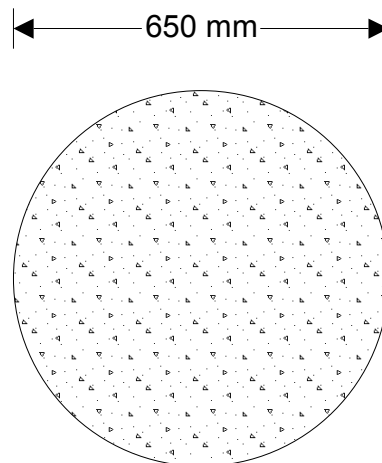
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PILE ANALYSIS

In accordance with EN 1997-1:2004 incorporating Corrigendum dated February 2009 and the recommended values

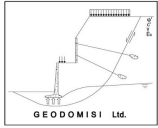


Pile details

Installation method;	Drilled
Shape;	650 mm diameter
Length;	L = 5000 mm

Material details

Material;	Concrete
Concrete strength class;	C40/50
Part. factor, concrete (EN1992-1-1 cl. 2.4.2.4(1));	$\gamma_C = 1.50$
Coefficient α_{cc} (EN1992-1-1 cl. 3.1.6(1));	$\alpha_{cc} = 1.00$
Characteristic compression cylinder strength;	$f_{ck} = 40 \text{ N/mm}^2$
Design comp. strength (EN1992-1-1 cl. 3.1.6(1));	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C = 26.7 \text{ N/mm}^2$
Mean value of cyl. strength (EN1992-1-1 Table 3.1);	$f_{cm} = f_{ck} + 8 \text{ MPa} = 48.0 \text{ N/mm}^2$
Secant mod. of elasticity (EN1992-1-1 Table 3.1);	$E_{cm} = 22000 \text{ MPa} \times (f_{cm} / 10 \text{ MPa})^{0.3} = 35.2$
kN/mm ²	
Modulus of elasticity;	$E = E_{cm} = 35.2 \text{ kN/mm}^2$



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Geometric properties

Pile section depth;

$$h = 650 \text{ mm}$$

Bearing area;

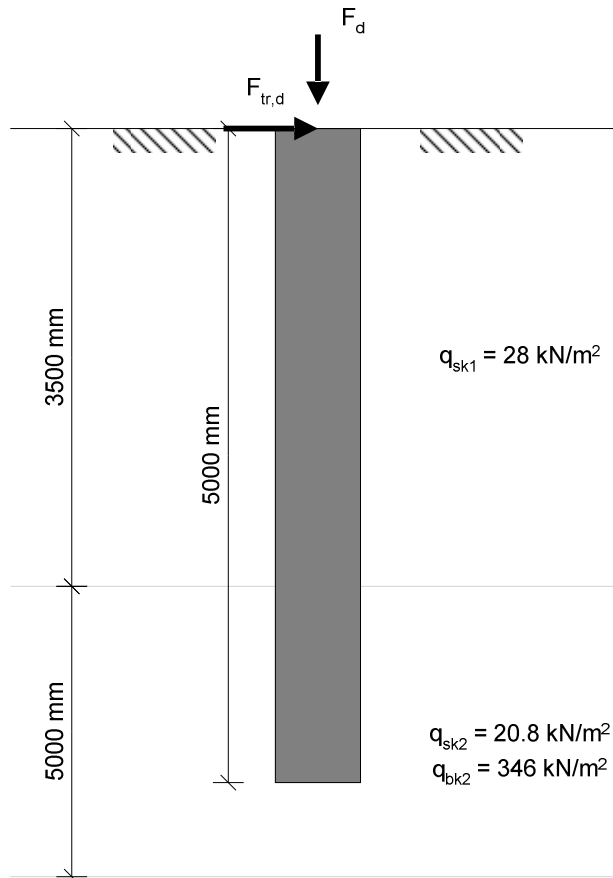
$$A_{\text{bearing}} = \pi \times h^2 / 4 = 0.332 \text{ m}^2$$

Pile perimeter;

$$\text{Perim}_{\text{pile}} = \pi \times h = 2.042 \text{ m}$$

Moment of inertia;

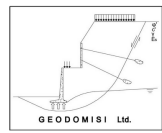
$$I = \pi \times h^4 / 64 = 876241 \text{ cm}^4$$



q_{ski} = Characteristic value, shaft resistance, q_{bki} = Characteristic value, base

Stratum details

Stratum	Geomaterial	Thickness, t_{stratai} (mm)	Characteristic value, base, q_{bki} (kN/m ²)	Characteristic value, shaft, q_{ski} (kN/m ²)
1	Cohesionless	3500	-	28
2	Cohesive	5000	346	20.8



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Action details

Characteristic perm. unfav. action, compression;	$G_{c,k,unfav} = 35 \text{ kN}$
Characteristic perm. fav. action, compression;	$G_{c,k,fav} = 0 \text{ kN}$
Characteristic variable unfav. action, compression;	$Q_{c,k} = 15 \text{ kN}$
Characteristic perm. unfav. action, tension;	$G_{t,k,unfav} = 0 \text{ kN}$
Characteristic perm. fav. action, tension;	$G_{t,k,fav} = 0 \text{ kN}$
Characteristic variable unfav. action, tension;	$Q_{t,k} = 0 \text{ kN}$
Characteristic unfavourable perm. lateral action;	$G_{tr,k,unfav} = 15 \text{ kN}$
Characteristic favourable permanent lateral action;	$G_{tr,k,fav} = 0 \text{ kN}$
Characteristic variable lateral action;	$Q_{tr,k} = 42 \text{ kN}$

Geotechnical partial and model factors:

Design approach 2:	
Model factor on axial resistance;	$\gamma_{model} = 1.40$
Permanent unfavourable, A1 (Table A.3);	$\gamma_{G,unfav,A1} = 1.35$
Permanent favourable, A1 (2);	$\gamma_{G,fav,A1} = 1.00$
Variable unfavourable, A1 (Table A.3);	$\gamma_{Q,A1} = 1.50$

