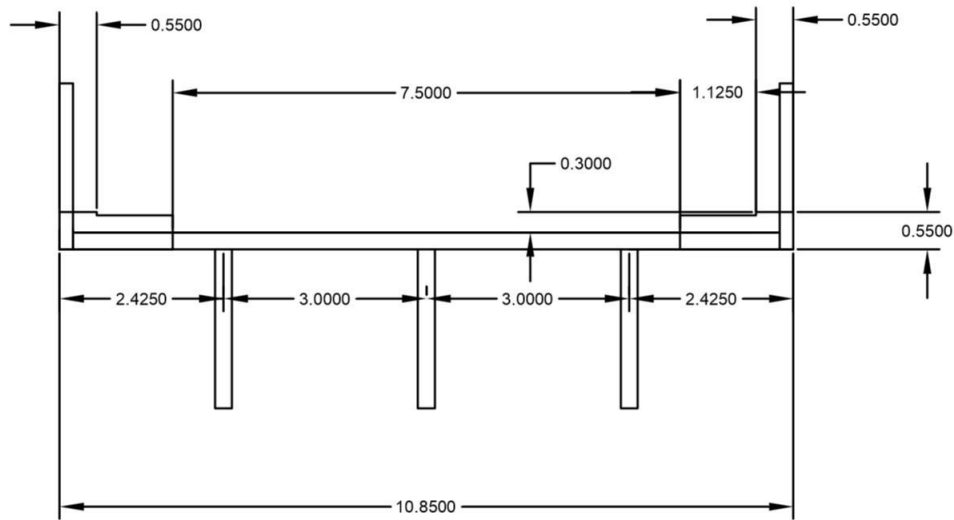


Structural Design of Bridge Khadi Khad, Pathankot



All unit in meter(m)

DECK SLAB

Thickness of slab = 0.25

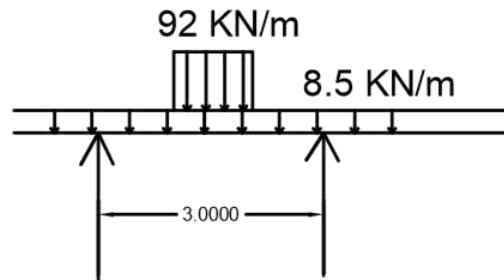
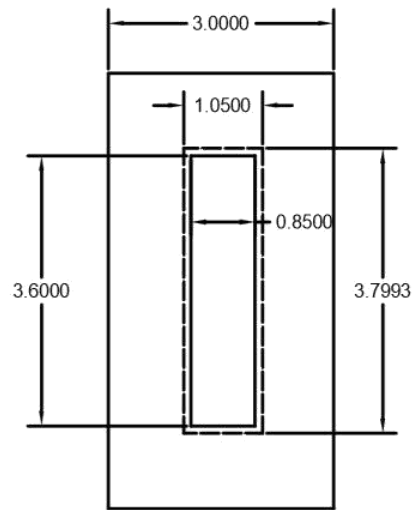
Wearing Coat = 0.1 m

Grade of Concrete = M30

Dead Load = 6.25 KN/ m²

DL of Wearing Coat = 2.2 KN/ m²

Total DL = 8.5 KN/ m²



Class AA Tracked Vehicle

Wheel Division:-

$$l = 0.85 \text{ m}$$

$$b = 3.6 \text{ m}$$

$$u = 0.85 + 0.2 = 1.05 \text{ m} \quad v = 3.6 + 0.2 = 3.8 \text{ m}$$

One Way Slab:-

Impact factor = 0.25 m

$$\text{Wheel Load / m} = 350/0.380 = 92 \text{ KN/ m} \quad \text{DL} = 8.5 \text{ KN/ m}$$

$$\text{B.M} = 8.5 \times 3^2/8 + (92/2 \times 3/2 - 92/2 \times 1.05/4) \times 1.25 = 9.56 + 56.92 \times 1.25 = 80.7 \text{ KN-m}$$

Continuity Effect:-

$$\text{B.M at support} = 9.56 \times 8/10 + 56.92 \times 4/8 \times 1.25 = 43.25 \text{ KN-m}$$

