** **kN-m**

Total TRANSVERSE MOMENT = **52.07** + **94.75** = **146.82** **kN-m**

STRESS with Buoyancy = (3885.32 / 14.40)+ / - (52.07 / 2.88)+ / - (146.82 / 28.80)

= 269.81 + / - 18.08 + / - 5.10

P_{max} = 269.81 + 18.08 + 5.10

= **292.99** **kN/m^2**

< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.

P_{min} = 269.81 - 18.08 - 5.10

= **246.64** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.

STRESS without Buoyancy = (3978.69 / 14.40)+ / - (52.07 / 2.88)+ / - (146.82 / 28.80)

= 276.30 + / - 18.08 + / - 5.10

P_{max} = 276.30 + 18.08 + 5.10

= **299.47** **kN/m^2**

< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.

P_{min} = 276.30 - 18.08 - 5.10

= **253.12** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.