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CALCULATION SHEET

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Sump Pump. I

[2.70 × 3.90 × 2.80 dp]

Weight of Tank

1) Dead Load

Paving Block 80mm. + Compacted Sand 50 mm.

3.20 × 4.40 × 0.27 = 3.81

Roof Slab [t=0.20] = 3.20 × 4.40 × 0.20 × 2.40 = 6.76

RC Wall [t=0.25] = 2 [3.20 + 3.90] × 2.80 × 0.25 × 2.4 = 23.85

B. Slab [t=0.25] = 3.50 × 4.70 × 0.25 × 2.40 = 9.87

Pump	= 2 × 0.50	1.00
Check Valve	= 2 × 0.12	0.24
Valve		0.90
Butterfly Valve	= 2 × 0.05	0.10
Pipe	=	0.35
		46.88 T

2) Live load

Roof = 3.20 × 4.40 × 0.40 = 5.632 T

Water = [(2.70 × 3.90 × 2.80) + [0.7 × 0.9π × 6.30]] × 1.0 = 30.28 T

35.90 T

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Check Boyancy

Case I : Construction Stage

[Considered Ground Water Level @-1.00 m. from existing Ground]

Uplift = [3.20×4.40×1.8 + 3.5×4.7×0.25] × 1.0

= 29.46 T

Deadload = 23.85 + 9.87 = 33.72 T

$$F.S. = \frac{33.72}{29.46} = 1.14$$

Case II : Long term

[Considered Ground Water Level @ ±0.00m]

Uplift = [3.20×4.40×3.00 + 3.5×4.7×0.25] × 1.0.

= 46.35 T

Skin friction = $K \cdot S_u \cdot \Sigma_o \cdot d$.

= 1.09 × 0.82 × 2 [3.20 + 4.40] × 3.0

= 40.75 T

a) Empty Tank

$$F.S. = \frac{46.88 + 40.75}{46.35} = 1.89$$

b) Full Tank

$$F.S. = \frac{46.88 + 30.28 + 40.75}{46.35} = 2.54$$

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Check Bearing Capacity

End Bearing Capacity

$q_{ult} = S_u.N_C + \sigma_v.N_q + 0.5\sigma_v.N_\gamma$

$= 0.82\times5.71 + 0.60\times3.0\times1.0$

$= 6.48 \ T/m^2$

$Q_e = 6.48 \times 3.50 \times 4.70 = 106.5$

$Q_{eall} = \frac{Q_e}{F.S.} = \frac{106.5}{3.0} = 35.53^T$

Skin Friction

$Q_{fult} = \lambda.S_u.\Sigma_o.H$

$= 1.09\times0.82\times2[3.20+4.40]\times3.0$

$= 40.75^T$

$Q_{fall} = \frac{Q_{f.ult}}{F.S.} = \frac{40.75}{3.0} = 13.58^T$

Allowable Soil Bearing Capacity $= Q_{eall} + Q_{fall}$

$= 35.53 + 13.58 = \underline{49.11^T}$

Weight of Sump Pump

$P_{ult} = 46.88 + 35.90 = 82.78$

$P_{net} = 82.78 - 49.11 = 33.67^T$

Provided : 20 ⌀6"x6.00m.

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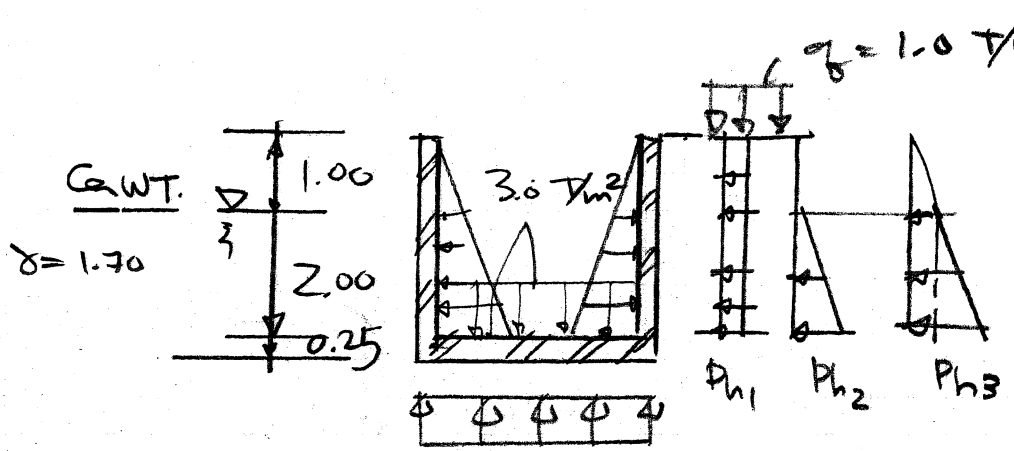
Sump Pump Analysis