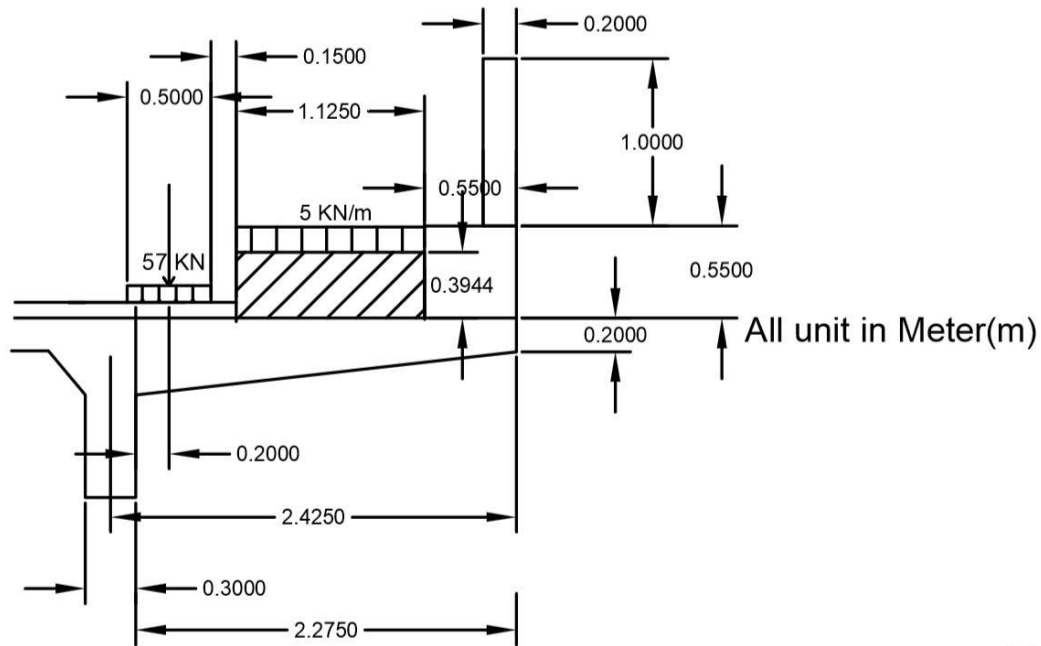
$$\text{S.F} = 8.5 \times 3/2 + 92 \times 1.05/2 \times 1.25 = 73.13 \text{ KN-m}$$

$$\text{Mu} = 64.87 \text{ KN-m}$$

$$\text{Vu} = 109.7 \text{ KN}$$

Provide $\phi 12 @ 100\text{mm c/c}$ main(cross)

Provide $\phi 10 @ 100\text{mm c/c}$ distance (long.)



CANTILEVER SLAB

$$b_e = 1.2x + b_w = 1.2 \times 0.2 + (0.25 + 2 \times 0.1) = 0.69 \text{ m}$$

$$\text{Live Load/m} = 57 \times 1.5/0.69$$

$$\text{Maximum moment due to L.L} = 123.9 \times 0.2 + 5 \times 1.125 \times 0.763 = 29.07 \text{ KNm}$$

$$\text{Moment due to D.L} = 1.7 \times 1.4 + 0.55 \times 0.55 \times 2 \times 25 + 0.26 \times 25 \times 2.275^2/2 + 0.1 \times 0.6 \times 0.3 \times 20$$

$$= 2.436 + 15.13 + 16.82 + 0.36 = 34.746 \text{ KN-m}$$

$$\text{Total B.M} = 29.07 + 34.75 = 63.82 \text{ KN-m}$$

$$\text{S.F} = (123.9 \times 0.45) + 5 * 1.125 + (7.6 + 14.8 + 1.8) = 83.6 \text{ KN}$$

$$\text{Mu} = 95.73 \text{ KN-m}$$

$$\text{Vu} = 128.4 \text{ KN-m}$$

$$\text{Mu/bd}^2 = 95.73 \times 10^6/1000 \times 300^2 = 1.064$$

$$\text{Pt} = 0.265\%$$

$$\text{Ast} = 7.95\text{cm}^2$$

Provide $\phi 12 @ 100 \text{ c/c main}$

Provide $\phi 10 @ 150 \text{ c/c dist.}$

Longitudinal Girders (Intermediate Girders):-

B.M due to dead load (Intermediate Girder/m length)

