VERTVES

AN INTEGRATED PACKAGE FOR DESIGN, DRAFTING & M.T.O OF VERTICAL VESSEL FOUNDATION

Version 6.0.0-evaluation-1

VALIDATION REPORT

B	02-09-2022	ISSUED FOR CONSTRUCTION	VS	RS	DA
A	02-09-2022	ISSUED FOR COMMENTS	VS	RS	DA
Rev. No.	**Date**	**Description**	**Prepared by**	**Approved by**	**Review by**

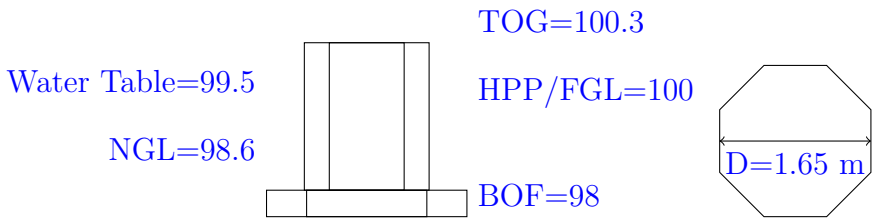
Contents

1 Default Values

Following values are taken as default by the software, unless user changes them in the interface.

Common Parameters	
Concrete Grade (f_{ck})	M30
Steel Grade (f_y)	Fe 500
Code	Indian(LSD)
Shape of Pedestal	Octagon
Shape of Footing / Pile Cap	Octagon
Minimum Thickness of Footing	300
Minimum Thickness of Pile Cap	500
Density	
Concrete (γ_{conc})	2.5 T/m^3
Soil Density (γ_{dry})	1.8 T/m^3
Soil Excl. Water (γ_{sat})	0.8 T/m^3
Grout Thickness (C_{grt})	30 mm
Concrete Clear Covers	
Top (C_{top})	50 mm
Side (Pedestal / Footing / Pile Cap) (C_{sid})	50 mm
Bottom (Footing)(C_{bot})	50 mm
Factor of Safety	
Factor of Safety Sliding (FOSS)	2.0
Factor of Safety Overturning (FOSO)	1.5
Partial Safety Factor for LSD	
Without Wind / Seismic	1.5
With Wind Seismic	1.2
Pile Foundation	
Min. Pile Diameter	300 mm
Min. Pile to Pile Distance	300 mm
Max. Pile to Pile Distance	2000 mm
Min. Distance from Pile Edge to Pile-Cap edge	250 mm
Min. Pile Cap bottom Reinforcement	!

2 Inputs



Levels
Top of Pedestal =100.3 m
Finished Ground =100 m
Natural Ground =98.6 m
Bottom of Foundation =98 m
Water Table =99.5 m

Minimum Thickness of Footing / Pile Cap (mm)=0.35
Shape of Pedestal =Octagon
Minimum Size of Pedestal (m) =1.65
Shape of Footing / Pile Cap =Octagon
Grout Thickness (C_{grt}) =30 mm

Concrete Clear Covers
Top (C_{top}) =50 mm
Side (Pedestal / Footing / Pile Cap) (C_{sid}) =50 mm
Bottom (Footing)(C_{bot}) =50 mm

Concrete Grade (f_{ck}) =M30 ($30N/mm^2$)
Steel Grade (f_y) =Fe 500 ($500N/mm^2$)
Code =Indian(LSD)

Density
Concrete (γ_{conc}) =2.5 T/m^3
Soil Density (γ_{dry}) =1.8 T/m^3
Soil Excl. Water (γ_{sat}) =0.8 T/m^3

Allowable Net Bearing Pressure =16 T/m^2
Net SBC Increase (DBE) =50.0 %
Net SBC Increase (MCE) =100.0 %
Net SBC Increase (Wind) =25.0 %
Coefficient of friction between soil and concrete (μ) =0.32

Factor of Safety
Refer load combination details for FOSO, FOSS specific to each Load Combination.
Partial Safety Factor for LSD =
Without Wind / Seismic =1.5
With Wind Seismic =1.2

Inputs for Vertves generated Equipment Loads

Wind
Basic Wind Speed (V_b) = 44 T/m2
K_1 = 1
K_2 (Terrain Category) = 1
K_3 = 1
K_4 = 1
K_d = 1
K_a = NA
K_c = NA
Seismic
Seismc Coeff (DBE) = 0.25
Seismc Coeff (MCE) = 0.35

Vessel Segment Information

Seismic C.G. of the Vessel = 104 m

No.	Vessel Diameter	Shape Factor	Top Level	Bottom Level
1	1.5	0.85	112.10	105.5
2	1.8	0.9	105.5	103.5
3	2.1	0.95	103.5	100.3

Equipment Weights
Empty (W_e) = 3.5 T
Operating (W_o) = 11 T
Hydrotest (W_h) = 13.2 T

Equipment Lateral Loads	**Shear**	**Moment**
Wind	$H_w = 1.54$ T	$M_w = 5.73$ Tm
Seismic DBE	$H_{dbe} = 2.54$ T	$M_{dbe} = 9.26$ Tm
Seismic MCE	$H_{mce} = 5.69$ T	$M_{mce} = 10.54$ Tm

3 Computed Wind Forces

Number of Segments ($N_{segments}$) = 3
Top most Point ($Point_{top}$) = 112.1
Bottom most Point ($Point_{bottom}$) = 100.3
Height of vessel (Ht_{vessel}) = 12.1
BreakPoints :
0. 0.3
1. 3.5
2. 5.5
3. 10
4. 12.1

Wind Calculation Factors
Basic Wind Speed (V_b) = 44
Factor 1 (K_1) = 1
Terrain Category = 1
Factor 3 (K_3) = 1
Factor 4 (K_4) = 1
Factor (K_d) = 1

Calculation for part : from 0.3 to 3.5
Factor 2 (K_2) = 1.05
Design Speed (V_{wind}) = $V_b * K_1 * K_2 * K_3 * K_4 = 44 * 1 * 1.05 * 1 * 1 = 46.2 m/s$
Design Pressure (P_{wind}) = $0.6 * {V_{wind}}^2 * K_d = 0.6 * 46.2^2 * 1 = 1280.664 N/m^2$

Calculation for part : from 3.5 to 5.5
Factor 2 (K_2) = 1.05
Design Speed (V_{wind}) = $V_b * K_1 * K_2 * K_3 * K_4 = 44 * 1 * 1.05 * 1 * 1 = 46.2 m/s$
Design Pressure (P_{wind}) = $0.6 * {V_{wind}}^2 * K_d = 0.6 * 46.2^2 * 1 = 1280.664 N/m^2$

Calculation for part : from 5.5 to 10
Factor 2 (K_2) = 1.05
Design Speed (V_{wind}) = $V_b * K_1 * K_2 * K_3 * K_4 = 44 * 1 * 1.05 * 1 * 1 = 46.2 m/s$
Design Pressure (P_{wind}) = $0.6 * {V_{wind}}^2 * K_d = 0.6 * 46.2^2 * 1 = 1280.664 N/m^2$

Calculation for part : from 10 to 12.1
Factor 2 (K_2) = 1.067
Design Speed (V_{wind}) = $V_b * K_1 * K_2 * K_3 * K_4 = 44 * 1 * 1.067 * 1 * 1 = 46.939 m/s$
Design Pressure (P_{wind}) = $0.6 * {V_{wind}}^2 * K_d = 0.6 * 46.939^2 * 1 = 1321.973 N/m^2$

Breakpoints-wise Calculations for all the Segments

Segment no : 1 from 0.3 to 3.5
Height ($H_{segment}$) = 3.5 - 0.3 = 3.2m
Diameter ($D_{segment}$) = 2.1m
Shape Factor ($S_{segment}$) = 0.95
Area ($A_{segment}$) = $S_{segment}$ * $D_{segment}$ * $H_{segment}$ = 0.95 * 2.1 * 3.2 = 6.384m^2
Wind Shear on segment ($Shear_{seg}$) = $A_{segment}$ * P_{wind} =6.384 * 1280.664/ 9810 = 0.833T

Lever arm ($L_{segment}$) = 1.6m
Wind moment on segment (M_{seg}) = $Shear_{wind}$ * $L_{segment}$ =0.833 * 1.6 = 1.333T-m

Segment no : 2 from 3.5 to 5.5
Height ($H_{segment}$) = 5.5 - 3.5 = 2m
Diameter ($D_{segment}$) = 1.8m
Shape Factor ($S_{segment}$) = 0.9
Area ($A_{segment}$) = $S_{segment}$ * $D_{segment}$ * $H_{segment}$ = 0.9 * 1.8 * 2 = 3.24m^2
Wind Shear on segment ($Shear_{seg}$) = $A_{segment}$ * P $_{wind}$ =3.24 * 1280.664/ 9810 = 0.423T
Lever arm ($L_{segment}$) = 4.2m
Wind moment on segment (M_{seg}) = $Shear_{wind}$ * $L_{segment}$ =0.423 * 4.2 = 1.776T-m

Segment no : 3 from 5.5 to 10
Height ($H_{segment}$) = 10 - 5.5 = 4.5m
Diameter ($D_{segment}$) = 1.5m
Shape Factor ($S_{segment}$) = 0.85
Area ($A_{segment}$) = $S_{segment}$ * $D_{segment}$ * $H_{segment}$ = 0.85 * 1.5 * 4.5 = 5.738m^2
Wind Shear on segment ($Shear_{seg}$) = $A_{segment}$ * P $_{wind}$ =5.738 * 1280.664/ 9810 = 0.749T
Lever arm ($L_{segment}$) = 7.45m
Wind moment on segment (M_{seg}) = $Shear_{wind}$ * $L_{segment}$ =0.749 * 7.45 = 5.58T-m

Segment no : 4 from 10 to 12.1
Height ($H_{segment}$) = 12.1 - 10 = 2.1m
Diameter ($D_{segment}$) = 1.5m
Shape Factor ($S_{segment}$) = 0.85
Area ($A_{segment}$) = $S_{segment}$ * $D_{segment}$ * $H_{segment}$ = 0.85 * 1.5 * 2.1 = 2.678m^2
Wind Shear on segment ($Shear_{seg}$) = $A_{segment}$ * P $_{wind}$ =2.678 * 1321.973/ 9810 = 0.361T
Lever arm ($L_{segment}$) = 10.75m
Wind moment on segment (M_{seg}) = $Shear_{wind}$ * $L_{segment}$ =0.361 * 10.75 = 3.879T-m

Total Wind Shear ($Shear_{\text{wind}}$) = $\sum Shear_{\text{seg}} = 2.366T$
Total Wind Moment ($Moment_{\text{wind}}$) = $\sum M_{\text{seg}} = 12.569T - m$
Factored Wind Shear ($Shear_{\text{wind}}$) $* 1.2 = 2.839T$
Factored Wind Moment ($Moment_{\text{wind}}$) $* 1.2 = 15.083T - m$

4 Computed Seismic Forces

Lever arm (L_{seis}) = CG - TOP = 104 - 100.3 = 3.7m
Factored Seismic Shear DBE = Seis Coeff DBE * Dead Wt * 1.05 = 0.25 * 11 = 2.888T
Factored Seismic Shear MCE = Seis Coeff MCE * Dead Wt * 1.05 = 0.35 * 11 = 4.043T
Factored Seismic Moment DBE = L_{seis} * Seismic Shear DBE = 3.7 * 2.888 = 10.684T-m
Factored Seismic Moment MCE = L_{seis} * Seismic Shear MCE = 3.7 * 4.043 = 14.957T-m

5 Load combinations

Load combinations generated from Input data.
All loadings at top of pedestal.

