CONTIGUOUS PILED RETAINING WALL DESIGN

FOR TEMPORARY AND PERMANENT CONDITIONS

AT

LAND ADJACENT TO 39A PRIORY TERRACE

WEST HAMPSTEAD

GREATER LONDON - CAMDEN

Revision	C1	Design Calculations for Comment / Approval	14th October 2021
Stage	**Revision**	**Comments**	**Date**

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1.0 INTRODUCTION

As part of the redevelopment of a site at adjacent to 39a Priory Terrace, West Hampstead, London, it is proposed to construct a new detached, three storey house, including one level of basement beneath. The existing garage on the site will be demolished.

The site can be located by Latitude 51.540609, Longitude -0.189101 and lies at the junction of Priory Terrace and Abbey Road, which provides the site access. The Southern boundary adjoins the house and garden of numbers 39 and 39a Priory Terrace, while the Western boundary adjoins the house and garden of Priory Lodge. (see aerial view below).

To allow construction of the proposed basement, contiguous piled walls are proposed along the West, South and East sides of the basement. The North side will be supported by underpinning or similar.

The plan positions of the new basement and the proposed retaining walls are shown on the site plan, given on Figure 1 – see page 4. This also shows the sections taken for the design.

These calculations cover the design of the temporary / permanent piled retaining walls, axial loads on the retaining wall piles and a small number of bearing piles within the basement area.

The calculations have been carried out by Piledesigns Limited on behalf of MM Piling Limited.

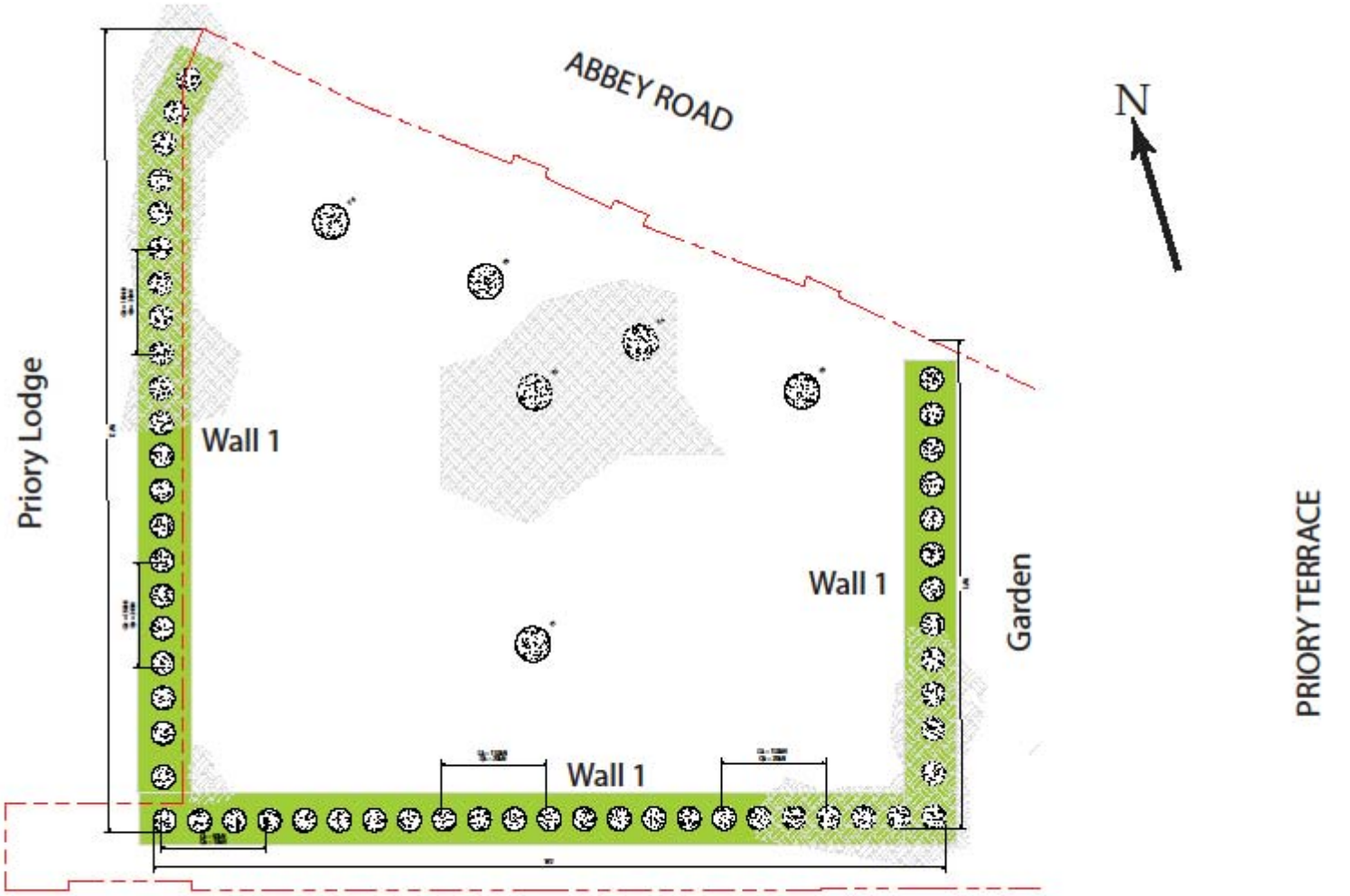


Figure 1 - Site Plan

2.0 INFORMATION PROVIDED

2.1 General and Structural Arrangements for the Proposed Development

Details of the proposed retaining walls and bearing piles have been taken from the relevant drawings provided, which are from engineersHRW, Consulting Engineers for the project. Further clarification has been provided following email and verbal communication with the Engineer and the Piling Contractor.

The main retaining wall and bearing pile drawings can be summarised as follows:

2015-HRW-XX-00-DR-S-152 revision P3: Proposed Ground Floor GA
2015-HRW-XX-B1-DR-S-150 revision P2: Pile Layout
2015-HRW-XX-B1-DR-S-151 revision P3: Proposed Basement GA
2015-HRW-XX-XX-DR-S-250 revision P3: Proposed Section A-A
2015-HRW-XX-XX-DR-S-251 revision P3: Proposed Section B-B
2015-HRW-XX-ZZ-DR-S-350 revision P2: Detailed Sections - Basement
2015-HRW-XX-ZZ-DR-S-352 revision P2: Detailed Sections
2015-HRW-XX-ZZ-DR-S-900 revision P3: Construction Sequence

One wall section has been identified for this analysis, labelled Wall 1. The section has been indicated on Figure 1, and has been chosen to represent the general soil and structural criteria for the site.

The piling platform level has been taken as 38.5mAD.

Wall 1 covers the whole wall, for which the Basement structural slab level is given as 35.21mAD. With a 350mm deep basement slab, 90mm of Cellcore and 50mm of blinding concrete the SLS dig level has been taken as 34.72mAD. A further allowance of 380mm for possible (unplanned) over-dig has been taken for the ULS case. A general surcharge of 10kN/m² has been taken behind the wall for the temporary and permanent conditions.

2.2 Ground Conditions

Ground conditions have been taken from a Desk Study & Ground Investigation Report carried out by GEA; report reference: J20012, dated September 2020. The investigation contains the records of one Cable Percussion borehole taken to a maximum depth of 15.0m.

The borehole showed the ground conditions to comprise Made Ground over London Clay.

The Made Ground generally comprised concrete over clayey sand with brick and concrete fragments, while the London Clay Formation was noted as firm to stiff, fissured, brown shading to bluish grey clay.

As no level was given for the borehole it has been assumed as approximate existing ground level – i.e. 38.5mAD.

A summary of the borehole results is presented in Table 1.

Table 1: Borehole Results

Borehole No	Location	Ground Level (mAD)	Level of London Clay (mAD)	Ground water levels in boreholes / standpipes (mAD)
BH1	Not given	38.5	37.5	- / 36.0

A plot of SPT 'N' values and shear strength results is presented in Figure 2 – see page 7.

For the purpose of the retaining wall design the Made Ground has been taken to a level of 37.5mAD with the London Clay taken to depth.

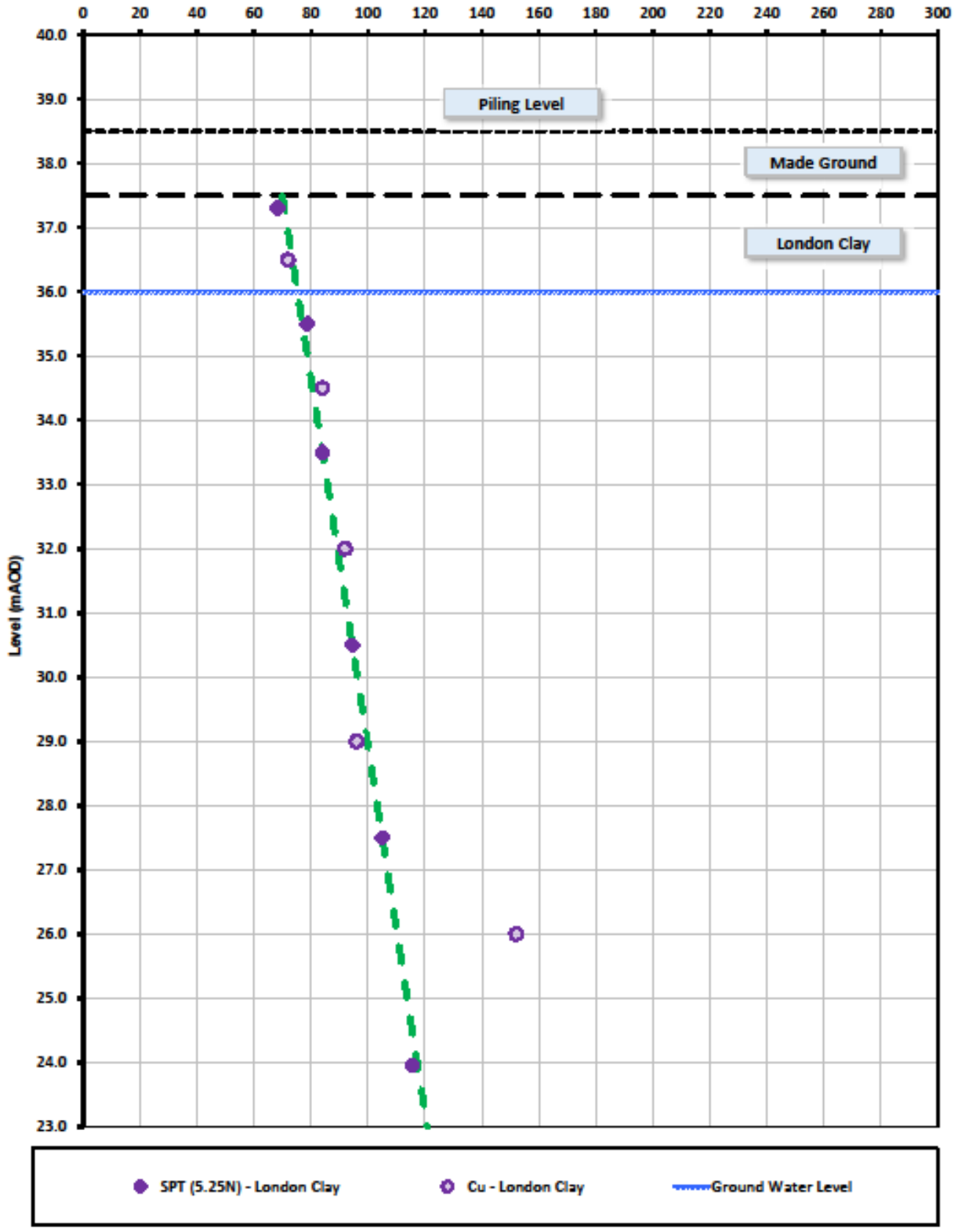
Groundwater was not recorded in the boreholes, but was recorded in a standpipe and indicated as arising from possible perched water in the made ground.

The assumed soil profile and design parameters should be checked during initial piling operations and any variations notified to the designer.

PILEDESIGNS
GEOTECHNICAL EXPERTISE

Project Name: WEST HAMPSTEAD - 39a Priory Terrace **Date:** 14/10/21
Project No: 24787 **Drawn by:** DBS **Rev:** C1

All against level for all boreholes



3.0 DESIGN PARAMETERS

3.1 Geotechnical

The pile design calculations have been based on the information provided. The soil parameters employed have generally been taken from the soils information provided and checked against published data and other ground investigation reports in the area. The analysis has considered drained conditions for the Made Ground and undrained conditions for the London Clay when applied to the temporary condition. For the permanent condition all strata have been changed to drained.

The sections shown on Figures 3 and 4 on sheets 9 and 10 show the typical soil profile used in the analysis and the soil parameters for the drained and undrained conditions.

Groundwater for the temporary condition has been taken at a level of about 36.0m. For the permanent condition groundwater has been taken at the underside of the Basement slab on the passive side and at about 1.0m below ground level on the active side.

3.2 Construction / Design Sequence

Wall 1

- Carry out piling from the assumed piling platform level (38.5mAD)
- After adequate curing of the piles excavate to a level of 38.0mAD
- Construct Ground Floor RC slab (38.45mAD)
- After adequate curing of the Ground Floor slab excavate to Basement slab formation level (34.72mAD)
- Construct Basement RC slab (35.03mAD)
- Apply long term parameters to piles and soils
- Apply long term high water check

3.3 Structural Design Parameters

The contiguous retaining wall piles will be constructed using Auger Bored piling techniques with a minimum C30/37 designed concrete pump mix and 'B' (500N/mm²) grade main reinforcement bars with helical shear links. A minimum of 75mm cover to the main reinforcement will be provided by propriety spacers.

The main structural design parameters used in the retaining wall analysis have been summarized in Table 2, for 350mm diameter piles at approximately 500mm centres.

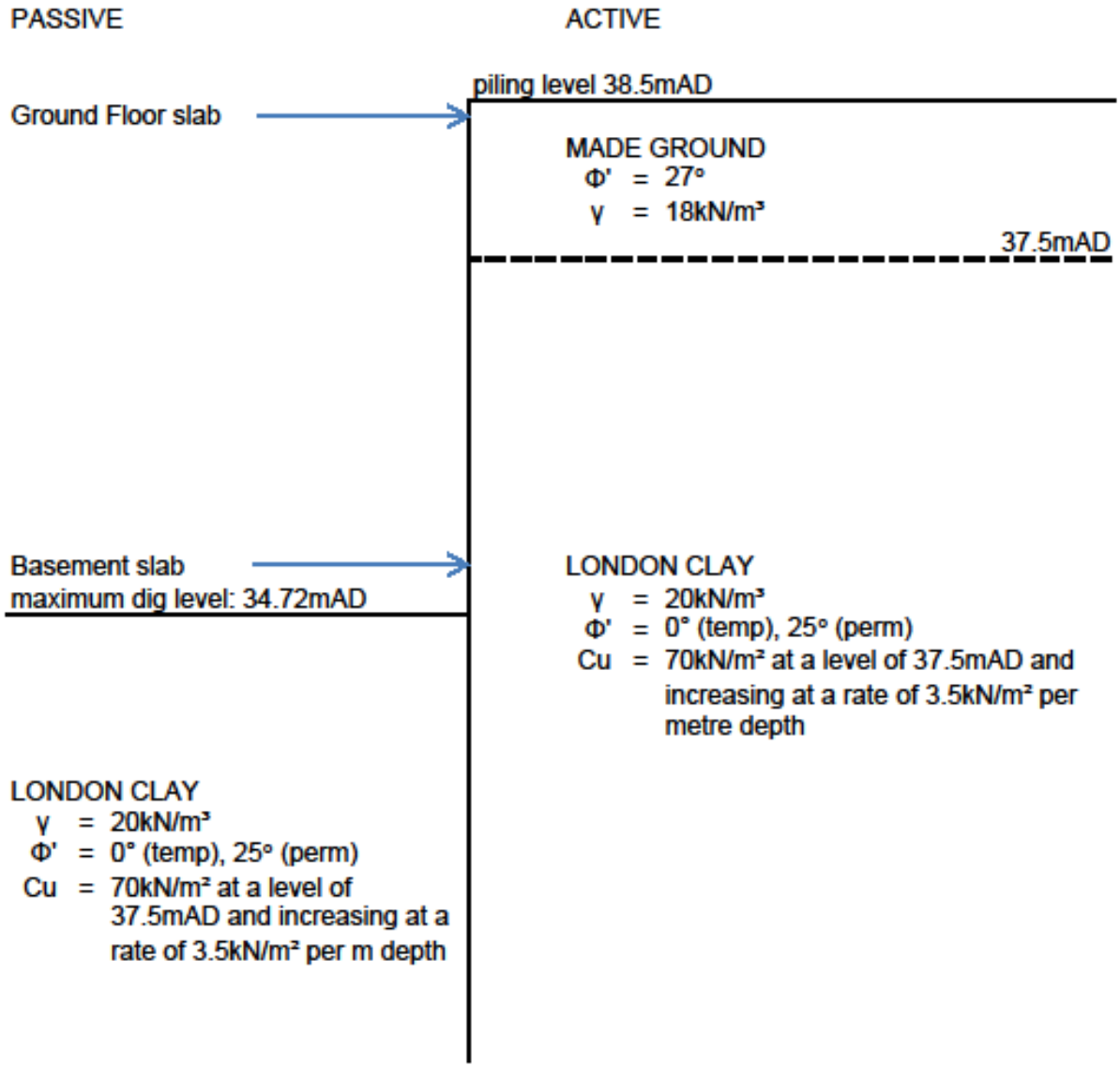
Table 2 – Main Structural Design Parameters

Material	Short Term Parameters	Long Term Parameters
Concrete 350mm diameter @ 500mm centres	E = 2.31 x 10^{+7} kN/m² I = 1.47 x 10^{-3} m⁴/m run E.I = 34032 kN.m² / m run	E = 1.65 x 10^{+7} kN/m² I = 1.47 x 10^{-3} m⁴/m run E.I = 24308 kN.m² / m run
Steel	E = 2.05 x 10^{+8} kN/m²	E = 2.05 x 10^{+8} kN/m²

Notes: Short term EI = 70% of the initial value; Long term EI = 50% of the initial value

TYPICAL SECTION FOR SLS CONDITIONS - Figure 3

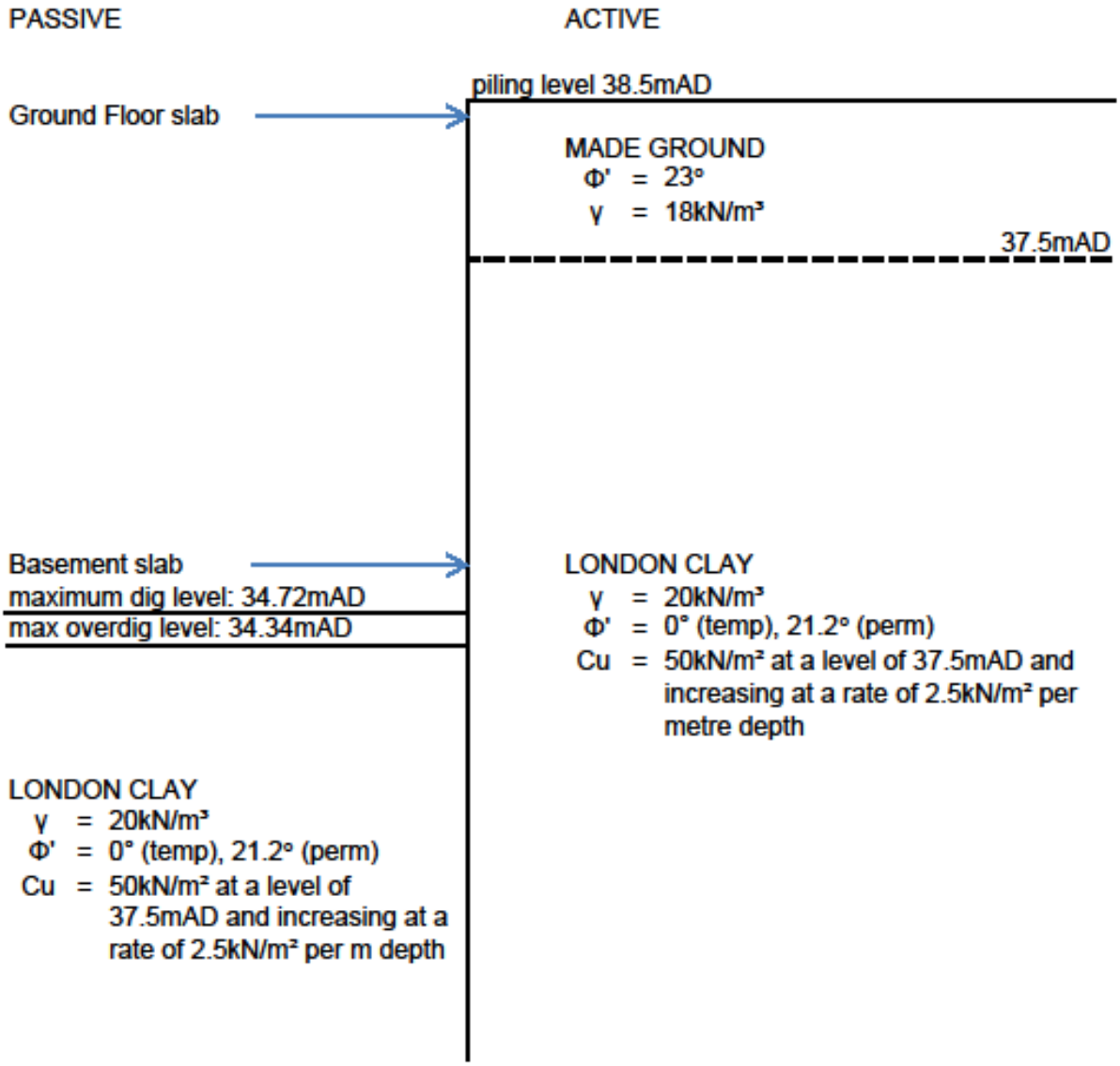
General surcharge of 10kN/m² allowed



A typical initial water level of about 36mAD has been taken on the passive and active sides for the temporary condition. For the permanent condition groundwater has been taken at 1.0m below ground level on the active side and to the underside of the Basement slab on the passive side.

TYPICAL SECTION FOR ULS CONDITIONS - Figure 4

General surcharge of 10kN/m² allowed



A typical initial water level of about 36mAD has been taken on the passive and active sides for the temporary condition. For the permanent condition groundwater has been taken at 1.0m below ground level on the active side and to the underside of the Basement slab on the passive side.

3.4 Retaining Wall and Propping Geometry

Wall 1 will be propped at one level in the temporary condition utilising the Ground Floor slab in a 'top down' construction sequence, and be propped by the Basement and Ground Floor slabs in the permanent condition.

Table 3 presents the structural and geometrical properties of the propping that has been used in the design of the retaining wall.

Table 3: Assumed details of horizontal propping

Wall no / Prop no (Perm/Temp)	Prop Elevation (mAD)	Prop Spacing (m)	Prop Sectional area (m^2)	Prop Young's modulus (kN/m^2)	Prop free length (m)
1 / 1 (Perm) Ground Floor Slab	38.45	1.0	0.25	$1.65 \times 10^{+7}$	5.00
1 / 2 (Perm) Basement Slab	35.03	1.0	0.35	$1.65 \times 10^{+7}$	5.00

Prop levels taken as the approximate midpoint of the structural slabs/capping beams.

Should the construction sequence or propping system be changed from that assumed then the retaining wall design will require to be reassessed which could result in changes to the pile length and / or reinforcement.

4.0 DESIGN METHODOLOGY

4.1 Geotechnical Analysis for Contiguous Bored Pile Retaining Wall

The retaining wall analysis has been carried out using the computer program 'WALLAP' Version 6.06 developed by Geosolve.

The design has been carried out using the 'Strength Factor' approach with partial factors in accordance with BS EN 1997-1: 2004 Eurocode 7 and to the approach as prescribed in the UK National Annex of BS EN 1997–1. Using this approach three runs for each section may be carried out and these are typically referenced as:-

SLS	service limit state
ULS-comb 1	ultimate limit state – structural (STR)
ULS-comb 2	ultimate limit state – geotechnical (GEO)

With respect to the above the wall design is checked in its ultimate state by applying partial factors and carrying out two separate checks (combinations), as shown in Table 4 which have been taken from Tables NA.A1. (B) and (C) of the UK National Annex to BA EN 1990+A1; 2005 for the actions and Table A. NA.4 of the National annex to BS EN 1997-1: 2004 for the soil parameters.

Both represent ultimate conditions with combination 1 the structural ultimate case (ULS-STR), and combination 2 the geotechnical ultimate case (ULS-GEO). Combination 1 applies partial factors to actions (A) - (temporary/permanent actions, Gk, and variable actions, Qk) while soil parameters (M1) and pile resistances (R1) are kept un-factored (R1 & M1 = 1.0). Combination 2 applies partial factors to the soil parameters (M2) and partial factors of smaller magnitude to the variable actions (A). For both these cases the design is mainly to verify that the proposed embedment length i.e. reinforced pile length / toe level, provides a nominal factor of safety against failure. Bending and shear forces are unfactored in any subsequent structural calculations for ULS-comb 2, but factored by 1.35 for ULS-comb 1. An allowance for overdig within both ultimate cases is included and taken as up to a maximum of 10% of the retained height (or 0.5m whichever is the lesser).

Table 4 Partial factors adopted for design (Retaining Wall Earth Pressures).

	Notation	Partial Factor		
		SLS	DA1 Comb. 1	DA1 Comb. 2
ACTIONS: (A)				
Permanent Action (Unfavourable)	G_k	1.0	1.35 (A1)	1.0 (A2)
Variable Action (Unfavourable)	Q_k	1.0	1.50 (A1)	1.3 (A2)
SOIL FACTORS: (M)				
Effective angle of shearing resistance	tan Ø'	1.0	1.0 (M1)	1.25 (M2)
Effective cohesion	C'	1.0	1.0 (M1)	1.25 (M2)
Undrained shear strength	C_u	1.0	1.0 (M1)	1.40 (M2)
RESISTANCES: (R)				
Earth resistance	γ_{Re}	1.0	1.0 (R1)	1.0 (R1)

Notes – factors given above apply to Actions which refer to unfavourable conditions

- Combination 1 (ULS-STR): A1 + M1 + R1.
- Combination 2 (ULS–GEO): A2 + M2 + R1.

A further analysis is included which represents SLS conditions and usually carried out to determine wall deflections. The analysis assumes moderately conservative soil parameters,

with a partial factor (M2) taken as 1.0 and no allowance for overdig. This calculation also provides bending moments and shear forces which are factored up by 1.35 in any subsequent structural calculations. The results from this analysis are provided per metre run and therefore amended to the particular pile diameter and spacing.

The input and output data from the WALLAP analyses are presented in Appendix B. The Ultimate Limit State (ULS) conditions employ factored soil parameters as required for the (ULS–GEO), DA1 Combination 2 conditions.

Calculated wall displacements and corresponding program outputs may be considered to be an upper bound estimate of long-term movements, due to the following factors:

(a) Geotechnical parameters, pile stiffness and surcharges are considered to be reasonably conservative values. A more accurate assessment of wall displacements would require the input of 'actual' parameters to be obtained from more sophisticated laboratory testing.

(b) The computer program does not consider the beneficial effects of structural elements such as a capping beam.

(c) The computer program is a two-dimensional analysis program and does not consider the beneficial effects of geometrical features such as internal or external wall corners which increase its overall stiffness.

(d) The computer program uses a Winkler spring analysis to determine the wall displacements, in which springs are used to represent a continuum and there is no transfer of shear stresses between springs. In general, the application of this concept leads to an overestimation of structural deformations; hence the resulting displacements may be over-predicted.

The results of the WALLAP analysis are given in Appendix B. These are summarised in Tables 5, 6 and 7 and given below. Table 5 provides the results of the stability analysis from WALLAP and calculated deflections. It includes varying sets of bending moments and shear forces. Reinforcement calculations are based on the worst case bending moments and shear values determined from the un-factored ULS-comb 2 and factored SLS and ULS-comb 1 results. Table 6 details the temporary and permanent prop forces and Table 7 shows the details of the sections with the proposed pile length.

Actual deflections are expected to be in the region of 50 to 70% of the calculated figures. Additional ground movements may be generated due to pile installation and reference should be made to CIRIA C760. Horizontal movement and settlement will vary with distance from the piles.

4.2 Individual Pile Section Structural Analysis

Reinforcement requirements have been analysed for the shear forces and bending moments indicated within the WALLAP outputs (Appendix B) and summarized in the wall schedule, (Table 7). Using the Oasys ADC software, all bending moments and shear force calculations have been carried out in accordance with the requirements of BS EN 1992, Eurocode No. 2 ‘Design of Concrete Structures’.

The results of the ADC analyses are given in Appendix C. For all cases the concrete grade has been taken as a minimum C30/37 and a worst case axial load of 0kN compression load.

TABLE 5 - Results of Retaining Wall Analysis (Wall 1)

Sections Ref	Case	Pile diameter	Pile spacing (approx)	Calculated deflection	Estimated deflection	Bending Moments			Shear			Ultimate Design Values per pile at spacing given	
						Maximum	Factor	Ultimate	Maximum	Factor	Ultimate	Moment	Shear
	Temp / Perm	mm	mm	mm	mm	kN.m/m		kN.m/m	kN/m		kN/m	kN.m	kN
SLS	T/P	350	500	3	2	26.0	1.35	35.1	49.0	1.35	66.2	17.6	33.1
ULS1	T/P	350	500			29.0	1.35	39.2	48.0	1.35	64.8	19.6	32.4
ULS2	T/P	350	500			29.0	1.00	29.0	56.2	1.00	56.2	14.5	28.1
										Max	350	**19.6**	**33.1**

TABLE 6 - Details of Prop Forces

Wall Ref	Strut Ref	Type	Level	SLS Results Prop Force unfactored	ULS Results Prop Force unfactored	
					ULS1	ULS2
			mAD	kN/m run	kN/m run	
1	1	Ground Floor Slab	38.45	17.0	18.0	19.8
	2	Basement Slab	35.03	83.0	77.0	90.9

TABLE 7 - Details of Retaining Wall Piles

Wall Section	Pile diameter	Pile spacing	Assumed Piling Level	RW Pile Length	RW Pile Toe Level	Reinforcement					
						Main Bars					Helical
						No		size		length	size @ spacing
	mm	mm	mAD	m	mAD			mm		m	mm @ mm
1	350	500	38.500	7.0	31.500	5	*	B16	*	7.0	B8 @ 150

NOTE: Pile lengths given above are for retaining function only - check pile lengths on schedule, which have been adjusted to account for the specified axial loads

4.3 Retaining Wall & Bearing Pile Axial Load Carrying Capacity

The retaining wall piles will be required to carry axial compression loads of 75kN (permanent) and 10kN (variable), with some piles subject to additional column loads of 37.5kN / 22.5kN (permanent) and 5kN / 2.5kN (variable) at a discounted level of 34.7mAD.

For piles in a retaining wall a reduction factor is usually applicable due to the close centres of the piles within the wall. This factor is applied to the shaft resistance only. For the 350mm diameter piles at a spacing of 500mm, take the surface area per metre depth as 1.0m², i.e. the wall is considered as a straight sided section, (2 * 0.5m pile spacing). Relating this value to the surface area of an isolated 350mm diameter pile (1.099m²/m), the reduction factor for shaft friction is determined to be 0.9. No reduction factor is applicable to the end bearing since the base surface area per metre per pile in the wall (0.175m²) is larger than the base area of a single pile (0.096m²).

A small number of bearing piles will be subject to compression loads of 425kN / 200kN (permanent) and 65kN / 25kN (variable), along with lateral loads of 25kN (permanent) and 5kN (variable).

Axial Design

The design has been carried out in general in accordance with Eurocode (BS EN 1997-1:2004) with reference made to the UK National Annex. This is an ultimate limit state design approach with partial factors applied to actions (A), materials (M) and resistances (R). Pile lengths have been determined to satisfy a structural check (STR), with partial factors only applied to actions, and a geotechnical check (GEO), with partial factors applied to both actions and resistances. These are in accordance with the Eurocode Design Approach 1 and referred to as combinations DA1-1 and DA1-2 respectively.

An explanation of the appropriate partial factors as usually derived for these combinations is indicated below.

Design Approach 1 - Combination - 1

Taken as A1 + M1 + R1

With partial factors of 1.0 applied to both M1 and R1

For A1 a factor of 1.35 has been applied to the permanent loads and 1.5 applied to the variable loads.

Design Approach 1 - Combination - 2

Taken as A2 + M1 + R4

For A2 a factor of 1.0 has been applied to the permanent loads and 1.3 applied to the variable loads.

For M1 all factors have been taken as unity.

Partial factors for R4 relate mainly to testing and also pile type, with factors applied to both shaft adhesion and end bearing for the latter. For this site it is understood that no pile testing is proposed.

Partial factors for GEO limit state from Table A.NA.8 as follows:

1.6 (compression) applied to shaft resistance and 2.0 to the base resistance with a model factor of 1.4 applied to both. The above factors apply without any explicit verification testing.

Vertical Design

Assumed soil profile

Piling Level	to	Discounted Level	DISCOUNTED SOIL
Discounted Level	to	--- mAD	LONDON CLAY

Groundwater level taken as 36.0mAD.

Design A: Discounted level 34.7mAD – Wall piles (350mm diameter)
Design B: Discounted level 34.7mAD – Bearing piles (450mm diameter)

Shaft Adhesion

In DISCOUNTED SOIL	Density taken as 18kN/m³ Discounted for positive skin friction Taken as Made Ground & London Clay
In LONDON CLAY	Density taken as 20kN/m³ with shear strength as 70N/m² at a level of 37.5mAD and increasing at a rate of 3.5kN/m² per metre depth Use (0.5 * 0.9) = 0.45 shear strength (wall piles) Use 0.5 shear strength (bearing piles)

End Bearing

In LONDON CLAY	For unit end bearing use 9 * shear strength with shear strength values as given above.

Factor of Safety

Shaft resistance, FOS	1.6 (compression)
End resistance, FOS	2.0

For EC7 approach also with model factor of 1.4 applied to both

The resulting design actions for the given loads are detailed in the separate Retaining Wall & Bearing Pile Schedule.

The above calculations have been carried out using the OASYS Pile program, version 19.7 which allows the appropriate partial factors to be applied to the soil parameters. The results are given in Appendix D. Perusal of the appropriate actions shows that design approach case 2 (DA1-2) dictates and the calculated results for the 350mm diameter wall piles and 450mm diameter bearing piles are given in the Pile Schedule.

Appendix D1: Discounted level	34.7mAD – Wall piles
Appendix D1: Discounted level	34.7mAD – Bearing piles

Concrete	C30/37 minimum	DC-1 Chemical Class

4.4 Bearing Pile Lateral Capacity

The bearing piles are required to carry horizontal wind loads of 25kN (permanent) and 5kN (variable). All loads have been taken as applied at cut-off level.

The design has been carried out in general in accordance with Eurocode (BS EN 1997-1:2004) with reference made to the UK National Annex. This is an ultimate limit state design approach with partial factors applied to actions (A), materials (M) and resistances (R). Pile lengths have been determined to satisfy a structural check (STR), with partial factors only applied to actions, and a geotechnical check (GEO), with partial factors applied to both actions and resistances. These are in accordance with the Eurocode Design Approach 1 and referred to as combinations DA-1 and DA-2 respectively.

An explanation of the appropriate partial factors as usually derived for these combinations is indicated below.

Design Approach 1 - Combination - 1

Taken as A1 + M1 + R1

For A1 a factor of 1.35 is applied to the permanent loads and 1.5 applied to the sum of the variable loads.

With partial factors of 1.0 applied to both M1 and R1.

Design Approach 1 - Combination - 2

Taken as A2 + M2 + R1

For A2 a factor of 1.0 is applied to the permanent loads and 1.3 applied to the sum of the variable loads.

For M2 factors of 1.25 (drained soils) and 1.4 (undrained soils) have been applied to the Materials.

With a partial factor of 1.0 applied to R1.

See pile schedule for details of lateral actions taken on the piles.

Geotechnical Analysis

Analysis of the pile under horizontal load / bending moments has been carried out using the OASYS – ALP programme; version 19.3. The program models the interaction between the pile and the surrounding soil, predicts the pressures, horizontal movements, shear forces and the bending moments induced in the pile.

The pile is modelled as a series of elastic beam elements. The soil is modelled as a series of non-interactive, non-linear springs. The soil deflection has been modelled assuming an elastic plastic behaviour. Two stiffness matrices relating nodal forces to displacements are developed - one represents the pile in bending the other represents the soil.

The assumed soil profile and soil parameters are detailed in the vertical pile calculations.

Coefficients for passive resistance for the various soils have been taken from the data given in the program manual which are based on Tomlinson's coefficients, 1986.

For the piles at this site the pile head is likely to be intermediate between both free and fixed conditions. The method of analysis used has allowed for a nominal rotational stiffness applied at the pile head, taken as 10000kN.m per radian.

The flexural rigidity (EI) of the pile is calculated as follows:-

$EI = E\ (concrete) * I\ (pile)$

where E (concrete) is the Young's Modulus of the concrete taken as 20GN/m²

and I (pile) is the Moment of Inertia of the pile

$$EI = \frac{20 * 10^9 * \pi * (0.45)^4}{64 * 10^3}$$

= 40258kN/m² for a 450mm diameter pile

The lateral loads have been taken as applied at cut-off level, taken as 34.935mAD. All piles have been taken as restrained with no allowance taken for possible positional tolerances.

Details of the ALP analysis carried out are given in the Table below. For the analysis both lateral actions to DA1-1 (STR) and DA1-2 (GEO) have been considered and the worst case considered for moment condition. The results of the ALP analysis are given in Appendix E1 and show the maximum derived moment and indicate the depth below cut-off level the moment can be considered as sensibly dissipated.

Table of ALP Analyses

Lateral Reference	Lateral Case	Cut-off Level mAD	Design Action kN	Derived Moment kN.m	Depth to dissipate (below cut-off level) m
E1 – A	DA1-1	34.935	41	25.4	4.0
E1 – B	DA1-2		32	19.9	4.0

Structural Analysis

The derived maximum bending moments are checked against the ultimate moments obtained using the OASYS - ADC programme for columns to Eurocode (BS EN 1992-1-1:2004). This program calculates the ultimate moment capacity of the pile section with particular concrete and reinforcement and at specified working loads. The analyses have been carried out on the basis of the lateral loads and also for the range of axial loads.

The results are as follows; with each case analysed for specific pile diameter, reinforcement and axial load. For all cases the concrete has been taken as minimum C30/37.

Table of ADC Analyses

Appendix (Lateral Case)	Reinforcement (minimum) mm	Lateral reference	Axial Load m	Ultimate moment capacity kN.m
F1-A	4 * B16mm * 8m	DA1-1 (Min)	180	77.9
F1-B		DA1-1 (Max)	671	123.9
F1-C		DA1-2 (Min)	200	80.1
F1-D		DA1-2 (Max)	510	111.4

From the results of the STR / GEO (DA1-1 and DA1-2) ALP analyses the ADC check allow for a safety factor of at least unity on the equivalent derived ultimate moments.

The proposed steel represents a minimum and the number / size of the reinforcement bars may be increased for practical purposes.

Further the proposed helical has been taken as:

B8mm helical, using 75mm cover and with a spacing of 200mm centre to centre.

5.0 SUMMARY OF RESULTS AND GENERAL COMMENTS

Summary results of the various wall analyses are presented in Table 5. Temporary and permanent prop forces are presented in Table 6. The pile summary schedule indicating pile lengths and reinforcement is presented in Table 7.

The CDM Risk Register is presented in Appendix A.

The detailed retaining wall analysis comprising the computer print outs are presented in Appendix B.

Reinforcement calculations comprising the computer printouts from the ADC design software and the Helical check are presented in Appendix C.

Retaining Wall & Bearing Pile axial capacity calculations comprising the computer printouts from the PILE design software are presented in Appendix D.

Bearing Pile lateral capacity calculations comprising the computer printouts from the ALP design software are presented in Appendix E.

Bearing Pile reinforcement calculations comprising the computer printouts from the ADC design software and the Helical check are presented in Appendix F.

