

Client:

Originator:

VITALENERGI



AARSLEFF

Aarsleff Ground Engineering Ltd
Hawton Lane
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Design Calculations: Driven Precast Concrete Bearing Piles

Suitable for approval

Project:

Part:

Neath, Sofidel Biomass Plant

AGE Design Check Category:

2

Document release date:

04/12/2024

	Name	Role	Date
Document Originator	Ash Rogers	Technical Director	04/12/2024
Design Checker	Wisam Al-Ani	Principal Geotechnical Engineer	04/12/2024
Department Approver	Parth Patel	Major Projects Manager	04/12/2024

Document reference

Revision

Method of issue

Date of issue

2028022-AGE-01-XX-CA-X-0601

P01

Email

04/12/2024

Calculation Sheet

	Project No/Reference No: 2028022	Sheet No: 1
	Project and Description: Neath, Sofidel Biomass	Rev: 00
		Computed by: AWR
Client: Vital Energy	Calculation Details: Bearing Pile Design	Date: 03/12/2024
	Driven Precast Concrete	Checked by: WAA
		Date: 03/12/2024

Ref											Output															
Scope																										
Installation of Driven Precast Concrete (DPC) piles for a new development on the Sofiden Biomass Plant in Neath.																										
Standards and Specifications																										
ICE "Specification for Piling and Embedded Retaining Walls" including Aarsleff particular terms																										
BS8004:1986 Code of Practice for Foundations																										
BS EN 1992-1-1:2004 Design of concrete strucutres																										
BS EN 12794:2005; Precast concrete products - Foundation piles																										
Drawings																										
50795-BGH-EC-XX-DR-S-1001 Rev P3, Plan on Piling Layout																										
50795-BGH-EC-XX-DR-S-1001 Rev P3, Piling Coordinates																										
Ground Investigations																										
Ground Investigation Report by Sub Surface North West Ltd (M3822A May 24)																										
PC19783 Boreholes by Geotechnics & GI report EPG/AWE/8309/2019_QR1 by EPG																										
Pile Loads																										
Load type 1: 250mmSQ				Compression =		300-600kN																				
				Horizontal =		50kN																				
Load type 2: 300mmSQ				Compression =		Nil																				
				Horizontal =		50kN																				
				Tension =		200kN																				
Pile Design Summary																										
<table><tr><th>Section Size (mm sq)</th><th>Type</th><th>No. 12mm dia, Main Bars</th><th>Dia. Of Lateral Bars</th><th>Pile length</th></tr><tr><td>250</td><td>DPC</td><td>6</td><td>5mm</td><td><12.5m</td></tr><tr><td>300</td><td>DPC</td><td>12</td><td>5mm</td><td>11-12.5m</td></tr></table>					Section Size (mm sq)	Type	No. 12mm dia, Main Bars	Dia. Of Lateral Bars	Pile length	250	DPC	6	5mm	<12.5m	300	DPC	12	5mm	11-12.5m							
Section Size (mm sq)	Type	No. 12mm dia, Main Bars	Dia. Of Lateral Bars	Pile length																						
250	DPC	6	5mm	<12.5m																						
300	DPC	12	5mm	11-12.5m																						
Concrete: -		C50/60			Design Chemical Class: -		DC-1																			
Margin of safety		Geotechnical: 2.0 compression & 3.0 tension Structural: Partial factor of 1.5 applied to horizontal wind load; 1.0 to favourable axial load (dead compression), and 1.35 to unfavourable axial load (permanent tension)																								
Testing		A total of one maintained and eight dynamic load tests will be taken on working piles. Of these dynamic tests, two will have a signal match analysis (CAPWAP) to estimate the load carrying distribution of the pile. Test piles are to be selected on site to suit the variety of ground conditions encountered and the project programme.																								
Settlement Criteria																										
Maximum permitted settlement under test excl elastic pile compresison																										
										@ DVL =	12	mm														
										@ DVL + ½ SWL =	18	mm														

Calculation Sheet

	Project No/Reference No: 2028022	Sheet No: 2
	Project and Description: Neath, Sofidel Biomass	Rev: 00
		0 Computed by: AWR
		0 Date: 03/12/2024
Client: Vital Energy	Calculation Details: Bearing Pile Design	Checked by: WAA
	Driven Precast Concrete	Date: 03/12/2024
		0

Ref		Output
	Design Philosophy	
	The pile bearing capacity is initially estimated in these calculations based on the Ground and Site information provided. The actual design bearing resistance will be established on site by calibrating the pile installation set with dynamic load test results. The design calculations are based on the adoptions of moderately conservative ground conditions included an assume ground water level of 3.0m below final ground level (in the absence of ground water strikes and further monitoring.	
	Installation Criteria	
	The piles will be installed to a predetermined driving set based on the modified Hylie formula. Due to the variation in the level and strength of the bearing strata, it is possible that piles will achieve "set" before the design length is reached. In this event the results of Dynamic testing and CAPWAP analysis will be used to verify bearing capacity. Test probes should be driven across the site on arrival to confirm length and expectation of strata as predicted within the design. For the 12nr piles under tension, the piles should be driven to the design length or until practical refusal is met. If refusal is met, the tensile resistance is to be verified through the CAPWAP analyses.	
	Negative Skin Friction	
	Given the absence of compressible soils, organic/decomposing soils, increase in site levels and applications of a large surcharge area, downdrag forces on the piles (negative skin friction) is not expected to be present and so has not been considered.	
	Structural Design	
	The structural design is based upon the calcauled bending moment snd shear effects in the pile due to the applied pile loads. The design bending moments are calculated using Brom (1978) expressions while allowing for the horizontal load to be variable (a partial factor of 1.5 is applied). The resulting bending moment, along with the corresponding axial load, is then checked against the pile sections' flexural design resistance in accordance with BS EN 1992-1-1. The shear resistance of the pile sections are calculated in accordance with BS EN 1992-1-1.	