Stage I : Construction Stage.

[Consider Ground Water level -1.00 m. from existing Ground & Surchasge = 1.00 t/m²]



Uplift = [2.0+0.25] × 1.0 = 2.25 t/m²

Ph_1 = $k_o . q$ = 0.65 "

Ph_2 = $\gamma_w (3.0-1.0)$ = 2.00 "

Ph_3 = $k_o . \gamma_s . 1.0 + k_o . \gamma_s' (3.0-1.0)$ = 2.015 "

= 4.67 "

Load Case I : Empty Tank

long wall = l_x / l_z = 3.90 / 2.00 = 1.30

M_{0r} = 0.055 × 4.67 × 3.0^2

= 2.311 T.m/m

M_{Ur} = 1.70 × 2.31 = 3.93 T.m/m

M_h = 0.03 × 4.67 × 3.90^2 = 2.13 T.m/m

M_{Uh} = 1.70 × 2.13 = 3.63 T.m/m

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Short Wall : $l_x/l_2 = 2.70/3.00 = 0.90$.

$M_G = 0.045 \times 4.67 \times 3.0^2$

$= 1.89$ T.m/m

$M_{GW} = 1.70 \times 1.89 = 3.57$ T.m/m

Load Case 2 : Tank is Full.

Long Wall

$M_G = 0.05 \times 3.00 \times 3.00^2$

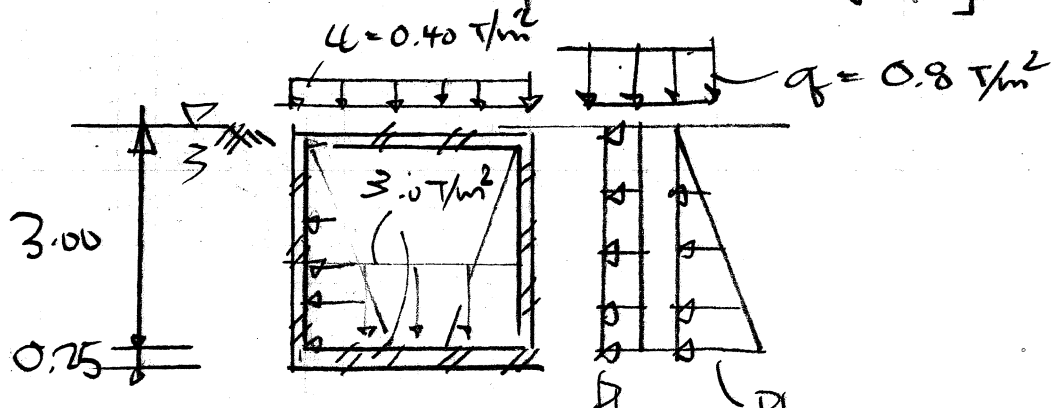
$= 7.35$ T.m/m

$M_{GW} = 1.70 \times 1.35 = 2.295$ T.m/m

$M_{GH} = 1.70 \times 0.81 = 1.377$ T.m/m

Stage II : Long Term Condition

[Consider Ground Water Level ±0.00 m. & Surcharge = 800 kg/m²]



