EUROCODE 7

CONTRACT DESIGN

Project :	**Contiguous & Secant Bored Pile Wall**
Location :	**Plot C1, Trinity Islands, Manchester**
Client :	**Renaker Build Limited**
FP Ref :	**21.1182a**
Renaker Ref :	**C1-Z1-FPL-G210-CA-X-101**
Date :	**13/11/25**
Design Revision :	**P06 [Not For Construction]**

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DOCUMENT CONTROL SHEET

Project: **Contiguous & Secant Bored Pile Wall, Plot C1 Trinity Islands, Manchester**
Ref : **C1-Z1-FPL-G210-CA-X-101**
Client : **Renaker Build Limited**

Date	Project Revision	Design prepared by	Design approved by
08/11/21	**P01** Preliminary scheme	**TPK**	**JRP**
09/12/21	**P02**	**TPK**	**-**
17/09/25	**P03** Updated to revised scheme	**TPK**	**JRP**
25/09/25	**P04** Design development	**TPK**	**-**
20/10/25	**P05** Plot C1 only Full Design Report for approval	**TPK**	**JRP**
13/11/25	**P06** Increased excavation depth section A Pile arrangements amended to sections E1 (900mm secant) / E2 (750mm contig) Amendments following WSP comments received 28/10, 31/10	**TPK**	**JRP**

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1. DESIGN BRIEF

Foundation Piling Ltd has been instructed to design a contiguous and secant bored pile retaining wall, the scope of which is specified on the Engineer's Drawing Numbers detailed below and to a maximum retained height summarised within section 6.4 of this design.

The piles are to vary between 600mm diameter at 750mm centres, 600mm diameter at 950mm centres, 750mm diameter at 900mm centres, 900mm diameter at 1050mm centres and 900mm diameter at 1350mm centres.

This design considers a long-term reduction in flexural stiffness due to relaxation as per the guidance in CIRIA C760.

Calculations for end bearing piles and axial loads acting on the piled retaining wall will be issued separately. Where the wall is designed as secant for groundwater cut off purposes the depth of cut off has been determined by others.

2. DATA PROVIDED

Specification :	ICE Specification for Piling and Embedded Retaining Walls C1-Z1-WSP-A180-SP-XX-0001
Site Investigation:	WSP Ground Investigation Report reference 70085298-WSP-GEO-GIR-001 dated September 2021 WSP Ground Investigation Report reference 70085298-11833(5) dated July 2022
Relevant Drawings :	Pile Arrangements: C1-B2-WSP-G210-PL-XX-0001 C1-B2-WSP-G210-PL-XX-0002 C1-B2-WSP-G210-PL-XX-0003 C1-B2-WSP-G210-SC-XX-0001 Foundation General Arrangements: C1-B2-WSP-G210-PL-B2-0002 C1-B2-WSP-G210-PL-B2-0003 Basement Slabs: C1-B2-WSP-G200-PL-B2-0002 C1-B2-WSP-G200-PL-B2-0003 Capping Beam Layouts: C1-B2-WSP-G210-PL-XX-0005 C1-B2-WSP-G210-PL-XX-0006 WSP Technical Note 3 – Structural Assessment of the New Trinity Development and It's Effect on Settlement of the Existing Ordall Chord Viaduct

3. GEOLOGICAL MODEL

As described in the site investigation provided, the general succession of strata to be expected on site is as follows:

Section A		
From	**To**	**Stratum**
25.90	22.50	Made Ground
22.50	21.00	Alluvial Gravel
21.00	19.00	Weathered Sandstone
19.00	-	Sandstone

Section D1		
From	**To**	**Stratum**
25.70	22.50	Made Ground
22.50	21.00	Alluvial Gravel
21.00	19.00	Weathered Sandstone
19.00	-	Sandstone

Section D2		
From	**To**	**Stratum**
25.70	21.70	Made Ground
21.70	20.00	Alluvial Gravel
20.00	18.00	Weathered Sandstone
18.00	-	Sandstone

Section E		
From	**To**	**Stratum**
25.70	21.70	Made Ground
21.70	20.00	Alluvial Gravel
20.00	18.00	Weathered Sandstone
18.00	-	Sandstone

Section J		
From	**To**	**Stratum**
23.70	20.50	Made Ground
20.50	19.50	Alluvial Gravel
19.50	18.50	Weathered Sandstone
18.50	-	Sandstone

Section K		
From	**To**	**Stratum**
23.70	22.50	Made Ground
22.50	20.50	Alluvial Gravel
20.50	18.50	Weathered Sandstone
18.50	-	Sandstone

WATER LEVEL PROFILES

Moderately Conservative
Active face : 22.0mOD
rising to the lower of 1.0m below ground level or 24.0mOD in long term
Passive face : formation level

Worst Credible
Active face : the lower of 1.0m below ground level or 23.0mOD
rising to the lower of 1.0m below ground level or 24.0mOD in long term for contiguous walls and to 1.0m below ground level for secant walls
Passive face : formation level

4. SOIL PARAMETERS

The soil profile adopted for design purposes is taken from the above site investigation data provided. Characteristic values are adopted for the SLS and the DC1-1 Simulated ULS (where applicable) and factored characteristic values based on the sets on Actions and Materials detailed within Section 6.6 (Tables A.NA.3 and A.NA.4).

Representative soil properties have been established from the test data where relevant tests have been carried out as part of the site investigation works otherwise properties and parameters have been deduced from experience and from appropriate correlation with the test data.

4.1 Strata 1 : Made Ground

The bulk density of the made ground is taken as 18kN/m^3.

An SPT 'N' value of 10 has been assumed for design purposes. Parameters are derived for the purposes of design using the method of Peck Hanson & Thorburn, thus:

$\emptyset = 30°$ and $c' = 0\ kN/m^2$
$E_{h\ SLS} = 12.5MPa$
$E_{h\ ULS} = E_{h\ SLS} \div 2$

4.2 Strata 2 : Alluvial Gravel

The bulk density of this strata is taken as 18 kN/m^3.

$\emptyset = 30°$ and $c' = 0\ kN/m^2$
$E_{h\ SLS} = 30MPa$
$E_{h\ ULS} = E_{h\ SLS} \div 2$

4.3 Strata 3 : Weathered Sandstone

The upper 1.0-2.0m of sandstone as reported on borehole logs is generally described as extremely weak to weak, with SPT results excess of 200 and point load $I_{s(50)}$ results in the range 0.02-0.20 MPa.

The bulk density of this strata is taken as 22 kN/m^3.

$\emptyset = 40°$ and $c' = 0\ kN/m^2$

$E_{h\ SLS} = 100MPa$

$E_{h\ ULS} = E_{h\ SLS} \div 2$

4.4 Strata 4 : Sandstone

Sandstone within the anticipated founding depths of the piles is described as extremely weak to weak, with point load $I_{s(50)}$ results in the range 0.02-0.20 MPa and UCS results in the range 5-15MPa. Results indicate a typical strength of 5MPa.

The bulk density of this strata is taken as 22 kN/m^3

$\emptyset = 38°$ and $c' = 10\ kN/m^2$

$E_{h\ SLS} = 250MPa$

$E_{h\ ULS} = E_{h\ SLS} \div 2$

A summary of all values including the Kp values calculated from Eurocode 7, are indicated within the data listing in the Wallap outputs.

Wall friction for smooth pile walls are taken as:

$\delta_a = \frac{2}{3}\ \emptyset'_{CRIT}$ $\delta_p = \frac{1}{2}\ \emptyset'_{CRIT}$ (backfill)

Wall friction for rough pile walls are taken as

$\delta_a = \emptyset'_{CRIT}$ $\delta_p = \frac{2}{3}\ \emptyset'_{CRIT}$

Walls will be treated as smooth above excavation level and rough below excavation level.

5. PILE SELECTION AND ENVIRONMENTAL CONSIDERATIONS

Given the general site and ground conditions present on this project, CFA techniques are considered to be the most appropriate in terms of achieving the required design embedment.

6. WALL DESIGN CALCULATION

Wallap calculations are presented for the contiguous piled retaining wall. Piles are to be constructed using a CFA technique with nominal diameter varying 600-900mm. Controlled construction processes are to be employed to ensure that the design diameter is achieved. These processes satisfy the requirements for "other provisions" stated in EC2 Part 2 (clause

2.3.4.2 refers) see also FPS position paper issued May 2011). Where these controlled processes are not achievable the steel design is to be based on a reduced diameter 10% less than the nominal diameter or where temporary casing is used, on the actual bore diameter out of casing (whichever is smallest), if the peak design moment is within this section of the pile.

Pile reinforcement cages laced together will be installed within the concreted bore. Analysis of the pile reinforcement is included within Appendix 2 and summarised in Appendix 3.

Pile reinforcement is specified as Main Bar and if it is to be spliced a full tension lap is required. Shear reinforcement where applicable is specified as helical or hoops with the calculation enclosed within Appendix 2 and summarised within Appendix 3 along the required pitch or spacing.

6.1 Geotechnical Analysis

The analysis is carried out using the computer programme Wallap under license from Geo-solve. The input and output data from the computer analysis is presented in Appendix 1.

The calculations have been carried out using the "Factor of Strength" method, with factor "M" set to 1.40 for undrained parameters and 1.25 for drained parameters in accordance with EC7. Details of the soil parameters are presented within the Wallap outputs attached.

Indicative anticipated displacements that may be expected to occur under working conditions are also presented in detail within the Wallap outputs. It should be noted that Wallap uses a Winkler spring analysis to determine the wall displacements. In a Winkler medium, 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 by the programme. Where a top prop or multiple props are utilised a degree of soil arching will occur. The arching rule allows active **pressures** to fall to values below the Coulomb active limiting pressure, provided the total active **force** on each potential active wedge mechanism is not less than the Coulomb active limiting force.

With arching the program predicts the sort of trapezoidal pressure distribution observed in strutted excavations, instead of the usual triangular pressure diagram based on Coulomb active limit pressures. Hence soil pressures near ground level are well in excess of the active limit while active pressures near excavation level are significantly below Coulomb active limiting pressure.

METHOD OF ANALYSIS

In checking the adequacy of a retaining wall at ultimate limit state (ULS) it must be noted that in many real situations the loads imposed by the soil at the ultimate (Collapse) limit state are smaller than those under working conditions, as at working conditions the soil is unlikely to be fully mobilised. The Factors of Safety introduced into the ULS calculations lead generally to more severe action effects that those calculated for SLS.

To better model conditions at SLS computer analysis using soil-structure interactions is

used with the Wallap programme. This programme uses both subgrade reactions and pseudo-finite element methods. In the subgrade reaction method, the wall is modelled as a beam and the soil as a series of horizontal springs, and the finite element as an elastic continuum.

Actual construction sequences are modelled with the accuracy of the results being dependant on the quality/appropriateness of the design input parameters.

The ULS condition is consequently used to determine the worst cast pile/wall depth and bending moment for the wall design and the SLS condition is used to assess more realistic potential deflections.

6.2 Tension Cracks

For cantilever walls particularly in the temporary case where undrained soil strengths are used, rather than rely on tensile stress acting across the soil / wall interface to help support the wall, it is usual to assume a tension crack develops to depths below the retained surface where the calculated active lateral total stress is negative.

Where water is not expected, the depth of tension cracks are assumed to be :

$$(2\ C_u - q) \text{ and where expected } 2\ (C_u - q)\ /\ \sigma\ -\ \sigma\ w$$

The total pressure acting on the retained side of the wall at any depth Ƶ (in metres) below ground level is assumed as a minimum equivalent fluid pressure of 5 Ƶ Kn/m² or for total stress analysis of :

$$\sigma'_a = \left(\int_0^z \sigma'_v + q\right) - 2\ C_u\sqrt{(1 + \frac{\mathrm{Cw}}{Cu})}$$ whichever is greater.

Where water is expected a minimum total horizontal stress = $\sigma'_H = \gamma_w\ z$ is used instead of 5z.

Where walls are propped, so long as lateral stresses are greater than the hydrostatic pressure at the same level in the top 1m of the wall then tension cracks are discounted. It is unlikely that tension cracks greater than 3.0m to 4.0m will occur. It may be prudent to take the full excavated height equal to tension crack depth for a cantilever wall in stiff clay.

6.3 Drained / Undrained Analysis

The undrained cohesion parameter C_u is the frictional strength of soil at the moisture content and effective stress level pertaining in situ.

Undrained analysis is often used in calculating the capacity of bored shafts installed into clay. Application of load usually causes initial excess pore water pressure together with a change in the relationship between major and minor principal stresses. As these excess pore water pressures dissipate, effective stress change, accompanied by a corresponding change in cohesive strength.

For embedded retaining walls, the unloading caused by excavation gives rise to negative excess pore water pressures. As these dissipate, the C_u value of soil reduces. The speed of dissipation of the negative excess pore water pressures generated by wall installations

and excavation in front of the wall is dependent on the permeability and degree of fissuring for stiff over consolidated clays and the original C_u does not apply for very long.

In general, it is prudent only to use undrained (total stress) analysis for the short-term condition (for stiff over consolidated clay soils), using drained soil parameters for the long-term conditions. Where undrained analysis is used, to provide an economic design, it is prudent to provide control measures to monitor wall deflections during these temporary works to ensure that the serviceable conditions are satisfied.

For normally consolidated clay or for clays where C_u<75 kN/m^2 the use of undrained parameters may be more appropriate than using drained values, especially where little or no soil suction exists. $\sigma_a = \int_o \sigma' + q - 2.45\, C_u > 0$

6.4 Design Excavation Depth

(A) Ultimate Limit State

Actual maximum proposed excavation depth plus 10% of depth below the lowest support, limited to a maximum of 0.5m overdig.

(B) Service Limit State

Actual Retained Height
Modelled design depths :

Design Section	Adjacent to Wall		Maximum Excavation	
	A (ULS) (mOD)	B (SLS) (mOD)	A (ULS) (mOD)	B (SLS) (mOD)
A	18.70	19.20	-	-
D1	19.40	19.90	-	-
D2	19.40	19.90	-	-
E	19.00	19.50	-	-
J	19.40	19.90	-	-
K	20.15 18.90	20.65 (slab) 19.40 (pads)	18.10	18.60 (raft)

6.5 Eurocode 7 / CP2 Methods Compared

The Eurocode 7 approach differs from the gross pressure (CP2) and net total pressure methods (Burland & Potts) which apply a FOS to the respective gross and net resisting moment against overturning moments in applying factors to the mobilised values of Ø' and C' whilst maintaining the proportional relationships between

$(\delta/Ø')_m$ and $(Cw/C')_m$ equal to the assumed values for $(\delta/Ø')$ and (Cw/C').

The use of the factor on strength method increase Ka and decrease Kp modifying the relative distribution of earth pressures.

The factored parameters provide a safety margin and the geometry is adjusted to satisfy equilibrium with pressures derived from factored parameters. This provides the basis of the

ULS (Ultimate Limit State) Design Condition of Design Case 1 Combination 2 within EC7 1994 (DC1-2)

To obtain more realistic deflections an analysis is undertaken using unfactured soil strengths and stiffnesses. The accuracy of these deflections is dependent on the choice of characteristic (moderately conservative values) chosen for the design and the method of analysis used by the computer programme.

The CP2 approach was to use moderately conservative soil parameters and use an appropriate FOS on the resulting restoring-destabilising moments to achieve a safe wall embedment depth. The moments calculated were then usually factored upwards to simulate an ultimate state moment.

6.6 Design to Eurocode 7

Eurocode 7 asks us to consider various limit states, mainly EQU, GEO, STR, SLS, HYD and UPL for an embedded wall our main concerns are to satisfy GEO, SLS and STR.

EQU for equilibrium is more useful in checking the equilibrium of convention cantilever walls, with HYD and UPL requiring specific attention in the design process when hydraulic or uplift conditions dictate. To satisfy GEO two combinations of loading are considered to satisfy the Ultimate Limit State design condition, within the UK we are being advised to adopt our designs in accordance with “Design Approach 1, Clause 2.4.7.3.1.2.

The limit state calculation is considered to obtain a safe wall embedment depth and an ultimate limit state moment M_{ULS}.

In consideration of this ULS of rupture or excessive deformation the worst case of two combinations need to be considered.

Combination 1 (GEO) Limit State A1 + M1 + R1 and
Combination 2 (GEO) Limit State A2 + M2 + R1 where

A = Actions (Forces) applied to the wall
M = Soil Parameters
R = Partial Resistance Factors

The Design Combination 1, where unfavourable actions are increased and soils are un-factored, is usually critical as discussed below. For walls with significant active surcharges in both temporary and permanent considerations combination 1 needs be considered with particular note to the method of surcharge pressure distribution used (see surcharges) and the active soil pressure distribution (arching).

Nevertheless, in order to comply strictly with the requirement to factor "actions" it has become widely accepted that we should somehow factor the ***effect*** of self-weight of soil. This is achieved by factoring total wall pressures and hence the resulting bending moments and strut forces. The main source for this approach is the Designer’s Guide Section 9.7 p.158:

All soil parameters, water pressures, and permanent actions enter the calculation with their Characteristic values. Variable loads and surcharges enter the calculation with their Characteristic values multiplied by γ_Q/γ_G (see Table 4 i.e.1.5/1.35 = 1.1). The resulting bending moments and strut forces are regarded as unfavourable permanent actions which are then multiplied by γ_G (1.35) to obtain their design values.

It is noted note that, apart from Overdig and Variable loads, which are pre-factored by 1.1, the input parameters are identical to the input for a SLS analysis. Similarly, the resulting bending moments and strut forces get factored by 1.35 to obtain their design values. Looking at Section 7.1.1 we see that the Designer's Guide interpretation of Combination 1 leads to design bending moments and strut forces which are only marginally greater than those obtained from an SLS design. We also note that any FoS obtained from this (Combination 1) analysis would be a lumped factor for which it is difficult to define a suitable design value. However, we still have Combination 2 to ensure that stability is achieved and that design bending moments are safe.

Design Case 1 Combination 2 where active pressures are increased by factoring soil strength and passive resistances reduced is usually the worst-case design condition. The Moderately Conservative values of Soil strength, Modulus, Surcharges and Applied Loads are used in the analysis after having been factored by the Partial Factors appropriate to the selected Ultimate Limit State. The factored parameters are used in both the Factor of Safety and the Bending Moment calculation. Water pressures are normally set to their "Worst Credible" values. The resulting bending moments and displacements are Ultimate Limit State values.

Factors for the above combination are summarised below. The shear strength design value ($\emptyset'_D$) for each combination is obtained by factoring on tan $\emptyset$, *w*here :

Combination 1 $$\emptyset'_D = \tan^{-1}\left(\frac{\tan \emptyset'}{M1}\right)$$

Combination 2 $$\emptyset'_D = \tan^{-1}\left(\frac{\tan \emptyset'}{M2}\right)$$

Table A.NA.3 : Partial Factors on actions (γ_F) or the effects of actions (γ_E)

ACTION		**SYMBOL**	**SET**	
			A1	**A2**
Permanent	Unfavourable	γ_G	1.35	1.00
	Favourable		1.00	1.00
Variable	Unfavourable	γ_Q	1.50	1.30
	Favourable		0	0

Table A.NA.4 : Partial Factors for soil parameters (γ_M) for the STR and GEO limit state (γ_E)

SOIL PARAMETER	SYMBOL	SET	
		M1	M2
* Angle of Shearing Resistance	γ_Q	1.00	1.25
Effective Cohesion	γ_Q	1.00	1.25
Undrained Shear Strength	γ_Q	1.00	1.40
Unconfined Strength	γ_Q	1.00	1.40
Weight Density	γ_Q	1.00	1.00
*** This factor applied to tan Ø' (See above)**			

Table A.NA.13 : Partial Resistance Factors for retaining structures at the STR & GEO limit states

RESISTANCE	SYMBOL	SET R1
Bearing Capacity	γ_{RV}	1.00
Sliding Resistance	γ_{RH}	1.00
Earth Resistance	γ_{Re}	1.00

6.7 Surcharges

(A) Minimum construction load surcharge should be applied for both temporary and permanent works stages where S_1 = 10 kN/m^2.

(B) The above value is identical to a standard H_A highway load BS5400 Part 2 or EC1 15 unit = 10 KN/m^2

(C) For designated loads H_B loading will need to be considered and for simplicity can be taken up to a maximum of 45 units = 20 kN/m^2.

(D) For adjacent structures, trial pit evidence is needed to establish distance to and depth of nearby foundation and surcharge taken on :

$$\frac{\text{weight of building / m}}{\text{width of foundations}}$$

(E) Where a block of soil is present on the active face and adjusting the K_a value using an active slope incline angle β is inappropriate two approaches to modelling this block of soil as a surcharge are possible:

a. Treat block of active soil as a surcharge of density of soil x f when f can vary as the height of the soil block increase away from the face of the wall, then add a horizontal force at the top of wall equivalent to the active thrust of the soil block being modelled as a surcharge.

b. Latest revision of Wallap allows an active block of soil to be modelled as a surcharge by checking multiple slope stability wedges as the wall is excavated.

(F) The railway viaduct running adjacent to the Northern boundary of the site comprises a Victorian masonry structure with a recent piled extension. Refer to WSP Technical

Note 3. To assess the impact of the viaduct on the basement excavation an assumed maximum allowable bearing pressure of 600kPa will be applied at the location of the Victorian masonry piers.

Surcharge Assumed :

No	Type	Distance from Wall m	Width m	Value kN/m²	Value End kN/m²	
1	Highways Construction	1.0	10.0	12 (H_A+20%)	12 (H_A+20%)	Variable Unfavourable γ_Q
2	Rail viaduct 19.6mOD (A, D1)	7.0	1.0	600	600	Permanent Unfavourable γ_G

6.8 Surcharge Calculations

Generally, Boussinesq elastic lateral stress distributions are used to model applied surcharges. Unless the wall is rigid it is appropriate to check the sensitivity of strip or line load surcharges using methods by Kray or Williams and Waite particularly for clays.

7 BOUNDARY CONDITIONS

This is the elevation of the rigid lower boundary of the finite element mesh in the 2-D F.E. analysis. A reasonable depth in many problems would be half the wall depth below the toe of the wall.

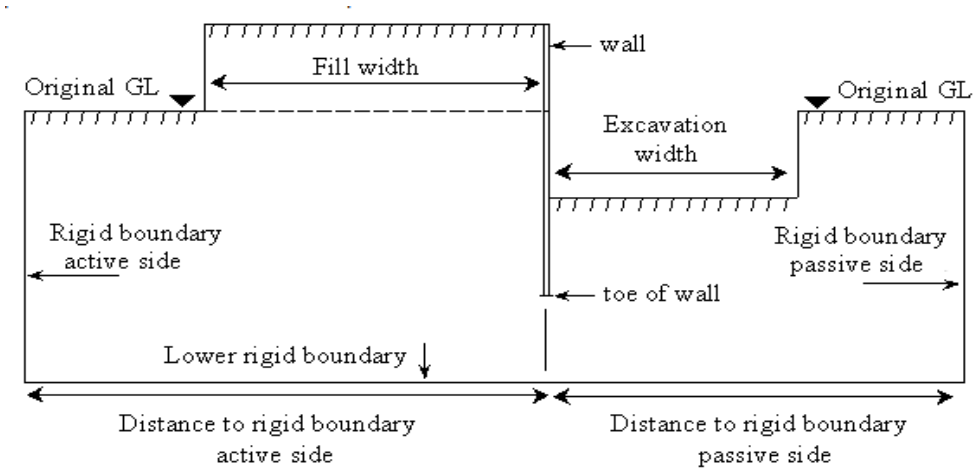


Figure 9a. Boundary conditions for very wide or asymmetrical excavation

8 VALIDATION REQUIREMENTS

The Contiguous / Secant Bored Pile Wall is to be designed to have an overdesign factor in excess of one, $\Gamma > 1$, for the two GEO combinations, (where combination 1 is relevant), and also to satisfy the deflection criteria at the SLS limit state. The method of analysis of short- and long-term soil parameters uses either the Factor on strength method, or (factor on moments method were applicable) all in accordance with CIRIA Report 580, or (CIRIA 104

where applicable). Resulting bending moments and shear forces are factored by a load factor γf =1.35 from the SLS calculations and γf =1.0 for each of the ULS combinations. Where the output for the DC1-1 analysis is unfactored the moments and shears are factored by the A1 sets detailed on page 10. The worst-case moment from these ultimate limit state values is taken as the ULS design moment (M_D). The pile cage is then designed to this moment to either BS8110 or EC2.

9 CONSTRUCTION DETAILS

The contiguous wall piles are to be constructed in the following sequence:

1. Confirm level of Piling Platform is the same as that in the Design Summary (Appendix 3), if not adjust pile length to accommodate.
2. Bore piles to toe level stated in Design Summary (Appendix 3)
3. Concrete to minimum level of capping beam cut off level +450mm, top of guide wall, or PPL.
4. Insert pile cages to PPL.
5. Excavate to a level to construct capping beam.
6. Construct capping beam.
7. Excavate to elevation not exceeding 18.6mOD for main raft foundation, leaving berms to underside of basement slab level (minimum 19.6mOD).
8. Construct raft to underside of basement slab level.
9. Excavate locally on hit and miss basis to elevation not exceeding 19.20mOD for pad foundations.
10. Construct pad foundations to underside of basement slab level.
11. Construct basement slab providing a permanent propping reaction.
12. Construct ground floor slab.
13. Construct any columns above ground floor level supported by the capping beam.

10 ACTION REQUIRED BY CLIENT FOR REALISATION OF DESIGN

1. This design is subject is subject to the provision of and checking of the final construction drawings.
2. Engineer approval of the preliminary pile design contained herein.
3. Confirmation of concrete class in accordance with BRE SD1, 201.
4. Confirmation of piling platform levels.
5. Control measures to ensure the design excavation depths are not exceeded.
6. Where foundation excavation trenches are opened adjacent to wall these are not to be left open overnight.
7. Provision of any monitoring system for the pile wall and/or adjacent buildings considered necessary during both bulk excavation and the subsequent construction period.

8. Acceptance of the basis for design by all parties and the effect of the predicted wall displacements.

9. Construction in the sequence noted.

11 CONFLICTING ITEMS TO BE RESOLVED

1 Wall surcharge loadings.

2 Position of wall with allowance for additional tolerances & permeability of wall in accordance with tolerances as illustrated in Appendix 5

12 REFERENCES

1. BS8002: 1994, Code of Practice for Earth Retaining Structures, BSI London.

2. BRE, Special Digest 1, Concrete in Aggressive Ground, 3rd Edition 2005.

3. BS5950-1 2000.

4 CIRIA Report 760, Embedded Retaining Walls – guidance for economic design CIRIA London (2017).

5 Eurocode 7 EN 1997-1 UK National Annex
UK National Annex to Eurocode 7: Geotechnical Design – Part 1: General Rules
British Standards Institution 2004.

6 Designers Guide to EN 1997-1. Eurocode 7: Geotechnical design – General Rules.
R.Frank, C.Bauduin, R.Driscoll, M.Kavvadas, N.Krebs Ovesen, T.Orr,
B.Schuppener. Thomas Telford 2004.

7 EN 1997 Part 1, Eurocode 7: Geotechnical Design - General Rules
European Committee for Standardisation, Brussels.

8 CIRIA Report No.104. (1984) Design of Retaining Walls in Stiff Clay.

9 Civil Engineering Code of Practice No.2 (1951)
Earth Retaining Structures. Institution of Structural Engineers.

13 CDM Design Risk Assessment

INTRODUCTION

The methodology for assessing problems associated with construction risk has been based upon information contained within the CDM 2015 regulations. The buildability risk assessment has five elements, which include:

- Identification of the design, construction and buildability risks
- Assessment of the likelihood of accident, damage, injury and disruption
- Assessment of the consequence of accident, damage, injury and disruption
- Combination of probability and consequence to produce the risk assessment
- Assessment of possible mitigation measures

The assessment of the likelihood or probability of accident, damage, injury and disruption has been based upon the judgement of experienced Chartered Engineers and Health & Safety professionals and has been scaled as High, Medium, Low and Improbable. The joint combination of likelihood and severity is represented as a matrix (see Table 1).
Table 2 shows a scale of severity used for the risk assessment and gives guidance in evaluating the severity of the risk. The scale is classified into five descriptors from Catastrophic to Negligible. For example, an occupational threatening injury is classified as Critical whereas an injury requiring simple first aid at work is classified as Marginal.
An assessment of a particular design/construction issue which produces a score greater than 7 in the matrix is considered unacceptable. This is shown shaded RED. Similarly, YELLOW is undesirable (score between 4 and 6) and BLUE is acceptable (score less than 4). In certain cases the risk matrix contained in the assessment can include two shaded areas, which relate to the case with, and without, mitigation.

Table 1 - Risk Matrix

			Likelihood			
			High	Medium	Low	Impossible
			4	3	2	1
Severity	Catastrophic	4	16	12	8	4
	Critical	3	12	9	6	3
	Serious	2	8	6	4	2
	Marginal	1	4	3	2	1

Table 2 - Guidance for the Assessment of Severity

Severity	Guidance
Catastrophic	Death, system loss, criminal guilt, bankruptcy, complete collapse of asset, building or structure.
Critical	Occupation threatening illness or injury, major damage, substantial damages, exceeds contingency dividends at risk, partial collapse of building or structure leading to major damage or building or structure.
Serious	Loss of time, injury or illness, damage causing downtime of plant, consumes contingency, requires an insurance claim, project delays, community disruption in the form of long traffic diversions for long periods of time or similar.
Marginal	Injury or illness requiring first aid at work only, minor damage that can await routine maintenance, will only require an apology letter, accommodated as part of contingency or insurance excess, community disruption for short periods of time, pedestrian diversions for long periods of time.