Load Combination No. 1 : 1 * Operating
Vertical Load (p)= 11
Horizontal Load (v)= 0
Moment (m)= 0
Factor of Safety Overturning (FOSO) =1.5
Factor of Safety Sliding (FOSO) =2.0

Load Combination No. 2 : 1 * Operating + 1 * Wind
Vertical Load (p)= 11
Horizontal Load (v)= 1.54
Moment (m)= 5.73
Factor of Safety Overturning (FOSO) =1.5
Factor of Safety Sliding (FOSO) =2.0

Load Combination No. 3 : 1 * Empty + 1 * Wind
Vertical Load (p)= 3.5
Horizontal Load (v)= 1.54
Moment (m)= 5.73
Factor of Safety Overturning (FOSO) =1.5
Factor of Safety Sliding (FOSO) =2.0

Load Combination No. 4 : 1 * Hydrotest (Field) + 0.25 * Wind
Vertical Load (p)= 13.20
Horizontal Load (v)= 0.3850
Moment (m)= 1.4325
Factor of Safety Overturning (FOSO) =1.5
Factor of Safety Sliding (FOSO) =2.0

Load Combination No. 5 : 1 * Operating + 1 * Seismic DBE
Vertical Load (p)= 11
Horizontal Load (v)= 2.54
Moment (m)= 9.26
Factor of Safety Overturning (FOSO) =1.5
Factor of Safety Sliding (FOSO) =2.0

Load Combination No. 6 : 1 * Operating + 1 * Seismic MCE
Vertical Load (p)= 11
Horizontal Load (v)= 5.69
Moment (m)= 10.54
Factor of Safety Overturning (FOSO) =1
Factor of Safety Sliding (FOSO) =1

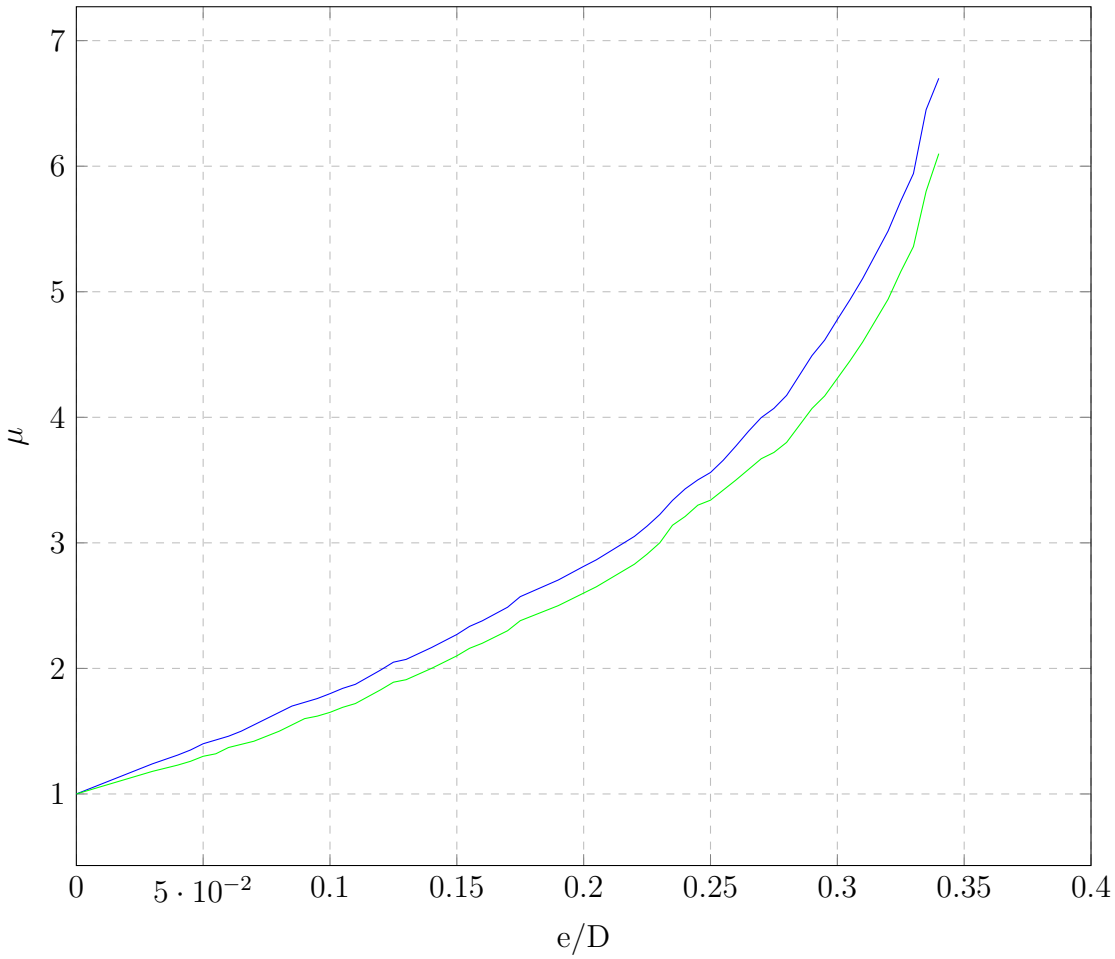
6 Base Pressure Calculations

(Note : D_f specified here is medium diagonal but as longest diagonal is used for base pressure calculations . D has been adjusted at various places by multiplying by 1.0824 to get the required dimension.)

Footing
Area factor(F_{area}) = 0.828427
Section Modulus factor (n-n axis)(F_{smnn}) = 0.101142
Section Modulus factor (m-m axis)(F_{smmm}) = 0.093443

Pedestal
Area factor (P_{area})= 0.828427
Section Modulus factor (P_{sm}) = 0.101142

OCTAGON NOMOGRAPH



Design calculation for Load Combinations No. = 1

Net Bearing Pressure (σ_{net}) = $16T/m^2$
Load Combination Classification: Normal
Gross Bearing Pressure (σ_{gross}) = $\sigma_{\text{net}} + h_{\text{n}} * \gamma_{\text{dry}} = 16 + 0.6 * 1.8 = 17.08T/m^2$

Water Table elevation >Bottom of Foundation =>Water table effects shall be checked.

Pedestal size (D_{p}) = $1.65m$
Initial Footing Size = $Pedestalsize(D_{\text{f}}) = 1.65m$

Incremental Footing Size = 1.65 m
Area of Footing (A_{f}) = $(F_{\text{area}}) * (D_{\text{f}})^2 = 0.828 * 1.65^2 = 2.255m^2$
Section Modulus of Footing (Z_{f}) = $(F_{\text{smmm}}) * (D_{\text{f}})^3 = 0.093 * 1.65^3 = 0.42m^3$
Shear Force at BOF (V) = 0 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 0 + 0 * (100.3 - 98) = 0T - m$

Without Water Table

Weight of Footing (W_{f}) = $(A_{\text{f}}) * \gamma_{\text{conc}} * FdnDepth = 2.255 * 2.5 * 0.35 = 1.973T$
Weight of Pedestal (W_{p}) = $(A_{\text{p}}) * \gamma_{\text{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65^2 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_{s}) = $(0.828 * 1.65^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 0T$
Total Structural Weight (W) = $W_{\text{f}} + W_{\text{p}} + W_{\text{s}} = 1.973 + 10.995 + 0 = 12.969T$
Total Vertical Load at BOF (P) = $axialLoad + W = 11 + 12.969 = 23.969T$
Eccentricity (e) = $M/P = 0/23.969 = 0m$
Eccentricity Ratio (e/D_{f}) = $0/1.65 = 0$
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = $0/1.0824 = 0$
Pressure Coefficient from Nomograph (μ_{nomo}) = 1
$P_{\text{max}} = P/A + M/Z = 23.969/2.255 + 0/0.42 = 10.627T/m^2$
$P_{\text{min}} = P/A - M/Z = 23.969/2.255 - 0/0.42 = 10.627T/m^2$
Moment at BOF value too small. Skipping Overturning Check.
Shear at BOF value too small. Skipping Sliding Check.
Contact Area = 2.255 m^2.
Percentage Contact Area = 2.255 / 2.255 * 100 = 100% .

With Water Table

Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 - 98), 0.35)) = 1.184T$
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35)) = 8.401$T
Weight of Soil above Footing (W_{swt}) = (0.828*(1.65 * 1.65)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 0T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 1.184 + 8.401 + 0 = 9.585T

Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 11 + 9.585 = 20.585T
Eccentricity (e_{wt}) = M_{wt}/P_{wt} = 0 / 20.585 = 0 m
Eccentricity Ratio (e_{wt}/D_f) = 0 / 1.65 = 0
Long Diagonal Adjustment – Eccentricity Ratio (e/D_f) = 0/1.0824 = 0
Pressure Coefficient from Nomograph (μ_{nomo}) = 1
P_{max} = P/A + M/Z = 20.585 / 2.255 + 0 / 0.42 = 9.127 T/m2
P_{min} = P/A - M/Z = 20.585 / 2.255 - 0 / 0.42 = 9.127 T/m2
Moment at BOF value too small. Skipping Overturning Check.
Shear at BOF value too small. Skipping Sliding Check.
Contact Area = 2.255 m^2.
Percentage Contact Area = 2.255 / 2.255* 100 = 100% .

Bearing Check Calculation Finished with Finalized foundation size **1.65 m**

Design calculation for Load Combinations No. = 2

Net Bearing Pressure (σ_{net}) = $16T/m^2$
Load Combination Classification: Wind
Gross Bearing Pressure (σ_{gross}) = $(1+25.0/100)*\sigma_{\text{net}}+h_{\text{n}}*\gamma_{\text{dry}} = (1+25.0/100)16+0.6*1.8 = 21.08T/m^2$

Water Table elevation >Bottom of Foundation =>Water table effects shall be checked.

