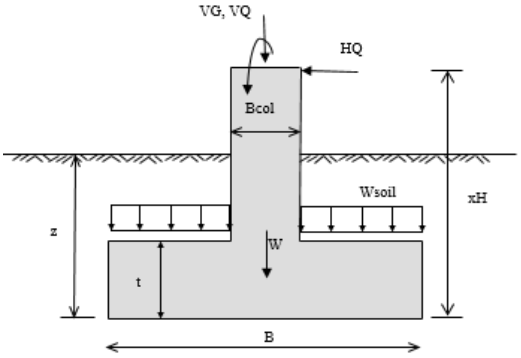
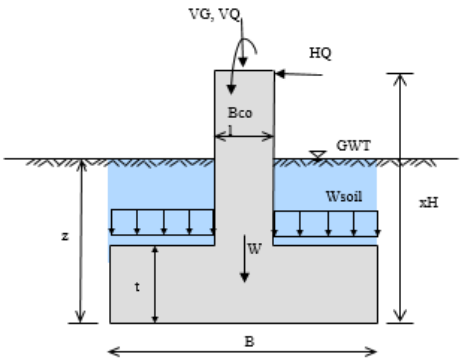
TYPICAL BEARING CAPACITY CALCULATION



a) short term



b) long term

A. Short-term (undrained) analysis

i) GEO limit state, Design Approach 1 - Combination 1 (DA1-1)

Input parameters

Breadth of footing	B =	5.00	m
Length of footing	L =	6.00	m
Thickness of footing	t =	1.00	m
Breath of column	B_{col} =	0.90	m
Length of column	L_{col} =	0.90	m
Depth to underside of footing	d =	3.00	m
GWT depth from ground surface	d_w =	**10.00**	m
Magnitude of vertical variable applied load	P_Q =	2,500.00	kN
Magnitude of vertical permanent applied load	P_G =	3,500.00	kN
Magnitude of horizontal permanent applied load	H_G =	1,500.00	kN
Point of application of H from foundation base	x_H =	1.00	m
Unit weight of concrete	γ_{conc} =	25.00	kN/m^3
Weight density of soil	γ_{soil} =	20.00	kN/m^3
Weight density of water	γ_{water} =	9.81	kN/m3
Undrained shear strength	c_u =	110.00	kPa
Effective cohesion	c' =	5.00	kPa
Effective angle of shearing resistance	ϕ' =	28.00	o

Initial calculations:

Weight of soil on top of foundation	W_{soil} =	1,167.60	kN
Total self-weight of foundation	$W_{concrete}$ =	790.50	kN
Water uplift thrust	U =	2,060.10	kN
Overburden at base of foundation	σ_{vb} =	60.00	kPa

Design material properties:

Undrained shear strength	c_u =	110.00	kPa

Design actions:

Total horizontal action	H_d =	2,250.00	kN
Self-weight of foundation	W_d =	2,643.44	kN
Applied permanent load	P_{dG} =	4,725.00	kN
Applied variable load	P_{dQ} =	3,750.00	kN
Water uplift thrust	U_d =	2,781.14	kN
Total vertical action	F_d =	13,899.57	kN
Area of footing	A =	30.00	m^2
Moment due to horizontal force	M =	2,250.00	kNm

Bearing capacity factors

Shape factor

s_c = 1.17

Load inclination factor

i_c = 0.87

Partial factors

On unfavourable actions/action effects

Permanent actions, γ_G = 1.35

Variable actions, γ_Q = 1.50

On material properties/resistances

Undrained strength, γ_{Cu} = 1.00

Bearing resistance, γ_{Rv} = 1.00

Bearing Capacity results:

Ultimate bearing capacity/m^2	q_u =	633.58	kPa
Ultimate bearing capacity	R_k =	19007.40	kN
Total bearing resistance	R_d =	19007.40	kN

Ratio of resistance to effects

Overdesign factor	**1.37**	**1.37**
Degree of utilisation	**73%**	**73%**

ii) GEO limit state, Design Approach 1 - Combination 2 (DA1-2)