MOBILISATION, MOVEMENT AND RISK TO SERVICES

Ref.No	Activity / Task	Hazard	People at risk	Existing Control	L	S	RR	Recommended Action Controls	L	S	RR
1.1	Access, egress and movement of plant into, and on, working area.	The danger of plant and equipment overloading predetermined haul roads.	FPL and other operatives	Designated access routes designed to take the loading conditions of all plant to be installed before project commencement.	2	4	8	FPL is to provide PC with the correct loading documentation for the plant planned to undertake the work. Track pressures to be calculated in line with appropriate guidance (British Standards or relevant organisation).	1	4	5
1.2	Contact with overhead powerlines.	The danger of plant and equipment coming into contact with or encroaching on, overhead powerlines and their sagging radius.	FPL and other operatives	All overhead powerlines are to be identified and the owners notified as to the ongoing work.	1	5	5	FPL is to provide PC with all dimensions of the plant, including transportation dimensions, to ensure contact with overhead lines does not occur.	1	3	3
1.3	Rigging up of piling rig and setting up associated plant.	Incorrect rigging up procedures leading to rig instability or installation issues.	FPL and other operatives	Compliance with FPL and manufacturer documentation to ensure correct procedures in place for rigging up of equipment.	1	2	2	Ensure RAMS are submitted to PC before rig arrival, including a detailed description of the rigging up procedure.	1	1	1
1.4	Contact with underground services.	Potential for piling operations to impact, penetrate or damage sub- surface obstructions/services.	FPL and other operatives, general public	PC to ensure all buried services and obstructions are removed/diverted before piling operations.	1	2	2	All actions remain with PC.	1	2	2

PILING RIG OPERATIONS

Ref.No	Activity / Task	Hazard	People at Risk	Existing Control	L	S	RR	Recommended Action Controls	L	S	RR
2.1	Noise	Excessive noise from plant and equipment causing long- term health effects.	FPL operatives	All rig operations are to be carried out per FPL and the manufacturer's guidance.	2	3	6	FPL RAMS and Toolbox Talks to be cognizant of the dangers associated with noise and vibration. See appropriate documentation to support this.	1	3	3
2.2	Vibration	Excessive vibration causing injury and long-term health issues to operative and/or damage to surrounding structures.	FPL operatives, adjacent structures	Vibration from Bored piles is expected to be very low and well within the limits set out in BS:5228 Part 2	1	1	1	No action required.	1	1	1
2.3	CO_2 emissions	Inhalation of noxious gases by operatives	FPL and other operatives	Methods for extracting diesel engine fumes	1	3	3	No indoor or covered piling activities are expected.	1	1	1
2.4	Piling rig stability	Overturning or collapse of piling rig due to inadequacy of the designed piling mat	FPL and other operatives and plant	PC to install and maintain a working platform adequate for the imposed loadings from the piling plant	1	5	5	FPL is to provide PC with the correct loading documentation for the plant planned to undertake the work. Track pressures to be calculated in line with appropriate guidance (British Standards or relevant organisation).	1	4	4

GEOTECHNICAL CONSIDERATIONS

Ref.No	Activity / Task	Hazard	People at Risk	Existing Control	L	S	RR	Recommended Action Controls	L	S	RR
3.1	Ground conditions expected vs encountered	Significantly different ground conditions encountered than expected at the design stage can result in inappropriate plant and equipment	FPL and other operatives and plant	Full review of the contract documentation at the design stage and several pre-bores upon mobilisation to cross-check expectations.	3	2	6	Regular dialogue between rig operator and designer to ensure the ground conditions are as expected.	3	1	3
3.2	Piling in organic material (i.e. Peat)	Risk of concrete necking/slumping into soft, organic material	N/A	Temporary casing to be used to mitigate soft material or PC to remove all organics from the piling area.	4	2	8	PC to excavate the piling area down to solid strata and backfill with appropriate material.	4	1	1
3.3	Ground gases/ asbestos	Risk to operative health from ground gases and/or asbestos	FPL and other operatives	Full review of ground investigation information to determine the likelihood of noxious gases/materials and remove them where necessary.	3	4	12	All noxious gases, asbestos and other such materials are to be removed and/or treated before piling works commence.	3	1	3
3.4	Rock socket drilling	Risk of damage to plant from drilling into hard strata such as Sandstone	FPL plant	Full review of ground conditions to determine the appropriate plant, tooling and optimum rock socket to ensure damage is minimised.	4	2	8	Consultation between the FPL designer, operations team and plant manager to ensure the correct equipment is mobilised to carry out the work.	4	1	4
3.5	Groundwater / artesian water / aquifers	Risk of water ingress into pile, piping or contamination of water courses	FPL and other operatives, general public	Full review of ground investigation information to determine the likelihood of water ingress, artesian water or aquifer presence.	3	3	9	Correct piling technique will be selected to mitigate the influence of water on the construction of the piles.	3	1	3

DRILLING, CONCRETING AND REINFORCING CONSIDERATIONS

Ref.No	Activity / Task	Hazard	People at Risk	Existing Control	L	S	RR	Recommended Action Controls	L	S	RR
4.1	Overflighting	Piling through soft material into hard material can cause overflighting, potentially destabilising the working platform	FPL and other operatives	Full analysis of GI report to determine the risk of overflighting and selecting appropriate tooling and/or increasing pile diameter to shorten rock sockets.	3	3	9	Further control measures can be implemented on site including monitoring of revolutions per metre of penetration in accordance with FPS guidance or temporarily sleeving the piles through the soft material to negate the effect of overflighting.	3	1	3
4.2	Insufficient penetration into bedrock	Piling rig unable to achieve the designed rock socket depth	N/A	Full analysis and design of the piles to minimise the required penetration into bedrock.	3	2	6	A further design check on 'practical refusal' is to be undertaken before work commences. Designer to brief Foreman on required sockets versus minimum sockets.	3	1	3
4.3	Inadequate concrete cube results	Cube results failing indicating poor or inadequate concrete in the piles	N/A	FPL operatives are to be trained in the correct cube-making procedure and concrete is to be supplied by QSRMC plants only.	3	2	6	FPL design to include minimum required concrete strength for the pile load conditions.	3	1	3
4.4	Pile reinforcement and lifting operations	Pile cages too heavy to install with the lifting equipment on the piling rig/attendant machine	FPL and other operatives, general public	Pile cages are designed to be as short and light as possible to suit the required loading criteria.	4	3	12	Dedicated lifting equipment utilised (crawler cranes, etc), pile cages prefabricated by specialist suppliers and Toolbox Talks employed to brief all site operatives on the dangers of lifting pile reinforcement.	4	1	4
4.5	Reinforcement projection	Operatives in danger of falling onto exposed rebar. Plant tracking over exposed bar damaging cages.	FPL and other operatives and plant	Minimise protruding rebar where possible. Mushroom caps are placed on the exposed bar where necessary.	2	4	8	Ensure the piling platform level is coincident with the top of the pile cap/groundbeam, therefore there will be no exposed rebar during work.	1	4	4

DRILLING, CONCRETING AND REINFORCING CONSIDERATIONS

Ref.No	Activity / Task	Hazard	People at Risk	Existing Control	L	S	RR	Recommended Action Controls	L	S	RR
4.6	Trimming of piles	HAV, Vibration White Finger, other associated dangers to health	FPL and other operatives	Piling platform level and cut-off level reviewed to minimise trimming. Debonding foam added above the cut-off level.	4	4	16	Bored piles allow the use of mechanical croppers, hand trimming is not required.	4	1	4
4.7	Manual handling of pile cages / centre bars	Risk of injury from lifting heavy loads	FPL operatives	Pile cages are minimised in length and weight to reduce the risk of injury from lifting the bar.	4	4	16	Lifting equipment/crane in attendance to provide mechanical assistance for lifting bars/cages.	4	1	4
4.8	Integrity testing	Exposed pile reinforcement/congested pile reinforcement making access to pile head difficult	FPL and other operatives	Quantity of bars in the reinforcement cages is considered to provide as much spacing as possible.	3	4	12	Mushroom caps added to exposed rebar by PC following cropping, Toolbox talks and induction to make the Integrity tester aware of issues.	1	4	4
4.9	Static load testing	Dangers from working at height and lifting operations when using Kentledge systems for pile testing	FPL and other operatives	RAMS, lift plans in place before the activity takes place. Operations are carried out only by trained and authorised personnel.	4	5	20	Piles designed to use reaction test frames rather than Kentledge.	4	1	4

4.10	Over-reliance on end bearing in variable soil / rock	Excessive pile settlement/possible pile failure	FPL and other operatives	Incorporate a pile settlement check within pile design calculations.	3	4	12	Adopt a partial factor greater than 1.0 on shaft resistance only or a reduced end-bearing component.	3	1	3

SPECIFICS FOR RETAINING WALL CONSTRUCTION

Ref.No	Activity / Task	Hazard	People at Risk	Existing Control	L	S	RR	Recommended Action Controls	L	S	RR
5.1	Wall surcharge loadings.	Values are assumed based on the information readily available to the Designer.	FPL and other operatives, general public	Principal Contractor / Designer to review all surcharge assumptions.	2	5	10	Full review of FPL design document to be undertaken by Principal Contractor / Designer and advise if the assumed surcharge loadings are different.	1	5	5
5.2	Temporary propping locations and stiffness values.	Values are assumed based on the information readily available to the Designer.	FPL and other operatives, general public	Proposal for all temporary and permanent propping is to be reviewed by the Principal Contractor / Designer before works commence.	3	4	12	The Principal Contractor is to coordinate the propping regime as described within the FPL design document. The Designer shall be informed of any deviation from the sequence.	1	4	4
5.3	Construction sequence.	The sequence of construction is assumed based on information readily available to the Designer.	FPL and other operatives, general public	Principal Contractor / Designer to review the proposed construction sequence.	3	5	15	The Principal Contractor is to confirm acceptance of the construction sequence or advise of any/all required changes before work commences.	1	5	5
5.4	Excavation.	Excessive over digging of excavation following pile construction.	Other operatives and general public	The design is to accommodate an appropriate level of over-dig.	4	5	20	The Principal Contractor to ensure all construction levels are communicated to the groundworker in control of excavation.	1	5	5

5.5	Temporary propping.	Failure due to incorrect installation or specification of temporary props.	Other operatives and general public	Ensure all propping requirements are communicated to the temporary works team and propping contractor.	4	5	20	The Principal Contractor to ensure all propping requirements are communicated to the wider team. Consider changing the construction sequence if necessary.	1	5	5
5.6	Excavation.	Loss of stability of site boundaries leading to damage to adjacent structures and services.	Other operatives and general public	Design to appropriate overdesign factors. Controls as above in relation to ground conditions and overexcavation.	2	5	10	Provide suitable deflection monitoring to capping beam before, during and after excavation and pause excavation works in the event that anticipated deflections are exceeded. Provide groundwater monitoring.	1	5	5
5.7	Pile positioning.	Piles drilled out of position leading to structural issues.	Other operatives and general public	Setting out in accordance with specification tolerances.	2	2	4	Use of guide wall for secant piles. Monitor pile position during construction and conduct as built checks prior to any capping beam / follow on works.	1	2	2

APPENDIX 1
Wallap Design Output

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	25.90	1 Fill	1 Fill
2	22.50	2 Alluvial Gravel	2 Alluvial Gravel
3	21.00	3 Weath Sandstone	3 Weath Sandstone
4	19.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES

Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

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	22.00	22.00	0.0	1	19.20	19.20	0.0	MC
2	1	23.00	23.00	0.0	1	18.70	18.70	0.0	WC
3	1	24.00	24.00	0.0	1	19.20	19.20	0.0	MC
4	1	24.90	24.90	0.0	1	19.20	19.20	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 11.40
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.038200 m4/m run
E.I = 1.0696E+06 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.43	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	19.87	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	25.90	1.00(L)	50.00	10.00	12.00	=	N/A	1.00 Var
2	19.60	7.00(L)	50.00	1.00	600.00	=	N/A	1.00 P/U

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 water pressure profile no.1 (Mod. Conserv.)
2	Apply surcharge no.1 at elevation 25.90
3	Apply surcharge no.2 at elevation 19.60
4	Excavate to elevation 19.20 on RIGHT side
5	Fill to elevation 20.70 on RIGHT side with soil type 5
6	Install strut or anchor no.4 at elevation 19.87
7	Install strut or anchor no.3 at elevation 20.43
8	Install strut or anchor no.2 at elevation 23.58
9	Apply water pressure profile no.3 (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 = 1.25

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

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

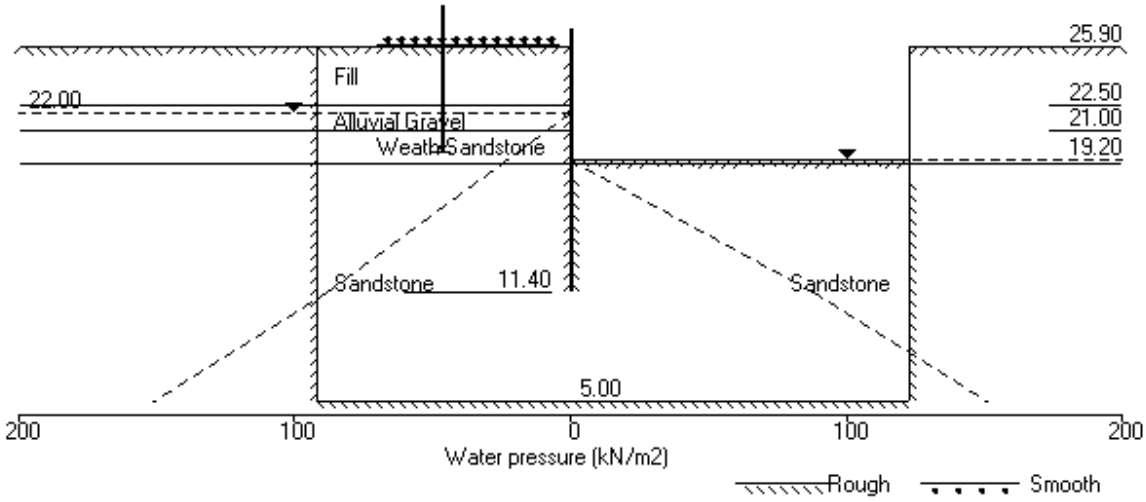
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.1	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.90	Yes	Yes	Yes
3	Apply surcharge no.2 at elev. 19.60	Yes	Yes	Yes
4	Excav. to elev. 19.20 on RIGHT side	Yes	Yes	Yes
5	Fill to elev. 20.70 on RIGHT side	No	No	No
6	Install prop no.4 at elev. 19.87	Yes	Yes	Yes
7	Install prop no.3 at elev. 20.43	No	No	No
8	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
9	Apply water pressure profile no.3	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.4 Excav. to elev. 19.20 on RIGHT side



Units: kN,m

Stage No. 4 Excavate to elevation 19.20 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 11.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
4	25.90	19.20	Cant.	1.577	12.11	13.94	5.26	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
Limit State: Serviceability Limit State
Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.90	0.00	0.019	2.10E-03	0.0	-0.0	
2	25.55	1.77	0.019	2.10E-03	0.3	0.1	
3	25.20	3.74	0.018	2.10E-03	1.3	0.4	
4	24.60	7.29	0.017	2.10E-03	4.6	2.2	
5	24.00	10.74	0.015	2.10E-03	10.0	6.6	
6	23.58	13.09	0.014	2.09E-03	15.1	11.9	
7	23.04	15.98	0.013	2.08E-03	22.9	22.1	
8	22.50	18.79	0.012	2.07E-03	32.2	37.0	
9	22.00	21.37	0.011	2.05E-03	42.3	55.6	
10	21.50	26.94	0.010	2.02E-03	54.3	79.7	
11	21.00	32.48	0.009	1.97E-03	69.2	110.5	
		23.51	0.009	1.97E-03	69.2	110.5	
12	20.70	26.73	0.009	1.94E-03	76.7	132.4	
13	20.43	29.62	0.008	1.90E-03	84.3	154.1	
14	19.87	35.62	0.007	1.81E-03	102.6	206.3	
15	19.60	38.50	0.007	1.75E-03	112.6	235.4	
16	19.20	42.78	0.006	1.65E-03	128.9	283.6	
17	19.00	22.17	0.006	1.60E-03	135.4	310.2	
		-74.73	0.006	1.60E-03	135.4	310.2	
18	18.50	-118.52	0.005	1.44E-03	87.0	368.5	
19	18.00	-139.30	0.004	1.26E-03	22.6	397.2	
20	17.40	-77.71	0.003	1.04E-03	-42.5	385.6	
21	16.80	-38.01	0.003	8.40E-04	-77.2	346.1	
22	16.20	-14.24	0.002	6.61E-04	-92.9	292.9	
23	15.60	8.49	0.002	5.13E-04	-94.6	234.6	
24	15.00	18.97	0.002	3.97E-04	-86.4	179.3	
25	14.40	22.09	0.002	3.10E-04	-74.1	130.9	
26	13.80	21.29	0.001	2.48E-04	-61.1	90.4	
27	13.20	19.11	0.001	2.07E-04	-48.9	57.6	

(continued)

Stage No.4 Excavate to elevation 19.20 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	12.60	17.52	0.001	1.82E-04	-38.0	31.6	
29	12.00	21.43	0.001	1.69E-04	-26.3	12.0	
30	11.40	52.91	0.001	1.66E-04	-4.0	0.0	
31	11.25	-0.09	0.001	0	-0.0	0.0	
32	9.69	0.13	0.001	0	0.0	0.0	
33	8.13	0.09	0.001	0	0.2	0.0	
34	6.56	0.06	0.000	0	0.3	0.0	
35	5.00	-0.46	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.90	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.55	0.00	6.49	1.77	30.07	1.77	1.77a	12463
3	25.20	0.00	13.68	3.74	63.36	3.74	3.74a	12463
4	24.60	0.00	26.69	7.29	123.67	7.29	7.29a	12463
5	24.00	0.00	39.32	10.74	182.20	10.74	10.74a	12463
6	23.58	0.00	47.93	13.09	222.06	13.09	13.09a	12463
7	23.04	0.00	58.49	15.98	271.02	15.98	15.98a	12463
8	22.50	0.00	68.81	18.79	318.81	18.79	18.79a	12463
		0.00	68.81	18.79	318.83	18.79	18.79a	29912
9	22.00	0.00	78.24	21.37	362.54	21.37	21.37a	29912
10	21.50	4.16	83.40	22.78	386.45	22.78	26.94a	29912
11	21.00	8.32	88.47	24.17	409.95	24.17	32.48a	29912
		8.32	88.47	15.20	847.14	15.20	23.51a	99705
12	20.70	10.81	92.68	15.92	887.44	15.92	26.73a	99705
13	20.43	13.06	96.45	16.57	923.53	16.57	29.62a	99705
14	19.87	17.72	104.22	17.90	997.92	17.90	35.62a	99705
15	19.60	19.96	107.94	18.54	1033.59	18.54	38.50a	99705
16	19.20	23.29	113.46	19.49	1086.40	19.49	42.78a	99705
17	19.00	24.95	116.24	19.96	1113.00	19.96	44.92a	99705
		24.95	116.24	11.61	1039.52	11.61	36.56a	249263
18	18.50	29.11	123.33	12.95	1097.35	12.95	42.06a	249263
19	18.00	33.27	130.74	14.35	1157.77	14.35	47.62a	249263
20	17.40	38.26	140.16	16.13	1234.63	16.13	54.39a	249263
21	16.80	43.25	150.19	18.03	1316.41	18.03	61.28a	249263
22	16.20	48.24	160.74	20.02	1402.43	20.98	69.22	249263
23	15.60	53.23	171.65	22.09	1491.44	33.75	86.98	249263
24	15.00	58.22	182.75	24.19	1581.95	41.20	99.42	249263
25	14.40	63.21	193.86	26.29	1672.55	45.50	108.71	249263
26	13.80	68.20	204.84	28.36	1762.10	48.16	116.36	249263
27	13.20	73.19	215.59	30.40	1849.74	50.35	123.54	249263
28	12.60	78.18	226.04	32.37	1934.98	52.97	131.15	249263
29	12.00	83.17	236.16	34.29	2017.55	58.35	141.53	249263
30	11.40	88.16	245.96	36.14	2097.41	78.35	166.51	249263
31	11.25	89.63	248.13	36.55	2115.13	51.64	141.27	249263
32	9.69	104.96	269.67	40.63	2290.80	59.11	164.07	249263
33	8.13	120.29	289.56	44.39	2453.04	66.18	186.47	249263
34	6.56	135.62	308.33	47.94	2606.05	73.61	209.22	249263
35	5.00	150.95	326.37	51.35	2753.21	86.21	237.16	249263

(continued)

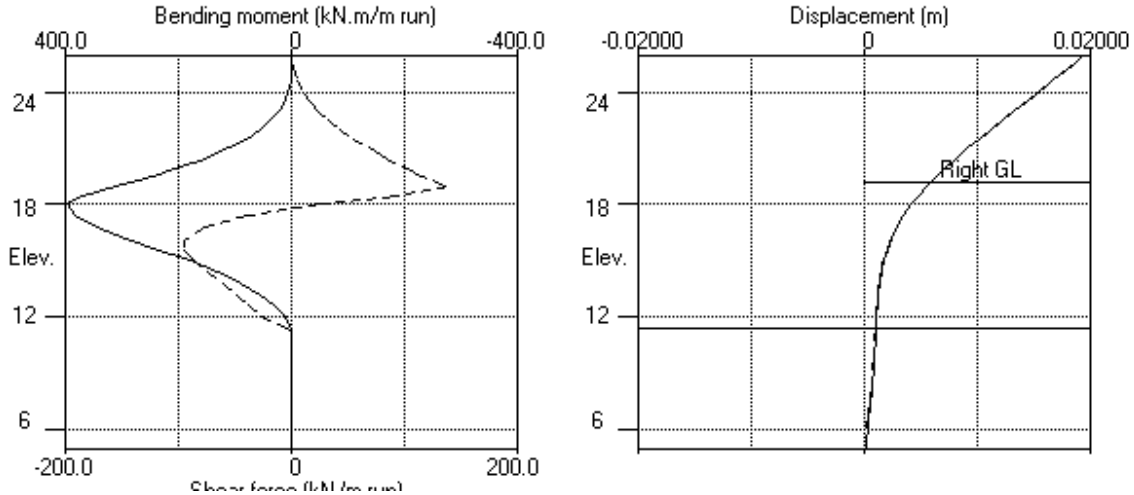
Stage No.4 Excavate to elevation 19.20 on RIGHT side

RIGHT side

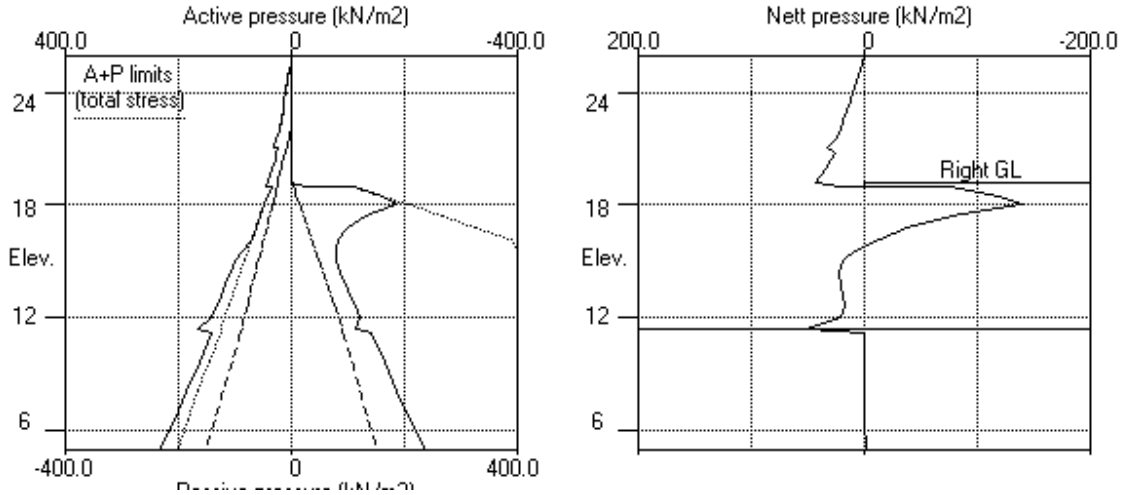
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.55	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	25.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	23.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	20.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	20.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	19.87	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	19.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	19.20	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	99783
17	19.00	2.26	2.14	0.37	20.49	20.49	22.75p	99783
		2.26	2.14	0.00	109.03	109.03	111.29p	249458
18	18.50	7.91	7.49	0.00	152.67	152.67	160.58p	249458
19	18.00	13.56	12.85	0.00	196.36	173.35	186.91	249458
20	17.40	20.35	19.29	0.00	248.93	111.76	132.10	249458
21	16.80	27.13	25.77	0.00	301.70	72.16	99.29	249458
22	16.20	33.91	32.27	0.00	354.75	49.56	83.47	249458
23	15.60	40.69	38.81	0.00	408.12	37.80	78.49	249458
24	15.00	47.47	45.41	0.00	461.87	32.98	80.46	249458
25	14.40	54.25	52.05	0.00	516.04	32.36	86.62	249458
26	13.80	61.04	58.75	0.73	570.66	34.03	95.07	249458
27	13.20	67.82	65.50	2.01	625.77	36.61	104.43	249458
28	12.60	74.60	72.32	3.30	681.39	39.02	113.62	249458
29	12.00	81.38	79.20	4.60	737.51	38.72	120.10	249458
30	11.40	88.16	86.15	5.92	794.16	25.44	113.60	249458
31	11.25	89.63	88.12	6.29	810.23	51.72	141.36	249458
32	9.69	104.96	108.88	10.21	979.48	58.98	163.94	249458
33	8.13	120.29	130.03	14.21	1151.96	66.09	186.38	249458
34	6.56	135.62	151.52	18.28	1327.22	73.54	209.16	249458
35	5.00	150.95	173.28	22.39	1504.72	86.67	237.62	249458

Note: 61.28 a Soil pressure at active limit
160.58 p Soil pressure at passive limit

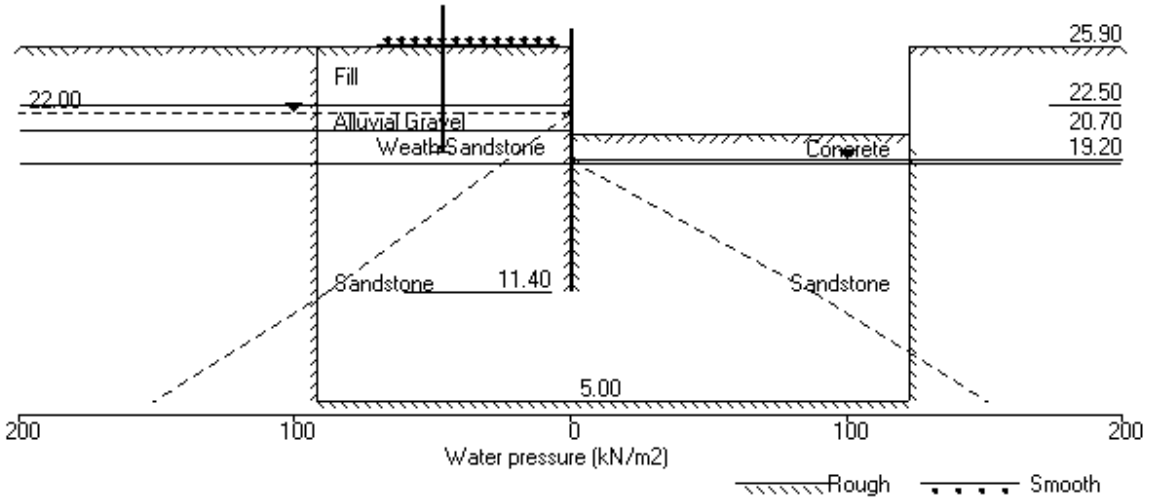
Stage No.4 Excav. to elev. 19.20 on RIGHT side



Stage No.4 Excav. to elev. 19.20 on RIGHT side



Stage No.5 Fill to elev. 20.70 on RIGHT side



Units: kN,m

Stage No. 5 Fill to elevation 20.70 on RIGHT side with soil type 5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
5	25.90	20.70	Cant.	4.583	11.73	19.27	1.43	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.90	0.00	0.019	2.11E-03	0.0	-0.0	
2	25.55	2.06	0.018	2.11E-03	0.4	0.1	
3	25.20	3.99	0.018	2.11E-03	1.4	0.4	
4	24.60	7.55	0.016	2.11E-03	4.9	2.3	
5	24.00	11.02	0.015	2.11E-03	10.5	7.0	
6	23.58	13.40	0.014	2.11E-03	15.7	12.5	
7	23.04	16.33	0.013	2.10E-03	23.6	23.1	
8	22.50	19.23	0.012	2.08E-03	33.2	38.4	
		19.84	0.012	2.08E-03	33.2	38.4	
9	22.00	22.32	0.011	2.06E-03	43.7	57.7	
10	21.50	27.99	0.010	2.03E-03	56.3	82.6	
11	21.00	33.84	0.009	1.98E-03	71.8	114.6	
		28.02	0.009	1.98E-03	71.8	114.6	
12	20.70	30.46	0.008	1.94E-03	80.5	137.4	
13	20.43	30.65	0.008	1.91E-03	88.8	160.2	
14	19.87	28.76	0.007	1.81E-03	105.4	214.5	
15	19.60	26.28	0.006	1.75E-03	112.9	244.0	
16	19.20	22.74	0.006	1.65E-03	122.7	291.1	
		39.98	0.006	1.65E-03	122.7	291.1	
17	19.00	18.24	0.005	1.59E-03	128.5	316.4	
		-68.27	0.005	1.59E-03	128.5	316.4	
18	18.50	-115.00	0.005	1.43E-03	82.7	372.1	
19	18.00	-136.83	0.004	1.25E-03	19.7	399.0	
20	17.40	-75.98	0.003	1.03E-03	-44.1	386.1	
21	16.80	-36.88	0.003	8.32E-04	-78.0	346.0	
22	16.20	-13.55	0.002	6.52E-04	-93.1	292.5	
23	15.60	8.85	0.002	5.05E-04	-94.5	234.2	
24	15.00	19.10	0.002	3.89E-04	-86.2	179.0	
25	14.40	22.05	0.001	3.02E-04	-73.8	130.8	

(continued)

Stage No.5 Fill to elevation 20.70 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	13.80	21.14	0.001	2.40E-04	-60.9	90.5	
27	13.20	18.88	0.001	1.98E-04	-48.8	57.7	
28	12.60	17.27	0.001	1.73E-04	-38.0	31.8	
29	12.00	21.31	0.001	1.61E-04	-26.4	12.1	
30	11.40	53.42	0.001	1.57E-04	-4.0	0.0	
31	11.25	-0.10	0.001	0	-0.0	0.0	
32	9.69	0.12	0.001	0	0.0	0.0	
33	8.13	0.08	0.000	0	0.2	0.0	
34	6.56	0.05	0.000	0	0.3	0.0	
35	5.00	-0.39	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.90	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.55	0.00	6.49	1.77	30.07	2.06	2.06	12463
3	25.20	0.00	13.68	3.74	63.36	3.99	3.99	12463
4	24.60	0.00	26.69	7.29	123.67	7.55	7.55	12463
5	24.00	0.00	39.32	10.74	182.20	11.02	11.02	12463
6	23.58	0.00	47.93	13.09	222.06	13.40	13.40	12463
7	23.04	0.00	58.49	15.98	271.02	16.33	16.33	12463
8	22.50	0.00	68.81	18.79	318.81	19.23	19.23	12463
		0.00	68.81	18.79	318.83	19.84	19.84	29912
9	22.00	0.00	78.24	21.37	362.54	22.32	22.32	29912
10	21.50	4.16	83.40	22.78	386.45	23.83	27.99	29912
11	21.00	8.32	88.47	24.17	409.95	25.52	33.84	29912
		8.32	88.47	15.20	847.14	19.71	28.02	99705
12	20.70	10.81	92.68	15.92	887.44	19.65	30.46	99705
13	20.43	13.06	96.45	16.57	923.53	20.24	33.30	99705
14	19.87	17.72	104.22	17.90	997.92	21.65	39.37	99705
15	19.60	19.96	107.94	18.54	1033.59	22.47	42.43	99705
16	19.20	23.29	113.46	19.49	1086.40	23.61	46.90	99705
17	19.00	24.95	116.24	19.96	1113.00	24.40	49.35	99705
		24.95	116.24	11.61	1039.52	22.70	47.65	249263
18	18.50	29.11	123.33	12.95	1097.35	21.92	51.03	249263
19	18.00	33.27	130.74	14.35	1157.77	22.61	55.88	249263
20	17.40	38.26	140.16	16.13	1234.63	23.96	62.22	249263
21	16.80	43.25	150.19	18.03	1316.41	25.52	68.77	249263
22	16.20	48.24	160.74	20.02	1402.43	28.23	76.47	249263
23	15.60	53.23	171.65	22.09	1491.44	40.82	94.05	249263
24	15.00	58.22	182.75	24.19	1581.95	48.15	106.38	249263
25	14.40	63.21	193.86	26.29	1672.55	52.36	115.57	249263
26	13.80	68.20	204.84	28.36	1762.10	54.96	123.16	249263
27	13.20	73.19	215.59	30.40	1849.74	57.10	130.29	249263
28	12.60	78.18	226.04	32.37	1934.98	59.70	137.88	249263
29	12.00	83.17	236.16	34.29	2017.55	65.13	148.31	249263
30	11.40	88.16	245.96	36.14	2097.41	85.44	173.60	249263
31	11.25	89.63	248.13	36.55	2115.13	58.43	148.06	249263
32	9.69	104.96	269.67	40.63	2290.80	65.84	170.81	249263
33	8.13	120.29	289.56	44.39	2453.04	72.83	193.12	249263
34	6.56	135.62	308.33	47.94	2606.05	80.09	215.71	249263
35	5.00	150.95	326.37	51.35	2753.21	91.37	242.32	249263