APPENDIX A

CDM Risk Register

PILEDESIGNS GEOTECHNICAL EXPERTISE			CDM Risk Register
Project: West Hampstead – 39a Priory Terrace			Date: 14th October 2021
Design By: DBS	Job No:	Design Ref: 24787	Rev: C0

STATEMENT ON CDM REGULATIONS (2015) AND RESIDUAL RISKS

CDM Regulations (2015)

The Client and Designer for this project are subject to certain duties under the CDM (2015) Regulations. It is the duty of the Designer to ensure that the client is aware of these duties prior to commencing the design. Piledesigns Ltd are responsible for an 'elemental' part of the design only and are not the 'overall' scheme designer. This 'elemental' design has been undertaken on the premise that this duty has been carried out by the scheme designer, and that no separate approach, in respect of this elemental design, by Piledesigns Ltd is required.

Residual Risks – In accordance with the CDM Regulations (2015) any specific residual design risks and construction sequences relevant to this design are given below. As stated in the CDM Regulations (2015), whilst we have assessed the design risks for our works we have only listed the risks we consider significant to the design and which we consider are not likely to be obvious to a competent contractor or other designer. It does not constitute or remove the need for task related risk assessments for the activities carried out in the implementation of the design. Furthermore, it is the responsibility of the client and principal designer to ensure a competent principal contractor is appointed for these works.

The residual risks below should be added to any relevant construction drawing or method statements and copied to relevant designers and contractors on site.

PILEDESIGNS GEOTECHNICAL EXPERTISE			CDM Risk Register
Project: West Hampstead – 39a Priory Terrace			Date: 14th October 2021
Design By: DBS	Job No:	Design Ref: 24787	Rev: C0

Item No	Risk	Potential Effects	Risk Management / Mitigation
1	Unforeseen ground conditions	Pile performance could be compromised.	Ground conditions encountered during pile construction should be logged and checked against the assumed design profile and any variations from that assumed in the design must be reported immediately to the designer.
2	Obstructions	Unable to achieve proposed design lengths.	Ensure all known existing obstructions are removed prior to piling works.
3	Unable to install reinforcement cages in CFA piles	Pile reinforcement does not achieve the required level.	Reinforcement stated within the design is the minimum required. Reinforcement can be increased in bar diameter and number to increase cage stiffness for pile installation and to ensure adequate rigidity.
4	Construction sequence	Excessive deflection / wall failure	The design construction sequence shown above must be followed to ensure stability.
5	Deflection of pile walls	Movement of adjacent ground and structures	Monitor retaining wall and compare actual wall movements to that calculated throughout the construction process.
6	Piling adjacent to neighbouring structures.	Damage to structures	Ensure all piling activities are agreed with the required third parties and the appropriate sign off have been completed before commencement.

APPENDIX B

Ref No	Description
1-SLS	WALLAP analysis for wall section 1, moments and deflection.
1-ULS1	WALLAP analysis for wall section 1, moments and embedment.
1-ULS2	WALLAP analysis for wall section 1, moments and embedment.

WALLAP

1-SLS

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	38.50	1 Made Ground dr	1 Made Ground dr
2	37.50	2 London Clay und	2 London Clay und

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Made Ground dr	18.00	10000	0.577	OC (0.250)	0.323 (0.000)	3.647 (0.000)	
2	London Cl.. (37.50)	20.00	52500 (2625)	1.300	OC (0.490)	1.000 (2.476)	1.000 (2.390)	70.00u (3.500)
3	London Cl.. (37.50)	20.00	39375 (1968)	1.300	OC (0.200)	0.351 (1.391)	3.253 (4.831)	0.0d

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Made Ground dr	27.00	0.670	0.00	27.00	0.500	0.00
2	London Clay und	0.00	0.670	0.00	0.00	0.500	0.00
3	London Clay dr	25.00	0.670	0.00	25.00	0.500	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	36.00	36.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	36.00	36.00	0.0	1	34.00	34.00	0.0	MC+WC
2	1	37.50	37.50	0.0	1	34.72	34.72	0.0	MC+WC
					2	34.72	37.50	27.3	

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 31.50
Maximum finite element length = 0.40 m
Youngs modulus of wall E = 2.3100E+07 kN/m2
Moment of inertia of wall I = 1.4732E-03 m4/m run
E.I = 34032 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Strut/ anchor no.	Elev.	Strut spacing m	X-section area of strut sq.m	Youngs modulus kN/m2	Free length m	Inclin -ation (degs)	Pre- stress /strut kN	Tension allowed
1	38.45	1.00	0.250000	1.650E+07	5.00	0.00	0	No
2	35.03	1.00	0.350000	1.650E+07	5.00	0.00	0	No

SURCHARGE LOADS

Surch -arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge ----- kN/m2 ----- Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	38.50	0.50(L)	20.00	20.00	10.00	=	N/A	1.00 Var
2	34.72	-0.00(R)	10.00	10.00	28.00	=	N/A	1.00 P/F

Note: L = Left side, R = Right side
Limit State Categories P/U = Permanent Unfavourable
P/F = Permanent Favourable
Var = Variable (unfavourable)

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 38.50
2	Excavate to elevation 38.00 on RIGHT side
3	Install strut or anchor no.1 at elevation 38.45
4	Apply water pressure profile no.1 (Mod. Conserv.)
5	Excavate to elevation 34.72 on RIGHT side
6	Install strut or anchor no.2 at elevation 35.03
7	Change EI of wall to 24308 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value
8	Change properties of soil type 2 to soil type 3 No analysis at this stage Ko pressures will not be reset
9	Apply surcharge no.2 at elevation 34.72 No analysis at this stage
10	Apply water pressure profile no.2 (Mod. Conserv.)

FACTORS OF SAFETY and ANALYSIS OPTIONS

Limit State options: Serviceability Limit State
All loads and soil strengths are unfactored

Stability analysis:
Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 5.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 7.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 50.00 m

Width of excavation on Left side of wall = 50.00 m
Width of excavation on Right side of wall = 50.00 m

Distance to rigid boundary on Left side = 50.00 m
Distance to rigid boundary on Right side = 50.00 m

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 38.50	No	No	No
2	Excav. to elev. 38.00 on RIGHT side	Yes	Yes	Yes
3	Install strut no.1 at elev. 38.45	Yes	Yes	Yes
4	Apply water pressure profile no.1	Yes	Yes	Yes
5	Excav. to elev. 34.72 on RIGHT side	Yes	Yes	Yes
6	Install strut no.2 at elev. 35.03	Yes	Yes	Yes
7	Change EI of wall to 24308kN.m2/m run	Yes	Yes	Yes
8	Change soil type 2 to soil type 3	Yes	Yes	Yes
9	Apply surcharge no.2 at elev. 34.72	Yes	Yes	Yes
10	Apply water pressure profile no.2	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 38.50

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	38.50	38.50	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall
Limit State: Serviceability Limit State
Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-2.41E-05	0.0	0.0		34032
2	38.45	-0.51	0.000	-2.41E-05	-0.0	-0.0		34032
3	38.22	-0.42	0.000	-2.40E-05	-0.1	-0.0		34032
4	38.00	-0.01	0.000	-2.39E-05	-0.2	-0.0		34032
5	37.75	0.47	0.000	-2.34E-05	-0.1	-0.1		34032
6	37.50	0.84	0.000	-2.28E-05	0.1	-0.1		34032
		-1.08	0.000	-2.28E-05	0.1	-0.1		
7	37.15	-0.34	0.000	-2.17E-05	-0.2	-0.1		34032
8	36.80	0.03	0.000	-2.02E-05	-0.2	-0.2		34032
9	36.40	0.21	0.000	-1.75E-05	-0.2	-0.3		34032
10	36.00	0.24	0.000	-1.40E-05	-0.1	-0.3		34032
11	35.60	0.21	0.000	-1.01E-05	-0.0	-0.3		34032
12	35.32	0.16	0.000	-7.30E-06	0.0	-0.3		34032
13	35.03	0.12	0.000	-4.56E-06	0.1	-0.3		34032
14	34.72	0.08	0.000	-1.77E-06	0.1	-0.3		34032
15	34.36	0.03	0.000	1.06E-06	0.1	-0.2		34032
16	34.00	-0.00	0.000	3.44E-06	0.1	-0.2		34032
17	33.60	-0.02	0.000	5.50E-06	0.1	-0.1		34032
18	33.20	-0.04	0.000	6.99E-06	0.1	-0.1		34032
19	32.80	-0.05	0.000	7.96E-06	0.1	-0.1		34032
20	32.40	-0.06	0.000	8.52E-06	0.1	-0.0		34032
21	32.00	-0.07	0.000	8.77E-06	0.0	-0.0		34032
22	31.75	-0.08	0.000	8.82E-06	0.0	-0.0		34032
23	31.50	-0.10	0.000	8.83E-06	0.0	0.0		---

(continued)

Stage No.1 Apply surcharge no.1 at elevation 38.50

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	2189
2	38.45	0.00	0.92	0.30	3.36	0.30	0.30a	2189
3	38.22	0.00	5.47	1.77	19.96	2.74	2.74	2189
4	38.00	0.00	10.82	3.49	39.45	5.49	5.49	2189
5	37.75	0.00	16.82	5.42	61.33	8.58	8.58	2189
6	37.50	0.00	22.50	7.26	82.05	11.55	11.55	2189
		Total>	22.50	5.00m	189.80	25.02	25.02	17854
7	37.15	Total>	30.66	6.75m	200.89	35.05	35.05	18166
8	36.80	Total>	38.44	8.50m	211.59	44.71	44.71	18478
9	36.40	Total>	47.04	10.50m	223.54	55.49	55.49	18836
10	36.00	Total>	55.46	12.50m	235.30	66.10	66.10	19193
11	35.60	Total>	63.75	14.50m	246.95	75.45	75.45	19550
12	35.32	Total>	69.61	15.92m	255.19	82.08	82.08	19804
13	35.03	Total>	75.43	17.35m	263.40	88.69	88.69	20059
14	34.72	Total>	81.74	18.90m	272.29	95.86	95.86	20335
15	34.36	Total>	89.03	20.70m	282.59	104.18	104.18	20657
16	34.00	Total>	96.28	22.50m	292.86	112.49	112.49	20978
17	33.60	Total>	104.32	24.50m	304.24	121.72	121.72	21335
18	33.20	Total>	112.33	26.50m	315.60	130.94	130.94	21692
19	32.80	Total>	120.32	28.50m	326.93	140.15	140.15	22049
20	32.40	Total>	128.29	30.50m	338.25	149.36	149.36	22406
21	32.00	Total>	136.24	32.50m	349.55	158.55	158.55	22763
22	31.75	Total>	141.21	33.75m	356.61	164.29	164.29	22986
23	31.50	Total>	146.17	35.00m	363.66	170.03	170.03	23210

RIGHT side

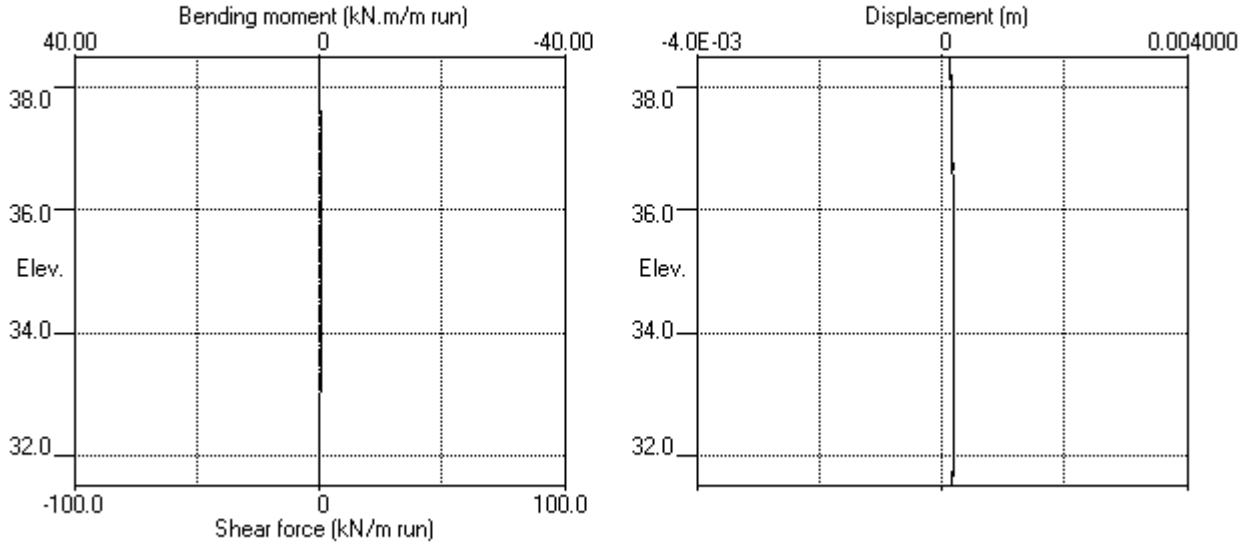
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	2189
2	38.45	0.00	0.92	0.30	3.35	0.81	0.81	2189
3	38.22	0.00	4.96	1.60	18.08	3.16	3.16	2189
4	38.00	0.00	9.00	2.90	32.82	5.50	5.50	2189
5	37.75	0.00	13.50	4.35	49.23	8.11	8.11	2189
6	37.50	0.00	18.00	5.81	65.64	10.72	10.72	2189
		Total>	18.00	5.00m	185.30	26.10	26.10	17854
7	37.15	Total>	25.00	6.75m	195.23	35.39	35.39	18166
8	36.80	Total>	32.00	8.50m	205.16	44.68	44.68	18478
9	36.40	Total>	40.00	10.50m	216.50	55.28	55.28	18836
10	36.00	Total>	48.00	12.50m	227.85	65.86	65.86	19193
11	35.60	Total>	56.00	14.50m	239.19	75.24	75.24	19550
12	35.32	Total>	61.70	15.92m	247.28	81.91	81.91	19804
13	35.03	Total>	67.40	17.35m	255.36	88.56	88.56	20059
14	34.72	Total>	73.60	18.90m	264.15	95.78	95.78	20335
15	34.36	Total>	80.80	20.70m	274.37	104.15	104.15	20657
16	34.00	Total>	88.00	22.50m	284.58	112.49	112.49	20978
17	33.60	Total>	96.00	24.50m	295.92	121.75	121.75	21335
18	33.20	Total>	104.00	26.50m	307.27	130.98	130.98	21692
19	32.80	Total>	112.00	28.50m	318.62	140.20	140.20	22049
20	32.40	Total>	120.00	30.50m	329.96	149.42	149.42	22406
21	32.00	Total>	128.00	32.50m	341.31	158.62	158.62	22763
22	31.75	Total>	133.00	33.75m	348.40	164.38	164.38	22986
23	31.50	Total>	138.00	35.00m	355.49	170.13	170.13	23210

(continued)

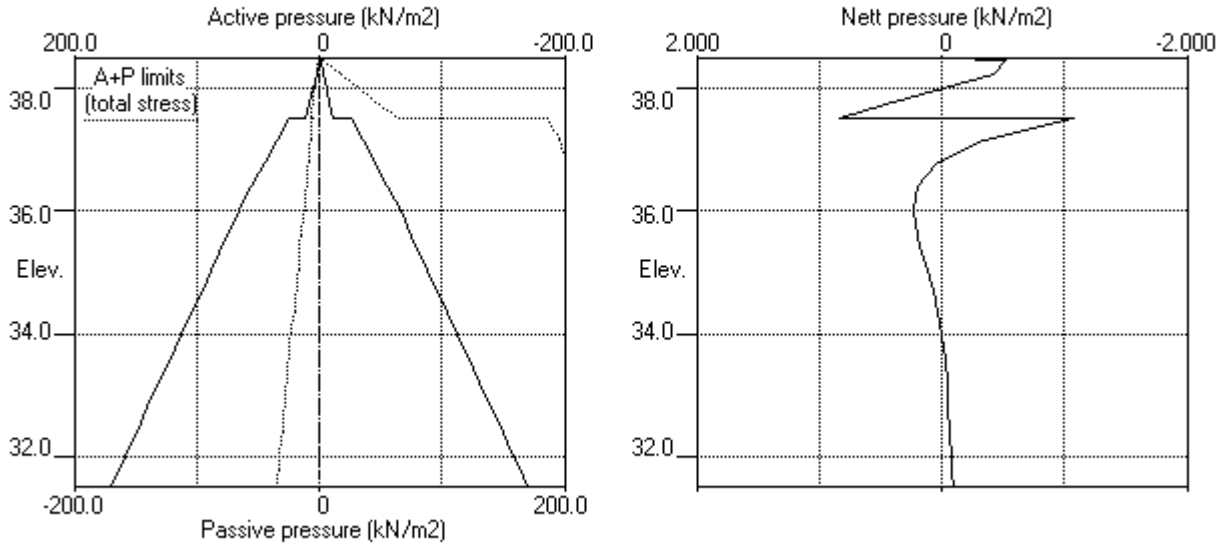
Stage No.1 Apply surcharge no.1 at elevation 38.50
Note: 0.30a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.1 Apply surcharge no.1 at elev. 38.50



Stage No.1 Apply surcharge no.1 at elev. 38.50



Units: kN,m

Stage No. 2 Excavate to elevation 38.00 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
2	38.50	38.00	Cant.	19.500	31.78	37.43	0.57	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall
Limit State: Serviceability Limit State
Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	7.43E-05	0.0	-0.0		34032
2	38.45	0.30	0.000	7.43E-05	0.0	0.0		34032
3	38.22	1.77	0.000	7.42E-05	0.2	0.0		34032
4	38.00	4.39	0.000	7.36E-05	0.9	0.2		34032
5	37.75	1.53	0.000	7.12E-05	1.7	0.5		34032
6	37.50	2.07	0.000	6.58E-05	2.1	1.0		34032
		-5.56	0.000	6.58E-05	2.1	1.0		
7	37.15	-3.37	0.000	5.36E-05	0.6	1.4		34032
8	36.80	-1.79	0.000	3.92E-05	-0.3	1.4		34032
9	36.40	-0.59	0.000	2.43E-05	-0.8	1.1		34032
10	36.00	0.12	0.000	1.31E-05	-0.9	0.8		34032
11	35.60	0.46	0.000	6.06E-06	-0.8	0.4		34032
12	35.32	0.55	0.000	3.35E-06	-0.7	0.2		34032
13	35.03	0.55	0.000	2.20E-06	-0.5	0.1		34032
14	34.72	0.50	0.000	2.26E-06	-0.3	-0.1		34032
15	34.36	0.40	0.000	3.44E-06	-0.2	-0.2		34032
16	34.00	0.29	0.000	5.26E-06	-0.0	-0.2		34032
17	33.60	0.18	0.000	7.44E-06	0.0	-0.2		34032
18	33.20	0.08	0.000	9.38E-06	0.1	-0.1		34032
19	32.80	0.00	0.000	1.08E-05	0.1	-0.1		34032
20	32.40	-0.06	0.000	1.17E-05	0.1	-0.1		34032
21	32.00	-0.11	0.000	1.22E-05	0.1	-0.0		34032
22	31.75	-0.14	0.000	1.23E-05	0.0	-0.0		34032
23	31.50	-0.18	0.000	1.23E-05	0.0	0.0		---

(continued)

Stage No.2 Excavate to elevation 38.00 on RIGHT side

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	3995
2	38.45	0.00	0.92	0.30	3.36	0.30	0.30a	3995
3	38.22	0.00	5.47	1.77	19.96	1.77	1.77a	3995
4	38.00	0.00	10.82	3.49	39.45	4.39	4.39	3995
5	37.75	0.00	16.82	5.42	61.33	7.57	7.57	3995
6	37.50	0.00	22.50	7.26	82.05	10.64	10.64	3995
		Total>	22.50	5.00m	189.80	18.25	18.25	29656
7	37.15	Total>	30.66	6.75m	200.89	29.03	29.03	30175
8	36.80	Total>	38.44	8.50m	211.59	39.31	39.31	30694
9	36.40	Total>	47.04	10.50m	223.54	50.62	50.62	31287
10	36.00	Total>	55.46	12.50m	235.30	61.58	61.58	31880
11	35.60	Total>	63.75	14.50m	246.95	71.12	71.12	32473
12	35.32	Total>	69.61	15.92m	255.19	77.82	77.82	32896
13	35.03	Total>	75.43	17.35m	263.40	84.45	84.45	33319
14	34.72	Total>	81.74	18.90m	272.29	91.62	91.62	33778
15	34.36	Total>	89.03	20.70m	282.59	99.92	99.92	34312
16	34.00	Total>	96.28	22.50m	292.86	108.19	108.19	34846
17	33.60	Total>	104.32	24.50m	304.24	117.37	117.37	35439
18	33.20	Total>	112.33	26.50m	315.60	126.55	126.55	36032
19	32.80	Total>	120.32	28.50m	326.93	135.73	135.73	36625
20	32.40	Total>	128.29	30.50m	338.25	144.90	144.90	37218
21	32.00	Total>	136.24	32.50m	349.55	154.08	154.08	37812
22	31.75	Total>	141.21	33.75m	356.61	159.81	159.81	38182
23	31.50	Total>	146.17	35.00m	363.66	165.54	165.54	38553

RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	3733
5	37.75	0.00	4.50	1.45	16.41	6.05	6.05	3733
6	37.50	0.00	9.00	2.90	32.82	8.57	8.57	3733
		Total>	9.00	2.50m	176.30	23.82	23.82	27886
7	37.15	Total>	16.00	4.25m	186.23	32.40	32.40	28374
8	36.80	Total>	23.00	6.00m	196.16	41.10	41.10	28862
9	36.40	Total>	31.00	8.00m	207.50	51.21	51.21	29420
10	36.00	Total>	39.00	10.00m	218.85	61.47	61.47	29978
11	35.60	Total>	47.00	12.00m	230.19	70.67	70.67	30536
12	35.32	Total>	52.70	13.42m	238.28	77.27	77.27	30933
13	35.03	Total>	58.40	14.85m	246.36	83.90	83.90	31330
14	34.72	Total>	64.60	16.40m	255.16	91.12	91.12	31763
15	34.36	Total>	71.80	18.20m	265.37	99.51	99.51	32265
16	34.00	Total>	79.00	20.00m	275.58	107.90	107.90	32767
17	33.60	Total>	87.00	22.00m	286.93	117.19	117.19	33324
18	33.20	Total>	95.00	24.00m	298.27	126.47	126.47	33882
19	32.80	Total>	103.00	26.00m	309.62	135.72	135.72	34440
20	32.40	Total>	111.01	28.00m	320.97	144.96	144.96	34997
21	32.00	Total>	119.01	30.00m	332.31	154.19	154.19	35555
22	31.75	Total>	124.01	31.25m	339.41	159.95	159.95	35904

(continued)

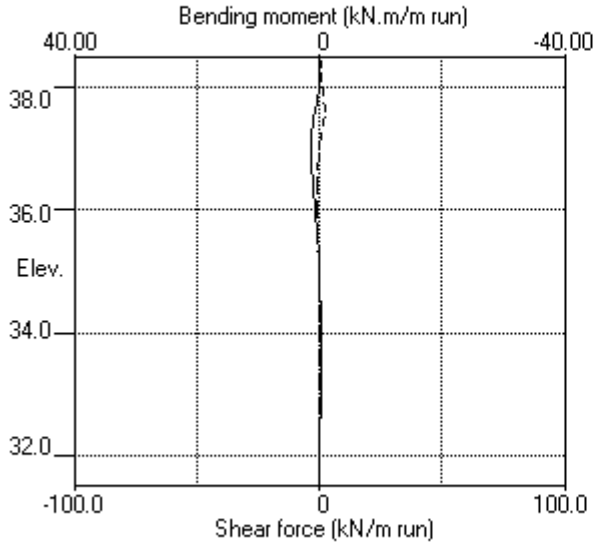
Stage No.2 Excavate to elevation 38.00 on RIGHT side

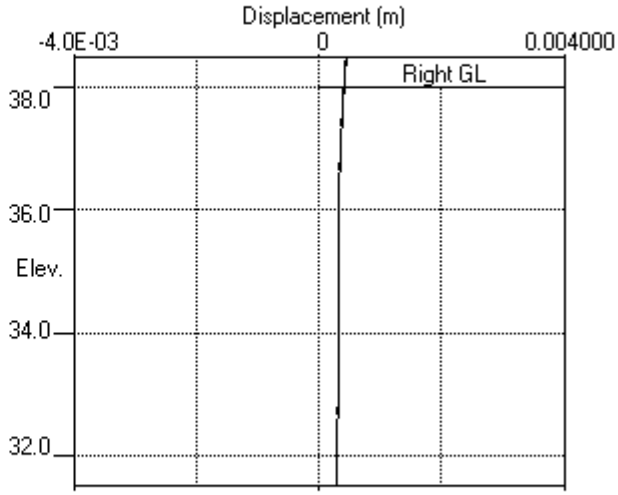
Node no.	Y coord	RIGHT side Water press. kN/m2	Effective stresses Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
23	31.50	Total>	129.01	32.50m	346.50	165.72	165.72	36252

Note: 1.77a Soil pressure at active limit
123.45p Soil pressure at passive limit

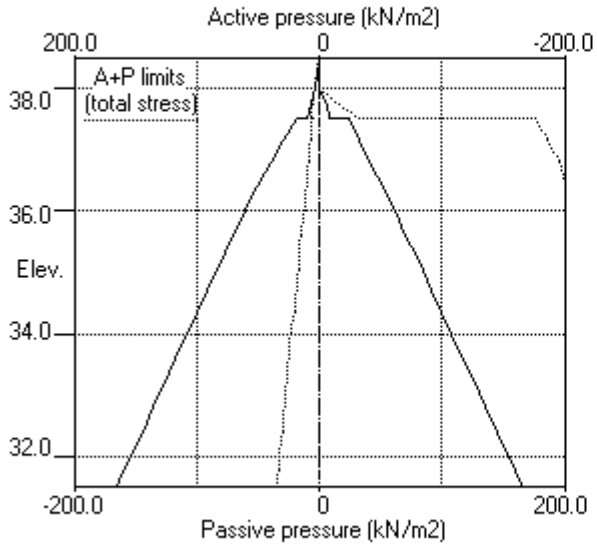
Units: kN,m

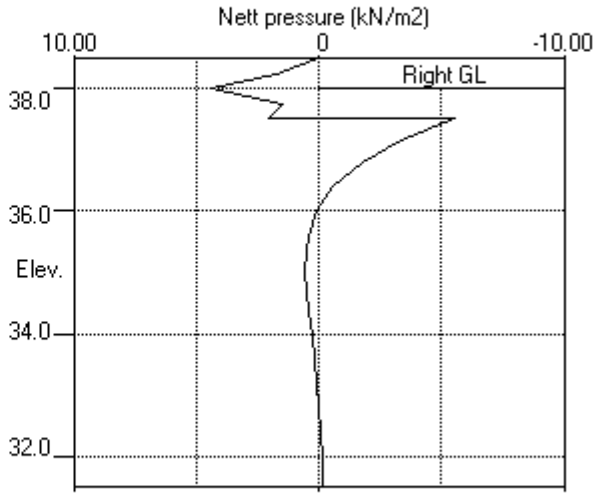
Stage No.2 Excav. to elev. 38.00 on RIGHT side





Stage No.2 Excav. to elev. 38.00 on RIGHT side





Units: kN,m

Stage No. 4 Apply water pressure profile no.1 (Mod. Conserv.)

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
4	38.50	38.00	38.45	23.563	n/a	37.67	0.33	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m

Subgrade reaction model - Boussinesq Influence coefficients

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: Serviceability Limit State

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	7.23E-05	0.0	-0.0		34032
2	38.45	0.32	0.000	7.23E-05	0.0	0.0	-0.0	34032
3	38.22	1.78	0.000	7.22E-05	0.2	0.0		34032
4	38.00	4.41	0.000	7.16E-05	0.9	0.2		34032
5	37.75	1.55	0.000	6.92E-05	1.7	0.5		34032
6	37.50	2.09	0.000	6.37E-05	2.1	1.0		34032
		-5.44	0.000	6.37E-05	2.1	1.0		
7	37.15	-3.34	0.000	5.13E-05	0.6	1.4		34032
8	36.80	-1.81	0.000	3.66E-05	-0.3	1.4		34032
9	36.40	-0.67	0.000	2.11E-05	-0.8	1.2		34032
10	36.00	-0.04	0.000	9.27E-06	-0.9	0.8		34032
11	35.60	0.37	0.000	1.64E-06	-0.9	0.5		34032
12	35.32	0.51	0.000	-1.29E-06	-0.7	0.2		34032
13	35.03	0.55	0.000	-2.48E-06	-0.6	0.0		34032
14	34.72	0.54	0.000	-2.21E-06	-0.4	-0.1		34032
15	34.36	0.49	0.000	-4.91E-07	-0.2	-0.2		34032
16	34.00	0.44	0.000	2.09E-06	-0.1	-0.3		34032
17	33.60	0.26	0.000	5.21E-06	0.1	-0.3		34032
18	33.20	0.11	0.000	7.98E-06	0.1	-0.2		34032
19	32.80	-0.00	0.000	1.00E-05	0.2	-0.1		34032
20	32.40	-0.09	0.000	1.13E-05	0.1	-0.1		34032
21	32.00	-0.16	0.000	1.20E-05	0.1	-0.0		34032
22	31.75	-0.20	0.000	1.21E-05	0.1	-0.0		34032
23	31.50	-0.24	0.000	1.21E-05	0.0	0.0		---

At elev. 38.45 The strut is slack

(continued)

Stage No.4 Apply water pressure profile no.1 (Mod. Conserv.)

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	7489
2	38.45	0.00	0.92	0.30	3.36	0.32	0.32	7489
3	38.22	0.00	5.47	1.77	19.96	1.78	1.78	7489
4	38.00	0.00	10.82	3.49	39.45	4.41	4.41	7489
5	37.75	0.00	16.82	5.42	61.33	7.58	7.58	7489
6	37.50	0.00	22.50	7.26	82.05	10.65	10.65	7489
		Total>	22.50	5.00m	189.80	18.31	18.31	53472
7	37.15	Total>	30.66	6.75m	200.89	29.04	29.04	54408
8	36.80	Total>	38.44	8.50m	211.59	39.30	39.30	23257
9	36.40	Total>	47.04	10.50m	223.54	50.58	50.58	23707
10	36.00	Total>	55.46	12.50m	235.30	61.51	61.51	24156
11	35.60	Total>	63.75	14.50m	246.95	71.00	71.00	24606
12	35.32	Total>	69.61	15.92m	255.19	77.66	77.66	24926
13	35.03	Total>	75.43	17.35m	263.40	84.26	84.26	25246
14	34.72	Total>	81.74	18.90m	272.29	91.40	91.40	25594
15	34.36	Total>	89.03	20.70m	282.59	99.65	99.65	25999
16	34.00	Total>	96.28	22.50m	292.86	107.88	107.88	26403
17	33.60	Total>	104.32	24.50m	304.24	117.03	117.03	26853
18	33.20	Total>	112.33	26.50m	315.60	126.18	126.18	27302
19	32.80	Total>	120.32	28.50m	326.93	135.34	135.34	27752
20	32.40	Total>	128.29	30.50m	338.25	144.51	144.51	28201
21	32.00	Total>	136.24	32.50m	349.55	153.67	153.67	28650
22	31.75	Total>	141.21	33.75m	356.61	159.40	159.40	28931
23	31.50	Total>	146.17	35.00m	363.66	165.12	165.12	29212

RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	10075
5	37.75	0.00	4.50	1.45	16.41	6.03	6.03	10075
6	37.50	0.00	9.00	2.90	32.82	8.56	8.56	10075
		Total>	9.00	2.50m	176.30	23.75	23.75	71122
7	37.15	Total>	16.00	4.25m	186.23	32.38	32.38	72366
8	36.80	Total>	23.00	6.00m	196.16	41.11	41.11	23257
9	36.40	Total>	31.00	8.00m	207.50	51.25	51.25	23707
10	36.00	Total>	39.00	10.00m	218.85	61.54	61.54	24156
11	35.60	Total>	47.00	12.00m	230.19	70.63	70.63	24606
12	35.32	Total>	52.70	13.42m	238.28	77.16	77.16	24926
13	35.03	Total>	58.40	14.85m	246.36	83.71	83.71	25246
14	34.72	Total>	64.60	16.40m	255.16	90.86	90.86	25594
15	34.36	Total>	71.80	18.20m	265.37	99.15	99.15	25999
16	34.00	Total>	79.00	20.00m	275.58	107.44	107.44	26403
17	33.60	Total>	87.00	22.00m	286.93	116.77	116.77	26853
18	33.20	Total>	95.00	24.00m	298.27	126.07	126.07	27302
19	32.80	Total>	103.00	26.00m	309.62	135.34	135.34	27752
20	32.40	Total>	111.01	28.00m	320.97	144.59	144.59	28201
21	32.00	Total>	119.01	30.00m	332.31	153.83	153.83	28650
22	31.75	Total>	124.01	31.25m	339.41	159.60	159.60	28931

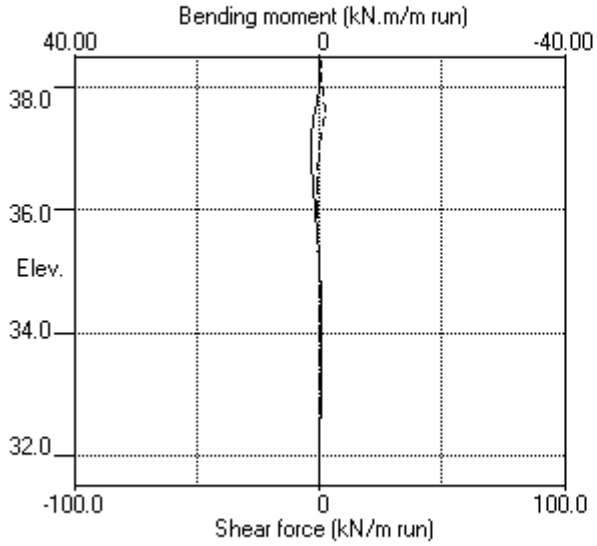
(continued)

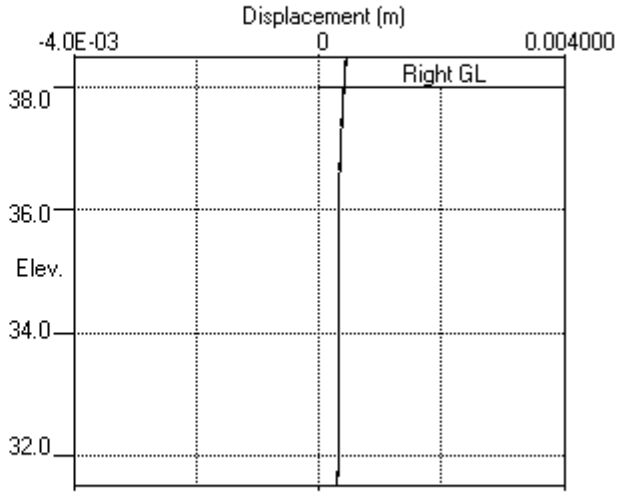
Stage No.4 Apply water pressure profile no.1 (Mod. Conserv.)

Node no.	Y coord	RIGHT side						
			Effective stresses				Total earth pressure	Coeff. of subgrade reaction
		Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	kN/m2	kN/m3
23	31.50	Total>	129.01	32.50m	346.50	165.36	165.36	29212

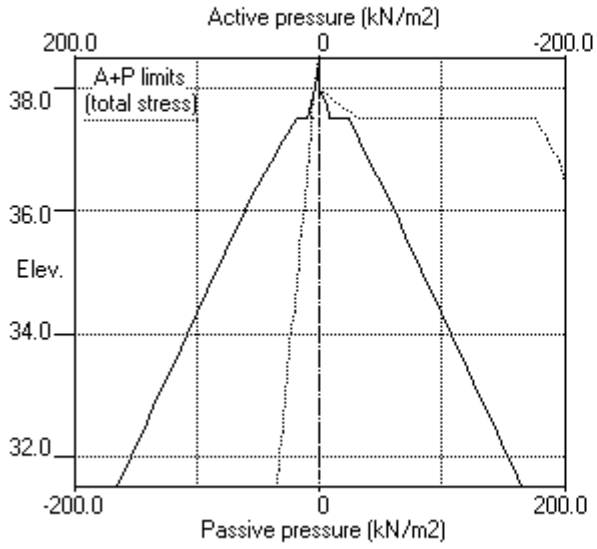
Units: kN,m

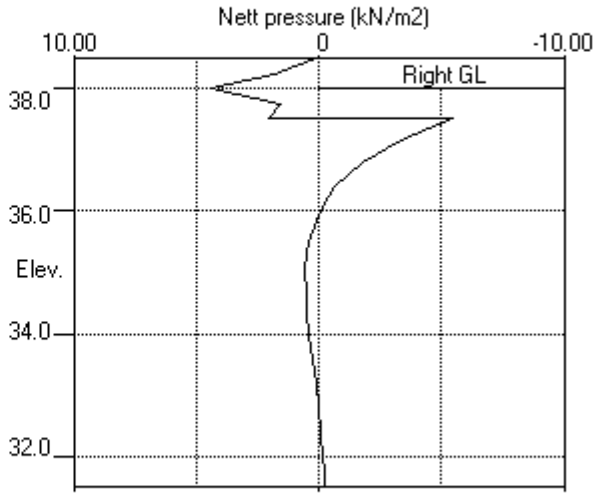
Stage No.4 Apply water pressure profile no.1 (Mod. Conserv.)





Stage No.4 Apply water pressure profile no.1 (Mod. Conserv.)