Characteristic axial resistance

Characteristic axial base resistance;	$R_{bk} = A_{bearing} \times q_{bk} = 114.8 \text{ kN}$
Characteristic axial shaft resistance per stratum	
Stratum 1;	$R_{sk1} = q_{sk1} \times Perim_{pile} \times t_{strata1} = 200.1 \text{ kN}$
Stratum 2;	$R_{sk2} = q_{sk2} \times Perim_{pile} \times (L - D_{strata2}) = 63.7 \text{ kN}$
Characteristic total axial shaft resistance;	$R_{sk} = R_{sk1} + R_{sk2} = 263.8 \text{ kN}$

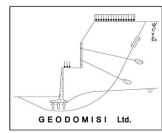
Axial compressive resistance

Load combination 1: A1 + M1 + R2	
Design compression action;	$F_{c,d,C1} = \gamma_{G,unfav,A1} \times G_{c,k,unfav} - \gamma_{G,fav,A1} \times G_{c,k,fav} + \gamma_{Q,A1}$
$\times Q_{c,k} = 69.8 \text{ kN}$	
Partial resistance factor, bearing (Table A.7);	$\gamma_{b,R2} = 1.10$
Partial resistance factor, shaft (Table A.7);	$\gamma_{s,R2} = 1.10$
Design compressive resistance;	$R_{c,d,C1} = (R_{bk} / \gamma_{b,R2} + R_{sk} / \gamma_{s,R2}) / \gamma_{model} = 245.9 \text{ kN}$
	$F_{c,d,C1} / R_{c,d,C1} = 0.284$

PASS - Design compressive resistance exceeds design load

Lateral analysis properties

Pile head fixity;	Free
Eccentricity of applied action;	$e_{actual} = 0 \text{ mm}$
Lateral action duration;	Long-term



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Lateral stratum details

Overburden pressure,

$$p_{ozSi} = \sum_{i=1}^n \gamma'_i \times t_{stratai}$$

Stratum	Characteristic cohesion, $c_{i,k}$ (kN/m ²)	Characteristic friction angle, $\phi_{i,k}$ (degrees)	Characteristic unit weight of soil, $\gamma_{i,k}$ (kN/m ³)	Characteristic overburden pressure, $p_{ozSi,k}$ (kN/m ²)
1	0	22	18	63
2	0	1	21.4	170

Load combination 1: A1 + M1 + R2

Partial factors:

Angle of shearing resistance (Table A.4);

$$\gamma_{\phi,M1} = 1.00$$

Effective cohesion (Table A.4);

$$\gamma_{c,M1} = 1.00$$

Undrained shear strength (Table A.4);

$$\gamma_{cu,M1} = 1.00$$

Weight density (Table A.4);

$$\gamma_{\gamma,M1} = 1.00$$

Lateral resistance factor;

$$\gamma_{tr,R2} = 1.10$$

Stratum	Design cohesion, $c_{i,d}$ (kN/m ²)	Design friction angle, $\phi_{i,d}$ (degrees)	Design unit weight of soil, $\gamma_{i,d}$ (kN/m ³)	Design overburden pressure, $p_{ozSi,d}$ (kN/m ²)
1	0	22	18	63
2	0	1	21.4	170

Resisting soil is divided into 10 segments to determine lateral resistance

From iteration, assume depth of point of rotation;

$$X = 3053 \text{ mm}$$

Distance from lateral action to ground;

$$e = e_{\text{actual}} = 0 \text{ mm}$$

Segment 1 properties:

Depth to base of segment from ground;

$$z_{Kq1} = 1 \times L / 10 = 500 \text{ mm}$$

Depth to base of segment from top of stratum;

$$z_{Kc1} = z_{Kq1} - D_{\text{strata1}} = 500 \text{ mm}$$

Depth to pile width ratio for K_q ;

$$z_{Kq1} / h = 0.8$$

Depth to pile width ratio for K_c ;

$$z_{Kc1} / h = 0.8$$

Effective overburden pressure;

$$p_{oz1} = p_{ozS0,d} + (z_{Kq1} - D_{\text{strata1}}) \times \gamma'_{1,d} = 9 \text{ kN/m}^2$$

Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);

$$K_{q1} = 3.15$$

Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);

$$K_{c1} = 10.05$$

Unit passive resist. at base (Tomlinson Eqn 7.49);

$$p_{z1} = p_{oz1} \times K_{q1} + c'_{1,d} \times K_{c1} = 28.358 \text{ kN/m}^2$$

Unit passive resistance at mid-height;

$$p_{z1,m} = (p_{z1} + p_{z0}) / 2 = 14.179 \text{ kN/m}^2$$

Segment lateral point load;

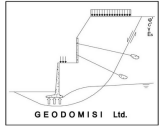
$$P_{\text{LatS1}} = L / 10 \times p_{z1,m} \times h = 4.6 \text{ kN}$$

Segment moment about applied load;

$$M_{\text{trS1}} = P_{\text{LatS1}} \times (e + (1 - 0.5) \times L / 10) = 1.2 \text{ kNm}$$

Segment moment about X;

$$M_{\text{XS1}} = P_{\text{LatS1}} \times (X - (1 - 0.5) \times L / 10) = 12.9 \text{ kNm}$$



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Segment 2 properties:

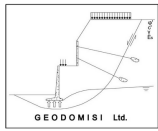
Depth to base of segment from ground; $Z_{Kq2} = 2 \times L / 10 = \mathbf{1000 \text{ mm}}$
 Depth to base of segment from top of stratum; $Z_{Kc2} = Z_{Kq2} - D_{strata1} = \mathbf{1000 \text{ mm}}$
 Depth to pile width ratio for K_q ; $Z_{Kq2} / h = \mathbf{1.5}$
 Depth to pile width ratio for K_c ; $Z_{Kc2} / h = \mathbf{1.5}$
 Effective overburden pressure; $p_{oz2} = p_{ozS0,d} + (Z_{Kq2} - D_{strata1}) \times \gamma'_{1,d} = \mathbf{18 \text{ kN/m}^2}$
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37); $K_{q2} = \mathbf{3.56}$
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37); $K_{c2} = \mathbf{13.31}$
 Unit passive resist. at base (Tomlinson Eqn 7.49); $p_{z2} = p_{oz2} \times K_{q2} + c'_{1,d} \times K_{c2} = \mathbf{64.051 \text{ kN/m}^2}$
 Unit passive resistance at mid-height; $p_{z2,m} = (p_{z2} + p_{z1}) / 2 = \mathbf{46.205 \text{ kN/m}^2}$
 Segment lateral point load; $P_{LatS2} = L / 10 \times p_{z2,m} \times h = \mathbf{15 \text{ kN}}$
 Segment moment about applied load; $M_{trS2} = P_{LatS2} \times (e + (2 - 0.5) \times L / 10) = \mathbf{11.3 \text{ kNm}}$
 Segment moment about X; $M_{XS2} = P_{LatS2} \times (X - (2 - 0.5) \times L / 10) = \mathbf{34.6 \text{ kNm}}$