(continued)

Stage No.5 Fill to elevation 20.70 on RIGHT side with soil type 5

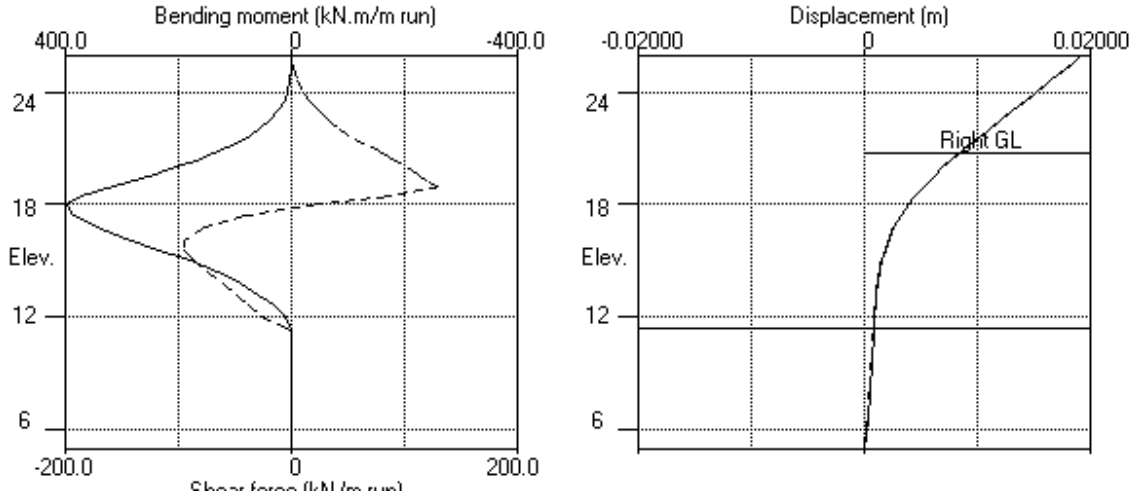
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.55	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	25.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	23.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	20.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	1190.00	0.00	0.00a	199513
13	20.43	Total>	6.32	2.65w	1196.32	2.65	2.65a	199513
14	19.87	Total>	19.42	8.14w	1209.42	10.61	10.61	199513
15	19.60	Total>	25.75	10.79w	1215.75	16.15	16.15	199513
16	19.20	Total>	35.12	14.71w	1225.12	24.16	24.16	199513
		0.00	35.12	6.03	336.25	6.92	6.92	99756
17	19.00	2.26	37.26	6.40	356.81	28.85	31.11	99756
		2.26	37.26	0.00	395.48	113.66	115.92	249391
18	18.50	7.91	42.64	0.00	439.33	158.12	166.03	249391
19	18.00	13.56	48.03	0.00	483.30	179.14	192.71	249391
20	17.40	20.35	54.53	0.00	536.28	117.85	138.19	249391
21	16.80	27.13	61.06	1.17	589.52	78.52	105.65	249391
22	16.20	33.91	67.62	2.41	643.06	56.12	90.03	249391
23	15.60	40.69	74.23	3.66	696.93	44.52	85.21	249391
24	15.00	47.47	80.88	4.92	751.14	39.81	87.28	249391
25	14.40	54.25	87.57	6.18	805.72	39.27	93.52	249391
26	13.80	61.04	94.31	7.46	860.68	40.99	102.02	249391
27	13.20	67.82	101.09	8.74	916.02	43.59	111.41	249391
28	12.60	74.60	107.93	10.03	971.75	46.00	120.60	249391
29	12.00	81.38	114.81	11.34	1027.85	45.62	127.00	249391
30	11.40	88.16	121.73	12.64	1084.33	32.02	120.18	249391
31	11.25	89.63	123.69	13.02	1100.33	58.53	148.17	249391
32	9.69	104.96	144.29	16.91	1268.29	65.73	170.69	249391
33	8.13	120.29	165.14	20.85	1438.33	72.74	193.03	249391
34	6.56	135.62	186.20	24.84	1610.04	80.04	215.65	249391
35	5.00	150.95	207.41	28.85	1783.02	91.76	242.71	249391

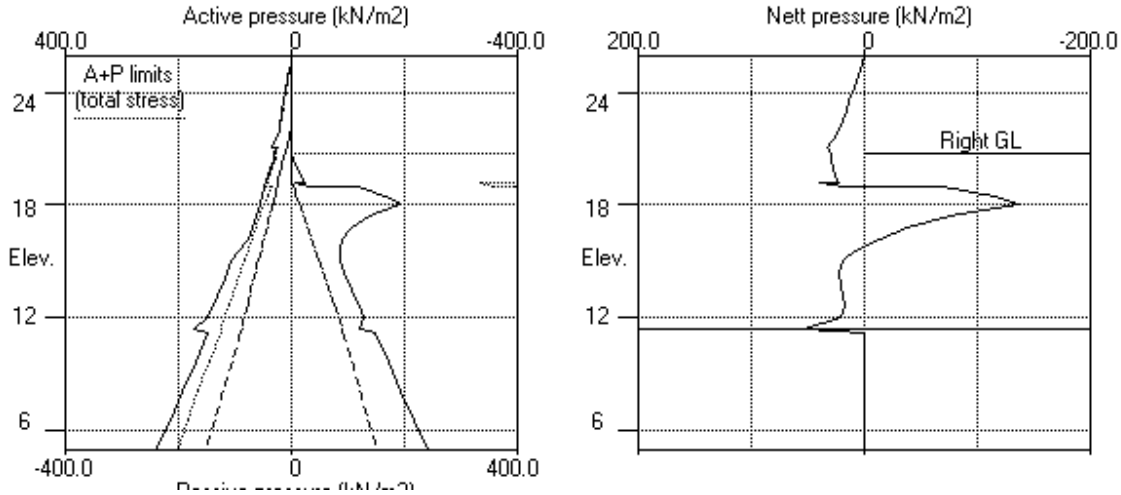
Note: 2.65 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

FOUNDATION PILING LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
Licensed from GEOSOLVE | Made by :
Data filename/Run ID: 21-1182_A_Cant_900-1350__SLS |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
| Checked :

Stage No.5 Fill to elev. 20.70 on RIGHT side



Stage No.5 Fill to elev. 20.70 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.90	25.90	Cant.	Conditions not suitable for FoS calc.				
2	25.90	25.90	Cant.	Conditions not suitable for FoS calc.				
3	25.90	25.90	Cant.	Conditions not suitable for FoS calc.				
4	25.90	19.20	Cant.	1.577	12.11	13.94	5.26	L to R
5	25.90	20.70	Cant.	4.583	11.73	19.27	1.43	L to R
6	25.90	20.70		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	25.90	0.019	0.000	0	-0	0	-0	0	0	0	0
2	25.55	0.019	0.000	0	-0	0	-0	0	-0	0	-0
3	25.20	0.018	0.000	0	-0	1	-0	1	-1	2	-1
4	24.60	0.017	0.000	2	-1	3	-1	5	-1	7	-2
5	24.00	0.015	0.000	7	-2	9	-2	10	-1	14	-2
6	23.58	0.014	0.000	13	-2	17	-3	16	-1	22	-2
7	23.04	0.013	0.000	23	-3	31	-4	24	-1	32	-2
8	22.50	0.012	0.000	38	-3	52	-4	33	-2	45	-3
9	22.00	0.011	0.000	58	-4	78	-5	46	-3	63	-4
10	21.50	0.010	0.000	83	-6	112	-7	64	-3	87	-4
11	21.00	0.009	0.000	117	-7	158	-9	85	-2	115	-3
12	20.70	0.009	0.000	144	-7	194	-10	97	-2	131	-3
13	20.43	0.008	0.000	172	-8	232	-11	108	-2	145	-3
14	19.87	0.007	0.000	227	-9	307	-12	111	-0	150	-0
15	19.60	0.007	0.000	253	-9	341	-12	113	0	152	0
16	19.20	0.006	0.000	295	-8	398	-10	129	0	174	0
17	19.00	0.006	0.000	318	-7	429	-9	135	0	183	0
18	18.50	0.005	0.000	372	-5	502	-6	87	0	118	0
19	18.00	0.004	0.000	399	-3	539	-4	23	0	30	0
20	17.40	0.003	0.000	386	-2	521	-3	2	-45	3	-61
21	16.80	0.003	0.000	346	-1	467	-1	1	-78	2	-105
22	16.20	0.002	0.000	293	-0	395	-1	1	-93	1	-126
23	15.60	0.002	0.000	235	0	317	0	1	-95	1	-128
24	15.00	0.002	0.000	179	0	242	0	1	-86	1	-117
25	14.40	0.002	0.000	131	0	177	0	0	-74	1	-100
26	13.80	0.001	0.000	90	0	122	0	0	-61	0	-82
27	13.20	0.001	0.000	58	-0	78	-0	0	-49	0	-66
28	12.60	0.001	0.000	32	-0	43	-0	0	-38	0	-51
29	12.00	0.001	0.000	12	-0	16	-0	0	-26	0	-36
30	11.40	0.001	0.000	0	0	0	0	0	-4	0	-5
31	11.25	0.001	0.000	0	0	0	0	0	-0	0	-0
32	9.69	0.001	0.000	0	0	0	0	0	-0	0	-0
33	8.13	0.001	0.000	0	0	0	0	0	-0	0	-0
34	6.56	0.000	0.000	0	0	0	0	0	-0	0	-0
35	5.00	0.000	0.000	0	0	0	0	0	-0	0	-0

Summary of results (continued)

Calculated Bending Moments and Prop 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					
no.	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	1	13.20	-9	19.87	1	-12	6	19.00	-3	21.50	7	-4
2	1	15.60	-6	19.87	1	-8	7	19.00	-2	22.00	9	-2
3	2	16.80	-5	19.87	3	-7	7	19.00	-1	22.00	9	-2
4	397	18.00	-0	25.90	536	-0	135	19.00	-95	15.60	183	-128
5	399	18.00	-0	25.90	539	-0	128	19.00	-95	15.60	173	-128
6	No calculation at this stage											
7	No calculation at this stage											
8	No calculation at this stage											
9	395	18.00	-0	25.90	533	-0	119	19.00	-93	15.60	161	-126

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.000	21.00	0.000	25.90	Apply water pressure profile no.1
2	0.000	25.90	0.000	25.90	Apply surcharge no.1 at elev. 25.90
3	0.000	25.90	0.000	25.90	Apply surcharge no.2 at elev. 19.60
4	0.019	25.90	0.000	25.90	Excav. to elev. 19.20 on RIGHT side
5	0.019	25.90	0.000	25.90	Fill to elev. 20.70 on RIGHT side
6	No calculation at this stage				Install prop no.4 at elev. 19.87
7	No calculation at this stage				Install prop no.3 at elev. 20.43
8	No calculation at this stage				Install prop no.2 at elev. 23.58
9	0.019	25.90	0.000	25.90	Apply water pressure profile no.3

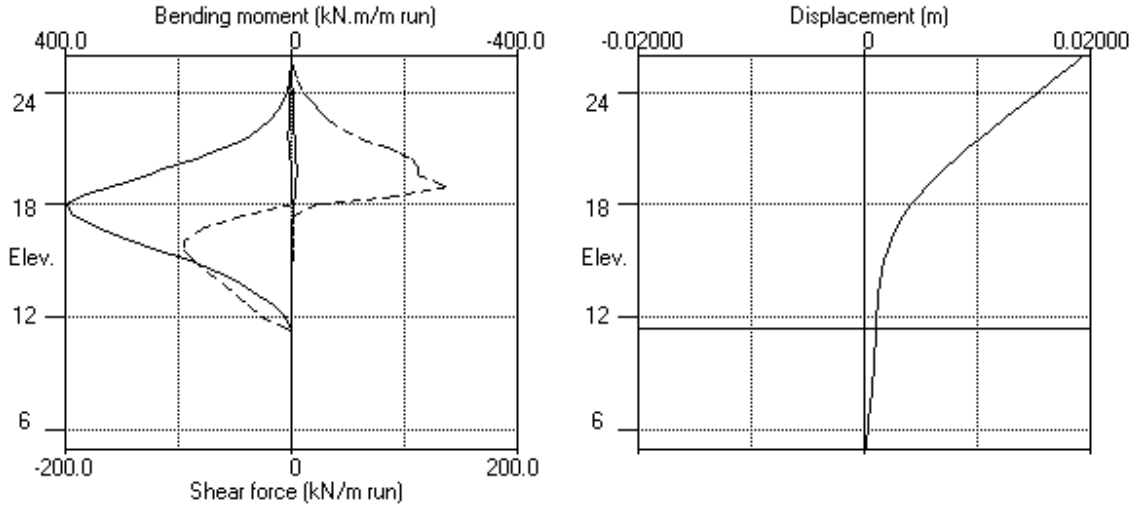
Summary of results (continued)

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

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 2 at elev. 23.58			Prop no. 3 at elev. 20.43			Prop no. 4 at elev. 19.87		
	--Calculated-- kN per m run	kN per prop	Factored kN per prop	--Calculated-- kN per m run	kN per prop	Factored kN per prop	--Calculated-- kN per m run	kN per prop	Factored kN per prop
9	9	9	12	19	19	25	23	23	31

Bending moment, shear force, displacement envelopes



FOUNDATION PILING LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
Licensed from GEOSOLVE | Made by :
Data filename/Run ID: 21-1182_A_Cant_900-1350_ULS2 |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
| Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	25.90	1 Fill	1 Fill
2	22.50	2 Alluvial Gravel	2 Alluvial Gravel
3	21.00	3 Weath Sandstone	3 Weath Sandstone
4	19.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES (Unfactored SLS soil strengths)
Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

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	22.00	22.00	0.0	1	19.20	19.20	0.0	MC
2	1	23.00	23.00	0.0	1	18.70	18.70	0.0	WC
3	1	24.00	24.00	0.0	1	19.20	19.20	0.0	MC
4	1	24.90	24.90	0.0	1	19.20	19.20	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 11.40
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.038200 m4/m run
E.I = 1.0696E+06 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.43	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	19.87	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge ----- kN/m2 Near edge	Surcharge ----- kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	25.90	1.00(L)	50.00	10.00	12.00	=	N/A	1.30 Var
2	19.60	7.00(L)	50.00	1.00	600.00	=	N/A	1.00 P/U

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 water pressure profile no.2 (Worst Cred.)
2	Apply surcharge no.1 at elevation 25.90
3	Apply surcharge no.2 at elevation 19.60
4	Excavate to elevation 18.70 on RIGHT side
5	Fill to elevation 20.70 on RIGHT side with soil type 5
6	Install strut or anchor no.4 at elevation 19.87
7	Install strut or anchor no.3 at elevation 20.43
8	Install strut or anchor no.2 at elevation 23.58
9	Apply water pressure profile no.4 (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 = 5.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

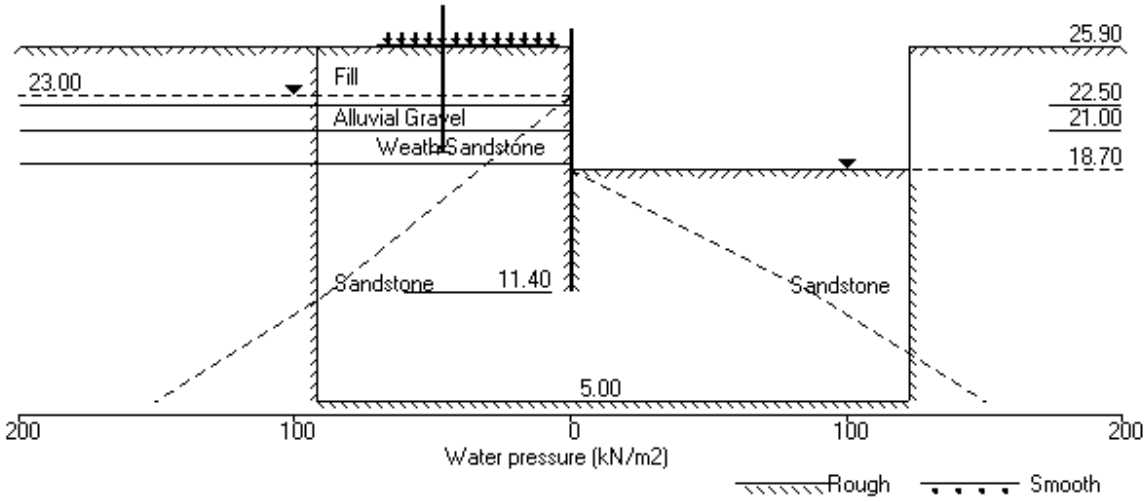
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side   - Rough
Rigid boundary on Right side   - Rough
Wall / soil interface   - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.2	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.90	Yes	Yes	Yes
3	Apply surcharge no.2 at elev. 19.60	Yes	Yes	Yes
4	Excav. to elev. 18.70 on RIGHT side	Yes	Yes	Yes
5	Fill to elev. 20.70 on RIGHT side	No	No	No
6	Install prop no.4 at elev. 19.87	Yes	Yes	Yes
7	Install prop no.3 at elev. 20.43	No	No	No
8	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
9	Apply water pressure profile no.4	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.4 Excav. to elev. 18.70 on RIGHT side



Units: kN,m

Stage No. 4 Excavate to elevation 18.70 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall FoS for toe elev. = 11.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
4	25.90	18.70	Cant.	1.099	12.03	12.53	6.17	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	25.90	0.00	0.068	6.21E-03	0.0	0.0	
2	25.40	3.31	0.065	6.21E-03	0.8	0.2	
3	24.90	7.15	0.062	6.21E-03	3.4	1.3	
4	24.57	9.74	0.060	6.21E-03	6.2	2.9	
5	24.24	12.27	0.058	6.21E-03	9.9	5.5	
6	23.91	14.71	0.056	6.21E-03	14.4	9.5	
7	23.58	17.08	0.054	6.20E-03	19.6	15.2	
8	23.00	21.05	0.050	6.19E-03	30.6	29.6	
9	22.50	26.89	0.047	6.17E-03	42.6	47.8	
10	22.00	32.66	0.044	6.14E-03	57.5	72.7	
11	21.50	38.38	0.041	6.10E-03	75.2	105.8	
12	21.00	44.06	0.038	6.04E-03	95.8	148.5	
		34.47	0.038	6.04E-03	95.8	148.5	
13	20.70	37.76	0.036	6.00E-03	106.7	178.8	
14	20.43	40.73	0.035	5.95E-03	117.3	209.0	
15	19.87	46.85	0.031	5.82E-03	141.8	281.4	
16	19.60	49.80	0.030	5.74E-03	154.8	321.4	
17	19.20	54.17	0.027	5.61E-03	175.6	387.5	
18	19.00	56.35	0.026	5.54E-03	186.7	423.7	
		49.06	0.026	5.54E-03	186.7	423.7	
19	18.70	52.44	0.025	5.41E-03	201.9	481.9	
		-1.85	0.025	5.41E-03	201.9	481.9	
20	18.35	-20.36	0.023	5.24E-03	198.0	552.4	
21	18.00	-38.84	0.021	5.05E-03	187.7	620.5	
22	17.40	-70.45	0.018	4.67E-03	154.9	726.0	
23	16.80	-102.02	0.015	4.24E-03	103.1	806.1	
24	16.20	-133.61	0.013	3.78E-03	32.4	849.6	
25	15.60	-165.30	0.011	3.30E-03	-57.2	844.9	
26	15.00	-137.96	0.009	2.84E-03	-148.2	780.7	
27	14.40	-76.07	0.007	2.44E-03	-212.4	666.9	

(continued)

Stage No.4 Excavate to elevation 18.70 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	13.80	-32.30	0.006	2.10E-03	-244.9	525.7	
29	13.20	1.74	0.005	1.85E-03	-254.1	372.8	
30	12.60	50.54	0.004	1.69E-03	-238.4	220.6	
31	12.00	132.11	0.003	1.60E-03	-183.6	86.5	
32	11.40	384.09	0.002	1.58E-03	-28.8	0.0	
33	11.25	-0.07	0.002	0	0.0	0.0	
34	9.69	0.13	0.002	0	0.1	0.0	
35	8.13	0.09	0.001	0	0.3	0.0	
36	6.56	0.06	0.001	0	0.4	0.0	
37	5.00	-0.49	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.90	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.40	0.00	9.63	3.31	32.36	3.31	3.31a	12463
3	24.90	0.00	20.83	7.15	69.99	7.15	7.15a	12463
4	24.57	0.00	28.38	9.74	95.37	9.74	9.74a	12463
5	24.24	0.00	35.74	12.27	120.08	12.27	12.27a	12463
6	23.91	0.00	42.85	14.71	143.99	14.71	14.71a	12463
7	23.58	0.00	49.75	17.08	167.17	17.08	17.08a	12463
8	23.00	0.00	61.33	21.05	206.07	21.05	21.05a	12463
9	22.50	3.79	67.30	23.10	226.14	23.10	26.89a	12463
		3.79	67.30	23.10	226.16	23.10	26.89a	29912
10	22.00	7.58	73.07	25.08	245.56	25.08	32.66a	29912
11	21.50	11.37	78.70	27.01	264.46	27.02	38.38a	29912
12	21.00	15.16	84.21	28.91	282.98	28.91	44.06a	29912
		15.16	84.21	19.31	500.83	19.31	34.47a	99705
13	20.70	17.43	88.67	20.33	527.37	20.33	37.76a	99705
14	20.43	19.48	92.66	21.25	551.11	21.25	40.73a	99705
15	19.87	23.72	100.88	23.13	599.97	23.13	46.85a	99705
16	19.60	25.77	104.81	24.04	623.37	24.04	49.80a	99705
17	19.20	28.80	110.63	25.37	657.97	25.37	54.17a	99705
18	19.00	30.31	113.56	26.04	675.38	26.04	56.35a	99705
		30.31	113.56	18.75	649.57	18.75	49.06a	249263
19	18.70	32.59	118.00	19.85	672.87	19.85	52.44a	249263
20	18.35	35.24	123.31	21.18	700.68	21.18	56.42a	249263
21	18.00	37.89	128.78	22.55	729.38	22.55	60.44a	249263
22	17.40	42.44	138.63	25.00	781.00	25.00	67.44a	249263
23	16.80	46.98	149.07	27.61	835.74	27.61	74.60a	249263
24	16.20	51.53	160.03	30.35	893.18	30.35	81.88a	249263
25	15.60	56.08	171.35	33.17	952.51	33.18	89.26	249263
26	15.00	60.62	182.85	36.04	1012.78	36.04	96.67a	249263
27	14.40	65.17	194.35	38.92	1073.10	38.92	104.09a	249263
28	13.80	69.72	205.73	41.76	1132.73	41.76	111.47a	249263
29	13.20	74.27	216.87	44.54	1191.13	44.54	118.80a	249263
30	12.60	78.81	227.71	47.24	1247.97	62.49	141.30	249263
31	12.00	83.36	238.23	49.87	1303.10	129.44	212.80	249263
32	11.40	87.91	248.41	52.41	1356.49	384.10	472.01	249263
33	11.25	89.38	250.57	52.95	1367.82	40.02	129.40A	249263
34	9.69	104.71	271.98	58.29	1480.03	49.98	154.69A	249263
35	8.13	120.03	291.74	63.23	1583.63	57.57	177.61A	249263
36	6.56	135.36	310.38	67.88	1681.34	66.76	202.12A	249263
37	5.00	150.69	328.31	72.36	1775.32	82.98	233.67	249263

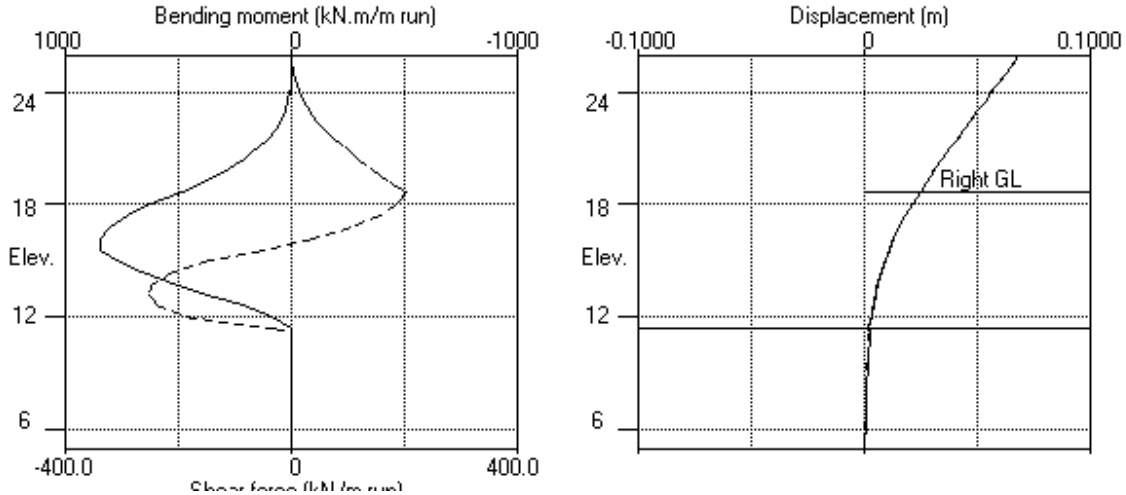
(continued)

Stage No.4 Excavate to elevation 18.70 on RIGHT side

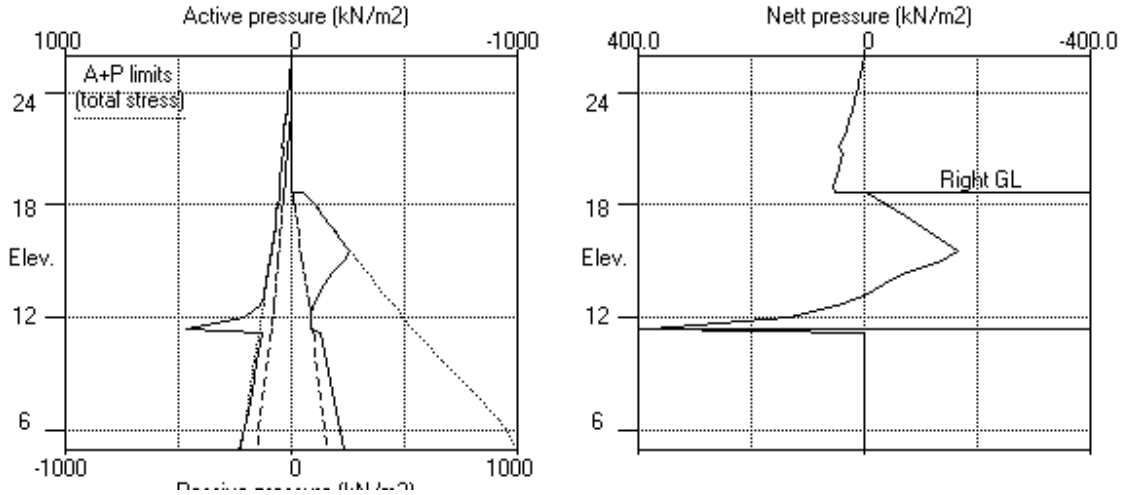
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.57	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	24.24	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	20.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	20.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	19.87	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	19.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	19.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	19.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	18.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	54.30	54.30	54.30p	249481
20	18.35	4.21	3.49	0.00	72.57	72.57	76.78p	249481
21	18.00	8.43	6.97	0.00	90.85	90.84	99.27	249481
22	17.40	15.65	12.96	0.00	122.24	122.24	137.89p	249481
23	16.80	22.88	18.97	0.00	153.74	153.74	176.62p	249481
24	16.20	30.10	25.01	0.00	185.39	185.39	215.49p	249481
25	15.60	37.33	31.08	0.00	217.24	217.23	254.56	249481
26	15.00	44.56	37.20	0.00	249.32	190.07	234.63	249481
27	14.40	51.78	43.37	1.22	281.67	128.37	180.15	249481
28	13.80	59.01	49.60	2.78	314.31	84.77	143.77	249481
29	13.20	66.23	55.89	4.35	347.28	50.83	117.06	249481
30	12.60	73.46	62.25	5.94	380.59	17.30	90.76	249481
31	12.00	80.68	68.67	7.54	414.25	0.00	80.68A	249481
32	11.40	87.91	75.16	9.16	448.28	0.01	87.91A	249481
33	11.25	89.38	77.13	9.65	458.59	40.09	129.47	249481
34	9.69	104.71	97.88	14.83	567.40	49.85	154.56	249481
35	8.13	120.03	119.08	20.12	678.52	57.48	177.51	249481
36	6.56	135.36	140.67	25.51	791.70	66.70	202.06	249481
37	5.00	150.69	162.58	30.98	906.56	83.47	234.16	249481

Note: 118.80 a Soil pressure at active limit
215.49 p Soil pressure at passive limit
87.91A Arching - soil pressure below active limit

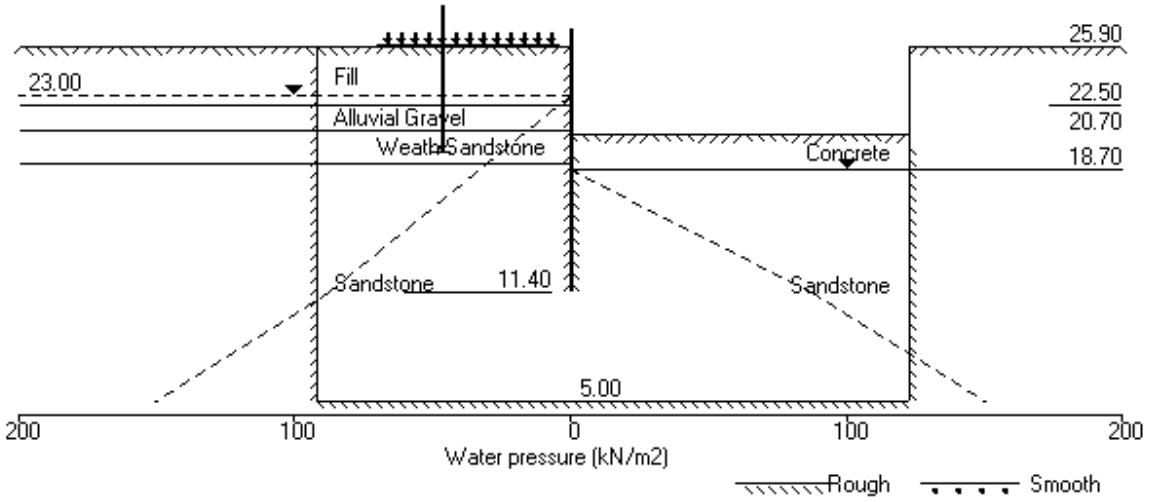
Stage No.4 Excav. to elev. 18.70 on RIGHT side