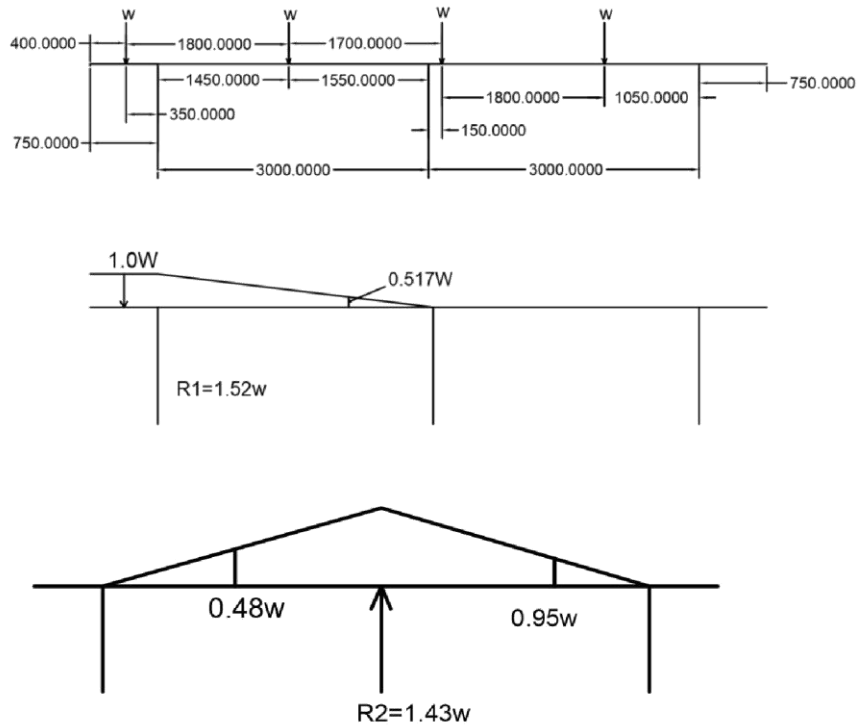
Sr No.	Item	Details	Weight (KN)
1.	Wearing Coat	3.0 x 0.1 x 22	66
2.	Deck Slab	3.0 x 0.25 x 25	18.75
3.	Tub	0.4 x 2.0 x 25	20
4.	Cross Beams	(3.0 x 2.0 x 25 x 0.5)/41	2.57(say) = 47.92 KN/m ≈ 50 KN/m

$$\text{Maximum B.M due to DL} = 50 \times 41^2/8 = 10506 \text{ KN-m}$$

$$\text{Maximum S.F due to DL} = 50 \times 41/2 = 1025 \text{ KN}$$

D.L in end Girder/m length:-

Sr No.	Item	Details	Weight (KN)
1.	Wearing Coat	0.75 x 0.1 x 22	4.96
2.	Deck Slab	0.263 x 2.425 x 25	15.94
3.	End Cub	0.55 x 0.55 x 25	7.56
4.	Parapet	0.2 x 1 x 25	5
5.	Front Path	0.3 x 1.125 x 20	6.75
6.	Cross Beam		1.29 (say)
			= 41.5 KN/m ≈ 42KN/m



Live Load Calculations:-

$$\text{Impact Load} = 4.5 / (6 + 41) = 0.1$$

$$\text{Max. Wheel Load}(W) = \text{Axle Load} / 2 \times 1.1 \times 1.52 = \text{Axle Load} \times 0.836$$

Seismic analysis:

$$T = 2.0 \sqrt{D / 1000F}$$

$$D = DL + 0.2LL = 3075 + 0.2 \times (365 \times 3) = 3294 \text{ kN}$$

$$\text{Here } F = \Delta \times 6EI / L^3$$

$$= (1) \times 6 \times 31.22 \times 1.083 \times 10^{12} / 5000^3 = 1623 \text{ kN}$$

$$T = 2.0 \sqrt{3294 / 1000 \times 1623} = 0.9 \text{ sec}$$

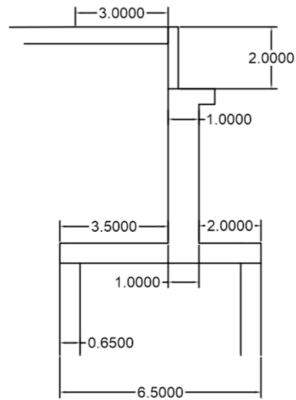
$$S_a / g = 1.1$$

$$A_h = Z / 2 \times 2 \times I \times S_a / g = 0.24 / 2 \times (1.2 \times 1.1) = 0.16$$