Pedestal size (D_{p}) = $1.65m$
Initial Footing Size = $Pedestalsize(D_{\text{f}}) = 1.65m$

Incremental Footing Size = 1.955 m
Area of Footing (A_{f}) = $(F_{\text{area}}) * (D_{\text{f}})^2 = 0.828 * 1.955^2 = 3.166m^2$
Section Modulus of Footing (Z_{f}) = $(F_{\text{smmm}}) * (D_{\text{f}})^3 = 0.093 * 1.955^3 = 0.698m^3$
Shear Force at BOF (V) = 1.54 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 5.73 + 1.54 * (100.3 - 98) = 9.272T - m$

Without Water Table

Weight of Footing (W_{f}) = $(A_{\text{f}}) * \gamma_{\text{conc}} * FdnDepth = 3.166 * 2.5 * 0.35 = 2.77T$
Weight of Pedestal (W_{p}) = $(A_{\text{p}}) * \gamma_{\text{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65^2 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_{s}) = $(0.828 * 1.955^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 2.705T$
Total Structural Weight (W) = $W_{\text{f}} + W_{\text{p}} + W_{\text{s}} = 2.77 + 10.995 + 2.705 = 16.471T$
Total Vertical Load at BOF (P) = $axialLoad + W = 11 + 16.471 = 27.471T$
Eccentricity (e) = $M/P = 9.272/27.471 = 0.338m$
Eccentricity Ratio (e/D_{f}) = $0.338/1.955 = 0.173$
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = $0.173/1.0824 = 0.16$
Pressure Coefficient from Nomograph (μ_{nomo}) = 2.379
$P_{\max} = P/A + M/Z = 27.471/3.166 + 9.272/0.698 = 21.956T/m^2$
$P_{\min} = P/A - M/Z = 27.471/3.166 - 9.272/0.698 = -4.604T/m^2$
$P_{\min}$ is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{\max} = \mu_{\text{nomo}} * P/A = 2.379 * 27.471/3.166 = 20.638T/m^2$
$P_{\min}$ = 0 T/m^2
Overturnign FOS = $(P * D/2)/M = (27.471 * 1.955/2)/9.272 = 2.896$.
Sliding FOS = $(\mu * P)/H = 27.471 * 0.32/1.54 = 5.708$.
Contact Area = 3.053 m^2.
Percentage Contact Area = 3.053 / 3.166 * 100 = 96.407% .

With Water Table

Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 1.955 * 1.955 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 -$

98), 0.35)) = 1.662T
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35))$ = 8.401T
Weight of Soil above Footing (W_{swt}) = (0.828*(1.955 * 1.955)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 1.658T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 1.662 + 8.401 + 1.658 = 11.721T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 11 + 11.721 = 22.721T
Eccentricity (e_{wt}) = $M_{\text{wt}}/P_{\text{wt}}$ = 9.272 / 22.721 = 0.408 m
Eccentricity Ratio ($e_{\text{wt}}/D_{\text{f}}$) = 0.408 / 1.955 = 0.209
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = 0.209/1.0824 = 0.209
Pressure Coefficient from Nomograph (μ_{nomo}) = 2.927
P_{max} = P/A + M/Z = 22.721 / 3.166 + 9.272 / 0.698 = 20.456 T/m2
P_{min} = P/A - M/Z = 22.721 / 3.166 - 9.272 / 0.698 = -6.104 T/m2
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
P_{max}= $\mu_{\text{nomo}} * P/A = 2.927 * 22.721/3.166 = 21.005T/m2$
P_{min} = 0 T/m2
Overturnign FOS= $(P * D/2)/M = 22.721 * 1.955/2/9.272 = 2.395$.
Sliding FOS = $(\mu * P)/H = 22.721 * 0.32/1.54 = 4.721$.
Contact Area = 2.356 m^2.
Percentage Contact Area = 2.356 / 3.166* 100 = 74.413% .

Bearing Check Calculation Finished with Finalized foundation size **1.955 m**

Design calculation for Load Combinations No. = 3

Net Bearing Pressure (σ_{net}) = $16T/m^2$
Load Combination Classification: Wind
Gross Bearing Pressure (σ_{gross}) = $(1+25.0/100)*\sigma_{\text{net}}+h_{\text{n}}*\gamma_{\text{dry}} = (1+25.0/100)16+0.6*1.8 = 21.08T/m^2$

Water Table elevation >Bottom of Foundation =>Water table effects shall be checked.

Pedestal size (D_{p}) = $1.65m$
Initial Footing Size = $Pedestalsize(D_{\text{f}}) = 1.65m$

Incremental Footing Size = 2.035 m
Area of Footing (A_{f}) = $(F_{\text{area}}) * (D_{\text{f}})^2 = 0.828 * 2.035^2 = 3.431m^2$
Section Modulus of Footing (Z_{f}) = $(F_{\text{smmm}}) * (D_{\text{f}})^3 = 0.093 * 2.035^3 = 0.787m^3$
Shear Force at BOF (V) = 1.54 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 5.73 + 1.54 * (100.3 - 98) = 9.272T - m$

Without Water Table

Weight of Footing (W_{f}) = $(A_{\text{f}}) * \gamma_{\text{conc}} * FdnDepth = 3.431 * 2.5 * 0.35 = 3.002T$
Weight of Pedestal (W_{p}) = $(A_{\text{p}}) * \gamma_{\text{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65^2 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_{s}) = $(0.828 * 2.035^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 3.491T$
Total Structural Weight (W) = $W_{\text{f}} + W_{\text{p}} + W_{\text{s}} = 3.002 + 10.995 + 3.491 = 17.488T$
Total Vertical Load at BOF (P) = $axialLoad + W = 3.5 + 17.488 = 20.988T$
Eccentricity (e) = $M/P = 9.272/20.988 = 0.442m$
Eccentricity Ratio (e/D_{f}) = $0.442/2.035 = 0.217$
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = $0.217/1.0824 = 0.201$
Pressure Coefficient from Nomograph (μ_{nomo}) = 2.865
$P_{\max} = P/A + M/Z = 20.988/3.431 + 9.272/0.787 = 17.892T/m^2$
$P_{\min} = P/A - M/Z = 20.988/3.431 - 9.272/0.787 = -5.657T/m^2$
$P_{\min}$ is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{\max} = \mu_{\text{nomo}} * P/A = 2.865 * 20.988/3.431 = 17.526T/m^2$
$P_{\min}$ = 0 T/m^2
Overturnign FOS = $(P * D/2)/M = (20.988 * 2.035/2)/9.272 = 2.303$.
Sliding FOS = $(\mu * P)/H = 20.988 * 0.32/1.54 = 4.361$.
Contact Area = 2.726 m^2.
Percentage Contact Area = 2.726 / 3.431 * 100 = 79.446% .

With Water Table

Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 2.035 * 2.035 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 -$

98), 0.35)) = 1.801T
Weight of Pedestal (W_{pwt}) = 0.828 * 1.65 * 1.65 * (2.5 * (100.3 − 99.5) + (2.5 − 1.0) * (99.5 − 98 − 0.35)) = 8.401T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.035 * 2.035)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 2.139T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 1.801 + 8.401 + 2.139 = 12.342T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 3.5 + 12.342 = 15.842T
Eccentricity (e_{wt}) = $M_{\text{wt}}/P_{\text{wt}}$ = 9.272 / 15.842 = 0.585 m
Eccentricity Ratio ($e_{\text{wt}}/D_{\text{f}}$) = 0.585 / 2.035 = 0.288
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = 0.288/1.0824 = 0.288
Pressure Coefficient from Nomograph (μ_{nomo}) = 4.491
P_{max} = P/A + M/Z = 15.842 / 3.431 + 9.272 / 0.787 = 16.392 T/m2
P_{min} = P/A - M/Z = 15.842 / 3.431 - 9.272 / 0.787 = -7.157 T/m2
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
P_{max}= $\mu_{\text{nomo}} * P/A = 4.491 * 15.842/3.431 = 20.739T/m2$
P_{min} = 0 T/m2
Overturnign FOS= $(P * D/2)/M = 15.842 * 2.035/2/9.272 = 1.738$.
Sliding FOS = $(\mu * P)/H = 15.842 * 0.32/1.54 = 3.292$.
Contact Area = 3.004 m^2.
Percentage Contact Area = 3.004 / 3.431* 100 = 87.566% .

Bearing Check Calculation Finished with Finalized foundation size **2.035 m**

Design calculation for Load Combinations No. = 4

Net Bearing Pressure (σ_{net}) = $16T/m^2$
Load Combination Classification: ServiceWind
Gross Bearing Pressure (σ_{gross}) = $(1+25.0/100)\sigma_{\text{net}} + h_{\text{n}} * \gamma_{\text{dry}} = (1+25.0/100)16 + 0.6 * 1.8 = 21.08T/m^2$

Water Table elevation >Bottom of Foundation =>Water table effects shall be checked.

Pedestal size (D_{p}) = $1.65m$
Initial Footing Size = $Pedestalsize(D_{\text{f}}) = 1.65m$

Incremental Footing Size = 1.65 m
Area of Footing (A_{f}) = $(F_{\text{area}}) * (D_{\text{f}})^2 = 0.828 * 1.65^2 = 2.255m^2$
Section Modulus of Footing (Z_{f}) = $(F_{\text{smmm}}) * (D_{\text{f}})^3 = 0.093 * 1.65^3 = 0.42m^3$
Shear Force at BOF (V) = 0.385 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 1.433 + 0.385 * (100.3 - 98) = 2.318T - m$

Without Water Table

Weight of Footing (W_{f}) = $(A_{\text{f}}) * \gamma_{\text{conc}} * FdnDepth = 2.255 * 2.5 * 0.35 = 1.973T$
Weight of Pedestal (W_{p}) = $(A_{\text{p}}) * \gamma_{\text{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65^2 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_{s}) = $(0.828 * 1.65^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 0T$
Total Structural Weight (W) = $W_{\text{f}} + W_{\text{p}} + W_{\text{s}} = 1.973 + 10.995 + 0 = 12.969T$
Total Vertical Load at BOF (P) = $axialLoad + W = 13.2 + 12.969 = 26.169T$
Eccentricity (e) = $M/P = 2.318/26.169 = 0.089m$
Eccentricity Ratio (e/D_{f}) = $0.089/1.65 = 0.054$
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = $0.054/1.0824 = 0.05$
Pressure Coefficient from Nomograph (μ_{nomo}) = 1.4
$P_{\max} = P/A + M/Z = 26.169/2.255 + 2.318/0.42 = 17.125T/m^2$
$P_{\min} = P/A - M/Z = 26.169/2.255 - 2.318/0.42 = 6.08T/m^2$
Overturnign FOS = $(P * D/2)/M = (26.169 * 1.65/2)/2.318 = 9.314$.
Sliding FOS = $(\mu * P)/H = 26.169 * 0.32/0.385 = 21.75$.
Contact Area = 2.255 m^2.
Percentage Contact Area = 2.255 / 2.255 * 100 = 100% .

With Water Table

Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 - 98), 0.35)) = 1.184T$
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35)) = 8.401$T
Weight of Soil above Footing (W_{swt}) = (0.828*(1.65 * 1.65)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5

- 98 - 0.35)*0.8) = 0T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 1.184 + 8.401 + 0 = 9.585T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 13.2 + 9.585 = 22.785T
Eccentricity (e_{wt}) = M_{wt}/P_{wt} = 2.318 / 22.785 = 0.102 m
Eccentricity Ratio (e_{wt}/D_f) = 0.102 / 1.65 = 0.062
Long Diagonal Adjustment – Eccentricity Ratio (e/D_f) = 0.062/1.0824 = 0.062
Pressure Coefficient from Nomograph (μ_{nomo}) = 1.5
P_{max} = P/A + M/Z = 22.785 / 2.255 + 2.318 / 0.42 = 15.625 T/m2
P_{min} = P/A - M/Z = 22.785 / 2.255 - 2.318 / 0.42 = 4.58 T/m2
Overturnign FOS= $(P * D/2)/M = 22.785 * 1.65/2/2.318 = 8.11$.
Sliding FOS = $(\mu * P)/H = 22.785 * 0.32/0.385 = 18.939$.
Contact Area = 2.255 m^2.
Percentage Contact Area = 2.255 / 2.255* 100 = 100% .