Stage No.4 Excav. to elev. 18.70 on RIGHT side



Stage No.5 Fill to elev. 20.70 on RIGHT side



Units: kN,m

Stage No. 5 Fill to elevation 20.70 on RIGHT side with soil type 5

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall FoS for toe elev. = 11.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
5	25.90	20.70	Cant.	3.795	11.73	19.08	1.62	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	25.90	0.00	0.068	6.23E-03	0.0	0.0	
2	25.40	3.62	0.065	6.23E-03	0.9	0.2	
3	24.90	7.45	0.062	6.23E-03	3.7	1.4	
4	24.57	10.05	0.060	6.23E-03	6.6	3.0	
5	24.24	12.59	0.058	6.23E-03	10.3	5.8	
6	23.91	15.06	0.056	6.23E-03	14.9	10.0	
7	23.58	17.46	0.054	6.22E-03	20.3	15.8	
8	23.00	21.49	0.050	6.21E-03	31.5	30.7	
9	22.50	27.42	0.047	6.19E-03	43.7	49.4	
		28.17	0.047	6.19E-03	43.7	49.4	
10	22.00	33.84	0.044	6.16E-03	59.2	75.1	
11	21.50	39.69	0.041	6.12E-03	77.6	109.2	
12	21.00	45.76	0.038	6.06E-03	99.0	153.2	
		40.13	0.038	6.06E-03	99.0	153.2	
13	20.70	42.49	0.036	6.01E-03	111.4	184.7	
14	20.43	42.80	0.034	5.96E-03	122.9	216.3	
15	19.87	43.43	0.031	5.83E-03	147.0	291.5	
16	19.60	41.63	0.029	5.75E-03	158.5	332.7	
17	19.20	38.21	0.027	5.61E-03	174.5	399.3	
18	19.00	37.28	0.026	5.53E-03	182.0	435.0	
		39.44	0.026	5.53E-03	182.0	435.0	
19	18.70	32.13	0.024	5.40E-03	192.7	491.2	
		8.49	0.024	5.40E-03	192.7	491.2	
20	18.35	-16.57	0.022	5.23E-03	191.3	559.2	
21	18.00	-35.17	0.021	5.04E-03	182.3	625.1	
22	17.40	-67.54	0.018	4.66E-03	151.5	728.1	
23	16.80	-99.95	0.015	4.23E-03	101.2	806.7	
24	16.20	-132.24	0.013	3.76E-03	31.6	849.4	
25	15.60	-164.48	0.011	3.29E-03	-57.5	844.4	
26	15.00	-137.55	0.009	2.83E-03	-148.1	780.3	

(continued)

Stage No.5 Fill to elevation 20.70 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	14.40	-75.96	0.007	2.43E-03	-212.1	666.6	
28	13.80	-32.41	0.006	2.09E-03	-244.6	525.6	
29	13.20	1.49	0.005	1.84E-03	-253.9	372.9	
30	12.60	50.23	0.004	1.67E-03	-238.4	220.7	
31	12.00	131.92	0.003	1.59E-03	-183.7	86.6	
32	11.40	384.57	0.002	1.56E-03	-28.8	0.0	
33	11.25	-0.09	0.002	0	0.0	0.0	
34	9.69	0.12	0.001	0	0.1	0.0	
35	8.13	0.08	0.001	0	0.2	0.0	
36	6.56	0.05	0.000	0	0.3	0.0	
37	5.00	-0.40	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.90	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.40	0.00	9.63	3.31	32.36	3.62	3.62	12463
3	24.90	0.00	20.83	7.15	69.99	7.45	7.45	12463
4	24.57	0.00	28.38	9.74	95.37	10.05	10.05	12463
5	24.24	0.00	35.74	12.27	120.08	12.59	12.59	12463
6	23.91	0.00	42.85	14.71	143.99	15.06	15.06	12463
7	23.58	0.00	49.75	17.08	167.17	17.46	17.46	12463
8	23.00	0.00	61.33	21.05	206.07	21.49	21.49	12463
9	22.50	3.79	67.30	23.10	226.14	23.64	27.42	12463
		3.79	67.30	23.10	226.16	24.39	28.17	29912
10	22.00	7.58	73.07	25.08	245.56	26.26	33.84	29912
11	21.50	11.37	78.70	27.01	264.46	28.32	39.69	29912
12	21.00	15.16	84.21	28.91	282.98	30.60	45.76	29912
		15.16	84.21	19.31	500.83	24.97	40.13	99705
13	20.70	17.43	88.67	20.33	527.37	25.06	42.49	99705
14	20.43	19.48	92.66	21.25	551.11	25.97	45.45	99705
15	19.87	23.72	100.88	23.13	599.97	28.02	51.74	99705
16	19.60	25.77	104.81	24.04	623.37	29.24	55.00	99705
17	19.20	28.80	110.63	25.37	657.97	30.90	59.70	99705
18	19.00	30.31	113.56	26.04	675.38	32.35	62.66	99705
		30.31	113.56	18.75	649.57	34.52	64.83	249263
19	18.70	32.59	118.00	19.85	672.87	32.62	65.21	249263
20	18.35	35.24	123.31	21.18	700.68	33.14	68.38	249263
21	18.00	37.89	128.78	22.55	729.38	33.94	71.83	249263
22	17.40	42.44	138.63	25.00	781.00	35.83	78.27	249263
23	16.80	46.98	149.07	27.61	835.74	37.93	84.92	249263
24	16.20	51.53	160.03	30.35	893.18	40.28	91.81	249263
25	15.60	56.08	171.35	33.17	952.51	42.81	98.89	249263
26	15.00	60.62	182.85	36.04	1012.78	45.45	106.08	249263
27	14.40	65.17	194.35	38.92	1073.10	48.16	113.33	249263
28	13.80	69.72	205.73	41.76	1132.73	50.88	120.60	249263
29	13.20	74.27	216.87	44.54	1191.13	53.58	127.84	249263
30	12.60	78.81	227.71	47.24	1247.97	71.48	150.30	249263
31	12.00	83.36	238.23	49.87	1303.10	138.47	221.83	249263
32	11.40	87.91	248.41	52.41	1356.49	393.46	481.37	249263
33	11.25	89.38	250.57	52.95	1367.82	49.10	138.48A	249263
34	9.69	104.71	271.98	58.29	1480.03	58.99	163.70	249263
35	8.13	120.03	291.74	63.23	1583.63	66.47	186.50	249263
36	6.56	135.36	310.38	67.88	1681.34	75.45	210.81	249263
37	5.00	150.69	328.31	72.36	1775.32	89.90	240.59	249263

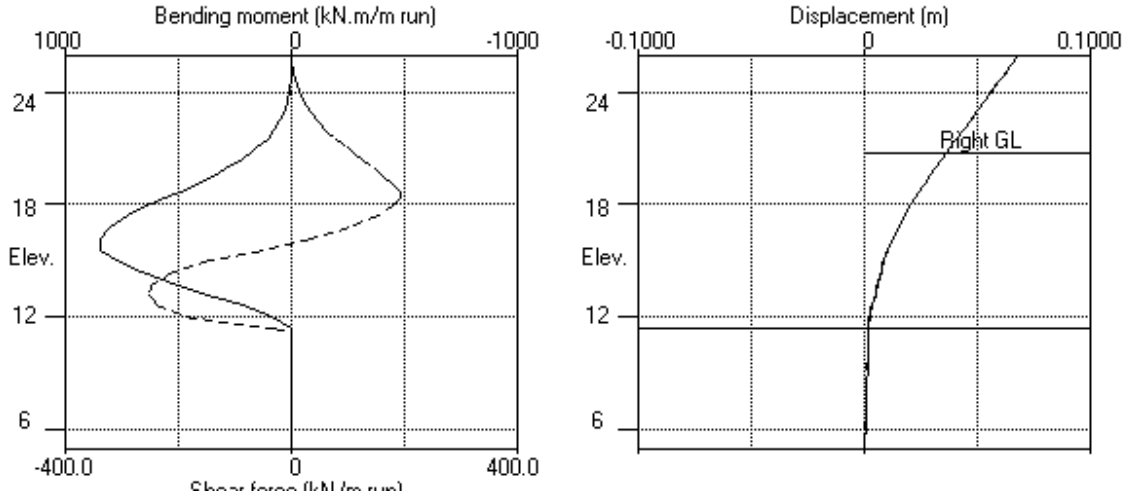
(continued)

Stage No.5 Fill to elevation 20.70 on RIGHT side with soil type 5

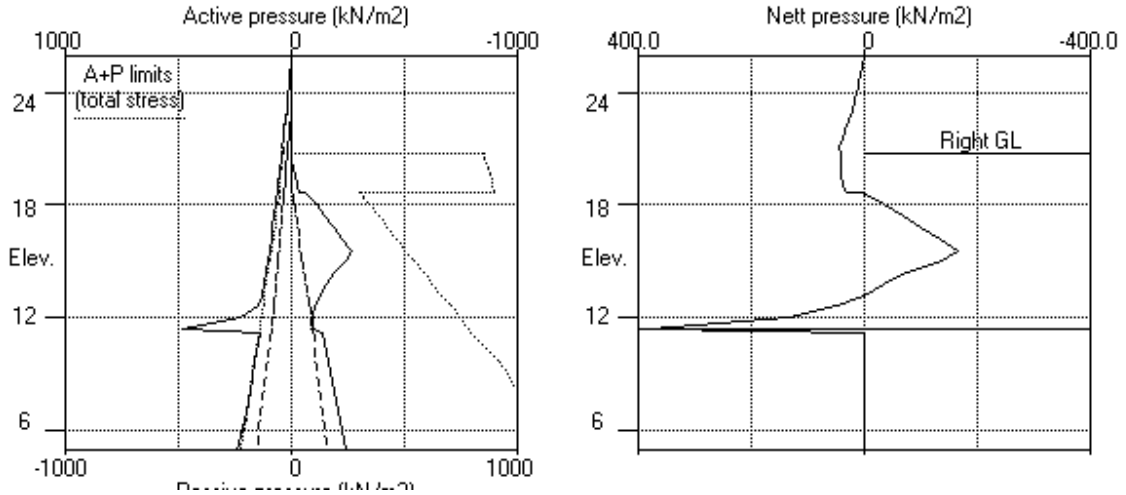
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.57	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	24.24	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	20.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	850.00	0.00	0.00a	199513
14	20.43	Total>	6.32	2.65w	856.32	2.65	2.65a	199513
15	19.87	Total>	19.42	8.14w	869.43	8.31	8.31	199513
16	19.60	Total>	25.75	10.79w	875.75	13.37	13.37	199513
17	19.20	Total>	35.12	14.71w	885.13	21.49	21.49	199513
18	19.00	Total>	39.80	16.68w	889.81	25.38	25.38	199513
19	18.70	Total>	46.84	19.62w	896.85	33.08	33.08	199513
		0.00	46.84	2.09	299.83	56.72	56.72	249391
20	18.35	4.21	50.35	2.97	318.23	80.73	84.94	249391
21	18.00	8.43	53.87	3.84	336.67	98.57	107.00	249391
22	17.40	15.65	59.92	5.35	368.40	130.16	145.81	249391
23	16.80	22.88	66.01	6.87	400.30	161.99	184.87	249391
24	16.20	30.10	72.13	8.40	432.39	193.94	224.05	249391
25	15.60	37.33	78.29	9.94	464.69	226.03	263.36	249391
26	15.00	44.56	84.49	11.49	497.21	199.07	243.62	249391
27	14.40	51.78	90.74	13.05	529.97	137.51	189.29	249391
28	13.80	59.01	97.04	14.62	562.97	94.00	153.01	249391
29	13.20	66.23	103.38	16.20	596.22	60.12	126.35	249391
30	12.60	73.46	109.77	17.80	629.72	26.61	100.07	249391
31	12.00	80.68	116.21	19.41	663.45	9.23	89.91A	249391
32	11.40	87.91	122.69	21.02	697.43	8.90	96.80A	249391
33	11.25	89.38	124.65	21.51	707.72	49.19	138.57	249391
34	9.69	104.71	145.25	26.66	815.68	58.88	163.58	249391
35	8.13	120.03	166.10	31.86	924.98	66.39	186.42	249391
36	6.56	135.36	187.15	37.12	1035.36	75.40	210.76	249391
37	5.00	150.69	208.36	42.41	1146.54	90.30	240.99	249391

Note: 2.65 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
96.80A Arching - soil pressure below active limit

Stage No.5 Fill to elev. 20.70 on RIGHT side



Stage No.5 Fill to elev. 20.70 on RIGHT side



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.	Ground level Act.	Ground level Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.90	25.90	Cant.	Conditions not suitable for FoS calc.				
2	25.90	25.90	Cant.	Conditions not suitable for FoS calc.				
3	25.90	25.90	Cant.	Conditions not suitable for FoS calc.				
4	25.90	18.70	Cant.	1.099	12.03	12.53	6.17	L to R
5	25.90	20.70	Cant.	3.795	11.73	19.08	1.62	L to R
6	25.90	20.70		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: ULS DA1 Combination 2

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment		Shear force	
no.	coord	maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	25.90	0.068	0.000	0.0	-0.0	0.0	0.0
2	25.40	0.065	0.000	0.2	-0.0	0.9	-0.6
3	24.90	0.062	0.000	1.4	-0.6	3.7	-1.6
4	24.57	0.060	0.000	3.1	-1.2	6.9	-2.1
5	24.24	0.058	0.000	6.1	-1.9	11.5	-2.4
6	23.91	0.056	0.000	10.9	-2.7	17.5	-2.5
7	23.58	0.054	0.000	17.9	-3.6	25.0	-2.7
8	23.00	0.050	0.000	30.7	-5.2	31.5	-3.4
9	22.50	0.047	0.000	49.4	-6.4	43.7	-3.5
10	22.00	0.044	0.000	75.1	-8.0	61.6	-3.3
11	21.50	0.041	0.000	109.2	-9.3	84.9	-1.6
12	21.00	0.038	0.000	154.1	-9.4	111.0	0.0
13	20.70	0.036	0.000	189.6	-9.3	125.9	0.0
14	20.43	0.035	0.000	225.3	-9.2	139.5	0.0
15	19.87	0.031	0.000	300.9	-8.8	150.1	0.0
16	19.60	0.030	0.000	338.9	-8.1	158.5	0.0
17	19.20	0.027	0.000	401.9	-6.4	175.6	0.0
18	19.00	0.026	0.000	436.2	-5.1	186.7	0.0
19	18.70	0.025	0.000	491.2	-3.5	201.9	0.0
20	18.35	0.023	0.000	559.2	-2.3	198.0	0.0
21	18.00	0.021	0.000	625.1	-1.4	187.7	0.0
22	17.40	0.018	0.000	728.1	-0.4	154.9	-0.2
23	16.80	0.015	0.000	806.7	0.0	103.1	-0.9
24	16.20	0.013	0.000	849.6	0.0	32.4	-1.2
25	15.60	0.011	0.000	844.9	0.0	0.6	-57.5
26	15.00	0.009	0.000	780.7	0.0	0.5	-148.2
27	14.40	0.007	0.000	666.9	0.0	0.4	-212.4
28	13.80	0.006	0.000	525.7	0.0	0.2	-244.9
29	13.20	0.005	0.000	372.9	0.0	0.0	-254.1
30	12.60	0.004	0.000	220.7	0.0	0.0	-238.4
31	12.00	0.003	0.000	86.6	0.0	0.0	-183.7
32	11.40	0.002	0.000	0.0	0.0	0.0	-28.8
33	11.25	0.002	0.000	0.0	0.0	0.0	-0.0
34	9.69	0.002	0.000	0.0	0.0	0.1	-0.1
35	8.13	0.001	0.000	0.0	0.0	0.3	-0.0
36	6.56	0.001	0.000	0.0	0.0	0.4	0.0
37	5.00	0.000	0.000	0.0	0.0	0.0	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	1.3	13.80	-9.4	21.00	7.2	19.00	-3.5	22.50
2	3.1	17.40	-8.0	21.50	8.4	19.00	-2.8	23.00
3	4.7	17.40	-7.4	21.50	8.8	19.00	-2.6	23.00
4	849.6	16.20	0.0	25.90	201.9	18.70	-254.1	13.20
5	849.4	16.20	0.0	25.90	192.7	18.70	-253.9	13.20
6	No calculation at this stage							
7	No calculation at this stage							
8	No calculation at this stage							
9	847.1	16.20	0.0	25.90	189.3	18.70	-253.4	13.20

Maximum and minimum displacement at each stage

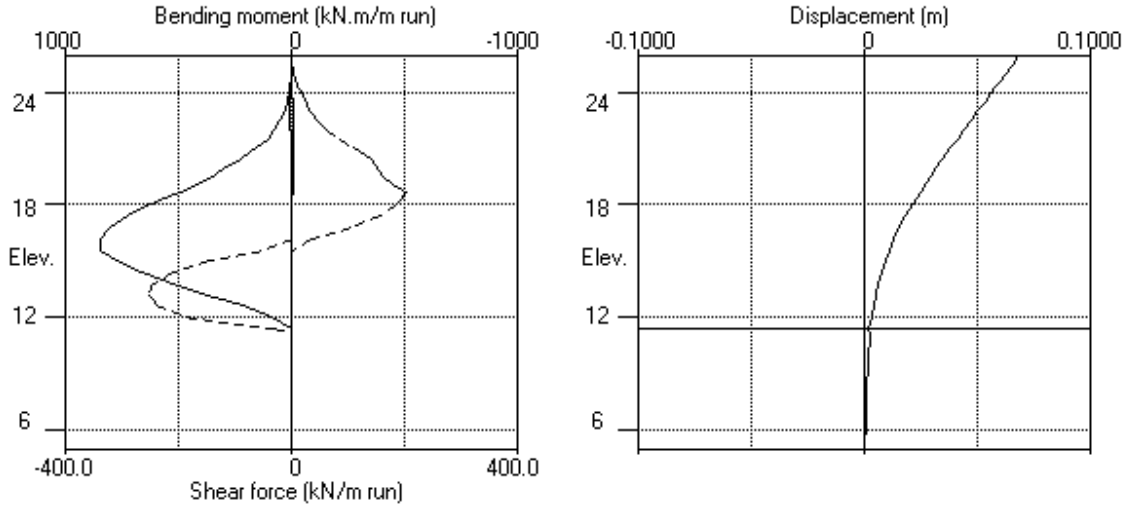
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.000	23.00	0.000	25.90	Apply water pressure profile no.2
2	0.001	25.90	0.000	25.90	Apply surcharge no.1 at elev. 25.90
3	0.001	25.90	0.000	25.90	Apply surcharge no.2 at elev. 19.60
4	0.068	25.90	0.000	25.90	Excav. to elev. 18.70 on RIGHT side
5	0.068	25.90	0.000	25.90	Fill to elev. 20.70 on RIGHT side
6	No calculation at this stage				Install prop no.4 at elev. 19.87
7	No calculation at this stage				Install prop no.3 at elev. 20.43
8	No calculation at this stage				Install prop no.2 at elev. 23.58
9	0.068	25.90	0.000	25.90	Apply water pressure profile no.4

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	--- Strut no. 2 --- at elev. 23.58		--- Strut no. 3 --- at elev. 20.43		--- Strut no. 4 --- at elev. 19.87	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
9	17.26	17.26	18.37	18.37	16.28	16.28

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	23.70	1 Fill	1 Fill
2	20.50	2 Alluvial Gravel	2 Alluvial Gravel
3	19.50	3 Weath Sandstone	3 Weath Sandstone
4	18.50	4 Sandstone	4 Sandstone

SOIL PROPERTIES

Soil Properties File = 21-1182_Soils__SLS.dat

-- 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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

Water press. profile no.	Point no.	Left side Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Right side Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	22.00	22.00	0.0	1	19.90	19.90	0.0	MC
2	1	22.70	22.70	0.0	1	19.40	19.40	0.0	WC
3	1	22.70	22.70	0.0	1	19.90	19.90	0.0	MC
4	1	22.70	22.70	0.0	1	19.40	19.40	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 14.70
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 7.4000E-03 m4/m run
E.I = 207200 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	23.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.00 Var

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 water pressure profile no.1 (Mod. Conserv.)
2	Apply surcharge no.1 at elevation 23.70
3	Excavate to elevation 19.90 on RIGHT side
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Install strut or anchor no.4 at elevation 20.17
6	Install strut or anchor no.3 at elevation 20.73
7	Install strut or anchor no.2 at elevation 23.58
8	Apply water pressure profile no.3 (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 = 1.25

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

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough

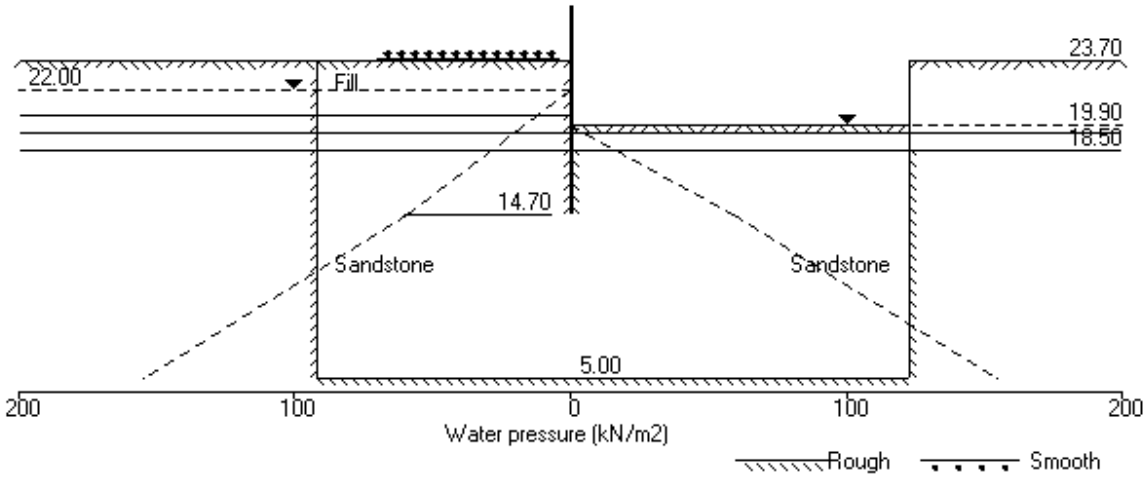
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.1	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 23.70	Yes	Yes	Yes
3	Excav. to elev. 19.90 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	No	No	No
5	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
6	Install prop no.3 at elev. 20.73	No	No	No
7	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
8	Apply water pressure profile no.3	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 19.90 on RIGHT side



Units: kN,m

Stage No. 3 Excavate to elevation 19.90 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 14.70 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
3	23.70	19.90	Cant.	1.565	15.28	16.04	3.86	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	23.70	0.00	0.013	2.24E-03	0.0	0.0	
2	23.58	0.62	0.013	2.24E-03	0.0	0.0	
3	23.14	2.94	0.012	2.24E-03	0.8	0.2	
4	22.70	5.51	0.011	2.24E-03	2.7	1.0	
5	22.35	7.58	0.010	2.23E-03	5.0	2.3	
6	22.00	9.61	0.009	2.23E-03	8.0	4.6	
7	21.50	15.37	0.008	2.21E-03	14.2	10.1	
8	21.00	21.04	0.007	2.17E-03	23.3	19.4	
9	20.73	24.08	0.007	2.14E-03	29.4	26.5	
10	20.50	26.65	0.006	2.11E-03	35.2	33.9	
11	20.17	30.32	0.005	2.05E-03	44.6	47.0	
12	19.90	33.32	0.005	1.98E-03	53.2	60.2	
13	19.50	21.02	0.004	1.84E-03	64.1	83.9	
		1.66	0.004	1.84E-03	64.1	83.9	
14	19.00	-49.25	0.003	1.60E-03	52.2	116.1	
15	18.50	-54.24	0.003	1.29E-03	26.3	136.0	
		-171.14	0.003	1.29E-03	26.3	136.0	
16	18.00	-65.63	0.002	9.78E-04	-32.9	127.7	
17	17.50	-18.04	0.002	6.99E-04	-53.8	103.1	
18	17.00	14.48	0.001	4.86E-04	-54.7	73.9	
19	16.50	22.93	0.001	3.38E-04	-45.3	48.3	
20	16.00	21.09	0.001	2.46E-04	-34.3	28.5	
21	15.50	17.35	0.001	1.94E-04	-24.7	13.9	
22	15.10	19.53	0.001	1.76E-04	-17.3	5.4	
23	14.70	51.13	0.001	1.71E-04	-3.2	0.0	
24	14.57	0.08	0.001	0	0.0	0.0	
25	13.29	0.01	0.001	0	0.1	0.0	
26	12.00	0.09	0.001	0	0.1	0.0	
27	10.00	0.02	0.000	0	0.2	0.0	

(continued)

Stage No.3 Excavate to elevation 19.90 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	8.00	-0.06	0.000	0	0.2	0.0	
29	6.50	0.01	0.000	0	0.2	0.0	
30	5.00	-0.23	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.62	10.47	0.62	0.62a	12474
3	23.14	0.00	10.77	2.94	49.92	2.94	2.94a	12474
4	22.70	0.00	20.18	5.51	93.48	5.51	5.51a	12474
5	22.35	0.00	27.77	7.58	128.65	7.58	7.58a	12474
6	22.00	0.00	35.18	9.61	163.00	9.61	9.61a	12474
7	21.50	4.08	41.34	11.29	191.55	11.29	15.37a	12474
8	21.00	8.16	47.17	12.88	218.54	12.88	21.04a	12474
9	20.73	10.37	50.21	13.71	232.63	13.71	24.08a	12474
10	20.50	12.24	52.75	14.41	244.41	14.41	26.65a	12474
		12.24	52.75	14.41	244.43	14.41	26.65a	29938
11	20.17	14.94	56.34	15.39	261.05	15.39	30.32a	29938
12	19.90	17.14	59.22	16.18	274.43	16.18	33.32a	29938
13	19.50	20.40	63.44	17.33	293.95	17.33	37.73a	29938
		20.40	63.44	10.90	607.44	10.90	31.30a	99795
14	19.00	24.49	70.62	12.13	676.20	12.13	36.62a	99795
15	18.50	28.57	77.73	13.35	744.24	13.35	41.92a	99795
		28.57	77.73	4.32	725.45	4.32	32.89a	249486
16	18.00	32.65	84.77	5.65	782.91	5.65	38.30a	249486
17	17.50	36.73	91.77	6.98	839.96	8.52	45.25	249486
18	17.00	40.81	98.72	8.29	896.68	26.07	66.88	249486
19	16.50	44.89	105.64	9.60	953.13	32.10	76.99	249486
20	16.00	48.97	112.54	10.91	1009.35	33.31	82.29	249486
21	15.50	53.05	119.41	12.21	1065.37	33.81	86.87	249486
22	15.10	56.32	124.89	13.24	1110.08	36.74	93.06	249486
23	14.70	59.58	130.36	14.28	1154.69	55.72	115.30	249486
24	14.57	60.81	131.86	14.56	1166.94	29.23	90.04	249486
25	13.29	73.44	147.29	17.48	1292.73	34.48	107.92	249486
26	12.00	86.07	162.65	20.38	1418.06	39.61	125.68	249486
27	10.00	105.69	186.47	24.89	1612.31	47.81	153.50	249486
28	8.00	125.31	210.28	29.39	1806.45	56.19	181.50	249486
29	6.50	140.02	228.14	32.77	1952.13	62.79	202.82	249486
30	5.00	154.74	246.02	36.15	2097.95	71.68	226.42	249486

RIGHT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

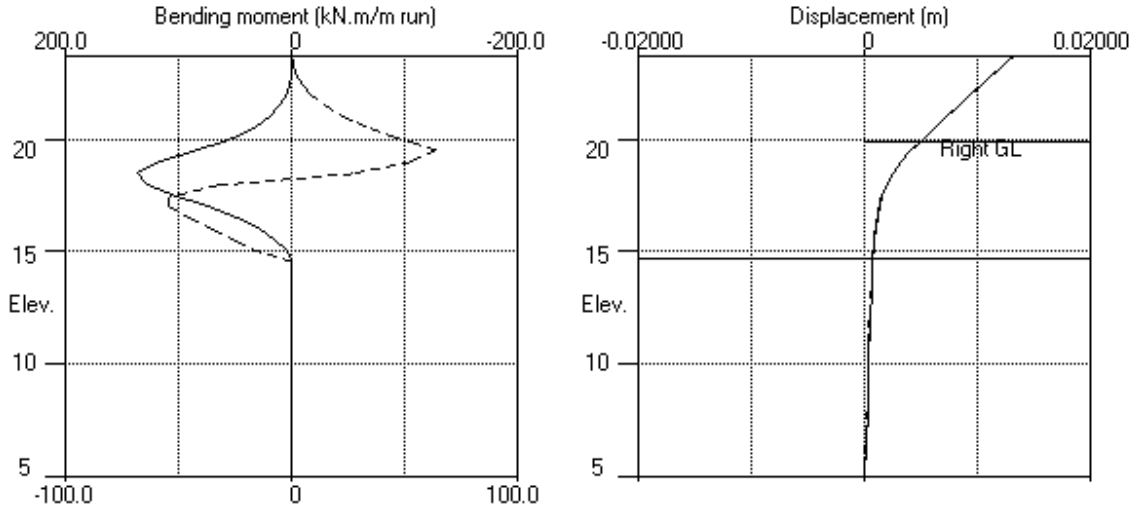
(continued)

Stage No.3 Excavate to elevation 19.90 on RIGHT side

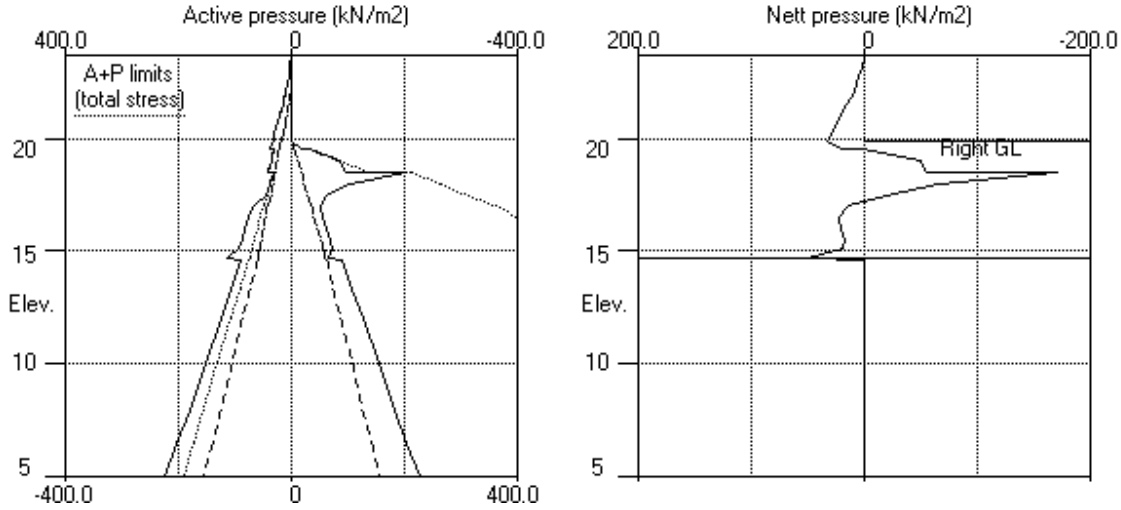
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
9	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	20.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	19.90	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	29949
13	19.50	4.58	2.62	0.71	12.13	12.13	16.71p	29949
		4.58	2.62	0.45	25.06	25.06	29.64p	99829
14	19.00	10.31	7.89	1.36	75.55	75.55	85.86p	99829
15	18.50	16.04	13.17	2.26	126.09	80.12	96.16	99829
		16.04	13.17	0.00	198.97	187.99	204.03	249574
16	18.00	21.77	18.45	0.00	242.08	82.16	103.93	249574
17	17.50	27.50	23.75	0.00	285.27	35.79	63.29	249574
18	17.00	33.23	29.06	0.00	328.55	19.17	52.40	249574
19	16.50	38.96	34.38	0.00	371.96	15.10	54.06	249574
20	16.00	44.69	39.72	0.00	415.50	16.51	61.20	249574
21	15.50	50.42	45.08	0.00	459.19	19.10	69.51	249574
22	15.10	55.00	49.38	0.00	494.26	18.54	73.54	249574
23	14.70	59.58	53.69	0.00	529.43	4.59	64.17	249574
24	14.57	60.81	55.25	0.07	542.13	29.15	89.96	249574
25	13.29	73.44	71.36	3.12	673.55	34.47	107.91	249574
26	12.00	86.07	87.63	6.20	806.25	39.52	125.59	249574
27	10.00	105.69	113.21	11.03	1014.86	47.79	153.48	249574
28	8.00	125.31	139.13	15.94	1226.20	56.25	181.56	249574
29	6.50	140.02	158.74	19.65	1386.17	62.79	202.81	249574
30	5.00	154.74	178.48	23.38	1547.12	71.91	226.65	249574