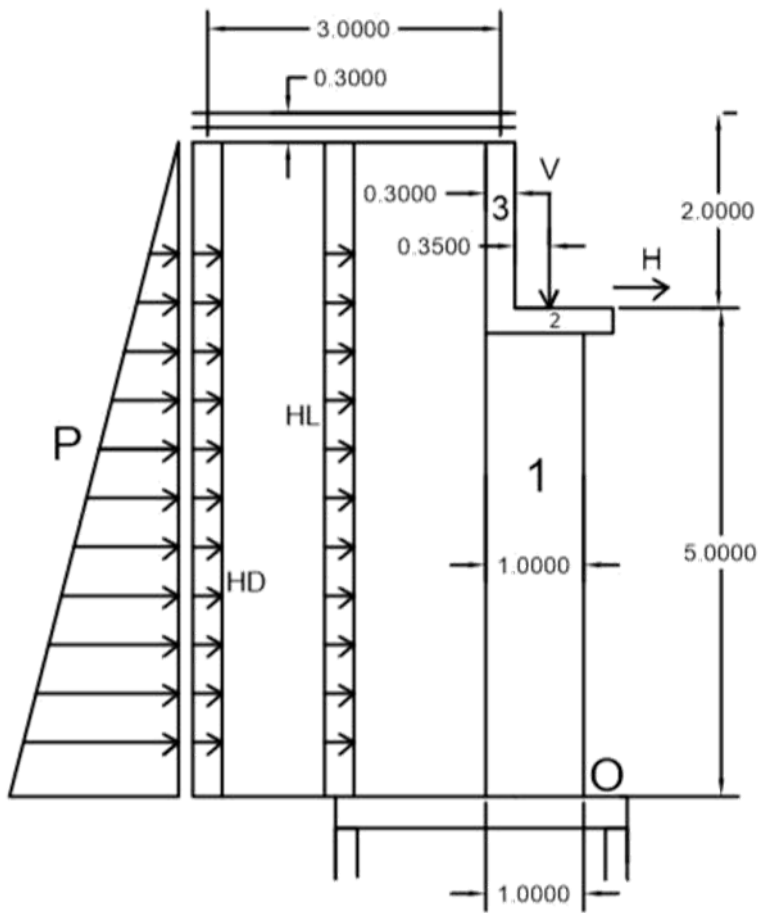
$$H = 0.16 \times 1244 = 199 \text{ kN}$$

$$M = 199 \times 5 = 995 \text{ kN}$$

Total moment = 995 + 869.3 = 1865 kN m



All units in Meter(m)



Loads on Abutment

Forces and moments about base/m length of Abutment :

Sr No.	Details	Vertical Forces (KN)	Horizontal Forces(KN)	Lever Arm (m)	Moment About 0 KNm
1.	Dead Load For Structure	$1025 * 3 / 7.5 = 410$	--	0.15	61.5
2.	Active Earth Pressure	---	45	2.23	100.35
3.	Horizontal Force Due to live load Surcharge	---	80	3.35	268
4.	Vertival force due to Live load surcharge	75	---	1.85	139
5.	Self weight 1 2 3 4 Total:	125 -- 13 -- 138 KN	---	0 -- -0.35 --	0 -- -4.55 --
6.	Live load for structure	$365 * 3 / 7.5 = 146$	--	0.15	219
7.	Horizontal Bending moment	---	15	5.71	86
	Total	769	170		869.3 kNm