Bearing Check Calculation Finished with Finalized foundation size **1.65 m**

Design calculation for Load Combinations No. = 5

Net Bearing Pressure (σ_{net}) = $16T/m^2$
Load Combination Classification: DBE
Gross Bearing Pressure (σ_{gross}) = $(1+50.0/100)\sigma_{\text{net}} + h_{\text{n}} * \gamma_{\text{dry}} = (1+50.0/100)16 + 0.6 * 1.8 = 25.08T/m^2$

Water Table elevation >Bottom of Foundation =>Water table effects shall be checked.

Pedestal size (D_{p}) = $1.65m$
Initial Footing Size = $Pedestalsize(D_{\text{f}}) = 1.65m$

Incremental Footing Size = 2.215 m
Area of Footing (A_{f}) = $(F_{\text{area}}) * (D_{\text{f}})^2 = 0.828 * 2.215^2 = 4.064m^2$
Section Modulus of Footing (Z_{f}) = $(F_{\text{smmm}}) * (D_{\text{f}})^3 = 0.093 * 2.215^3 = 1.015m^3$
Shear Force at BOF (V) = 2.54 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 9.26 + 2.54 * (100.3 - 98) = 15.102T - m$

Without Water Table

Weight of Footing (W_{f}) = $(A_{\text{f}}) * \gamma_{\text{conc}} * FdnDepth = 4.064 * 2.5 * 0.35 = 3.556T$
Weight of Pedestal (W_{p}) = $(A_{\text{p}}) * \gamma_{\text{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65^2 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_{s}) = $(0.828 * 2.215^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 5.373T$
Total Structural Weight (W) = $W_{\text{f}} + W_{\text{p}} + W_{\text{s}} = 3.556 + 10.995 + 5.373 = 19.924T$
Total Vertical Load at BOF (P) = $axialLoad + W = 11 + 19.924 = 30.924T$
Eccentricity (e) = $M/P = 15.102/30.924 = 0.488m$
Eccentricity Ratio (e/D_{f}) = $0.488/2.215 = 0.22$
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = $0.22/1.0824 = 0.204$
Pressure Coefficient from Nomograph (μ_{nomo}) = 2.865
$P_{\max} = P/A + M/Z = 30.924/4.064 + 15.102/1.015 = 22.48T/m^2$
$P_{\min} = P/A - M/Z = 30.924/4.064 - 15.102/1.015 = -7.263T/m^2$
$P_{\min}$ is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{\max} = \mu_{\text{nomo}} * P/A = 2.865 * 30.924/4.064 = 21.798T/m^2$
$P_{\min}$ = 0 T/m^2
Overturnign FOS = $(P * D/2)/M = (30.924 * 2.215/2)/15.102 = 2.268$.
Sliding FOS = $(\mu * P)/H = 30.924 * 0.32/2.54 = 3.896$.
Contact Area = 3.153 m^2.
Percentage Contact Area = 3.153 / 4.064 * 100 = 77.585% .

With Water Table

Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 2.215 * 2.215 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 -$

98), 0.35)) = 2.134T
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35))$ = 8.401T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.215 * 2.215)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 3.292T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 2.134 + 8.401 + 3.292 = 13.828T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 11 + 13.828 = 24.828T
Eccentricity (e_{wt}) = $M_{\text{wt}}/P_{\text{wt}}$ = 15.102 / 24.828 = 0.608 m
Eccentricity Ratio ($e_{\text{wt}}/D_{\text{f}}$) = 0.608 / 2.215 = 0.275
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = 0.275/1.0824 = 0.275
Pressure Coefficient from Nomograph (μ_{nomo}) = 4.071
P_{max} = P/A + M/Z = 24.828 / 4.064 + 15.102 / 1.015 = 20.98 T/m2
P_{min} = P/A - M/Z = 24.828 / 4.064 - 15.102 / 1.015 = -8.763 T/m2
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
P_{max}= $\mu_{\text{nomo}} * P/A = 4.071 * 24.828/4.064 = 24.868T/m2$
P_{min} = 0 T/m2
Overturnign FOS= $(P * D/2)/M = 24.828 * 2.215/2/15.102 = 1.821$.
Sliding FOS = $(\mu * P)/H = 24.828 * 0.32/2.54 = 3.128$.
Contact Area = 3.955 m^2.
Percentage Contact Area = 3.955 / 4.064* 100 = 97.3% .

Bearing Check Calculation Finished with Finalized foundation size **2.215 m**

Design calculation for Load Combinations No. = 6

Net Bearing Pressure (σ_{net}) = $16T/m^2$
Load Combination Classification: MCE
Gross Bearing Pressure (σ_{gross}) = $(1+100.0/100)\sigma_{\text{net}}+h_{\text{n}}*\gamma_{\text{dry}} = (1+100.0/100)16+0.6*1.8 = 33.08T/m^2$

Water Table elevation >Bottom of Foundation =>Water table effects shall be checked.

Pedestal size (D_{p}) = $1.65m$
Initial Footing Size = $Pedestalsize(D_{\text{f}}) = 1.65m$

Incremental Footing Size = 2.565 m
Area of Footing (A_{f}) = $(F_{\text{area}}) * (D_{\text{f}})^2 = 0.828 * 2.565^2 = 5.45m^2$
Section Modulus of Footing (Z_{f}) = $(F_{\text{smmm}}) * (D_{\text{f}})^3 = 0.093 * 2.565^3 = 1.577m^3$
Shear Force at BOF (V) = 5.69 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 10.54 + 5.69 * (100.3 - 98) = 23.627T - m$

Without Water Table

Weight of Footing (W_{f}) = $(A_{\text{f}}) * \gamma_{\text{conc}} * FdnDepth = 5.45 * 2.5 * 0.35 = 4.769T$
Weight of Pedestal (W_{p}) = $(A_{\text{p}}) * \gamma_{\text{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65^2 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_{s}) = $(0.828 * 2.565^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 9.489T$
Total Structural Weight (W) = $W_{\text{f}} + W_{\text{p}} + W_{\text{s}} = 4.769 + 10.995 + 9.489 = 25.253T$
Total Vertical Load at BOF (P) = $axialLoad + W = 11 + 25.253 = 36.253T$
Eccentricity (e) = $M/P = 23.627/36.253 = 0.652m$
Eccentricity Ratio (e/D_{f}) = $0.652/2.565 = 0.254$
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = $0.254/1.0824 = 0.235$
Pressure Coefficient from Nomograph (μ_{nomo}) = 3.338
$P_{\max} = P/A + M/Z = 36.253/5.45 + 23.627/1.577 = 21.635T/m^2$
$P_{\min} = P/A - M/Z = 36.253/5.45 - 23.627/1.577 = -8.332T/m^2$
$P_{\min}$ is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{\max} = \mu_{\text{nomo}} * P/A = 3.338 * 36.253/5.45 = 22.2T/m^2$
$P_{\min}$ = 0 T/m^2
Overturnign FOS = $(P * D/2)/M = (36.253 * 2.565/2)/23.627 = 1.968$.
Sliding FOS = $(\mu * P)/H = 36.253 * 0.32/5.69 = 2.039$.
Contact Area = 5.436 m^2.
Percentage Contact Area = 5.436 / 5.45 * 100 = 99.744% .

With Water Table

Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 2.565 * 2.565 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 -$

98), 0.35)) = 2.861T
Weight of Pedestal (W_{pwt}) = 0.828 * 1.65 * 1.65 * (2.5 * (100.3 − 99.5) + (2.5 − 1.0) * (99.5 − 98 − 0.35)) = 8.401T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.565 * 2.565)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 5.815T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 2.861 + 8.401 + 5.815 = 17.078T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 11 + 17.078 = 28.078T
Eccentricity (e_{wt}) = $M_{\text{wt}}/P_{\text{wt}}$ = 23.627 / 28.078 = 0.841 m
Eccentricity Ratio ($e_{\text{wt}}/D_{\text{f}}$) = 0.841 / 2.565 = 0.328
Long Diagonal Adjustment – Eccentricity Ratio (e/D_{f}) = 0.328/1.0824 = 0.328
Pressure Coefficient from Nomograph (μ_{nomo}) = 5.941
P_{max} = P/A + M/Z = 28.078 / 5.45 + 23.627 / 1.577 = 20.135 T/m2
P_{min} = P/A - M/Z = 28.078 / 5.45 - 23.627 / 1.577 = -9.832 T/m2
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
P_{max}= $\mu_{\text{nomo}} * P/A = 5.941 * 28.078/5.45 = 30.606T/m2$
P_{min} = 0 T/m2
Overturnign FOS= $(P * D/2)/M = 28.078 * 2.565/2/23.627 = 1.524$.
Sliding FOS = $(\mu * P)/H = 28.078 * 0.32/5.69 = 1.579$.
Contact Area = 5.45 m^2.
Percentage Contact Area = 5.45 / 5.45* 100 = 100% .

Bearing Check Calculation Finished with Finalized foundation size **2.565 m**

7 Final Base Pressure Calculations

Maximum footing size across all load combinations = 2.565 m
Area of Footing $(A_{\mathrm{f}}) = (F_{\mathrm{area}}) * (D_{\mathrm{f}})^2 = 0.828 * 2.565^2 = 5.45m^2$
Section Modulus of Footing $(Z_{\mathrm{f}}) = (F_{\mathrm{smmm}}) * (D_{\mathrm{f}})^3 = 0.101 * 2.565^3 = 0.42m^3$

Design calculation for Load Combinations No. = 1

Shear Force at BOF (V) = 0 T
Moment at BOF (M) $= Moment + Shear * (TOG - BOF) = 0 + 0 * (100.3 - 98) = 0T - m$