Units: kN,m

Stage No. 5 Excavate to elevation 34.72 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
5	38.50	34.72	38.45	4.642	n/a	34.51	0.21	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall
Limit State: Serviceability Limit State
Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.30E-03	0.0	-0.0		34032
2	38.45	0.30	0.000	-1.30E-03	0.0	0.0	16.5	34032
		0.30	0.000	-1.30E-03	-16.5	0.0		
3	38.22	1.77	0.001	-1.29E-03	-16.3	-3.7		34032
4	38.00	3.49	0.001	-1.26E-03	-15.7	-7.3		34032
5	37.75	5.42	0.001	-1.19E-03	-14.6	-11.1		34032
6	37.50	7.34	0.002	-1.09E-03	-13.0	-14.5		34032
		5.00	0.002	-1.09E-03	-13.0	-14.5		
7	37.15	6.75	0.002	-9.28E-04	-10.9	-18.7		34032
8	36.80	8.50	0.002	-7.18E-04	-8.3	-22.1		34032
9	36.40	10.50	0.003	-4.43E-04	-4.5	-24.7		34032
10	36.00	12.50	0.003	-1.48E-04	0.1	-25.6		34032
11	35.60	18.99	0.003	1.37E-04	6.4	-23.0		34032
12	35.32	26.46	0.003	3.18E-04	12.9	-20.3		34032
13	35.03	35.02	0.002	4.68E-04	21.7	-15.4		34032
14	34.72	45.29	0.002	5.69E-04	34.1	-6.9		34032
		-45.07	0.002	5.69E-04	34.1	-6.9		
15	34.36	-35.03	0.002	5.93E-04	19.7	2.4		34032
16	34.00	-25.03	0.002	5.42E-04	8.9	7.3		34032
17	33.60	-15.43	0.002	4.47E-04	0.8	8.8		34032
18	33.20	-7.79	0.002	3.49E-04	-3.9	7.9		34032
19	32.80	-2.00	0.001	2.69E-04	-5.8	5.7		34032
20	32.40	2.39	0.001	2.16E-04	-5.7	3.3		34032
21	32.00	6.00	0.001	1.90E-04	-4.1	1.1		34032
22	31.75	8.11	0.001	1.85E-04	-2.3	0.3		34032
23	31.50	10.23	0.001	1.84E-04	0.0	0.0		---

At elev. 38.45 Strut force = 16.5 kN/strut = 16.5 kN/m run

(continued)

Stage No.5 Excavate to elevation 34.72 on RIGHT side

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	19110
2	38.45	0.00	0.92	0.30	3.36	0.30	0.30a	2617
3	38.22	0.00	5.47	1.77	19.96	1.77	1.77a	2617
4	38.00	0.00	10.82	3.49	39.45	3.49	3.49a	2617
5	37.75	0.00	16.82	5.42	61.33	5.42	5.42a	2617
6	37.50	0.00	22.50	7.26	82.05	7.34	7.34	2617
		Total>	22.50	5.00m	189.80	5.00	5.00a	20486
7	37.15	Total>	30.66	6.75m	200.89	6.75	6.75a	20844
8	36.80	Total>	38.44	8.50m	211.59	8.50	8.50a	21203
9	36.40	Total>	47.04	10.50m	223.54	10.50	10.50a	21613
10	36.00	Total>	55.46	12.50m	235.30	12.50	12.50a	22022
11	35.60	Total>	63.75	14.50m	246.95	18.99	18.99	22432
12	35.32	Total>	69.61	15.92m	255.19	26.46	26.46	22724
13	35.03	Total>	75.43	17.35m	263.40	35.02	35.02	23016
14	34.72	Total>	81.74	18.90m	272.29	45.29	45.29	23333
15	34.36	Total>	89.03	20.70m	282.59	57.86	57.86	23702
16	34.00	Total>	96.28	22.50m	292.86	70.39	70.39	24071
17	33.60	Total>	104.32	24.50m	304.24	83.73	83.73	24481
18	33.20	Total>	112.33	26.50m	315.60	96.22	96.22	24890
19	32.80	Total>	120.32	28.50m	326.93	107.90	107.90	25300
20	32.40	Total>	128.29	30.50m	338.25	118.99	118.99	25710
21	32.00	Total>	136.24	32.50m	349.55	129.73	129.73	26120
22	31.75	Total>	141.21	33.75m	356.61	136.38	136.38	26376
23	31.50	Total>	146.17	35.00m	363.66	143.03	143.03	26632

RIGHT side

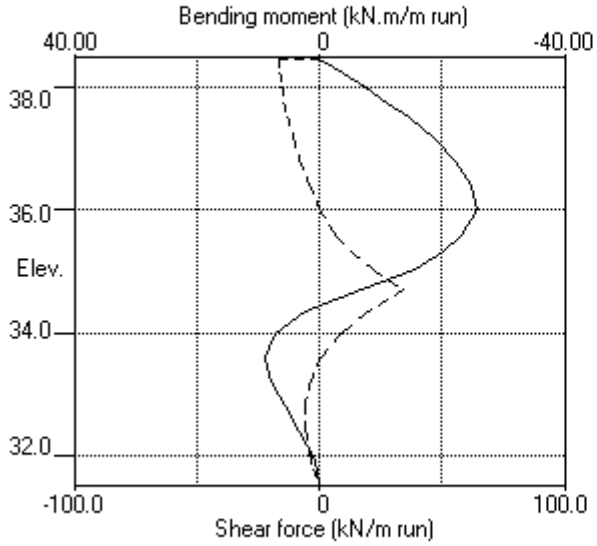
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	190.55	90.35	90.35	31155
15	34.36	Total>	7.20	1.80m	200.77	92.88	92.88	31648
16	34.00	Total>	14.40	3.60m	210.98	95.42	95.42	32140
17	33.60	Total>	22.40	5.60m	222.32	99.16	99.16	32687
18	33.20	Total>	30.40	7.60m	233.67	104.01	104.01	33234
19	32.80	Total>	38.40	9.60m	245.02	109.91	109.91	33781
20	32.40	Total>	46.40	11.60m	256.36	116.60	116.60	34328
21	32.00	Total>	54.41	13.60m	267.71	123.73	123.73	34875
22	31.75	Total>	59.41	14.85m	274.81	128.27	128.27	35217
23	31.50	Total>	64.41	16.10m	281.90	132.80	132.80	35559

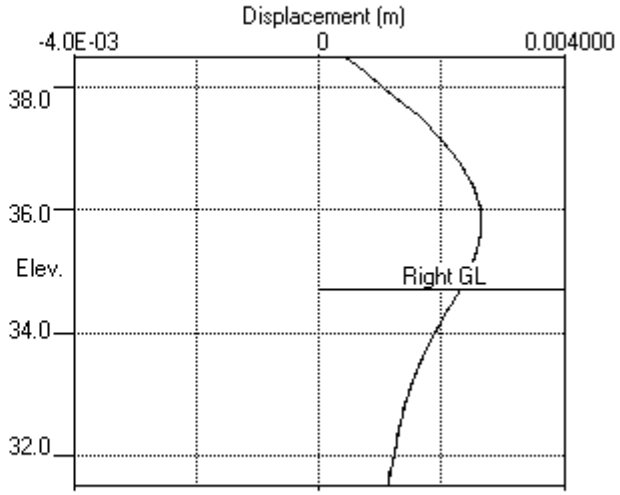
(continued)

Stage No.5 Excavate to elevation 34.72 on RIGHT side
Note: 12.50a Soil pressure at active limit
123.45p Soil pressure at passive limit

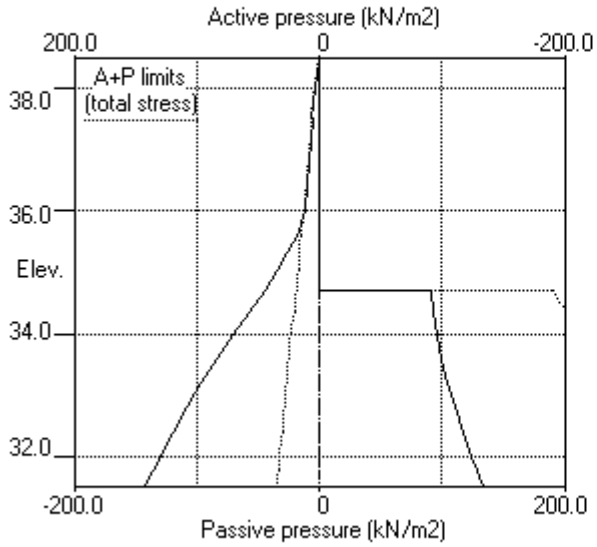
Units: kN,m

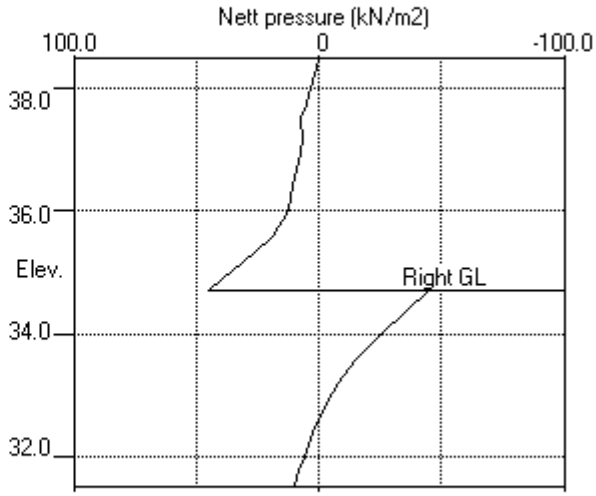
Stage No.5 Excav. to elev. 34.72 on RIGHT side





Stage No.5 Excav. to elev. 34.72 on RIGHT side





Units: kN,m

Stage No. 7 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
7	38.50	34.72		More than one strut. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall
Limit State: Serviceability Limit State
Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.44E-03	0.0	-0.0		24308
2	38.45	0.49	0.000	-1.44E-03	0.0	0.0	14.6	24308
		0.49	0.000	-1.44E-03	-14.6	0.0		
3	38.22	1.77	0.001	-1.43E-03	-14.3	-3.3		24308
4	38.00	3.49	0.001	-1.38E-03	-13.7	-6.6		24308
5	37.75	5.42	0.001	-1.30E-03	-12.6	-10.0		24308
6	37.50	7.26	0.002	-1.18E-03	-11.0	-13.0		24308
		5.00	0.002	-1.18E-03	-11.0	-13.0		
7	37.15	6.75	0.002	-9.80E-04	-9.0	-16.7		24308
8	36.80	8.50	0.002	-7.28E-04	-6.3	-19.6		24308
9	36.40	10.50	0.003	-4.02E-04	-2.5	-21.6		24308
10	36.00	12.50	0.003	-6.13E-05	2.1	-21.9		24308
11	35.60	16.73	0.003	2.53E-04	7.9	-18.7		24308
12	35.32	25.23	0.003	4.39E-04	13.9	-15.7		24308
13	35.03	34.82	0.002	5.78E-04	22.5	-10.7	7.2	24308
		34.82	0.002	5.78E-04	15.2	-10.7		
14	34.72	46.14	0.002	6.55E-04	27.8	-3.7		24308
		-43.36	0.002	6.55E-04	27.8	-3.7		
15	34.36	-31.54	0.002	6.44E-04	14.3	4.0		24308
16	34.00	-20.66	0.002	5.55E-04	4.9	7.4		24308
17	33.60	-11.08	0.002	4.30E-04	-1.5	8.0		24308
18	33.20	-4.20	0.001	3.13E-04	-4.5	6.7		24308
19	32.80	0.43	0.001	2.26E-04	-5.3	4.5		24308
20	32.40	3.55	0.001	1.74E-04	-4.5	2.4		24308
21	32.00	5.74	0.001	1.52E-04	-2.6	0.7		24308
22	31.75	5.21	0.001	1.48E-04	-1.2	0.2		24308
23	31.50	4.70	0.001	1.47E-04	0.0	0.0		---

At elev. 38.45 Strut force = 14.6 kN/strut = 14.6 kN/m run
At elev. 35.03 Strut force = 7.2 kN/strut = 7.2 kN/m run

(continued)

Stage No.7 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	81724
2	38.45	0.00	0.92	0.30	3.36	0.49	0.49	81724
3	38.22	0.00	5.47	1.77	19.96	1.77	1.77a	3731
4	38.00	0.00	10.82	3.49	39.45	3.49	3.49a	3731
5	37.75	0.00	16.82	5.42	61.33	5.42	5.42a	3731
6	37.50	0.00	22.50	7.26	82.05	7.26	7.26a	3731
		Total>	22.50	5.00m	189.80	5.00	5.00a	27869
7	37.15	Total>	30.66	6.75m	200.89	6.75	6.75a	28357
8	36.80	Total>	38.44	8.50m	211.59	8.50	8.50a	28844
9	36.40	Total>	47.04	10.50m	223.54	10.50	10.50a	29402
10	36.00	Total>	55.46	12.50m	235.30	12.50	12.50a	29959
11	35.60	Total>	63.75	14.50m	246.95	16.73	16.73	30517
12	35.32	Total>	69.61	15.92m	255.19	25.23	25.23	30914
13	35.03	Total>	75.43	17.35m	263.40	34.82	34.82	31311
14	34.72	Total>	81.74	18.90m	272.29	46.14	46.14	35006
15	34.36	Total>	89.03	20.70m	282.59	59.60	59.60	35559
16	34.00	Total>	96.28	22.50m	292.86	72.57	72.57	36112
17	33.60	Total>	104.32	24.50m	304.24	85.90	85.90	36727
18	33.20	Total>	112.33	26.50m	315.60	98.01	98.01	37341
19	32.80	Total>	120.32	28.50m	326.93	109.12	109.12	37956
20	32.40	Total>	128.29	30.50m	338.25	119.57	119.57	38571
21	32.00	Total>	136.24	32.50m	349.55	129.60	129.60	139047
22	31.75	Total>	141.21	33.75m	356.61	134.93	134.93	140410
23	31.50	Total>	146.17	35.00m	363.66	140.26	140.26	141773

RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	190.55	89.50	89.50	35006
15	34.36	Total>	7.20	1.80m	200.77	91.14	91.14	35559
16	34.00	Total>	14.40	3.60m	210.98	93.24	93.24	36112
17	33.60	Total>	22.40	5.60m	222.32	96.99	96.99	36727
18	33.20	Total>	30.40	7.60m	233.67	102.21	102.21	37341
19	32.80	Total>	38.40	9.60m	245.02	108.69	108.69	37956
20	32.40	Total>	46.40	11.60m	256.36	116.01	116.01	38571
21	32.00	Total>	54.41	13.60m	267.71	123.86	123.86	139047

(continued)

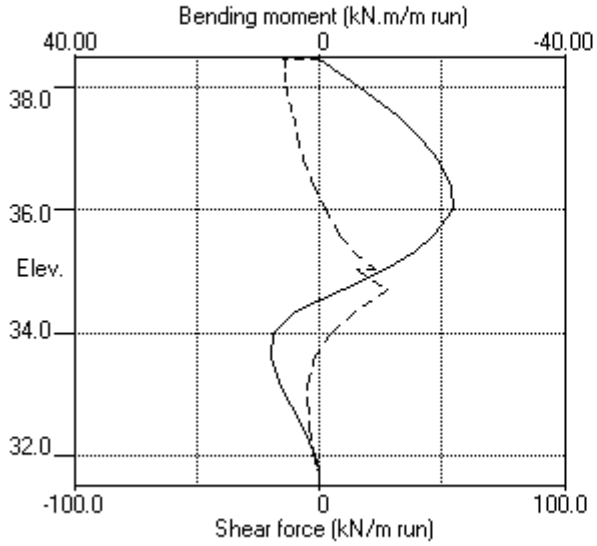
Stage No.7 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

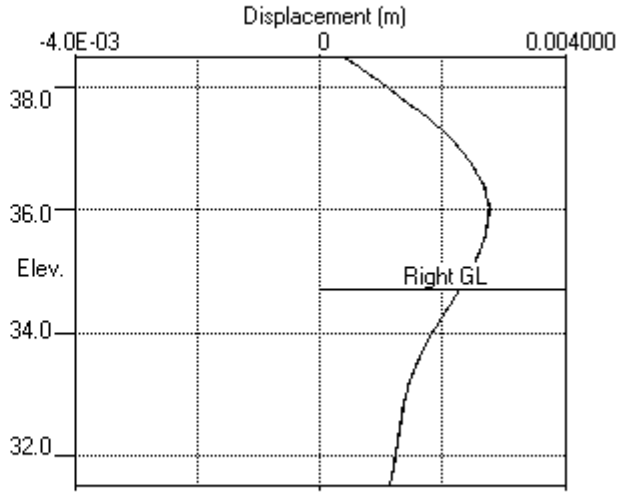
Node no.	Y coord	RIGHT side						
		Effective stresses				Total earth pressure	Coeff. of subgrade reaction
		Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	kN/m2	kN/m3
22	31.75	Total>	59.41	14.85m	274.81	129.71	129.71	140410
23	31.50	Total>	64.41	16.10m	281.90	135.56	135.56	141773

Note: 12.50a Soil pressure at active limit
123.45p Soil pressure at passive limit

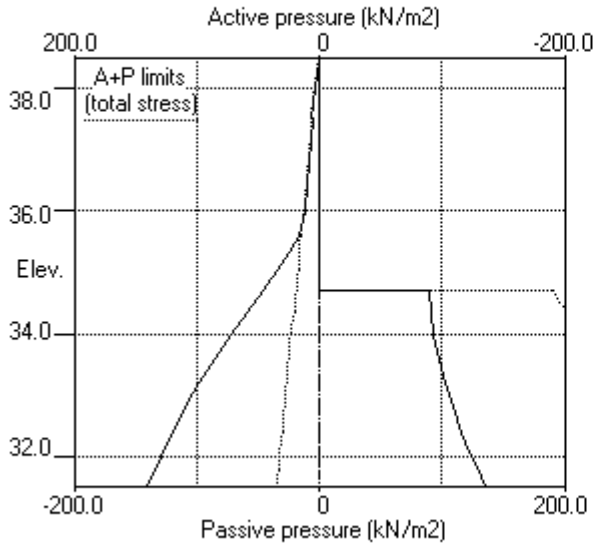
Units: kN,m

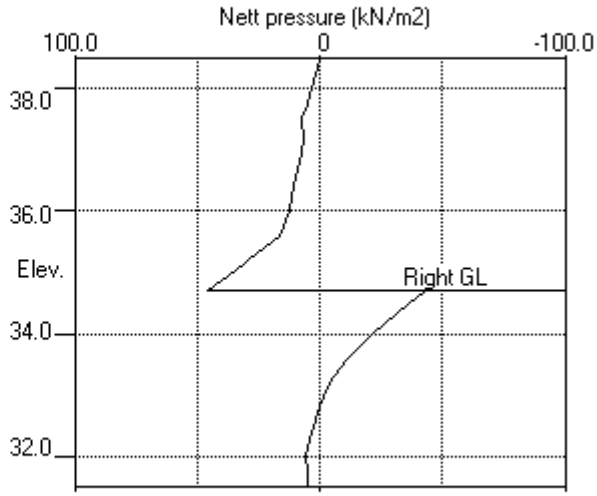
Stage No.7 Change EI of wall to 24308kN.m2/m run





Stage No.7 Change EI of wall to 24308kN.m2/m run





Units: kN,m

Stage No. 10 Apply water pressure profile no.2 (Mod. Conserv.)

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
10	38.50	34.72		More than one strut. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m

Subgrade reaction model - Boussinesq Influence coefficients

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: Serviceability Limit State

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.55E-03	0.0	-0.0		24308
2	38.45	0.47	0.000	-1.55E-03	0.0	0.0	17.5	24308
		0.47	0.000	-1.55E-03	-17.5	0.0		
3	38.22	1.77	0.001	-1.53E-03	-17.2	-4.0		24308
4	38.00	3.49	0.001	-1.48E-03	-16.6	-7.9		24308
5	37.75	5.42	0.002	-1.38E-03	-15.5	-12.0		24308
6	37.50	7.26	0.002	-1.24E-03	-13.9	-15.8		24308
		7.90	0.002	-1.24E-03	-13.9	-15.8		
7	37.15	13.00	0.002	-9.88E-04	-10.3	-20.3		24308
8	36.80	17.96	0.003	-6.85E-04	-4.9	-23.1		24308
9	36.40	23.52	0.003	-3.13E-04	3.4	-23.7		24308
10	36.00	29.03	0.003	3.32E-05	13.9	-20.5		24308
11	35.60	34.49	0.003	2.74E-04	26.6	-11.1		24308
12	35.32	38.36	0.003	3.37E-04	37.0	-2.2		24308
13	35.03	44.83	0.003	2.76E-04	48.9	9.9	82.8	24308
		44.83	0.003	2.76E-04	-33.9	9.9		
14	34.72	54.15	0.002	1.84E-04	-18.6	2.1		24308
		24.51	0.002	1.84E-04	-18.6	2.1		
15	34.36	19.67	0.002	1.79E-04	-10.7	-2.8		24308
16	34.00	14.83	0.002	2.35E-04	-4.4	-5.3		24308
17	33.60	9.73	0.002	3.29E-04	0.5	-5.9		24308
18	33.20	5.15	0.002	4.24E-04	3.4	-5.1		24308
19	32.80	1.21	0.002	5.02E-04	4.7	-3.6		24308
20	32.40	-2.05	0.002	5.53E-04	4.5	-2.0		24308
21	32.00	-4.80	0.001	5.77E-04	3.2	-0.6		24308
22	31.75	-7.15	0.001	5.82E-04	1.7	-0.1		24308
23	31.50	-6.27	0.001	5.83E-04	0.0	0.0		---

At elev. 38.45 Strut force = 17.5 kN/strut = 17.5 kN/m run

At elev. 35.03 Strut force = 82.8 kN/strut = 82.8 kN/m run

(continued)

Stage No.10 Apply water pressure profile no.2 (Mod. Conserv.)

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	253595
2	38.45	0.00	0.92	0.30	3.36	0.47	0.47	4302
3	38.22	0.00	5.47	1.77	19.96	1.77	1.77a	4302
4	38.00	0.00	10.82	3.49	39.45	3.49	3.49a	4302
5	37.75	0.00	16.82	5.42	61.33	5.42	5.42a	4302
6	37.50	0.00	22.50	7.26	82.05	7.26	7.26a	4302
		0.00	22.50	7.90	73.18	7.90	7.90a	16280
7	37.15	3.43	27.22	9.56	88.56	9.56	13.00a	16564
8	36.80	6.87	31.57	11.09	102.68	11.09	17.96a	16849
9	36.40	10.79	36.25	12.73	117.91	12.73	23.52a	17175
10	36.00	14.71	40.74	14.31	132.52	14.31	29.03a	17500
11	35.60	18.64	45.11	15.85	146.74	15.85	34.49a	30640
12	35.32	21.43	48.18	16.92	156.70	16.92	38.36a	15491
13	35.03	24.23	51.20	17.99	166.55	20.60	44.83	15689
14	34.72	27.27	54.47	19.13	177.17	26.88	54.15	15906
15	34.36	30.80	58.22	20.45	189.38	33.95	64.75	16157
16	34.00	34.34	61.95	21.76	201.50	40.94	75.27	16408
17	33.60	38.26	66.06	23.21	214.88	48.78	87.04	16688
18	33.20	42.18	70.15	24.64	228.17	56.86	99.04	16967
19	32.80	46.11	74.21	26.07	241.39	65.24	111.35	17246
20	32.40	50.03	78.26	27.49	254.55	73.95	123.98	17525
21	32.00	53.96	82.29	28.91	267.67	82.85	136.80	17804
22	31.75	56.41	84.80	29.79	275.84	87.62	144.03	17979
23	31.50	58.86	87.31	30.67	284.00	93.98	152.84	1727493

RIGHT side

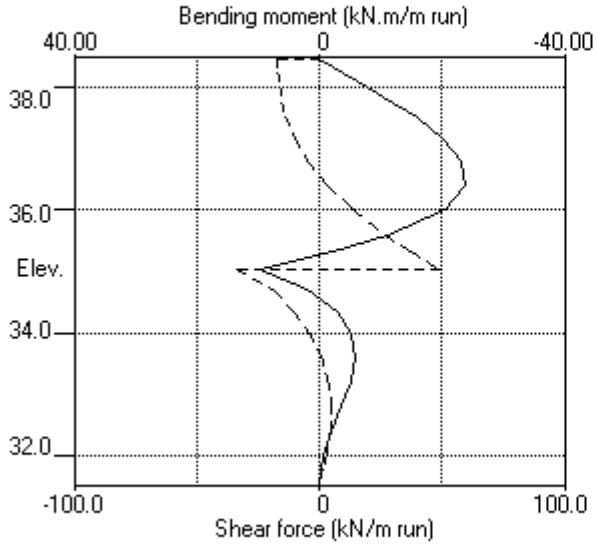
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		27.27	0.73	0.26	2.37	2.37	29.64p	15906
15	34.36	30.80	4.39	1.54	14.28	14.28	45.09p	16157
16	34.00	34.34	8.03	2.82	26.11	26.11	60.45p	16408
17	33.60	38.26	12.01	4.22	39.06	39.06	77.31p	16688
18	33.20	42.18	15.90	5.58	51.71	51.71	93.89p	16967
19	32.80	46.11	19.68	6.91	64.03	64.03	110.14p	17246
20	32.40	50.03	23.37	8.21	76.00	76.00	126.03p	17525
21	32.00	53.96	26.95	9.47	87.65	87.65	141.60p	17804
22	31.75	56.41	29.14	10.23	94.77	94.77	151.18p	17979
23	31.50	58.86	31.29	10.99	101.79	100.25	159.11	1727493

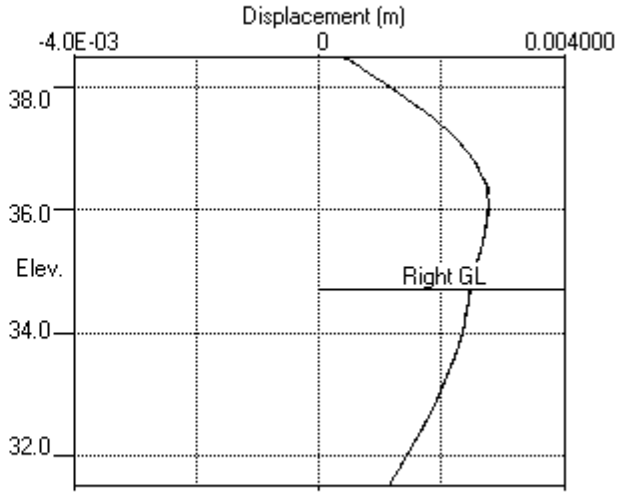
(continued)

Stage No.10 Apply water pressure profile no.2 (Mod. Conserv.)
Note: 38.36a Soil pressure at active limit
151.18p Soil pressure at passive limit

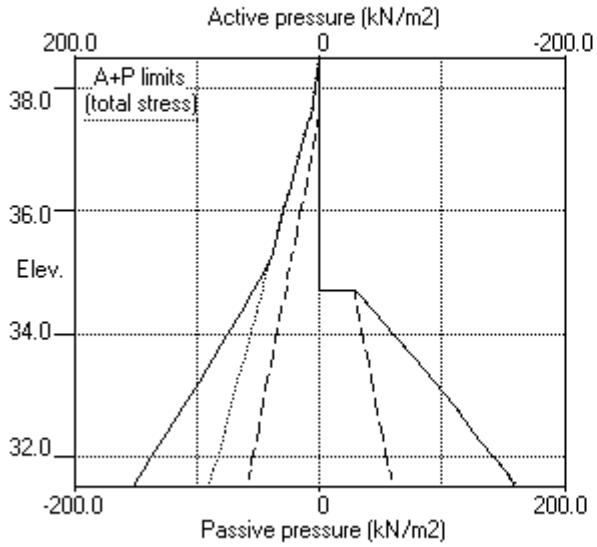
Units: kN,m

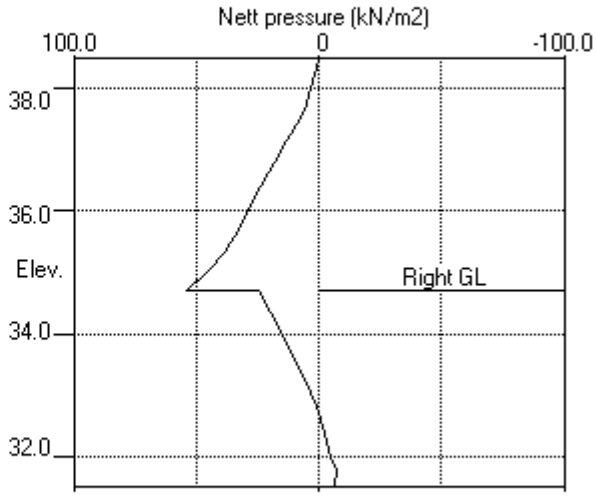
Stage No.10 Apply water pressure profile no.2 (Mod. Conserv.)





Stage No.10 Apply water pressure profile no.2 (Mod. Conserv.)





Units: kN,m

Summary of results

LIMIT STATE PARAMETERS

Limit State: Serviceability Limit State

All loads and soil strengths are unfactored

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	38.50	38.50	Cant.	Conditions not suitable for FoS calc.				
2	38.50	38.00	Cant.	19.500	31.78	37.43	0.57	L to R
3	38.50	38.00		No analysis at this stage				
4	38.50	38.00	38.45	23.563	n/a	37.67	0.33	L to R
5	38.50	34.72	38.45	4.642	n/a	34.51	0.21	L to R
6	38.50	34.72		No analysis at this stage				

All remaining stages have more than one strut - FoS calculation n/a

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: Serviceability Limit State

Calculated Bending Moments and Strut Forces have been multiplied by a factor of 1.35 to obtain values for structural design.

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment				Shear force			
				Calculated		Factored		Calculated		Factored	
		max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
		m	m	kN.m/m		kN.m/m		kN/m	kN/m	kN/m	kN/m
1	38.50	0.000	0.000	0	-0	0	-0	0	0	0	0
2	38.45	0.000	0.000	0	-0	0	-0	0	-17	0	-24
3	38.22	0.001	0.000	0	-4	0	-5	0	-17	0	-23
4	38.00	0.001	0.000	0	-8	0	-11	1	-17	1	-22
5	37.75	0.002	0.000	1	-12	1	-16	2	-16	2	-21
6	37.50	0.002	0.000	1	-16	1	-21	2	-14	3	-19
7	37.15	0.002	0.000	1	-20	2	-27	1	-11	1	-15
8	36.80	0.003	0.000	1	-23	2	-31	0	-8	0	-11
9	36.40	0.003	0.000	1	-25	2	-33	3	-4	5	-6
10	36.00	0.003	0.000	1	-26	1	-35	14	-1	19	-1
11	35.60	0.003	0.000	0	-23	1	-31	27	-1	36	-1
12	35.32	0.003	0.000	0	-20	0	-27	37	-1	50	-1
13	35.03	0.003	0.000	10	-15	13	-21	49	-34	66	-46
14	34.72	0.002	0.000	2	-7	3	-9	34	-19	46	-25
15	34.36	0.002	0.000	4	-3	5	-4	20	-11	27	-14
16	34.00	0.002	0.000	7	-5	10	-7	9	-4	12	-6
17	33.60	0.002	0.000	9	-6	12	-8	1	-1	1	-2
18	33.20	0.002	0.000	8	-5	11	-7	3	-5	5	-6
19	32.80	0.002	0.000	6	-4	8	-5	5	-6	6	-8
20	32.40	0.002	0.000	3	-2	4	-3	5	-6	6	-8
21	32.00	0.001	0.000	1	-1	2	-1	3	-4	4	-5
22	31.75	0.001	0.000	0	-0	0	-0	2	-2	2	-3
23	31.50	0.001	0.000	0	0	0	0	0	0	0	0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment						Shear force					
	Calculated				Factored		Calculated				Factored	
	max.	elev.	min.	elev.	max.	min.	max.	elev.	min.	elev.	max.	min.
	kN.m/m		kN.m/m		kN.m/m		kN/m		kN/m		kN/m	kN/m
1	0	38.50	-0	35.60	0	-0	0	34.00	-0	36.80	0	-0
2	1	36.80	-0	34.00	2	-0	2	37.50	-1	36.00	3	-1
3	No calculation at this stage											
4	1	36.80	-0	34.00	2	-0	2	37.50	-1	36.00	3	-1
5	9	33.60	-26	36.00	12	-35	34	34.72	-17	38.45	46	-22
6	No calculation at this stage											
7	8	33.60	-22	36.00	11	-30	28	34.72	-15	38.45	37	-20
8	No calculation at this stage											
9	No calculation at this stage											
10	10	35.03	-24	36.40	13	-32	49	35.03	-34	35.03	66	-46

Summary of results (continued)

Maximum and minimum displacement at each stage

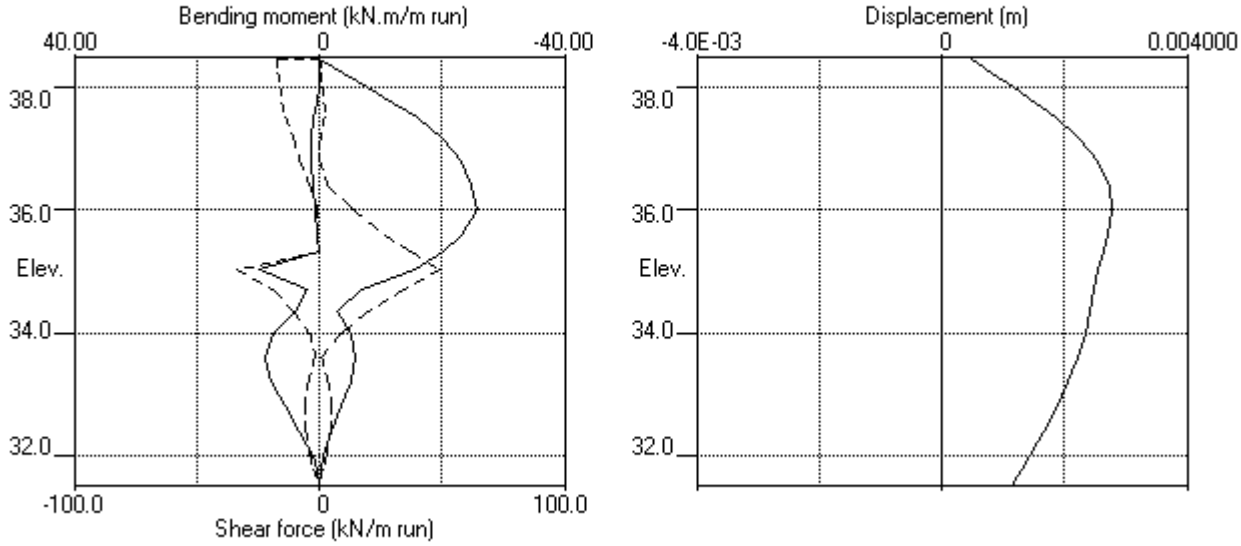
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.000	34.36	0.000	38.50	Apply surcharge no.1 at elev. 38.50
2	0.000	38.50	0.000	38.50	Excav. to elev. 38.00 on RIGHT side
3	No calculation at this stage				Install strut no.1 at elev. 38.45
4	0.000	38.50	0.000	38.50	Apply water pressure profile no.1
5	0.003	35.60	0.000	38.50	Excav. to elev. 34.72 on RIGHT side
6	No calculation at this stage				Install strut no.2 at elev. 35.03
7	0.003	36.00	0.000	38.50	Change EI of wall to 24308kN.m2/m run
8	No calculation at this stage				Change soil type 2 to soil type 3
9	No calculation at this stage				Apply surcharge no.2 at elev. 34.72
10	0.003	36.00	0.000	38.50	Apply water pressure profile no.2

Strut forces at each stage (horizontal components)

Stage no.	Strut no. 1 at elev. 38.45			Strut no. 2 at elev. 35.03		
	--Calculated-- kN per m run	kN per strut	Factored kN per strut	--Calculated-- kN per m run	kN per strut	Factored kN per strut
4	slack	slack	slack	---	---	---
5	17	17	22	---	---	---
7	15	15	20	7	7	10
10	17	17	24	83	83	112

Units: kN,m

Bending moment, shear force, displacement envelopes



WALLAP

1-ULS1

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	38.50	1 Made Ground dr	1 Made Ground dr
2	37.50	2 London Clay und	2 London Clay und

SOIL PROPERTIES (Unfactored SLS soil strengths)

No.	-- Soil type -- Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Made Ground dr	18.00	10000	0.577	OC (0.250)	0.323 (0.000)	3.647 (0.000)	
2	London Cl.. (37.50)	20.00	52500 (2625)	1.300	OC (0.490)	1.000 (2.476)	1.000 (2.390)	70.00u (3.500)
3	London Cl.. (37.50)	20.00	39375 (1968)	1.300	OC (0.200)	0.351 (1.391)	3.253 (4.831)	0.0d

Additional soil parameters associated with Ka and Kp

No.	------- Soil type ------- Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Made Ground dr	27.00	0.670	0.00	27.00	0.500	0.00
2	London Clay und	0.00	0.670	0.00	0.00	0.500	0.00
3	London Clay dr	25.00	0.670	0.00	25.00	0.500	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	36.00	36.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	36.00	36.00	0.0	1	34.00	34.00	0.0	MC+WC
2	1	37.50	37.50	0.0	1	34.72	34.72	0.0	MC+WC
					2	34.72	37.50	27.3	

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 31.50
Maximum finite element length = 0.40 m
Youngs modulus of wall E = 2.3100E+07 kN/m2
Moment of inertia of wall I = 1.4732E-03 m4/m run
E.I = 34032 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Strut/ anchor no.	Elev.	Strut spacing m	X-section area of strut sq.m	Youngs modulus kN/m2	Free length m	Inclin -ation (degs)	Pre- stress /strut kN	Tension allowed
1	38.45	1.00	0.250000	1.650E+07	5.00	0.00	0	No
2	35.03	1.00	0.350000	1.650E+07	5.00	0.00	0	No

SURCHARGE LOADS

Surch -arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge ----- kN/m2 ----- Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	38.50	0.50(L)	20.00	20.00	10.00	=	N/A	1.10 Var
2	34.72	-0.00(R)	10.00	10.00	28.00	=	N/A	1.00 P/F

Note: L = Left side, R = Right side
Limit State Categories P/U = Permanent Unfavourable
P/F = Permanent Favourable
Var = Variable (unfavourable)

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 38.50
2	Excavate to elevation 38.00 on RIGHT side
3	Install strut or anchor no.1 at elevation 38.45
4	Apply water pressure profile no.1 (Mod. Conserv.)
5	Excavate to elevation 34.34 on RIGHT side
6	Fill to elevation 34.72 on RIGHT side with soil type 1
7	Install strut or anchor no.2 at elevation 35.03
8	Change EI of wall to 24308 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value
9	Change properties of soil type 2 to soil type 3 No analysis at this stage Ko pressures will not be reset
10	Apply surcharge no.2 at elevation 34.72 No analysis at this stage
11	Apply water pressure profile no.2 (Mod. Conserv.)