Total vertical load at base = $769 * 7.5 = 5768$ KN

Total horizontal load at base = $170 * 7.5 = 1275$ kN

Total bending moment at base = $869 * 7.5 = 6518$ KNm

Design of Abutment :-

1.5 (DL+LL):

$$M = 869.3 \text{ KN-m}$$

$$M_u = 1304 \text{ KN-m}$$

$$V = 170 \text{ KN}$$

$$V_u = 255 \text{ KN}$$

$$M_u/bd^2 = 1304 \times 10^6 / (1000 \times 950^2) = 1.45$$

$$P_t = 0.368\%$$

1.2 (DL+LL+EQ):

$$M = 1865/7.5 = 248.67 \text{ KN-m}$$

$$M_u = 373 \text{ KN-m}$$

$$V = 170 + 448/7.5 = 230 \text{ KN}$$

$$V_u = 276 \text{ KN}$$

$$M_u/bd^2 = 373 \times 10^6 / (1000 \times 950^2) = 0.41$$

$$A_{st} = 3496 \text{ mm}^2$$

$$\tau_u = 276 \times 10^3 / 1000 \times 950 = 0.29 \text{ N/mm}^2$$

$$\tau_c = 0.36 \text{ N/mm}^2 \text{ SAFE}$$

Provide 20Ø @ 80 c/c main steel on Earth force

Provide 20Ø @ 160 c/c main steel on Free force

Provide 12Ø @ 100 c/c Distribution steel

MEAN SCOUR DEPTH

$$\text{Clear waterway} = 39.8 \text{ m}$$

$$\text{Silt factor}(f) = 2.96$$

$$Q = 454 \text{ cumec}$$

$$\text{Unit discharge}(q) = 454/39.8 = 11.41 \text{ cumec/m width}$$

$$\text{Mean Scour Depth} = 1.34(q^2/f)^{1/3} = 4.56\text{m}$$

$$\text{Max. Scour Depth} = 2 \times 4.71 = 9.12\text{m}$$

$$\text{Grip Length} = \frac{1}{3}(\text{max scour depth} = 3.04 \text{ m (provide} = 5.78\text{m)})$$

$$\text{Depth of Foundation below HFL} = 9.12 + 3.04 = 12.16 \text{ m (provide} = 15.2\text{m)}$$

$$\text{Depth of foundation Below} = 12.16 - 2.2 = 9.96\text{m (provide} = 13\text{m)}$$

$$M = (3843 - 1190) \times 7.5 = 19898 \text{ KN-m}$$

$$V = 1098 \times 7.5 = 8235 \text{ KN}$$

$$H = 289 \times 7.5 = 2168 \text{ KN}$$

DESIGN OF WELL

Min thickness of stiening = 500 mm

$$\text{Thickness} = h = Kd\sqrt{L} = 0.030 \times 6.5 \times \sqrt{13} = 0.703 \text{ m (Provide 750mm)}$$

Bearing Pressure

Self Weight of well :

$$\text{Area of cross section of well} = \pi/4(6.5^2 - 5^2) + 6.5 \times 0.75 \times 2 + 0.75 \times 5.2 = 27.2 \text{ m}^2$$

$$\text{Internal area of well} = 75.43 - 27.2 = 48.23 \text{ m}^2$$

$$\text{Area of base} = \pi/4 \times 6.5^2 + 6.5 \times 6.5 = 75.43 \text{ m}^2$$

$$\text{Weight of well} = (27.2 \times 13 \times 25) + (48.23 \times 11 \times 18) + 48.23 \times 2 \times 2 \times 25 = 23386 \text{ KN}$$

$$\text{Weight of soil on cap} = (13 + 6.5)/2 \times 6.7 \times 3.5 \times 18 = 3904 \text{ KN}$$

$$\text{Total load at base} = 5768 + 23386 + 3904 = 33058 \text{ KN}$$

$$\text{Bearing pressure} = 33058/75.73 = 438.3 \text{ KN/m}^2 \text{ (Neglecting friction)}$$

Reinforcement

Vertical reinforcement (0.12%)

$$= .12/100 \times \pi/4 \times 23.78 = .023 \text{ m}^2 = 230 \text{ cm}^2$$

Provide 12 ϕ bars @ 100 c/c on each face vertically

Horizontal reinforcement (0.2%)

Provide 12Ø @100c/c on each face

Bottom Plug

Thickness of bottom plug is

$$t^2 = 1.18 \times r^2 q / f_c = 1.18 \times 3.25^2 \times 400 / 7000 = .71 \text{ m say } 800 \text{ mm}$$