Input parameters

Breadth of footing	B =	5.00	m
Length of footing	L =	6.00	m
Thickness of footing	t =	1.00	m
Breath of column	B_{col} =	0.90	m
Length of column	L_{col} =	0.90	m
Depth to underside of footing	d =	3.00	m
GWT depth from ground surface	d_w =	**1.50**	m
Magnitude of vertical variable applied load	P_Q =	2500.00	kN
Magnitude of vertical permanent applied load	P_G =	3500.00	kN
Magnitude of horizontal permanent applied load	H_G =	1500.00	kN
Point of application of H from foundation base	x_H =	1.00	m
Unit weight of concrete	γ_{conc} =	25.00	kN/m^3
Weight density of soil	γ_{soil} =	20.00	kN/m^3
Weight density of water	γ_{water} =	9.81	kN/m3
Undrained shear strength	c_u =	110.00	kPa
Effective cohesion	c' =	0.00	kPa
Effective angle of shearing resistance	ϕ' =	28.00	o

Initial calculations:

Weight of soil on top of foundation	W_{soil} =	1167.6	kN
Total self-weight of foundation	$W_{concrete}$ =	790.5	kN
Water uplift thrust	U =	-441.5	kN
Overburden at base of foundation	σ_{vb} =	45.3	kPa

Design material properties:

Undrained shear strength	c_u =	78.6	kPa

Design actions:

Total horizontal action	H_d =	1950.0	kN
Self-weight of foundation	W_d =	1958.1	kN
Applied permanent load	P_{dG} =	3500.0	kN
Applied variable load	P_{dQ} =	3250.0	kN
Water uplift thrust	U_d =	-441.5	kN
Total vertical action	F_d =	8266.7	kN
Area of footing	A =	30.00	m^2
Moment due to horizontal force	M =	1950.0	kNm

Bearing capacity factors

Shape factor

s_c = 1.17

Load inclination factor

i_c = 0.87

Partial factors

On unfavourable actions/action effects

Permanent actions, γ_G = 1.00

Variable actions, γ_Q = 1.30

On material properties/resistances

Undrained strength, γ_{Cu} = 1.40

Bearing resistance, γ_{Rv} = 1.00

Bearing Capacity results:

Ultimate bearing capacity/m^2	q_u =	454.99	kPa
Ultimate bearing capacity	R_k =	13649.55	kN
Total bearing resistance	R_d =	13649.55	kN

Ratio of resistance to effects

Overdesign factor	Γ =	**1.65**
Degree of utilisation	Λ =	**61%**

B. Long-term (drained) analysis

i) GEO limit state, Design Approach 1 - Combination 1

Breadth of footing	B =	5.00	m
Length of footing	L =	6.00	m
Thickness of footing	t =	1.00	m
Breath of column	B_{col} =	0.90	m
Length of column	L_{col} =	0.90	m
Depth to underside of footing	d =	3.00	m
GWT depth from ground surface	d_w =	**0.00**	m
Magnitude of vertical variable applied load	P_Q =	2500.00	kN
Magnitude of vertical permanent applied load	P_G =	3500.00	kN
Magnitude of horizontal permanent applied load	H_G =	1500.00	kN
Point of application of H from foundation base	x_H =	1.00	m
Unit weight of concrete	γ_{conc} =	25.00	kN/m^3
Weight density of soil	γ_{soil} =	20.00	kN/m^3
Weight density of water	γ_{water} =	9.81	kN/m3
Undrained shear strength	c_u =	110.00	kPa
Effective cohesion	c' =	5.00	kPa
Effective angle of shearing resistance	ϕ' =	28.00	o

Initial calculations:

Weight of soil on top of foundation	W_{soil} =	1167.6	kN
Total self-weight of foundation	$W_{concrete}$ =	790.5	kN
Water uplift thrust	U =	-882.9	kN
Overburden at base of foundation	σ_{vb} =	30.6	kPa

Design material properties:

Effective cohesion	c'_d =	0.0	kPa
Effective angle of shearing resistance	ϕ'_d =	28.0	o

Design actions:

Total horizontal action	H_d =	2250.0	kN
Self-weight of foundation	W_d =	2643.4	kN
Applied permanent load	P_{dG} =	4725.0	kN
Applied variable load	P_{dQ} =	3750.0	kN
Water uplift thrust	U_d =	-1191.9	kN
Total vertical action	F_d =	9926.5	kN
Area of footing	A =	30.00	m^2
Moment due to horizontal force	M =	2250.0	kNm