FACTORS OF SAFETY and ANALYSIS OPTIONS

Limit State options: ULS DA1 Combination 1
Water pressures : Moderately Conservative
Partial factor on C' = 1.000
Partial factor on Phi' = 1.000
Partial factor on Cu = 1.000
Partial factor on Soil Modulus = 1.000
Partial factor on Permanent Unfavourable loads = 1.000
Partial factor on Permanent Favourable loads = 1.000
Partial factor on Variable Unfavourable loads = 1.100
Design factor on calculated Bending Moments = 1.350

Parameters for undrained strata:
Minimum equivalent fluid density = 5.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 7.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 50.00 m

Width of excavation on Left side of wall = 50.00 m
Width of excavation on Right side of wall = 50.00 m

Distance to rigid boundary on Left side = 50.00 m
Distance to rigid boundary on Right side = 50.00 m

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 38.50	No	No	No
2	Excav. to elev. 38.00 on RIGHT side	Yes	Yes	Yes
3	Install strut no.1 at elev. 38.45	Yes	Yes	Yes
4	Apply water pressure profile no.1	Yes	Yes	Yes
5	Excav. to elev. 34.34 on RIGHT side	Yes	Yes	Yes
6	Fill to elev. 34.72 on RIGHT side	Yes	Yes	Yes
7	Install strut no.2 at elev. 35.03	Yes	Yes	Yes
8	Change EI of wall to 24308kN.m2/m run	Yes	Yes	Yes
9	Change soil type 2 to soil type 3	Yes	Yes	Yes
10	Apply surcharge no.2 at elev. 34.72	Yes	Yes	Yes
11	Apply water pressure profile no.2	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 38.50

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-2.63E-05	0.0	0.0		34032
2	38.45	-0.54	0.000	-2.63E-05	-0.0	-0.0		34032
3	38.22	-0.46	0.000	-2.63E-05	-0.1	-0.0		34032
4	38.00	-0.01	0.000	-2.61E-05	-0.2	-0.0		34032
5	37.75	0.51	0.000	-2.56E-05	-0.1	-0.1		34032
6	37.50	0.92	0.000	-2.49E-05	0.1	-0.1		34032
		-1.20	0.000	-2.49E-05	0.1	-0.1		
7	37.15	-0.38	0.000	-2.37E-05	-0.2	-0.1		34032
8	36.80	0.03	0.000	-2.21E-05	-0.3	-0.2		34032
9	36.40	0.23	0.000	-1.92E-05	-0.2	-0.3		34032
10	36.00	0.26	0.000	-1.54E-05	-0.1	-0.4		34032
11	35.60	0.23	0.000	-1.11E-05	-0.0	-0.4		34032
12	35.32	0.18	0.000	-8.02E-06	0.0	-0.4		34032
13	35.03	0.13	0.000	-5.00E-06	0.1	-0.4		34032
14	34.72	0.08	0.000	-1.95E-06	0.1	-0.3		34032
15	34.34	0.03	0.000	1.32E-06	0.1	-0.3		34032
16	34.00	0.00	0.000	3.77E-06	0.1	-0.2		34032
17	33.60	-0.03	0.000	6.04E-06	0.1	-0.2		34032
18	33.20	-0.04	0.000	7.68E-06	0.1	-0.1		34032
19	32.80	-0.05	0.000	8.75E-06	0.1	-0.1		34032
20	32.40	-0.07	0.000	9.37E-06	0.1	-0.0		34032
21	32.00	-0.08	0.000	9.64E-06	0.0	-0.0		34032
22	31.75	-0.09	0.000	9.70E-06	0.0	-0.0		34032
23	31.50	-0.11	0.000	9.71E-06	0.0	0.0		---

Node no.	Y coord	LEFT side: Water press. kN/m2	Vertic -al kN/m2	Effective stresses: Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	2189
2	38.45	0.00	0.92	0.30	3.37	0.30	0.30a	2189
3	38.22	0.00	5.53	1.78	20.15	2.73	2.73	2189
4	38.00	0.00	11.00	3.55	40.11	5.52	5.52	2189
5	37.75	0.00	17.15	5.53	62.54	8.65	8.65	2189
6	37.50	0.00	22.95	7.40	83.69	11.67	11.67	2189
		Total>	22.95	5.00m	190.25	25.18	25.18	17854
7	37.15	Total>	31.22	6.75m	201.46	35.30	35.30	18166
8	36.80	Total>	39.08	8.50m	212.24	45.02	45.02	18478
9	36.40	Total>	47.74	10.50m	224.25	55.83	55.83	18836
10	36.00	Total>	56.20	12.50m	236.06	66.47	66.47	19193

(continued)

Stage No.1 Apply surcharge no.1 at elevation 38.50

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
11	35.60	Total>	64.53	14.50m	247.73	75.83	75.83	19550
12	35.32	Total>	70.40	15.92m	255.99	82.46	82.46	19804
13	35.03	Total>	76.24	17.35m	264.21	89.08	89.08	20059
14	34.72	Total>	82.55	18.90m	273.12	96.26	96.26	20335
15	34.34	Total>	90.25	20.80m	284.00	105.04	105.04	20674
16	34.00	Total>	97.11	22.50m	293.70	112.89	112.89	20978
17	33.60	Total>	105.15	24.50m	305.09	122.12	122.12	21335
18	33.20	Total>	113.16	26.50m	316.45	131.34	131.34	21692
19	32.80	Total>	121.15	28.50m	327.78	140.55	140.55	22049
20	32.40	Total>	129.12	30.50m	339.10	149.75	149.75	22406
21	32.00	Total>	137.07	32.50m	350.39	158.94	158.94	22763
22	31.75	Total>	142.03	33.75m	357.45	164.68	164.68	22986
23	31.50	Total>	146.99	35.00m	364.50	170.42	170.42	23210

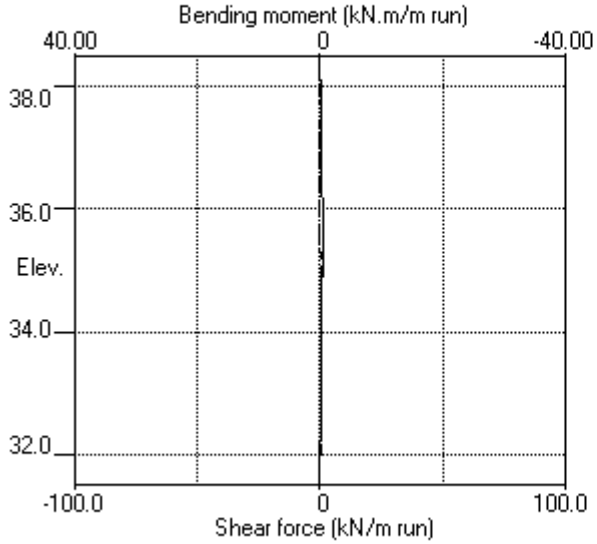
RIGHT side

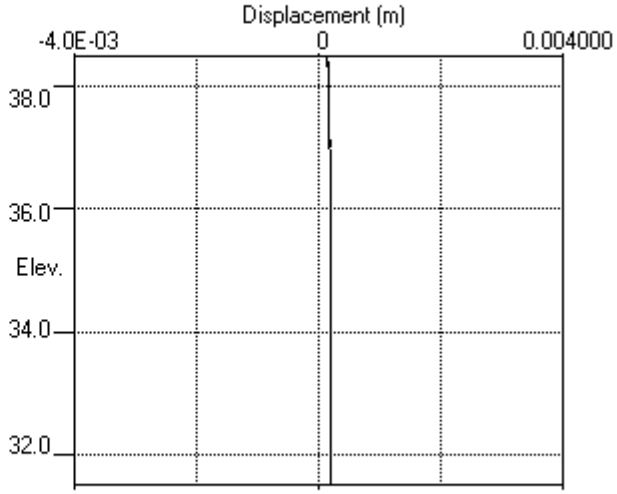
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	2189
2	38.45	0.00	0.92	0.30	3.35	0.84	0.84	2189
3	38.22	0.00	4.96	1.60	18.08	3.19	3.19	2189
4	38.00	0.00	9.00	2.90	32.82	5.53	5.53	2189
5	37.75	0.00	13.50	4.35	49.23	8.14	8.14	2189
6	37.50	0.00	18.00	5.81	65.64	10.75	10.75	2189
		Total>	18.00	5.00m	185.30	26.37	26.37	17854
7	37.15	Total>	25.00	6.75m	195.23	35.68	35.68	18166
8	36.80	Total>	32.00	8.50m	205.16	44.99	44.99	18478
9	36.40	Total>	40.00	10.50m	216.51	55.61	55.61	18836
10	36.00	Total>	48.00	12.50m	227.86	66.21	66.21	19193
11	35.60	Total>	56.00	14.50m	239.20	75.61	75.61	19550
12	35.32	Total>	61.70	15.92m	247.29	82.28	82.28	19804
13	35.03	Total>	67.40	17.35m	255.37	88.94	88.94	20059
14	34.72	Total>	73.60	18.90m	264.17	96.17	96.17	20335
15	34.34	Total>	81.20	20.80m	274.94	105.01	105.01	20674
16	34.00	Total>	88.00	22.50m	284.59	112.89	112.89	20978
17	33.60	Total>	96.00	24.50m	295.94	122.15	122.15	21335
18	33.20	Total>	104.00	26.50m	307.28	131.38	131.38	21692
19	32.80	Total>	112.00	28.50m	318.63	140.60	140.60	22049
20	32.40	Total>	120.00	30.50m	329.98	149.82	149.82	22406
21	32.00	Total>	128.00	32.50m	341.32	159.02	159.02	22763
22	31.75	Total>	133.00	33.75m	348.42	164.78	164.78	22986
23	31.50	Total>	138.00	35.00m	355.51	170.53	170.53	23210

Note: 0.30a Soil pressure at active limit
123.45p Soil pressure at passive limit

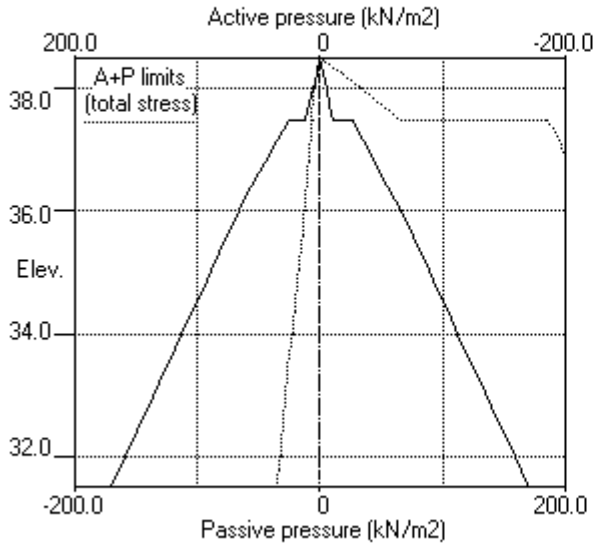
Units: kN,m

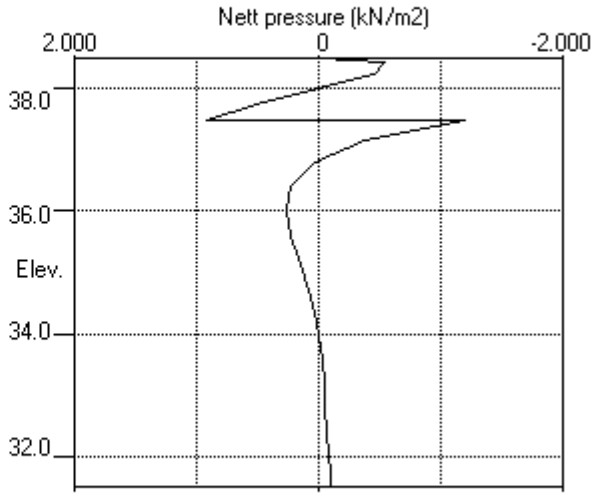
Stage No.1 Apply surcharge no.1 at elev. 38.50





Stage No.1 Apply surcharge no.1 at elev. 38.50





Units: kN,m

Stage No. 2 Excavate to elevation 38.00 on RIGHT side

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	7.28E-05	0.0	0.0		34032
2	38.45	0.30	0.000	7.28E-05	0.0	0.0		34032
3	38.22	1.78	0.000	7.28E-05	0.2	0.0		34032
4	38.00	4.42	0.000	7.22E-05	0.9	0.2		34032
5	37.75	1.56	0.000	6.97E-05	1.7	0.5		34032
6	37.50	2.15	0.000	6.43E-05	2.1	1.0		34032
		-5.74	0.000	6.43E-05	2.1	1.0		
7	37.15	-3.44	0.000	5.20E-05	0.5	1.4		34032
8	36.80	-1.80	0.000	3.75E-05	-0.4	1.4		34032
9	36.40	-0.57	0.000	2.27E-05	-0.9	1.1		34032
10	36.00	0.14	0.000	1.17E-05	-0.9	0.8		34032
11	35.60	0.48	0.000	4.97E-06	-0.8	0.4		34032
12	35.32	0.57	0.000	2.52E-06	-0.7	0.2		34032
13	35.03	0.57	0.000	1.63E-06	-0.5	0.0		34032
14	34.72	0.52	0.000	1.97E-06	-0.3	-0.1		34032
15	34.34	0.41	0.000	3.55E-06	-0.2	-0.2		34032
16	34.00	0.30	0.000	5.52E-06	-0.0	-0.2		34032
17	33.60	0.17	0.000	7.92E-06	0.1	-0.2		34032
18	33.20	0.08	0.000	1.00E-05	0.1	-0.2		34032
19	32.80	-0.00	0.000	1.16E-05	0.1	-0.1		34032
20	32.40	-0.06	0.000	1.25E-05	0.1	-0.1		34032
21	32.00	-0.12	0.000	1.30E-05	0.1	-0.0		34032
22	31.75	-0.15	0.000	1.31E-05	0.0	-0.0		34032
23	31.50	-0.19	0.000	1.31E-05	0.0	0.0		---

Node no.	Y coord	LEFT side: Effective stresses: Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	4024
2	38.45	0.00	0.92	0.30	3.37	0.30	0.30a	4024
3	38.22	0.00	5.53	1.78	20.15	1.78	1.78a	4024
4	38.00	0.00	11.00	3.55	40.11	4.42	4.42	4024
5	37.75	0.00	17.15	5.53	62.54	7.65	7.65	4024
6	37.50	0.00	22.95	7.40	83.69	10.76	10.76	4024
		Total>	22.95	5.00m	190.25	18.40	18.40	29850
7	37.15	Total>	31.22	6.75m	201.46	29.28	29.28	30373
8	36.80	Total>	39.08	8.50m	212.24	39.63	39.63	30895
9	36.40	Total>	47.74	10.50m	224.25	50.98	50.98	31492
10	36.00	Total>	56.20	12.50m	236.06	61.96	61.96	32089

(continued)

Stage No.2 Excavate to elevation 38.00 on RIGHT side

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
11	35.60	Total>	64.53	14.50m	247.73	71.52	71.52	32686
12	35.32	Total>	70.40	15.92m	255.99	78.22	78.22	33111
13	35.03	Total>	76.24	17.35m	264.21	84.86	84.86	33537
14	34.72	Total>	82.55	18.90m	273.12	92.03	92.03	34000
15	34.34	Total>	90.25	20.80m	284.00	100.79	100.79	34567
16	34.00	Total>	97.11	22.50m	293.70	108.60	108.60	35074
17	33.60	Total>	105.15	24.50m	305.09	117.78	117.78	35671
18	33.20	Total>	113.16	26.50m	316.45	126.95	126.95	36268
19	32.80	Total>	121.15	28.50m	327.78	136.13	136.13	36865
20	32.40	Total>	129.12	30.50m	339.10	145.31	145.31	37462
21	32.00	Total>	137.07	32.50m	350.39	154.48	154.48	38059
22	31.75	Total>	142.03	33.75m	357.45	160.21	160.21	38432
23	31.50	Total>	146.99	35.00m	364.50	165.94	165.94	38805

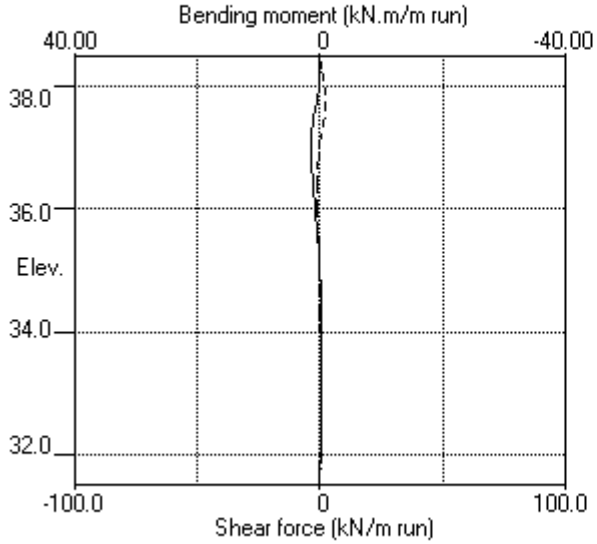
RIGHT side

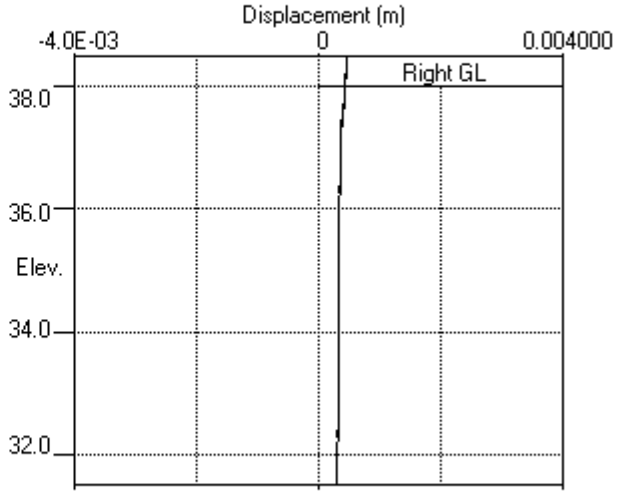
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	3779
5	37.75	0.00	4.50	1.45	16.41	6.09	6.09	3779
6	37.50	0.00	9.00	2.90	32.82	8.61	8.61	3779
		Total>	9.00	2.50m	176.30	24.13	24.13	28194
7	37.15	Total>	16.00	4.25m	186.23	32.72	32.72	28687
8	36.80	Total>	23.00	6.00m	196.16	41.43	41.43	29181
9	36.40	Total>	31.00	8.00m	207.51	51.55	51.55	29744
10	36.00	Total>	39.00	10.00m	218.85	61.82	61.82	30308
11	35.60	Total>	47.00	12.00m	230.20	71.03	71.03	30872
12	35.32	Total>	52.70	13.42m	238.29	77.65	77.65	31274
13	35.03	Total>	58.40	14.85m	246.37	84.28	84.28	31676
14	34.72	Total>	64.60	16.40m	255.16	91.51	91.51	32113
15	34.34	Total>	72.20	18.30m	265.94	100.38	100.38	32648
16	34.00	Total>	79.00	20.00m	275.59	108.30	108.30	33128
17	33.60	Total>	87.00	22.00m	286.94	117.60	117.60	33692
18	33.20	Total>	95.00	24.00m	298.28	126.88	126.88	34255
19	32.80	Total>	103.00	26.00m	309.63	136.13	136.13	34819
20	32.40	Total>	111.01	28.00m	320.98	145.37	145.37	35383
21	32.00	Total>	119.01	30.00m	332.33	154.60	154.60	35947
22	31.75	Total>	124.01	31.25m	339.42	160.36	160.36	36299
23	31.50	Total>	129.01	32.50m	346.51	166.12	166.12	36652

Note: 1.78a Soil pressure at active limit
123.45p Soil pressure at passive limit

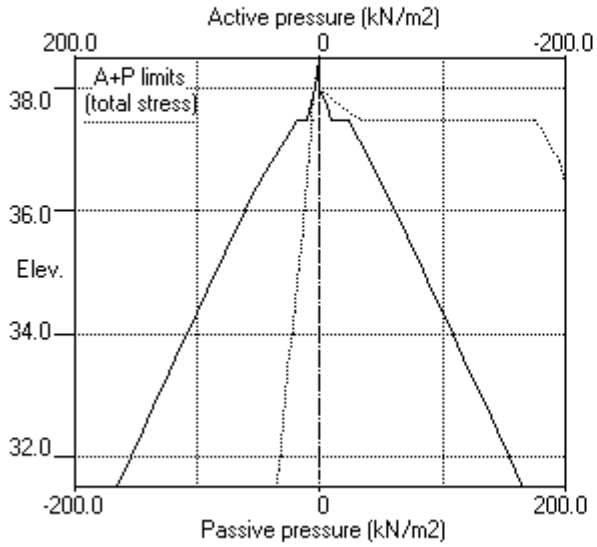
Units: kN,m

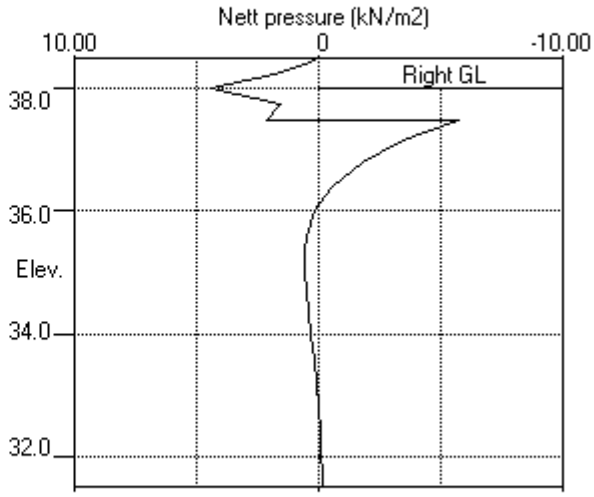
Stage No.2 Excav. to elev. 38.00 on RIGHT side





Stage No.2 Excav. to elev. 38.00 on RIGHT side





Units: kN,m

Stage No. 4 Apply water pressure profile no.1 (Mod. Conserv.)

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	7.08E-05	0.0	0.0		34032
2	38.45	0.32	0.000	7.08E-05	0.0	0.0	-0.0	34032
3	38.22	1.80	0.000	7.08E-05	0.2	0.0		34032
4	38.00	4.43	0.000	7.02E-05	0.9	0.2		34032
5	37.75	1.59	0.000	6.77E-05	1.7	0.5		34032
6	37.50	2.16	0.000	6.22E-05	2.2	1.0		34032
		-5.62	0.000	6.22E-05	2.2	1.0		
7	37.15	-3.41	0.000	4.97E-05	0.6	1.4		34032
8	36.80	-1.83	0.000	3.50E-05	-0.3	1.4		34032
9	36.40	-0.65	0.000	1.95E-05	-0.8	1.2		34032
10	36.00	-0.01	0.000	7.88E-06	-1.0	0.8		34032
11	35.60	0.40	0.000	5.61E-07	-0.9	0.4		34032
12	35.32	0.53	0.000	-2.12E-06	-0.7	0.2		34032
13	35.03	0.57	0.000	-3.05E-06	-0.6	0.0		34032
14	34.72	0.56	0.000	-2.50E-06	-0.4	-0.1		34032
15	34.34	0.50	0.000	-3.49E-07	-0.2	-0.2		34032
16	34.00	0.45	0.000	2.35E-06	-0.1	-0.3		34032
17	33.60	0.26	0.000	5.69E-06	0.1	-0.3		34032
18	33.20	0.11	0.000	8.63E-06	0.2	-0.2		34032
19	32.80	-0.01	0.000	1.08E-05	0.2	-0.2		34032
20	32.40	-0.09	0.000	1.22E-05	0.2	-0.1		34032
21	32.00	-0.17	0.000	1.28E-05	0.1	-0.0		34032
22	31.75	-0.21	0.000	1.29E-05	0.1	-0.0		34032
23	31.50	-0.26	0.000	1.30E-05	0.0	0.0		---

At elev. 38.45 The strut is slack

Node no.	Y coord	LEFT side ------- Effective stresses ------- Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	7489
2	38.45	0.00	0.92	0.30	3.37	0.32	0.32	7489
3	38.22	0.00	5.53	1.78	20.15	1.80	1.80	7489
4	38.00	0.00	11.00	3.55	40.11	4.43	4.43	7489
5	37.75	0.00	17.15	5.53	62.54	7.66	7.66	7489
6	37.50	0.00	22.95	7.40	83.69	10.76	10.76	7489
		Total>	22.95	5.00m	190.25	18.45	18.45	53474
7	37.15	Total>	31.22	6.75m	201.46	29.29	29.29	54410
8	36.80	Total>	39.08	8.50m	212.24	39.61	39.61	23257
9	36.40	Total>	47.74	10.50m	224.25	50.94	50.94	23707

(continued)

Stage No.4 Apply water pressure profile no.1 (Mod. Conserv.)

LEFT side

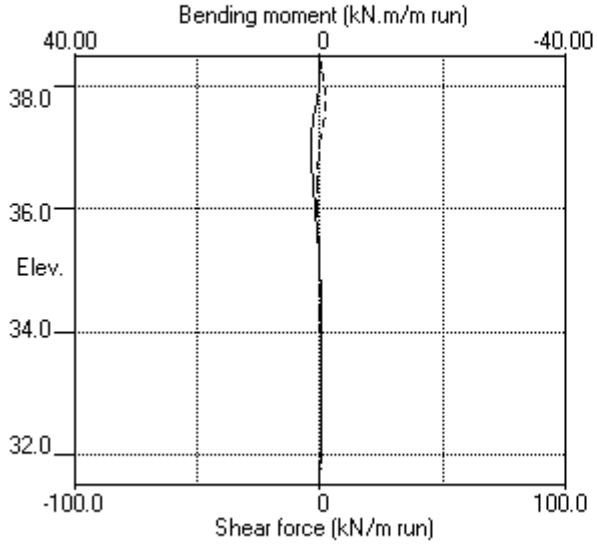
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
10	36.00	Total>	56.20	12.50m	236.06	61.89	61.89	24156
11	35.60	Total>	64.53	14.50m	247.73	71.40	71.40	24606
12	35.32	Total>	70.40	15.92m	255.99	78.07	78.07	24926
13	35.03	Total>	76.24	17.35m	264.21	84.67	84.67	25246
14	34.72	Total>	82.55	18.90m	273.12	91.80	91.80	25594
15	34.34	Total>	90.25	20.80m	284.00	100.51	100.51	26021
16	34.00	Total>	97.11	22.50m	293.70	108.29	108.29	26403
17	33.60	Total>	105.15	24.50m	305.09	117.43	117.43	26853
18	33.20	Total>	113.16	26.50m	316.45	126.59	126.59	27302
19	32.80	Total>	121.15	28.50m	327.78	135.75	135.75	27752
20	32.40	Total>	129.12	30.50m	339.10	144.91	144.91	28201
21	32.00	Total>	137.07	32.50m	350.39	154.07	154.07	28650
22	31.75	Total>	142.03	33.75m	357.45	159.80	159.80	28931
23	31.50	Total>	146.99	35.00m	364.50	165.52	165.52	29212

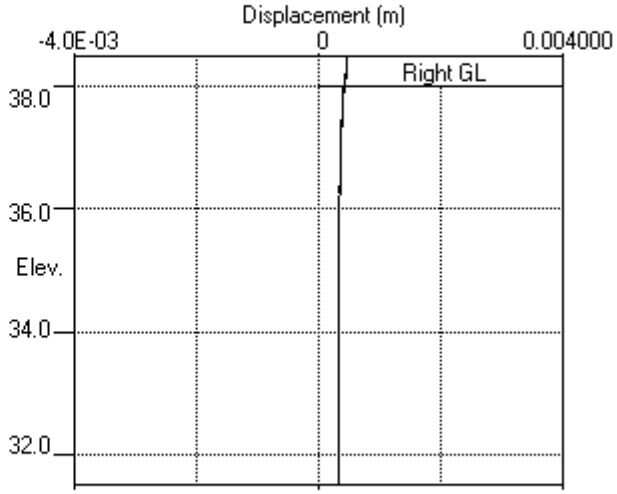
RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	10075
5	37.75	0.00	4.50	1.45	16.41	6.07	6.07	10075
6	37.50	0.00	9.00	2.90	32.82	8.60	8.60	10075
		Total>	9.00	2.50m	176.30	24.06	24.06	71126
7	37.15	Total>	16.00	4.25m	186.23	32.70	32.70	72371
8	36.80	Total>	23.00	6.00m	196.16	41.44	41.44	23257
9	36.40	Total>	31.00	8.00m	207.51	51.59	51.59	23707
10	36.00	Total>	39.00	10.00m	218.85	61.90	61.90	24156
11	35.60	Total>	47.00	12.00m	230.20	71.00	71.00	24606
12	35.32	Total>	52.70	13.42m	238.29	77.54	77.54	24926
13	35.03	Total>	58.40	14.85m	246.37	84.10	84.10	25246
14	34.72	Total>	64.60	16.40m	255.17	91.25	91.25	25594
15	34.34	Total>	72.20	18.30m	265.95	100.01	100.01	26021
16	34.00	Total>	79.00	20.00m	275.59	107.84	107.84	26403
17	33.60	Total>	87.00	22.00m	286.94	117.18	117.18	26853
18	33.20	Total>	95.00	24.00m	298.29	126.48	126.48	27302
19	32.80	Total>	103.00	26.00m	309.64	135.75	135.75	27752
20	32.40	Total>	111.01	28.00m	320.98	145.00	145.00	28201
21	32.00	Total>	119.01	30.00m	332.33	154.24	154.24	28650
22	31.75	Total>	124.01	31.25m	339.43	160.01	160.01	28931
23	31.50	Total>	129.01	32.50m	346.52	165.77	165.77	29212

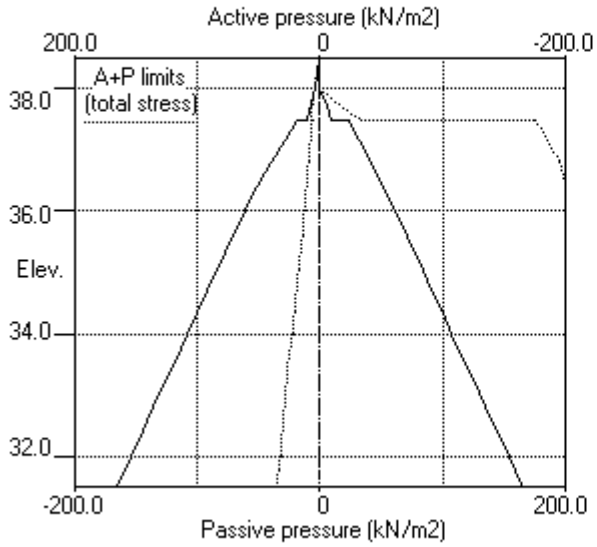
Units: kN,m

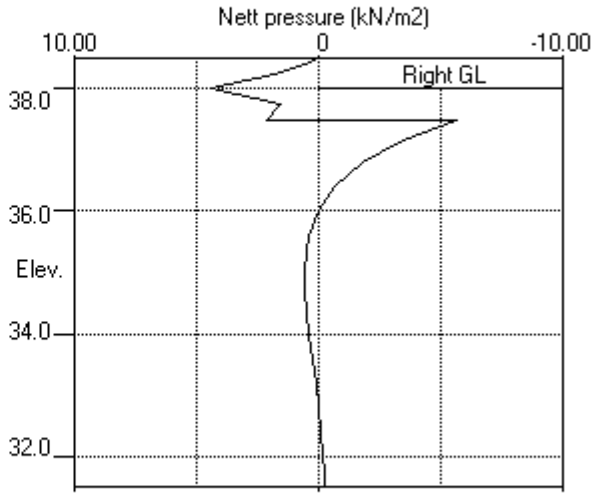
Stage No.4 Apply water pressure profile no.1 (Mod. Conserv.)





Stage No.4 Apply water pressure profile no.1 (Mod. Conserv.)





Units: kN,m

Stage No. 5 Excavate to elevation 34.34 on RIGHT side

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.50E-03	0.0	-0.0		34032
2	38.45	0.30	0.000	-1.50E-03	0.0	0.0	17.6	34032
		0.30	0.000	-1.50E-03	-17.6	0.0		
3	38.22	1.78	0.001	-1.49E-03	-17.3	-3.9		34032
4	38.00	3.55	0.001	-1.45E-03	-16.7	-7.7		34032
5	37.75	5.53	0.002	-1.38E-03	-15.6	-11.8		34032
6	37.50	7.40	0.002	-1.28E-03	-14.0	-15.5		34032
		5.00	0.002	-1.28E-03	-14.0	-15.5		
7	37.15	6.75	0.002	-1.10E-03	-11.9	-20.1		34032
8	36.80	8.50	0.003	-8.76E-04	-9.3	-23.8		34032
9	36.40	10.50	0.003	-5.79E-04	-5.5	-26.8		34032
10	36.00	12.50	0.003	-2.56E-04	-0.9	-28.1		34032
11	35.60	14.50	0.003	7.00E-05	4.5	-27.4		34032
12	35.32	15.92	0.003	2.91E-04	8.9	-25.5		34032
13	35.03	23.66	0.003	4.88E-04	14.5	-21.4		34032
14	34.72	34.23	0.003	6.57E-04	23.5	-15.7		34032
15	34.34	48.63	0.002	7.67E-04	39.2	-4.1		34032
		-59.28	0.002	7.67E-04	39.2	-4.1		
16	34.00	-45.25	0.002	7.58E-04	21.4	5.9		34032
17	33.60	-29.76	0.002	6.60E-04	6.4	10.8		34032
18	33.20	-16.70	0.002	5.31E-04	-2.8	11.0		34032
19	32.80	-6.37	0.002	4.17E-04	-7.5	8.5		34032
20	32.40	1.76	0.001	3.37E-04	-8.4	5.0		34032
21	32.00	8.60	0.001	2.96E-04	-6.3	1.8		34032
22	31.75	12.62	0.001	2.88E-04	-3.7	0.5		34032
23	31.50	16.65	0.001	2.86E-04	0.0	0.0		---

At elev. 38.45 Strut force = 17.6 kN/strut = 17.6 kN/m run

Node no.	Y coord	LEFT side: Water press. kN/m2	Vertic -al kN/m2	Effective stresses: Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	37868
2	38.45	0.00	0.92	0.30	3.37	0.30	0.30a	2677
3	38.22	0.00	5.53	1.78	20.15	1.78	1.78a	2677
4	38.00	0.00	11.00	3.55	40.11	3.55	3.55a	2677
5	37.75	0.00	17.15	5.53	62.54	5.53	5.53a	2677
6	37.50	0.00	22.95	7.40	83.69	7.40	7.40a	2677
		Total>	22.95	5.00m	190.25	5.00	5.00a	20873
7	37.15	Total>	31.22	6.75m	201.46	6.75	6.75a	21239

(continued)

Stage No.5 Excavate to elevation 34.34 on RIGHT side

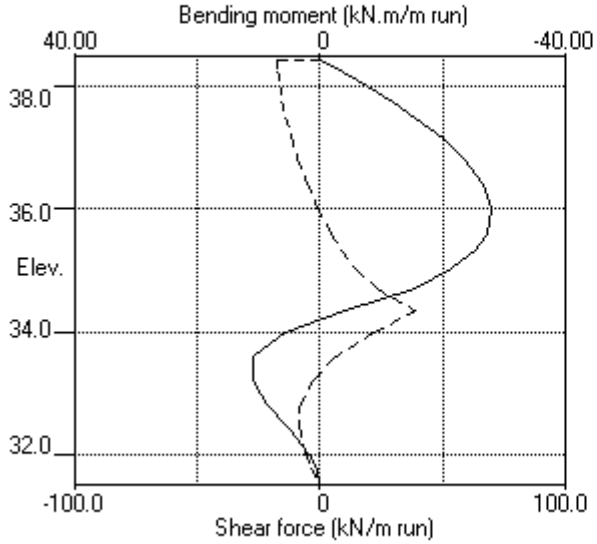
Node no.	Y coord	LEFT side						
		Water press. kN/m2	Effective stresses Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
8	36.80	Total>	39.08	8.50m	212.24	8.50	8.50a	21604
9	36.40	Total>	47.74	10.50m	224.25	10.50	10.50a	22021
10	36.00	Total>	56.20	12.50m	236.06	12.50	12.50a	22439
11	35.60	Total>	64.53	14.50m	247.73	14.50	14.50a	22856
12	35.32	Total>	70.40	15.92m	255.99	15.92	15.92a	23154
13	35.03	Total>	76.24	17.35m	264.21	23.66	23.66	23451
14	34.72	Total>	82.55	18.90m	273.12	34.23	34.23	23775
15	34.34	Total>	90.25	20.80m	284.00	48.63	48.63	24171
16	34.00	Total>	97.11	22.50m	293.70	62.06	62.06	24526
17	33.60	Total>	105.15	24.50m	305.09	77.51	77.51	24944
18	33.20	Total>	113.16	26.50m	316.45	91.97	91.97	25361
19	32.80	Total>	121.15	28.50m	327.78	105.32	105.32	25778
20	32.40	Total>	129.12	30.50m	339.10	117.79	117.79	26196
21	32.00	Total>	137.07	32.50m	350.39	129.72	129.72	26613
22	31.75	Total>	142.03	33.75m	357.45	137.08	137.08	26874
23	31.50	Total>	146.99	35.00m	364.50	144.44	144.44	27135

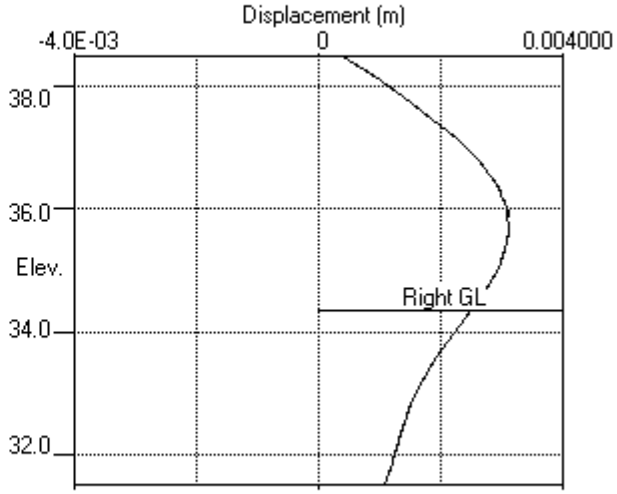
Node no.	Y coord	RIGHT side						
		Water press. kN/m2	Effective stresses Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	34.34	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	193.73	107.91	107.91	35996
16	34.00	Total>	6.80	1.70m	203.37	107.31	107.31	36525
17	33.60	Total>	14.80	3.70m	214.72	107.27	107.27	37146
18	33.20	Total>	22.80	5.70m	226.07	108.67	108.67	37768
19	32.80	Total>	30.80	7.70m	237.42	111.69	111.69	38390
20	32.40	Total>	38.80	9.70m	248.76	116.02	116.02	39011
21	32.00	Total>	46.80	11.70m	260.11	121.13	121.13	39633
22	31.75	Total>	51.80	12.95m	267.21	124.46	124.46	40022
23	31.50	Total>	56.81	14.20m	274.30	127.79	127.79	40410

Note: 15.92a Soil pressure at active limit
123.45p Soil pressure at passive limit

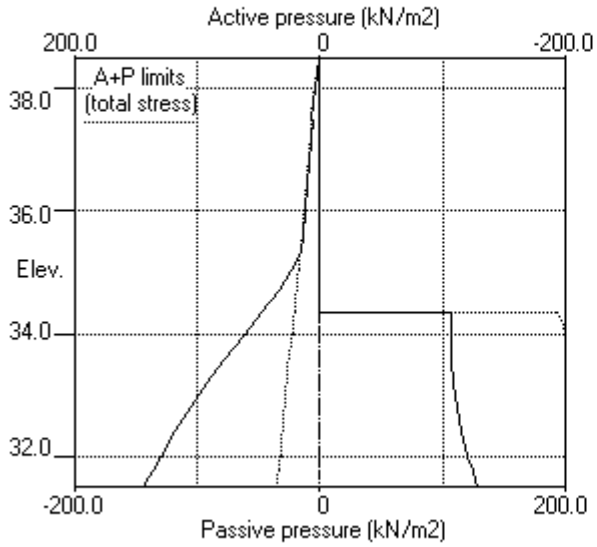
Units: kN,m

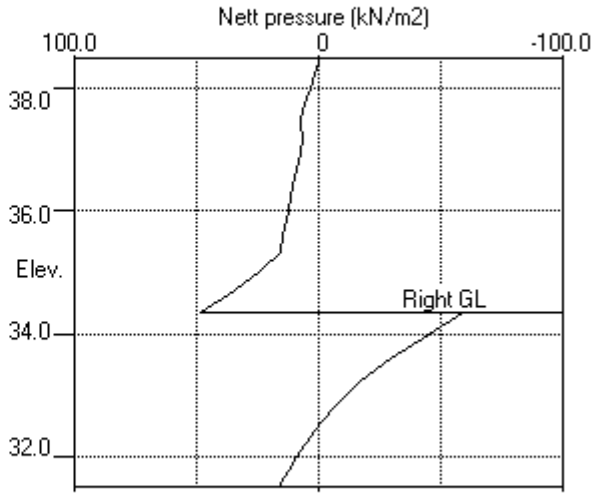
Stage No.5 Excav. to elev. 34.34 on RIGHT side





Stage No.5 Excav. to elev. 34.34 on RIGHT side





Units: kN,m

Stage No. 6 Fill to elevation 34.72 on RIGHT side with soil type 1

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.51E-03	0.0	-0.0		34032
2	38.45	0.30	0.000	-1.51E-03	0.0	0.0	17.9	34032
		0.30	0.000	-1.51E-03	-17.9	0.0		
3	38.22	1.78	0.001	-1.49E-03	-17.6	-4.0		34032
4	38.00	3.55	0.001	-1.45E-03	-17.0	-7.9		34032
5	37.75	5.53	0.002	-1.38E-03	-15.9	-12.0		34032
6	37.50	7.40	0.002	-1.28E-03	-14.3	-15.8		34032
		5.00	0.002	-1.28E-03	-14.3	-15.8		
7	37.15	6.77	0.002	-1.09E-03	-12.2	-20.4		34032
8	36.80	8.58	0.003	-8.67E-04	-9.5	-24.3		34032
9	36.40	10.70	0.003	-5.64E-04	-5.7	-27.4		34032
10	36.00	12.90	0.003	-2.34E-04	-0.9	-28.7		34032
11	35.60	15.17	0.003	9.89E-05	4.7	-28.0		34032
12	35.32	16.84	0.003	3.25E-04	9.2	-26.0		34032
13	35.03	24.85	0.003	5.25E-04	15.2	-21.8		34032
14	34.72	35.76	0.003	6.96E-04	24.6	-15.8		34032
15	34.34	48.40	0.002	8.05E-04	40.6	-3.7		34032
		-61.90	0.002	8.05E-04	40.6	-3.7		
16	34.00	-47.12	0.002	7.91E-04	22.0	6.5		34032
17	33.60	-30.88	0.002	6.85E-04	6.4	11.5		34032
18	33.20	-17.23	0.002	5.49E-04	-3.2	11.6		34032
19	32.80	-6.46	0.001	4.28E-04	-7.9	9.0		34032
20	32.40	1.99	0.001	3.44E-04	-8.8	5.3		34032
21	32.00	9.07	0.001	3.01E-04	-6.6	1.9		34032
22	31.75	13.24	0.001	2.92E-04	-3.8	0.5		34032
23	31.50	17.41	0.001	2.90E-04	0.0	0.0		---

At elev. 38.45 Strut force = 17.9 kN/strut = 17.9 kN/m run

Node no.	Y coord	LEFT side: Water press. kN/m2	Vertic -al kN/m2	Effective stresses: Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	6586
2	38.45	0.00	0.92	0.30	3.37	0.30	0.30a	6586
3	38.22	0.00	5.53	1.78	20.15	1.78	1.78a	6586
4	38.00	0.00	11.00	3.55	40.11	3.55	3.55a	6586
5	37.75	0.00	17.15	5.53	62.54	5.53	5.53a	6586
6	37.50	0.00	22.95	7.40	83.69	7.40	7.40a	6586
		Total>	22.95	5.00m	190.25	5.00	5.00a	47311
7	37.15	Total>	31.22	6.75m	201.46	6.77	6.77	24188

(continued)

Stage No.6 Fill to elevation 34.72 on RIGHT side with soil type 1

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
8	36.80	Total>	39.08	8.50m	212.24	8.58	8.58	24604
9	36.40	Total>	47.74	10.50m	224.25	10.70	10.70	25079
10	36.00	Total>	56.20	12.50m	236.06	12.90	12.90	25555
11	35.60	Total>	64.53	14.50m	247.73	15.17	15.17	26030
12	35.32	Total>	70.40	15.92m	255.99	16.84	16.84	26369
13	35.03	Total>	76.24	17.35m	264.21	24.85	24.85	26708
14	34.72	Total>	82.55	18.90m	273.12	35.76	35.76	27076
15	34.34	Total>	90.25	20.80m	284.00	50.60	50.60	27528
16	34.00	Total>	97.11	22.50m	293.70	64.41	64.41	27932
17	33.60	Total>	105.15	24.50m	305.09	80.23	80.23	28408
18	33.20	Total>	113.16	26.50m	316.45	94.99	94.99	28883
19	32.80	Total>	121.15	28.50m	327.78	108.56	108.56	29358
20	32.40	Total>	129.12	30.50m	339.10	121.18	121.18	29834
21	32.00	Total>	137.07	32.50m	350.39	133.25	133.25	30309
22	31.75	Total>	142.03	33.75m	357.45	140.68	140.68	30606
23	31.50	Total>	146.99	35.00m	364.50	148.11	148.11	30904