Check For Section adopted

Distance of zero shear (max. BM) for scour level

$$X = \sqrt{(2FH / -K_a) \gamma b (K_p \beta)}$$

Assuming $\theta = 30^\circ$, $\delta \theta / 2 = 15^\circ$, $\theta^\circ = 45$

$$K_a = (\cos \theta / (\sqrt{\cos \delta} + \sqrt{\sin(\theta + \delta)} \times \sin \theta))^2$$

$$K_p = (\cos \theta / (\sqrt{\cos \delta} - \sin(\theta + \delta) \times \sin \theta))^2$$

$$K_a = .30, K_p = 5.0$$

$$\text{Therefore } x^2 = 2 * 2 * 1275 / (9.5(5-0.3)6.5) = 17.57 \text{ X} = 4.19 \text{m}$$

$$\text{Max BM is } M_{\max} = M_o + 2/3 Hx$$

Permissible tilt = 50 mm

$$\text{Tilt at scour level} = 50 \times 3.14 / 15.5 = 10.13 \text{ mm} = 11 \text{mm}$$

$$\text{Moment to tilt} = 0.012 \times 27226 = 327 \text{ KN-m}$$

$$M_{\max} = 327 + 2/3 \times 1275 \times 4.19 = 3888 \text{ KN-m}$$

$$\text{MOI} = \pi / 64 \times -5(.2^4)6 + (.65^4 \cdot 5 \cdot 6.5^3 / 12 - 6.5 \cdot 5.2^3 / 12) = 124.32 \text{ m}^4$$

Max Stress in steining

$$\sigma_{\max} = 33058 / 23.78 + (3888 / 124.32 \times 3.25)$$

$$1390 \pm 103 \text{ KN/m}^2 = 1492 \text{ KN} / \text{m}^2 = 1.5 \text{ N/mm}^2 < 6.0 \text{ N/mm}^2 \text{ (M25)}$$

$$V = 5768 \text{ KN}, H = 1275 \text{ KN}, M = 6518 \text{ KN}$$

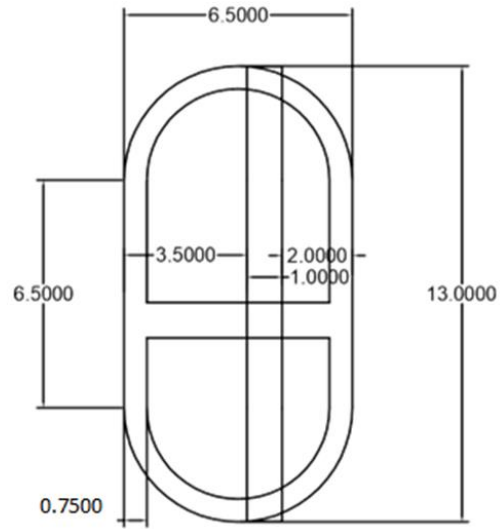
Upward Pressure = μP ;

$$P = \gamma (K_p - K_a) L D^2 / 6$$

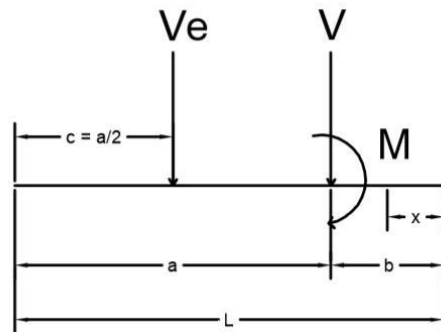
$$P = 9.5(5-0.3) 13 \cdot 5.78^2 / 6 = 3232 \text{ kN}$$

$$\text{Total vertical load} = (33058 - 3232) = 29826 \text{ KN}$$

$$\text{Bearing pressure} = 29826 / 75.43 = 395.4 \text{ KN/m}^2$$



Design of well cap



$$\begin{aligned}
 L &= 5.85 \text{ m} \\
 b &= 1.54 \text{ m} \\
 a &= 4.31 \text{ m} \\
 c &= 2.16 \text{ m}
 \end{aligned}$$