Segment 3 properties:

Depth to base of segment from ground; $Z_{Kq3} = 3 \times L / 10 = \mathbf{1500 \text{ mm}}$
 Depth to base of segment from top of stratum; $Z_{Kc3} = Z_{Kq3} - D_{strata1} = \mathbf{1500 \text{ mm}}$
 Depth to pile width ratio for K_q ; $Z_{Kq3} / h = \mathbf{2.3}$
 Depth to pile width ratio for K_c ; $Z_{Kc3} / h = \mathbf{2.3}$
 Effective overburden pressure; $p_{oz3} = p_{ozS0,d} + (Z_{Kq3} - D_{strata1}) \times \gamma'_{1,d} = \mathbf{27 \text{ kN/m}^2}$
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37); $K_{q3} = \mathbf{3.89}$
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37); $K_{c3} = \mathbf{15.59}$
 Unit passive resist. at base (Tomlinson Eqn 7.49); $p_{z3} = p_{oz3} \times K_{q3} + c'_{1,d} \times K_{c3} = \mathbf{105.068 \text{ kN/m}^2}$
 Unit passive resistance at mid-height; $p_{z3,m} = (p_{z3} + p_{z2}) / 2 = \mathbf{84.559 \text{ kN/m}^2}$
 Segment lateral point load; $P_{LatS3} = L / 10 \times p_{z3,m} \times h = \mathbf{27.5 \text{ kN}}$
 Segment moment about applied load; $M_{trS3} = P_{LatS3} \times (e + (3 - 0.5) \times L / 10) = \mathbf{34.4 \text{ kNm}}$
 Segment moment about X; $M_{XS3} = P_{LatS3} \times (X - (3 - 0.5) \times L / 10) = \mathbf{49.5 \text{ kNm}}$

Segment 4 properties:

Depth to base of segment from ground; $Z_{Kq4} = 4 \times L / 10 = \mathbf{2000 \text{ mm}}$
 Depth to base of segment from top of stratum; $Z_{Kc4} = Z_{Kq4} - D_{strata1} = \mathbf{2000 \text{ mm}}$
 Depth to pile width ratio for K_q ; $Z_{Kq4} / h = \mathbf{3.1}$
 Depth to pile width ratio for K_c ; $Z_{Kc4} / h = \mathbf{3.1}$
 Effective overburden pressure; $p_{oz4} = p_{ozS0,d} + (Z_{Kq4} - D_{strata1}) \times \gamma'_{1,d} = \mathbf{36 \text{ kN/m}^2}$
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37); $K_{q4} = \mathbf{4.17}$
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37); $K_{c4} = \mathbf{17.27}$
 Unit passive resist. at base (Tomlinson Eqn 7.49); $p_{z4} = p_{oz4} \times K_{q4} + c'_{1,d} \times K_{c4} = \mathbf{150.073 \text{ kN/m}^2}$
 Unit passive resistance at mid-height; $p_{z4,m} = (p_{z4} + p_{z3}) / 2 = \mathbf{127.570 \text{ kN/m}^2}$
 Segment lateral point load; $P_{LatS4} = L / 10 \times p_{z4,m} \times h = \mathbf{41.5 \text{ kN}}$
 Segment moment about applied load; $M_{trS4} = P_{LatS4} \times (e + (4 - 0.5) \times L / 10) = \mathbf{72.6 \text{ kNm}}$
 Segment moment about X; $M_{XS4} = P_{LatS4} \times (X - (4 - 0.5) \times L / 10) = \mathbf{54 \text{ kNm}}$



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Segment 5 properties:

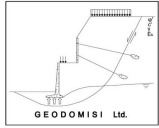
Depth to base of segment from ground; $Z_{Kq5} = 5 \times L / 10 = \mathbf{2500 \text{ mm}}$
 Depth to base of segment from top of stratum; $Z_{Kc5} = Z_{Kq5} - D_{strata1} = \mathbf{2500 \text{ mm}}$
 Depth to pile width ratio for K_q ; $Z_{Kq5} / h = \mathbf{3.8}$
 Depth to pile width ratio for K_c ; $Z_{Kc5} / h = \mathbf{3.8}$
 Effective overburden pressure; $p_{oz5} = p_{ozS0,d} + (Z_{Kq5} - D_{strata1}) \times \gamma'_{1,d} = \mathbf{45 \text{ kN/m}^2}$
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37); $K_{q5} = \mathbf{4.4}$
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37); $K_{c5} = \mathbf{18.57}$
 Unit passive resist. at base (Tomlinson Eqn 7.49); $p_{z5} = p_{oz5} \times K_{q5} + c'_{1,d} \times K_{c5} = \mathbf{198.142 \text{ kN/m}^2}$
 Unit passive resistance at mid-height; $p_{z5,m} = (p_{z5} + p_{z4}) / 2 = \mathbf{174.107 \text{ kN/m}^2}$
 Segment lateral point load; $P_{LatS5} = L / 10 \times p_{z5,m} \times h = \mathbf{56.6 \text{ kN}}$
 Segment moment about applied load; $M_{trS5} = P_{LatS5} \times (e + (5 - 0.5) \times L / 10) = \mathbf{127.3 \text{ kNm}}$
 Segment moment about X; $M_{XS5} = P_{LatS5} \times (X - (5 - 0.5) \times L / 10) = \mathbf{45.4 \text{ kNm}}$

Segment 6 properties:

Depth to base of segment from ground; $Z_{Kq6} = 6 \times L / 10 = \mathbf{3000 \text{ mm}}$
 Depth to base of segment from top of stratum; $Z_{Kc6} = Z_{Kq6} - D_{strata1} = \mathbf{3000 \text{ mm}}$
 Depth to pile width ratio for K_q ; $Z_{Kq6} / h = \mathbf{4.6}$
 Depth to pile width ratio for K_c ; $Z_{Kc6} / h = \mathbf{4.6}$
 Effective overburden pressure; $p_{oz6} = p_{ozS0,d} + (Z_{Kq6} - D_{strata1}) \times \gamma'_{1,d} = \mathbf{54 \text{ kN/m}^2}$
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37); $K_{q6} = \mathbf{4.6}$
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37); $K_{c6} = \mathbf{19.6}$
 Unit passive resist. at base (Tomlinson Eqn 7.49); $p_{z6} = p_{oz6} \times K_{q6} + c'_{1,d} \times K_{c6} = \mathbf{248.616 \text{ kN/m}^2}$
 Unit passive resistance at mid-height; $p_{z6,m} = (p_{z6} + p_{z5}) / 2 = \mathbf{223.379 \text{ kN/m}^2}$
 Segment lateral point load; $P_{LatS6} = L / 10 \times p_{z6,m} \times h = \mathbf{72.6 \text{ kN}}$
 Segment moment about applied load; $M_{trS6} = P_{LatS6} \times (e + (6 - 0.5) \times L / 10) = \mathbf{199.6 \text{ kNm}}$
 Segment moment about X; $M_{XS6} = P_{LatS6} \times (X - (6 - 0.5) \times L / 10) = \mathbf{22 \text{ kNm}}$

Segment 7 properties:

Depth to base of segment from ground; $Z_{Kq7} = 7 \times L / 10 = \mathbf{3500 \text{ mm}}$
 Depth to base of segment from top of stratum; $Z_{Kc7} = Z_{Kq7} - D_{strata1} = \mathbf{3500 \text{ mm}}$
 Depth to pile width ratio for K_q ; $Z_{Kq7} / h = \mathbf{5.4}$
 Depth to pile width ratio for K_c ; $Z_{Kc7} / h = \mathbf{5.4}$
 Effective overburden pressure; $p_{oz7} = p_{ozS0,d} + (Z_{Kq7} - D_{strata1}) \times \gamma'_{1,d} = \mathbf{63 \text{ kN/m}^2}$
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37); $K_{q7} = \mathbf{4.78}$
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37); $K_{c7} = \mathbf{20.43}$
 Unit passive resist. at base (Tomlinson Eqn 7.49); $p_{z7} = p_{oz7} \times K_{q7} + c'_{1,d} \times K_{c7} = \mathbf{301.013 \text{ kN/m}^2}$
 Unit passive resistance at mid-height; $p_{z7,m} = (p_{z7} + p_{z6}) / 2 = \mathbf{274.814 \text{ kN/m}^2}$
 Approximate calculation applying the unit passive resistance at mid-height above and below X:
 Segment (above X) lateral point load; $P_{LatS7t} = (X - 6 \times L / 10) \times h \times p_{z7,m} = \mathbf{9.4 \text{ kN}}$



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Segment (above X) moment about applied load;
 kNm

$$M_{trS7t} = P_{LatS7t} \times (e + X - (X - (6 \times L / 10)) / 2) = \mathbf{28.5}$$

Segment (above X) moment about X;

$$M_{XS7t} = P_{LatS7t} \times ((X - (6 \times L / 10)) / 2) = \mathbf{0.2 \text{ kNm}}$$

Segment (below X) lateral point load;

$$P_{LatS7b} = -(7 \times L / 10 - X) \times h \times p_{z7,m} = \mathbf{-79.9 \text{ kN}}$$

Segment (below X) moment about applied load;
261.8 kNm

$$M_{trS7b} = P_{LatS7b} \times (e + X + (7 \times L / 10 - X) / 2) = -$$

Segment (below X) moment about X;

$$M_{XS7b} = P_{LatS7b} \times ((X - (7 \times L / 10)) / 2) = \mathbf{17.9 \text{ kNm}}$$

Segment 8 properties:

Depth to base of segment from ground;

$$Z_{Kq8} = 8 \times L / 10 = \mathbf{4000 \text{ mm}}$$

Depth to base of segment from top of stratum;

$$Z_{Kc8} = Z_{Kq8} - D_{strata2} = \mathbf{500 \text{ mm}}$$

Depth to pile width ratio for K_q ;

$$Z_{Kq8} / h = \mathbf{6.2}$$

Depth to pile width ratio for K_c ;

$$Z_{Kc8} / h = \mathbf{0.8}$$

Effective overburden pressure;

$$p_{oz8} = p_{ozS1,d} + (Z_{Kq8} - D_{strata2}) \times \gamma'_{2,d} = \mathbf{73.7 \text{ kN/m}^2}$$

Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);

$$K_{q8} = \mathbf{0.1}$$

Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);

$$K_{c8} = \mathbf{4.58}$$

Unit passive resist. at base (Tomlinson Eqn 7.49);

$$p_{z8} = p_{oz8} \times K_{q8} + c'_{2,d} \times K_{c8} = \mathbf{7.409 \text{ kN/m}^2}$$

Unit passive resistance at mid-height;

$$p_{z8,m} = (p_{z8} + p_{z7}) / 2 = \mathbf{154.211 \text{ kN/m}^2}$$

Segment lateral point load;

$$P_{LatS8} = -L / 10 \times p_{z8,m} \times h = \mathbf{-50.1 \text{ kN}}$$

Segment moment about applied load;

$$M_{trS8} = P_{LatS8} \times (e + (8 - 0.5) \times L / 10) = \mathbf{-187.9 \text{ kNm}}$$

Segment moment about X;

$$M_{XS8} = P_{LatS8} \times (X - (8 - 0.5) \times L / 10) = \mathbf{34.9 \text{ kNm}}$$

Segment 9 properties:

Depth to base of segment from ground;

$$Z_{Kq9} = 9 \times L / 10 = \mathbf{4500 \text{ mm}}$$

Depth to base of segment from top of stratum;

$$Z_{Kc9} = Z_{Kq9} - D_{strata2} = \mathbf{1000 \text{ mm}}$$

Depth to pile width ratio for K_q ;

$$Z_{Kq9} / h = \mathbf{6.9}$$

Depth to pile width ratio for K_c ;

$$Z_{Kc9} / h = \mathbf{1.5}$$

Effective overburden pressure;

$$p_{oz9} = p_{ozS1,d} + (Z_{Kq9} - D_{strata2}) \times \gamma'_{2,d} = \mathbf{84.4 \text{ kN/m}^2}$$

Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);

$$K_{q9} = \mathbf{0.1}$$

Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);

$$K_{c9} = \mathbf{5.55}$$

Unit passive resist. at base (Tomlinson Eqn 7.49);

$$p_{z9} = p_{oz9} \times K_{q9} + c'_{2,d} \times K_{c9} = \mathbf{8.574 \text{ kN/m}^2}$$

Unit passive resistance at mid-height;

$$p_{z9,m} = (p_{z9} + p_{z8}) / 2 = \mathbf{7.991 \text{ kN/m}^2}$$

Segment lateral point load;

$$P_{LatS9} = -L / 10 \times p_{z9,m} \times h = \mathbf{-2.6 \text{ kN}}$$

Segment moment about applied load;

$$M_{trS9} = P_{LatS9} \times (e + (9 - 0.5) \times L / 10) = \mathbf{-11 \text{ kNm}}$$

Segment moment about X;

$$M_{XS9} = P_{LatS9} \times (X - (9 - 0.5) \times L / 10) = \mathbf{3.1 \text{ kNm}}$$

Segment 10 properties:

Depth to base of segment from ground;

$$Z_{Kq10} = 10 \times L / 10 = \mathbf{5000 \text{ mm}}$$

Depth to base of segment from top of stratum;

$$Z_{Kc10} = Z_{Kq10} - D_{strata2} = \mathbf{1500 \text{ mm}}$$

Depth to pile width ratio for K_q ;

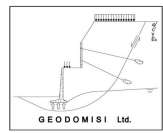
$$Z_{Kq10} / h = \mathbf{7.7}$$

Depth to pile width ratio for K_c ;

$$Z_{Kc10} / h = \mathbf{2.3}$$

Effective overburden pressure;

$$p_{oz10} = p_{ozS1,d} + (Z_{Kq10} - D_{strata2}) \times \gamma'_{2,d} = \mathbf{95.1 \text{ kN/m}^2}$$



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Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);

$$K_{q10} = \mathbf{0.1}$$

Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);

$$K_{c10} = \mathbf{6.14}$$

Unit passive resist. at base (Tomlinson Eqn 7.49);

$$p_{z10} = p_{oz10} \times K_{q10} + c'_{2,d} \times K_{c10} = \mathbf{9.757 \text{ kN/m}^2}$$

Unit passive resistance at mid-height;

$$p_{z10,m} = (p_{z10} + p_{z0}) / 2 = \mathbf{9.165 \text{ kN/m}^2}$$

Segment lateral point load;

$$P_{LatS10} = -L / 10 \times p_{z10,m} \times h = \mathbf{-3 \text{ kN}}$$

Segment moment about applied load;

$$M_{trS10} = P_{LatS10} \times (e + (10 - 0.5) \times L / 10) = \mathbf{-14.1 \text{ kNm}}$$

kNm

Segment moment about X;

$$M_{XS10} = P_{LatS10} \times (X - (10 - 0.5) \times L / 10) = \mathbf{5.1 \text{ kNm}}$$

Sum of moments about point of load application near zero;

$$\Sigma M_{tr} = M_{trS1} + M_{trS2} + M_{trS3} + M_{trS4} + M_{trS5} + M_{trS6} +$$

$$M_{trS7} + M_{trS7b} + M_{trS8} + M_{trS9} + M_{trS10} = \mathbf{-0 \text{ kNm}}$$

Sum of moments about point of rotation;

$$\Sigma M_X = M_{XS1} + M_{XS2} + M_{XS3} + M_{XS4} + M_{XS5} + M_{XS6} +$$

$$M_{XS7} + M_{XS7b} + M_{XS8} + M_{XS9} + M_{XS10} = \mathbf{279.7 \text{ kNm}}$$

Calculated soil lateral resist. (Tomlinson Eqn 7.52);

$$R_{tr,calc} = \Sigma M_X / (e + X) = \mathbf{91.6 \text{ kN}}$$

Design lateral action;

$$F_{tr,d,C1} = \gamma_{G,unfav,A1} \times G_{tr,k,unfav} - \gamma_{G,fav,A1} \times G_{tr,k,fav} +$$

$$\gamma_{Q,A1} \times Q_{tr,k} = \mathbf{83.3 \text{ kN}}$$

Design lateral resistance;

$$R_{tr,d,C1} = R_{tr,calc} / \gamma_{tr,R2} = \mathbf{83.3 \text{ kN}}$$

$$F_{tr,d,C1} / R_{tr,d,C1} = \mathbf{1}$$

PASS - Design lateral resistance exceeds lateral load

Lateral deflection analysis (Characteristic values)

Resisting soil is divided into 10 segments to determine lateral resistance

From iteration, assume depth of point of rotation;

$$X = \mathbf{3053 \text{ mm}}$$

Distance from lateral action to ground;

$$e = e_{actual} = \mathbf{0 \text{ mm}}$$

Segment 1 properties:

Depth to base of segment from ground;

$$Z_{Kq1} = 1 \times L / 10 = \mathbf{500 \text{ mm}}$$

Depth to base of segment from top of stratum;

$$Z_{Kc1} = Z_{Kq1} - D_{strata1} = \mathbf{500 \text{ mm}}$$

Depth to pile width ratio for K_q ;

$$Z_{Kq1} / h = \mathbf{0.8}$$

Depth to pile width ratio for K_c ;

$$Z_{Kc1} / h = \mathbf{0.8}$$

Effective overburden pressure;

$$p_{oz1} = p_{ozS0,k} + (Z_{Kq1} - D_{strata1}) \times \gamma'_{1,k} = \mathbf{9 \text{ kN/m}^2}$$

Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);

$$K_{q1} = \mathbf{3.15}$$

Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);

$$K_{c1} = \mathbf{10.05}$$

Unit passive resist. at base (Tomlinson Eqn 7.49);

$$p_{z1} = p_{oz1} \times K_{q1} + c'_{1,k} \times K_{c1} = \mathbf{28.358 \text{ kN/m}^2}$$