Note: 38.30 a Soil pressure at active limit
85.86 p Soil pressure at passive limit

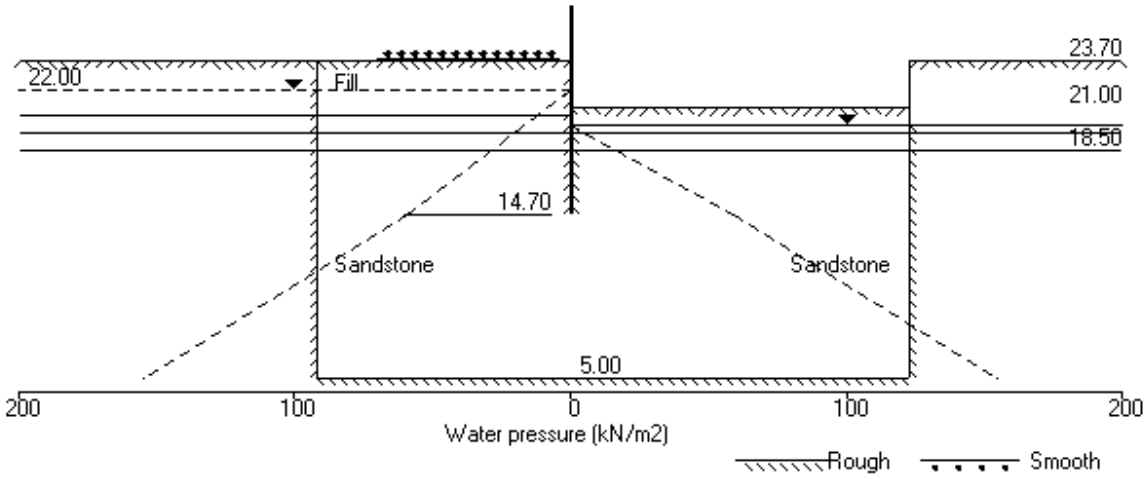
Stage No.3 Excav. to elev. 19.90 on RIGHT side



Stage No.3 Excav. to elev. 19.90 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
4	23.70	21.00	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	23.70	0.00	0.013	2.23E-03	0.0	0.0	
2	23.58	1.53	0.013	2.23E-03	0.1	0.0	
3	23.14	3.70	0.012	2.23E-03	1.2	0.3	
4	22.70	6.22	0.011	2.23E-03	3.4	1.3	
5	22.35	8.29	0.010	2.22E-03	5.9	3.0	
6	22.00	10.33	0.009	2.22E-03	9.2	5.7	
7	21.50	16.13	0.008	2.20E-03	15.8	11.8	
8	21.00	21.86	0.007	2.15E-03	25.3	22.0	
9	20.73	22.33	0.006	2.12E-03	31.3	29.6	
10	20.50	22.81	0.006	2.08E-03	36.5	37.4	
		24.29	0.006	2.08E-03	36.5	37.4	
11	20.17	22.96	0.005	2.01E-03	44.3	50.7	
12	19.90	14.49	0.005	1.94E-03	49.3	63.4	
		28.31	0.005	1.94E-03	49.3	63.4	
13	19.50	18.52	0.004	1.80E-03	58.7	85.1	
		6.19	0.004	1.80E-03	58.7	85.1	
14	19.00	-48.49	0.003	1.55E-03	48.1	115.2	
15	18.50	-54.23	0.002	1.25E-03	22.4	133.2	
		-159.17	0.002	1.25E-03	22.4	133.2	
16	18.00	-61.66	0.002	9.48E-04	-32.8	124.4	
17	17.50	-17.17	0.001	6.77E-04	-52.5	100.3	
18	17.00	14.23	0.001	4.69E-04	-53.2	71.9	
19	16.50	22.33	0.001	3.26E-04	-44.1	47.0	
20	16.00	20.48	0.001	2.35E-04	-33.4	27.7	
21	15.50	16.83	0.001	1.86E-04	-24.0	13.6	
22	15.10	18.97	0.001	1.68E-04	-16.9	5.3	
23	14.70	49.86	0.001	1.62E-04	-3.1	0.0	
24	14.57	0.07	0.001	0	0.0	0.0	
25	13.29	0.01	0.000	0	0.1	0.0	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	12.00	0.08	0.000	0	0.1	0.0	
27	10.00	0.01	0.000	0	0.2	0.0	
28	8.00	-0.05	0.000	0	0.2	0.0	
29	6.50	0.00	0.000	0	0.1	0.0	
30	5.00	-0.18	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.62	10.47	1.53	1.53	12474
3	23.14	0.00	10.77	2.94	49.92	3.70	3.70	12474
4	22.70	0.00	20.18	5.51	93.48	6.22	6.22	12474
5	22.35	0.00	27.77	7.58	128.65	8.29	8.29	12474
6	22.00	0.00	35.18	9.61	163.00	10.33	10.33	12474
7	21.50	4.08	41.34	11.29	191.55	12.05	16.13	12474
8	21.00	8.16	47.17	12.88	218.54	13.70	21.86	12474
9	20.73	10.37	50.21	13.71	232.63	14.61	24.98	12474
10	20.50	12.24	52.75	14.41	244.41	15.47	27.71	12474
		12.24	52.75	14.41	244.43	16.96	29.20	29938
11	20.17	14.94	56.34	15.39	261.05	17.46	32.39	29938
12	19.90	17.14	59.22	16.18	274.43	18.20	35.34	29938
13	19.50	20.40	63.44	17.33	293.95	19.55	39.96	29938
		20.40	63.44	10.90	607.44	18.31	38.72	99795
14	19.00	24.49	70.62	12.13	676.20	17.23	41.72	99795
15	18.50	28.57	77.73	13.35	744.24	17.97	46.54	99795
		28.57	77.73	4.32	725.45	15.87	44.44	249486
16	18.00	32.65	84.77	5.65	782.91	12.97	45.61	249486
17	17.50	36.73	91.77	6.98	839.96	14.20	50.93	249486
18	17.00	40.81	98.72	8.29	896.68	31.13	71.94	249486
19	16.50	44.89	105.64	9.60	953.13	36.96	81.85	249486
20	16.00	48.97	112.54	10.91	1009.35	38.14	87.11	249486
21	15.50	53.05	119.41	12.21	1065.37	38.65	91.70	249486
22	15.10	56.32	124.89	13.24	1110.08	41.55	97.87	249486
23	14.70	59.58	130.36	14.28	1154.69	60.13	119.72	249486
24	14.57	60.81	131.86	14.56	1166.94	34.29	95.10	249486
25	13.29	73.44	147.29	17.48	1292.73	39.50	112.94	249486
26	12.00	86.07	162.65	20.38	1418.06	44.57	130.64	249486
27	10.00	105.69	186.47	24.89	1612.31	52.69	158.38	249486
28	8.00	125.31	210.28	29.39	1806.45	60.98	186.29	249486
29	6.50	140.02	228.14	32.77	1952.13	67.45	207.47	249486
30	5.00	154.74	246.02	36.15	2097.95	75.37	230.11	249486

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

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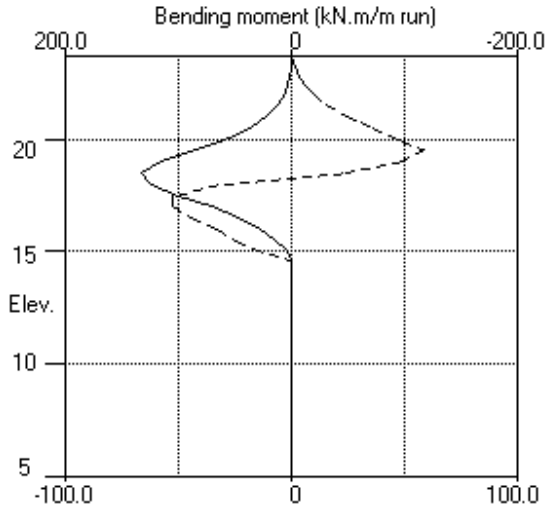
Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

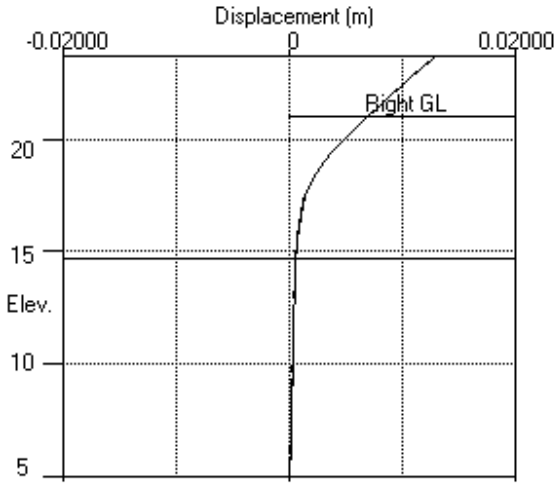
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	1190.00	0.00	0.00a	199620
9	20.73	Total>	6.32	2.65w	1196.32	2.65	2.65a	199620
10	20.50	Total>	11.70	4.90w	1201.70	4.90	4.90a	199620
11	20.17	Total>	19.42	8.14w	1209.42	9.43	9.43	199620
12	19.90	Total>	25.74	10.79w	1215.74	20.85	20.85	199620
		0.00	25.74	7.03	119.29	7.03	7.03a	29943
13	19.50	4.58	28.37	7.75	131.44	16.85	21.44	29943
		4.58	28.37	4.87	271.61	27.94	32.53	99810
14	19.00	10.31	33.65	5.78	322.19	79.90	90.21	99810
15	18.50	16.04	38.94	6.69	372.84	84.73	100.77	99810
		16.04	38.94	0.00	409.13	187.56	203.61	249525
16	18.00	21.77	44.24	0.00	452.35	85.50	107.27	249525
17	17.50	27.50	49.55	0.00	495.65	40.60	68.10	249525
18	17.00	33.23	54.87	0.00	539.05	24.49	57.71	249525
19	16.50	38.96	60.20	1.01	582.56	20.56	59.52	249525
20	16.00	44.69	65.55	2.02	626.18	21.94	66.63	249525
21	15.50	50.42	70.92	3.03	669.93	24.46	74.88	249525
22	15.10	55.00	75.22	3.85	705.02	23.90	78.90	249525
23	14.70	59.58	79.53	4.66	740.19	10.27	69.85	249525
24	14.57	60.81	81.09	4.96	752.88	34.21	95.02	249525
25	13.29	73.44	97.18	8.00	884.08	39.49	112.93	249525
26	12.00	86.07	113.38	11.06	1016.18	44.49	130.56	249525
27	10.00	105.69	138.74	15.86	1223.06	52.68	158.37	249525
28	8.00	125.31	164.33	20.70	1431.69	61.03	186.34	249525
29	6.50	140.02	183.62	24.35	1589.05	67.45	207.47	249525
30	5.00	154.74	202.98	28.01	1746.96	75.55	230.29	249525

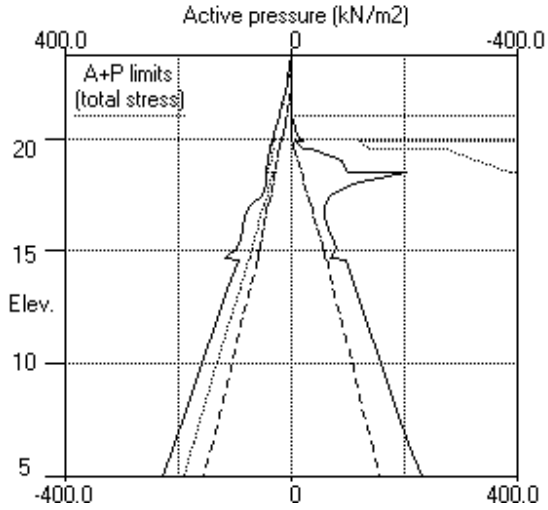
Note: 7.03 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

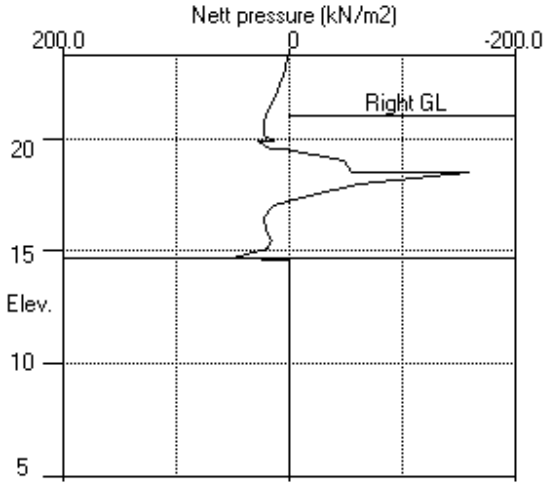
Stage No.4 Fill to elev. 21.00 on RIGHT side





Stage No.4 Fill to elev. 21.00 on RIGHT side





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.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
1	23.70	23.70	Cant.	Conditions not suitable for FoS calc.				
2	23.70	23.70	Cant.	Conditions not suitable for FoS calc.				
3	23.70	19.90	Cant.	1.565	15.28	16.04	3.86	L to R
4	23.70	21.00	Cant.	Conditions not suitable for FoS calc.				
5	23.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: Serviceability Limit State

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

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment				Shear force			
				Calculated		Factored		Calculated		Factored	
no.	coord	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	23.70	0.013	0.000	0	0	0	0	0	0	0	0
2	23.58	0.013	0.000	0	-0	0	-0	0	-1	0	-1
3	23.14	0.012	0.000	0	-0	0	-0	1	-1	2	-2
4	22.70	0.011	0.000	1	-1	2	-1	3	-2	5	-3
5	22.35	0.010	0.000	3	-2	4	-2	6	-3	8	-4
6	22.00	0.009	0.000	6	-3	8	-4	9	-3	13	-4
7	21.50	0.008	0.000	12	-5	16	-6	18	-3	24	-4
8	21.00	0.007	0.000	23	-6	31	-8	29	-2	40	-2
9	20.73	0.007	0.000	32	-6	43	-8	36	-0	49	-1
10	20.50	0.006	0.000	39	-6	53	-8	37	0	50	0
11	20.17	0.005	0.000	53	-5	71	-6	46	0	62	0
12	19.90	0.005	0.000	65	-4	87	-5	53	0	72	0
13	19.50	0.004	0.000	85	-1	115	-2	64	0	87	0
14	19.00	0.003	0.000	116	0	157	0	52	0	70	0
15	18.50	0.003	0.000	136	0	184	0	26	0	36	0
16	18.00	0.002	0.000	128	0	172	0	0	-33	0	-44
17	17.50	0.002	0.000	103	0	139	0	0	-54	0	-73
18	17.00	0.001	0.000	74	0	100	0	0	-55	0	-74
19	16.50	0.001	0.000	48	0	65	0	0	-45	0	-61
20	16.00	0.001	0.000	28	0	38	0	0	-34	0	-46
21	15.50	0.001	0.000	14	0	19	0	0	-25	0	-33
22	15.10	0.001	0.000	5	0	7	0	0	-17	0	-23
23	14.70	0.001	0.000	0	-0	0	-0	0	-3	0	-4
24	14.57	0.001	0.000	0	0	0	0	0	0	0	0
25	13.29	0.001	0.000	0	0	0	0	0	0	0	0
26	12.00	0.001	0.000	0	0	0	0	0	0	0	0
27	10.00	0.000	0.000	0	0	0	0	0	0	0	0
28	8.00	0.000	0.000	0	0	0	0	0	0	0	0
29	6.50	0.000	0.000	0	0	0	0	0	0	0	0
30	5.00	0.000	0.000	0	0	0	0	0	0	0	0

Summary of results (continued)

Calculated Bending Moments and Prop 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 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	5	18.00	-5	20.73	6	-7	7	19.50	-3	21.50	10	-4
2	6	18.00	-6	20.73	8	-8	9	19.50	-3	22.00	12	-4
3	136	18.50	0	23.70	184	0	64	19.50	-55	17.00	87	-74
4	133	18.50	0	23.70	180	0	59	19.50	-53	17.00	79	-72
5	No calculation at this stage											
6	No calculation at this stage											
7	No calculation at this stage											
8	132	18.50	-0	23.14	179	-0	56	19.50	-53	17.00	76	-71

Maximum and minimum displacement at each stage

Stage no.	Displacement				
	maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.000	23.70	0.000	23.70	Apply water pressure profile no.1
2	0.001	23.70	0.000	23.70	Apply surcharge no.1 at elev. 23.70
3	0.013	23.70	0.000	23.70	Excav. to elev. 19.90 on RIGHT side
4	0.013	23.70	0.000	23.70	Fill to elev. 21.00 on RIGHT side
5	No calculation at this stage				Install prop no.4 at elev. 20.17
6	No calculation at this stage				Install prop no.3 at elev. 20.73
7	No calculation at this stage				Install prop no.2 at elev. 23.58
8	0.013	23.70	0.000	23.70	Apply water pressure profile no.3

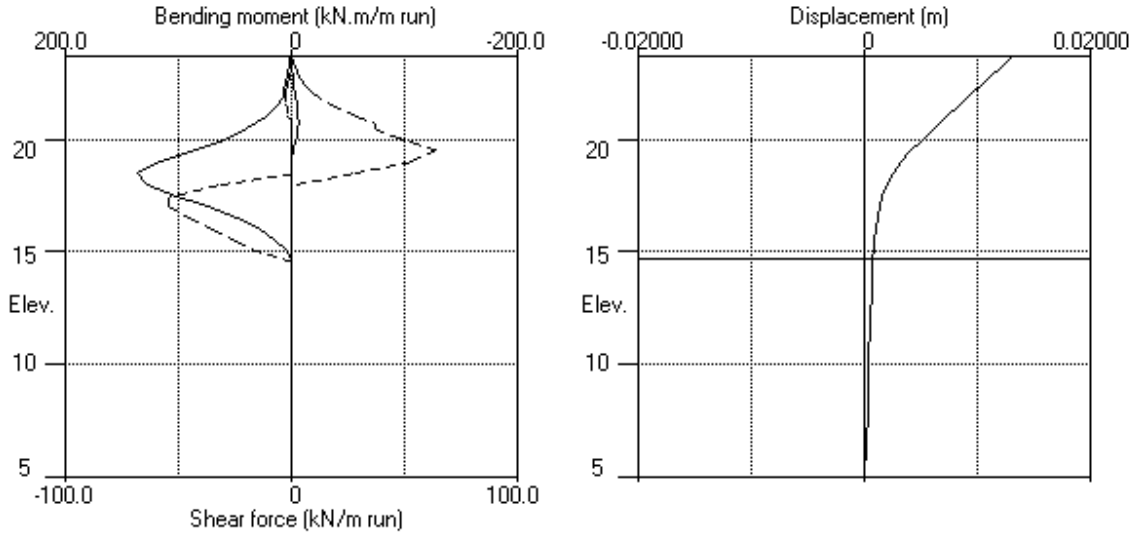
Summary of results (continued)

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

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 2 at elev. 23.58			Prop no. 3 at elev. 20.73			Prop no. 4 at elev. 20.17		
	--Calculated-- kN per m run	Factored kN per prop	Factored kN per prop	--Calculated-- kN per m run	Factored kN per prop	Factored kN per prop	--Calculated-- kN per m run	Factored kN per prop	Factored kN per prop
8	1	1	2	6	6	7	6	6	8

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	23.70	1 Fill	1 Fill
2	20.50	2 Alluvial Gravel	2 Alluvial Gravel
3	19.50	3 Weath Sandstone	3 Weath Sandstone
4	18.50	4 Sandstone	4 Sandstone

SOIL PROPERTIES (Unfactored SLS soil strengths)
Soil Properties File = 21-1182_Soils__SLS.dat

-- 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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

Additional soil parameters associated with Ka and Kp

		--- parameters for Ka ---			--- parameters for Kp ---		
------- Soil type ------- No.	Description	Soil friction angle	Wall adhesion coeff.	Back-fill angle	Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

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	22.00	22.00	0.0	1	19.90	19.90	0.0	MC
2	1	22.70	22.70	0.0	1	19.40	19.40	0.0	WC
3	1	22.70	22.70	0.0	1	19.90	19.90	0.0	MC
4	1	22.70	22.70	0.0	1	19.40	19.40	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 14.70
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 7.4000E-03 m4/m run
E.I = 207200 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

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	23.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.30 Var

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 water pressure profile no.2 (Worst Cred.)
2	Apply surcharge no.1 at elevation 23.70
3	Excavate to elevation 19.40 on RIGHT side
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Install strut or anchor no.4 at elevation 20.17
6	Install strut or anchor no.3 at elevation 20.73
7	Install strut or anchor no.2 at elevation 23.58
8	Apply water pressure profile no.4 (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 = 5.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

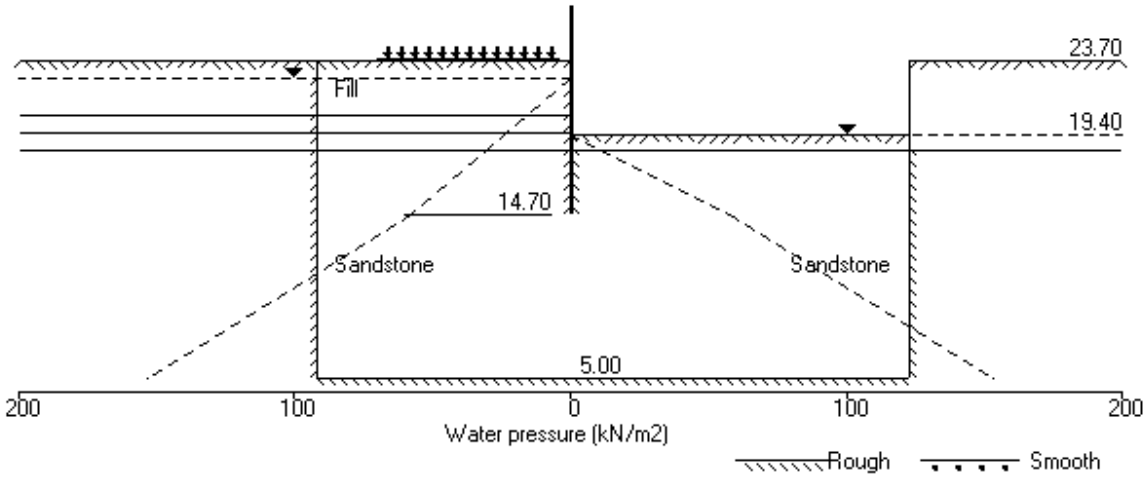
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.2	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 23.70	Yes	Yes	Yes
3	Excav. to elev. 19.40 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	No	No	No
5	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
6	Install prop no.3 at elev. 20.73	No	No	No
7	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
8	Apply water pressure profile no.4	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 19.40 on RIGHT side



Units: kN,m

Stage No. 3 Excavate to elevation 19.40 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall FoS for toe elev. = 14.70 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
3	23.70	19.40	Cant.	1.069	15.20	15.14	4.26	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	23.70	0.00	0.043	6.19E-03	0.0	0.0	
2	23.58	0.78	0.043	6.19E-03	0.0	0.0	
3	23.14	3.77	0.040	6.19E-03	1.0	0.2	
4	22.70	7.15	0.037	6.18E-03	3.4	1.2	
5	22.35	11.56	0.035	6.18E-03	6.7	2.9	
6	22.00	15.89	0.033	6.17E-03	11.5	6.1	
7	21.50	21.91	0.030	6.15E-03	21.0	14.1	
8	21.00	27.79	0.027	6.10E-03	33.4	27.6	
9	20.73	30.92	0.025	6.06E-03	41.3	37.6	
10	20.50	33.56	0.024	6.01E-03	48.7	48.0	
11	20.17	37.33	0.022	5.92E-03	60.4	65.9	
12	19.84	41.12	0.020	5.79E-03	73.6	88.3	
13	19.50	44.89	0.018	5.63E-03	88.0	115.4	
		37.70	0.018	5.63E-03	88.0	115.4	
14	19.40	38.78	0.017	5.57E-03	91.8	124.4	
15	18.95	12.27	0.015	5.25E-03	103.3	169.1	
16	18.50	-14.27	0.013	4.83E-03	102.8	216.7	
		-70.45	0.013	4.83E-03	102.8	216.7	
17	18.00	-96.43	0.010	4.26E-03	61.1	259.3	
18	17.50	-122.48	0.008	3.61E-03	6.4	277.7	
19	17.00	-147.37	0.007	2.95E-03	-61.1	265.5	
20	16.50	-64.75	0.005	2.37E-03	-114.1	216.5	
21	16.00	-17.02	0.004	1.93E-03	-134.6	151.3	
22	15.50	38.00	0.003	1.65E-03	-129.3	81.8	
23	15.10	97.83	0.003	1.54E-03	-102.1	33.1	
24	14.70	314.62	0.002	1.51E-03	-19.7	0.0	
25	14.57	0.09	0.002	0	0.0	0.0	
26	13.29	0.02	0.002	0	0.1	0.0	
27	12.00	0.10	0.001	0	0.2	0.0	
28	10.00	0.03	0.001	0	0.3	0.0	

(continued)

Stage No.3 Excavate to elevation 19.40 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
29	8.00	-0.06	0.000	0	0.2	0.0	
30	6.50	0.01	0.000	0	0.2	0.0	
31	5.00	-0.26	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.78	7.60	0.78	0.78a	12474
3	23.14	0.00	10.97	3.77	36.86	3.77	3.77a	12474
4	22.70	0.00	20.83	7.15	69.99	7.15	7.15a	12474
5	22.35	2.54	26.26	9.02	88.25	9.02	11.56a	12474
6	22.00	5.08	31.47	10.80	105.75	10.80	15.89a	12474
7	21.50	8.71	38.46	13.20	129.22	13.20	21.91a	12474
8	21.00	12.34	45.00	15.45	151.22	15.45	27.79a	12474
9	20.73	14.30	48.40	16.61	162.64	16.61	30.92a	12474
10	20.50	15.97	51.24	17.59	172.17	17.59	33.56a	12474
		15.97	51.24	17.59	172.18	17.59	33.56a	29938
11	20.17	18.37	55.22	18.96	185.57	18.96	37.33a	29938
12	19.84	20.80	59.19	20.32	198.89	20.32	41.12a	29938
13	19.50	23.24	63.08	21.65	211.98	21.65	44.89a	29938
		23.24	63.08	14.47	375.17	14.47	37.70a	99795
14	19.40	23.96	64.63	14.82	384.40	14.82	38.78a	99795
15	18.95	27.23	71.56	16.41	425.59	16.41	43.64a	99795
16	18.50	30.50	78.40	17.98	466.31	17.98	48.48a	99795
		30.50	78.40	9.97	465.30	9.97	40.47a	249486
17	18.00	34.13	85.94	11.85	504.79	11.85	45.98a	249486
18	17.50	37.76	93.41	13.71	543.94	13.71	51.47a	249486
19	17.00	41.39	100.82	15.57	582.82	15.57	56.95a	249486
20	16.50	45.02	108.20	17.41	621.47	17.41	62.42a	249486
21	16.00	48.65	115.53	19.24	659.93	19.24	67.89a	249486
22	15.50	52.28	122.84	21.06	698.22	43.80	96.07	249486
23	15.10	55.18	128.67	22.52	728.77	95.79	150.97	249486
24	14.70	58.09	134.48	23.97	759.23	314.62	372.70	249486
25	14.57	59.31	135.97	24.34	767.07	23.93	83.24A	249486
26	13.29	71.94	151.32	28.17	847.50	31.17	103.12	249486
27	12.00	84.57	166.59	31.98	927.55	35.65	120.23	249486
28	10.00	104.19	190.24	37.89	1051.53	43.85	148.04	249486
29	8.00	123.81	213.87	43.79	1175.42	52.68	176.49	249486
30	6.50	138.53	231.61	48.22	1268.40	60.11	198.63	249486
31	5.00	153.24	249.37	52.65	1361.49	70.40	223.64	249486

RIGHT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0

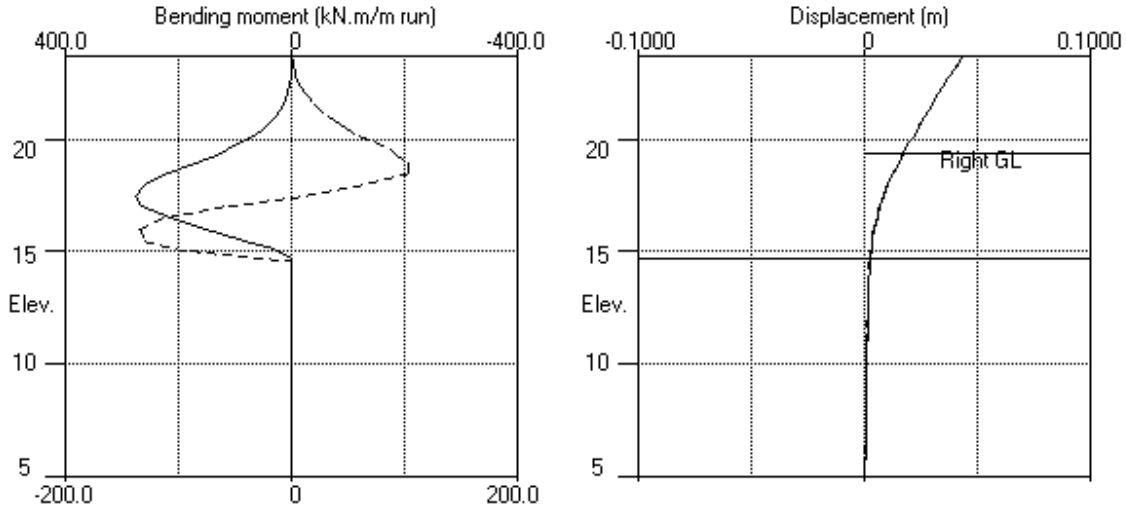
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Stage No.3 Excavate to elevation 19.40 on RIGHT side