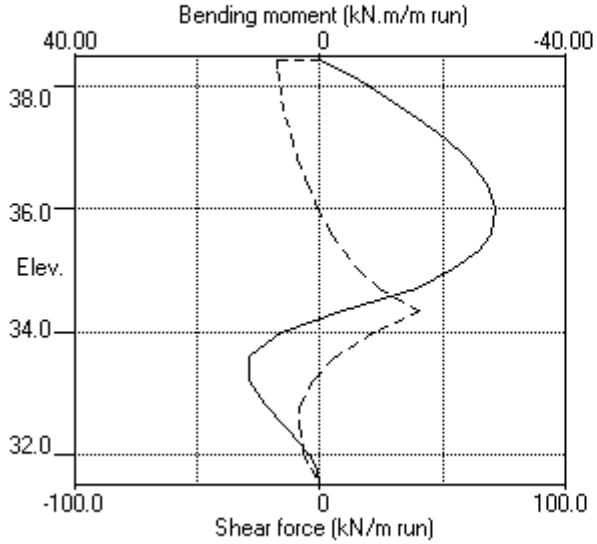
RIGHT side

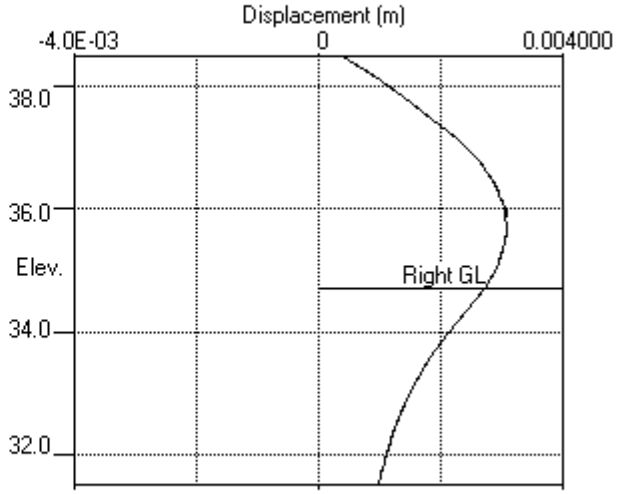
Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	3119
15	34.34	0.00	6.84	2.21	24.94	2.21	2.21a	3119
		Total>	6.84	1.90m	200.57	112.51	112.51	27528
16	34.00	Total>	13.64	3.60m	210.22	111.53	111.53	27932
17	33.60	Total>	21.64	5.60m	221.56	111.11	111.11	28408
18	33.20	Total>	29.64	7.60m	232.91	112.22	112.22	28883
19	32.80	Total>	37.64	9.60m	244.26	115.02	115.02	29358
20	32.40	Total>	45.64	11.60m	255.61	119.20	119.20	29834
21	32.00	Total>	53.65	13.60m	266.96	124.18	124.18	30309
22	31.75	Total>	58.65	14.85m	274.05	127.44	127.44	30606
23	31.50	Total>	63.65	16.10m	281.14	130.70	130.70	30904

Note: 2.21a Soil pressure at active limit
123.45p Soil pressure at passive limit

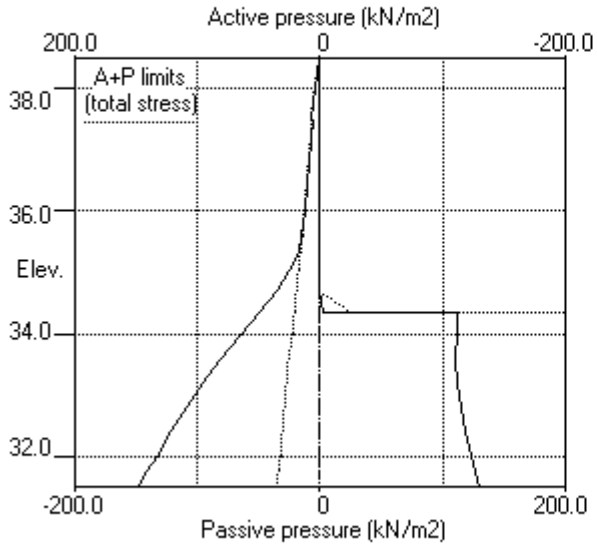
Units: kN,m

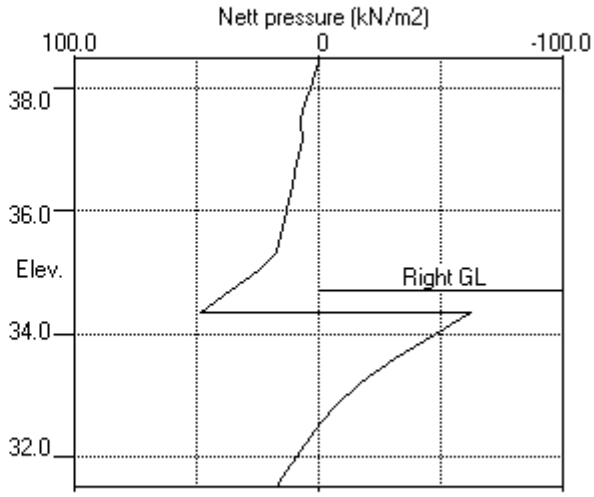
Stage No.6 Fill to elev. 34.72 on RIGHT side





Stage No.6 Fill to elev. 34.72 on RIGHT side





Units: kN,m

Stage No. 8 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.63E-03	0.0	-0.0		24308
2	38.45	0.52	0.000	-1.63E-03	0.0	0.0	15.4	24308
		0.52	0.000	-1.63E-03	-15.4	0.0		
3	38.22	1.78	0.001	-1.62E-03	-15.2	-3.6		24308
4	38.00	3.55	0.001	-1.57E-03	-14.6	-7.0		24308
5	37.75	5.53	0.002	-1.48E-03	-13.4	-10.6		24308
6	37.50	7.40	0.002	-1.36E-03	-11.8	-13.9		24308
		5.00	0.002	-1.36E-03	-11.8	-13.9		
7	37.15	6.75	0.002	-1.14E-03	-9.7	-18.0		24308
8	36.80	8.50	0.003	-8.76E-04	-7.1	-21.1		24308
9	36.40	10.50	0.003	-5.26E-04	-3.3	-23.5		24308
10	36.00	12.50	0.003	-1.55E-04	1.3	-24.1		24308
11	35.60	14.50	0.003	2.06E-04	6.7	-22.7		24308
12	35.32	15.92	0.003	4.39E-04	11.1	-20.3		24308
13	35.03	24.61	0.003	6.30E-04	16.8	-15.7	9.0	24308
		24.61	0.003	6.30E-04	7.8	-15.7		
14	34.72	36.53	0.003	7.84E-04	17.3	-11.5		24308
15	34.34	50.22	0.002	8.71E-04	33.7	-1.5		24308
		-58.26	0.002	8.71E-04	33.7	-1.5		
16	34.00	-42.18	0.002	8.26E-04	16.7	7.1		24308
17	33.60	-25.44	0.002	6.80E-04	3.1	10.8		24308
18	33.20	-12.37	0.002	5.12E-04	-4.4	10.2		24308
19	32.80	-2.92	0.001	3.74E-04	-7.5	7.4		24308
20	32.40	3.85	0.001	2.86E-04	-7.3	4.1		24308
21	32.00	9.23	0.001	2.45E-04	-4.7	1.3		24308
22	31.75	9.40	0.001	2.37E-04	-2.3	0.3		24308
23	31.50	9.39	0.001	2.36E-04	0.0	0.0		---

At elev. 38.45 Strut force = 15.4 kN/strut = 15.4 kN/m run
At elev. 35.03 Strut force = 9.0 kN/strut = 9.0 kN/m run

Node no.	Y coord	LEFT side Water press. kN/m2	Effective stresses Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	76434
2	38.45	0.00	0.92	0.30	3.37	0.52	0.52	76434
3	38.22	0.00	5.53	1.78	20.15	1.78	1.78a	3716
4	38.00	0.00	11.00	3.55	40.11	3.55	3.55a	3716

(continued)

Stage No.8 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
5	37.75	0.00	17.15	5.53	62.54	5.53	5.53a	3716
6	37.50	0.00	22.95	7.40	83.69	7.40	7.40a	3716
		Total>	22.95	5.00m	190.25	5.00	5.00a	27770
7	37.15	Total>	31.22	6.75m	201.46	6.75	6.75a	28256
8	36.80	Total>	39.08	8.50m	212.24	8.50	8.50a	28742
9	36.40	Total>	47.74	10.50m	224.25	10.50	10.50a	29297
10	36.00	Total>	56.20	12.50m	236.06	12.50	12.50a	29852
11	35.60	Total>	64.53	14.50m	247.73	14.50	14.50a	30408
12	35.32	Total>	70.40	15.92m	255.99	15.92	15.92a	30803
13	35.03	Total>	76.24	17.35m	264.21	24.61	24.61	31199
14	34.72	Total>	82.55	18.90m	273.12	36.53	36.53	34847
15	34.34	Total>	90.25	20.80m	284.00	52.42	52.42	35429
16	34.00	Total>	97.11	22.50m	293.70	66.88	66.88	35949
17	33.60	Total>	105.15	24.50m	305.09	82.95	82.95	36561
18	33.20	Total>	113.16	26.50m	316.45	97.42	97.42	37172
19	32.80	Total>	121.15	28.50m	327.78	110.33	110.33	37784
20	32.40	Total>	129.12	30.50m	339.10	122.11	122.11	38396
21	32.00	Total>	137.07	32.50m	350.39	133.33	133.33	70886
22	31.75	Total>	142.03	33.75m	357.45	138.76	138.76	149266
23	31.50	Total>	146.99	35.00m	364.50	144.10	144.10	150715

RIGHT side

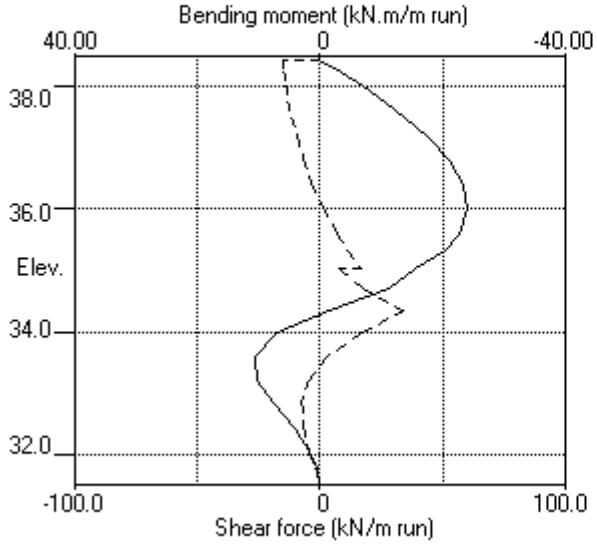
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	4134
15	34.34	0.00	6.84	2.21	24.94	2.21	2.21a	4134
		Total>	6.84	1.90m	200.57	110.69	110.69	35429
16	34.00	Total>	13.64	3.60m	210.22	109.06	109.06	35949
17	33.60	Total>	21.64	5.60m	221.56	108.39	108.39	36561
18	33.20	Total>	29.64	7.60m	232.91	109.79	109.79	37172
19	32.80	Total>	37.64	9.60m	244.26	113.25	113.25	37784
20	32.40	Total>	45.64	11.60m	255.61	118.27	118.27	38396
21	32.00	Total>	53.65	13.60m	266.96	124.10	124.10	70886
22	31.75	Total>	58.65	14.85m	274.05	129.36	129.36	149266
23	31.50	Total>	63.65	16.10m	281.14	134.71	134.71	150715

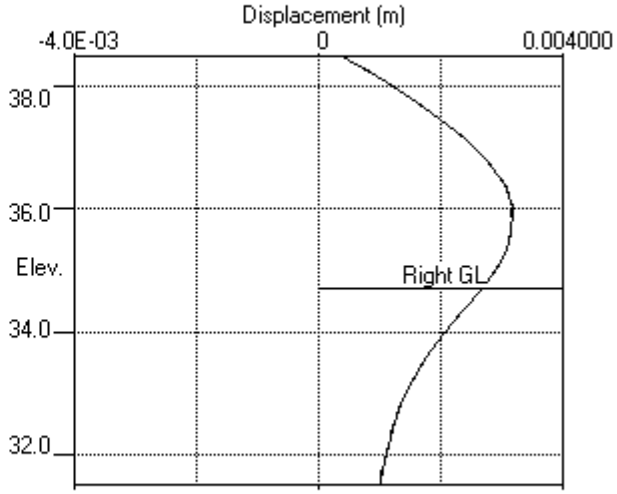
(continued)

Stage No.8 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value
Note: 2.21a Soil pressure at active limit
123.45p Soil pressure at passive limit

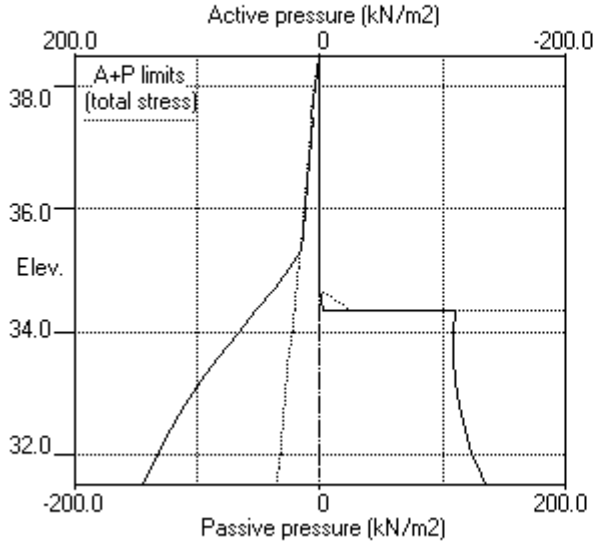
Units: kN,m

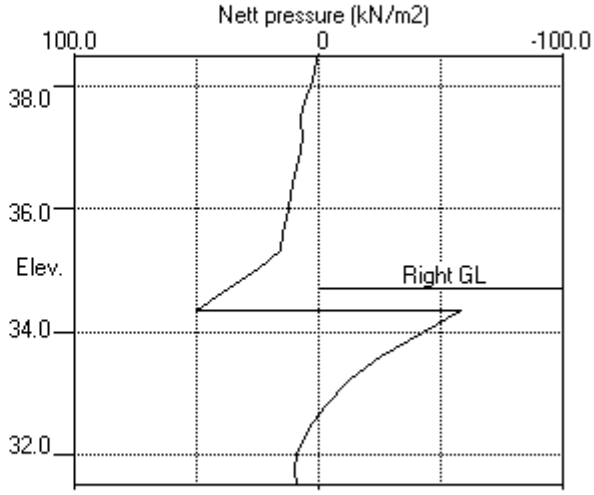
Stage No.8 Change EI of wall to 24308kN.m2/m run





Stage No.8 Change EI of wall to 24308kN.m2/m run





Units: kN,m

Stage No. 11 Apply water pressure profile no.2 (Mod. Conserv.)

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.74E-03	0.0	-0.0		24308
2	38.45	0.51	0.000	-1.74E-03	0.0	0.0	18.4	24308
		0.51	0.000	-1.74E-03	-18.4	0.0		
3	38.22	1.78	0.001	-1.72E-03	-18.2	-4.2		24308
4	38.00	3.55	0.001	-1.67E-03	-17.6	-8.4		24308
5	37.75	5.53	0.002	-1.56E-03	-16.4	-12.8		24308
6	37.50	7.40	0.002	-1.42E-03	-14.8	-16.8		24308
		8.06	0.002	-1.42E-03	-14.8	-16.8		
7	37.15	13.20	0.002	-1.15E-03	-11.1	-21.6		24308
8	36.80	18.18	0.003	-8.30E-04	-5.6	-24.8		24308
9	36.40	23.77	0.003	-4.32E-04	2.8	-25.7		24308
10	36.00	29.29	0.003	-5.42E-05	13.4	-22.7		24308
11	35.60	34.76	0.003	2.33E-04	26.2	-15.1		24308
12	35.32	38.64	0.003	3.39E-04	36.7	-6.3		24308
13	35.03	42.50	0.003	3.17E-04	48.2	6.5	77.0	24308
		42.50	0.003	3.17E-04	-28.8	6.5		
14	34.72	46.69	0.003	2.56E-04	-15.0	0.2		24308
		18.52	0.003	2.56E-04	-15.0	0.2		
15	34.34	23.68	0.003	2.67E-04	-7.0	-3.5		24308
		13.83	0.003	2.67E-04	-7.0	-3.5		
16	34.00	10.79	0.003	3.20E-04	-2.8	-4.9		24308
17	33.60	7.40	0.003	4.03E-04	0.9	-5.2		24308
18	33.20	4.16	0.002	4.88E-04	3.2	-4.5		24308
19	32.80	1.16	0.002	5.58E-04	4.2	-3.2		24308
20	32.40	-1.49	0.002	6.06E-04	4.2	-1.8		24308
21	32.00	-3.68	0.002	6.31E-04	3.1	-0.7		24308
22	31.75	-6.29	0.002	6.36E-04	1.9	-0.2		24308
23	31.50	-8.82	0.001	6.37E-04	0.0	0.0		---

At elev. 38.45 Strut force = 18.4 kN/strut = 18.4 kN/m run
At elev. 35.03 Strut force = 77.0 kN/strut = 77.0 kN/m run

Node no.	Y coord	LEFT side: Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	260153
2	38.45	0.00	0.92	0.30	3.37	0.51	0.51	4338
3	38.22	0.00	5.53	1.78	20.15	1.78	1.78a	4338
4	38.00	0.00	11.00	3.55	40.11	3.55	3.55a	4338
5	37.75	0.00	17.15	5.53	62.54	5.53	5.53a	4338

(continued)

Stage No.11 Apply water pressure profile no.2 (Mod. Conserv.)

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
6	37.50	0.00	22.95	7.40	83.69	7.40	7.40a	4338
		0.00	22.95	8.06	74.64	8.06	8.06a	16417
7	37.15	3.43	27.79	9.76	90.40	9.76	13.20a	16705
8	36.80	6.87	32.21	11.32	104.78	11.32	18.18a	16992
9	36.40	10.79	36.95	12.98	120.20	12.98	23.77a	17320
10	36.00	14.71	41.49	14.57	134.95	14.57	29.29a	17648
11	35.60	18.64	45.89	16.12	149.27	16.12	34.76a	103813
12	35.32	21.43	48.97	17.20	159.28	17.20	38.64a	14239
13	35.03	24.23	52.01	18.27	169.17	18.27	42.50a	14422
14	34.72	27.27	55.28	19.42	179.81	19.42	46.69a	14621
15	34.34	31.00	59.25	20.81	192.74	26.30	57.30	14865
16	34.00	34.34	62.78	22.05	204.20	34.43	68.76	15083
17	33.60	38.26	66.89	23.50	217.58	43.98	82.24	15340
18	33.20	42.18	70.98	24.93	230.88	53.40	95.58	15596
19	32.80	46.11	75.04	26.36	244.10	62.72	108.83	15853
20	32.40	50.03	79.09	27.78	257.25	72.04	122.07	16110
21	32.00	53.96	83.11	29.20	270.35	81.50	135.45	16366
22	31.75	56.41	85.62	30.08	278.51	86.01	142.42	16527
23	31.50	58.86	88.13	30.96	286.66	90.50	149.36	16687

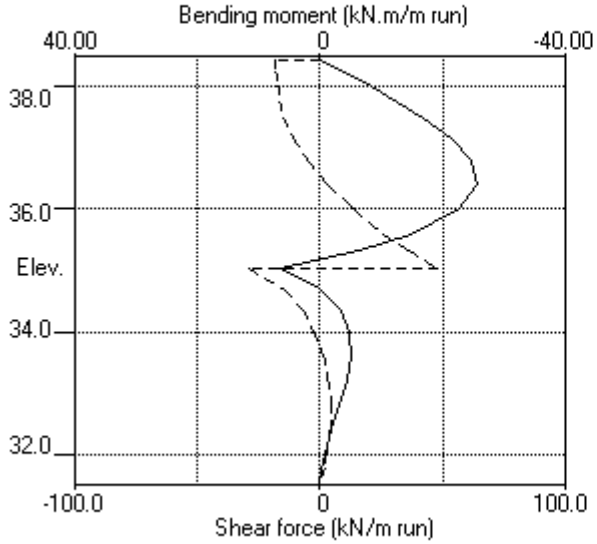
RIGHT side

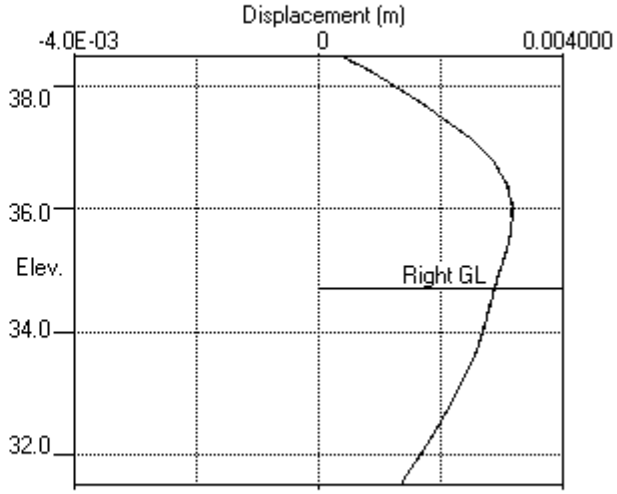
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		27.27	0.73	0.23	2.66	0.90	28.17	3401
15	34.34	31.00	3.83	1.24	13.98	2.61	33.61	3401
		31.00	3.83	1.35	12.47	12.47	43.47p	14865
16	34.00	34.34	7.27	2.55	23.64	23.64	57.98p	15083
17	33.60	38.26	11.25	3.95	36.58	36.58	74.84p	15340
18	33.20	42.18	15.14	5.32	49.24	49.24	91.42p	15596
19	32.80	46.11	18.92	6.65	61.56	61.56	107.67p	15853
20	32.40	50.03	22.61	7.94	73.53	73.53	123.56p	16110
21	32.00	53.96	26.19	9.20	85.17	85.17	139.13p	16366
22	31.75	56.41	28.38	9.97	92.30	92.30	148.71p	16527
23	31.50	58.86	30.53	10.73	99.32	99.32	158.18p	16687

Note: 46.69a Soil pressure at active limit
158.18p Soil pressure at passive limit

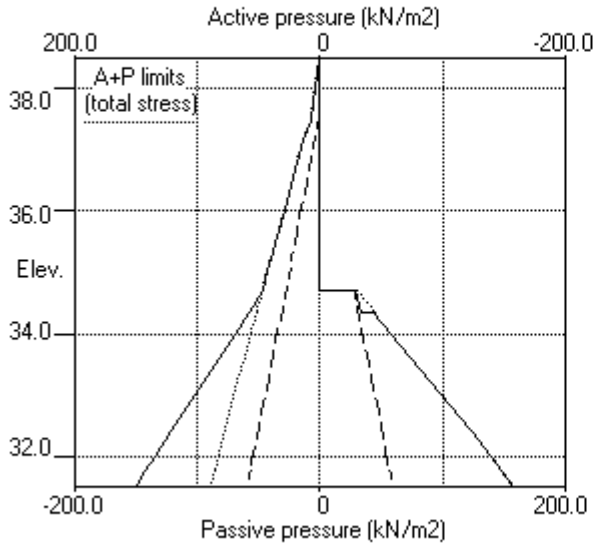
Units: kN,m

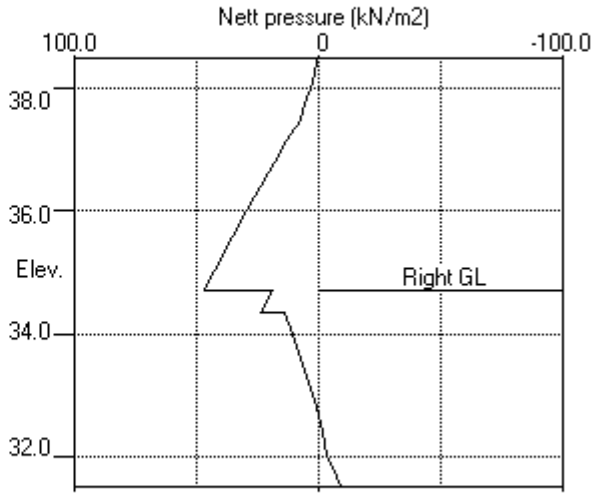
Stage No.11 Apply water pressure profile no.2 (Mod. Conserv.)





Stage No.11 Apply water pressure profile no.2 (Mod. Conserv.)





Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces have been multiplied by a factor of 1.35 to obtain values for structural design.

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment Calculated		Bending moment Factored		Shear force Calculated		Shear force Factored	
		max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
		m	m	kN.m/m		kN.m/m		kN/m	kN/m	kN/m	kN/m
1	38.50	0.000	0.000	0	-0	0	-0	0	0	0	0
2	38.45	0.000	0.000	0	-0	0	-0	0	-18	0	-25
3	38.22	0.001	0.000	0	-4	0	-6	0	-18	0	-25
4	38.00	0.001	0.000	0	-8	0	-11	1	-18	1	-24
5	37.75	0.002	0.000	1	-13	1	-17	2	-16	2	-22
6	37.50	0.002	0.000	1	-17	1	-23	2	-15	3	-20
7	37.15	0.002	0.000	1	-22	2	-29	1	-12	1	-16
8	36.80	0.003	0.000	1	-25	2	-33	0	-10	0	-13
9	36.40	0.003	0.000	1	-27	2	-37	3	-6	4	-8
10	36.00	0.003	0.000	1	-29	1	-39	13	-1	18	-1
11	35.60	0.003	0.000	0	-28	1	-38	26	-1	35	-1
12	35.32	0.003	0.000	0	-26	0	-35	37	-1	50	-1
13	35.03	0.003	0.000	7	-22	9	-29	48	-29	65	-39
14	34.72	0.003	0.000	0	-16	0	-21	25	-15	33	-20
15	34.34	0.003	0.000	0	-4	0	-5	41	-7	55	-9
16	34.00	0.003	0.000	7	-5	10	-7	22	-3	30	-4
17	33.60	0.003	0.000	12	-5	16	-7	6	0	9	0
18	33.20	0.002	0.000	12	-4	16	-6	3	-4	4	-6
19	32.80	0.002	0.000	9	-3	12	-4	4	-8	6	-11
20	32.40	0.002	0.000	5	-2	7	-2	4	-9	6	-12
21	32.00	0.002	0.000	2	-1	3	-1	3	-7	4	-9
22	31.75	0.002	0.000	1	-0	1	-0	2	-4	3	-5
23	31.50	0.001	0.000	0	0	0	0	0	0	0	0

Summary of results (continued)

Calculated Bending Moments and Strut Forces have been multiplied by a factor of 1.35 to obtain values for structural design.

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment						Shear force					
	Calculated				Factored		Calculated				Factored	
no.	max.	elev.	min.	elev.	max.	min.	max.	elev.	min.	elev.	max.	min.
	kN.m/m		kN.m/m		kN.m/m		kN/m		kN/m		kN/m	kN/m
1	0	38.50	-0	35.60	0	-1	0	34.00	-0	36.80	0	-0
2	1	37.15	-0	34.00	2	-0	2	37.50	-1	36.00	3	-1
3	No calculation at this stage											
4	1	36.80	-0	34.00	2	-0	2	37.50	-1	36.00	3	-1
5	11	33.20	-28	36.00	15	-38	39	34.34	-18	38.45	53	-24
6	12	33.20	-29	36.00	16	-39	41	34.34	-18	38.45	55	-24
7	No calculation at this stage											
8	11	33.60	-24	36.00	15	-33	34	34.34	-15	38.45	46	-21
9	No calculation at this stage											
10	No calculation at this stage											
11	7	35.03	-26	36.40	9	-35	48	35.03	-29	35.03	65	-39

Maximum and minimum displacement at each stage

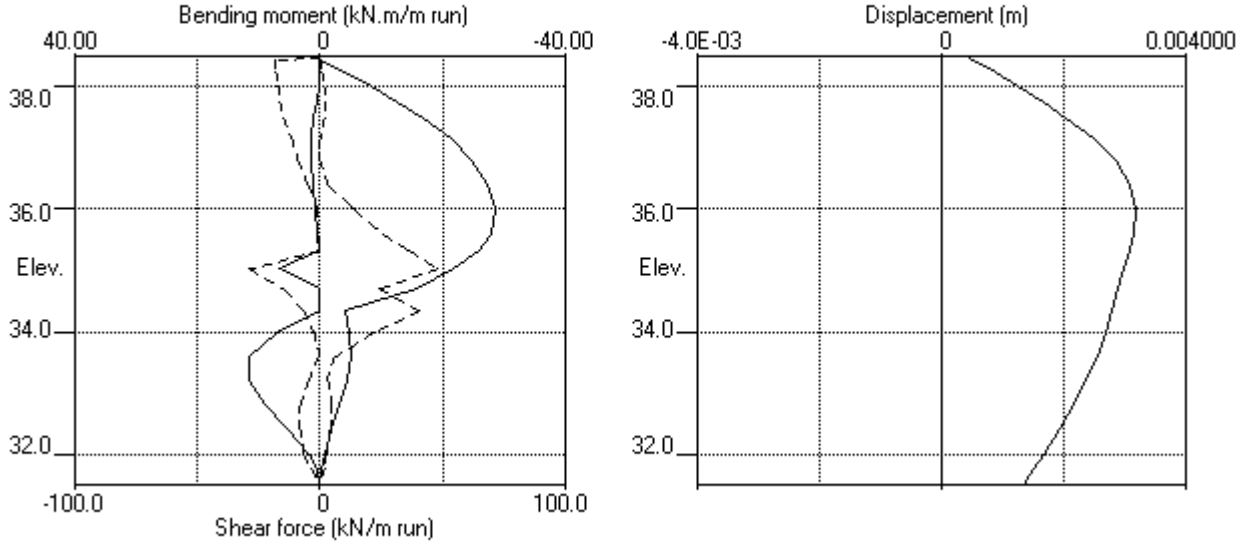
Stage	Displacement				Stage description
no.	maximum	elev.	minimum	elev.	
	m		m		
1	0.000	34.34	0.000	38.50	Apply surcharge no.1 at elev. 38.50
2	0.000	38.50	0.000	38.50	Excav. to elev. 38.00 on RIGHT side
3	No calculation at this stage				Install strut no.1 at elev. 38.45
4	0.000	38.50	0.000	38.50	Apply water pressure profile no.1
5	0.003	35.60	0.000	38.50	Excav. to elev. 34.34 on RIGHT side
6	0.003	35.60	0.000	38.50	Fill to elev. 34.72 on RIGHT side
7	No calculation at this stage				Install strut no.2 at elev. 35.03
8	0.003	36.00	0.000	38.50	Change EI of wall to 24308kN.m2/m run
9	No calculation at this stage				Change soil type 2 to soil type 3
10	No calculation at this stage				Apply surcharge no.2 at elev. 34.72
11	0.003	36.00	0.000	38.50	Apply water pressure profile no.2

Strut forces at each stage (horizontal components)

Stage	Strut no. 1 at elev. 38.45			Strut no. 2 at elev. 35.03		
	Calculated		Factored	Calculated		Factored
no.	kN per m run	kN per strut	kN per strut	kN per m run	kN per strut	kN per strut
4	slack	slack	slack	---	---	---
5	18	18	24	---	---	---
6	18	18	24	---	---	---
8	15	15	21	9	9	12
11	18	18	25	77	77	104

Units: kN,m

Bending moment, shear force, displacement envelopes



WALLAP

1-ULS2

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	38.50	1 Made Ground dr	1 Made Ground dr
2	37.50	2 London Clay und	2 London Clay und

SOIL PROPERTIES (Unfactored SLS soil strengths)

No.	-- Soil type -- Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Made Ground dr	18.00	10000	0.577	OC (0.250)	0.323 (0.000)	3.647 (0.000)	
2	London Cl.. (37.50)	20.00	52500 (2625)	1.300	OC (0.490)	1.000 (2.476)	1.000 (2.390)	70.00u (3.500)
3	London Cl.. (37.50)	20.00	39375 (1968)	1.300	OC (0.200)	0.351 (1.391)	3.253 (4.831)	0.0d

Additional soil parameters associated with Ka and Kp

No.	Soil type Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Made Ground dr	27.00	0.670	0.00	27.00	0.500	0.00
2	London Clay und	0.00	0.670	0.00	0.00	0.500	0.00
3	London Clay dr	25.00	0.670	0.00	25.00	0.500	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	36.00	36.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	36.00	36.00	0.0	1	34.00	34.00	0.0	MC+WC
2	1	37.50	37.50	0.0	1	34.72	34.72	0.0	MC+WC
					2	34.72	37.50	27.3	

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 31.50
Maximum finite element length = 0.40 m
Youngs modulus of wall E = 2.3100E+07 kN/m2
Moment of inertia of wall I = 1.4732E-03 m4/m run
E.I = 34032 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Strut/ anchor no.	Elev.	Strut spacing m	X-section area of strut sq.m	Youngs modulus kN/m2	Free length m	Inclin -ation (degs)	Pre- stress /strut kN	Tension allowed
1	38.45	1.00	0.250000	1.650E+07	5.00	0.00	0	No
2	35.03	1.00	0.350000	1.650E+07	5.00	0.00	0	No

SURCHARGE LOADS

Surch -arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge ----- kN/m2 ----- Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	38.50	0.50(L)	20.00	20.00	10.00	=	N/A	1.30 Var
2	34.72	-0.00(R)	10.00	10.00	28.00	=	N/A	1.00 P/F

Note: L = Left side, R = Right side
Limit State Categories P/U = Permanent Unfavourable
P/F = Permanent Favourable
Var = Variable (unfavourable)

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 38.50
2	Excavate to elevation 38.00 on RIGHT side
3	Install strut or anchor no.1 at elevation 38.45
4	Apply water pressure profile no.1 (Worst Cred.)
5	Excavate to elevation 34.34 on RIGHT side
6	Fill to elevation 34.72 on RIGHT side with soil type 1
7	Install strut or anchor no.2 at elevation 35.03
8	Change EI of wall to 24308 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value
9	Change properties of soil type 2 to soil type 3 No analysis at this stage Ko pressures will not be reset
10	Apply surcharge no.2 at elevation 34.72 No analysis at this stage
11	Apply water pressure profile no.2 (Worst Cred.)