Unit passive resistance at mid-height;

$$p_{z1,m} = (p_{z1} + p_{z0}) / 2 = \mathbf{14.179 \text{ kN/m}^2}$$

Segment lateral point load;

$$P_{LatS1} = L / 10 \times p_{z1,m} \times h = \mathbf{4.6 \text{ kN}}$$

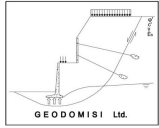
Segment moment about applied load;

$$M_{trS1} = P_{LatS1} \times (e + (1 - 0.5) \times L / 10) = \mathbf{1.2 \text{ kNm}}$$

Segment moment about X;

$$M_{XS1} = P_{LatS1} \times (X - (1 - 0.5) \times L / 10) = \mathbf{12.9 \text{ kNm}}$$

Segment 2 properties:



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Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);
 Unit passive resist. at base (Tomlinson Eqn 7.49);
 Unit passive resistance at mid-height;
 Segment lateral point load;
 Segment moment about applied load;
 Segment moment about X;

$$Z_{Kq2} = 2 \times L / 10 = \mathbf{1000 \text{ mm}}$$

$$Z_{Kc2} = Z_{Kq2} - D_{strata1} = \mathbf{1000 \text{ mm}}$$

$$Z_{Kq2} / h = \mathbf{1.5}$$

$$Z_{Kc2} / h = \mathbf{1.5}$$

$$p_{oz2} = p_{ozS0,k} + (Z_{Kq2} - D_{strata1}) \times \gamma'_{1,k} = \mathbf{18 \text{ kN/m}^2}$$

$$K_{q2} = \mathbf{3.56}$$

$$K_{c2} = \mathbf{13.31}$$

$$p_{z2} = p_{oz2} \times K_{q2} + c'_{1,k} \times K_{c2} = \mathbf{64.051 \text{ kN/m}^2}$$

$$p_{z2,m} = (p_{z2} + p_{z1}) / 2 = \mathbf{46.205 \text{ kN/m}^2}$$

$$P_{LatS2} = L / 10 \times p_{z2,m} \times h = \mathbf{15 \text{ kN}}$$

$$M_{trS2} = P_{LatS2} \times (e + (2 - 0.5) \times L / 10) = \mathbf{11.3 \text{ kNm}}$$

$$M_{XS2} = P_{LatS2} \times (X - (2 - 0.5) \times L / 10) = \mathbf{34.6 \text{ kNm}}$$

Segment 3 properties:

Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);
 Unit passive resist. at base (Tomlinson Eqn 7.49);
 Unit passive resistance at mid-height;
 Segment lateral point load;
 Segment moment about applied load;
 Segment moment about X;

$$Z_{Kq3} = 3 \times L / 10 = \mathbf{1500 \text{ mm}}$$

$$Z_{Kc3} = Z_{Kq3} - D_{strata1} = \mathbf{1500 \text{ mm}}$$

$$Z_{Kq3} / h = \mathbf{2.3}$$

$$Z_{Kc3} / h = \mathbf{2.3}$$

$$p_{oz3} = p_{ozS0,k} + (Z_{Kq3} - D_{strata1}) \times \gamma'_{1,k} = \mathbf{27 \text{ kN/m}^2}$$

$$K_{q3} = \mathbf{3.89}$$

$$K_{c3} = \mathbf{15.59}$$

$$p_{z3} = p_{oz3} \times K_{q3} + c'_{1,k} \times K_{c3} = \mathbf{105.068 \text{ kN/m}^2}$$

$$p_{z3,m} = (p_{z3} + p_{z2}) / 2 = \mathbf{84.559 \text{ kN/m}^2}$$

$$P_{LatS3} = L / 10 \times p_{z3,m} \times h = \mathbf{27.5 \text{ kN}}$$

$$M_{trS3} = P_{LatS3} \times (e + (3 - 0.5) \times L / 10) = \mathbf{34.4 \text{ kNm}}$$

$$M_{XS3} = P_{LatS3} \times (X - (3 - 0.5) \times L / 10) = \mathbf{49.5 \text{ kNm}}$$

Segment 4 properties:

Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);
 Unit passive resist. at base (Tomlinson Eqn 7.49);
 Unit passive resistance at mid-height;
 Segment lateral point load;
 Segment moment about applied load;
 Segment moment about X;

$$Z_{Kq4} = 4 \times L / 10 = \mathbf{2000 \text{ mm}}$$

$$Z_{Kc4} = Z_{Kq4} - D_{strata1} = \mathbf{2000 \text{ mm}}$$

$$Z_{Kq4} / h = \mathbf{3.1}$$

$$Z_{Kc4} / h = \mathbf{3.1}$$

$$p_{oz4} = p_{ozS0,k} + (Z_{Kq4} - D_{strata1}) \times \gamma'_{1,k} = \mathbf{36 \text{ kN/m}^2}$$

$$K_{q4} = \mathbf{4.17}$$

$$K_{c4} = \mathbf{17.27}$$

$$p_{z4} = p_{oz4} \times K_{q4} + c'_{1,k} \times K_{c4} = \mathbf{150.073 \text{ kN/m}^2}$$

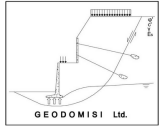
$$p_{z4,m} = (p_{z4} + p_{z3}) / 2 = \mathbf{127.570 \text{ kN/m}^2}$$

$$P_{LatS4} = L / 10 \times p_{z4,m} \times h = \mathbf{41.5 \text{ kN}}$$

$$M_{trS4} = P_{LatS4} \times (e + (4 - 0.5) \times L / 10) = \mathbf{72.6 \text{ kNm}}$$

$$M_{XS4} = P_{LatS4} \times (X - (4 - 0.5) \times L / 10) = \mathbf{54 \text{ kNm}}$$

Segment 5 properties:



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Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);
 Unit passive resist. at base (Tomlinson Eqn 7.49);
 Unit passive resistance at mid-height;
 Segment lateral point load;
 Segment moment about applied load;
 Segment moment about X;
Segment 6 properties:

$$Z_{Kq5} = 5 \times L / 10 = \mathbf{2500 \text{ mm}}$$

$$Z_{Kc5} = Z_{Kq5} - D_{strata1} = \mathbf{2500 \text{ mm}}$$

$$Z_{Kq5} / h = \mathbf{3.8}$$

$$Z_{Kc5} / h = \mathbf{3.8}$$

$$p_{oz5} = p_{ozS0,k} + (Z_{Kq5} - D_{strata1}) \times \gamma'_{1,k} = \mathbf{45 \text{ kN/m}^2}$$

$$K_{q5} = \mathbf{4.4}$$

$$K_{c5} = \mathbf{18.57}$$

$$p_{z5} = p_{oz5} \times K_{q5} + c'_{1,k} \times K_{c5} = \mathbf{198.142 \text{ kN/m}^2}$$

$$p_{z5,m} = (p_{z5} + p_{z4}) / 2 = \mathbf{174.107 \text{ kN/m}^2}$$

$$P_{LatS5} = L / 10 \times p_{z5,m} \times h = \mathbf{56.6 \text{ kN}}$$

$$M_{trS5} = P_{LatS5} \times (e + (5 - 0.5) \times L / 10) = \mathbf{127.3 \text{ kNm}}$$

$$M_{XS5} = P_{LatS5} \times (X - (5 - 0.5) \times L / 10) = \mathbf{45.4 \text{ kNm}}$$

Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);
 Unit passive resist. at base (Tomlinson Eqn 7.49);
 Unit passive resistance at mid-height;
 Segment lateral point load;
 Segment moment about applied load;
 Segment moment about X;
Segment 7 properties:

$$Z_{Kq6} = 6 \times L / 10 = \mathbf{3000 \text{ mm}}$$

$$Z_{Kc6} = Z_{Kq6} - D_{strata1} = \mathbf{3000 \text{ mm}}$$

$$Z_{Kq6} / h = \mathbf{4.6}$$

$$Z_{Kc6} / h = \mathbf{4.6}$$

$$p_{oz6} = p_{ozS0,k} + (Z_{Kq6} - D_{strata1}) \times \gamma'_{1,k} = \mathbf{54 \text{ kN/m}^2}$$

$$K_{q6} = \mathbf{4.6}$$

$$K_{c6} = \mathbf{19.6}$$

$$p_{z6} = p_{oz6} \times K_{q6} + c'_{1,k} \times K_{c6} = \mathbf{248.616 \text{ kN/m}^2}$$

$$p_{z6,m} = (p_{z6} + p_{z5}) / 2 = \mathbf{223.379 \text{ kN/m}^2}$$

$$P_{LatS6} = L / 10 \times p_{z6,m} \times h = \mathbf{72.6 \text{ kN}}$$

$$M_{trS6} = P_{LatS6} \times (e + (6 - 0.5) \times L / 10) = \mathbf{199.6 \text{ kNm}}$$

$$M_{XS6} = P_{LatS6} \times (X - (6 - 0.5) \times L / 10) = \mathbf{22 \text{ kNm}}$$

Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);
 Unit passive resist. at base (Tomlinson Eqn 7.49);
 Unit passive resistance at mid-height;
 Approximate calculation applying the unit passive resistance at mid-height above and below X:
 Segment (above X) lateral point load;
 Segment (above X) moment about applied load;
 kNm

$$Z_{Kq7} = 7 \times L / 10 = \mathbf{3500 \text{ mm}}$$

$$Z_{Kc7} = Z_{Kq7} - D_{strata1} = \mathbf{3500 \text{ mm}}$$

$$Z_{Kq7} / h = \mathbf{5.4}$$

$$Z_{Kc7} / h = \mathbf{5.4}$$

$$p_{oz7} = p_{ozS0,k} + (Z_{Kq7} - D_{strata1}) \times \gamma'_{1,k} = \mathbf{63 \text{ kN/m}^2}$$

$$K_{q7} = \mathbf{4.78}$$

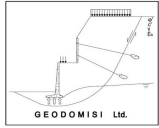
$$K_{c7} = \mathbf{20.43}$$

$$p_{z7} = p_{oz7} \times K_{q7} + c'_{1,k} \times K_{c7} = \mathbf{301.013 \text{ kN/m}^2}$$

$$p_{z7,m} = (p_{z7} + p_{z6}) / 2 = \mathbf{274.814 \text{ kN/m}^2}$$

$$P_{LatS7t} = (X - 6 \times L / 10) \times h \times p_{z7,m} = \mathbf{9.4 \text{ kN}}$$

$$M_{trS7t} = P_{LatS7t} \times (e + X - (X - (6 \times L / 10))) / 2 = \mathbf{28.5 \text{ kNm}}$$



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Segment (above X) moment about X;
 Segment (below X) lateral point load;
 Segment (below X) moment about applied load;
261.8 kNm

$$M_{XS7t} = P_{LatS7t} \times ((X - (6 \times L / 10)) / 2) = \mathbf{0.2 \text{ kNm}}$$

$$P_{LatS7b} = -(7 \times L / 10 - X) \times h \times p_{z7,m} = \mathbf{-79.9 \text{ kN}}$$

$$M_{trS7b} = P_{LatS7b} \times (e + X + (7 \times L / 10 - X) / 2) = -$$

Segment (below X) moment about X;

$$M_{XS7b} = P_{LatS7b} \times ((X - (7 \times L / 10)) / 2) = \mathbf{17.9 \text{ kNm}}$$

Segment 8 properties:

Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);
 Unit passive resist. at base (Tomlinson Eqn 7.49);
 Unit passive resistance at mid-height;
 Segment lateral point load;
 Segment moment about applied load;
 Segment moment about X;

$$Z_{Kq8} = 8 \times L / 10 = \mathbf{4000 \text{ mm}}$$

$$Z_{Kc8} = Z_{Kq8} - D_{strata2} = \mathbf{500 \text{ mm}}$$

$$Z_{Kq8} / h = \mathbf{6.2}$$

$$Z_{Kc8} / h = \mathbf{0.8}$$

$$p_{oz8} = p_{ozS1,k} + (Z_{Kq8} - D_{strata2}) \times \gamma'_{2,k} = \mathbf{73.7 \text{ kN/m}^2}$$

$$K_{q8} = \mathbf{0.1}$$

$$K_{c8} = \mathbf{4.58}$$

$$p_{z8} = p_{oz8} \times K_{q8} + c'_{2,k} \times K_{c8} = \mathbf{7.409 \text{ kN/m}^2}$$

$$p_{z8,m} = (p_{z8} + p_{z7}) / 2 = \mathbf{154.211 \text{ kN/m}^2}$$

$$P_{LatS8} = -L / 10 \times p_{z8,m} \times h = \mathbf{-50.1 \text{ kN}}$$

$$M_{trS8} = P_{LatS8} \times (e + (8 - 0.5) \times L / 10) = \mathbf{-187.9 \text{ kNm}}$$

$$M_{XS8} = P_{LatS8} \times (X - (8 - 0.5) \times L / 10) = \mathbf{34.9 \text{ kNm}}$$