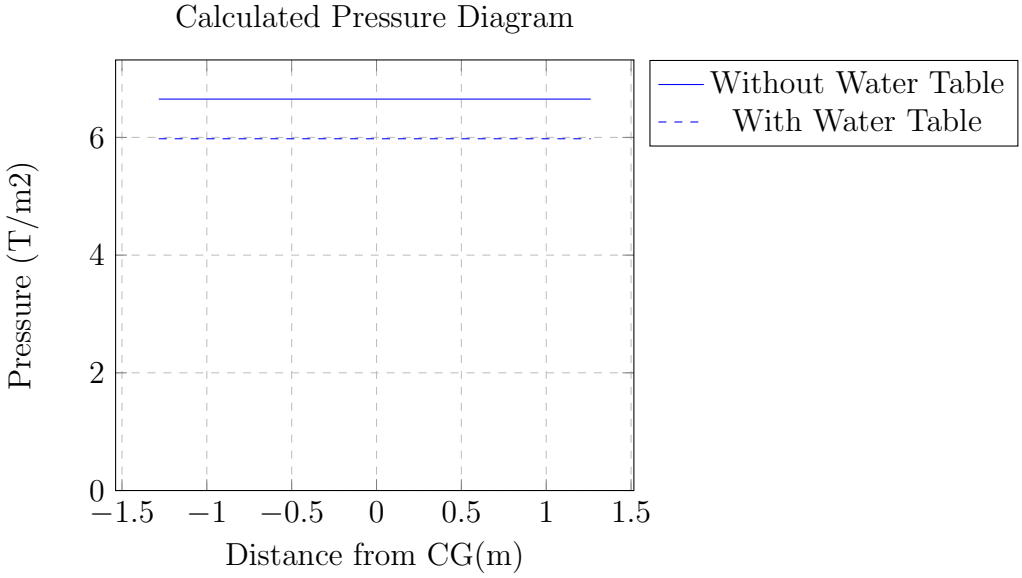
Without Water Table

Weight of Footing $(W_{\mathrm{f}}) = (A_{\mathrm{f}}) * \gamma_{\mathrm{conc}} * FdnDepth = 5.45 * 2.5 * 0.35 = 4.769T$
Weight of Pedestal $(W_{\mathrm{p}}) = (A_{\mathrm{p}}) * \gamma_{\mathrm{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65 * 1.65 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing $(W_{\mathrm{s}}) = (0.828 * 2.565^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 9.489T$
Total Structural Weight $(W) = W_{\mathrm{f}} + W_{\mathrm{p}} + W_{\mathrm{s}} = 4.769 + 10.995 + 9.489 = 25.253T$
Total Vertical Load at BOF $(P) = axialLoad + W = 11 + 25.253 = 36.253T$
Eccentricity $(e) = M/P = 0/36.253 = 0m$
Eccentricity Ratio $(e/D_{\mathrm{f}}) = 0/2.565 = 0$
Pressure Coefficient from Nomograph $(\mu_{\mathrm{nomo}}) = 1$
Contact Area = 5.45.
Percentage Contact Area = 100.
$P_{\mathrm{max}} = P/A + M/Z = 36.253/5.45 + 0/1.707 = 6.651T/m^2$
$P_{\mathrm{min}} = P/A - M/Z = 36.253/5.45 - 0/1.707 = 6.651T/m^2$
Moment at BOF value too small. FOS: Infinite.
Shear at BOF value too small. FOS: Infinite.

With Water Table

Footing upper level = 98 + 0.35 = 98.35
Water table level = 99.5
Water table above footing
Weight of Footing $(W_{\mathrm{fwt}}) = 0.828 * 2.565 * 2.565 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 - 98), 0.35)) = 2.861T$
Weight of Pedestal $(W_{\mathrm{pwt}}) = 0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35)) = 8.401$T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.565 * 2.565)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 5.815T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 2.861 + 8.401 + 5.815 = 21.579T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 11 + 21.579 = 32.579T
Eccentricity (e_{wt}) = $M_{\mathrm{wt}}/P_{\mathrm{wt}}$ = 0 / 32.579 = 0 m
Eccentricity Ratio ($e_{\mathrm{wt}}/D_{\mathrm{f}}$) = 0 / 2.565 = 0
Pressure Coefficient from Nomograph = 1

Contact Area = 5.45.
Percentage Contact Area = 100.
P_{max} = P/A + M/Z = 32.579 / 5.45 + 0 / 1.707 = 5.977 T/m2
P_{min} = P/A - M/Z = 32.579 / 5.45 - 0 / 1.707 = 5.977 T/m2
Moment at BOF value too small. FOS: Infinite.
Shear at BOF value too small. FOS: Infinite.



Design calculation for Load Combinations No. = 2

Shear Force at BOF (V) = 1.54 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF)$ = $5.73 + 1.54 * (100.3 - 98) = 9.272T - m$

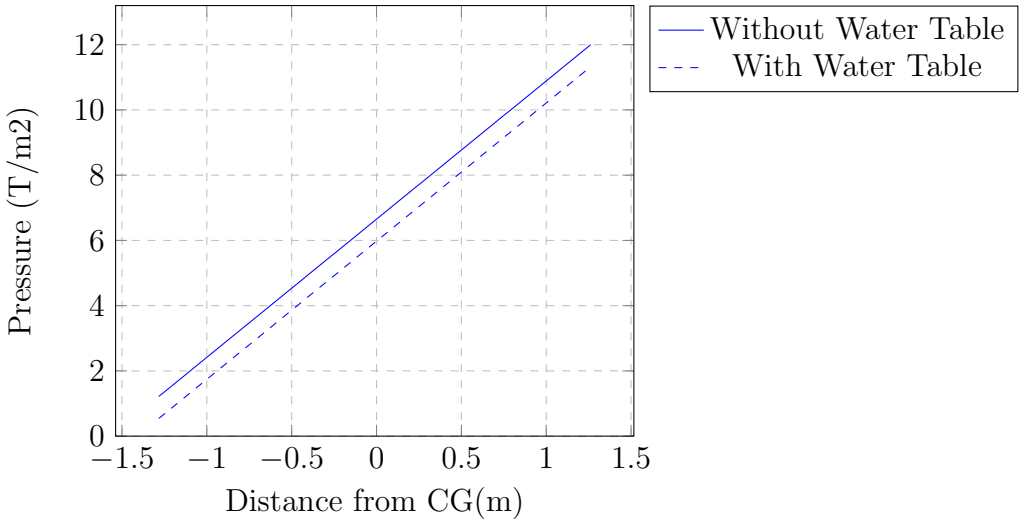
Without Water Table

Weight of Footing (W_f) = $(A_f) * \gamma_{conc} * FdnDepth = 5.45 * 2.5 * 0.35 = 4.769T$
Weight of Pedestal (W_p) = $(A_p) * \gamma_{conc} * (TOG - BOF - FdnDepth) = 0.828 * 1.65 * 1.65 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_s) = $(0.828 * 2.565^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 9.489T$
Total Structural Weight (W) = $W_f + W_p + W_s = 4.769 + 10.995 + 9.489 = 25.253T$
Total Vertical Load at BOF (P) = $axialLoad + W = 11 + 25.253 = 36.253T$
Eccentricity (e) = $M/P = 9.272/36.253 = 0.256m$
Eccentricity Ratio (e/D_f) = $0.256/2.565 = 0.1$
Pressure Coefficient from Nomograph (μ_{nomo}) = 1.65
Contact Area = 5.45.
Percentage Contact Area = 100.
$P_{max} = P/A + M/Z = 36.253/5.45 + 9.272/1.707 = 12.084T/m^2$
$P_{min} = P/A - M/Z = 36.253/5.45 - 9.272/1.707 = 1.219T/m^2$
Overturnign FOS = $(P * D/2)/M = (36.253 * 2.565/2)/9.272 = 5.015$.
Sliding FOS = $(\mu * P)/H = 36.253 * 0.32/1.54 = 7.533$.

With Water Table

Footing upper level = 98 + 0.35 = 98.35
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 2.565 * 2.565 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 - 98), 0.35)) = 2.861T$
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35)) = 8.401$T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.565 * 2.565)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 5.815T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 2.861 + 8.401 + 5.815 = 21.579T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 11 + 21.579 = 32.579T
Eccentricity (e_{wt}) = $M_{\text{wt}}/P_{\text{wt}}$ = 9.272 / 32.579 = 0.285 m
Eccentricity Ratio ($e_{\text{wt}}/D_{\text{f}}$) = 0.285 / 2.565 = 0.111
Pressure Coefficient from Nomograph = 1.775
Contact Area = 5.45.
Percentage Contact Area = 100.
P_{max} = P/A + M/Z = 32.579 / 5.45 + 9.272 / 1.707 = 11.41 T/m2
P_{min} = P/A - M/Z = 32.579 / 5.45 - 9.272 / 1.707 = 0.545 T/m2
Overturnign FOS= $(P * D/2)/M = 32.579 * 2.565/2/9.272 = 4.506$.
Sliding FOS = $(\mu * P)/H = 32.579 * 0.32/1.54 = 6.77$.

Calculated Pressure Diagram



Design calculation for Load Combinations No. = 3

Shear Force at BOF (V) = 1.54 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 5.73 + 1.54 * (100.3 - 98) = 9.272T - m$

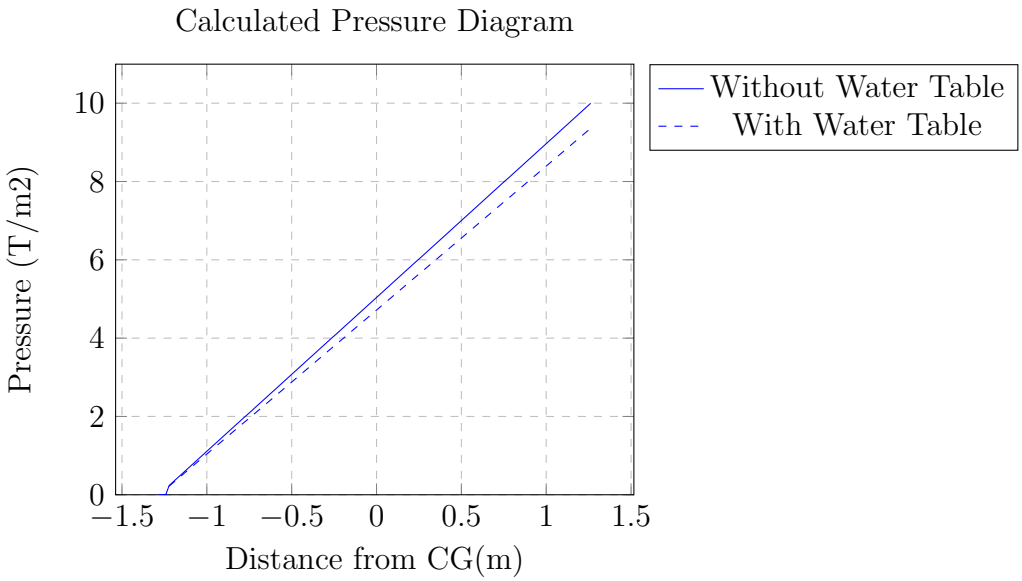
Without Water Table

Weight of Footing (W_{f}) = $(A_{\text{f}}) * \gamma_{\text{conc}} * FdnDepth = 5.45 * 2.5 * 0.35 = 4.769T$
Weight of Pedestal (W_{p}) = $(A_{\text{p}}) * \gamma_{\text{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65 * 1.65 *$

$2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_s) = $(0.828 * 2.565^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 9.489T$
Total Structural Weight (W) = $W_f + W_p + W_s = 4.769 + 10.995 + 9.489 = 25.253T$
Total Vertical Load at BOF (P) = $axialLoad + W = 3.5 + 25.253 = 28.753T$
Eccentricity (e) = $M/P = 9.272/28.753 = 0.322m$
Eccentricity Ratio (e/D_f) = $0.322/2.565 = 0.126$
Pressure Coefficient from Nomograph (μ_{nomo}) = 1.91
Contact Area = 5.444.
Percentage Contact Area = 99.885.
$P_{max} = P/A + M/Z = 28.753/5.45 + 9.272/1.707 = 10.708T/m^2$
$P_{min} = P/A - M/Z = 28.753/5.45 - 9.272/1.707 = -0.157T/m^2$
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{max} = \mu_{nomo} * P/A = 1.91 * 28.753/5.45 = 10.076T/m^2$
P_{min} = 0 T/m^2
Overturnign FOS = $(P * D/2)/M = (28.753 * 2.565/2)/9.272 = 3.977$.
Sliding FOS = $(\mu * P)/H = 28.753 * 0.32/1.54 = 5.975$.