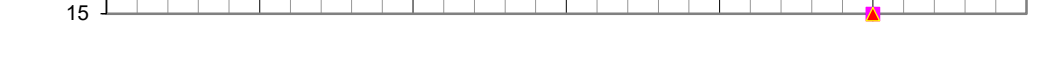
Calculation Sheet

 AARSLEFF	Project No/Reference No: 2028022	Sheet No: 3
	Project and Description: Neath, Sofidel Biomass	Rev: 00
		Computed by: AWR
		Date: 03/12/2024
Client: Vital Energy	Calculation Details: Bearing Pile Design	Checked by: WAA
		Date: 03/12/2024

Ref		Output
	Pile Bearing Design The piles shall be designed to derive their bearing capacity from shaft friction in the vaiable loose to dense sand, and base resistance in the dense to very dense sand. As the sand above 12mbgl is found to be variable, the bases resistance is limited to value according to a loose sand which is proportionally conservative until installation can prove otherwise.	
	Soil Parameters	
	Made Ground	
	Shaft Friction q_s = ignored	
	ϕ' = eff. Angle of shearing resistance	
	= 30° as lower bound value for granular soil	
	γ_b = Bulk unit weight	
	= 18kN/m ³	
	End Bearing q_b = Ignored	
	Sand	
	Shaft Friction q_s = $k \tan \delta p_o'$	
	k = Coefficient of radial earth pressure	
	= 1.5	
	δ = 0.75 ϕ'	
	ϕ' = eff. Angle of shearing resistance	
	= 31° up to 12mbgl based cautious upon a lower bound SPT of 12 (Peck et al 1974)	
	= 38° below 12mbgl based on SPTs in excess of 50 (Peck et al 1974)	
	p_o' = ave. eff. Overburden Pressure, based on...	
	γ_s = Saturated unit weight	
	= 20kN/m ³ above 12m bgl	
	= 22kN/m ³ below 12m bgl	
	End Bearing q_b = $N_q.p_o'$	
	N_q = Bearing capacity factor (Berezantsev et al, 1961)	
	= 30 above 12m bgl	
	= 120 below 12m bgl	
	p_o' = eff. Overburden Pressure at Pile Toe	

...

9



Static Pile Design - Compression

Enquiry/Project Name: Neath, Sofidel Biomass
Enquiry /Project Number: 2028022
Calculations by: AWR
Design status: Contract
Date: 03-Dec-24

Checked by: WAA
Approved by: PP

Date: 04/12/2024
Date: 04/12/2024

Data Input

(approval if required in acc. with QMS PG03)

1. Pile
Pile Type
Shape
Shaft Dia or width
Design Load

Driven
Square
250 mm
600 kN

Precast

12
Open-Ended

2. Design Criteria
BS 8004:1986 Code of Practice for Foundations

γ_b (Base)
 γ_s (Shaft)
 γ_f (Overall)

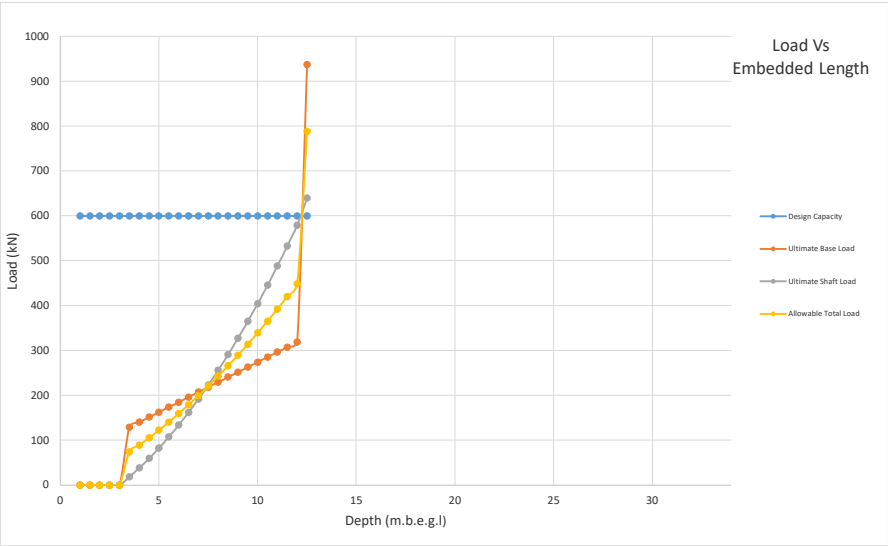
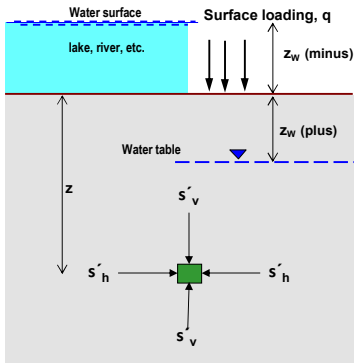
1.0
1.0
2.0
1.0