Segment 9 properties:

Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);
 Unit passive resist. at base (Tomlinson Eqn 7.49);
 Unit passive resistance at mid-height;
 Segment lateral point load;
 Segment moment about applied load;
 Segment moment about X;

$$Z_{Kq9} = 9 \times L / 10 = \mathbf{4500 \text{ mm}}$$

$$Z_{Kc9} = Z_{Kq9} - D_{strata2} = \mathbf{1000 \text{ mm}}$$

$$Z_{Kq9} / h = \mathbf{6.9}$$

$$Z_{Kc9} / h = \mathbf{1.5}$$

$$p_{oz9} = p_{ozS1,k} + (Z_{Kq9} - D_{strata2}) \times \gamma'_{2,k} = \mathbf{84.4 \text{ kN/m}^2}$$

$$K_{q9} = \mathbf{0.1}$$

$$K_{c9} = \mathbf{5.55}$$

$$p_{z9} = p_{oz9} \times K_{q9} + c'_{2,k} \times K_{c9} = \mathbf{8.574 \text{ kN/m}^2}$$

$$p_{z9,m} = (p_{z9} + p_{z8}) / 2 = \mathbf{7.991 \text{ kN/m}^2}$$

$$P_{LatS9} = -L / 10 \times p_{z9,m} \times h = \mathbf{-2.6 \text{ kN}}$$

$$M_{trS9} = P_{LatS9} \times (e + (9 - 0.5) \times L / 10) = \mathbf{-11 \text{ kNm}}$$

$$M_{XS9} = P_{LatS9} \times (X - (9 - 0.5) \times L / 10) = \mathbf{3.1 \text{ kNm}}$$

Segment 10 properties:

Depth to base of segment from ground;
 Depth to base of segment from top of stratum;
 Depth to pile width ratio for K_q ;
 Depth to pile width ratio for K_c ;
 Effective overburden pressure;
 Brinch Hansen coefficient, K_q (Tomlison Fig 7.37);
 Brinch Hansen coefficient, K_c (Tomlison Fig 7.37);

$$Z_{Kq10} = 10 \times L / 10 = \mathbf{5000 \text{ mm}}$$

$$Z_{Kc10} = Z_{Kq10} - D_{strata2} = \mathbf{1500 \text{ mm}}$$

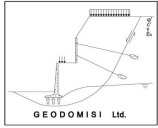
$$Z_{Kq10} / h = \mathbf{7.7}$$

$$Z_{Kc10} / h = \mathbf{2.3}$$

$$p_{oz10} = p_{ozS1,k} + (Z_{Kq10} - D_{strata2}) \times \gamma'_{2,k} = \mathbf{95.1 \text{ kN/m}^2}$$

$$K_{q10} = \mathbf{0.1}$$

$$K_{c10} = \mathbf{6.14}$$



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Project: Pile Analysis & Design, In accordance with EN 1997-1:2004 incorporating Corrigendum dated February 2009 and the recommended values.

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Section
Civil & Geotechnical Engineering

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Calc. by	Date	Chk'd by	Date	App'd by	Date
Dr. C. Sachpazis	21/11/2015				

Unit passive resist. at base (Tomlinson Eqn 7.49);

$$p_{z10} = p_{oz10} \times K_{q10} + c'_{2,k} \times K_{c10} = \mathbf{9.757 \text{ kN/m}^2}$$

Unit passive resistance at mid-height;

$$p_{z10,m} = (p_{z10} + p_{z9}) / 2 = \mathbf{9.165 \text{ kN/m}^2}$$

Segment lateral point load;

$$P_{LatS10} = -L / 10 \times p_{z10,m} \times h = \mathbf{-3 \text{ kN}}$$

Segment moment about applied load;
 kNm

$$M_{trS10} = P_{LatS10} \times (e + (10 - 0.5) \times L / 10) = \mathbf{-14.1}$$

Segment moment about X;

$$M_{XS10} = P_{LatS10} \times (X - (10 - 0.5) \times L / 10) = \mathbf{5.1 \text{ kNm}}$$

Sum of moments about point of load application near zero;

$$\Sigma M_{tr} = M_{trS1} + M_{trS2} + M_{trS3} + M_{trS4} + M_{trS5} + M_{trS6} +$$

$$M_{trS7} + M_{trS7b} + M_{trS8} + M_{trS9} + M_{trS10} = \mathbf{-0 \text{ kNm}}$$

Sum of moments about point of rotation;

$$\Sigma M_X = M_{XS1} + M_{XS2} + M_{XS3} + M_{XS4} + M_{XS5} + M_{XS6} +$$

$$M_{XS7} + M_{XS7b} + M_{XS8} + M_{XS9} + M_{XS10} = \mathbf{279.7 \text{ kNm}}$$

Calculated soil lateral resist. (Tomlinson Eqn 7.52);

$$R_{tr,calc} = \Sigma M_X / (e + X) = \mathbf{91.6 \text{ kN}}$$

Lateral deflection

Characteristic lateral action;

$$F_{tr,k} = G_{tr,k,unfav} - G_{tr,k,fav} + Q_{tr,k} = \mathbf{57 \text{ kN}}$$

Virtual point of fixity, from iteration;

$$V_{zf} = R_{tr,calc} - P_{LatS1} - P_{LatS2} - P_{LatS3} - P_{LatS4} - R \times$$

$$P_{LatS5} = \mathbf{0 \text{ kN}}$$

$$z_f = (4 + R) \times L / 10 = \mathbf{2027 \text{ mm}}$$

Actual lateral deflection at top of pile;

$$\delta_{Lat} = (F_{tr,k} \times (e + z_f)^3) / (3 \times E \times I) = \mathbf{0.51 \text{ mm}}$$

Allowable lateral deflection;

$$\delta_{LatAllow} = \mathbf{25 \text{ mm}}$$

$$\delta_{Lat} / \delta_{LatAllow} = \mathbf{0.021}$$

PASS - Allowable lateral deflection exceeds actual lateral deflection

;