Uplift = [3.0 + 0.25] × 1.0 = 3.25 T/m²

P_{h1} = $k_0 \cdot q$ = 0.52 T/m²

P_{h2} = $k_0 \cdot \gamma'_s \cdot H + \gamma_w H$ = 4.37 T/m²

P_h = 4.89 T/m²

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Load case 3 : Tank is Empty

Long Wall. : $\ell_x/\ell_z = 3.90/3.00 = 1.30$

$M_U = 0.035 \times 4.89 \times 3.00^2 = 1.55$ T.m/m

$M_{Uv} = 1.70 \times 1.54 = \underline{2.61}$ T.m/m

$M_h = 0.015 \times 4.89 \times 3.90^2 = 1.12$ T.m/m

$M_{Uh} = 1.70 \times 1.12 = \underline{1.90}$ T.m/m

Short Wall : $\ell_x/\ell_z = 2.70/3.00 = 0.90$

$M_U = 0.042 \times 4.89 \times 3.00^2 = 0.89$ T.m/m

$M_{Uv} = 1.70 \times 0.89 = \underline{1.52}$ T.m/m

Load Case 4 : Tank is Full

$M_U = 0.035 \times 5.00 \times 3.00^2 = 0.945$ T.m/m

$M_{Uv} = 1.70 \times 0.945 = \underline{1.61}$ T.m/m

$M_h = 0.015 \times 3.00 \times 3.90^2 = 0.41$ T.m/m

$M_{Uh} = 1.70 \times 0.405 = \underline{0.69}$ T.m/m

Summary Ultimated Bending Moment. [T.m/m]

Load Case	M_{Uv}	M_{Uh}	BM. Produce Tension
1	3.93	3.63	earth side
2	2.30	1.38	outer side
3	2.61	1.90	earth side
4	1.61	0.70	outer side

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Bending Reinforcement

$M_{Uv_{max}} = 3,930$ kg.m/m

$d = 0.25 - 0.04 - 0.006 = 0.204$

$A_{sv} = 5.50$ cm²/m : D12@200 [Vert. Bars] E.F.

$M_{Uh_{max}} = 3630$ kg.m/m

$d = 0.204$ cm/m

$A_{sh} = 5.06$ cm²/m : D12@200 [Horiz. Bars] (E.F.)

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Top Slab.

USE $t = 0.20$ m.

SW = $480 \times 1.4 = 672$ kg/m²

Paving Block + Compacted Sand

$= 270 \times 1.4 = 378$ "

LL $= 400 \times 1.7 = 680$ "

1730 "

$M^{\ominus} = 0.055 \times 1730 \times 2.70^2$

$= 693$ kg.m/m

$d = 0.164$ m

$A_{sb} = 1.18$ cm²/m : DB12@200

$M^{\oplus} = 0.041 \times 1730 \times 2.70^2$

$= 0.90$ cm²/m : DB12@200

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Base Slab.

[3.50 x 4.70 x 0.25^t]

Design as 2-Way Spanning Slab; $m = \frac{2.70}{3.90} = 0.70$

Weight of Tank.

D.L+L.L = 46.88 + 30.3

= 77.18^T

Weight of Soil on Base Slab.

= 2 [3.5 + 4.4] x 0.15 x 3.0 x 1.6

= 9.84^T

Total Weight on Base = 77.18 + 9.84

C_W = 87.02^T

Pressure on Base = $\frac{C_W - \text{Weight of Base}}{\text{Area}}$

= $\frac{87.02 - 9.87}{3.50 \times 4.70}$

= 4.68 T/m^2.

Uplift on Base = [3.0 + 0.25] x 1.0

= 3.25 T/m^2.

Max load on Base = 4.68 T/m^2.

W_U = 1.6 x 4.68 = 7.48 T/m^2.

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$M_{edge} = 0.055 \times 7.48 \times 2.70^2$

$= 2.99 \cdot T.m/m$

$d = 0.19$

$A_{sy} = 4.26 \ cm^2/m$: DB12@200 (T) E.F.

$M_{mid} = 0.041 \times 7.48 \times 2.70^2$

$= 2.24 \ T.m/m$

$A_{sy} = 3.17 \ cm^2/m$: DB12@200 (B) E.F.