3. Soil
Soil-pile friction angle(δ) =
Surcharge (q)
Water Table (from
surface) (Zw)
Unit Weight of Water
Depth Intervals

0.75
kN/m²
3 m
9.81 kN/m³
0.5 m

4. Negative Skin Friction
Negative Skin Friction

kN



Depth Range		Soil type	Soil Description	Unit Weight	Overburden Pressure			SPT		Granular Parameters							Cohesive Parameters			Rock Parameters						Unit Skin Friction	Unit Base Resistance	Driven		0.25	size in metres	
					σ _v	μ	σ' _v	SPT	Mean SPT	Φ _p	Φ _{cv}	K _s	tanδ	D/B Ratio	N _q	n	c _u	α	N _c	q _{uc}	Φ' _{cv}	N _φ	Mass Factor (j)	α	β	q _s	q _b	Q _s	ΣQ _s	Q _b	Allowable Capacity	Design Load
Start	End			(kN/m ³)	(kN/m ²)	(kN/m ²)	(kN/m ²)	N _{1(60)b}	N ₁₍₆₀₎	(°)	(°)			(For Info)			(kN/m ²)								(kN/m ²)	(kN/m ²)	(kN)	(kN)	(kN)	(kN)	(kN)	
m																																
0	1	Ignore		18	18	0	18	N _{1(60)b}	N ₁₍₆₀₎															0.0	0	0.0	0.0	0.0	0.0	600	600	
1	1.5	Ignore		18	27	0	27																0.0	0	0.0	0.0	0.0	0.0	0.0	600	600	
1.5	2	Ignore		18	36	0	36																0.0	0	0.0	0.0	0.0	0.0	0.0	600	600	
2	2.5	Ignore		18	45	0	45																0.0	0	0.0	0.0	0.0	0.0	0.0	600	600	
2.5	3	Ignore		18	54	0	54																0.0	0	0.0	0.0	0.0	0.0	0.0	600	600	
3	3.5	Granular		20	64	4.905	59.095			31	31	1.5	0.43		35								36.4	2068	18.2	18.2	129.3	73.7	600	600	600	
3.5	4	Granular		20	74	9.81	64.19			31	31	1.5	0.43		35								39.7	2246	19.9	38.1	140.4	89.2	600	600	600	
4	4.5	Granular		20	84	14.715	69.285			31	31	1.5	0.43		35								43.0	2424	21.5	59.6	151.5	105.5	600	600	600	
4.5	5	Granular		20	94	19.62	74.38			31	31	1.5	0.43		35								46.3	2603	23.2	82.7	162.7	122.7	600	600	600	
5	5.5	Granular		20	104	24.525	79.475			31	31	1.5	0.43		35								49.6	2781	24.8	107.5	173.8	140.7	600	600	600	
5.5	6	Granular		20	114	29.43	84.57			31	31	1.5	0.43		35								52.9	2959	26.5	134.0	184.9	159.4	600	600	600	
6	6.5	Granular		20	124	34.335	89.665			31	31	1.5	0.43		35								56.1	3138	28.1	162.0	196.1	179.1	600	600	600	
6.5	7	Granular		20	134	39.24	94.76			31	31	1.5	0.43		35								59.4	3316	29.7	191.7	207.3	199.5	600	600	600	
7	7.5	Granular		20	144	44.145	99.855			31	31	1.5	0.43		35								62.7	3494	31.4	223.1	218.4	220.7	600	600	600	
7.5	8	Granular		20	154	49.05	104.95			31	31	1.5	0.43		35								66.0	3673	33.0	256.1	229.6	242.8	600	600	600	
8	8.5	Granular		20	164	53.955	110.05			31	31	1.5	0.43		35								69.3	3851	34.7	290.7	240.7	265.7	600	600	600	
8.5	9	Granular		20	174	58.86	115.14			31	31	1.5	0.43		35								72.6	4029	36.3	327.0	251.8	289.4	600	600	600	
9	9.5	Granular		20	184	63.765	120.24			31	31	1.5	0.43		35								75.8	4208	37.9	364.9	263.0	314.0	600	600	600	
9.5	10	Granular		20	194	68.67	125.33			31	31	1.5	0.43		35								79.1	4386	39.6	404.5	274.1	339.3	600	600	600	
10	10.5	Granular		20	204	73.575	130.43			31	31	1.5	0.43		35								82.4	4564	41.2	445.7	285.3	365.5	600	600	600	
10.5	11	Granular		20	214	78.48	135.52			31	31	1.5	0.43		35								85.7	4743	42.9	488.5	296.4	392.5	600	600	600	
11	11.5	Granular		20	224	83.385	140.62			31	31	1.5	0.43		35								89.0	4921	44.5	533.0	307.6	420.3	600	600	600	
11.5	12	Granular		20	234	88.29	145.71			31	31	1.5	0.43		35								92.3	5099	46.2	579.2	318.7	448.9	600	600	600	
12	12.5	Granular		20	244	93.195	150.81			38	38	1.5	0.54		120								120.7	15000	60.4	639.5	937.5	788.5	600	600	600	

Static Pile Design - Compression

Enquiry/Project Name: Neath, Sofidel Biomass
Enquiry /Project Number: 2028022
Calculations by: AWR
Design status: Contract
Date: 03-Dec-24

Data Input

1. Pile
Pile Type Driven Precast
Shape Square
Shaft Dia or width 300 mm
Design Load 600 kN
Open-Ended 12

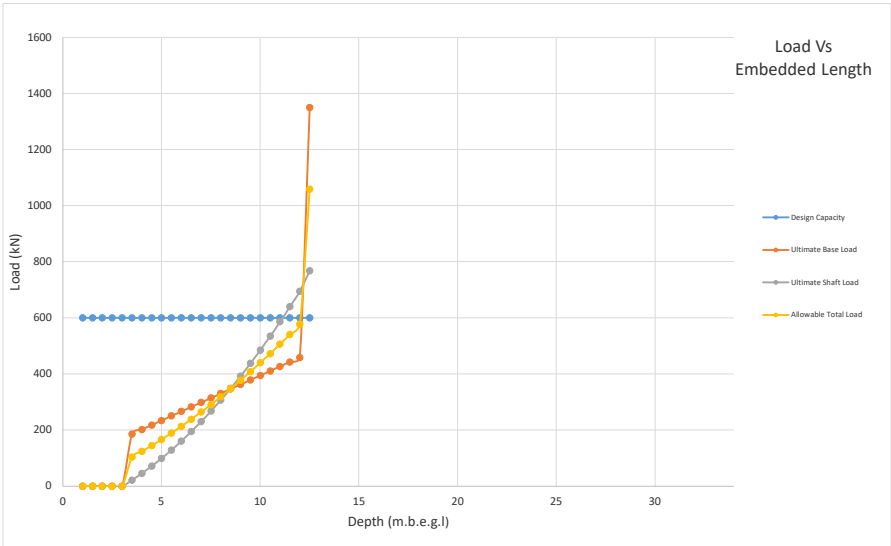
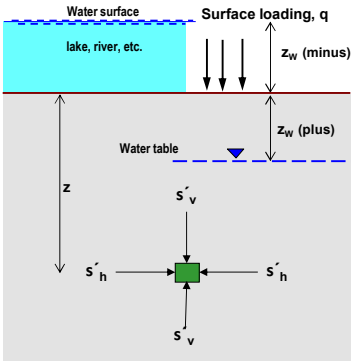
2. Design Criteria
BS 8004:1986 Code of Practice for Foundations
 γ_b (Base) 1.0
 γ_s (Shaft) 1.0
 γ_f (Overall) 2.0
1.0

3. Soil
Soil-pile friction angle(δ) = 0.75
Surcharge (q) kN/m²
Water Table (from surface) (Zw) 3 m
Unit Weight of Water 9.81 kN/m³
Depth Intervals 0.5 m

4. Negative Skin Friction
Negative Skin Friction kN

Checked by: WAA
Approved by: PP
(approval if required in acc. with QMS PG03)