FACTORS OF SAFETY and ANALYSIS OPTIONS

Limit State options: ULS DA1 Combination 2
Water pressures : Worst Credible
Partial factor on C' = 1.250
Partial factor on Phi' = 1.250
Partial factor on Cu = 1.400
Partial factor on Soil Modulus = 1.000
Partial factor on Permanent Unfavourable loads = 1.000
Partial factor on Permanent Favourable loads = 1.000
Partial factor on Variable Unfavourable loads = 1.300

Stability analysis:
Method of analysis - Strength Factor method
Overall factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:
Minimum equivalent fluid density = 5.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 7.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 50.00 m

Width of excavation on Left side of wall = 50.00 m
Width of excavation on Right side of wall = 50.00 m

Distance to rigid boundary on Left side = 50.00 m
Distance to rigid boundary on Right side = 50.00 m

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 38.50	No	No	No
2	Excav. to elev. 38.00 on RIGHT side	Yes	Yes	Yes
3	Install strut no.1 at elev. 38.45	Yes	Yes	Yes
4	Apply water pressure profile no.1	Yes	Yes	Yes
5	Excav. to elev. 34.34 on RIGHT side	Yes	Yes	Yes
6	Fill to elev. 34.72 on RIGHT side	Yes	Yes	Yes
7	Install strut no.2 at elev. 35.03	Yes	Yes	Yes
8	Change EI of wall to 24308kN.m2/m run	Yes	Yes	Yes
9	Change soil type 2 to soil type 3	Yes	Yes	Yes
10	Apply surcharge no.2 at elev. 34.72	Yes	Yes	Yes
11	Apply water pressure profile no.2	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 38.50

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Overall FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	38.50	38.50	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall
Limit State: ULS DA1 Combination 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-3.02E-05	0.0	-0.0		34032
2	38.45	-0.54	0.000	-3.02E-05	-0.0	-0.0		34032
3	38.22	-0.55	0.000	-3.02E-05	-0.1	-0.0		34032
4	38.00	-0.01	0.000	-2.99E-05	-0.2	-0.1		34032
5	37.75	0.60	0.000	-2.94E-05	-0.1	-0.1		34032
6	37.50	1.08	0.000	-2.87E-05	0.1	-0.1		34032
		-1.44	0.000	-2.87E-05	0.1	-0.1		
7	37.15	-0.47	0.000	-2.75E-05	-0.2	-0.1		34032
8	36.80	0.03	0.000	-2.56E-05	-0.3	-0.2		34032
9	36.40	0.26	0.000	-2.23E-05	-0.3	-0.3		34032
10	36.00	0.31	0.000	-1.79E-05	-0.2	-0.4		34032
11	35.60	0.27	0.000	-1.30E-05	-0.0	-0.4		34032
12	35.32	0.22	0.000	-9.42E-06	0.0	-0.4		34032
13	35.03	0.16	0.000	-5.89E-06	0.1	-0.4		34032
14	34.72	0.10	0.000	-2.31E-06	0.1	-0.4		34032
15	34.34	0.04	0.000	1.54E-06	0.2	-0.3		34032
16	34.00	0.00	0.000	4.43E-06	0.2	-0.3		34032
17	33.60	-0.03	0.000	7.10E-06	0.2	-0.2		34032
18	33.20	-0.05	0.000	9.04E-06	0.1	-0.1		34032
19	32.80	-0.06	0.000	1.03E-05	0.1	-0.1		34032
20	32.40	-0.08	0.000	1.10E-05	0.1	-0.0		34032
21	32.00	-0.09	0.000	1.13E-05	0.1	-0.0		34032
22	31.75	-0.11	0.000	1.14E-05	0.0	-0.0		34032
23	31.50	-0.13	0.000	1.14E-05	0.0	-0.0		---

(continued)

Stage No.1 Apply surcharge no.1 at elevation 38.50

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	2189
2	38.45	0.00	0.92	0.37	2.58	0.37	0.37a	2189
3	38.22	0.00	5.63	2.23	15.69	2.70	2.70	2189
4	38.00	0.00	11.36	4.50	31.67	5.58	5.58	2189
5	37.75	0.00	17.81	7.05	49.66	8.81	8.81	2189
6	37.50	0.00	23.85	9.43	66.48	11.90	11.90	2189
		Total>	23.85	5.00m	143.35	25.49	25.49	17854
7	37.15	Total>	32.36	6.75m	153.95	35.80	35.80	18166
8	36.80	Total>	40.37	8.50m	164.06	45.63	45.63	18478
9	36.40	Total>	49.15	10.50m	175.23	56.53	56.53	18836
10	36.00	Total>	57.69	12.50m	186.17	67.21	67.21	19193
11	35.60	Total>	66.08	14.50m	196.94	76.60	76.60	19550
12	35.32	Total>	71.98	15.92m	204.55	83.24	83.24	19804
13	35.03	Total>	77.84	17.35m	212.12	89.86	89.86	20059
14	34.72	Total>	84.18	18.90m	220.30	97.05	97.05	20335
15	34.34	Total>	91.90	20.80m	230.29	105.84	105.84	20674
16	34.00	Total>	98.77	22.50m	239.20	113.69	113.69	20978
17	33.60	Total>	106.81	24.50m	249.63	122.92	122.92	21335
18	33.20	Total>	114.83	26.50m	260.04	132.14	132.14	21692
19	32.80	Total>	122.81	28.50m	270.41	141.34	141.34	22049
20	32.40	Total>	130.77	30.50m	280.77	150.54	150.54	22406
21	32.00	Total>	138.72	32.50m	291.10	159.73	159.73	22763
22	31.75	Total>	143.67	33.75m	297.55	165.46	165.46	22986
23	31.50	Total>	148.62	35.00m	303.99	171.19	171.19	23210

RIGHT side

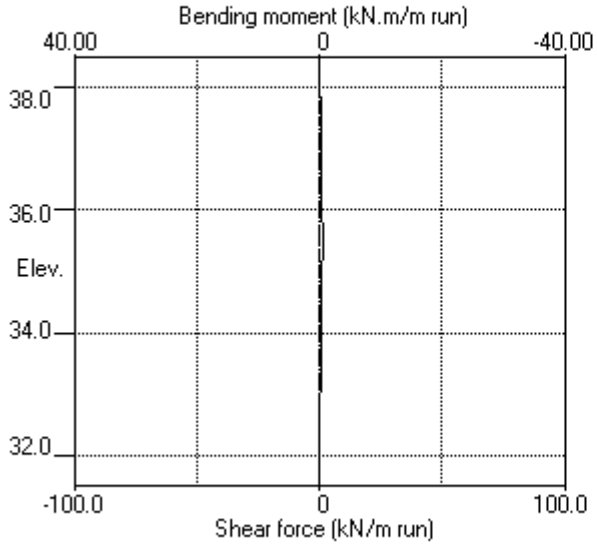
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	2189
2	38.45	0.00	0.92	0.36	2.56	0.90	0.90	2189
3	38.22	0.00	4.96	1.96	13.83	3.25	3.25	2189
4	38.00	0.00	9.00	3.56	25.09	5.59	5.59	2189
5	37.75	0.00	13.50	5.34	37.64	8.21	8.21	2189
6	37.50	0.00	18.00	7.12	50.18	10.82	10.82	2189
		Total>	18.00	5.00m	137.50	26.93	26.93	17854
7	37.15	Total>	25.00	6.75m	146.59	36.27	36.27	18166
8	36.80	Total>	32.00	8.50m	155.69	45.61	45.61	18478
9	36.40	Total>	40.00	10.50m	166.08	56.27	56.27	18836
10	36.00	Total>	48.00	12.50m	176.47	66.90	66.90	19193
11	35.60	Total>	56.00	14.50m	186.86	76.33	76.33	19550
12	35.32	Total>	61.70	15.92m	194.27	83.03	83.03	19804
13	35.03	Total>	67.40	17.35m	201.67	89.70	89.70	20059
14	34.72	Total>	73.60	18.90m	209.72	96.94	96.94	20335
15	34.34	Total>	81.20	20.80m	219.59	105.79	105.79	20674
16	34.00	Total>	88.00	22.50m	228.43	113.69	113.69	20978
17	33.60	Total>	96.00	24.50m	238.82	122.95	122.95	21335
18	33.20	Total>	104.00	26.50m	249.21	132.19	132.19	21692
19	32.80	Total>	112.00	28.50m	259.60	141.41	141.41	22049
20	32.40	Total>	120.00	30.50m	269.99	150.62	150.62	22406
21	32.00	Total>	128.00	32.50m	280.38	159.82	159.82	22763
22	31.75	Total>	133.00	33.75m	286.87	165.57	165.57	22986
23	31.50	Total>	138.00	35.00m	293.37	171.32	171.32	23210

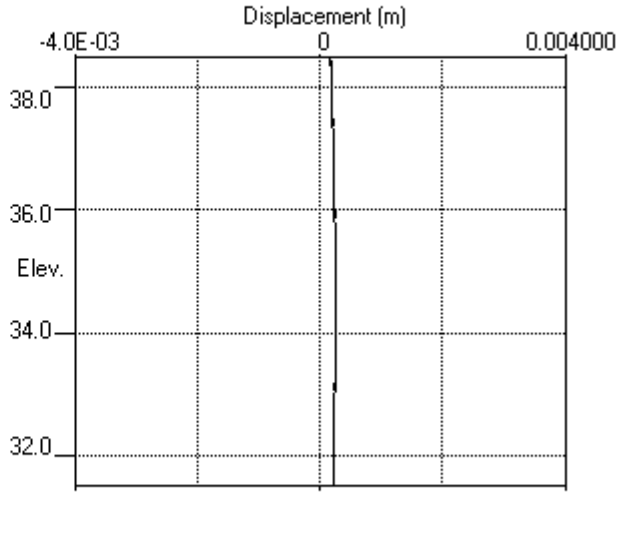
(continued)

Stage No.1 Apply surcharge no.1 at elevation 38.50
Note: 0.37a Soil pressure at active limit
123.45p Soil pressure at passive limit

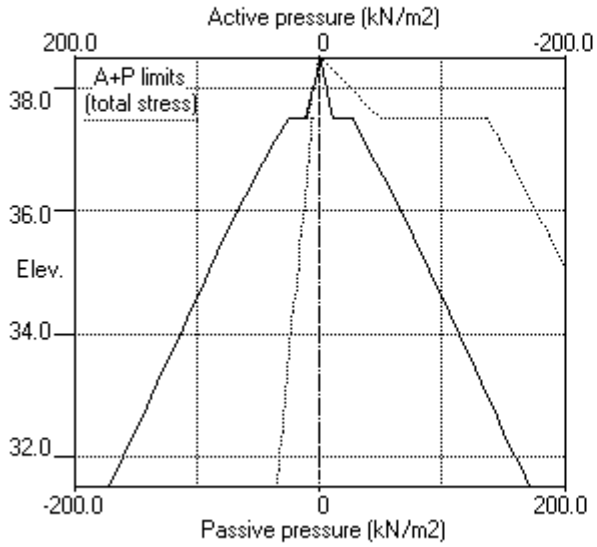
Units: kN,m

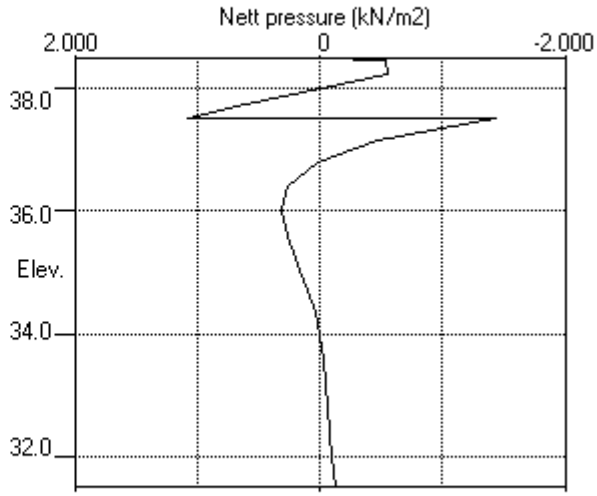
Stage No.1 Apply surcharge no.1 at elev. 38.50





Stage No.1 Apply surcharge no.1 at elev. 38.50





Units: kN,m

Stage No. 2 Excavate to elevation 38.00 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Overall FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
2	38.50	38.00	Cant.	12.451	31.75	37.45	0.55	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall
Limit State: ULS DA1 Combination 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	7.42E-05	0.0	-0.0		34032
2	38.45	0.37	0.000	7.42E-05	0.0	0.0		34032
3	38.22	2.23	0.000	7.41E-05	0.3	0.0		34032
4	38.00	4.50	0.000	7.34E-05	1.1	0.2		34032
5	37.75	1.57	0.000	7.07E-05	1.8	0.6		34032
6	37.50	2.25	0.000	6.46E-05	2.3	1.1		34032
		-6.37	0.000	6.46E-05	2.3	1.1		
7	37.15	-3.76	0.000	5.13E-05	0.5	1.5		34032
8	36.80	-1.92	0.000	3.58E-05	-0.5	1.5		34032
9	36.40	-0.55	0.000	2.02E-05	-1.0	1.2		34032
10	36.00	0.22	0.000	9.06E-06	-1.0	0.7		34032
11	35.60	0.58	0.000	2.55E-06	-0.9	0.4		34032
12	35.32	0.66	0.000	4.78E-07	-0.7	0.1		34032
13	35.03	0.65	0.000	5.62E-08	-0.5	-0.0		34032
14	34.72	0.57	0.000	9.52E-07	-0.3	-0.2		34032
15	34.34	0.44	0.000	3.20E-06	-0.1	-0.2		34032
16	34.00	0.31	0.000	5.71E-06	-0.0	-0.3		34032
17	33.60	0.18	0.000	8.64E-06	0.1	-0.2		34032
18	33.20	0.07	0.000	1.11E-05	0.1	-0.2		34032
19	32.80	-0.02	0.000	1.29E-05	0.2	-0.1		34032
20	32.40	-0.08	0.000	1.41E-05	0.1	-0.1		34032
21	32.00	-0.14	0.000	1.46E-05	0.1	-0.0		34032
22	31.75	-0.17	0.000	1.47E-05	0.0	-0.0		34032
23	31.50	-0.21	0.000	1.47E-05	0.0	-0.0		---

(continued)

Stage No.2 Excavate to elevation 38.00 on RIGHT side

LEFT side

Node no.	Y coord	Effective stresses: Water press. kN/m2	Vertic-al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	4185
2	38.45	0.00	0.92	0.37	2.58	0.37	0.37a	4185
3	38.22	0.00	5.63	2.23	15.69	2.23	2.23a	4185
4	38.00	0.00	11.36	4.50	31.67	4.50	4.50a	4185
5	37.75	0.00	17.81	7.05	49.66	7.78	7.78	4185
6	37.50	0.00	23.85	9.43	66.48	10.97	10.97	4185
		Total>	23.85	5.00m	143.35	18.59	18.59	30940
7	37.15	Total>	32.36	6.75m	153.95	29.74	29.74	31481
8	36.80	Total>	40.37	8.50m	164.06	40.25	40.25	32023
9	36.40	Total>	49.15	10.50m	175.23	51.72	51.72	32641
10	36.00	Total>	57.69	12.50m	186.17	62.77	62.77	33260
11	35.60	Total>	66.08	14.50m	196.94	72.36	72.36	33879
12	35.32	Total>	71.98	15.92m	204.55	79.07	79.07	34320
13	35.03	Total>	77.84	17.35m	212.12	85.72	85.72	34761
14	34.72	Total>	84.18	18.90m	220.30	92.89	92.89	35240
15	34.34	Total>	91.90	20.80m	230.29	101.64	101.64	35828
16	34.00	Total>	98.77	22.50m	239.20	109.45	109.45	36354
17	33.60	Total>	106.81	24.50m	249.63	118.63	118.63	36973
18	33.20	Total>	114.83	26.50m	260.04	127.81	127.81	37592
19	32.80	Total>	122.81	28.50m	270.41	136.98	136.98	38210
20	32.40	Total>	130.77	30.50m	280.77	146.15	146.15	38829
21	32.00	Total>	138.72	32.50m	291.10	155.32	155.32	39448
22	31.75	Total>	143.67	33.75m	297.55	161.04	161.04	39835
23	31.50	Total>	148.62	35.00m	303.99	166.76	166.76	40222

RIGHT side

Node no.	Y coord	Effective stresses: Water press. kN/m2	Vertic-al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	4041
5	37.75	0.00	4.50	1.78	12.55	6.21	6.21	4041
6	37.50	0.00	9.00	3.56	25.09	8.72	8.72	4041
		Total>	9.00	2.50m	128.50	24.96	24.96	29970
7	37.15	Total>	16.00	4.25m	137.59	33.49	33.49	30494
8	36.80	Total>	23.00	6.00m	146.69	42.17	42.17	31018
9	36.40	Total>	31.00	8.00m	157.08	52.27	52.27	31618
10	36.00	Total>	39.00	10.00m	167.47	62.55	62.55	32217
11	35.60	Total>	47.00	12.00m	177.86	71.79	71.79	32817
12	35.32	Total>	52.70	13.42m	185.26	78.42	78.42	33244
13	35.03	Total>	58.40	14.85m	192.67	85.07	85.07	33671
14	34.72	Total>	64.60	16.40m	200.72	92.32	92.32	34135
15	34.34	Total>	72.20	18.30m	210.59	101.21	101.21	34705
16	34.00	Total>	79.00	20.00m	219.43	109.14	109.14	35214
17	33.60	Total>	87.00	22.00m	229.82	118.45	118.45	35814
18	33.20	Total>	95.00	24.00m	240.21	127.74	127.74	36413
19	32.80	Total>	103.00	26.00m	250.60	136.99	136.99	37012
20	32.40	Total>	111.01	28.00m	260.99	146.23	146.23	37612
21	32.00	Total>	119.01	30.00m	271.38	155.46	155.46	38211
22	31.75	Total>	124.01	31.25m	277.88	161.22	161.22	38586

(continued)

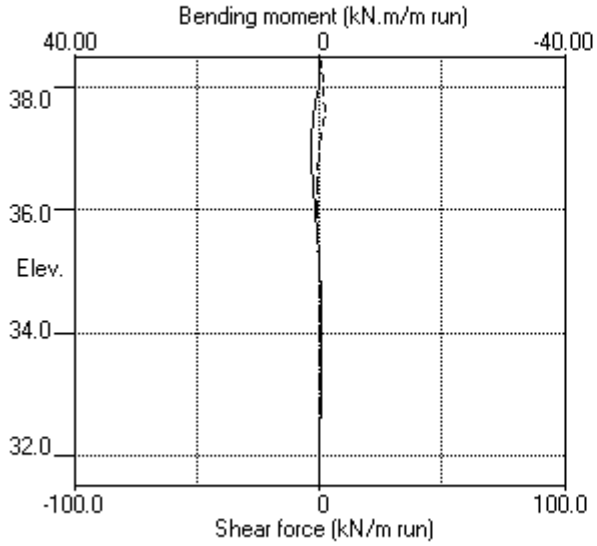
Stage No.2 Excavate to elevation 38.00 on RIGHT side

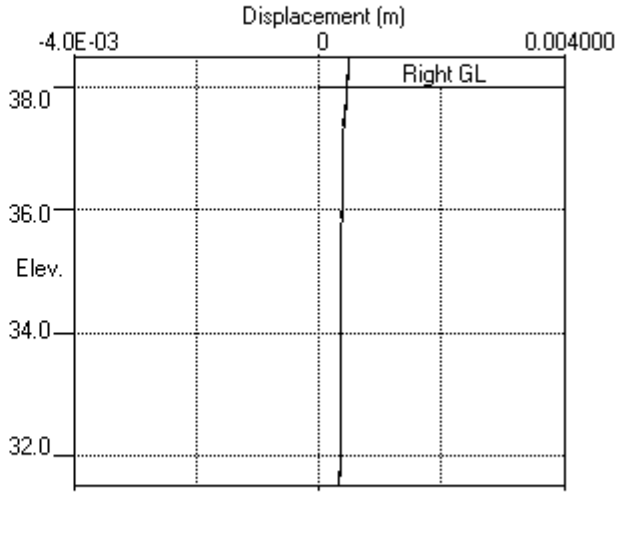
Node no.	Y coord	RIGHT side						
		Water press. kN/m2	Effective stresses Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
23	31.50	Total>	129.01	32.50m	284.38	166.97	166.97	38960

Note: 4.50a Soil pressure at active limit
123.45p Soil pressure at passive limit

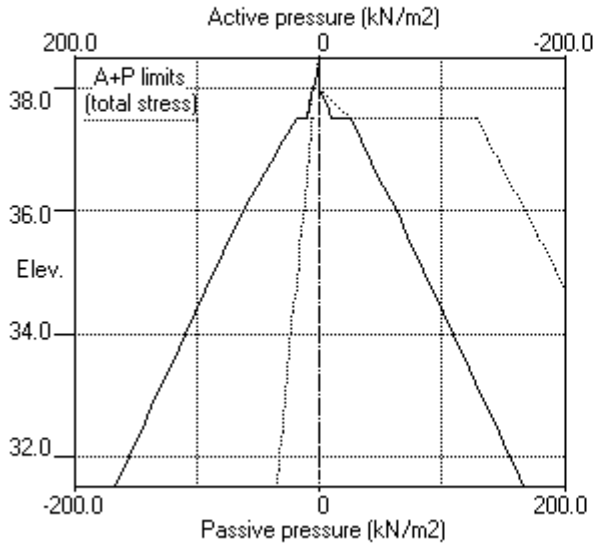
Units: kN,m

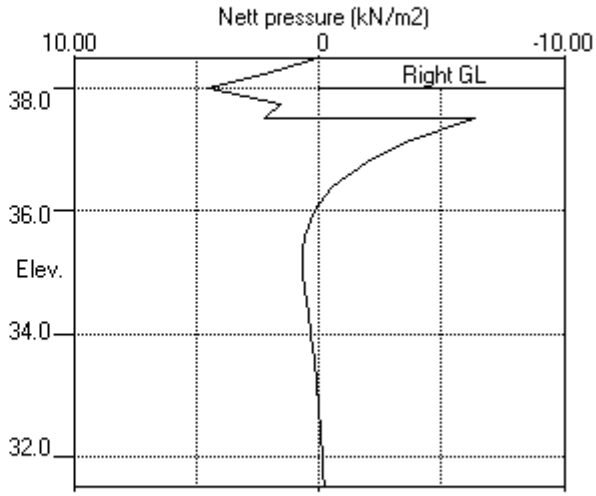
Stage No.2 Excav. to elev. 38.00 on RIGHT side





Stage No.2 Excav. to elev. 38.00 on RIGHT side





Units: kN,m

Stage No. 4 Apply water pressure profile no.1 (Worst Cred.)

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Overall FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
4	38.50	38.00	38.45	14.756	n/a	37.73	0.27	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m

Subgrade reaction model - Boussinesq Influence coefficients

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	7.22E-05	0.0	-0.0		34032
2	38.45	0.39	0.000	7.22E-05	0.0	0.0	-0.0	34032
3	38.22	2.25	0.000	7.21E-05	0.3	0.0		34032
4	38.00	4.51	0.000	7.14E-05	1.1	0.2		34032
5	37.75	1.60	0.000	6.86E-05	1.8	0.6		34032
6	37.50	2.27	0.000	6.26E-05	2.3	1.1		34032
		-6.25	0.000	6.26E-05	2.3	1.1		
7	37.15	-3.73	0.000	4.90E-05	0.6	1.5		34032
8	36.80	-1.95	0.000	3.33E-05	-0.4	1.5		34032
9	36.40	-0.64	0.000	1.71E-05	-0.9	1.2		34032
10	36.00	0.07	0.000	5.22E-06	-1.1	0.8		34032
11	35.60	0.49	0.000	-1.85E-06	-0.9	0.4		34032
12	35.32	0.62	0.000	-4.17E-06	-0.8	0.2		34032
13	35.03	0.64	0.000	-4.63E-06	-0.6	-0.0		34032
14	34.72	0.61	0.000	-3.52E-06	-0.4	-0.2		34032
15	34.34	0.53	0.000	-6.97E-07	-0.2	-0.3		34032
16	34.00	0.46	0.000	2.54E-06	-0.0	-0.3		34032
17	33.60	0.26	0.000	6.41E-06	0.1	-0.3		34032
18	33.20	0.10	0.000	9.74E-06	0.2	-0.3		34032
19	32.80	-0.02	0.000	1.22E-05	0.2	-0.2		34032
20	32.40	-0.11	0.000	1.37E-05	0.2	-0.1		34032
21	32.00	-0.19	0.000	1.44E-05	0.1	-0.0		34032
22	31.75	-0.23	0.000	1.45E-05	0.1	-0.0		34032
23	31.50	-0.28	0.000	1.46E-05	0.0	-0.0		---

At elev. 38.45 The strut is slack

(continued)

Stage No.4 Apply water pressure profile no.1 (Worst Cred.)

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	7489
2	38.45	0.00	0.92	0.37	2.58	0.39	0.39	7489
3	38.22	0.00	5.63	2.23	15.69	2.25	2.25	7489
4	38.00	0.00	11.36	4.50	31.67	4.51	4.51	7489
5	37.75	0.00	17.81	7.05	49.66	7.79	7.79	7489
6	37.50	0.00	23.85	9.43	66.48	10.98	10.98	7489
		Total>	23.85	5.00m	143.35	18.65	18.65	53474
7	37.15	Total>	32.36	6.75m	153.95	29.75	29.75	54410
8	36.80	Total>	40.37	8.50m	164.06	40.24	40.24	23257
9	36.40	Total>	49.15	10.50m	175.23	51.68	51.68	23707
10	36.00	Total>	57.69	12.50m	186.17	62.70	62.70	24156
11	35.60	Total>	66.08	14.50m	196.94	72.24	72.24	24606
12	35.32	Total>	71.98	15.92m	204.55	78.92	78.92	24926
13	35.03	Total>	77.84	17.35m	212.12	85.53	85.53	25246
14	34.72	Total>	84.18	18.90m	220.30	92.67	92.67	25594
15	34.34	Total>	91.90	20.80m	230.29	101.37	101.37	26021
16	34.00	Total>	98.77	22.50m	239.20	109.14	109.14	26403
17	33.60	Total>	106.81	24.50m	249.63	118.29	118.29	26853
18	33.20	Total>	114.83	26.50m	260.04	127.44	127.44	27302
19	32.80	Total>	122.81	28.50m	270.41	136.59	136.59	27752
20	32.40	Total>	130.77	30.50m	280.77	145.75	145.75	28201
21	32.00	Total>	138.72	32.50m	291.10	154.91	154.91	28650
22	31.75	Total>	143.67	33.75m	297.55	160.63	160.63	28931
23	31.50	Total>	148.62	35.00m	303.99	166.34	166.34	29212

RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	10075
5	37.75	0.00	4.50	1.78	12.55	6.19	6.19	10075
6	37.50	0.00	9.00	3.56	25.09	8.71	8.71	10075
		Total>	9.00	2.50m	128.50	24.89	24.89	71126
7	37.15	Total>	16.00	4.25m	137.59	33.48	33.48	72371
8	36.80	Total>	23.00	6.00m	146.69	42.19	42.19	23257
9	36.40	Total>	31.00	8.00m	157.08	52.32	52.32	23707
10	36.00	Total>	39.00	10.00m	167.47	62.63	62.63	24156
11	35.60	Total>	47.00	12.00m	177.86	71.75	71.75	24606
12	35.32	Total>	52.70	13.42m	185.27	78.31	78.31	24926
13	35.03	Total>	58.40	14.85m	192.67	84.89	84.89	25246
14	34.72	Total>	64.60	16.40m	200.72	92.06	92.06	25594
15	34.34	Total>	72.20	18.30m	210.60	100.84	100.84	26021
16	34.00	Total>	79.00	20.00m	219.43	108.68	108.68	26403
17	33.60	Total>	87.00	22.00m	229.82	118.03	118.03	26853
18	33.20	Total>	95.00	24.00m	240.21	127.34	127.34	27302
19	32.80	Total>	103.00	26.00m	250.61	136.61	136.61	27752
20	32.40	Total>	111.01	28.00m	261.00	145.86	145.86	28201
21	32.00	Total>	119.01	30.00m	271.39	155.09	155.09	28650
22	31.75	Total>	124.01	31.25m	277.88	160.86	160.86	28931

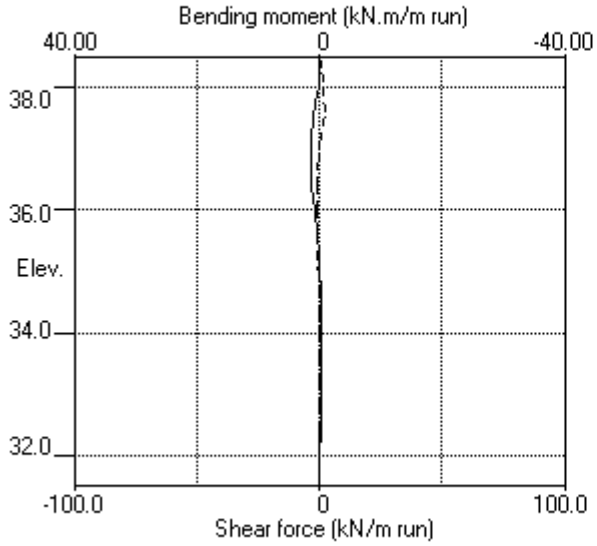
(continued)

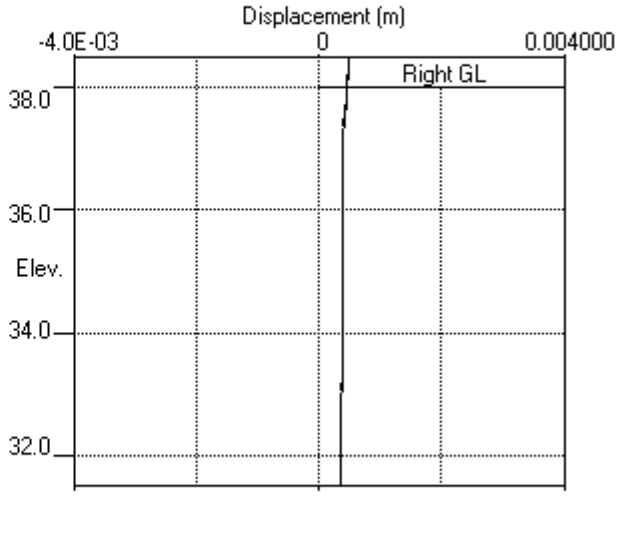
Stage No.4 Apply water pressure profile no.1 (Worst Cred.)

Node no.	Y coord	RIGHT side						
			Effective stresses				Total earth pressure	Coeff. of subgrade reaction
		Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	kN/m2	kN/m3
23	31.50	Total>	129.01	32.50m	284.38	166.62	166.62	29212

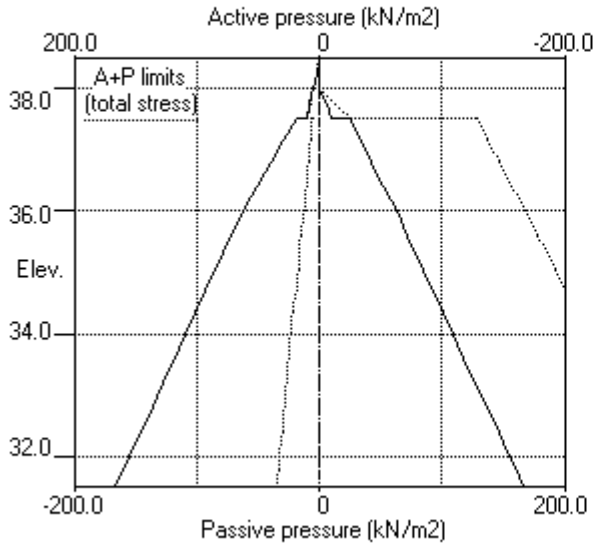
Units: kN,m

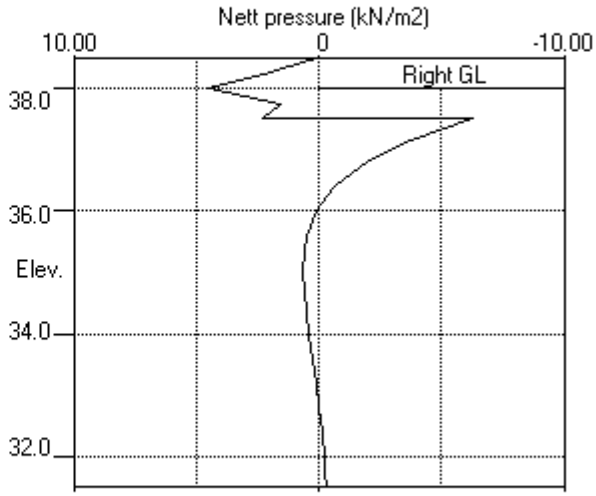
Stage No.4 Apply water pressure profile no.1 (Worst Cred.)





Stage No.4 Apply water pressure profile no.1 (Worst Cred.)





Units: kN,m

Stage No. 5 Excavate to elevation 34.34 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Overall FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
5	38.50	34.34	38.45	2.898	n/a	34.11	0.23	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall
Limit State: ULS DA1 Combination 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.53E-03	0.0	-0.0		34032
2	38.45	0.37	0.001	-1.53E-03	0.0	0.0	18.4	34032
		0.37	0.001	-1.53E-03	-18.4	0.0		
3	38.22	2.23	0.001	-1.51E-03	-18.1	-4.1		34032
4	38.00	4.50	0.001	-1.47E-03	-17.4	-8.1		34032
5	37.75	7.05	0.002	-1.40E-03	-15.9	-12.3		34032
6	37.50	9.43	0.002	-1.29E-03	-13.9	-16.0		34032
		5.00	0.002	-1.29E-03	-13.9	-16.0		
7	37.15	6.75	0.002	-1.11E-03	-11.8	-20.5		34032
8	36.80	8.50	0.003	-8.81E-04	-9.1	-24.2		34032
9	36.40	10.50	0.003	-5.79E-04	-5.3	-27.2		34032
10	36.00	12.50	0.003	-2.52E-04	-0.7	-28.4		34032
11	35.60	14.50	0.003	7.72E-05	4.7	-27.7		34032
12	35.32	15.92	0.003	3.00E-04	9.0	-25.7		34032
13	35.03	24.07	0.003	4.99E-04	14.7	-21.6		34032
14	34.72	34.73	0.003	6.69E-04	23.8	-15.8		34032
15	34.34	49.26	0.003	7.79E-04	39.8	-4.0		34032
		-60.31	0.003	7.79E-04	39.8	-4.0		
16	34.00	-45.97	0.002	7.69E-04	21.7	6.0		34032
17	33.60	-30.18	0.002	6.68E-04	6.5	11.0		34032
18	33.20	-16.89	0.002	5.38E-04	-3.0	11.2		34032
19	32.80	-6.39	0.002	4.21E-04	-7.6	8.7		34032
20	32.40	1.84	0.001	3.40E-04	-8.5	5.1		34032
21	32.00	8.75	0.001	2.99E-04	-6.4	1.9		34032
22	31.75	12.81	0.001	2.90E-04	-3.7	0.5		34032
23	31.50	16.87	0.001	2.88E-04	0.0	-0.0		---

At elev. 38.45 Strut force = 18.4 kN/strut = 18.4 kN/m run

(continued)

Stage No.5 Excavate to elevation 34.34 on RIGHT side

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	37965
2	38.45	0.00	0.92	0.37	2.58	0.37	0.37a	2682
3	38.22	0.00	5.63	2.23	15.69	2.23	2.23a	2682
4	38.00	0.00	11.36	4.50	31.67	4.50	4.50a	2682
5	37.75	0.00	17.81	7.05	49.66	7.05	7.05a	2682
6	37.50	0.00	23.85	9.43	66.48	9.43	9.43a	2682
		Total>	23.85	5.00m	143.35	5.00	5.00a	20908
7	37.15	Total>	32.36	6.75m	153.95	6.75	6.75a	21274
8	36.80	Total>	40.37	8.50m	164.06	8.50	8.50a	21640
9	36.40	Total>	49.15	10.50m	175.23	10.50	10.50a	22058
10	36.00	Total>	57.69	12.50m	186.17	12.50	12.50a	22476
11	35.60	Total>	66.08	14.50m	196.94	14.50	14.50a	22894
12	35.32	Total>	71.98	15.92m	204.55	15.92	15.92a	23192
13	35.03	Total>	77.84	17.35m	212.12	24.07	24.07	23490
14	34.72	Total>	84.18	18.90m	220.30	34.73	34.73	23814
15	34.34	Total>	91.90	20.80m	230.29	49.26	49.26	24211
16	34.00	Total>	98.77	22.50m	239.20	62.80	62.80	24567
17	33.60	Total>	106.81	24.50m	249.63	78.34	78.34	24985
18	33.20	Total>	114.83	26.50m	260.04	92.87	92.87	25403
19	32.80	Total>	122.81	28.50m	270.41	106.28	106.28	25821
20	32.40	Total>	130.77	30.50m	280.77	118.77	118.77	26239
21	32.00	Total>	138.72	32.50m	291.10	130.72	130.72	26658
22	31.75	Total>	143.67	33.75m	297.55	138.08	138.08	26919
23	31.50	Total>	148.62	35.00m	303.99	145.45	145.45	27180

RIGHT side

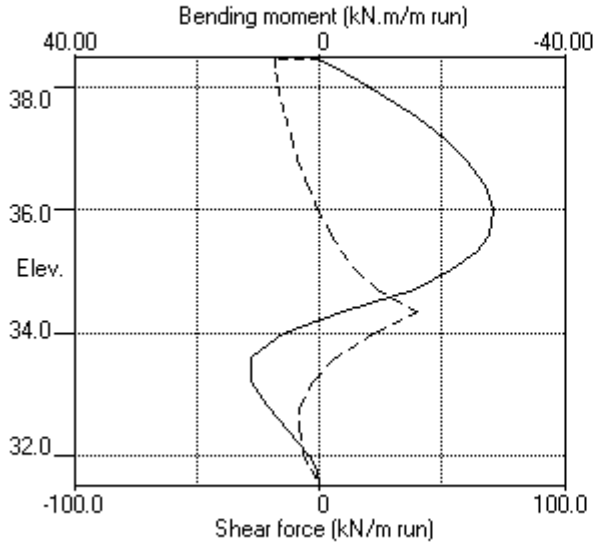
Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	34.34	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	138.38	109.57	109.57	36284
16	34.00	Total>	6.80	1.70m	147.21	108.77	108.77	36816
17	33.60	Total>	14.80	3.70m	157.60	108.52	108.52	37443
18	33.20	Total>	22.80	5.70m	167.99	109.76	109.76	38070
19	32.80	Total>	30.80	7.70m	178.38	112.67	112.67	38696
20	32.40	Total>	38.80	9.70m	188.78	116.93	116.93	39323
21	32.00	Total>	46.80	11.70m	199.17	121.97	121.97	39949
22	31.75	Total>	51.80	12.95m	205.66	125.28	125.28	40341
23	31.50	Total>	56.81	14.20m	212.16	128.57	128.57	40733

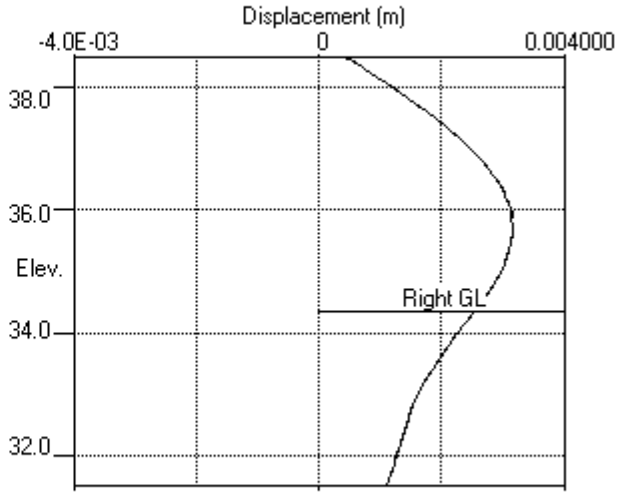
(continued)

Stage No.5 Excavate to elevation 34.34 on RIGHT side
Note: 15.92a Soil pressure at active limit
123.45p Soil pressure at passive limit

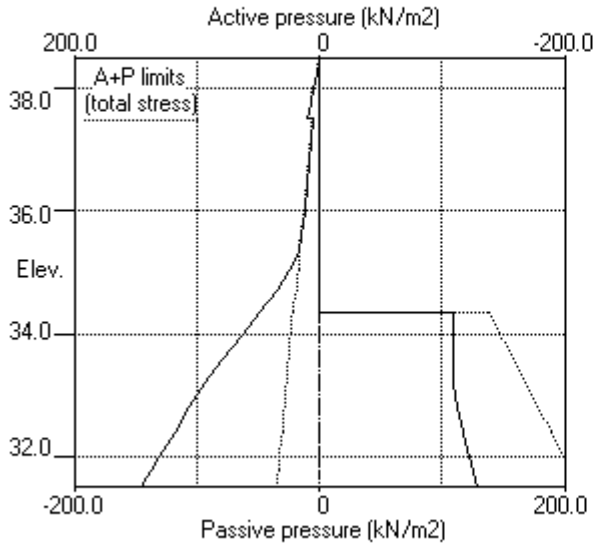
Units: kN,m

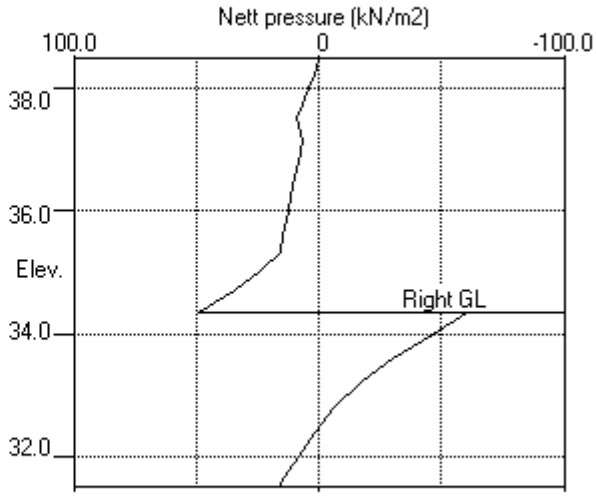
Stage No.5 Excav. to elev. 34.34 on RIGHT side





Stage No.5 Excav. to elev. 34.34 on RIGHT side





Units: kN,m

Stage No. 6 Fill to elevation 34.72 on RIGHT side with soil type 1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Overall FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
6	38.50	34.72	38.45	3.084	n/a	34.15	0.57	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.53E-03	0.0	-0.0		34032
2	38.45	0.37	0.001	-1.53E-03	0.0	0.0	18.7	34032
		0.37	0.001	-1.53E-03	-18.7	0.0		
3	38.22	2.23	0.001	-1.51E-03	-18.4	-4.2		34032
4	38.00	4.50	0.001	-1.47E-03	-17.7	-8.2		34032
5	37.75	7.05	0.002	-1.40E-03	-16.2	-12.5		34032
6	37.50	9.43	0.002	-1.29E-03	-14.1	-16.3		34032
		5.00	0.002	-1.29E-03	-14.1	-16.3		
7	37.15	6.77	0.002	-1.10E-03	-12.1	-20.9		34032
8	36.80	8.59	0.003	-8.71E-04	-9.4	-24.7		34032
9	36.40	10.72	0.003	-5.63E-04	-5.5	-27.7		34032
10	36.00	12.91	0.003	-2.30E-04	-0.8	-29.0		34032
11	35.60	15.19	0.003	1.06E-04	4.8	-28.3		34032
12	35.32	16.86	0.003	3.34E-04	9.4	-26.3		34032
13	35.03	25.29	0.003	5.36E-04	15.4	-22.0		34032
14	34.72	36.29	0.003	7.09E-04	24.9	-15.9		34032
15	34.34	48.55	0.002	8.18E-04	41.0	-3.6		34032
		-62.88	0.002	8.18E-04	41.0	-3.6		
16	34.00	-47.80	0.002	8.02E-04	22.2	6.7		34032
17	33.60	-31.26	0.002	6.94E-04	6.4	11.8		34032
18	33.20	-17.39	0.002	5.55E-04	-3.3	11.8		34032
19	32.80	-6.48	0.001	4.32E-04	-8.1	9.1		34032
20	32.40	2.07	0.001	3.47E-04	-9.0	5.4		34032
21	32.00	9.22	0.001	3.04E-04	-6.7	1.9		34032
22	31.75	13.42	0.001	2.94E-04	-3.9	0.6		34032
23	31.50	17.63	0.001	2.92E-04	0.0	-0.0		---

At elev. 38.45 Strut force = 18.7 kN/strut = 18.7 kN/m run

(continued)

Stage No.6 Fill to elevation 34.72 on RIGHT side with soil type 1

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	6596
2	38.45	0.00	0.92	0.37	2.58	0.37	0.37a	6596
3	38.22	0.00	5.63	2.23	15.69	2.23	2.23a	6596
4	38.00	0.00	11.36	4.50	31.67	4.50	4.50a	6596
5	37.75	0.00	17.81	7.05	49.66	7.05	7.05a	6596
6	37.50	0.00	23.85	9.43	66.48	9.43	9.43a	6596
		Total>	23.85	5.00m	143.35	5.00	5.00a	47377
7	37.15	Total>	32.36	6.75m	153.95	6.77	6.77	24100
8	36.80	Total>	40.37	8.50m	164.06	8.59	8.59	24514
9	36.40	Total>	49.15	10.50m	175.23	10.72	10.72	24988
10	36.00	Total>	57.69	12.50m	186.17	12.91	12.91	25462
11	35.60	Total>	66.08	14.50m	196.94	15.19	15.19	25935
12	35.32	Total>	71.98	15.92m	204.55	16.86	16.86	26273
13	35.03	Total>	77.84	17.35m	212.12	25.29	25.29	26610
14	34.72	Total>	84.18	18.90m	220.30	36.29	36.29	26977
15	34.34	Total>	91.90	20.80m	230.29	51.26	51.26	27427
16	34.00	Total>	98.77	22.50m	239.20	65.17	65.17	27830
17	33.60	Total>	106.81	24.50m	249.63	81.09	81.09	28304
18	33.20	Total>	114.83	26.50m	260.04	95.91	95.91	28778
19	32.80	Total>	122.81	28.50m	270.41	109.52	109.52	29251
20	32.40	Total>	130.77	30.50m	280.77	122.17	122.17	29725
21	32.00	Total>	138.72	32.50m	291.10	134.24	134.24	30199
22	31.75	Total>	143.67	33.75m	297.55	141.68	141.68	30495
23	31.50	Total>	148.62	35.00m	303.99	149.11	149.11	30791

RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	3106
15	34.34	0.00	6.84	2.71	19.07	2.71	2.71a	3106
		Total>	6.84	1.90m	145.22	114.14	114.14	27427
16	34.00	Total>	13.64	3.60m	154.05	112.97	112.97	27830
17	33.60	Total>	21.64	5.60m	164.44	112.35	112.35	28304
18	33.20	Total>	29.64	7.60m	174.84	113.30	113.30	28778
19	32.80	Total>	37.64	9.60m	185.23	116.00	116.00	29251
20	32.40	Total>	45.64	11.60m	195.62	120.10	120.10	29725
21	32.00	Total>	53.65	13.60m	206.01	125.02	125.02	30199
22	31.75	Total>	58.65	14.85m	212.51	128.26	128.26	30495

(continued)

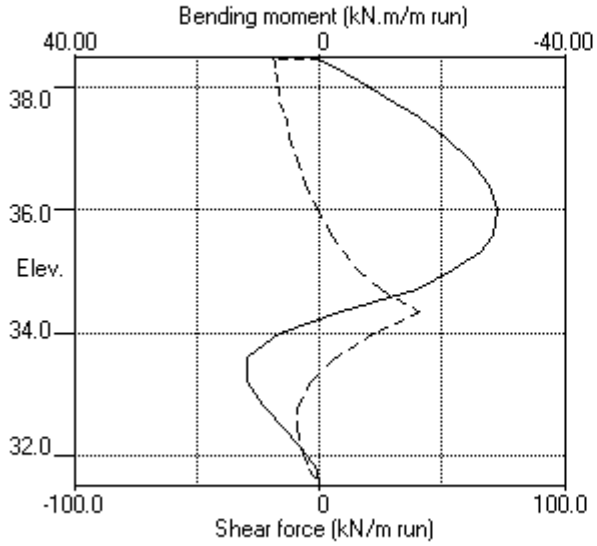
Stage No.6 Fill to elevation 34.72 on RIGHT side with soil type 1

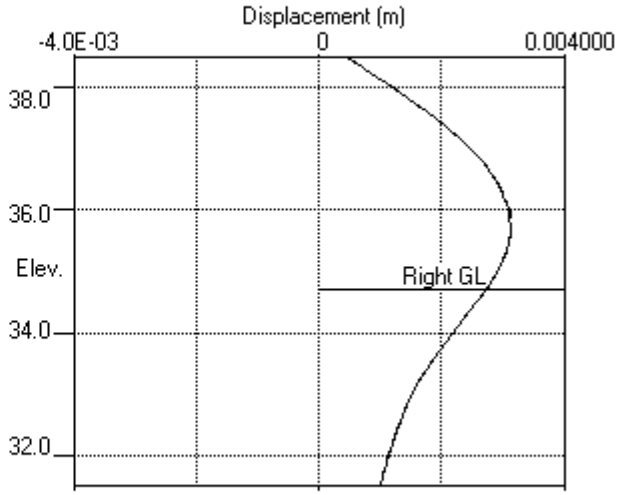
Node no.	Y coord	RIGHT side						
		Effective stresses				Total earth pressure	Coeff. of subgrade reaction
		Water press.	Vertic -al	Active limit	Passive limit	Earth pressure		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
23	31.50	Total>	63.65	16.10m	219.00	131.48	131.48	30791

Note: 2.71a Soil pressure at active limit
123.45p Soil pressure at passive limit

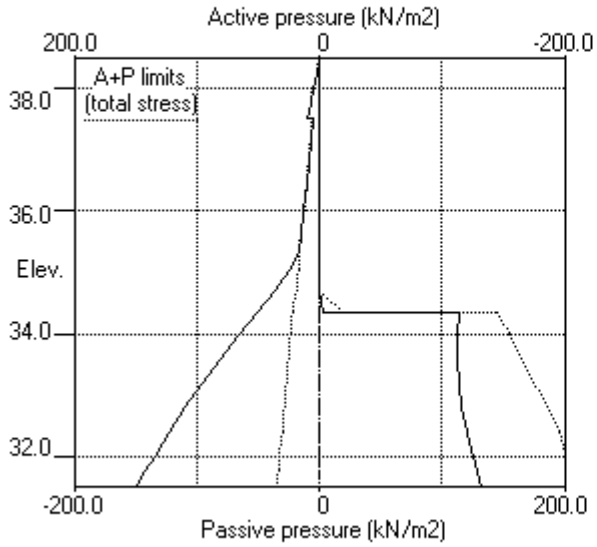
Units: kN,m

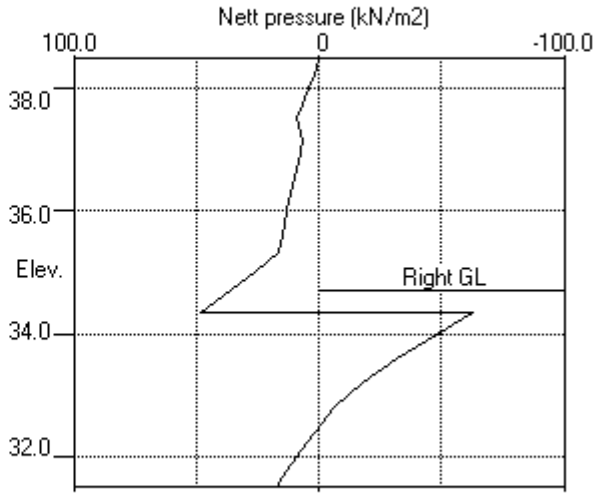
Stage No.6 Fill to elev. 34.72 on RIGHT side





Stage No.6 Fill to elev. 34.72 on RIGHT side





Units: kN,m

Stage No. 8 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Overall FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
8	38.50	34.72		More than one strut. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall
Limit State: ULS DA1 Combination 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.66E-03	0.0	-0.0		24308
2	38.45	0.60	0.001	-1.66E-03	0.0	0.0	16.2	24308
		0.60	0.001	-1.66E-03	-16.2	0.0		
3	38.22	2.23	0.001	-1.65E-03	-15.9	-3.7		24308
4	38.00	4.50	0.001	-1.60E-03	-15.2	-7.4		24308
5	37.75	7.05	0.002	-1.50E-03	-13.7	-11.1		24308
6	37.50	9.43	0.002	-1.38E-03	-11.7	-14.4		24308
		5.00	0.002	-1.38E-03	-11.7	-14.4		
7	37.15	6.75	0.002	-1.15E-03	-9.6	-18.4		24308
8	36.80	8.50	0.003	-8.80E-04	-6.9	-21.5		24308
9	36.40	10.50	0.003	-5.24E-04	-3.1	-23.8		24308
10	36.00	12.50	0.003	-1.49E-04	1.5	-24.3		24308
11	35.60	14.50	0.003	2.16E-04	6.9	-22.9		24308
12	35.32	15.92	0.003	4.51E-04	11.2	-20.5		24308
13	35.03	25.04	0.003	6.43E-04	17.0	-15.8	9.2	24308
		25.04	0.003	6.43E-04	7.9	-15.8		
14	34.72	37.07	0.003	7.98E-04	17.5	-11.5		24308
15	34.34	50.40	0.002	8.84E-04	34.1	-1.4		24308
		-59.18	0.002	8.84E-04	34.1	-1.4		
16	34.00	-42.78	0.002	8.37E-04	16.8	7.3		24308
17	33.60	-25.75	0.002	6.88E-04	3.1	11.0		24308
18	33.20	-12.46	0.002	5.18E-04	-4.5	10.3		24308
19	32.80	-2.89	0.001	3.77E-04	-7.6	7.6		24308
20	32.40	3.95	0.001	2.87E-04	-7.4	4.2		24308
21	32.00	9.37	0.001	2.46E-04	-4.7	1.4		24308
22	31.75	9.51	0.001	2.38E-04	-2.4	0.4		24308
23	31.50	9.49	0.001	2.37E-04	0.0	-0.0		---

At elev. 38.45 Strut force = 16.2 kN/strut = 16.2 kN/m run
At elev. 35.03 Strut force = 9.2 kN/strut = 9.2 kN/m run

(continued)

Stage No.8 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	76879
2	38.45	0.00	0.92	0.37	2.58	0.60	0.60	76879
3	38.22	0.00	5.63	2.23	15.69	2.23	2.23a	3715
4	38.00	0.00	11.36	4.50	31.67	4.50	4.50a	3715
5	37.75	0.00	17.81	7.05	49.66	7.05	7.05a	3715
6	37.50	0.00	23.85	9.43	66.48	9.43	9.43a	3715
		Total>	23.85	5.00m	143.35	5.00	5.00a	27763
7	37.15	Total>	32.36	6.75m	153.95	6.75	6.75a	28249
8	36.80	Total>	40.37	8.50m	164.06	8.50	8.50a	28735
9	36.40	Total>	49.15	10.50m	175.23	10.50	10.50a	29290
10	36.00	Total>	57.69	12.50m	186.17	12.50	12.50a	29846
11	35.60	Total>	66.08	14.50m	196.94	14.50	14.50a	30401
12	35.32	Total>	71.98	15.92m	204.55	15.92	15.92a	30796
13	35.03	Total>	77.84	17.35m	212.12	25.04	25.04	31192
14	34.72	Total>	84.18	18.90m	220.30	37.07	37.07	34851
15	34.34	Total>	91.90	20.80m	230.29	53.11	53.11	35432
16	34.00	Total>	98.77	22.50m	239.20	67.68	67.68	35953
17	33.60	Total>	106.81	24.50m	249.63	83.84	83.84	36565
18	33.20	Total>	114.83	26.50m	260.04	98.37	98.37	37177
19	32.80	Total>	122.81	28.50m	270.41	111.32	111.32	37789
20	32.40	Total>	130.77	30.50m	280.77	123.11	123.11	38400
21	32.00	Total>	138.72	32.50m	291.10	134.32	134.32	70747
22	31.75	Total>	143.67	33.75m	297.55	139.72	139.72	148983
23	31.50	Total>	148.62	35.00m	303.99	145.04	145.04	150429

RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	4134
15	34.34	0.00	6.84	2.71	19.07	2.71	2.71a	4134
		Total>	6.84	1.90m	145.22	112.29	112.29	35432
16	34.00	Total>	13.64	3.60m	154.05	110.46	110.46	35953
17	33.60	Total>	21.64	5.60m	164.44	109.59	109.59	36565
18	33.20	Total>	29.64	7.60m	174.84	110.84	110.84	37177
19	32.80	Total>	37.64	9.60m	185.23	114.20	114.20	37789
20	32.40	Total>	45.64	11.60m	195.62	119.16	119.16	38400

(continued)

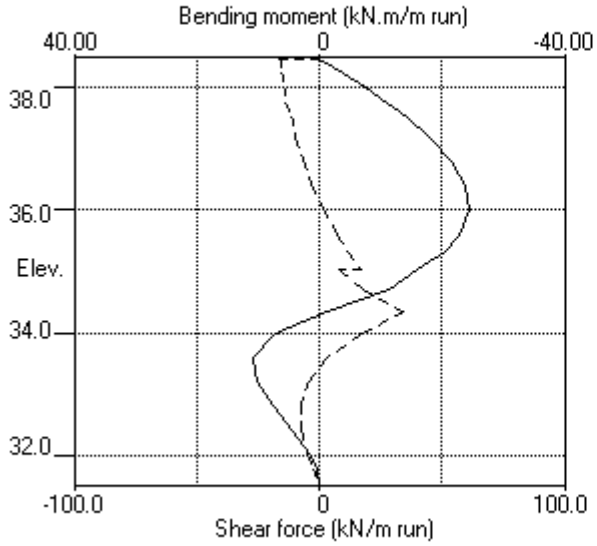
Stage No.8 Change EI of wall to 24308 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

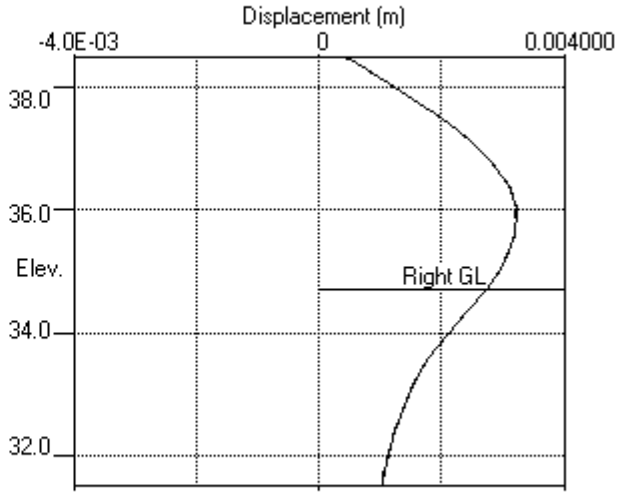
Node no.	Y coord	RIGHT side						
		Effective stresses					Total earth pressure	Coeff. of subgrade reaction
		Water press.	Vertic -al	Active limit	Passive limit	Earth pressure		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
21	32.00	Total>	53.65	13.60m	206.01	124.95	124.95	70747
22	31.75	Total>	58.65	14.85m	212.51	130.21	130.21	148983
23	31.50	Total>	63.65	16.10m	219.00	135.55	135.55	150429

Note: 2.71a Soil pressure at active limit
123.45p Soil pressure at passive limit

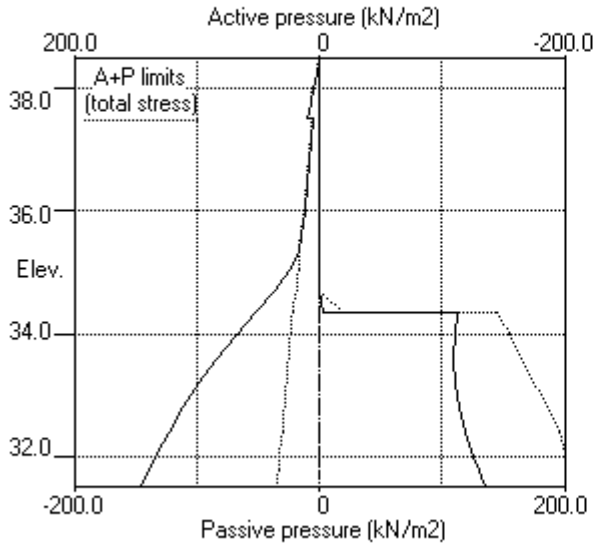
Units: kN,m

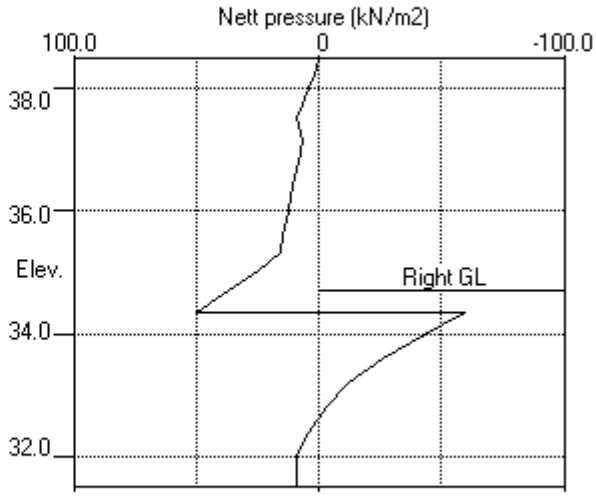
Stage No.8 Change EI of wall to 24308kN.m2/m run





Stage No.8 Change EI of wall to 24308kN.m2/m run





Units: kN,m

Stage No. 11 Apply water pressure profile no.2 (Worst Cred.)

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Overall FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
11	38.50	34.72		More than one strut. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m	EI of wall kN.m2/m
1	38.50	0.00	0.000	-1.77E-03	0.0	-0.0		24308
2	38.45	0.57	0.001	-1.77E-03	0.0	0.0	19.8	24308
		0.57	0.001	-1.77E-03	-19.8	0.0		
3	38.22	2.23	0.001	-1.75E-03	-19.5	-4.5		24308
4	38.00	4.50	0.001	-1.69E-03	-18.7	-9.0		24308
5	37.75	7.05	0.002	-1.57E-03	-17.3	-13.6		24308
6	37.50	9.43	0.002	-1.42E-03	-15.2	-17.8		24308
		10.14	0.002	-1.42E-03	-15.2	-17.8		
7	37.15	15.73	0.003	-1.14E-03	-10.7	-22.6		24308
8	36.80	21.11	0.003	-8.06E-04	-4.3	-25.5		24308
9	36.40	27.10	0.003	-4.02E-04	5.4	-25.6		24308
10	36.00	32.99	0.003	-3.63E-05	17.4	-21.3		24308
11	35.60	38.81	0.003	2.12E-04	31.8	-11.8		24308
12	35.32	42.92	0.003	2.70E-04	43.4	-1.2		24308
13	35.03	47.02	0.003	1.77E-04	56.2	13.7	90.9	24308
		47.02	0.003	1.77E-04	-34.6	13.7		
14	34.72	51.46	0.003	3.47E-05	-19.4	5.7		24308
		23.03	0.003	3.47E-05	-19.4	5.7		
15	34.34	22.13	0.003	-2.78E-05	-10.8	0.4		24308
		16.12	0.003	-2.78E-05	-10.8	0.4		
16	34.00	12.05	0.003	-2.29E-05	-6.0	-2.0		24308
17	33.60	9.09	0.003	2.16E-05	-1.8	-3.4		24308
18	33.20	5.96	0.003	8.39E-05	1.2	-3.5		24308
19	32.80	2.83	0.003	1.43E-04	3.0	-2.8		24308
20	32.40	-0.15	0.003	1.87E-04	3.5	-1.7		24308
21	32.00	-2.83	0.003	2.11E-04	2.9	-0.7		24308
22	31.75	-5.85	0.003	2.16E-04	1.8	-0.2		24308
23	31.50	-8.84	0.003	2.18E-04	0.0	-0.0		---

At elev. 38.45 Strut force = 19.8 kN/strut = 19.8 kN/m run
At elev. 35.03 Strut force = 90.9 kN/strut = 90.9 kN/m run

(continued)

Stage No.11 Apply water pressure profile no.2 (Worst Cred.)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	409046
2	38.45	0.00	0.92	0.37	2.58	0.57	0.57	6458
3	38.22	0.00	5.63	2.23	15.69	2.23	2.23a	4672
4	38.00	0.00	11.36	4.50	31.67	4.50	4.50a	4672
5	37.75	0.00	17.81	7.05	49.66	7.05	7.05a	4672
6	37.50	0.00	23.85	9.43	66.48	9.43	9.43a	4672
		0.00	23.85	10.14	60.75	10.14	10.14a	17690
7	37.15	3.43	28.92	12.30	73.68	12.30	15.73a	17999
8	36.80	6.87	33.50	14.24	85.34	14.24	21.11a	18309
9	36.40	10.79	38.36	16.31	97.72	16.31	27.10a	18663
10	36.00	14.71	42.98	18.27	109.49	18.27	32.99a	36497
11	35.60	18.64	47.44	20.17	120.85	20.17	38.81a	37175
12	35.32	21.43	50.55	21.49	128.77	21.49	42.92a	37659
13	35.03	24.23	53.61	22.79	136.58	22.79	47.02a	14727
14	34.72	27.27	56.91	24.19	144.97	24.19	51.46a	14930
15	34.34	31.00	60.90	25.89	155.13	25.89	56.89a	15179
16	34.00	34.34	64.43	27.39	164.14	30.56	64.90	15402
17	33.60	38.26	68.55	29.14	174.64	37.74	76.00	15664
18	33.20	42.18	72.64	30.88	185.06	44.52	86.71	15926
19	32.80	46.11	76.71	32.61	195.40	51.04	97.15	16188
20	32.40	50.03	80.74	34.33	205.69	57.44	107.47	16450
21	32.00	53.96	84.76	36.03	215.93	63.87	117.83	16712
22	31.75	56.41	87.26	37.10	222.30	66.44	122.85	16876
23	31.50	58.86	89.76	38.16	228.66	68.95	127.81	17040

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	38.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	38.22	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	37.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	37.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	37.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	36.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	35.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	35.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.72	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		27.27	0.73	0.29	2.03	1.16	28.44	3472
15	34.34	31.00	3.83	1.52	10.69	3.76	34.76	3472
		31.00	3.83	1.63	9.77	9.77	40.77p	15179
16	34.00	34.34	7.27	3.09	18.51	18.51	52.85p	15402
17	33.60	38.26	11.25	4.78	28.65	28.65	66.91p	15664
18	33.20	42.18	15.14	6.44	38.56	38.56	80.74p	15926
19	32.80	46.11	18.92	8.05	48.21	48.21	94.32p	16188
20	32.40	50.03	22.61	9.61	57.59	57.59	107.62p	16450
21	32.00	53.96	26.19	11.13	66.70	66.70	120.66p	16712
22	31.75	56.41	28.38	12.06	72.29	72.29	128.69p	16876

(continued)

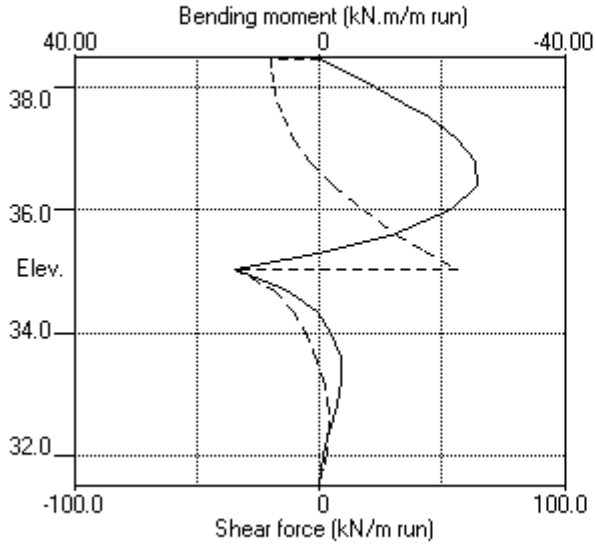
Stage No.11 Apply water pressure profile no.2 (Worst Cred.)

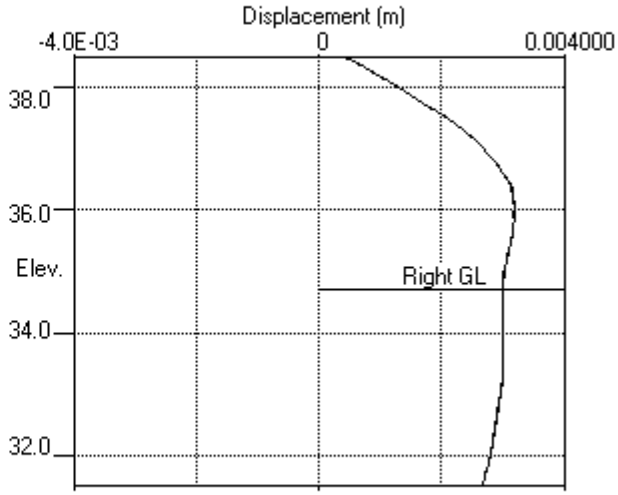
Node no.	Y coord	RIGHT side Water press. kN/m2	Effective stresses Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
23	31.50	58.86	30.53	12.98	77.79	77.79	136.65p	17040

Note: 56.89a Soil pressure at active limit
136.65p Soil pressure at passive limit

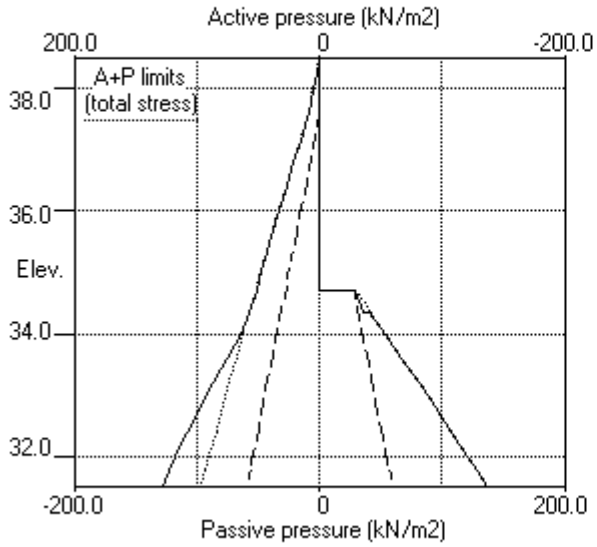
Units: kN,m

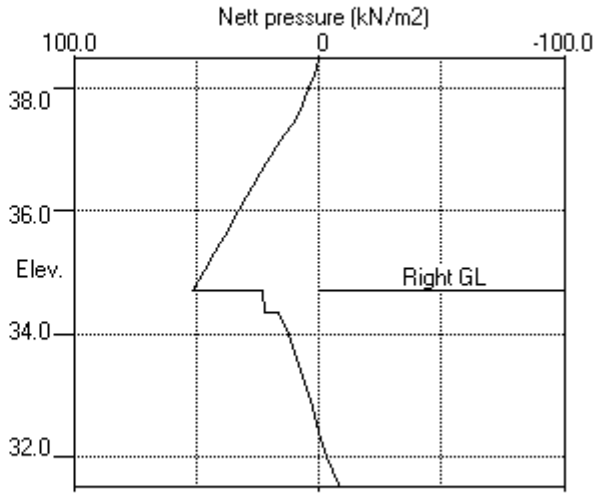
Stage No.11 Apply water pressure profile no.2 (Worst Cred.)





Stage No.11 Apply water pressure profile no.2 (Worst Cred.)





Units: kN,m

Summary of results

LIMIT STATE PARAMETERS

Limit State: ULS DA1 Combination 2
Water pressures : Worst Credible
Partial factor on C' = 1.250
Partial factor on Phi' = 1.250
Partial factor on Cu = 1.400
Partial factor on Soil Modulus = 1.000
Partial factor on Permanent Unfavourable loads = 1.000
Partial factor on Permanent Favourable loads = 1.000
Partial factor on Variable Unfavourable loads = 1.300

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	G.L. Act.	G.L. Pass.	Strut Elev.	Overall FoS for toe elev. = 31.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	38.50	38.50	Cant.	Conditions not suitable for FoS calc.				
2	38.50	38.00	Cant.	12.451	31.75	37.45	0.55	L to R
3	38.50	38.00		No analysis at this stage				
4	38.50	38.00	38.45	14.756	n/a	37.73	0.27	L to R
5	38.50	34.34	38.45	2.898	n/a	34.11	0.23	L to R
6	38.50	34.72	38.45	3.084	n/a	34.15	0.57	L to R
7	38.50	34.72		No analysis at this stage				

All remaining stages have more than one strut - FoS calculation n/a

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 50.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 50.00 from wall
Right side 50.00 from wall

Limit State: ULS DA1 Combination 2

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum m	Displacement minimum m	Bending moment maximum kN.m/m	Bending moment minimum kN.m/m	Shear force maximum kN/m	Shear force minimum kN/m
1	38.50	0.000	0.000	0.0	-0.0	0.0	0.0
2	38.45	0.001	0.000	0.0	-0.0	0.0	-19.8
3	38.22	0.001	0.000	0.0	-4.5	0.3	-19.5
4	38.00	0.001	0.000	0.2	-9.0	1.1	-18.7
5	37.75	0.002	0.000	0.6	-13.6	1.8	-17.3
6	37.50	0.002	0.000	1.1	-17.8	2.3	-15.2
7	37.15	0.003	0.000	1.5	-22.6	0.6	-12.1
8	36.80	0.003	0.000	1.5	-25.5	0.0	-9.4
9	36.40	0.003	0.000	1.2	-27.7	5.4	-5.5
10	36.00	0.003	0.000	0.8	-29.0	17.4	-1.1
11	35.60	0.003	0.000	0.4	-28.3	31.8	-0.9
12	35.32	0.003	0.000	0.2	-26.3	43.4	-0.8
13	35.03	0.003	0.000	13.7	-22.0	56.2	-34.6
14	34.72	0.003	0.000	5.7	-15.9	24.9	-19.4
15	34.34	0.003	0.000	0.4	-4.0	41.0	-10.8
16	34.00	0.003	0.000	7.3	-2.0	22.2	-6.0
17	33.60	0.003	0.000	11.8	-3.4	6.5	-1.8
18	33.20	0.003	0.000	11.8	-3.5	1.2	-4.5
19	32.80	0.003	0.000	9.1	-2.8	3.0	-8.1
20	32.40	0.003	0.000	5.4	-1.7	3.5	-9.0
21	32.00	0.003	0.000	1.9	-0.7	2.9	-6.7
22	31.75	0.003	0.000	0.6	-0.2	1.8	-3.9
23	31.50	0.003	0.000	0.0	-0.0	0.0	0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	Bending moment elev.	Bending moment minimum kN.m/m	Bending moment elev.	Shear force maximum kN/m	Shear force elev.	Shear force minimum kN/m	Shear force elev.
1	0.0	38.50	-0.4	35.60	0.2	34.00	-0.3	36.80
2	1.5	37.15	-0.3	34.00	2.3	37.50	-1.0	36.00
3	No calculation at this stage							
4	1.5	37.15	-0.3	34.00	2.3	37.50	-1.1	36.00
5	11.2	33.20	-28.4	36.00	39.8	34.34	-18.4	38.45
6	11.8	33.20	-29.0	36.00	41.0	34.34	-18.7	38.45
7	No calculation at this stage							
8	11.0	33.60	-24.3	36.00	34.1	34.34	-16.2	38.45
9	No calculation at this stage							
10	No calculation at this stage							
11	13.7	35.03	-25.6	36.40	56.2	35.03	-34.6	35.03

Summary of results (continued)

Maximum and minimum displacement at each stage

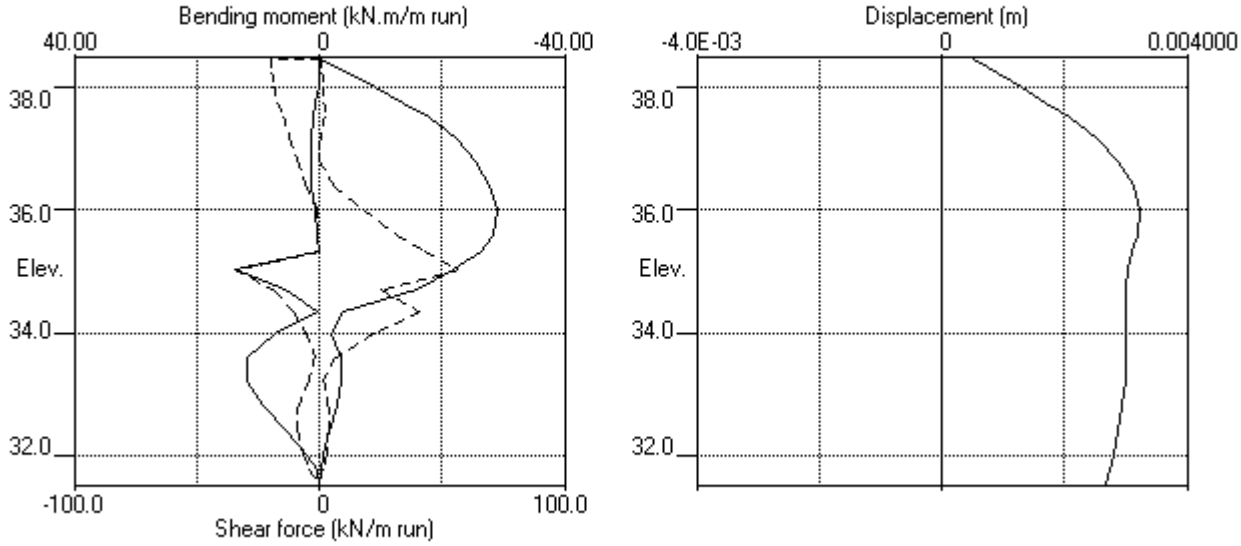
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.000	34.34	0.000	38.50	Apply surcharge no.1 at elev. 38.50
2	0.000	38.50	0.000	38.50	Excav. to elev. 38.00 on RIGHT side
3	No calculation at this stage				Install strut no.1 at elev. 38.45
4	0.000	38.50	0.000	38.50	Apply water pressure profile no.1
5	0.003	35.60	0.000	38.50	Excav. to elev. 34.34 on RIGHT side
6	0.003	35.60	0.000	38.50	Fill to elev. 34.72 on RIGHT side
7	No calculation at this stage				Install strut no.2 at elev. 35.03
8	0.003	36.00	0.000	38.50	Change EI of wall to 24308kN.m2/m run
9	No calculation at this stage				Change soil type 2 to soil type 3
10	No calculation at this stage				Apply surcharge no.2 at elev. 34.72
11	0.003	36.00	0.000	38.50	Apply water pressure profile no.2

Strut forces at each stage (horizontal components)

Stage no.	Strut no. 1 at elev. 38.45 kN/m run	Strut no. 1 at elev. 38.45 kN/strut	Strut no. 2 at elev. 35.03 kN/m run	Strut no. 2 at elev. 35.03 kN/strut
4	slack	slack	---	---
5	18.43	18.43	---	---
6	18.71	18.71	---	---
8	16.24	16.24	9.15	9.15
11	19.82	19.82	90.87	90.87

Units: kN,m

Bending moment, shear force, displacement envelopes



APPENDIX C

Ref No	Description
C1	Results of “ADC” analysis for 350mm diameter wall piles with 5 x B16mm bars, 0kN compression load (Wall 1).
C2	Results of Helical Check for 350mm diameter wall piles with 5 x B16mm bars, B8mm helical @ 150mm centres, 75mm cover (Wall 1).

PILEDESIGNS
GEOTECHNICAL EXPERTISE

West Hampstead - 39a Priory Terrace
350mm diameter RW - 5x16mm cage
Moment Check

Job No.	Sheet No.	Rev.
24787		

Drg. Ref.

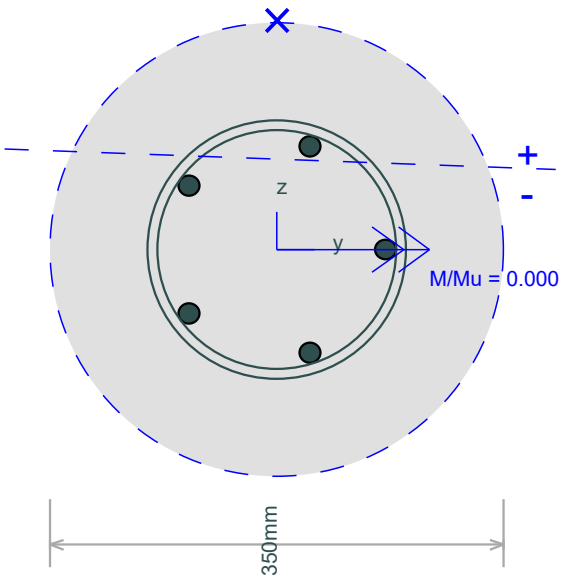
Made by	Date	Checked
DBS	13-Oct-2021	

Reinforcement Details

Bar Arrangement	1 ring(s)/5 bars per ring
Diameter of main bars	16mm
Area of reinforcement	1005.31mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 1
Axial Design Force	0kN
Axial Capacity	1873.49kN
Design Moment 'M'	0kNm
Ultimate Moment 'Mu'	45.3474kNm
Neutral Axis	— — —
Comp./Tens. Side	+/-
Governing Node/Bar	✕



Section 1
Analysis Case 1

PILEDESIGNS GEOTECHNICAL EXPERTISE
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Project	WEST HAMPSTEAD - 39a Priory Terrace	Project No.		24787	Date	14/10/21
Tilte	350mm Pile Shear Check - RW - 5xB16	By	DBS	Check By		Page 1

Shear to EN 1992-1-1:2004 (EC2) Circular Sections (Cast In-situ) using helical reinforcement

Pile section

pile dia d_{nom}	=	350	mm				
design pile diameter	=	350	mm				
Ac	=	96211	mm^2				
cover c_{nom}	=	75	mm	[4.4.1.3(4)]	k_2 =	75 mm	[NA.1 4.4.1.3 (4)]
main bar dia	=	16	mm				
no. main bars	=	5	no.				
helical dia.	=	8	mm				
d	=	223	mm		γ_c = 1.5 (This is adjusted by K_f=1.1 [2.4.2.5 (2)] to give 1.65)		
f_{ck}	=	30	MPa		γ_c = 1.65	α_{cc} = 0.85	[NA.1 3.1.6 (1)}
f_{yk}	=	500	MPa		γ_s = 1.15		
Ult V_{Ed}	=	33.1	kN		SF factor	1	
Ult V_{Ed}	=	33.1	kN				
factored actions	N_{Ed} =	0	kN				

Check requirement for shear reinforcement [6.2.2]

$V_{Rd,c}$ = $[C_{Rd,c}k(100\rho_1 f_{ck})^{1/3}+k_1\sigma_{cp}]b_w d$

with minimum = $(v_{min}+k_1\sigma_{cp})b_w d$

v_{min} = $0.035k^{3/2}f_{ck}^{1/2}$ = 0.5205

CRd,c	=	0.18 / γc	0.11
k	=	$1+(200/d)^{1/2}$	1.95 <=2.0
ρ_1	=	$A_{sl}/b_w d$	0.01 <=0.02
σ_{cp}	=	N_{ed}/A_c	0 < 0.2f_{cd}
k_1	=	0.15	[NA.1 6.2.2(1)]

$V_{Rd,c}$ = **41** kN

Is $V_{Rd,c}$ > V_{Ed} **=>** **YES** Action: ***No shear links needed - provide nominal links as req'd***

Design Shear Reinforcement [6.2.3]

Check concrete strut capacity at Cot θ = 2.5 :-

$V_{Rd,max}$ = $\alpha_{cw}.b_w.z.v_1.f_{cd}$ / (Cotθ+tanθ) (6.9)

cot θ	=	2.5	
tan θ	=	0.4	
α_{cw}	=	1	[NA.1 6.2.3(3)]
z	=	0.9d	201 mm
v_1	=	0.6 (1-(fck/250)	0.53 [6.6N]

$V_{Rd,max}$ = **198** **kN**

Is $V_{Rd,c}$ > V_{Ed} **=>** **NA** Action:

Calculation for strut inclination:-

θ = $0.5.\sin^{-1}[(6.54*V_{Ed})/(b_w.d.(1-f_{ck}/250).f_{ck})$

θ = NA rad cot θ = 2.5 > 1.0

Calculate shear reinforcement spacing after Turmo et al (2008);-

$V_{Rd,s}$ = $z.\cot\theta.(A_\Phi/0.5s).f_{ywd}.0.85$

s = $2.([z.\cot\theta.A_\Phi.fywd.0.85]/V_{Rd,s})$

= **NA** mm

A_Φ = 50.3 mm^2

f_{ywd} = 435 MPa

Check maximum shear link spacing:-

is $s_{l,max}$ > 0.75d **YES**

Provide **8** mm helical at nominal pitch **150** mm

Turo, J, *et al*. Shear truss analogy for concrete members of solid and hollow circular cross section. **Eng. Struc.** (2008)

APPENDIX D

Ref No	Description
D1	Results of “PILE” analysis for 350mm diameter wall piles based on piling level of 38.5mAD and discounted level of 34.7mAD.
D2	Results of “PILE” analysis for 450mm diameter bearing piles based on piling level of 38.5mAD and discounted level of 34.7mAD.

West Hampstead - 39a Priory Terrace
350mm dia auger pile
RW vertical capacity

Notes

38.5mAD PPL, 34.7mAD Discounted

Analysis Options

Design approach:	DA1(C1 + C2)
Pile type:	CFA
Model factor:	1.40
Partial factor on negative skin friction - Set A1:	1.00
Partial factor on negative skin friction - Set A2:	1.00
Serviceability verified by load tests (preliminary/working) carried out on more than 1% of constructed piles to loads not less than 1.5 times the representative load for which they are designed?	No
Resistance verified by a maintained load test taken to the calculated, unfactored, ultimate resistance?	No
Is BS8004 SLS check enabled?	No
Datum type	Elevation based
Effective stress profile	Calculated

Pile Properties

Pile type	Solid
Pile cross-section	Circular
Under-ream	No
Calculation profile	Range
Minimum pile length	7.0000 m
Maximum pile length	11.000 m
Increment size	0.50000

Cross-section	Number of cross sections	Top Diameter [m]	Second Diameter location [m]	Second Diameter [m]	Third Diameter location [m]	Third Diameter [m]
Cross-section 1	1	0.35000				

Undrained Materials - General Data

No.	Material description	Bulk unit weight [kN/m³]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	Discounted Soil	18.000	NA	0.0	0.0
2	London Clay	20.000	NA	79.800	114.80
3	London Clay 2	20.000	NA	114.80	114.80

Undrained Materials - Skin Friction Data

No.	Material description	Skin friction computation	Alpha	q_s Top [kPa]	q_s Base [kPa]	$q_{s,lim}$ Spec.	$q_{s,lim}$ Value [kPa]
1	Discounted Soil	Alpha specified	0.0	NA	NA	No	NA
2	London Clay	Alpha specified	0.45000	NA	NA	No	NA
3	London Clay 2	Alpha specified	0.45000	NA	NA	No	NA

Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	q_b Top [kPa]	q_b Base [kPa]	$q_{b,lim}$ Spec.	$q_{b,lim}$ Value [kPa]
1	Discounted Soil	Nc specified	0.0	NA	NA	No	NA
2	London Clay	Nc specified	9.0000	NA	NA	No	NA
3	London Clay	Nc specified	9.0000	NA	NA	No	NA

No.	Material description	End bearing computation	Nc	q_b Top [kPa]	q_b Base [kPa]	$q_{b,lim}$ Spec. Value [kPa]
2						

Undrained Materials - Material Factors (Code Based)

No.	Material description	Qs factors M1	Qs factors M2	Nc factors M1	Nc factors M2	Qb factors M1	Qb factors M2
1	Discounted Soil	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
2	London Clay	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
3	London Clay 2	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.