With Water Table

Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 2.565 * 2.565 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 - 98), 0.35)) = 2.861T$
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35)) = 8.401$T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.565 * 2.565)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 5.815T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 2.861 + 8.401 + 5.815 = 21.579T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 3.5 + 21.579 = 25.079T
Eccentricity (e_{wt}) = M_{wt}/P_{wt} = 9.272 / 25.079 = 0.37 m
Eccentricity Ratio (e_{wt}/D_f) = 0.37 / 2.565 = 0.144
Pressure Coefficient from Nomograph = 2.05
Contact Area = 5.339.
Percentage Contact Area = 97.947.
P_{max} = P/A + M/Z = 25.079 / 5.45 + 9.272 / 1.707 = 10.034 T/m2
P_{min} = P/A - M/Z = 25.079 / 5.45 - 9.272 / 1.707 = -0.831 T/m2
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{max} = \mu_{nomo} * P/A = 2.05 * 25.079/5.45 = 9.433T/m2$
P_{min} = 0 T/m2
Overturnign FOS= $(P * D/2)/M = 25.079 * 2.565/2/9.272 = 3.469$.
Sliding FOS = $(\mu * P)/H = 25.079 * 0.32/1.54 = 5.211$.



Design calculation for Load Combinations No. = 4

Shear Force at BOF (V) = 0.385 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 1.433 + 0.385 * (100.3 - 98) = 2.318T - m$

Without Water Table

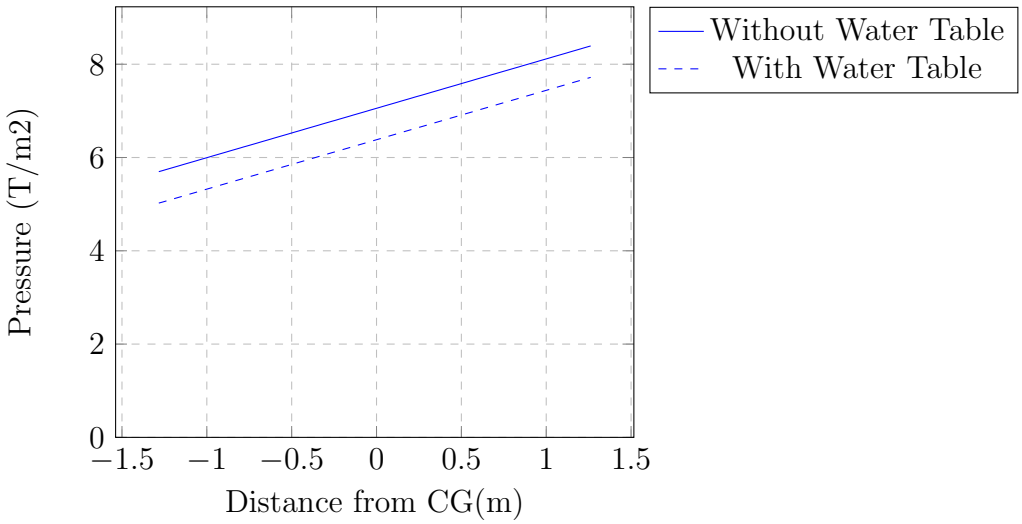
Weight of Footing (W_{f}) = $(A_{\mathrm{f}}) * \gamma_{\mathrm{conc}} * FdnDepth = 5.45 * 2.5 * 0.35 = 4.769T$
Weight of Pedestal (W_{p}) = $(A_{\mathrm{p}}) * \gamma_{\mathrm{conc}} * (TOG - BOF - FdnDepth) = 0.828 * 1.65 * 1.65 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_{s}) = $(0.828 * 2.565^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 9.489T$
Total Structural Weight (W) = $W_{\mathrm{f}} + W_{\mathrm{p}} + W_{\mathrm{s}} = 4.769 + 10.995 + 9.489 = 25.253T$
Total Vertical Load at BOF (P) = $axialLoad + W = 13.2 + 25.253 = 38.453T$
Eccentricity (e) = $M/P = 2.318/38.453 = 0.06m$
Eccentricity Ratio (e/D_{f}) = $0.06/2.565 = 0.024$
Pressure Coefficient from Nomograph (μ_{nomo}) = 1.15
Contact Area = 5.45.
Percentage Contact Area = 100.
$P_{\max} = P/A + M/Z = 38.453/5.45 + 2.318/1.707 = 8.413T/m^2$
$P_{\min} = P/A - M/Z = 38.453/5.45 - 2.318/1.707 = 5.697T/m^2$
Overturnign FOS = $(P * D/2)/M = (38.453 * 2.565/2)/2.318 = 21.275$.
Sliding FOS = $(\mu * P)/H = 38.453 * 0.32/0.385 = 31.961$.

With Water Table

Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 2.565 * 2.565 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 - 98), 0.35)) = 2.861T$
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 -$

98 − 0.35)) = 8.401T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.565 * 2.565)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 5.815T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 2.861 + 8.401 + 5.815 = 21.579T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 13.2 + 21.579 = 34.779T
Eccentricity (e_{wt}) = M_{wt}/P_{wt} = 2.318 / 34.779 = 0.067 m
Eccentricity Ratio (e_{wt}/D_f) = 0.067 / 2.565 = 0.026
Pressure Coefficient from Nomograph = 1.18
Contact Area = 5.45.
Percentage Contact Area = 100.
P_{max} = P/A + M/Z = 34.779 / 5.45 + 2.318 / 1.707 = 7.739 T/m2
P_{min} = P/A - M/Z = 34.779 / 5.45 - 2.318 / 1.707 = 5.023 T/m2
Overturnign FOS= $(P * D/2)/M = 34.779 * 2.565/2/2.318 = 19.243$.
Sliding FOS = $(\mu * P)/H = 34.779 * 0.32/0.385 = 28.907$.

Calculated Pressure Diagram



Design calculation for Load Combinations No. = 5

Shear Force at BOF (V) = 2.54 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF)$ = 9.26 + 2.54 * (100.3 − 98) = $15.102T - m$

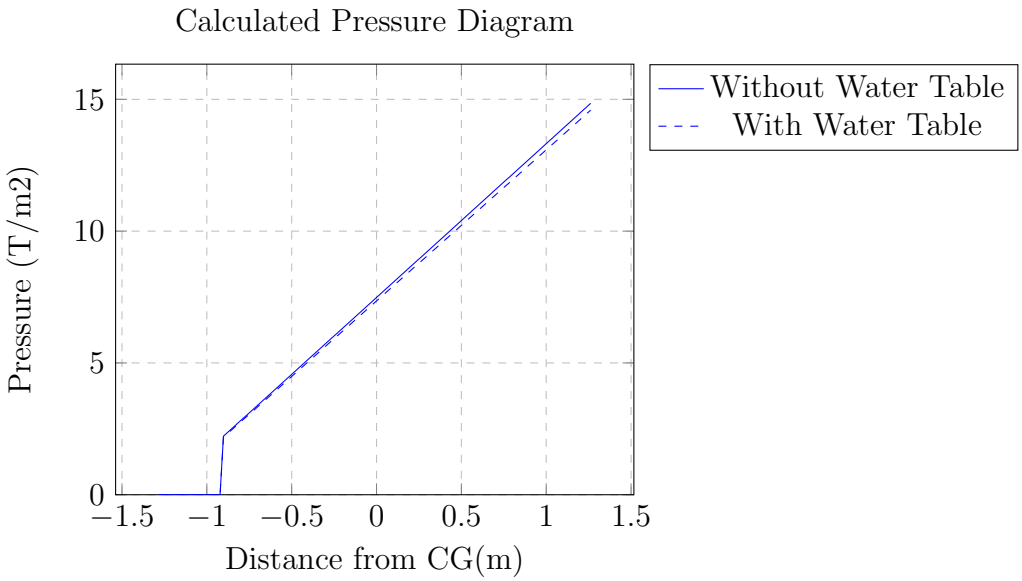
Without Water Table

Weight of Footing (W_f) = $(A_f) * \gamma_{conc} * FdnDepth = 5.45 * 2.5 * 0.35 = 4.769T$
Weight of Pedestal (W_p) = $(A_p) * \gamma_{conc} * (TOG - BOF - FdnDepth) = 0.828 * 1.65 * 1.65 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_s) = $(0.828 * 2.565^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 9.489T$
Total Structural Weight (W) = $W_f + W_p + W_s = 4.769 + 10.995 + 9.489 = 25.253T$
Total Vertical Load at BOF (P) = $axialLoad + W = 11 + 25.253 = 36.253T$
Eccentricity (e) = $M/P = 15.102/36.253 = 0.417m$
Eccentricity Ratio (e/D_f) = 0.417/2.565 = 0.162

Pressure Coefficient from Nomograph (μ_{nomo}) = 2.25
Contact Area = 5.105.
Percentage Contact Area = 93.665.
$P_{\max} = P/A + M/Z = 36.253/5.45 + 15.102/1.707 = 15.499T/m^2$
$P_{\min} = P/A - M/Z = 36.253/5.45 - 15.102/1.707 = -2.196T/m^2$
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{max} = \mu_{nomo} * P/A = 2.25 * 36.253/5.45 = 14.966T/m^2$
P_{min} = 0 T/m^2
Overturnign FOS = $(P * D/2)/M = (36.253 * 2.565/2)/15.102 = 3.079$.
Sliding FOS = $(\mu * P)/H = 36.253 * 0.32/2.54 = 4.567$.

With Water Table

Footing upper level = 98 + 0.35 = 98.35
Water table level = 99.5
Water table above footing
Weight of Footing (W_{fwt}) = $0.828 * 2.565 * 2.565 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 - 98), 0.35)) = 2.861T$
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35)) = 8.401$T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.565 * 2.565)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 5.815T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 2.861 + 8.401 + 5.815 = 21.579T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 11 + 21.579 = 32.579T
Eccentricity (e_{wt}) = M_{wt}/P_{wt} = 15.102 / 32.579 = 0.464 m
Eccentricity Ratio (e_{wt}/D_f) = 0.464 / 2.565 = 0.181
Pressure Coefficient from Nomograph = 2.46
Contact Area = 4.742.
Percentage Contact Area = 87.01.
P_{max} = P/A + M/Z = 32.579 / 5.45 + 15.102 / 1.707 = 14.825 T/m2
P_{min} = P/A - M/Z = 32.579 / 5.45 - 15.102 / 1.707 = -2.871 T/m2
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{max} = \mu_{nomo} * P/A = 2.46 * 32.579/5.45 = 14.704T/m2$
P_{min} = 0 T/m2
Overturnign FOS= $(P * D/2)/M = 32.579 * 2.565/2/15.102 = 2.767$.
Sliding FOS = $(\mu * P)/H = 32.579 * 0.32/2.54 = 4.104$.