Date: 04/12/2024
Date: 04/12/2024



Depth Range		Soil type	Soil Description	Unit Weight	Overburden Pressure			SPT		Granular Parameters							Cohesive Parameters			Rock Parameters						Unit Skin Friction	Unit Base Resistance	Driven		0.3	size in metres	
					σ _v	μ	σ' _v	SPT	Mean SPT	Φ _p	Φ _{cv}	K _s	tanδ	D/B Ratio	N _q	n	c _u	α	N _c	q _{uc}	Φ' _{cv}	N _φ	Mass Factor (j)	α	β	250	15000	Ult. Shaft	Ult. Base	Allowable Capacity	Design Load	
Start	End				q _s	q _b	Q _s	ΣQ _s	Q _b	(kN)	(kN)																					
m		(kN/m ³)	(kN/m ²)	(kN/m ²)	(kN/m ²)	N _{1(60)b}	N ₁₍₆₀₎	(°)	(°)			(For Info)			(kN/m ²)			(MPa)	(°)					(kN/m ²)	(kN/m ²)	(kN)		(kN)	(kN)	(kN)		
0	1	Ignore		18	18	0	18																0.0	0	0.0	0.0	0.0	0.0	0.0	600		
1	1.5	Ignore		18	27	0	27																0.0	0	0.0	0.0	0.0	0.0	0.0	600		
1.5	2	Ignore		18	36	0	36																0.0	0	0.0	0.0	0.0	0.0	0.0	600		
2	2.5	Ignore		18	45	0	45																0.0	0	0.0	0.0	0.0	0.0	0.0	600		
2.5	3	Ignore		18	54	0	54																0.0	0	0.0	0.0	0.0	0.0	0.0	600		
3	3.5	Granular		20	64	4.905	59.095			31	31	1.5	0.43		35								36.4	2068	21.8	21.8	186.1	104.0	600			
3.5	4	Granular		20	74	9.81	64.19			31	31	1.5	0.43		35								39.7	2246	23.8	45.7	202.1	123.9	600			
4	4.5	Granular		20	84	14.715	69.285			31	31	1.5	0.43		35								43.0	2424	25.8	71.5	218.2	144.8	600			
4.5	5	Granular		20	94	19.62	74.38			31	31	1.5	0.43		35								46.3	2603	27.8	99.2	234.3	166.8	600			
5	5.5	Granular		20	104	24.525	79.475			31	31	1.5	0.43		35								49.6	2781	29.8	129.0	250.3	189.6	600			
5.5	6	Granular		20	114	29.43	84.57			31	31	1.5	0.43		35								52.9	2959	31.7	160.7	266.3	213.5	600			
6	6.5	Granular		20	124	34.335	89.665			31	31	1.5	0.43		35								56.1	3138	33.7	194.4	282.4	238.4	600			
6.5	7	Granular		20	134	39.24	94.76			31	31	1.5	0.43		35								59.4	3316	35.6	230.0	298.4	264.2	600			
7	7.5	Granular		20	144	44.145	99.855			31	31	1.5	0.43		35								62.7	3494	37.6	267.7	314.5	291.1	600			
7.5	8	Granular		20	154	49.05	104.95			31	31	1.5	0.43		35								66.0	3673	39.6	307.3	330.6	318.9	600			
8	8.5	Granular		20	164	53.955	110.05			31	31	1.5	0.43		35								69.3	3851	41.6	348.8	346.6	347.7	600			
8.5	9	Granular		20	174	58.86	115.14			31	31	1.5	0.43		35								72.6	4029	43.6	392.4	362.6	377.5	600			
9	9.5	Granular		20	184	63.765	120.24			31	31	1.5	0.43		35								75.8	4208	45.5	437.9	378.7	408.3	600			
9.5	10	Granular		20	194	68.67	125.33			31	31	1.5	0.43		35								79.1	4386	47.5	485.3	394.7	440.0	600			
10	10.5	Granular		20	204	73.575	130.43			31	31	1.5	0.43		35								82.4	4564	49.4	534.8	410.8	472.8	600			
10.5	11	Granular		20	214	78.48	135.52			31	31	1.5	0.43		35								85.7	4743	51.4	586.2	426.9	506.5	600			
11	11.5	Granular		20	224	83.385	140.62			31	31	1.5	0.43		35								89.0	4921	53.4	639.6	442.9	541.2	600			
11.5	12	Granular		20	234	88.29	145.71			31	31	1.5	0.43		35								92.3	5099	55.4	695.0	458.9	576.9	600			
12	12.5	Granular		22	245	93.195	151.81			38	38	1.5	0.54		120								121.2	15000	72.7	767.7	1350.0	1058.9	600			

Enquiry/Project Name:	Neath, Sofidel Biomass
Enquiry /Project Number:	2028022
Calculations by:	AWR
Design status:	Contract
Data Input	03/12/2024

Checked by: WAA
Approved by: PP
(approval if required in acc. with QMS PG03)

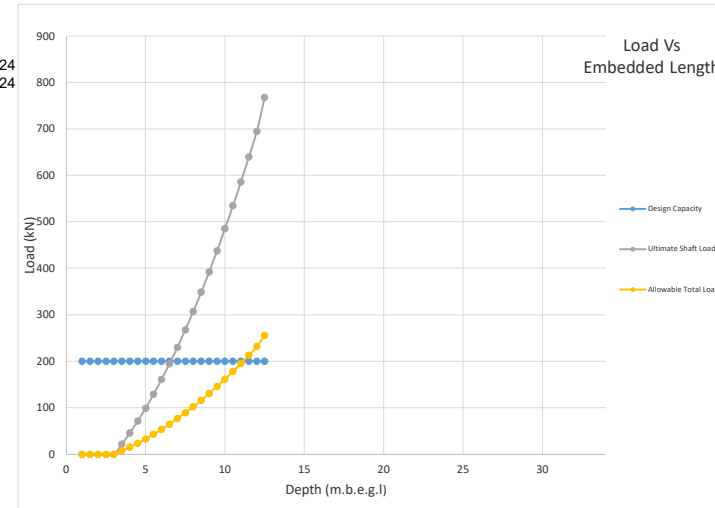
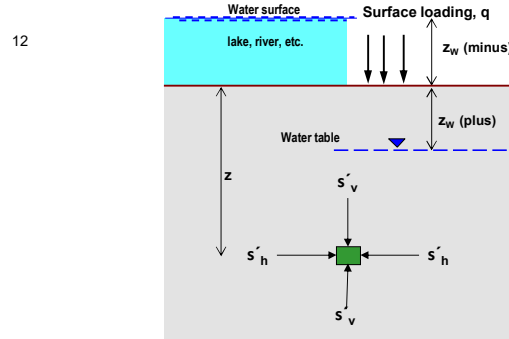
Date: 04/12/2024
Date: 04/12/2024

1. Pile	
Pile Type	Driven
Shape	Square
Shaft Dia or width	300 mm
Design Load	200 kN

 γ_{st} 3.0

Soil-pile friction angle(δ) =	0.75
Surcharge (q)	kN/m ²
Water Table (from surface) (Zw)	3 m
Unit Weight of Water	9.81 kN/m ³
Depth Intervals	0.5 m