Bearing capacity factors

N_c =	25.80
N_q =	14.72
N_γ =	14.59

Shape factor

s_c =	1.42
s_q =	1.39
s_γ =	0.75

Load inclination factor

i_c =	0.65
i_q =	0.67
i_γ =	0.52

m= 1.54545

Partial factors

On unfavourable actions/action effects

Permanent actions, γ_G =	1.35
Variable actions, γ_Q =	1.50

On material properties/resistances

Coef. of shearing resistance, γ_Φ =	1.00
Undrained strength, γ_{Cu} =	1.00
Bearing resistance, γ_{Rv} =	1.00

Bearing Capacity results:

Ultimate bearing capacity/m^2	q_u =	694.39	kPa
Ultimate bearing capacity	R_k =	20831.62	kN
Total bearing resistance	R_d =	20831.62	kN

Ratio of resistance to effects

Overdesign factor	**2.10**	**1.71**
Degree of utilisation	**48%**	**58%**

ii) GEO limit state, Design Approach 1 - Combination 2

Breadth of footing	B =	5.00	m
Length of footing	L =	6.00	m
Thickness of footing	t =	1.00	m
Breath of column	B_{col} =	0.90	m
Length of column	L_{col} =	0.90	m
Depth to underside of footing	d =	3.00	m
GWT depth from ground surface	d_w =	**0.00**	m
Magnitude of vertical variable applied load	P_Q =	2500.00	kN
Magnitude of vertical permanent applied load	P_G =	3500.00	kN
Magnitude of horizontal permanent applied load	H_G =	1500.00	kN
Point of application of H from foundation base	x_H =	1.00	m
Unit weight of concrete	γ_{conc} =	25.00	kN/m^3
Weight density of soil	γ_{soil} =	20.00	kN/m^3
Weight density of water	γ_{water} =	9.81	kN/m3
Undrained shear strength	c_u =	110.00	kPa
Effective cohesion	c' =	0.00	kPa
Effective angle of shearing resistance	ϕ' =	28.00	o

Initial calcs:

Weight of soil on top of foundation	W_{soil} =	1167.6	kN
Total self-weight of foundation	$W_{concrete}$ =	790.5	kN
Water uplift thrust	U =	-882.9	kN
Overburden at base of foundation	σ_{vb} =	30.6	kPa

Design material properties:

Effective cohesion	c'_d =	4.0	kPa
Effective angle of shearing resistance	ϕ'_d =	23.0	o

Design actions:

Total horizontal action	H_d =	1950.0	kN
Self-weight of foundation	W_d =	1958.1	kN
Applied permanent load	P_{dG} =	3500.0	kN
Applied variable load	P_{dQ} =	3250.0	kN
Water uplift thrust	U_d =	-882.9	kN
Total vertical action	F_d =	7825.2	kN
Area of footing	A =	30.00	m^2
Moment due to horizontal force	M =	1950.0	kNm

Bearing capacity factors

N_c =	18.10
N_q =	8.70
N_γ =	6.55

Shape factor

s_c =	1.37
s_q =	1.33
s_γ =	0.75

Load inclination factor

i_c =	0.60
i_q =	0.64
i_γ =	0.48

m= 1.5455

Partial factors

On unfavourable actions/action effects

Permanent actions, γ_G =	1.00
Variable actions, γ_Q =	1.30

On material properties/resistances

Coef. of shearing resistance, γ_Φ =	1.25
Undrained strength, γ_{Cu} =	1.25
Bearing resistance, γ_{Rv} =	1.00

Bearing Capacity results:

Ultimate bearing capacity/m^2	q_u =	352.99	kPa
Ultimate bearing capacity	R_k =	10589.57	kN
Total bearing resistance	R_d =	10589.57	kN

Ratio of resistance to effects

Overdesign factor	**1.35**	**1.10**
Degree of utilisation	**74%**	**91%**

Therefore a conservative value of 350 kN/m^2, determined from the long term (drained analyses), has been adopted for the design of the structures in this design document