Design calculation for Load Combinations No. = 6

Shear Force at BOF (V) = 5.69 T
Moment at BOF (M) = $Moment + Shear * (TOG - BOF) = 10.54 + 5.69 * (100.3 - 98) = 23.627T - m$

Without Water Table

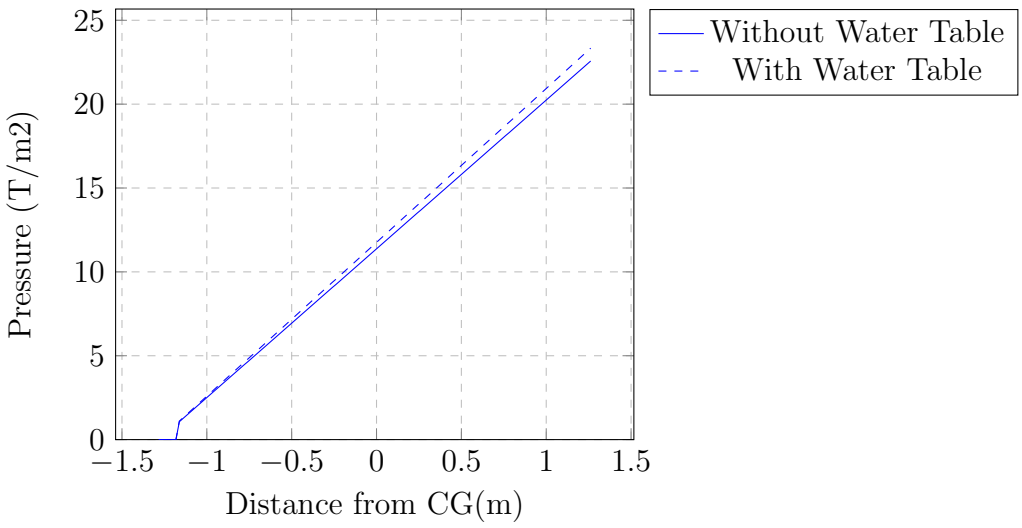
Weight of Footing (W_f) = $(A_f) * \gamma_{conc} * FdnDepth = 5.45 * 2.5 * 0.35 = 4.769T$
Weight of Pedestal (W_p) = $(A_p) * \gamma_{conc} * (TOG - BOF - FdnDepth) = 0.828 * 1.65 * 1.65 * 2.5 * (100.3 - 98 - 0.35) = 10.995T$
Weight of Soil above Footing (W_s) = $(0.828 * 2.565^2 - 0.828 * 1.65^2) * 1.8 * (100 - 98 - 0.35) = 9.489T$
Total Structural Weight (W) = $W_f + W_p + W_s = 4.769 + 10.995 + 9.489 = 25.253T$
Total Vertical Load at BOF (P) = $axialLoad + W = 11 + 25.253 = 36.253T$
Eccentricity (e) = $M/P = 23.627/36.253 = 0.652m$
Eccentricity Ratio (e/D_f) = $0.652/2.565 = 0.254$
Pressure Coefficient from Nomograph (μ_{nomo}) = 3.42
Contact Area = 5.416.
Percentage Contact Area = 99.366.
$P_{max} = P/A + M/Z = 36.253/5.45 + 23.627/1.707 = 20.494T/m^2$
$P_{min} = P/A - M/Z = 36.253/5.45 - 23.627/1.707 = -7.191T/m^2$
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{max} = \mu_{nomo} * P/A = 3.42 * 36.253/5.45 = 22.748T/m^2$
P_{min} = 0 T/m^2
Overturnign FOS = $(P * D/2)/M = (36.253 * 2.565/2)/23.627 = 1.968$.
Sliding FOS = $(\mu * P)/H = 36.253 * 0.32/5.69 = 2.039$.

With Water Table

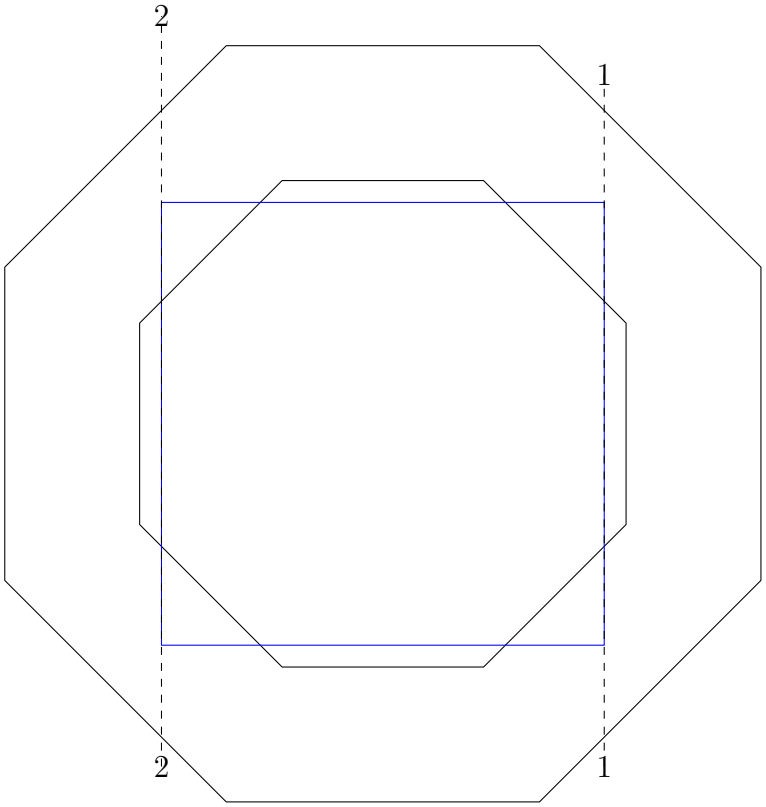
Footing upper level = $98 + 0.35 = 98.35$
Water table level = 99.5
Water table above footing

Weight of Footing (W_{fwt}) = $0.828 * 2.565 * 2.565 * (2.5 * (0) + (2.5 - 1.0) * Math.Min((99.5 - 98), 0.35)) = 2.861T$
Weight of Pedestal (W_{pwt}) = $0.828 * 1.65 * 1.65 * (2.5 * (100.3 - 99.5) + (2.5 - 1.0) * (99.5 - 98 - 0.35)) = 8.401$T
Weight of Soil above Footing (W_{swt}) = (0.828*(2.565 * 2.565)-0.828*(1.65 * 1.65))*((100 - 99.5)*1.8+(99.5 - 98 - 0.35)*0.8) = 5.815T
Total Structural Weight (W_{wt}) = (W_{swt}) + (W_{pwt}) + (W_{fwt}) = 2.861 + 8.401 + 5.815 = 21.579T
Total Vertical Load at BOF (P_{wt}) = axialLoad + (W_{wt}) = 11 + 21.579 = 32.579T
Eccentricity (e_{wt}) = $M_{\text{wt}}/P_{\text{wt}}$ = 23.627 / 32.579 = 0.725 m
Eccentricity Ratio ($e_{\text{wt}}/D_{\text{f}}$) = 0.725 / 2.565 = 0.283
Pressure Coefficient from Nomograph = 3.935
Contact Area = 5.079.
Percentage Contact Area = 93.188.
P_{max} = P/A + M/Z = 32.579 / 5.45 + 23.627 / 1.707 = 19.82 T/m2
P_{min} = P/A - M/Z = 32.579 / 5.45 - 23.627 / 1.707 = -7.865 T/m2
P_{min} is Negative, Pressure values shall updated using Nomograph coefficients.
$P_{\text{max}} = \mu_{\text{nomo}} * P/A = 3.935 * 32.579/5.45 = 23.521T/m2$
P_{min} = 0 T/m2
Overturnign FOS= $(P * D/2)/M = 32.579 * 2.565/2/23.627 = 1.768$.
Sliding FOS = $(\mu * P)/H = 32.579 * 0.32/5.69 = 1.832$.

Calculated Pressure Diagram



Section Used to calculate the moment for reinforcement design.



8 Moment R/F Calculations

Calculation for Footing Reinforcements

Calculation for Load Combination 1

For Reinforcement Steel of Grade 500N/mm2, Xumax/d (From IS456)= 0.46
Reinforcement design Depth (for Bottom R/f) = 0.27 m
Reinforcement design Depth (for Top R/f) = 0.27 m
Footing edge Length (a) = 0.751 m
Pedestal Size > Footing size edge Length.
Reinforcement design Width = 1.666 m
Mulim (Bottom R/f) = 119.982 Tm
Mulim (Top R/f) = 119.982 Tm

Without Water Table Case
Moment Pmin side = 0.79 Tm
Moment Pmax side = 0.79 Tm
Design Moment = 0.79 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.022
Minimum R/f required as per User Input. Providing Top R/f = 0.12
With Water Table Case
Moment Pmin side = 0.79 Tm
Moment Pmax side = 0.79 Tm
Design Moment = 0.79 Tm
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.022
Minimum R/f required . Providing Bottom R/f = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Bottom R/f = 0.12
Top R/f = 0.12
Bottom R/f (WT)= 0.12
Top R/f (WT)= 0.12

Calculation for Load Combination 2

Without Water Table Case
Moment Pmin side = -0.114 Tm
Moment Pmax side = 1.693 Tm
Design Moment = 1.693 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.002
Reinforcement received from Quadratic Solver = 0.048
Minimum R/f provided at Bottom. = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Design moment Top is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0
Reinforcement received from Quadratic Solver = 0.003
Minimum R/f provided at Top. = 0

Bottom R/f = max (Bottom R/f due to +ve Moment in Pmax side, Bottom R/f due to -ve Moment doubly R/f on Pmin side) = 0.12
Top R/f = max (Top R/f due to +ve Moment doubly R/f in Pmax side, Top R/f due to -ve Moment on Pmin side) = 0.12
With Water Table Case
Moment Pmin side = -0.114 Tm
Moment Pmax side = 1.693 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.002
Reinforcement received from Quadratic Solver = 0.048
Minimum R/f provided at Bottom. = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Design moment Top is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0
Reinforcement received from Quadratic Solver = 0.003
Minimum R/f provided at Top. = 0.12
Bottom R/f = max (Bottom R/f due to +ve Moment in Pmax side, Bottom R/f due to -ve Moment doubly R/f on Pmin side) = 0.12
Top R/f = max (Top R/f due to +ve Moment doubly R/f in Pmax side, Top R/f due to -ve Moment on Pmin side) = 0.12
Bottom R/f = 0.12
Top R/f = 0.12
Bottom R/f (WT)= 0.12
Top R/f (WT)= 0.12
Calculation for Load Combination 3

Without Water Table Case
Moment Pmin side = -0.624 Tm
Moment Pmax side = -2.298 Tm
Design Moment = -2.298 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = -0.003
Reinforcement received from Quadratic Solver = -0.063
Minimum R/f provided at Bottom. = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Design moment Top is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.017
Minimum R/f provided at Top. = 0
Bottom R/f = max (Bottom R/f due to +ve Moment in Pmax side, Bottom R/f due to -ve Moment doubly R/f on Pmin side) = 0.12
Top R/f = max (Top R/f due to +ve Moment doubly R/f in Pmax side, Top R/f due to -ve Moment on Pmin side) = 0.12
With Water Table Case
Moment Pmin side = -0.245 Tm
Moment Pmax side = 1.327 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = -0.003