Negative Skin Friction	kN
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Depth Range		Soil type	Soil Description	Unit Weight	Overburden Pressure				SPT		Granular Parameters						Cohesive Parameters		Rock Parameters						Unit Skin Friction	Driven		250	size in metres
					σ _v	μ	σ' _v	SPT	Mean SPT	Φ _p	Φ _{cv}	K _s	tanδ	D/B Ratio	n	c _u	α	q _{uc}	Φ' _{cv}	N _Φ	Mass Factor (j)	α	β	200	Ult. Shaft		Allowable Tensile Capacity	Design Load	
																								q _s	Q _s	ΣQ _s			
Start	End			(kN/m ³)	(kN/m ²)	(kN/m ²)	N _{1(60p)}	N ₁₍₆₀₎	(°)	(°)			(For Info)			(MPa)	(°)					(kN/m ²)	(kN)		(kN)	(kN)			
	m																												
	1	Ignore		18	18																					200			
1	1.5	Ignore		18	27	27																				200			
1.5	2	Ignore		18	36	36																				200			
2	2.5	Ignore		18	45	45																				200			
2.5	3	Ignore		18	54	54																				200			
3	3.5	Granular		20	64	4.905	59.095		31	31	1.5	0.43											36.4	21.8	21.8	7.3	200		
3.5	4	Granular		20	74	9.81	64.19		31	31	1.5	0.43											39.7	23.8	45.7	15.2	200		
4	4.5	Granular		20	84	14.715	69.285		31	31	1.5	0.43											43.0	25.8	71.5	23.8	200		
4.5	5	Granular		20	94	19.62	74.38		31	31	1.5	0.43											46.3	27.8	99.2	33.1	200		
5	5.5	Granular		20	104	24.525	79.475		31	31	1.5	0.43											49.6	29.8	129.0	43.0	200		
5.5	6	Granular		20	114	29.43	84.57		31	31	1.5	0.43											52.9	31.7	160.7	53.6	200		
6	6.5	Granular		20	124	34.335	89.665		31	31	1.5	0.43											56.1	33.7	194.4	64.8	200		
6.5	7	Granular		20	134	39.24	94.76		31	31	1.5	0.43											59.4	35.6	230.0	76.7	200		
7	7.5	Granular		20	144	44.145	99.855		31	31	1.5	0.43											62.7	37.6	267.7	89.2	200		
7.5	8	Granular		20	154	49.05	104.95		31	31	1.5	0.43											66.0	39.6	307.3	102.4	200		
8	8.5	Granular		20	164	53.955	110.05		31	31	1.5	0.43											69.3	41.6	348.8	116.3	200		
8.5	9	Granular		20	174	58.86	115.14		31	31	1.5	0.43											72.6	43.6	392.4	130.8	200		
9	9.5	Granular		20	184	63.765	120.24		31	31	1.5	0.43											75.8	45.5	437.9	146.0	200		
9.5	10	Granular		20	194	68.67	125.33		31	31	1.5	0.43											79.1	47.5	485.3	161.8	200		
10	10.5	Granular		20	204	73.575	130.43		31	31	1.5	0.43											82.4	49.4	534.8	178.3	200		
10.5	11	Granular		20	214	78.48	135.52		31	31	1.5	0.43											85.7	51.4	586.2	195.4	200		
11	11.5	Granular		20	224	83.385	140.62		31	31	1.5	0.43											89.0	53.4	639.6	213.2	200		
11.5	12	Granular		20	234	88.29	145.71		31	31	1.5	0.43											92.3	55.4	695.0	231.7	200		
12	12.5	Granular		20	244	93.195	150.81		31	31	1.5	0.54											121.2	72.7	767.7	255.9	200		

Calculation Sheet

	Project No/Reference No: 2028022	Sheet No: 8
	Project and Description: Neath, Sofidel Biomass	Rev: 00
		0 Computed by: AWR
Client: Vital Energy	Calculation Details: Bearing Pile Design	Date: 03/12/2024
	Driven Precast Concrete	Checked by: WAA
		Date: 03/12/2024

Ref					Output
	Evaluation of Moments induced by Horizontal Loads on Vertical Piles				
	Determination of the bending moments induced by the lateral loads has been carried out in accordance in Broms (1978). The fill in the upper soils has been taken as generally a mixture of cohesive and granular in the made ground and cohesive within the soft alluvial deposits.				
	Upper pile shaft in cohesive soils: -				
Broms (1978)	$M_u : FH_u(e + 1.5B + 0.5H_u / 9C_uB) \text{ kN-m}$				
	Upper pile shaft in cohesionless soils: -				
Broms (1978)	$M_u : FH_u(e + 0.54V (H_u/\gamma_bBK_p)) \text{ kN-m}$				
	Where	H =	50	kN	
		e =	0	m	
		B =	0.25	m	
		γ_f =	1.5		
		C _u =	0	kPa	
		ϕ' =	30	°	
		γ_b =	18	kPa	
		K _p =	3		
		F =	0.5	Fixed Head	
	For Cohesive Soils				
		M _u =	0	kN-m	
	For Cohesionless Soil				
		M _u =	47.7	kN-m	M _u = 47.7 kN-m
	Tolerance effect due to plan position				
		Max Resultant Plan Position =	0	mm (pile head is fixed)	
		Total Load =	0	kN	
		M _u =	0 x	0 x	1.5 = 0 kN-m
		<u>Total M_u</u> =	<u>47.7</u>	<u>kN-m</u>	M _u = 47.7 kN-m
Moment envelopes Appendix A		<u>M_R</u> =	<u>48</u>	<u>kN-m</u>	M _R = 48 kN-m
				M _R taken as with minimun unfactored axial load of 300kN	

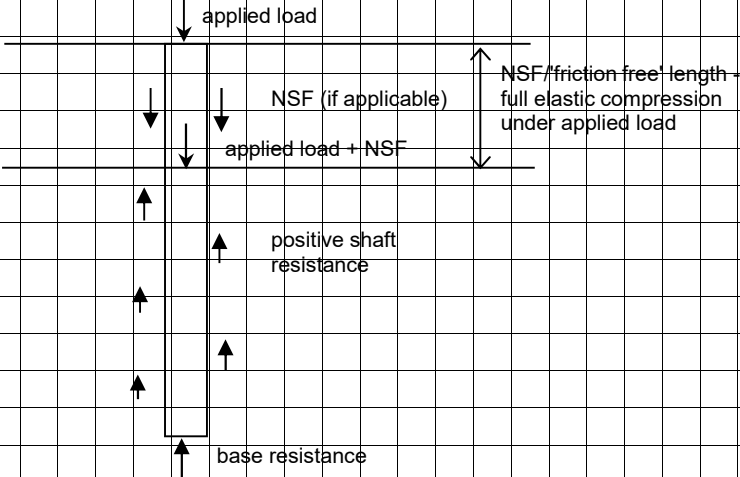
Calculation Sheet

	Project No/Reference No: 2028022	Sheet No: 9
	Project and Description: Neath, Sofidel Biomass	Rev: 00
		0 Computed by: AWR
Client: Vital Energy	Calculation Details: Bearing Pile Design	Date: 03/12/2024
	Driven Precast Concrete	Checked by: WAA
		Date: 03/12/2024