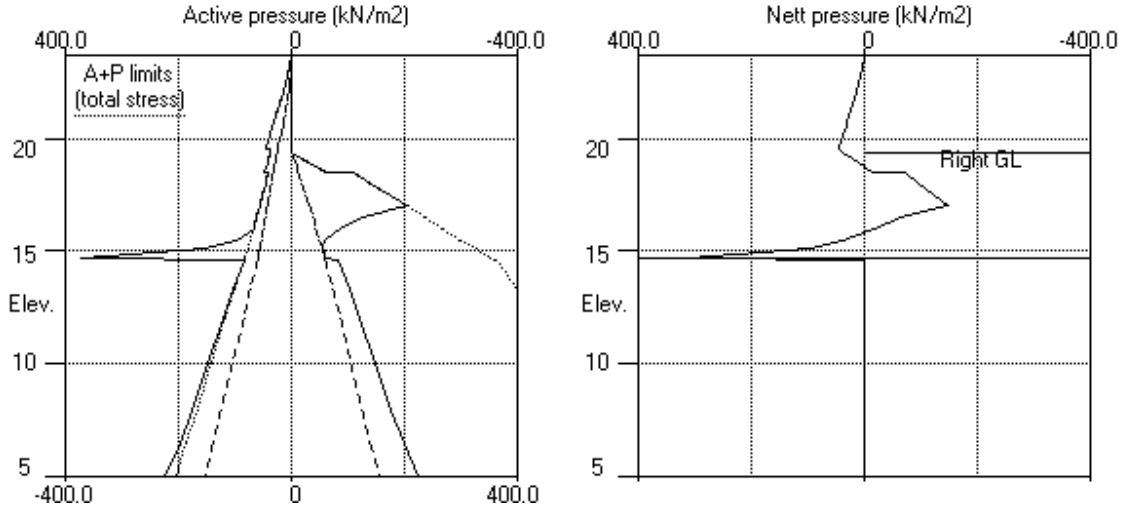
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	20.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	19.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	19.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	19.40	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	99838
15	18.95	5.56	4.34	1.00	25.80	25.80	31.37p	99838
16	18.50	11.12	8.68	1.99	51.62	51.62	62.75p	99838
		11.12	8.68	0.00	99.80	99.79	110.92p	249596
17	18.00	17.30	13.51	0.00	125.11	125.11	142.41p	249596
18	17.50	23.48	18.35	0.00	150.46	150.46	173.95p	249596
19	17.00	29.66	23.19	0.00	175.88	174.66	204.33	249596
20	16.50	35.84	28.06	0.00	201.37	91.34	127.18	249596
21	16.00	42.02	32.94	0.00	226.95	42.88	84.90	249596
22	15.50	48.20	37.83	0.00	252.62	9.88	58.08	249596
23	15.10	53.14	41.77	0.82	273.24	0.00	53.14A	249596
24	14.70	58.09	45.71	1.81	293.93	0.00	58.09A	249596
25	14.57	59.31	47.27	2.20	302.08	23.84	83.15	249596
26	13.29	71.94	63.38	6.22	386.52	31.16	103.10	249596
27	12.00	84.57	79.66	10.28	471.87	35.55	120.13	249596
28	10.00	104.19	105.30	16.68	606.28	43.82	148.01	249596
29	8.00	123.81	131.34	23.18	742.77	52.74	176.56	249596
30	6.50	138.53	151.08	28.11	846.28	60.10	198.63	249596
31	5.00	153.24	170.98	33.08	950.56	70.66	223.91	249596

Note: 67.89 a Soil pressure at active limit
173.95 p Soil pressure at passive limit
58.09A Arching - soil pressure below active limit

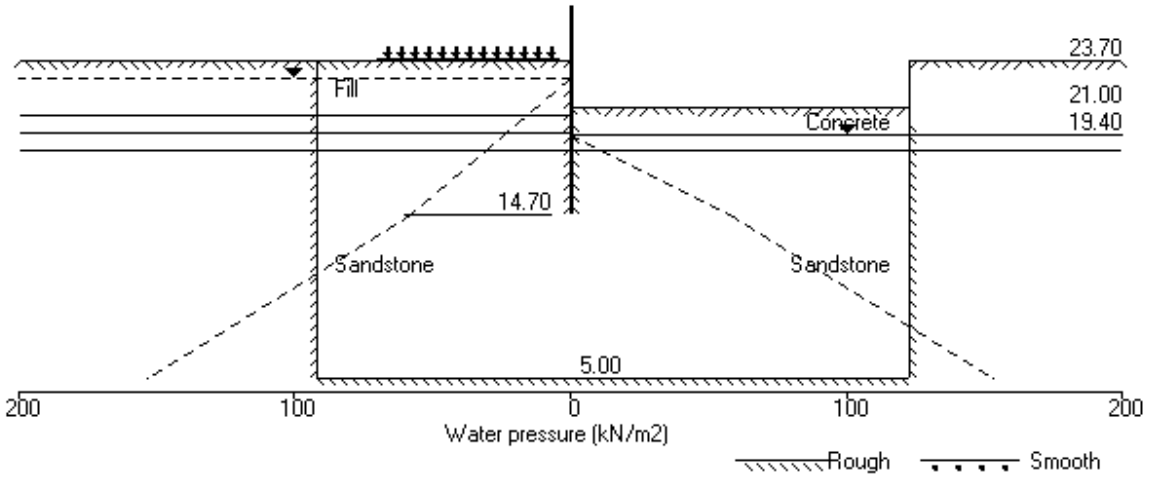
Stage No.3 Excav. to elev. 19.40 on RIGHT side



Stage No.3 Excav. to elev. 19.40 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall FoS for toe elev. = 14.70 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
4	23.70	21.00	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	23.70	0.00	0.043	6.18E-03	0.0	0.0	
2	23.58	1.92	0.042	6.18E-03	0.1	0.0	
3	23.14	4.73	0.040	6.18E-03	1.6	0.4	
4	22.70	8.06	0.037	6.18E-03	4.4	1.6	
5	22.35	12.47	0.035	6.18E-03	8.0	3.8	
6	22.00	16.84	0.033	6.17E-03	13.1	7.4	
7	21.50	22.93	0.029	6.14E-03	23.0	16.4	
8	21.00	28.90	0.026	6.08E-03	36.0	31.0	
9	20.73	29.50	0.025	6.03E-03	43.9	41.7	
10	20.50	30.10	0.023	5.98E-03	50.7	52.6	
		32.12	0.023	5.98E-03	50.7	52.6	
11	20.17	32.06	0.021	5.88E-03	61.3	71.0	
12	19.84	32.59	0.019	5.75E-03	72.2	93.3	
13	19.50	28.32	0.018	5.58E-03	82.4	119.2	
		30.74	0.018	5.58E-03	82.4	119.2	
14	19.40	21.12	0.017	5.52E-03	84.9	127.6	
		39.17	0.017	5.52E-03	84.9	127.6	
15	18.95	12.14	0.015	5.20E-03	96.5	169.3	
16	18.50	-14.24	0.012	4.78E-03	96.0	213.9	
		-53.00	0.012	4.78E-03	96.0	213.9	
17	18.00	-90.01	0.010	4.21E-03	60.3	255.2	
18	17.50	-120.55	0.008	3.58E-03	7.6	274.0	
19	17.00	-147.23	0.007	2.93E-03	-59.3	262.7	
20	16.50	-65.29	0.005	2.35E-03	-112.4	214.5	
21	16.00	-17.69	0.004	1.91E-03	-133.2	150.1	
22	15.50	37.33	0.003	1.63E-03	-128.3	81.2	
23	15.10	97.00	0.003	1.52E-03	-101.4	32.8	
24	14.70	312.46	0.002	1.49E-03	-19.5	0.0	
25	14.57	0.08	0.002	0	0.0	0.0	
26	13.29	0.01	0.002	0	0.1	0.0	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	12.00	0.08	0.001	0	0.1	0.0	
28	10.00	0.01	0.001	0	0.2	0.0	
29	8.00	-0.06	0.000	0	0.2	0.0	
30	6.50	0.00	0.000	0	0.2	0.0	
31	5.00	-0.20	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.78	7.60	1.92	1.92	12474
3	23.14	0.00	10.97	3.77	36.86	4.73	4.73	12474
4	22.70	0.00	20.83	7.15	69.99	8.06	8.06	12474
5	22.35	2.54	26.26	9.02	88.25	9.93	12.47	12474
6	22.00	5.08	31.47	10.80	105.75	11.75	16.84	12474
7	21.50	8.71	38.46	13.20	129.22	14.22	22.93	12474
8	21.00	12.34	45.00	15.45	151.22	16.55	28.90	12474
9	20.73	14.30	48.40	16.61	162.64	17.84	32.14	12474
10	20.50	15.97	51.24	17.59	172.17	19.03	35.00	12474
		15.97	51.24	17.59	172.18	21.05	37.03	29938
11	20.17	18.37	55.22	18.96	185.57	21.84	40.21	29938
12	19.84	20.80	59.19	20.32	198.89	23.22	44.02	29938
13	19.50	23.24	63.08	21.65	211.98	25.77	49.01	29938
		23.24	63.08	14.47	375.17	28.20	51.43	99795
14	19.40	23.96	64.63	14.82	384.40	23.80	47.76	99795
15	18.95	27.23	71.56	16.41	425.59	23.91	51.14	99795
16	18.50	30.50	78.40	17.98	466.31	25.03	55.53	99795
		30.50	78.40	9.97	465.30	27.59	58.09	249486
17	18.00	34.13	85.94	11.85	504.79	23.25	57.38	249486
18	17.50	37.76	93.41	13.71	543.94	22.58	60.34	249486
19	17.00	41.39	100.82	15.57	582.82	23.38	64.76	249486
20	16.50	45.02	108.20	17.41	621.47	24.77	69.79	249486
21	16.00	48.65	115.53	19.24	659.93	26.45	75.10	249486
22	15.50	52.28	122.84	21.06	698.22	50.96	103.24	249486
23	15.10	55.18	128.67	22.52	728.77	102.83	158.02	249486
24	14.70	58.09	134.48	23.97	759.23	320.93	379.02	249486
25	14.57	59.31	135.97	24.34	767.07	31.32	90.64	249486
26	13.29	71.94	151.32	28.17	847.50	38.50	110.44	249486
27	12.00	84.57	166.59	31.98	927.55	42.88	127.46	249486
28	10.00	104.19	190.24	37.89	1051.53	50.96	155.15	249486
29	8.00	123.81	213.87	43.79	1175.42	59.65	183.47	249486
30	6.50	138.53	231.61	48.22	1268.40	66.89	205.42	249486
31	5.00	153.24	249.37	52.65	1361.49	75.78	229.02	249486

RIGHT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0

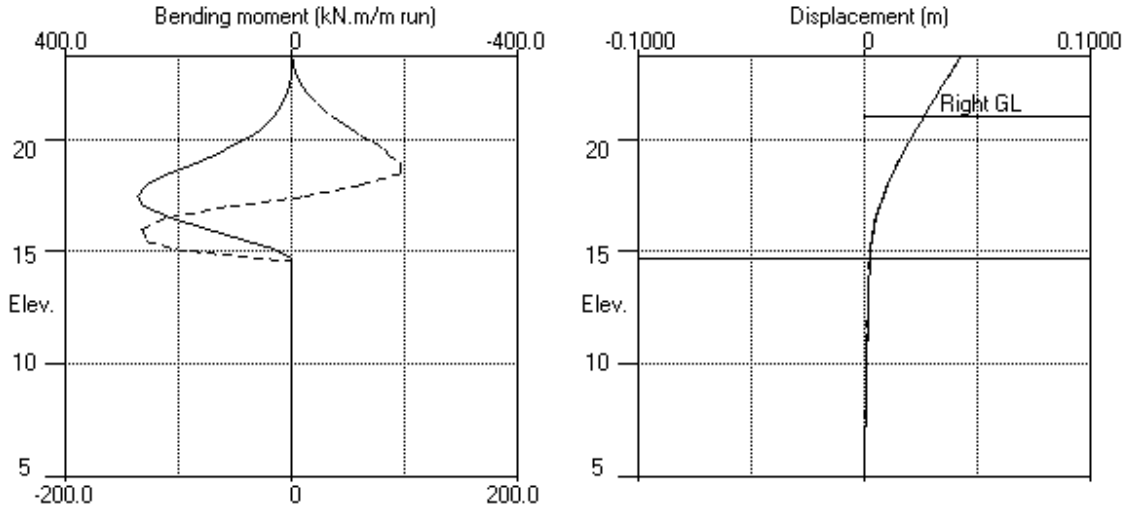
(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

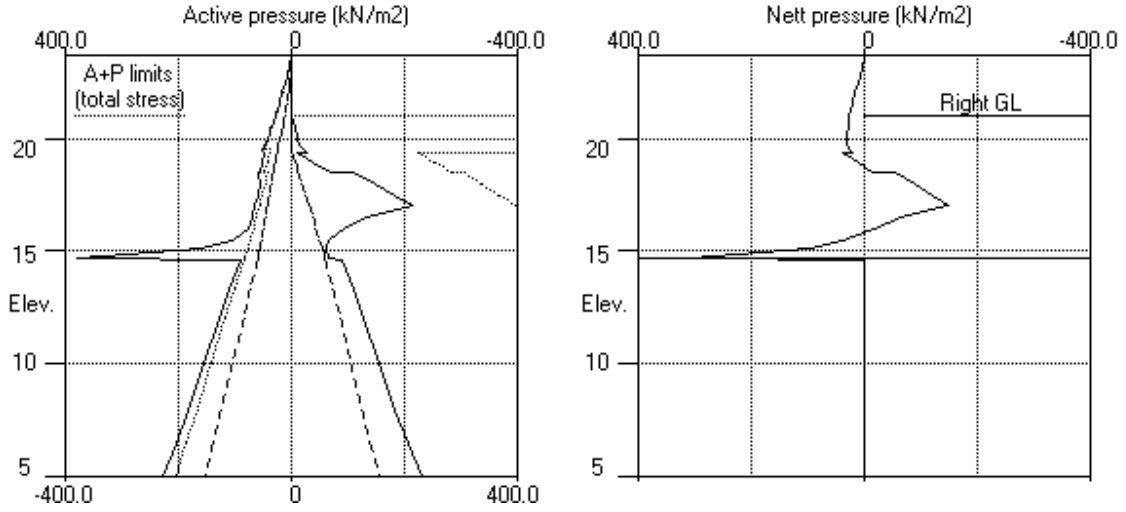
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	850.00	0.00	0.00a	199620
9	20.73	Total>	6.32	2.65w	856.32	2.65	2.65a	199620
10	20.50	Total>	11.70	4.90w	861.70	4.90	4.90a	199620
11	20.17	Total>	19.42	8.14w	869.43	8.14	8.14a	199620
12	19.84	Total>	27.27	11.43w	877.27	11.43	11.43a	199620
13	19.50	Total>	35.11	14.71w	885.12	20.69	20.69	199620
14	19.40	Total>	37.45	15.70w	887.46	26.64	26.64	199620
		0.00	37.45	8.59	222.74	8.59	8.59a	99810
15	18.95	5.56	41.80	9.59	248.61	33.43	39.00	99810
16	18.50	11.12	46.16	10.58	274.51	58.64	69.76	99810
		11.12	46.16	1.92	296.25	99.96	111.09	249525
17	18.00	17.30	51.01	3.13	321.67	130.09	147.39	249525
18	17.50	23.48	55.86	4.34	347.14	157.40	180.89	249525
19	17.00	29.66	60.74	5.56	372.67	182.33	212.00	249525
20	16.50	35.84	65.62	6.78	398.28	99.23	135.08	249525
21	16.00	42.02	70.52	8.00	423.96	50.77	92.79	249525
22	15.50	48.20	75.43	9.23	449.72	17.71	65.91	249525
23	15.10	53.14	79.38	10.21	470.38	7.87	61.01A	249525
24	14.70	58.09	83.33	11.20	491.10	8.46	66.55A	249525
25	14.57	59.31	84.88	11.59	499.26	31.24	90.55	249525
26	13.29	71.94	100.97	15.60	583.59	38.49	110.43	249525
27	12.00	84.57	117.17	19.65	668.51	42.80	127.37	249525
28	10.00	104.19	142.54	25.98	801.49	50.94	155.14	249525
29	8.00	123.81	168.12	32.37	935.59	59.71	183.52	249525
30	6.50	138.53	187.42	37.18	1036.74	66.89	205.42	249525
31	5.00	153.24	206.78	42.02	1138.24	75.98	229.22	249525

Note: 8.59 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
66.55A Arching - soil pressure below active limit

Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
1	23.70	23.70	Cant.	Conditions not suitable for FoS calc.				
2	23.70	23.70	Cant.	Conditions not suitable for FoS calc.				
3	23.70	19.40	Cant.	1.069	15.20	15.14	4.26	L to R
4	23.70	21.00	Cant.	Conditions not suitable for FoS calc.				
5	23.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries:	Left side 15.00 from wall	Rough boundary
	Right side 20.00 from wall	Rough boundary
Lower rigid boundary at elevation 5.00		Rough boundary

Limit State: ULS DA1 Combination 2

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment		Shear force	
no.	coord	maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	23.70	0.043	0.000	0.0	0.0	0.0	0.0
2	23.58	0.043	0.000	0.0	-0.0	0.1	-0.2
3	23.14	0.040	0.000	0.4	-0.4	1.6	-1.7
4	22.70	0.037	0.000	1.6	-1.5	4.4	-3.3
5	22.35	0.035	0.000	3.8	-2.8	8.0	-4.1
6	22.00	0.033	0.000	7.4	-4.3	13.1	-4.1
7	21.50	0.030	0.000	16.4	-6.1	23.0	-2.8
8	21.00	0.027	0.000	31.0	-6.8	36.0	-0.4
9	20.73	0.025	0.000	41.7	-6.4	43.9	0.0
10	20.50	0.024	0.000	52.6	-5.7	50.7	0.0
11	20.17	0.022	0.000	71.0	-4.5	61.3	0.0
12	19.84	0.020	0.000	93.3	-2.7	73.6	0.0
13	19.50	0.018	0.000	119.2	0.0	88.0	0.0
14	19.40	0.017	0.000	127.6	0.0	91.8	0.0
15	18.95	0.015	0.000	169.3	0.0	103.3	0.0
16	18.50	0.013	0.000	216.7	0.0	102.8	0.0
17	18.00	0.010	0.000	259.3	0.0	61.1	-1.6
18	17.50	0.008	0.000	277.7	0.0	7.6	-3.9
19	17.00	0.007	0.000	265.5	0.0	0.0	-61.1
20	16.50	0.005	0.000	216.5	0.0	0.0	-114.1
21	16.00	0.004	0.000	151.3	0.0	0.0	-134.6
22	15.50	0.003	0.000	81.8	0.0	0.0	-129.3
23	15.10	0.003	0.000	33.1	0.0	0.0	-102.1
24	14.70	0.002	0.000	0.0	0.0	0.0	-19.7
25	14.57	0.002	0.000	0.0	0.0	0.0	0.0
26	13.29	0.002	0.000	0.0	0.0	0.1	0.0
27	12.00	0.001	0.000	0.0	0.0	0.2	0.0
28	10.00	0.001	0.000	0.0	0.0	0.3	0.0
29	8.00	0.000	0.000	0.0	0.0	0.2	0.0
30	6.50	0.000	0.000	0.0	0.0	0.2	0.0
31	5.00	0.000	0.000	0.0	0.0	0.0	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	7.3	18.00	-6.3	21.00	9.4	19.50	-3.7	22.00
2	9.3	18.00	-6.8	21.00	11.0	19.50	-4.1	22.35
3	277.7	17.50	0.0	23.70	103.3	18.95	-134.6	16.00
4	274.0	17.50	0.0	23.70	96.5	18.95	-133.2	16.00
5	No calculation at this stage							
6	No calculation at this stage							
7	No calculation at this stage							
8	274.0	17.50	0.0	23.70	96.5	18.95	-133.2	16.00

Maximum and minimum displacement at each stage

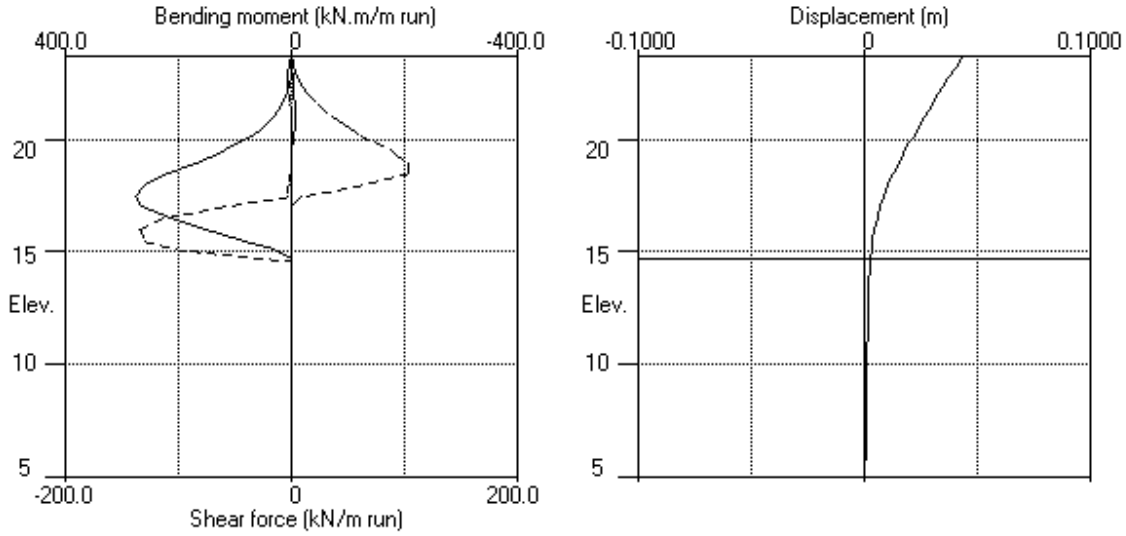
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.001	23.70	0.000	23.70	Apply water pressure profile no.2
2	0.001	23.70	0.000	23.70	Apply surcharge no.1 at elev. 23.70
3	0.043	23.70	0.000	23.70	Excav. to elev. 19.40 on RIGHT side
4	0.043	23.70	0.000	23.70	Fill to elev. 21.00 on RIGHT side
5	No calculation at this stage				Install prop no.4 at elev. 20.17
6	No calculation at this stage				Install prop no.3 at elev. 20.73
7	No calculation at this stage				Install prop no.2 at elev. 23.58
8	0.043	23.70	0.000	23.70	Apply water pressure profile no.4

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	Strut no. 2 at elev. 23.58		Strut no. 3 at elev. 20.73		Strut no. 4 at elev. 20.17	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
8	0.00	0.00	0.00	0.00	0.00	0.00

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	25.70	1 Fill	1 Fill
2	21.70	2 Alluvial Gravel	2 Alluvial Gravel
3	20.00	3 Weath Sandstone	3 Weath Sandstone
4	18.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES

Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

Water press. profile no.	Point no.	Left side Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Right side Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	22.00	22.00	0.0	1	19.50	19.50	0.0	MC
2	1	23.00	23.00	0.0	1	19.00	19.00	0.0	WC
3	1	24.00	24.00	0.0	1	19.00	19.00	0.0	MC
4	1	24.90	24.90	0.0	1	19.50	19.50	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 11.40
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.017300 m4/m run
E.I = 484400 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

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	25.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.00 Var

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 water pressure profile no.1 (Mod. Conserv.)
2	Apply surcharge no.1 at elevation 25.70
3	Excavate to elevation 19.50 on RIGHT side
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Install strut or anchor no.4 at elevation 20.17
6	Install strut or anchor no.3 at elevation 20.73
7	Install strut or anchor no.2 at elevation 23.58
8	Apply water pressure profile no.3 (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 = 1.25

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

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough

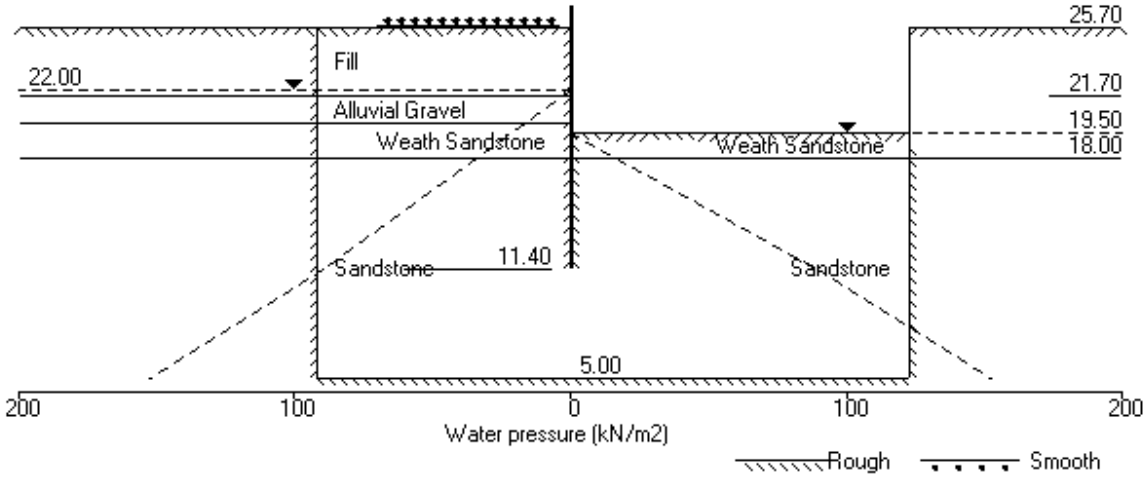
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.1	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.70	Yes	Yes	Yes
3	Excav. to elev. 19.50 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	No	No	No
5	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
6	Install prop no.3 at elev. 20.73	No	No	No
7	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
8	Apply water pressure profile no.3	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 19.50 on RIGHT side



Units: kN,m

Stage No. 3 Excavate to elevation 19.50 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 11.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
3	25.70	19.50	Cant.	1.624	12.28	14.00	5.50	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary

Right side 20.00 from wall Rough boundary

Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.70	0.00	0.035	4.15E-03	0.0	0.0	
2	25.15	2.87	0.033	4.15E-03	0.8	0.3	
3	24.60	6.11	0.031	4.15E-03	3.3	1.4	
4	24.00	9.61	0.028	4.15E-03	8.0	4.9	
5	23.58	11.99	0.026	4.14E-03	12.6	9.2	
6	23.19	14.11	0.025	4.13E-03	17.6	15.1	
7	22.80	16.17	0.023	4.11E-03	23.5	23.1	
8	22.40	18.27	0.022	4.09E-03	30.4	33.9	
9	22.00	20.34	0.020	4.06E-03	38.1	47.6	
10	21.70	23.73	0.019	4.02E-03	44.7	60.0	
11	21.35	27.68	0.017	3.97E-03	53.7	77.2	
12	21.00	31.61	0.016	3.91E-03	64.1	97.8	
13	20.73	34.63	0.015	3.85E-03	73.0	116.3	
14	20.17	40.89	0.013	3.69E-03	94.2	163.0	
15	20.00	42.79	0.012	3.63E-03	101.3	179.6	
		33.21	0.012	3.63E-03	101.3	179.6	
16	19.50	38.64	0.010	3.42E-03	119.3	234.5	
17	19.00	-13.60	0.009	3.14E-03	125.5	298.6	
18	18.50	-65.88	0.007	2.80E-03	105.6	359.6	
19	18.00	-118.26	0.006	2.41E-03	59.6	404.1	
		-194.90	0.006	2.41E-03	59.6	404.1	
20	17.40	-152.68	0.005	1.91E-03	-44.7	404.7	
21	16.80	-55.39	0.004	1.44E-03	-107.1	350.4	
22	16.20	0.57	0.003	1.05E-03	-123.5	276.1	
23	15.60	33.56	0.002	7.59E-04	-113.3	202.0	
24	15.00	41.14	0.002	5.47E-04	-90.9	140.0	
25	14.40	36.94	0.002	4.03E-04	-67.5	92.8	
26	13.80	28.48	0.001	3.09E-04	-47.8	58.9	
27	13.20	19.89	0.001	2.51E-04	-33.3	35.3	

(continued)

Stage No.3 Excavate to elevation 19.50 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	12.60	13.40	0.001	2.17E-04	-23.3	18.8	
29	12.00	12.55	0.001	2.01E-04	-15.6	7.1	
30	11.40	31.44	0.001	1.97E-04	-2.4	0.0	
31	11.25	0.23	0.001	0	0.0	0.0	
32	9.69	0.02	0.001	0	0.2	0.0	
33	8.13	0.02	0.000	0	0.2	0.0	
34	6.56	0.01	0.000	0	0.3	0.0	
35	5.00	-0.35	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.15	0.00	10.51	2.87	48.72	2.87	2.87a	12463
3	24.60	0.00	22.36	6.11	103.58	6.11	6.11a	12463
4	24.00	0.00	35.18	9.61	163.00	9.61	9.61a	12463
5	23.58	0.00	43.91	11.99	203.45	11.99	11.99a	12463
6	23.19	0.00	51.65	14.11	239.30	14.11	14.11a	12463
7	22.80	0.00	59.22	16.17	274.38	16.17	16.17a	12463
8	22.40	0.00	66.90	18.27	309.99	18.27	18.27a	12463
9	22.00	0.00	74.48	20.34	345.10	20.34	20.34a	12463
10	21.70	2.55	77.56	21.18	359.37	21.18	23.73a	12463
		2.55	77.56	21.19	359.40	21.19	23.74a	29912
11	21.35	5.52	81.11	22.15	375.83	22.15	27.68a	29912
12	21.00	8.50	84.61	23.11	392.05	23.11	31.61a	29912
13	20.73	10.79	87.28	23.84	404.44	23.84	34.63a	29912
14	20.17	15.55	92.77	25.34	429.87	25.34	40.89a	29912
15	20.00	17.00	94.42	25.79	437.52	25.79	42.79a	29912
		17.00	94.42	16.22	904.11	16.22	33.21a	99705
16	19.50	21.25	101.25	17.39	969.49	17.39	38.64a	99705
17	19.00	25.50	108.04	18.56	1034.47	18.56	44.05a	99705
18	18.50	29.74	114.79	19.72	1099.14	19.72	49.46a	99705
19	18.00	33.99	121.51	20.87	1163.53	20.87	54.87a	99705
		33.99	121.51	12.60	1082.56	12.60	46.60a	249264
20	17.40	39.09	129.55	14.12	1148.12	14.12	53.22a	249264
21	16.80	44.19	137.57	15.64	1213.47	15.64	59.83a	249264
22	16.20	49.29	145.56	17.15	1278.63	29.74	79.03	249264
23	15.60	54.39	153.53	18.66	1343.66	46.26	100.65	249264
24	15.00	59.49	161.49	20.16	1408.57	51.07	110.56	249264
25	14.40	64.59	169.44	21.67	1473.40	50.65	115.24	249264
26	13.80	69.69	177.38	23.17	1538.16	48.57	118.26	249264
27	13.20	74.79	185.32	24.67	1602.88	46.75	121.54	249264
28	12.60	79.89	193.25	26.17	1667.56	46.21	126.10	249264
29	12.00	84.99	201.18	27.67	1732.23	48.64	133.63	249264
30	11.40	90.08	209.11	29.17	1796.88	61.58	151.66	249264
31	11.25	91.56	210.89	29.51	1811.44	45.94	137.49	249264
32	9.69	106.88	229.49	33.03	1963.12	52.49	159.38	249264
33	8.13	122.21	248.10	36.55	2114.90	59.32	181.53	249264
34	6.56	137.54	266.73	40.07	2266.84	66.72	204.26	249264
35	5.00	152.87	285.39	43.60	2418.97	77.99	230.86	249264

(continued)