Reinforcement received from Quadratic Solver = 0.037
Minimum R/f provided at Bottom. = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Design moment Top is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.017
Minimum R/f provided at Top. = 0.12
Bottom R/f = max (Bottom R/f due to +ve Moment in Pmax side, Bottom R/f due to -ve Moment doubly R/f on Pmin side) = 0.12
Top R/f = max (Top R/f due to +ve Moment doubly R/f in Pmax side, Top R/f due to -ve Moment on Pmin side) = 0.12
Bottom R/f = 0.12
Top R/f = 0.12
Bottom R/f (WT)= 0.12
Top R/f (WT)= 0.12

Calculation for Load Combination 4

Without Water Table Case
Moment Pmin side = 0.643 Tm
Moment Pmax side = 1.095 Tm
Design Moment = 1.095 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.031
Minimum R/f required as per User Input. Providing Top R/f = 0.12

With Water Table Case
Moment Pmin side = 0.643 Tm
Moment Pmax side = 1.095 Tm
Design Moment = 1.095 Tm
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.031
Minimum R/f required . Providing Bottom R/f = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Bottom R/f = 0.12
Top R/f = 0.12
Bottom R/f (WT)= 0.12
Top R/f (WT)= 0.12

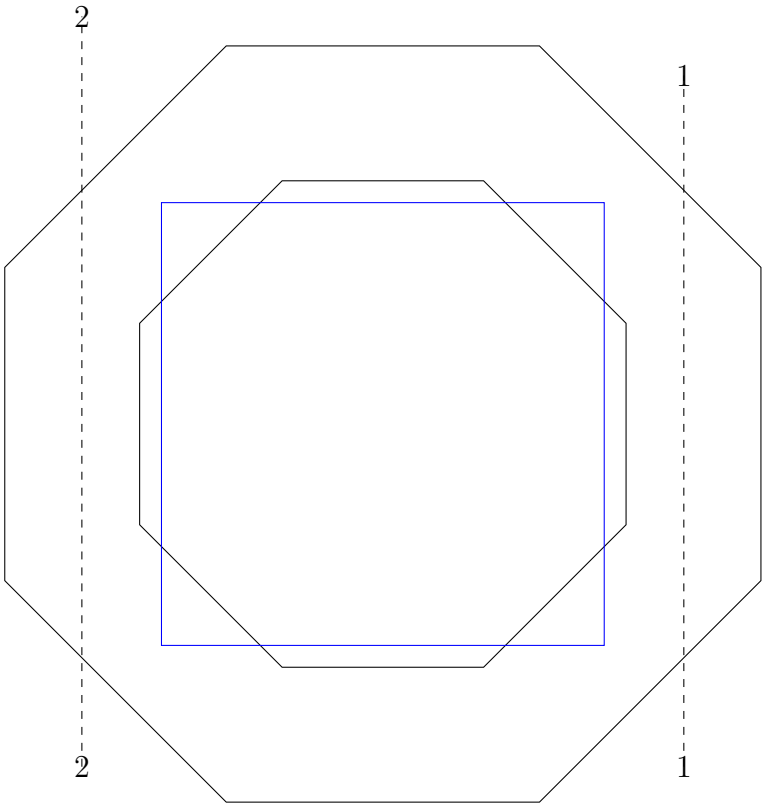
Calculation for Load Combination 5

Without Water Table Case
Moment Pmin side = -0.517 Tm
Moment Pmax side = -2.789 Tm
Design Moment = -2.789 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = -0.004
Reinforcement received from Quadratic Solver = -0.077
Minimum R/f provided at Bottom. = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12

Design moment Top is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.014
Minimum R/f provided at Top. = 0
Bottom R/f = max (Bottom R/f due to +ve Moment in Pmax side, Bottom R/f due to -ve Moment doubly R/f on Pmin side) = 0.12
Top R/f = max (Top R/f due to +ve Moment doubly R/f in Pmax side, Top R/f due to -ve Moment on Pmin side) = 0.12
With Water Table Case
Moment Pmin side = -0.337 Tm
Moment Pmax side = 2.282 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = -0.004
Reinforcement received from Quadratic Solver = 0.064
Minimum R/f provided at Bottom. = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Design moment Top is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.014
Minimum R/f provided at Top. = 0.12
Bottom R/f = max (Bottom R/f due to +ve Moment in Pmax side, Bottom R/f due to -ve Moment doubly R/f on Pmin side) = 0.12
Top R/f = max (Top R/f due to +ve Moment doubly R/f in Pmax side, Top R/f due to -ve Moment on Pmin side) = 0.12
Bottom R/f = 0.12
Top R/f = 0.12
Bottom R/f (WT)= 0.12
Top R/f (WT)= 0.12
Calculation for Load Combination 6

Without Water Table Case
Moment Pmin side = -0.674 Tm
Moment Pmax side = -4.422 Tm
Design Moment = -4.422 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = -0.006
Reinforcement received from Quadratic Solver = -0.121
Minimum R/f provided at Bottom. = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Design moment Top is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.019
Minimum R/f provided at Top. = 0
Bottom R/f = max (Bottom R/f due to +ve Moment in Pmax side, Bottom R/f due to -ve Moment doubly R/f on Pmin side) = 0.12
Top R/f = max (Top R/f due to +ve Moment doubly R/f in Pmax side, Top R/f due to -ve Moment on Pmin side) = 0.12
With Water Table Case

Moment Pmin side = -0.071 Tm
Moment Pmax side = 3.878 Tm
Design moment is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = -0.006
Reinforcement received from Quadratic Solver = 0.11
Minimum R/f provided at Bottom. = 0.12
Minimum R/f required as per User Input. Providing Top R/f = 0.12
Design moment Top is less than MuLim. = Singly R/f design shall be performed.
Mu / bd2 = 0.001
Reinforcement received from Quadratic Solver = 0.019
Minimum R/f provided at Top. = 0.12
Bottom R/f = max (Bottom R/f due to +ve Moment in Pmax side, Bottom R/f due to -ve Moment doubly R/f on Pmin side) = 0.12
Top R/f = max (Top R/f due to +ve Moment doubly R/f in Pmax side, Top R/f due to -ve Moment on Pmin side) = 0.12
Bottom R/f = 0.12
Top R/f = 0.12
Bottom R/f (WT)= 0.12
Top R/f (WT)= 0.12 Section Used to calculate the Shear for reinforcement design.



9 Shear R/F Calculations

T_{kscmax} based on Concrete Grade (Table 20 IS456)= 3.5 N/mm^2
Final Pt (Bottom) (Without Water Table) received from Moment Design = 0.12%
Final Pt (Bottom) (With Water Table) received from Moment Design = 0.12%
Final Pt (Top) (Without Water Table) received from Moment Design = 0.12%
Final Pt (Top) (With Water Table) received from Moment Design = 0.12%
Bottom Reinforcement Shear Check
Without Water Table

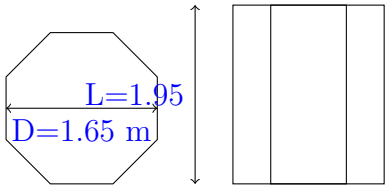
Shear Design for Load Combination No. = 1
Tv = Shear Force / (Width * depth) = 0.047 N/mm2
Tv < Tcmax. Go ahead for shear check / design.
For Pt = 0.12% Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 2
Tv = Shear Force / (Width * depth) = 0.103 N/mm2
Tv < Tcmax. Go ahead for shear check / design.
For Pt = 0.12% Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 3
Tv = Shear Force / (Width * depth) = -0.138 N/mm2
Tv < Tcmax. Go ahead for shear check / design.
For Pt = 0.12% Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 4
Tv = Shear Force / (Width * depth) = 0.065 N/mm2
Tv < Tcmax. Go ahead for shear check / design.
For Pt = 0.12% Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 5
Tv = Shear Force / (Width * depth) = -0.169 N/mm2
Tv < Tcmax. Go ahead for shear check / design.
For Pt = 0.12% Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 6
Tv = Shear Force / (Width * depth) = -0.267 N/mm2
Tv < Tcmax. Go ahead for shear check / design.
For Pt = 0.12% Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
With Water Table

Shear Design for Load Combination No. = 1
Tv = Shear Force / (Width * depth) = 0.047 N/mm2
Tv < tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 2

Tv = Shear Force / (Width * depth) = 0.103 N/mm2
Tv < tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 3
Tv = Shear Force / (Width * depth) = 0.081 N/mm2
Tv < tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 4
Tv = Shear Force / (Width * depth) = 0.065 N/mm2
Tv < tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 5
Tv = Shear Force / (Width * depth) = 0.139 N/mm2
Tv < tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 6
Tv = Shear Force / (Width * depth) = 0.235 N/mm2
Tv < tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv < Tc = Shear Check Pass.
Top T/f Shear Design for Load Combination No. = 1 need not be checked.
Shear Design for Load Combination No. = 2
Without Water Table
Tv = Shear Force / (Width * depth) = 0.009 N/mm2
Tv ¡ tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv ¡ Tc = Shear Check Pass.
Shear Design for Load Combination No. = 3
Without Water Table
Tv = Shear Force / (Width * depth) = 0.034 N/mm2
Tv ¡ tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv ¡ Tc = Shear Check Pass.
Top T/f Shear Design for Load Combination No. = 4 need not be checked.
Shear Design for Load Combination No. = 5
Without Water Table
Tv = Shear Force / (Width * depth) = 0.03 N/mm2
Tv ¡ tcmax. Go ahead for shear check / design.
For Pt = 0.12%Tc = 0.265 N/mm2
Tv ¡ Tc = Shear Check Pass.
Shear Design for Load Combination No. = 6
Without Water Table
Tv = Shear Force / (Width * depth) = 0.034 N/mm2
Tv ¡ tcmax. Go ahead for shear check / design.

For Pt = 0.12%Tc = 0.265 N/mm2
Tv ¡ Tc = Shear Check Pass.
Shear Design for Load Combination No. = 2
With Water Table
Tv = Shear Force / (Width * depth) = 0.009 N/mm2
Tv ¡ tcmax. Go ahead for shear check / design.
For Pt = 0.12Tc = 0.265
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 3
With Water Table
Tv = Shear Force / (Width * depth) = 0.017 N/mm2
Tv ¡ tcmax. Go ahead for shear check / design.
For Pt = 0.12Tc = 0.265
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 5
With Water Table
Tv = Shear Force / (Width * depth) = 0.022 N/mm2
Tv ¡ tcmax. Go ahead for shear check / design.
For Pt = 0.12Tc = 0.265
Tv < Tc = Shear Check Pass.
Shear Design for Load Combination No. = 6
With Water Table
Tv = Shear Force / (Width * depth) = 0.01 N/mm2
Tv ¡ tcmax. Go ahead for shear check / design.
For Pt = 0.12Tc = 0.265
Tv < Tc = Shear Check Pass.

10 Pedestal Design



Pedestal Length (L)= 1.95 m
Effective Pedestal Length $L_{ex} = 2 * L = 2 * 1.95 = 3.9$ m
Slenderness Ratio = $L_{ex}/D = 3.9/1.65 = 2.364$
Gross area = 2.255 m2
Slenderness Ratio smaller than 3
Designed as Pedestal 0.15
Pt column % = 0.15