Ref											Output
	Evaluation of Moments induced by Horizontal Loads on Vertical Piles										
	Determination of the bending moments induced by the lateral loads has been carried out in accordance in Broms (1978). The fill in the upper soils has been taken as generally a mixture of cohesive and granular in the made ground and cohesive within the soft alluvial deposits.										
	Upper pile shaft in cohesive soils: -										
Broms (1978)	$M_u : FH_u(e + 1.5B + 0.5H_u / 9C_uB)$ kN-m										
	Upper pile shaft in cohesionless soils: -										
Broms (1978)	$M_u : FH_u(e + 0.54V (H_u/\gamma_bBK_p))$ kN-m										
	Where	H =	50	kN							
		e =	0	m							
		B =	0.3	m							
		γ_f =	1.5								
		Cu =	0	kPa							
		ϕ' =	30	°							
		γ_b =	18	kPa							
		Kp =	3								
		F =	0.5		Fixed Head						
	For Cohesive Soils										
		Mu =	0	kN-m							
	For Cohesionless Soil										
		Mu =	43.6	kN-m							Mu = 43.6 kN-m
	Tolerance effect due to plan position										
		Max Resultant Plan Position =	0	mm	(pile head is fixed)						
		Total Load =	0	kN							
		Mu =	0	x	0	x	1.5	=	0	kN-m	
		Total Mu	=	43.6	kN-m						Mu = 43.6 kN-m
Moment envelopes Appendix A		MR	=	45	kN-m			MR taken as with factored axial load of -270kN			MR = 45 kN-m

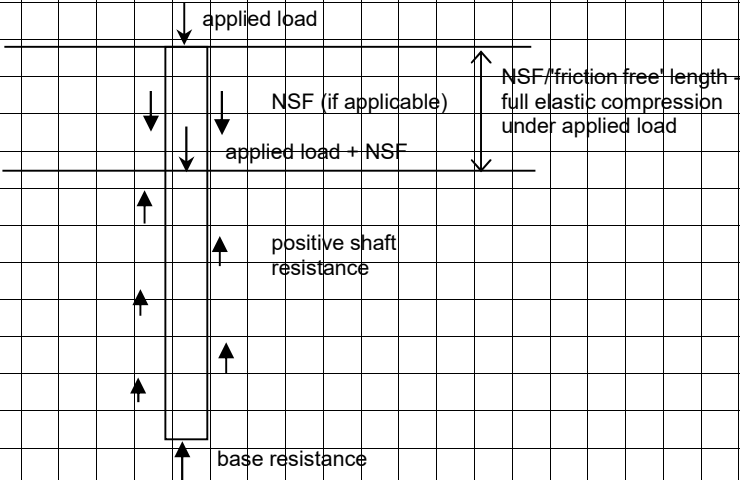
Calculation Sheet

	Project No/Reference No: 200770	Sheet No: 10
	Project and Description: Gate House Rd Sainsbury-Aylesbury	Rev: 00
		Computed by: AWR
Client: RG Group Ltd	Calculation Details: CFA Pile Calcs	Date: 03/12/2024
		Checked by: WAA
		Date: 03/12/2024

Ref					Output
	Pile Settlement				
	Settlement of an individual pile may be calculated as: -				
Tomlinson & Woodward (2015)	$\rho = (W_s + 2W_b) L / 2 A_s E_p + \pi W_b B (1 - v^2) I_p / 4 A_b E_b$				
					
	Pile Type	Precast Concrete Pile (PCC)			
	W _s	=	Applied Load to Pile Shaft		
	W _b	=	Applied Load to Pile Base		
	L	=	Total Pile Length from COL	= 12 m	(assume piles reach set at shallow depth)
	Pile length in NSF/'friction free' zone		=	0 m	
	Pile length providing positive resistance		=	12 m	
	B	=	Pile Size	= 0.25 m	
	A _s	=	A _b	= 0.06 m ²	
	E _p	=	32500 MPa		
	v	=	Poissons ratio	= 0.25	
	I _p	=	Influence factor	= 0.5	
	E _b	=	Soil Modulus at toe	= 100 MPa	
	Applied Load at Pile Head		=	600 kN	
	NSF Load (if applicable)		=	0 kN	
	Applied Load + NSF		=	600 kN	
	Positive Shaft Friction		=	767 kN	
	Applied load less than calculated shaft friction; assume load transfer to base				
	Assume load transfer to base		=	20%	
			=	120 kN	
	and W _s		=	480 kN	
	Full elastic compression in NSF Zone (p _e)		=	0.00 mm	
	ρ		=	2.13 + 1.77	
	ρ		=	p _e + ρ	
	ρ		=	3.9 mm	

Calculation Sheet

	Project No/Reference No: 200770	Sheet No: 11
	Project and Description: Gate House Rd Sainsbury-Aylesbury	Rev: 00
		Computed by: AWR
Client: RG Group Ltd	Calculation Details: CFA Pile Calcs	Date: 03/12/2024
		Checked by: WAA
		Date: 03/12/2024

Ref					Output
	Pile Settlement				
	Settlement of an individual pile may be calculated as: -				
Tomlinson & Woodward (2015)	$\rho = (W_s + 2W_b) L / 2 A_s E_p + \pi W_b B (1 - \nu^2) I_p / 4 A_b E_b$				
					
	Pile Type	Precast Concrete Pile (PCC)			
	W _s	=	Applied Load to Pile Shaft		
	W _b	=	Applied Load to Pile Base		
	L	=	Total Pile Length from COL	= 8 m	(assume piles reach set at shallow depth)
	Pile length in NSF/'friction free' zone		=	0 m	
	Pile length providing positive resistance		=	8 m	
	B	=	Pile Size	= 0.25 m	
	A _s	=	A _b	= 0.06 m ²	
	E _p	=	32500 MPa		
	ν	=	Poissons ratio	= 0.25	
	I _p	=	Influence factor	= 0.5	
	E _b	=	Soil Modulus at toe	= 100 MPa	
	Applied Load at Pile Head		=	600 kN	
	NSF Load (if applicable)		=	0 kN	
	Applied Load + NSF		=	600 kN	
	Positive Shaft Friction		=	392 kN	
	Applied load > Calculated shaft friction				
	Load transfer to base		=	35%	
			=	208 kN	
	and W _s		=	392 kN	
	Full elastic compression in NSF Zone (pe)		=	0.00 mm	
	ρ		=	1.59 + 3.06	
	ρ		=	pe + ρ	
	ρ		=	4.7 mm	

Calculation Sheet



Project No/Reference No: 2028022

Sheet No:

Project and Description:	Neath, Sofidel Biomass
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Rev:

Computed by:

Date:

Client: _____

Calculation Details:	Bearing Pile Design
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Checked by:

Vital Energy

Driven Precast Concrete

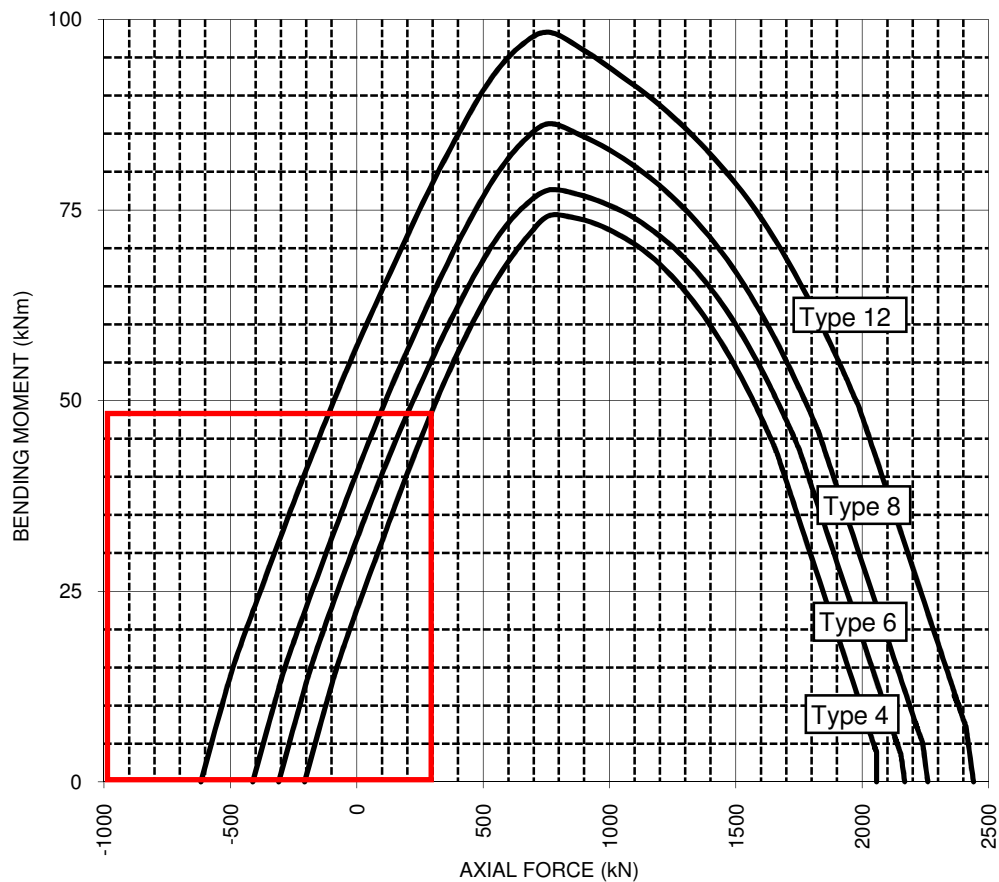
Date:

Ref

Output

[illegible]

CENTRUM 250



MOMENT VECTOR PARALLEL TO A SIDE

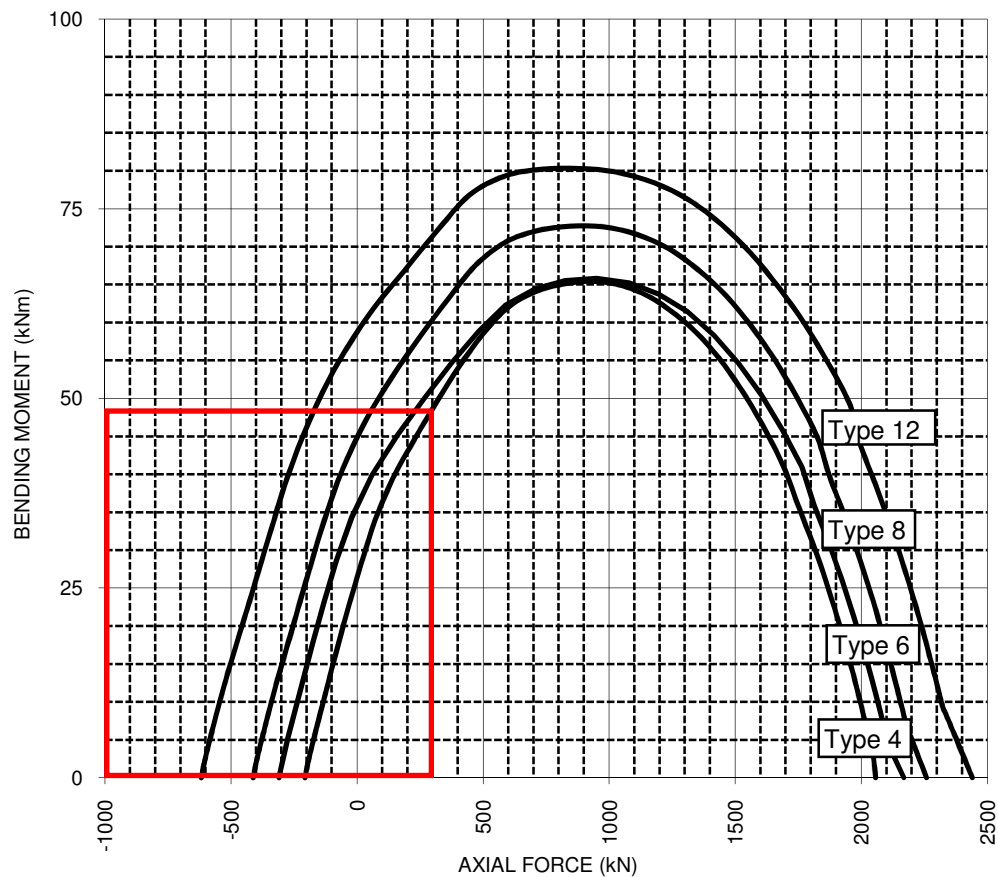
EC2

ULTIMATE LIMIT STATE DESIGN

Significant Values

		Pile Reference			
		Type 4	Type 6	Type 8	Type 12
Maximum Compression	kN	2078	2168	2259	2440
Maximum Tension	kN	205	308	411	616
Maximum Bending Moment	kNm	74	77	86	98
Bending Moment at zero axial	kNm	22	32	41	56