STAGE SPECIFIC DATA

Stage 0 : Initial Stage

Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
1	36.000	0.0	9.8100

Soil Profiles

Soil Profile 1: Soil Profile 1

No.	Level [mOD]	Material description	Contributes to negative skin friction
1	38.500	Air/Void	No
2	34.700	London Clay	No
3	24.700	London Clay 2	No

Soil Profile - Groundwater Map

No.	Soil Profile	Groundwater
1	Soil Profile 1	Groundwater Profile 1

Stage specific warnings

1 - Stage 0 - The bottom most layer in Soil Profile 1 is assigned "Total stress" material. For this layer the cohesion is assumed to be constant at "Cu-Top", i.e cohesion specified at the top of this layer. The user specified value of cohesion at the bottom of this layer, "Cu-Bottom" is ignored. (Material Properties)

CAPACITY RESULTS

Partial Resistance Factors Used:

DA1 C1

Shaft resistance factor for set R1 (Compression):	1.00
Base resistance factor for set R1:	1.00
Shaft resistance factor for set R1 (Tension):	1.00

DA1 C2

Shaft resistance factor for set R4 (Compression):	1.60
Base resistance factor for set R4:	2.00
Shaft resistance factor for set R4 (Tension):	2.00
Model factor:	1.40

No. Soil Profile Groundwater

Stress Profiles

Soil Profile 1: Soil Profile 1

Level [mOD]	Density [kN/m³]	Undrained Cohesion [kPa]	Nq	Total vertical stress [kPa]	Porewater pressure [kPa]	Effective vertical stress [kPa]	Effective horizontal stress* [kPa]	Cumulative skin friction per unit perimeter [kN/m]
38.500	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0
36.000	9.8100	0.0	0.0	0.0	0.0	0.0	NA	0.0
34.700	9.8100	0.0	0.0	12.753	12.753	0.0	NA	0.0
34.700	20.000	79.800	N.A.	12.753	12.753	0.0	NA	0.0
31.500	20.000	91.000	N.A.	76.753	44.145	32.608	NA	122.98
31.000	20.000	92.750	N.A.	86.753	49.050	37.703	NA	143.65
30.500	20.000	94.500	N.A.	96.753	53.955	42.798	NA	164.71
30.000	20.000	96.250	N.A.	106.75	58.860	47.893	NA	186.17
29.500	20.000	98.000	N.A.	116.75	63.765	52.988	NA	208.03
29.000	20.000	99.750	N.A.	126.75	68.670	58.083	NA	230.27
28.500	20.000	101.50	N.A.	136.75	73.575	63.178	NA	252.91
28.000	20.000	103.25	N.A.	146.75	78.480	68.273	NA	275.95
27.500	20.000	105.00	N.A.	156.75	83.385	73.368	NA	299.38

* Effective horizontal stress not calculated for "Total Stress" materials and for Beta Method.

Cross-section 1 results:

Uniform pile with top shaft diameter = 0.35 m

Results - Compression

Soil Profile 1: Soil Profile 1

Level [mOD]	Pile length [m]	Ultimate base capacity (Q_b) [kN]	Cumulative external Friction (Q_s) [kN]	Negative skin friction (Q_{nsf}) [kN]	Net ultimate resistance [kN]
31.500	7.0000	78.797	135.22	0.0	214.02
31.000	7.5000	80.312	157.95	0.0	238.26
30.500	8.0000	81.828	181.11	0.0	262.94
30.000	8.5000	83.343	204.71	0.0	288.05
29.500	9.0000	84.858	228.74	0.0	313.59
29.000	9.5000	86.374	253.20	0.0	339.57
28.500	10.000	87.889	278.09	0.0	365.98
28.000	10.500	89.404	303.42	0.0	392.82
27.500	11.000	90.920	329.18	0.0	420.10

Level [mOD]	Pile length [m]	Design resistance DA1-C1 [kN]	Design resistance DA1-C2 [kN]	Combination with least resistance #	Factored load* DA1-C1 [kN]	Factored load* DA1-C2 [kN]
31.500	7.0000	152.87	88.508	2	0.0(C)	0.0(C)
31.000	7.5000	170.19	99.196	2	0.0(C)	0.0(C)
30.500	8.0000	187.81	110.08	2	0.0(C)	0.0(C)
30.000	8.5000	205.75	121.15	2	0.0(C)	0.0(C)
29.500	9.0000	224.00	132.42	2	0.0(C)	0.0(C)
29.000	9.5000	242.55	143.88	2	0.0(C)	0.0(C)
28.500	10.000	261.42	155.54	2	0.0(C)	0.0(C)
28.000	10.500	280.59	167.39	2	0.0(C)	0.0(C)
27.500	11.000	300.07	179.43	2	0.0(C)	0.0(C)

\# Limiting criteria :
1 : DA1 C1
2 : DA1 C2
*(C)-> Compression load, (T)-> Tension load
Note: Design resistance does not include any consideration of negative skin friction.

Level	Pile length	Design resistance	Combination with least resistance #	Factored load*

Nq Calculation Details

Soil Profile 1: Soil Profile 1 - Material Factor Set - 1

There are no pile toe levels in any drained material(with Berezantzev/Bolton option) in the given soil profile.

Soil Profile 1: Soil Profile 1 - Material Factor Set - 2

There are no pile toe levels in any drained material(with Berezantzev/Bolton option) in the given soil profile.

West Hampstead - 39a Priory Terrace
450mm dia auger pile
BP vertical capacity

Notes

38.5mAD PPL, 34.7mAD Discounted

Analysis Options

Design approach:	DA1(C1 + C2)
Pile type:	CFA
Model factor:	1.40
Partial factor on negative skin friction - Set A1:	1.00
Partial factor on negative skin friction - Set A2:	1.00
Serviceability verified by load tests (preliminary/working) carried out on more than 1% of constructed piles to loads not less than 1.5 times the representative load for which they are designed?	No
Resistance verified by a maintained load test taken to the calculated, unfactored, ultimate resistance?	No
Is BS8004 SLS check enabled?	No
Datum type	Elevation based
Effective stress profile	Calculated

Pile Properties

Pile type	Solid
Pile cross-section	Circular
Under-ream	No
Calculation profile	Range
Minimum pile length	7.0000 m
Maximum pile length	20.000 m
Increment size	0.50000

Cross-section	Number of cross sections	Top Diameter [m]	Second Diameter location [m]	Second Diameter [m]	Third Diameter location [m]	Third Diameter [m]
Cross-section 1	1	0.45000				

Undrained Materials - General Data

No.	Material description	Bulk unit weight [kN/m³]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	Discounted Soil	18.000	NA	0.0	0.0
2	London Clay	20.000	NA	79.800	114.80
3	London Clay 2	20.000	NA	114.80	114.80

Undrained Materials - Skin Friction Data

No.	Material description	Skin friction computation	Alpha	q_s Top [kPa]	q_s Base [kPa]	$q_{s,lim}$ Spec.	$q_{s,lim}$ Value [kPa]
1	Discounted Soil	Alpha specified	0.0	NA	NA	No	NA
2	London Clay	Alpha specified	0.50000	NA	NA	No	NA
3	London Clay 2	Alpha specified	0.50000	NA	NA	No	NA

Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	q_b Top [kPa]	q_b Base [kPa]	$q_{b,lim}$ Spec.	$q_{b,lim}$ Value [kPa]
1	Discounted Soil	Nc specified	0.0	NA	NA	No	NA
2	London Clay	Nc specified	9.0000	NA	NA	No	NA
3	London Clay	Nc specified	9.0000	NA	NA	No	NA

No.	Material description	End bearing computation	Nc	q_b Top [kPa]	q_b Base [kPa]	$q_{b,lim}$ Spec. Value [kPa]
2						

Undrained Materials - Material Factors (Code Based)

No.	Material description	Qs factors M1	Qs factors M2	Nc factors M1	Nc factors M2	Qb factors M1	Qb factors M2
1	Discounted Soil	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
2	London Clay	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
3	London Clay 2	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.

STAGE SPECIFIC DATA

Stage 0 : Initial Stage

Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
1	36.000	0.0	9.8100

Soil Profiles

Soil Profile 1: Soil Profile 1

No.	Level [mOD]	Material description	Contributes to negative skin friction
1	38.500	Air/Void	No
2	34.700	London Clay	No
3	24.700	London Clay 2	No

Soil Profile - Groundwater Map

No.	Soil Profile	Groundwater
1	Soil Profile 1	Groundwater Profile 1

Stage specific warnings

1 - Stage 0 - The bottom most layer in Soil Profile 1 is assigned "Total stress" material. For this layer the cohesion is assumed to be constant at "Cu-Top", i.e cohesion specified at the top of this layer. The user specified value of cohesion at the bottom of this layer, "Cu-Bottom" is ignored. (Material Properties)

CAPACITY RESULTS

Partial Resistance Factors Used:

DA1 C1

Shaft resistance factor for set R1 (Compression):	1.00
Base resistance factor for set R1:	1.00
Shaft resistance factor for set R1 (Tension):	1.00

DA1 C2

Shaft resistance factor for set R4 (Compression):	1.60
Base resistance factor for set R4:	2.00
Shaft resistance factor for set R4 (Tension):	2.00
Model factor:	1.40

No. Soil Profile Groundwater

Stress Profiles

Soil Profile 1: Soil Profile 1

Level [mOD]	Density [kN/m³]	Undrained Cohesion [kPa]	Nq	Total vertical stress [kPa]	Porewater pressure [kPa]	Effective vertical stress [kPa]	Effective horizontal stress* [kPa]	Cumulative skin friction per unit perimeter [kN/m]
38.500	-2.5006	0.0	0.0	0.0	0.0	0.0	NA	0.0
36.000	9.8100	0.0	0.0	0.0	0.0	0.0	NA	0.0
34.700	9.8100	0.0	0.0	12.753	12.753	0.0	NA	0.0
34.700	20.000	79.800	N.A.	12.753	12.753	0.0	NA	0.0
31.500	20.000	91.000	N.A.	76.753	44.145	32.608	NA	136.64
31.000	20.000	92.750	N.A.	86.753	49.050	37.703	NA	159.61
30.500	20.000	94.500	N.A.	96.753	53.955	42.798	NA	183.02
30.000	20.000	96.250	N.A.	106.75	58.860	47.893	NA	206.86
29.500	20.000	98.000	N.A.	116.75	63.765	52.988	NA	231.14
29.000	20.000	99.750	N.A.	126.75	68.670	58.083	NA	255.86
28.500	20.000	101.50	N.A.	136.75	73.575	63.178	NA	281.02
28.000	20.000	103.25	N.A.	146.75	78.480	68.273	NA	306.61
27.500	20.000	105.00	N.A.	156.75	83.385	73.368	NA	332.64
27.000	20.000	106.75	N.A.	166.75	88.290	78.463	NA	359.11
26.500	20.000	108.50	N.A.	176.75	93.195	83.558	NA	386.02
26.000	20.000	110.25	N.A.	186.75	98.100	88.653	NA	413.36
25.500	20.000	112.00	N.A.	196.75	103.00	93.748	NA	441.14
25.000	20.000	113.75	N.A.	206.75	107.91	98.843	NA	469.36
24.700	20.000	114.80	N.A.	212.75	110.85	101.90	NA	486.50
24.700	20.000	114.80	N.A.	212.75	110.85	101.90	NA	486.50
24.500	20.000	114.80	N.A.	216.75	112.82	103.94	NA	497.98
24.000	20.000	114.80	N.A.	226.75	117.72	109.03	NA	526.68
23.500	20.000	114.80	N.A.	236.75	122.63	114.13	NA	555.38
23.000	20.000	114.80	N.A.	246.75	127.53	119.22	NA	584.08
22.500	20.000	114.80	N.A.	256.75	132.43	124.32	NA	612.78
22.000	20.000	114.80	N.A.	266.75	137.34	129.41	NA	641.48
21.500	20.000	114.80	N.A.	276.75	142.24	134.51	NA	670.18
21.000	20.000	114.80	N.A.	286.75	147.15	139.60	NA	698.88
20.500	20.000	114.80	N.A.	296.75	152.05	144.70	NA	727.58
20.000	20.000	114.80	N.A.	306.75	156.96	149.79	NA	756.28
19.500	20.000	114.80	N.A.	316.75	161.87	154.89	NA	784.98
19.000	20.000	114.80	N.A.	326.75	166.77	159.98	NA	813.68
18.500	20.000	114.80	N.A.	336.75	171.68	165.08	NA	842.38

* Effective horizontal stress not calculated for "Total Stress" materials and for Beta Method.

Cross-section 1 results:

Uniform pile with top shaft diameter = 0.45 m

Results - Compression

Soil Profile 1: Soil Profile 1

Level [mOD]	Pile length [m]	Ultimate base capacity (Q_b) [kN]	Cumulative external Friction (Q_s) [kN]	Negative skin friction (Q_{nsf}) [kN]	Net ultimate resistance [kN]
31.500	7.0000	130.26	193.17	0.0	323.43
31.000	7.5000	132.76	225.64	0.0	358.40
30.500	8.0000	135.27	258.73	0.0	394.00
30.000	8.5000	137.77	292.44	0.0	430.21
29.500	9.0000	140.28	326.77	0.0	467.04
29.000	9.5000	142.78	361.71	0.0	504.49
28.500	10.000	145.29	397.28	0.0	542.56
28.000	10.500	147.79	433.46	0.0	581.25
27.500	11.000	150.30	470.26	0.0	620.55
27.000	11.500	152.80	507.68	0.0	660.48
26.500	12.000	155.31	545.72	0.0	701.02
26.000	12.500	157.81	584.37	0.0	742.18
25.500	13.000	160.32	623.65	0.0	783.96

Level	Pile length	Ultimate base capacity (Q_b)	Cumulative external Friction (Q_s)	Negative skin friction (Q_{nsf})	Net ultimate resistance
25.000	13.500	162.82	663.54	0.0	826.36
24.500	14.000	164.32	704.00	0.0	868.33
24.000	14.500	164.32	744.58	0.0	908.90
23.500	15.000	164.32	785.15	0.0	949.47
23.000	15.500	164.32	825.72	0.0	990.05
22.500	16.000	164.32	866.30	0.0	1030.6
22.000	16.500	164.32	906.87	0.0	1071.2
21.500	17.000	164.32	947.44	0.0	1111.8
21.000	17.500	164.32	988.02	0.0	1152.3
20.500	18.000	164.32	1028.6	0.0	1192.9
20.000	18.500	164.32	1069.2	0.0	1233.5
19.500	19.000	164.32	1109.7	0.0	1274.1
19.000	19.500	164.32	1150.3	0.0	1314.6
18.500	20.000	164.32	1190.9	0.0	1355.2

Level	Pile length	Design resistance		Combination with least resistance #	Factored load*	
		DA1-C1	DA1-C2		DA1-C1	DA1-C2
[mOD]	[m]	[kN]	[kN]		[kN]	[kN]
31.500	7.0000	231.02	132.76	2	0.0(C)	0.0(C)
31.000	7.5000	256.00	148.15	2	0.0(C)	0.0(C)
30.500	8.0000	281.43	163.81	2	0.0(C)	0.0(C)
30.000	8.5000	307.29	179.76	2	0.0(C)	0.0(C)
29.500	9.0000	333.60	195.98	2	0.0(C)	0.0(C)
29.000	9.5000	360.35	212.47	2	0.0(C)	0.0(C)
28.500	10.000	387.54	229.24	2	0.0(C)	0.0(C)
28.000	10.500	415.18	246.29	2	0.0(C)	0.0(C)
27.500	11.000	443.25	263.61	2	0.0(C)	0.0(C)
27.000	11.500	471.77	281.21	2	0.0(C)	0.0(C)
26.500	12.000	500.73	299.09	2	0.0(C)	0.0(C)
26.000	12.500	530.13	317.24	2	0.0(C)	0.0(C)
25.500	13.000	559.97	335.67	2	0.0(C)	0.0(C)
25.000	13.500	590.26	354.37	2	0.0(C)	0.0(C)
24.500	14.000	620.23	372.97	2	0.0(C)	0.0(C)
24.000	14.500	649.21	391.09	2	0.0(C)	0.0(C)
23.500	15.000	678.20	409.20	2	0.0(C)	0.0(C)
23.000	15.500	707.18	427.31	2	0.0(C)	0.0(C)
22.500	16.000	736.16	445.43	2	0.0(C)	0.0(C)
22.000	16.500	765.14	463.54	2	0.0(C)	0.0(C)
21.500	17.000	794.12	481.65	2	0.0(C)	0.0(C)
21.000	17.500	823.10	499.77	2	0.0(C)	0.0(C)
20.500	18.000	852.08	517.88	2	0.0(C)	0.0(C)
20.000	18.500	881.06	535.99	2	0.0(C)	0.0(C)
19.500	19.000	910.04	554.11	2	0.0(C)	0.0(C)
19.000	19.500	939.03	572.22	2	0.0(C)	0.0(C)
18.500	20.000	968.01	590.33	2	0.0(C)	0.0(C)

Limiting criteria :
1 : DA1 C1
2 : DA1 C2
*(C)-> Compression load, (T)-> Tension load
Note: Design resistance does not include any consideration of negative skin friction.

Nq Calculation Details

Soil Profile 1: Soil Profile 1 - Material Factor Set - 1

There are no pile toe levels in any drained material(with Berezantzev/Bolton option) in the given soil profile.

Soil Profile 1: Soil Profile 1 - Material Factor Set - 2

There are no pile toe levels in any drained material(with Berezantzev/Bolton option) in the given soil profile.

APPENDIX E

Ref No	Description
E1-A	Results of “ALP” analysis for 450mm diameter bearing piles based on cut-off level of 34.935mAD and horizontal load of 30kN, DA1-1 analysis.
E1-B	Results of “ALP” analysis for 450mm diameter bearing piles based on cut-off level of 34.935mAD and horizontal load of 30kN, DA1-2 analysis.

Notes
Design 1 - 34.935 COL DA1-1

General Data
Number of increments = 1
Increment applied loads only

Convergence Control
Maximum number of iterations = 500
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Soil Data
Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level	E	Unit wt.	Phi	Factored Kq	Factored Kc	c(top)	dc/dz
	[m]	[kN/m²]	[kN/m³]	[deg]			[kN/m²]	[kN/m²/m]
1	34.935001	45000.	20.000	25.000	-	-	0.0	0.0
2	29.934999	55000.	20.000	25.000	-	-	0.0	0.0
3	24.934999	65000.	20.000	25.000	-	-	0.0	0.0

Calculated K_q and K_c Values

Node	Z/D	K_q	K_c
1	0.0	3.2869	5.6339
2	1.4815	4.4482	15.326
3	2.9630	5.2622	20.414
4	4.4444	5.8645	23.549
5	5.9259	6.3281	25.674
6	7.4074	6.6961	27.210
7	8.8889	6.9952	28.371
8	10.370	7.2431	29.280
9	11.852	7.4520	30.012
10	13.333	7.6303	30.612
11	15.233	7.8241	31.242
12	17.133	7.9874	31.754
13	19.033	8.1268	32.179
14	21.159	8.2604	32.577
15	23.285	8.3752	32.910
16	25.411	8.4750	33.195
17	27.633	8.5661	33.450
18	29.856	8.6462	33.671
19	32.078	8.7172	33.864

Sections

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
Section 1	Explicit	Description, Material and Class	not applicable		0.45000	40258.

Pile Properties

Level [m]	Section
34.935	Section 1

Pile base at 20.500000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	34.935	25.000	0.0	0.0
2	34.935	5.0000	0.0	0.0

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	10000.

Surcharges

No.	Level [m]	Pressure [kN/m²]
1	34.935	5.0000

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	34.935	1	40258.	0.45000	10.448	0.0
2	34.268	1	40258.	0.45000	16.988	0.0
3	33.602	1	40258.	0.45000	23.528	0.0
4	32.935	1	40258.	0.45000	30.068	0.0
5	32.268	1	40258.	0.45000	36.608	0.0
6	31.602	1	40258.	0.45000	43.148	0.0
7	30.935	1	40258.	0.45000	49.688	0.0
8	30.268	1	40258.	0.45000	56.228	0.0
9	29.602	2	40258.	0.45000	62.768	0.0
10	28.935	2	40258.	0.45000	69.308	0.0
11	28.080	2	40258.	0.45000	77.695	0.0
12	27.225	2	40258.	0.45000	86.083	0.0
13	26.370	2	40258.	0.45000	94.470	0.0
14	25.413	2	40258.	0.45000	103.86	0.0
15	24.457	3	40258.	0.45000	113.24	0.0
16	23.500	3	40258.	0.45000	122.63	0.0
17	22.500	3	40258.	0.45000	132.44	0.0
18	21.500	3	40258.	0.45000	142.25	0.0
19	20.500	3	40258.	0.45000	152.06	0.0

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
20	2.74	1	0.0009	0.07

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]	
1	34.935	-2.7387	-0.0013703	1	-27.391	0.0	0.0	P
1	34.935					-13.703	-41.250	
2	34.268	-1.7951	-0.0013922	1	-52.459	11.058	-29.273	P
3	33.602	-0.95415	-0.0010912	1	-76.332	25.327	-9.9540	
4	32.935	-0.36449	-680.56E-6	1	-29.159	24.330	5.8696	
5	32.268	-0.032267	-335.00E-6	1	-2.5813	17.501	10.631	
6	31.602	0.10831	-107.06E-6	1	8.6651	10.156	9.7181	
7	30.935	0.13439	13.311E-6	1	10.751	4.5437	6.8057	
8	30.268	0.10732	58.278E-6	1	8.5859	1.0816	3.9052	
9	29.602	0.066324	59.860E-6	2	6.4850	-0.66329	1.6446	
10	28.935	0.031605	43.014E-6	2	3.0903	-1.1112	0.14282	
11	28.080	0.0052370	19.760E-6	2	0.51206	-0.78098	-0.48471	
12	27.225	-0.0045658	4.8608E-6	2	-0.44644	-0.28233	-0.49733	
13	26.370	-0.0055212	-1.4554E-6	2	-0.53985	0.069457	-0.30142	
14	25.413	-0.0032323	-2.6980E-6	2	-0.31604	0.25256	-0.12336	
15	24.457	-0.0010746	-1.6965E-6	3	-0.12418	0.30549	-0.028606	
16	23.500	-15.023E-6	-605.01E-9	3	-0.0017360	0.30729	-0.0014949	
17	22.500	252.27E-6	-27.033E-9	3	0.029152	0.30840	-0.0076719	
18	21.500	179.63E-6	129.19E-9	3	0.020757	0.32263	-0.018901	
19	20.500	41.507E-6	142.59E-9	3	0.0047963	0.34621	-0.024651	

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min [mm]	Max [mm]	Min [rad]	Max [rad]	Min [kNm]	Max [kNm]	Min [kN]	Max [kN]

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
-2.7387	0.13439	-0.0013922	59.860E-6	-13.703	25.327	-41.250	10.631

RESTRAINT FORCES

No.	Node	Lateral force	Moment
		[kN]	[kNm]
1	1	0.0	13.703

Notes
Design 1 - 34.935 COL DA1-2

General Data
Number of increments = 1
Increment applied loads only

Convergence Control
Maximum number of iterations = 500
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Soil Data
Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level	E	Unit wt.	Phi	Factored Kq	Factored Kc	c(top)	dc/dz
	[m]	[kN/m²]	[kN/m³]	[deg]			[kN/m²]	[kN/m²/m]
1	34.935001	45000.	20.000	25.000	-	-	0.0	0.0
2	29.934999	55000.	20.000	25.000	-	-	0.0	0.0
3	24.934999	65000.	20.000	25.000	-	-	0.0	0.0

Calculated K_q and K_c Values

Node	Z/D	K_q	K_c
1	0.0	2.3566	4.7453
2	1.4815	3.1267	12.145
3	2.9630	3.6369	15.633
4	4.4444	3.9997	17.663
5	5.9259	4.2709	18.991
6	7.4074	4.4814	19.927
7	8.8889	4.6494	20.622
8	10.370	4.7867	21.160
9	11.852	4.9010	21.587
10	13.333	4.9976	21.935
11	15.233	5.1015	22.297
12	17.133	5.1883	22.590
13	19.033	5.2618	22.831
14	21.159	5.3317	23.055
15	23.285	5.3915	23.243
16	25.411	5.4431	23.402
17	27.633	5.4900	23.544
18	29.856	5.5311	23.667
19	32.078	5.5673	23.774

Sections

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
Section 1	Explicit	Description, Material and Class	not applicable		0.45000	40258.

Pile Properties

Level [m]	Section
34.935	Section 1

Pile base at 20.500000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	34.935	25.000	0.0	0.0
2	34.935	5.0000	0.0	0.0

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	10000.

Surcharges

No.	Level [m]	Pressure [kN/m²]
1	34.935	5.0000

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	34.935	1	40258.	0.45000	10.448	0.0
2	34.268	1	40258.	0.45000	16.988	0.0
3	33.602	1	40258.	0.45000	23.528	0.0
4	32.935	1	40258.	0.45000	30.068	0.0
5	32.268	1	40258.	0.45000	36.608	0.0
6	31.602	1	40258.	0.45000	43.148	0.0
7	30.935	1	40258.	0.45000	49.688	0.0
8	30.268	1	40258.	0.45000	56.228	0.0
9	29.602	2	40258.	0.45000	62.768	0.0
10	28.935	2	40258.	0.45000	69.308	0.0
11	28.080	2	40258.	0.45000	77.695	0.0
12	27.225	2	40258.	0.45000	86.083	0.0
13	26.370	2	40258.	0.45000	94.470	0.0
14	25.413	2	40258.	0.45000	103.86	0.0
15	24.457	3	40258.	0.45000	113.24	0.0
16	23.500	3	40258.	0.45000	122.63	0.0
17	22.500	3	40258.	0.45000	132.44	0.0
18	21.500	3	40258.	0.45000	142.25	0.0
19	20.500	3	40258.	0.45000	152.06	0.0

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
20	2.18	1	0.0007	0.06

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]	
1	34.935	-2.1783	-0.0010799	1	-19.638	0.0	0.0	P
1	34.935					-10.799	-31.500	
2	34.268	-1.4338	-0.0011012	1	-36.874	8.2367	-23.023	P
3	33.602	-0.76647	-868.47E-6	1	-61.318	19.898	-8.2943	
4	32.935	-0.29609	-544.38E-6	1	-23.687	19.296	4.4565	
5	32.268	-0.029655	-269.71E-6	1	-2.3724	13.956	8.3655	
6	31.602	0.084093	-87.621E-6	1	6.7275	8.1418	7.7122	
7	30.935	0.10614	9.1007E-6	1	8.4914	3.6730	5.4294	
8	30.268	0.085329	45.658E-6	1	6.8263	0.90258	3.1317	
9	29.602	0.052999	47.416E-6	2	5.1822	-0.50259	1.3304	
10	28.935	0.025422	34.262E-6	2	2.4857	-0.87134	0.12760	
11	28.080	0.0043572	15.852E-6	2	0.42603	-0.61662	-0.37987	
12	27.225	-0.0035456	3.9702E-6	2	-0.34668	-0.22175	-0.39514	
13	26.370	-0.0043716	-1.1057E-6	2	-0.42744	0.059070	-0.24133	
14	25.413	-0.0025794	-2.1338E-6	2	-0.25220	0.20660	-0.099925	
15	24.457	-865.73E-6	-1.3529E-6	3	-0.10004	0.25026	-0.024105	
16	23.500	-18.022E-6	-486.67E-9	3	-0.0020825	0.25272	-0.0021129	
17	22.500	198.96E-6	-24.688E-9	3	0.022990	0.25437	-0.0068273	
18	21.500	143.34E-6	101.35E-9	3	0.016563	0.26637	-0.015727	
19	20.500	34.547E-6	112.51E-9	3	0.0039921	0.28583	-0.020352	

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min [mm]	Max [mm]	Min [rad]	Max [rad]	Min [kNm]	Max [kNm]	Min [kN]	Max [kN]

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
-2.1783	0.10614	-0.0011012	47.416E-6	-10.799	19.898	-31.500	8.3655

RESTRAINT FORCES

No.	Node	Lateral force	Moment
		[kN]	[kNm]
1	1	0.0	10.799

APPENDIX F

Ref No	Description
F1-A	Results of “ADC” analysis for 450mm diameter bearing piles with 4 x B16mm bars, B8mm helical @ 200mm centres, 180kN compression load.
F1-B	Results of “ADC” analysis for 450mm diameter bearing piles with 4 x B16mm bars, B8mm helical @ 200mm centres, 671kN compression load.
F1-C	Results of “ADC” analysis for 450mm diameter bearing piles with 4 x B16mm bars, B8mm helical @ 200mm centres, 200kN compression load.
F1-D	Results of “ADC” analysis for 450mm diameter bearing piles with 4 x B16mm bars, B8mm helical @ 200mm centres, 510kN compression load.
F2	Results of Helical Check for 450mm diameter bearing piles with 4 x B16mm bars, B8mm helical @ 200mm centres, 75mm cover.

PILEDESIGNS
GEOTECHNICAL EXPERTISE

West Hampstead - 39a Priory Terrace
450mm diameter BP - 4x16mm cage
Moment Check

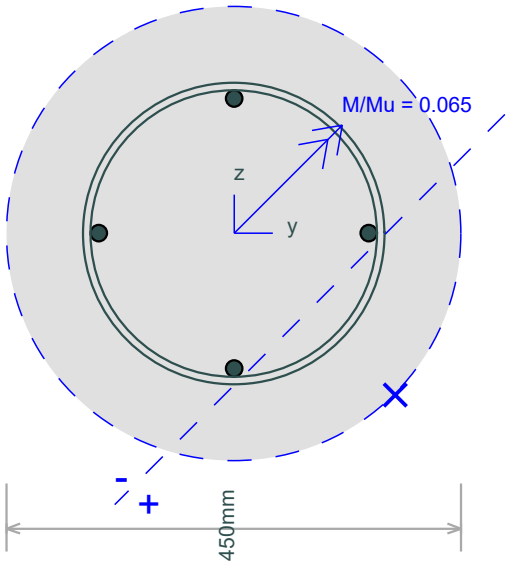
Job No.	Sheet No.	Rev.
24787		
Drg. Ref.		
Made by DBS	Date 13-Oct-2021	Checked

Reinforcement Details

Bar Arrangement	1 ring(s)/4 bars per ring
Diameter of main bars	16mm
Area of reinforcement	804.248mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 1
Axial Design Force	180kN
Axial Capacity	2767.21kN
Design Moment 'M'	5.09117kNm
Ultimate Moment 'Mu'	77.9016kNm
Neutral Axis	— — —
Comp./Tens. Side	+/-
Governing Node/Bar	✕



Section 1
Analysis Case 1

PILEDESIGNS
GEOTECHNICAL EXPERTISE

West Hampstead - 39a Priory Terrace
450mm diameter BP - 4x16mm cage
Moment Check

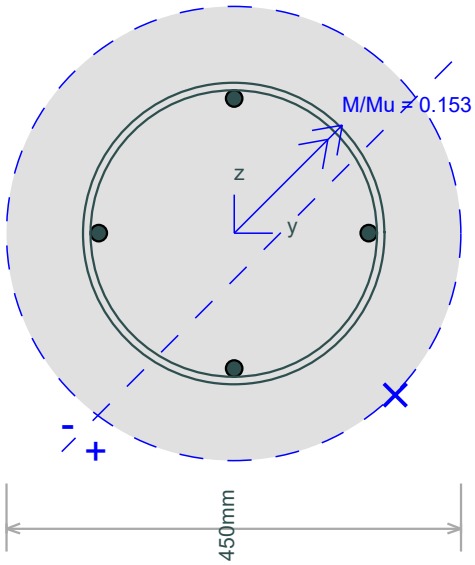
Job No.	Sheet No.	Rev.
24787		
Drg. Ref.		
Made by DBS	Date 13-Oct-2021	Checked

Reinforcement Details

Bar Arrangement	1 ring(s)/4 bars per ring
Diameter of main bars	16mm
Area of reinforcement	804.248mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 2
Axial Design Force	671kN
Axial Capacity	2767.21kN
Design Moment 'M'	18.9787kNm
Ultimate Moment 'Mu'	123.923kNm
Neutral Axis	— — —
Comp./Tens. Side	+/-
Governing Node/Bar	✕



Section 1
Analysis Case 2

PILEDESIGNS
GEOTECHNICAL EXPERTISE

West Hampstead - 39a Priory Terrace
450mm diameter BP - 4x16mm cage
Moment Check

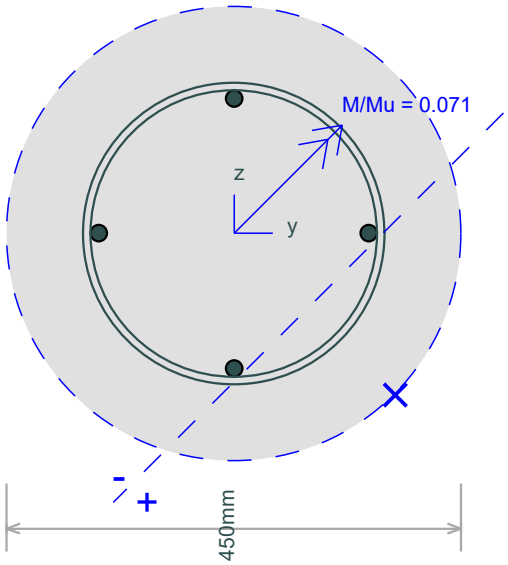
Job No.	Sheet No.	Rev.
24787		
Drg. Ref.		
Made by DBS	Date 13-Oct-2021	Checked

Reinforcement Details

Bar Arrangement	1 ring(s)/4 bars per ring
Diameter of main bars	16mm
Area of reinforcement	804.248mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 3
Axial Design Force	200kN
Axial Capacity	2767.21kN
Design Moment 'M'	5.65685kNm
Ultimate Moment 'Mu'	80.1479kNm
Neutral Axis	— — —
Comp./Tens. Side	+/-
Governing Node/Bar	X



Section 1
Analysis Case 3

PILEDESIGNS
GEOTECHNICAL EXPERTISE

West Hampstead - 39a Priory Terrace
450mm diameter BP - 4x16mm cage
Moment Check

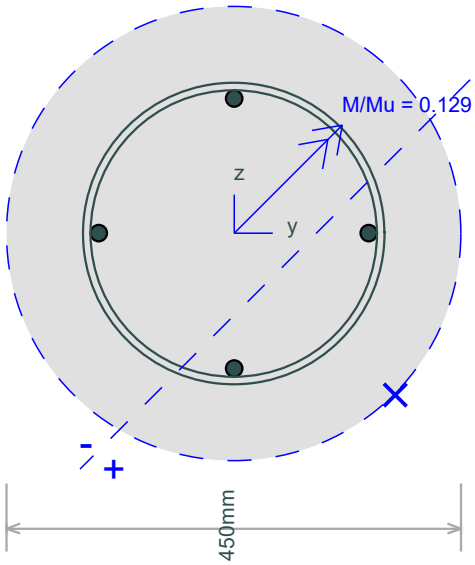
Job No.	Sheet No.	Rev.
24787		
Drg. Ref.		
Made by DBS	Date 13-Oct-2021	Checked

Reinforcement Details

Bar Arrangement	1 ring(s)/4 bars per ring
Diameter of main bars	16mm
Area of reinforcement	804.248mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 4
Axial Design Force	510kN
Axial Capacity	2767.21kN
Design Moment 'M'	14.425kNm
Ultimate Moment 'Mu'	111.489kNm
Neutral Axis	— — —
Comp./Tens. Side	+/-
Governing Node/Bar	X



Section 1
Analysis Case 4

PILEDESIGNS GEOTECHNICAL EXPERTISE
Unit 23 | Chiltern Trading Estate | Earl Howe Road | High Wycombe | Bucks | HP15 6QT
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Project	WEST HAMPSTEAD - 39a Priory Terrace	Project No.		24787	Date	13/10/21
Tilte	450mm Pile Shear Check - BP - 4xB16	By	DBS	Check By		Page 1

Shear to EN 1992-1-1:2004 (EC2) Circular Sections (Cast In-situ) using helical reinforcement

Pile section

pile dia d_{nom}	=	450	mm				
design pile diameter	=	450	mm				
Ac	=	159043	mm^2				
cover c_{nom}	=	75	mm	[4.4.1.3(4)]	k_2 =	75 mm	[NA.1 4.4.1.3 (4)]
main bar dia	=	16	mm				
no. main bars	=	4	no.				
helical dia.	=	8	mm				
d	=	305	mm		γ_c = 1.5 (This is adjusted by K_f=1.1 [2.4.2.5 (2)] to give 1.65)		
f_{ck}	=	30	MPa		γ_c = 1.65	α_{cc} = 0.85	[NA.1 3.1.6 (1)}
f_{yk}	=	500	MPa		γ_s = 1.15		
Ult V_{Ed}	=	19.9	kN		SF factor	1	
Ult V_{Ed}	=	19.9	kN				
factored actions	N_{Ed} =	180	kN				

Check requirement for shear reinforcement [6.2.2]

$V_{Rd,c}$	=	$[C_{Rd,c}k(100\rho_1 f_{ck})^{1/3}+k_1\sigma_{cp}]b_w d$	CRd,c	=	0.18 / γc	0.11
with minimum	=	$(v_{min}+k_1\sigma_{cp})b_w d$	k	=	$1+(200/d)^{1/2}$	1.81 <=2.0
			ρ_1	=	$A_{sl}/b_w d$	0 <=0.02
v_{min}	=	$0.035k^{3/2}f_{ck}^{1/2}$	σ_{cp}	=	N_{ed}/A_c	1.13 < $0.2f_{cd}$
		0.4666	k_1	=	0.15	[NA.1 6.2.2(1)]

$V_{Rd,c}$ = **79** kN

Is $V_{Rd,c}$ > V_{Ed} **=>** **YES** Action: ***No shear links needed - provide nominal links as req'd***

Design Shear Reinforcement [6.2.3]

Check concrete strut capacity at Cot θ = 2.5 :-

				cot θ	=	2.5	
				tan θ	=	0.4	
$V_{Rd,max}$	=	$\alpha_{cw}.b_w.z.v_1.f_{cd}$ / (Cotθ+tanθ)	(6.9)	α_{cw}	=	1	[NA.1 6.2.3(3)]
				z	=	0.9d	275 mm
$V_{Rd,max}$	=	**348** **kN**		v_1	=	0.6 (1-(fck/250)	0.53 [6.6N]

Is $V_{Rd,c}$ > V_{Ed} **=>** **NA** Action:

Calculation for strut inclination:-

θ = $0.5.\sin^{-1}[(6.54*V_{Ed})/(b_w.d.(1-f_{ck}/250).f_{ck})$

θ = NA rad cot θ = 2.5 > 1.0

Calculate shear reinforcement spacing after Turmo et al (2008);-

$V_{Rd,s}$	=	$z.\cot\theta.(A_\Phi/0.5s).f_{ywd}.0.85$	A_Φ	=	50.3	mm^2
s	=	$2.([z.\cot\theta.A_\Phi.fywd.0.85]/V_{Rd,s})$	f_{ywd}	=	435	MPa
	=	**NA** mm				

Check maximum shear link spacing:-

is $s_{l,max}$ > 0.75d **YES**

Provide **8** mm helical at nominal pitch **225** mm

Turo, J, *et al*. Shear truss analogy for concrete members of solid and hollow circular cross section. **Eng. Struc.** (2008)