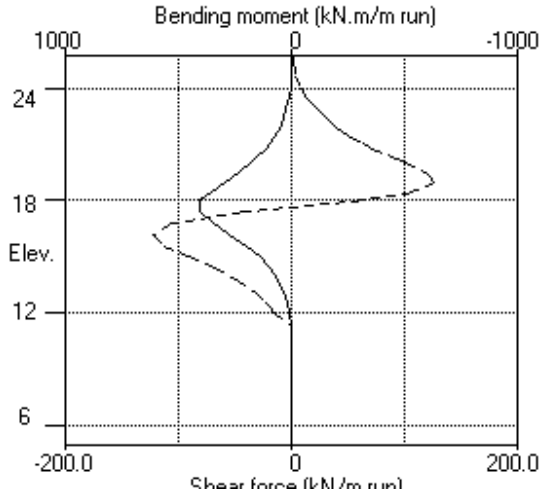
Stage No.3 Excavate to elevation 19.50 on RIGHT side

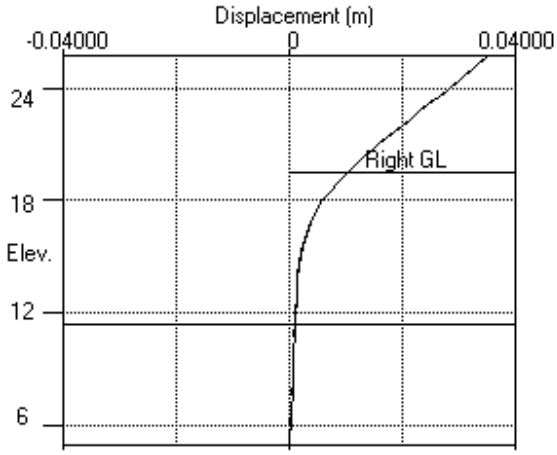
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.19	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	19.50	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	99777
17	19.00	5.56	5.44	0.93	52.09	52.09	57.65p	99777
18	18.50	11.12	10.88	1.87	104.22	104.22	115.34p	99777
19	18.00	16.68	16.34	2.81	156.44	156.44	173.12p	99777
		16.68	16.34	0.00	224.82	224.82	241.50p	249443
20	17.40	23.36	22.90	0.00	278.33	182.54	205.89	249443
21	16.80	30.03	29.49	0.00	332.06	85.19	115.22	249443
22	16.20	36.70	36.11	0.00	386.06	41.76	78.46	249443
23	15.60	43.37	42.77	0.00	440.36	23.71	67.09	249443
24	15.00	50.05	49.47	0.00	495.02	19.37	69.42	249443
25	14.40	56.72	56.22	0.25	550.08	21.59	78.31	249443
26	13.80	63.39	63.02	1.54	605.55	26.39	89.78	249443
27	13.20	70.07	69.88	2.84	661.46	31.58	101.64	249443
28	12.60	76.74	76.79	4.15	717.82	35.96	112.70	249443
29	12.00	83.41	83.76	5.46	774.65	37.66	121.08	249443
30	11.40	90.08	90.78	6.79	831.93	30.14	120.23	249443
31	11.25	91.56	92.74	7.16	847.93	45.71	137.26	249443
32	9.69	106.88	113.38	11.07	1016.21	52.47	159.36	249443
33	8.13	122.21	134.36	15.03	1187.29	59.30	181.52	249443
34	6.56	137.54	155.63	19.06	1360.76	66.71	204.25	249443
35	5.00	152.87	177.13	23.12	1536.12	78.34	231.21	249443

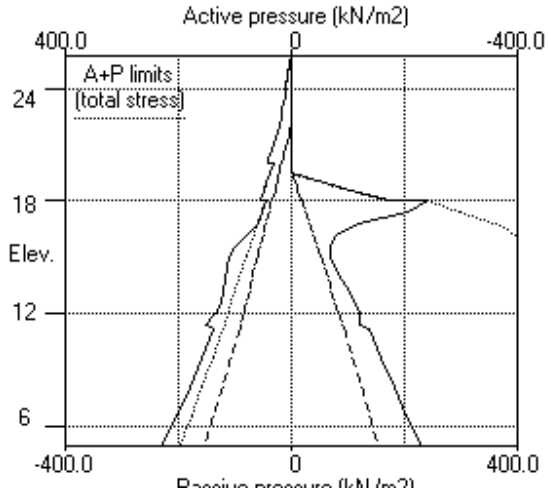
Note: 59.83 a Soil pressure at active limit
241.50 p Soil pressure at passive limit

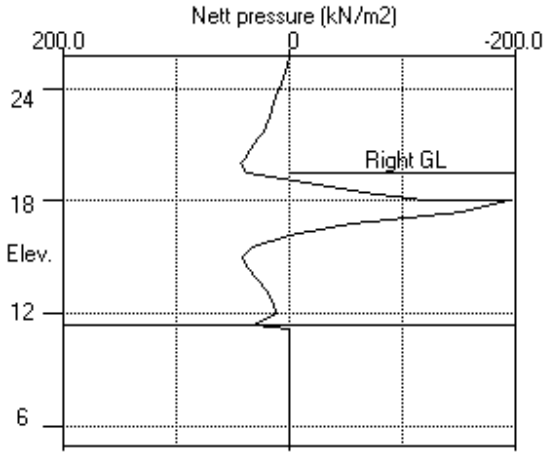
Stage No.3 Excav. to elev. 19.50 on RIGHT side



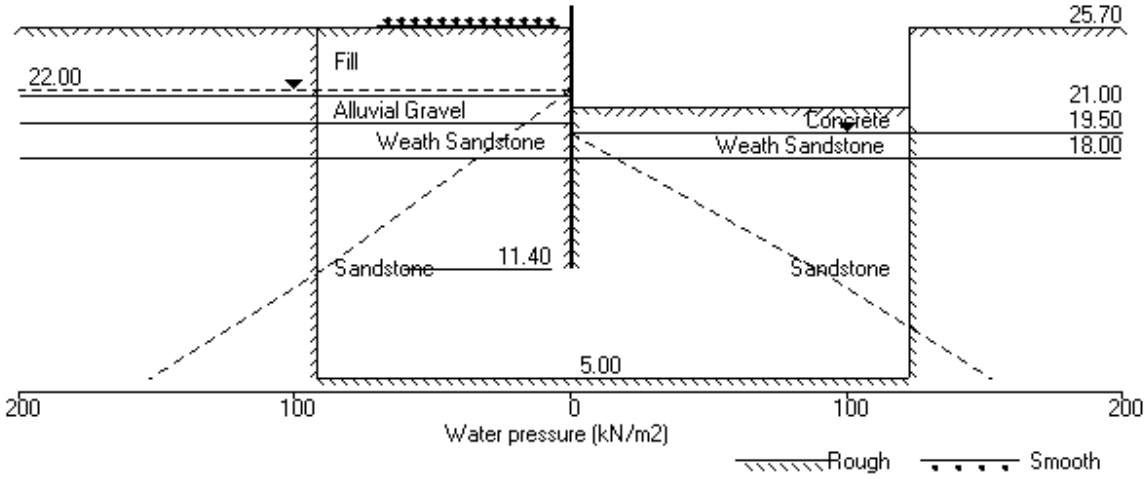


Stage No.3 Excav. to elev. 19.50 on RIGHT side





Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 11.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
4	25.70	21.00	Cant.	5.212	11.91	19.57	1.43	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.70	0.00	0.035	4.17E-03	0.0	-0.0	
2	25.15	3.35	0.033	4.17E-03	0.9	0.3	
3	24.60	6.56	0.030	4.17E-03	3.6	1.6	
4	24.00	10.09	0.028	4.16E-03	8.6	5.3	
5	23.58	12.51	0.026	4.15E-03	13.4	10.0	
6	23.19	14.66	0.024	4.14E-03	18.7	16.3	
7	22.80	16.77	0.023	4.13E-03	24.8	24.7	
8	22.40	18.92	0.021	4.10E-03	31.9	36.1	
9	22.00	21.06	0.020	4.07E-03	39.9	50.5	
10	21.70	24.57	0.018	4.03E-03	46.8	63.4	
		25.73	0.018	4.03E-03	46.8	63.4	
11	21.35	29.44	0.017	3.98E-03	56.4	81.5	
12	21.00	33.39	0.016	3.91E-03	67.4	103.1	
13	20.73	33.88	0.015	3.85E-03	76.5	122.5	
14	20.17	34.79	0.012	3.68E-03	95.7	170.4	
15	20.00	35.33	0.012	3.62E-03	101.7	187.2	
		31.23	0.012	3.62E-03	101.7	187.2	
16	19.50	20.86	0.010	3.40E-03	114.7	241.6	
		37.97	0.010	3.40E-03	114.7	241.6	
17	19.00	-15.66	0.008	3.11E-03	120.3	303.3	
18	18.50	-67.75	0.007	2.77E-03	99.4	361.4	
19	18.00	-119.78	0.006	2.38E-03	52.6	402.6	
		-182.41	0.006	2.38E-03	52.6	402.6	
20	17.40	-147.60	0.004	1.88E-03	-46.4	401.3	
21	16.80	-53.39	0.003	1.42E-03	-106.7	346.8	
22	16.20	1.16	0.003	1.03E-03	-122.4	273.1	
23	15.60	33.47	0.002	7.44E-04	-112.0	199.8	
24	15.00	40.78	0.002	5.34E-04	-89.7	138.5	
25	14.40	36.49	0.001	3.92E-04	-66.6	91.9	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	13.80	28.05	0.001	2.99E-04	-47.2	58.5	
27	13.20	19.50	0.001	2.41E-04	-32.9	35.1	
28	12.60	13.06	0.001	2.07E-04	-23.2	18.8	
29	12.00	12.34	0.001	1.91E-04	-15.6	7.2	
30	11.40	31.62	0.001	1.87E-04	-2.4	0.0	
31	11.25	0.21	0.001	0	0.0	0.0	
32	9.69	0.01	0.001	0	0.2	0.0	
33	8.13	0.01	0.000	0	0.2	0.0	
34	6.56	0.01	0.000	0	0.2	0.0	
35	5.00	-0.29	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.15	0.00	10.51	2.87	48.72	3.35	3.35	12463
3	24.60	0.00	22.36	6.11	103.58	6.56	6.56	12463
4	24.00	0.00	35.18	9.61	163.00	10.09	10.09	12463
5	23.58	0.00	43.91	11.99	203.45	12.51	12.51	12463
6	23.19	0.00	51.65	14.11	239.30	14.66	14.66	12463
7	22.80	0.00	59.22	16.17	274.38	16.77	16.77	12463
8	22.40	0.00	66.90	18.27	309.99	18.92	18.92	12463
9	22.00	0.00	74.48	20.34	345.10	21.06	21.06	12463
10	21.70	2.55	77.56	21.18	359.37	22.02	24.57	12463
		2.55	77.56	21.19	359.40	23.18	25.73	29912
11	21.35	5.52	81.11	22.15	375.83	23.92	29.44	29912
12	21.00	8.50	84.61	23.11	392.05	24.89	33.39	29912
13	20.73	10.79	87.28	23.84	404.44	25.73	36.53	29912
14	20.17	15.55	92.77	25.34	429.87	27.38	42.93	29912
15	20.00	17.00	94.42	25.79	437.52	28.14	45.14	29912
		17.00	94.42	16.22	904.11	24.05	41.04	99705
16	19.50	21.25	101.25	17.39	969.49	23.51	44.76	99705
17	19.00	25.50	108.04	18.56	1034.47	24.11	49.60	99705
18	18.50	29.74	114.79	19.72	1099.14	25.04	54.79	99705
19	18.00	33.99	121.51	20.87	1163.53	26.30	60.30	99705
		33.99	121.51	12.60	1082.56	26.18	60.18	249264
20	17.40	39.09	129.55	14.12	1148.12	23.77	62.87	249264
21	16.80	44.19	137.57	15.64	1213.47	23.67	67.87	249264
22	16.20	49.29	145.56	17.15	1278.63	37.03	86.32	249264
23	15.60	54.39	153.53	18.66	1343.66	53.18	107.57	249264
24	15.00	59.49	161.49	20.16	1408.57	57.83	117.32	249264
25	14.40	64.59	169.44	21.67	1473.40	57.36	121.95	249264
26	13.80	69.69	177.38	23.17	1538.16	55.27	124.95	249264
27	13.20	74.79	185.32	24.67	1602.88	53.45	128.23	249264
28	12.60	79.89	193.25	26.17	1667.56	52.92	132.80	249264
29	12.00	84.99	201.18	27.67	1732.23	55.39	140.37	249264
30	11.40	90.08	209.11	29.17	1796.88	68.51	158.59	249264
31	11.25	91.56	210.89	29.51	1811.44	52.74	144.29	249264
32	9.69	106.88	229.49	33.03	1963.12	59.23	166.12	249264
33	8.13	122.21	248.10	36.55	2114.90	65.97	188.18	249264
34	6.56	137.54	266.73	40.07	2266.84	73.21	210.75	249264
35	5.00	152.87	285.39	43.60	2418.97	83.16	236.03	249264

(continued)

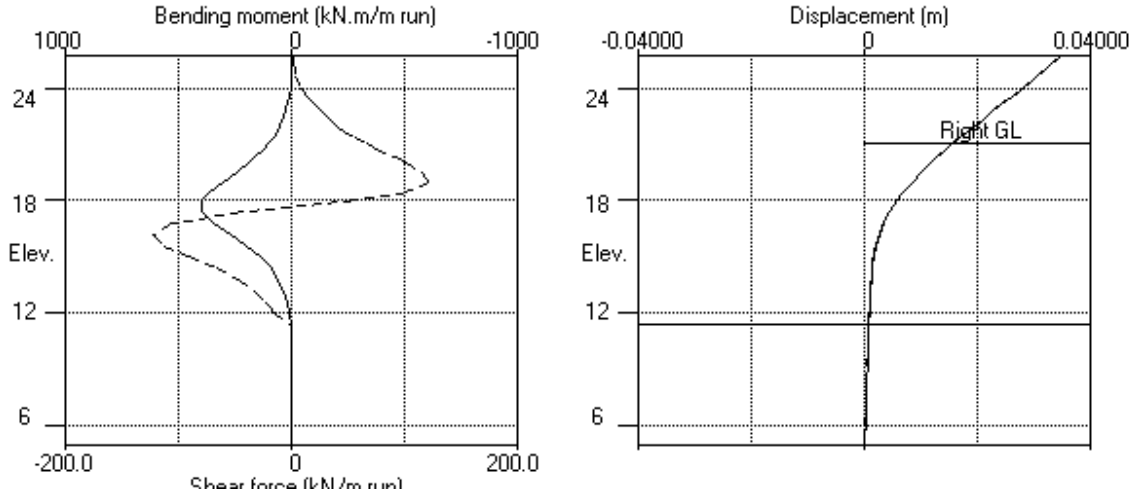
Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

RIGHT side

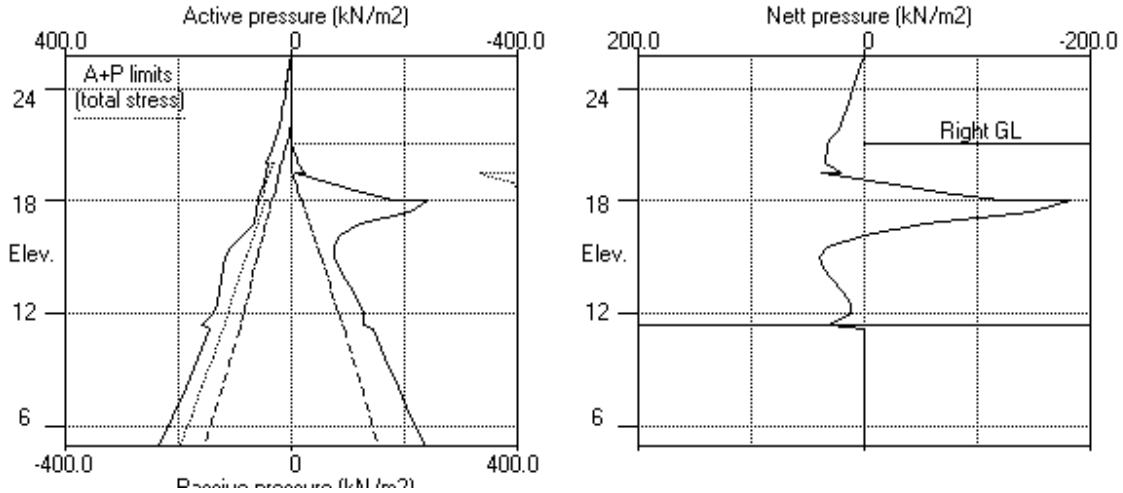
Node no.	Y coord	Water press.	Effective stresses Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.19	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	1190.00	0.00	0.00a	199503
13	20.73	Total>	6.32	2.65w	1196.32	2.65	2.65a	199503
14	20.17	Total>	19.42	8.14w	1209.42	8.14	8.14a	199503
15	20.00	Total>	23.40	9.81w	1213.40	9.81	9.81a	199503
16	19.50	Total>	35.12	14.71w	1225.12	23.90	23.90	199503
		0.00	35.12	6.03	336.23	6.79	6.79	99751
17	19.00	5.56	40.57	6.97	388.51	59.70	65.26	99751
18	18.50	11.12	46.05	7.91	440.91	111.42	122.54	99751
19	18.00	16.68	51.54	8.85	493.47	163.40	180.08	99751
		16.68	51.54	0.00	511.86	225.90	242.59	249378
20	17.40	23.36	58.15	0.62	565.78	187.11	210.46	249378
21	16.80	30.03	64.79	1.87	619.94	91.22	121.25	249378
22	16.20	36.70	71.46	3.14	674.38	48.46	85.16	249378
23	15.60	43.37	78.18	4.41	729.12	30.72	74.10	249378
24	15.00	50.05	84.93	5.68	784.18	26.50	76.54	249378
25	14.40	56.72	91.72	6.97	839.57	28.74	85.45	249378
26	13.80	63.39	98.55	8.26	895.31	33.51	96.90	249378
27	13.20	70.07	105.43	9.56	951.39	38.67	108.73	249378
28	12.60	76.74	112.35	10.87	1007.81	43.01	119.75	249378
29	12.00	83.41	119.31	12.19	1064.56	44.63	128.04	249378
30	11.40	90.08	126.31	13.51	1121.64	36.89	126.97	249378
31	11.25	91.56	128.26	13.88	1137.57	52.53	144.08	249378
32	9.69	106.88	148.74	17.75	1304.55	59.22	166.10	249378
33	8.13	122.21	169.43	21.67	1473.32	65.96	188.17	249378
34	6.56	137.54	190.30	25.61	1643.52	73.20	210.74	249378
35	5.00	152.87	211.30	29.59	1814.77	83.45	236.32	249378

Note: 9.81 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
2	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
3	25.70	19.50	Cant.	1.624	12.28	14.00	5.50	L to R
4	25.70	21.00	Cant.	5.212	11.91	19.57	1.43	L to R
5	25.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	25.70	0.035	0.000	0	-0	0	-0	0	0	0	0
2	25.15	0.033	0.000	0	-0	0	-0	1	-0	1	-1
3	24.60	0.031	0.000	2	-0	2	-1	4	-1	5	-2
4	24.00	0.028	0.000	5	-1	7	-2	9	-2	12	-2
5	23.58	0.026	0.000	10	-2	14	-3	14	-2	19	-3
6	23.19	0.025	0.000	16	-3	22	-4	19	-2	25	-3
7	22.80	0.023	0.000	25	-4	33	-5	25	-2	33	-3
8	22.40	0.022	0.000	36	-5	49	-6	32	-3	43	-4
9	22.00	0.020	0.000	50	-6	68	-7	44	-3	59	-4
10	21.70	0.019	0.000	63	-6	86	-8	54	-3	73	-4
11	21.35	0.017	0.000	83	-7	112	-10	67	-3	91	-5
12	21.00	0.016	0.000	109	-8	147	-11	82	-3	111	-4
13	20.73	0.015	0.000	133	-9	179	-12	94	-2	127	-2
14	20.17	0.013	0.000	184	-9	248	-12	104	0	141	0
15	20.00	0.012	0.000	197	-8	266	-11	102	0	137	0
16	19.50	0.010	0.000	244	-7	330	-10	119	0	161	0
17	19.00	0.009	0.000	303	-5	409	-7	126	0	169	0
18	18.50	0.007	0.000	361	-3	488	-4	106	0	143	0
19	18.00	0.006	0.000	404	0	546	0	60	0	80	0
20	17.40	0.005	0.000	405	0	546	0	2	-46	3	-63
21	16.80	0.004	0.000	350	0	473	0	0	-107	0	-145
22	16.20	0.003	0.000	276	0	373	0	0	-124	0	-167
23	15.60	0.002	0.000	202	0	273	0	0	-113	0	-153
24	15.00	0.002	0.000	140	0	189	0	0	-91	0	-123
25	14.40	0.002	0.000	93	0	125	0	0	-67	0	-91
26	13.80	0.001	0.000	59	0	80	0	0	-48	0	-65
27	13.20	0.001	0.000	35	0	48	0	0	-33	0	-45
28	12.60	0.001	0.000	19	0	26	0	0	-23	0	-32
29	12.00	0.001	0.000	7	0	10	0	0	-16	0	-21
30	11.40	0.001	0.000	0	-0	0	-0	0	-2	0	-3
31	11.25	0.001	0.000	0	0	0	0	0	-0	0	-0
32	9.69	0.001	0.000	0	0	0	0	0	-0	0	-0
33	8.13	0.000	0.000	0	0	0	0	0	-0	0	-0
34	6.56	0.000	0.000	0	0	0	0	0	-0	0	-0
35	5.00	0.000	0.000	0	0	0	0	0	-0	0	-0

Summary of results (continued)

Calculated Bending Moments and Prop 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					
no.	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	3	16.80	-9	20.17	5	-12	7	18.00	-3	21.35	10	-5
2	6	17.40	-8	20.73	8	-11	8	18.00	-2	21.35	11	-3
3	405	17.40	0	25.70	546	0	126	19.00	-124	16.20	169	-167
4	403	18.00	-0	25.70	544	-0	120	19.00	-122	16.20	162	-165
5	No calculation at this stage											
6	No calculation at this stage											
7	No calculation at this stage											
8	396	18.00	-0	25.70	535	-0	112	19.00	-120	16.20	151	-163

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.000	21.35	0.000	25.70	Apply water pressure profile no.1
2	0.000	25.70	0.000	25.70	Apply surcharge no.1 at elev. 25.70
3	0.035	25.70	0.000	25.70	Excav. to elev. 19.50 on RIGHT side
4	0.035	25.70	0.000	25.70	Fill to elev. 21.00 on RIGHT side
5	No calculation at this stage				Install prop no.4 at elev. 20.17
6	No calculation at this stage				Install prop no.3 at elev. 20.73
7	No calculation at this stage				Install prop no.2 at elev. 23.58
8	0.035	25.70	0.000	25.70	Apply water pressure profile no.3

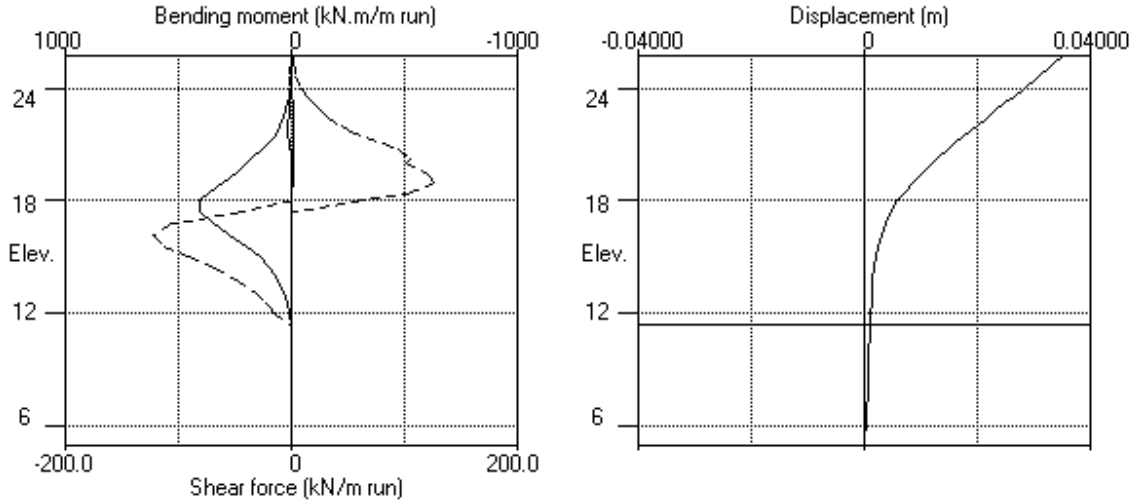
Summary of results (continued)

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

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 2 at elev. 23.58			Prop no. 3 at elev. 20.73			Prop no. 4 at elev. 20.17		
	--Calculated-- kN per m run	kN per prop	Factored kN per prop	--Calculated-- kN per m run	kN per prop	Factored kN per prop	--Calculated-- kN per m run	kN per prop	Factored kN per prop
8	7	7	10	15	15	20	27	27	37

Bending moment, shear force, displacement envelopes



FOUNDATION PILING LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
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Data filename/Run ID: 21-1182_E2_Cant_750-900_ULS2 |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
| Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	25.70	1 Fill	1 Fill
2	21.70	2 Alluvial Gravel	2 Alluvial Gravel
3	20.00	3 Weath Sandstone	3 Weath Sandstone
4	18.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES (Unfactored SLS soil strengths)
Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

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	22.00	22.00	0.0	1	19.50	19.50	0.0	MC
2	1	23.00	23.00	0.0	1	19.00	19.00	0.0	WC
3	1	24.00	24.00	0.0	1	19.00	19.00	0.0	MC
4	1	24.90	24.90	0.0	1	19.50	19.50	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 11.40
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.017300 m4/m run
E.I = 484400 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

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	25.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.30 Var

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 water pressure profile no.2 (Worst Cred.)
2	Apply surcharge no.1 at elevation 25.70
3	Excavate to elevation 19.00 on RIGHT side
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Install strut or anchor no.4 at elevation 20.17
6	Install strut or anchor no.3 at elevation 20.73
7	Install strut or anchor no.2 at elevation 23.58
8	Apply water pressure profile no.4 (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 = 5.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

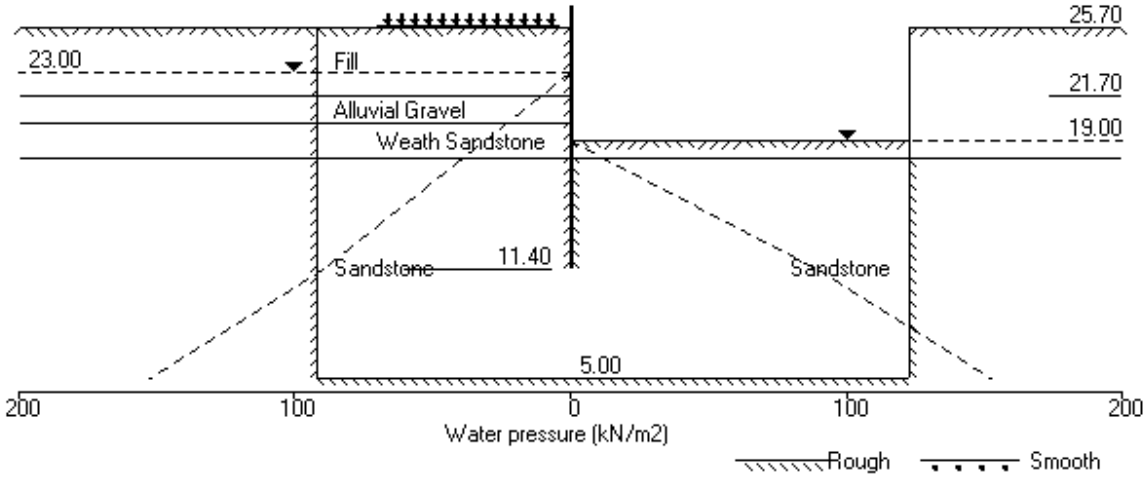
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.2	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.70	Yes	Yes	Yes
3	Excav. to elev. 19.00 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	No	No	No
5	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
6	Install prop no.3 at elev. 20.73	No	No	No
7	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
8	Apply water pressure profile no.4	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 19.00 on RIGHT side



FOUNDATION PILING LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
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Data filename/Run ID: 21-1182_E2_Cant_750-900_ULS2 |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
| Checked :

Units: kN,m

Stage No. 3 Excavate to elevation 19.00 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr-ation	Direction of failure
3	25.70	19.00	Cant.	1.126	12.18	12.67	6.33	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	25.70	0.00	0.117	1.14E-02	0.0	-0.0	
2	25.30	2.60	0.112	1.14E-02	0.5	0.1	
3	24.90	5.58	0.107	1.14E-02	2.2	0.7	
4	24.57	8.18	0.104	1.14E-02	4.4	1.7	
5	24.24	10.75	0.100	1.14E-02	7.6	3.7	
6	23.91	13.25	0.096	1.14E-02	11.5	6.9	
7	23.58	15.66	0.092	1.14E-02	16.3	11.5	
8	23.00	19.69	0.086	1.14E-02	26.5	23.8	
9	22.50	25.62	0.080	1.14E-02	37.8	39.8	
10	22.00	31.48	0.074	1.13E-02	52.1	62.2	
11	21.70	34.97	0.071	1.13E-02	62.1	79.3	
12	21.35	39.02	0.067	1.12E-02	75.0	103.2	
13	21.00	43.04	0.063	1.11E-02	89.4	132.0	
14	20.73	46.13	0.060	1.10E-02	101.4	157.7	
15	20.17	52.53	0.054	1.08E-02	129.0	222.1	
16	20.00	54.46	0.052	1.07E-02	138.1	244.8	
		44.13	0.052	1.07E-02	138.1	244.8	
17	19.50	49.66	0.047	1.04E-02	161.6	319.4	
18	19.00	55.19	0.041	1.01E-02	187.8	406.6	
19	18.50	24.61	0.036	9.63E-03	207.7	506.8	
20	18.00	-6.02	0.032	9.06E-03	212.4	613.6	
		-60.30	0.032	9.06E-03	212.4	613.6	
21	17.40	-92.68	0.027	8.22E-03	166.5	730.1	
22	16.80	-125.17	0.022	7.27E-03	101.1	813.1	
23	16.20	-157.82	0.018	6.24E-03	16.2	851.0	
24	15.60	-190.67	0.014	5.20E-03	-88.3	832.1	
25	15.00	-124.76	0.012	4.22E-03	-182.9	744.6	
26	14.40	-42.61	0.009	3.38E-03	-233.1	612.1	
27	13.80	1.64	0.008	2.71E-03	-245.4	464.3	
28	13.20	34.45	0.006	2.23E-03	-234.6	317.1	

(continued)