(At $x = b$)

$$M = V_e \cdot c_b/L + M_b/L + V_a/L \quad S.F = V_e \cdot c/L + M/L + V_a$$

$$M = 3904 \times 2.16 \times 1.54/5.85 + 6518 \times 1.54/5.85 + 5768 \times 1.54/5.85 = 2220 + 1716 + 1518 = 5454 \text{ KM-m}$$

$$S.F = 3904 \times 2.16/5.85 + 6518/5.85 + 5768 \times 4.31/5.85 = 6805 \text{ KN M/Width} = 5454/13 = 420 \text{ KN-m}$$

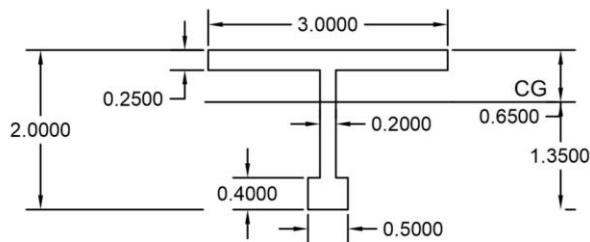
$M_u = 630 \text{ KN-m/m}$

$$S.F/Width = 6805/13 = 523 \text{ KN} \quad V_u = 785 \text{ KN/m} \quad T_u = 785 \times 10^3/1000 \times 950 = 0.83 \text{ M/mm}^2$$

$$M_u/bd^2 = 630 \times 10^3/1000 \times 950^2 \times 10^{-6} = 0.698$$

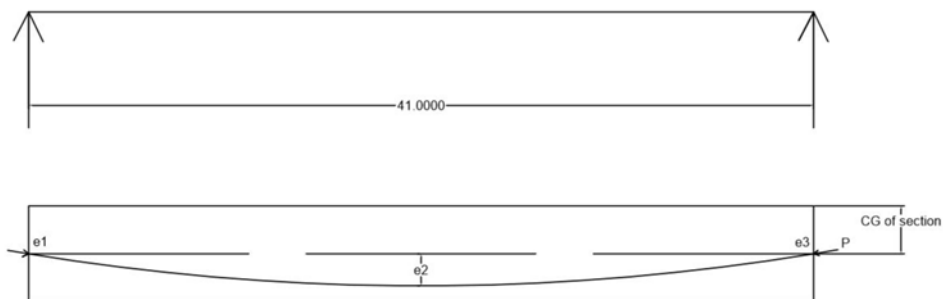
$A_{st} = 18.72 \text{ cm}^2/\text{m}$, provide = $16\phi @ 100 \text{ c/c}$ bathway at bottom Provide $12 \phi @ 100 \text{ c/c}$ bathway at top.

Analysis of Girder with Staad Pro:-



All units in meter(m)

$P = 12000 \text{ kN}$, $e_1 = e_3 = 0$, $e_2 = 1.00 \text{ m}$



$P = 12000 \text{ KN}$, $e_1 = e_3 = 0$, $e_2 = 1.0 \text{ m}$

Using Freyssinet system drainage type 27K15 (27 stands of 15.0 mm diameter) in 110 mm cable ducts.

Permissible Tensile Capacity of each cable = $27 \times 0.75 \times 265 = 5366$ kN

The cables are arranged in parabolic profile with end eccentricity zero and central eccentricity is 1000 mm.

Post stressing force required = 12000 kN

Post stressing force at Jack Level = $12000 \times 1.1 = 13200$ kN

Provide 3 cables

Post stressing force in each cable = 4400 kN < 5366 kN

Safe

Base Pressure Calculations

Moment at base of well = $53.74 \times 18 = 3582$ kNm

Total Moment = $3888 + 3582 = 7470$ kNm

Total vertical Load when half well is empty = $29826 - 4341 = 25485$ kN

MOI = $\pi/64 \times 6.5^4 + 6.5 \times 6.5^3/12 = 237.4$ m⁴

Beam pressure with BG = $25485/75.43 + 7470 \times 3.25 / 237.4 = 440$ kN/m² < 400×1.5 kN/m² Beam pressure

without BG = $25485/75.43 + 3888 \times 3.25 / 237.4 = 391.1$ kN/m² > 400 kN/m²

Safe