CENTRUM 250



MOMENT VECTOR PARALLEL TO A DIAGONAL

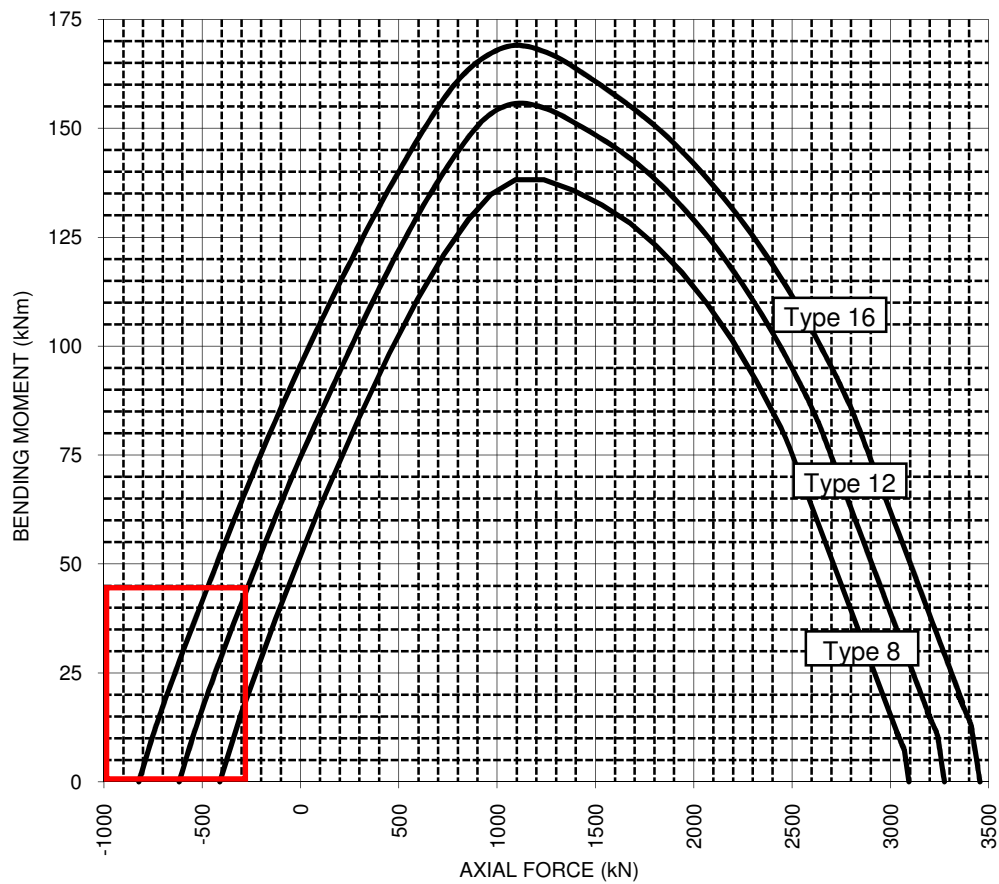
EC2

ULTIMATE LIMIT STATE DESIGN

Significant Values

		Pile Reference			
		Type 4	Type 6	Type 8	Type 12
Maximum Compression	kN	2078	2168	2259	2440
Maximum Tension	kN	205	308	411	616
Maximum Bending Moment	kNm	65	66	72	80
Bending Moment at zero axial	kNm	26	35	44	58

CENTRUM 300



MOMENT VECTOR PARALLEL TO A SIDE

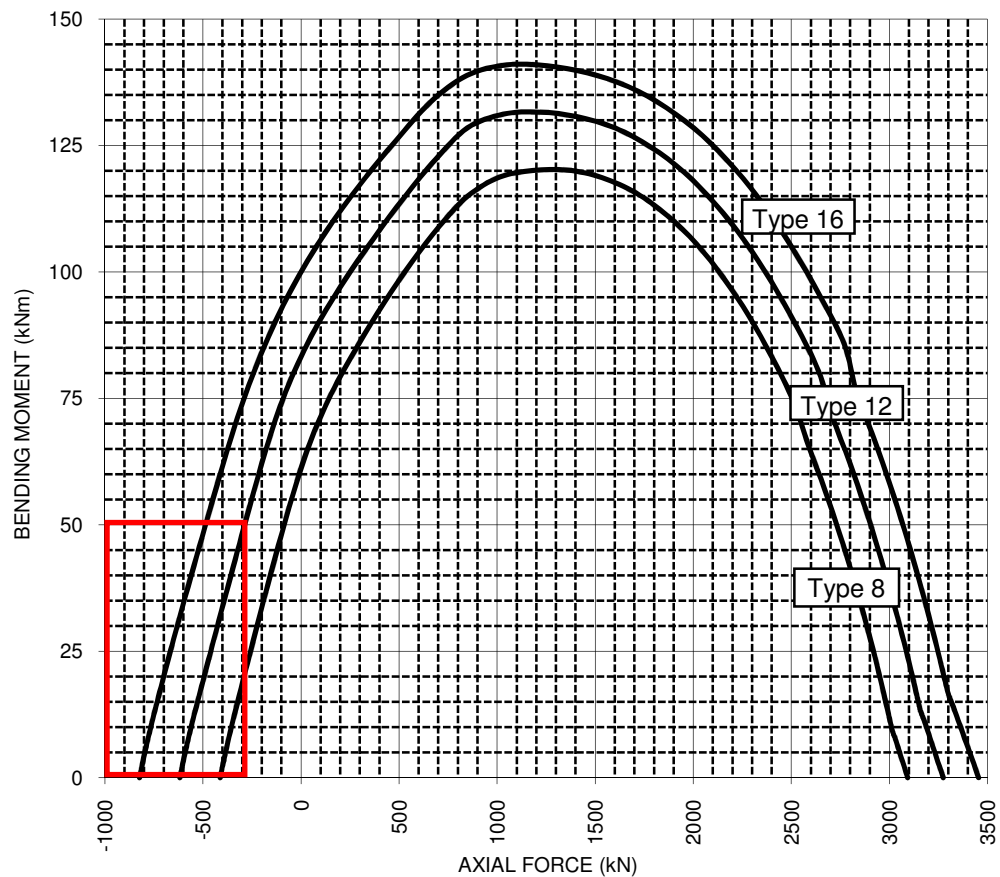
EC2

ULTIMATE LIMIT STATE DESIGN

Significant Values

		Pile Reference		
		Type 8	Type 12	Type 16
Maximum Compression	kN	3094	3275	3456
Maximum Tension	kN	411	616	822
Maximum Bending Moment	kNm	138	155	169
Bending Moment at zero axial	kNm	52	75	95

CENTRUM 300



MOMENT VECTOR PARALLEL TO A DIAGONAL

EC2

ULTIMATE LIMIT STATE DESIGN

Significant Values

		Pile Reference		
		Type 8	Type 12	Type 16
Maximum Compression	<i>kN</i>	3094	3275	3456
Maximum Tension	<i>kN</i>	411	616	822
Maximum Bending Moment	<i>kNm</i>	120	131	140
Bending Moment at zero axial	<i>kNm</i>	60	83	100