Stage No.3 Excavate to elevation 19.00 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
29	12.60	65.87	0.005	1.92E-03	-204.5	182.3	
30	12.00	110.77	0.004	1.76E-03	-151.5	71.2	
31	11.40	316.04	0.003	1.72E-03	-23.5	-0.0	
32	11.25	0.24	0.003	0	0.2	0.0	
33	9.69	0.02	0.002	0	0.5	0.0	
34	8.13	0.02	0.001	0	0.5	0.0	
35	6.56	0.02	0.001	0	0.5	0.0	
36	5.00	-0.39	0.000	0	0.2	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.30	0.00	7.55	2.59	25.38	2.60	2.60a	12463
3	24.90	0.00	16.25	5.58	54.62	5.58	5.58a	12463
4	24.57	0.00	23.84	8.18	80.10	8.18	8.18a	12463
5	24.24	0.00	31.33	10.75	105.26	10.75	10.75a	12463
6	23.91	0.00	38.58	13.24	129.65	13.25	13.25a	12463
7	23.58	0.00	45.61	15.66	153.25	15.66	15.66a	12463
8	23.00	0.00	57.35	19.68	192.70	19.69	19.69a	12463
9	22.50	3.88	63.33	21.74	212.80	21.74	25.62a	12463
10	22.00	7.77	69.08	23.71	232.13	23.71	31.48a	12463
11	21.70	10.10	72.45	24.87	243.44	24.87	34.97a	12463
		10.10	72.45	24.87	243.46	24.87	34.97	29912
12	21.35	12.81	76.32	26.20	256.45	26.20	39.02a	29912
13	21.00	15.53	80.13	27.50	269.25	27.51	43.04a	29912
14	20.73	17.63	83.03	28.50	279.02	28.51	46.13a	29912
15	20.17	21.98	88.98	30.54	299.00	30.55	52.53a	29912
16	20.00	23.30	90.77	31.16	305.01	31.16	54.46a	29912
		23.30	90.77	20.82	539.83	20.83	44.13	99705
17	19.50	27.18	97.98	22.47	582.75	22.48	49.66	99705
18	19.00	31.07	105.15	24.11	625.36	24.12	55.19	99705
19	18.50	34.95	112.27	25.75	667.70	25.75	60.70	99705
20	18.00	38.83	119.35	27.37	709.83	27.38	66.21	99705
		38.83	119.35	20.19	679.94	20.21	59.04	249264
21	17.40	43.49	127.81	22.30	724.29	22.32	65.81	249264
22	16.80	48.15	136.24	24.41	768.45	24.42	72.57	249264
23	16.20	52.81	144.63	26.50	812.47	26.51	79.32	249264
24	15.60	57.47	153.01	28.59	856.37	28.60	86.07	249264
25	15.00	62.13	161.36	30.68	900.18	30.68	92.81a	249264
26	14.40	66.79	169.71	32.76	943.91	32.77	99.55a	249264
27	13.80	71.45	178.04	34.84	987.59	34.84	106.29a	249264
28	13.20	76.11	186.37	36.92	1031.24	46.80	122.91	249264
29	12.60	80.77	194.69	39.00	1074.85	63.28	144.05	249264
30	12.00	85.43	203.00	41.08	1118.45	108.32	193.75	249264
31	11.40	90.09	211.32	43.15	1162.04	316.04	406.13	249264
32	11.25	91.56	213.09	43.59	1171.33	32.29	123.85A	249264
33	9.69	106.89	231.56	48.20	1268.13	41.04	147.93A	249264
34	8.13	122.22	250.04	52.82	1365.00	48.75	170.96A	249264
35	6.56	137.54	268.54	57.44	1462.02	58.52	196.06	249264
36	5.00	152.87	287.08	62.06	1559.18	74.24	227.11	249264

(continued)

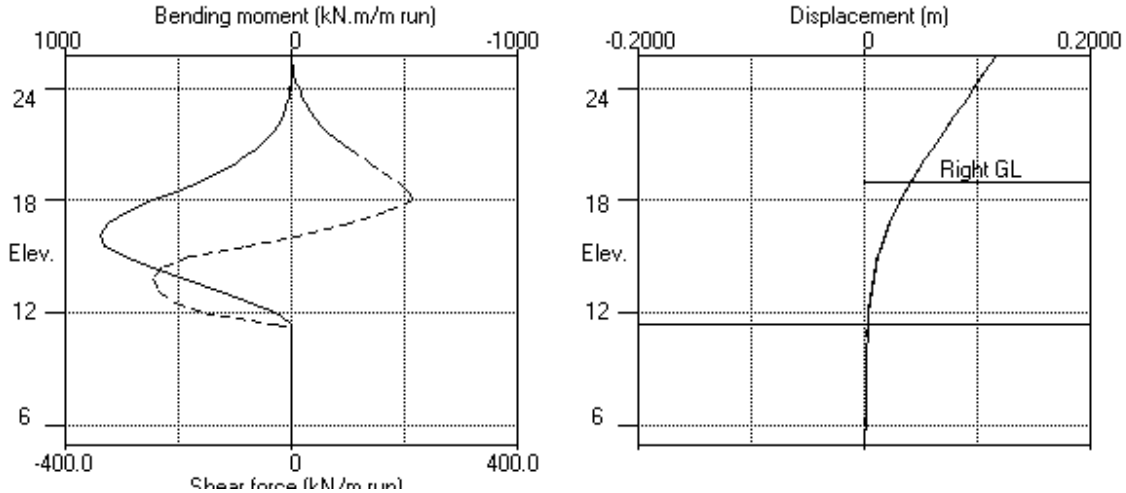
Stage No.3 Excavate to elevation 19.00 on RIGHT side

RIGHT side

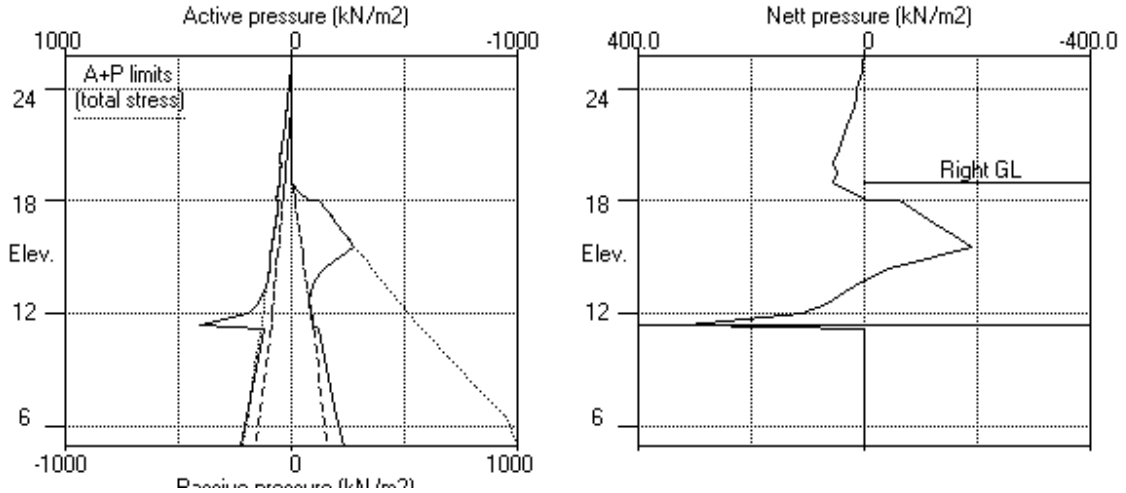
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.57	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	24.24	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	19.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	19.00	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	99787
19	18.50	5.93	5.07	1.16	30.18	30.17	36.09	99787
20	18.00	11.85	10.15	2.33	60.38	60.37	72.23	99787
		11.85	10.15	0.00	107.52	107.49	119.35	249469
21	17.40	18.97	16.26	0.00	139.54	139.52	158.48	249469
22	16.80	26.08	22.39	0.00	171.67	171.66	197.74	249469
23	16.20	33.19	28.55	0.00	203.96	203.95	237.14	249469
24	15.60	40.30	34.75	0.00	236.45	236.44	276.74	249469
25	15.00	47.41	40.99	0.63	269.16	170.15	217.57	249469
26	14.40	54.53	47.28	2.20	302.13	87.64	142.17	249469
27	13.80	61.64	53.62	3.78	335.37	43.01	104.65	249469
28	13.20	68.75	60.02	5.38	368.92	19.70	88.46	249469
29	12.60	75.86	66.48	6.99	402.77	2.32	78.18A	249469
30	12.00	82.98	73.00	8.62	436.95	0.00	82.98A	249469
31	11.40	90.09	79.58	10.26	471.45	0.00	90.09A	249469
32	11.25	91.56	81.54	10.75	481.73	32.05	123.61	249469
33	9.69	106.89	102.20	15.91	590.03	41.02	147.91	249469
34	8.13	122.22	123.25	21.16	700.38	48.73	170.94	249469
35	6.56	137.54	144.64	26.50	812.50	58.50	196.05	249469
36	5.00	152.87	166.31	31.91	926.08	74.62	227.49	249469

Note: 106.29 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
90.09A Arching - soil pressure below active limit

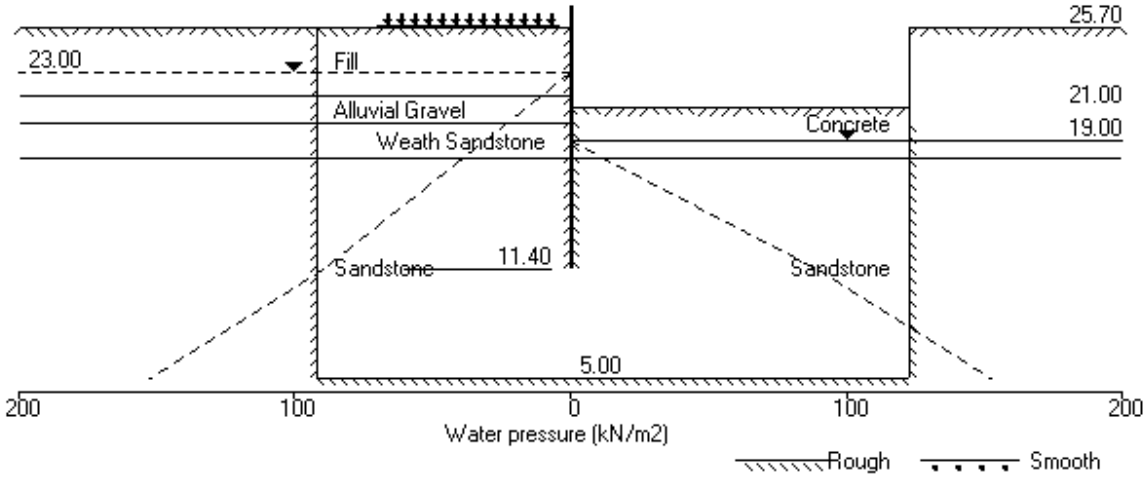
Stage No.3 Excav. to elev. 19.00 on RIGHT side



Stage No.3 Excav. to elev. 19.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
4	25.70	21.00	Cant.	4.327	11.91	19.48	1.52	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries:	Left side 15.00 from wall	Rough boundary
	Right side 20.00 from wall	Rough boundary
Lower rigid boundary at elevation 5.00		Rough boundary

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	Prop forces kN/m
1	25.70	0.00	0.116	1.14E-02	0.0	-0.0	
2	25.30	3.17	0.112	1.14E-02	0.6	0.1	
3	24.90	6.12	0.107	1.14E-02	2.5	0.7	
4	24.57	8.74	0.103	1.14E-02	5.0	2.0	
5	24.24	11.33	0.099	1.14E-02	8.3	4.1	
6	23.91	13.86	0.096	1.14E-02	12.4	7.6	
7	23.58	16.31	0.092	1.14E-02	17.4	12.5	
8	23.00	20.41	0.085	1.14E-02	28.0	25.5	
9	22.50	26.43	0.079	1.14E-02	39.7	42.4	
10	22.00	32.38	0.074	1.13E-02	54.4	65.9	
11	21.70	36.03	0.070	1.13E-02	64.7	83.7	
		37.51	0.070	1.13E-02	64.7	83.7	
12	21.35	41.29	0.066	1.12E-02	78.5	108.7	
13	21.00	45.36	0.062	1.11E-02	93.6	138.8	
14	20.73	45.97	0.059	1.10E-02	106.0	165.7	
15	20.17	47.07	0.053	1.08E-02	132.0	231.9	
16	20.00	47.76	0.051	1.07E-02	140.1	255.0	
		44.68	0.051	1.07E-02	140.1	255.0	
17	19.50	40.50	0.046	1.04E-02	161.4	330.2	
18	19.00	31.21	0.041	1.00E-02	179.3	415.7	
		52.15	0.041	1.00E-02	179.3	415.7	
19	18.50	22.18	0.036	9.60E-03	197.9	511.2	
20	18.00	-7.67	0.031	9.02E-03	201.5	612.8	
		-42.69	0.031	9.02E-03	201.5	612.8	
21	17.40	-85.07	0.026	8.19E-03	163.2	725.9	
22	16.80	-121.90	0.022	7.24E-03	101.1	808.3	
23	16.20	-156.66	0.018	6.21E-03	17.5	846.8	
24	15.60	-190.59	0.014	5.17E-03	-86.7	828.8	
25	15.00	-125.15	0.011	4.20E-03	-181.4	742.3	
26	14.40	-43.17	0.009	3.36E-03	-231.9	610.7	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	13.80	1.07	0.007	2.70E-03	-244.5	463.5	
28	13.20	33.92	0.006	2.21E-03	-234.0	316.8	
29	12.60	65.40	0.005	1.90E-03	-204.2	182.2	
30	12.00	110.45	0.003	1.75E-03	-151.5	71.2	
31	11.40	316.14	0.002	1.70E-03	-23.5	-0.0	
32	11.25	0.22	0.003	0	0.2	0.0	
33	9.69	0.01	0.002	0	0.4	0.0	
34	8.13	0.01	0.001	0	0.4	0.0	
35	6.56	0.01	0.000	0	0.5	0.0	
36	5.00	-0.30	0.000	0	0.2	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.30	0.00	7.55	2.59	25.38	3.17	3.17	12463
3	24.90	0.00	16.25	5.58	54.62	6.12	6.12	12463
4	24.57	0.00	23.84	8.18	80.10	8.74	8.74	12463
5	24.24	0.00	31.33	10.75	105.26	11.33	11.33	12463
6	23.91	0.00	38.58	13.24	129.65	13.86	13.86	12463
7	23.58	0.00	45.61	15.66	153.25	16.31	16.31	12463
8	23.00	0.00	57.35	19.68	192.70	20.41	20.41	12463
9	22.50	3.88	63.33	21.74	212.80	22.54	26.43	12463
10	22.00	7.77	69.08	23.71	232.13	24.62	32.38	12463
11	21.70	10.10	72.45	24.87	243.44	25.93	36.03	12463
		10.10	72.45	24.87	243.46	27.42	37.51	29912
12	21.35	12.81	76.32	26.20	256.45	28.47	41.29	29912
13	21.00	15.53	80.13	27.50	269.25	29.82	45.36	29912
14	20.73	17.63	83.03	28.50	279.02	30.99	48.61	29912
15	20.17	21.98	88.98	30.54	299.00	33.23	55.21	29912
16	20.00	23.30	90.77	31.16	305.01	34.27	57.57	29912
		23.30	90.77	20.82	539.83	31.19	54.49	99705
17	19.50	27.18	97.98	22.47	582.75	30.79	57.97	99705
18	19.00	31.07	105.15	24.11	625.36	31.82	62.89	99705
19	18.50	34.95	112.27	25.75	667.70	33.19	68.14	99705
20	18.00	38.83	119.35	27.37	709.83	34.94	73.77	99705
		38.83	119.35	20.19	679.94	39.11	77.94	249264
21	17.40	43.49	127.81	22.30	724.29	35.76	79.25	249264
22	16.80	48.15	136.24	24.41	768.45	35.52	83.67	249264
23	16.20	52.81	144.63	26.50	812.47	36.48	89.29	249264
24	15.60	57.47	153.01	28.59	856.37	37.98	95.45	249264
25	15.00	62.13	161.36	30.68	900.18	39.79	101.92	249264
26	14.40	66.79	169.71	32.76	943.91	41.75	108.54	249264
27	13.80	71.45	178.04	34.84	987.59	43.80	115.25	249264
28	13.20	76.11	186.37	36.92	1031.24	55.75	131.86	249264
29	12.60	80.77	194.69	39.00	1074.85	72.24	153.01	249264
30	12.00	85.43	203.00	41.08	1118.45	117.31	202.74	249264
31	11.40	90.09	211.32	43.15	1162.04	325.23	415.32	249264
32	11.25	91.56	213.09	43.59	1171.33	41.38	132.94A	249264
33	9.69	106.89	231.56	48.20	1268.13	50.05	156.94	249264
34	8.13	122.22	250.04	52.82	1365.00	57.63	179.84	249264
35	6.56	137.54	268.54	57.44	1462.02	67.19	204.73	249264
36	5.00	152.87	287.08	62.06	1559.18	81.14	234.01	249264

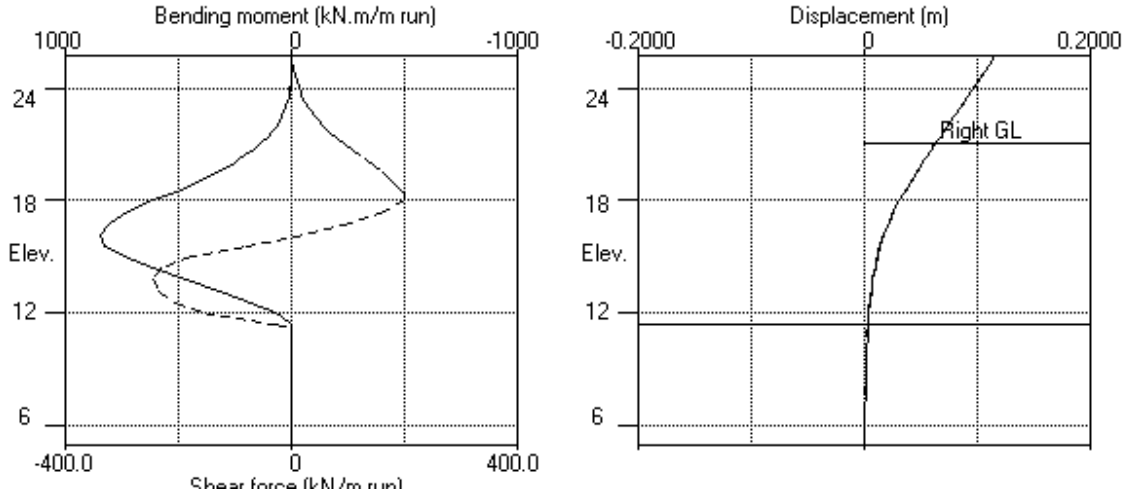
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Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

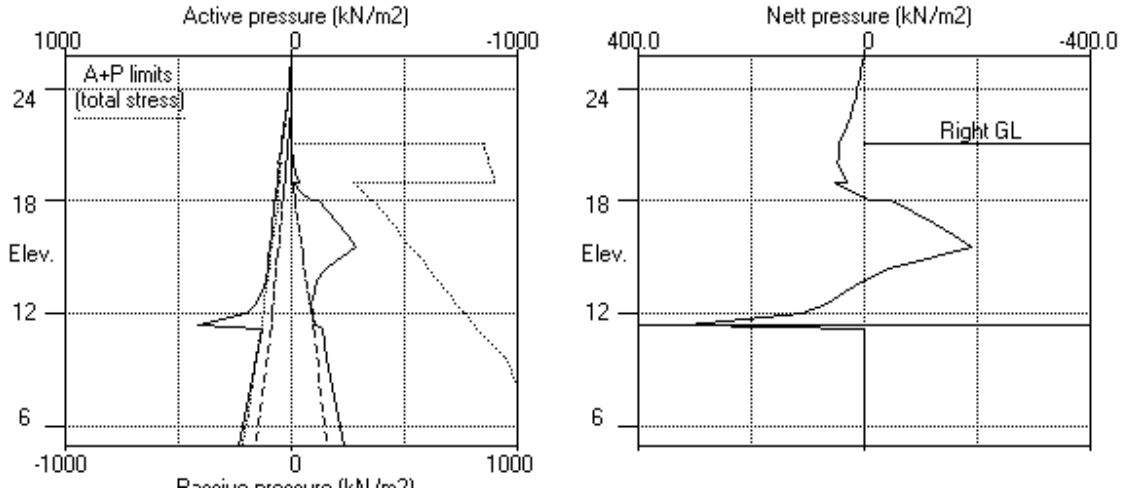
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.57	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	24.24	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	850.00	0.00	0.00a	199503
14	20.73	Total>	6.32	2.65w	856.32	2.65	2.65a	199503
15	20.17	Total>	19.42	8.14w	869.43	8.14	8.14a	199503
16	20.00	Total>	23.40	9.81w	873.41	9.81	9.81a	199503
17	19.50	Total>	35.12	14.71w	885.12	17.48	17.48	199503
18	19.00	Total>	46.84	19.62w	896.85	31.68	31.68	199503
		0.00	46.84	10.74	278.55	10.74	10.74a	99751
19	18.50	5.93	51.94	11.91	308.92	40.04	45.96	99751
20	18.00	11.85	57.06	13.09	339.39	69.59	81.44	99751
		11.85	57.06	4.64	353.43	108.78	120.64	249378
21	17.40	18.97	63.24	6.18	385.78	145.35	164.32	249378
22	16.80	26.08	69.44	7.73	418.29	179.50	205.57	249378
23	16.20	33.19	75.67	9.29	450.98	212.76	245.95	249378
24	15.60	40.30	81.95	10.85	483.86	245.73	286.04	249378
25	15.00	47.41	88.26	12.43	516.95	179.65	227.06	249378
26	14.40	54.53	94.61	14.02	550.26	97.18	151.71	249378
27	13.80	61.64	101.01	15.61	583.78	52.53	114.17	249378
28	13.20	68.75	107.44	17.22	617.52	29.18	97.93	249378
29	12.60	75.86	113.92	18.84	651.48	11.74	87.60A	249378
30	12.00	82.98	120.44	20.46	685.66	9.32	92.30A	249378
31	11.40	90.09	127.00	22.10	720.05	9.09	99.18A	249378
32	11.25	91.56	128.96	22.59	730.29	41.16	132.72	249378
33	9.69	106.89	149.43	27.70	837.62	50.04	156.93	249378
34	8.13	122.22	170.13	32.87	946.10	57.62	179.83	249378
35	6.56	137.54	191.00	38.08	1055.51	67.18	204.73	249378
36	5.00	152.87	212.00	43.32	1165.59	81.45	234.32	249378

Note: 10.74 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
99.18A Arching - soil pressure below active limit

Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
2	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
3	25.70	19.00	Cant.	1.126	12.18	12.67	6.33	L to R
4	25.70	21.00	Cant.	4.327	11.91	19.48	1.52	L to R
5	25.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: ULS DA1 Combination 2

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment		Shear force	
no.	coord	maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	25.70	0.117	0.000	0.0	-0.0	0.0	0.0
2	25.30	0.112	0.000	0.1	-0.0	0.6	-0.5
3	24.90	0.107	0.000	0.8	-0.4	2.5	-1.6
4	24.57	0.104	0.000	2.0	-1.1	5.3	-2.4
5	24.24	0.100	0.000	4.4	-2.0	9.5	-3.0
6	23.91	0.096	0.000	8.5	-3.1	15.2	-3.6
7	23.58	0.092	0.000	14.7	-4.3	22.3	-4.0
8	23.00	0.086	0.000	25.5	-6.9	28.0	-4.7
9	22.50	0.080	0.000	42.4	-9.2	39.7	-4.9
10	22.00	0.074	0.000	65.9	-11.1	57.9	-4.0
11	21.70	0.071	0.000	83.7	-11.7	71.1	-2.8
12	21.35	0.067	0.000	108.7	-12.2	88.4	-2.2
13	21.00	0.063	0.000	142.2	-12.6	107.0	-0.7
14	20.73	0.060	0.000	173.0	-12.5	121.7	0.0
15	20.17	0.054	0.000	239.6	-10.8	135.4	0.0
16	20.00	0.052	0.000	260.7	-9.7	140.1	0.0
17	19.50	0.047	0.000	331.4	-7.1	161.6	0.0
18	19.00	0.041	0.000	415.7	-4.6	187.8	0.0
19	18.50	0.036	0.000	511.2	-1.0	207.7	0.0
20	18.00	0.032	0.000	613.6	0.0	212.4	0.0
21	17.40	0.027	0.000	730.1	0.0	166.5	0.0
22	16.80	0.022	0.000	813.1	0.0	101.9	-2.0
23	16.20	0.018	0.000	851.0	0.0	18.2	-2.8
24	15.60	0.014	0.000	832.1	0.0	0.0	-88.3
25	15.00	0.012	0.000	744.6	0.0	0.0	-182.9
26	14.40	0.009	0.000	612.1	0.0	0.0	-233.1
27	13.80	0.008	0.000	464.3	0.0	0.0	-245.4
28	13.20	0.006	0.000	317.1	0.0	0.0	-234.6
29	12.60	0.005	0.000	182.3	0.0	0.0	-204.5
30	12.00	0.004	0.000	71.3	0.0	0.0	-151.5
31	11.40	0.003	0.000	0.0	-0.0	0.0	-23.5
32	11.25	0.003	0.000	0.0	0.0	0.2	0.0
33	9.69	0.002	0.000	0.0	0.0	0.5	0.0
34	8.13	0.001	0.000	0.0	0.0	0.5	0.0
35	6.56	0.001	0.000	0.0	0.0	0.5	0.0
36	5.00	0.000	0.000	0.0	0.0	0.2	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	6.4	17.40	-12.6	21.00	10.4	18.00	-4.9	22.50
2	9.7	17.40	-12.2	21.00	11.2	18.00	-4.7	23.00
3	851.0	16.20	-0.0	25.70	212.4	18.00	-245.4	13.80
4	846.8	16.20	-0.0	25.70	201.5	18.00	-244.5	13.80
5	No calculation at this stage							
6	No calculation at this stage							
7	No calculation at this stage							
8	845.6	16.20	-0.0	25.70	201.7	18.00	-244.3	13.80

Maximum and minimum displacement at each stage

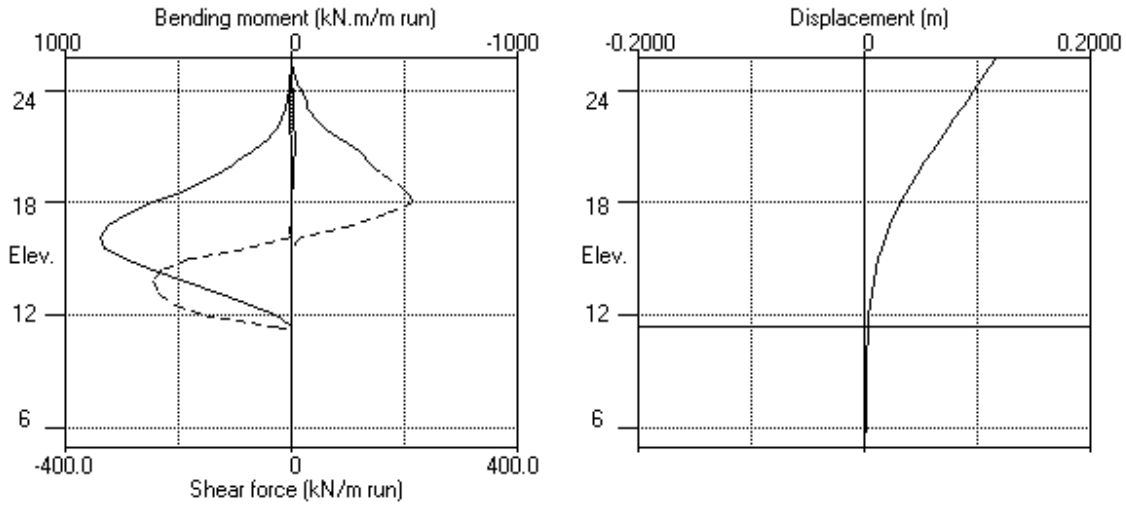
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.001	22.50	0.000	25.70	Apply water pressure profile no.2
2	0.001	25.70	0.000	25.70	Apply surcharge no.1 at elev. 25.70
3	0.117	25.70	0.000	25.70	Excav. to elev. 19.00 on RIGHT side
4	0.116	25.70	0.000	25.70	Fill to elev. 21.00 on RIGHT side
5	No calculation at this stage				Install prop no.4 at elev. 20.17
6	No calculation at this stage				Install prop no.3 at elev. 20.73
7	No calculation at this stage				Install prop no.2 at elev. 23.58
8	0.116	25.70	0.000	25.70	Apply water pressure profile no.4

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	Strut no. 2 at elev. 23.58		Strut no. 3 at elev. 20.73		Strut no. 4 at elev. 20.17	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
8	16.75	16.75	17.80	17.80	16.24	16.24

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	25.70	1 Fill	1 Fill
2	22.50	2 Alluvial Gravel	2 Alluvial Gravel
3	21.00	3 Weath Sandstone	3 Weath Sandstone
4	19.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES

Soil Properties File = 21-1182_Soils__SLS.dat

-- 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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

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	22.00	22.00	0.0	1	19.90	19.90	0.0	MC
2	1	23.00	23.00	0.0	1	19.40	19.40	0.0	WC
3	1	24.00	24.00	0.0	1	19.90	19.90	0.0	MC
4	1	24.90	24.90	0.0	1	19.90	19.90	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 12.40
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.038200 m4/m run
E.I = 1.0696E+06 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	25.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.00 Var
2	19.60	7.00(L)	50.00	1.00	600.00	=	N/A	1.00 P/U

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 water pressure profile no.1 (Mod. Conserv.)
2	Apply surcharge no.1 at elevation 25.70
3	Apply surcharge no.2 at elevation 19.60
4	Excavate to elevation 19.90 on RIGHT side
5	Fill to elevation 21.00 on RIGHT side with soil type 5
6	Install strut or anchor no.4 at elevation 20.17
7	Install strut or anchor no.3 at elevation 20.73
8	Install strut or anchor no.2 at elevation 23.58
9	Apply water pressure profile no.3 (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 = 1.25

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

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

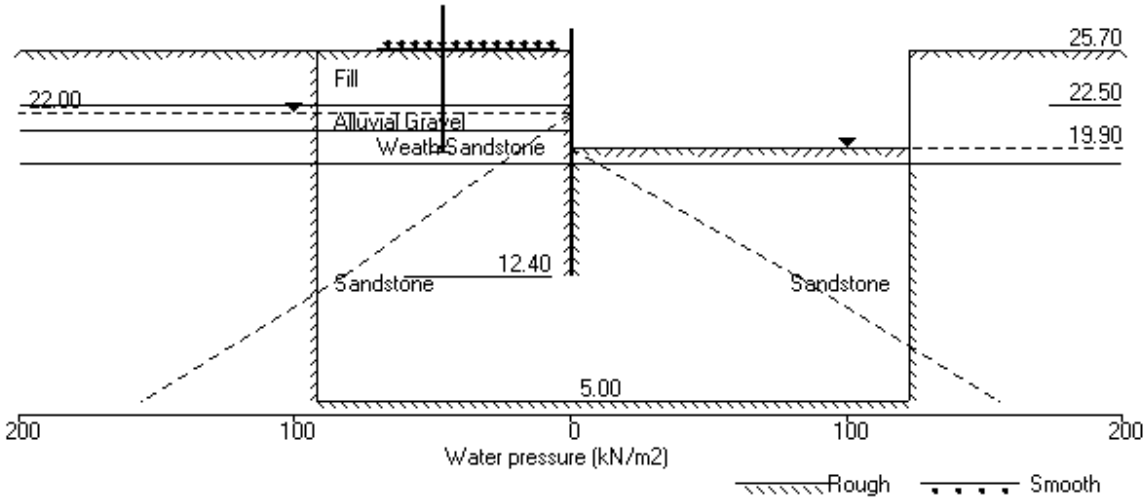
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.1	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.70	Yes	Yes	Yes
3	Apply surcharge no.2 at elev. 19.60	Yes	Yes	Yes
4	Excav. to elev. 19.90 on RIGHT side	Yes	Yes	Yes
5	Fill to elev. 21.00 on RIGHT side	No	No	No
6	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
7	Install prop no.3 at elev. 20.73	No	No	No
8	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
9	Apply water pressure profile no.3	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.4 Excav. to elev. 19.90 on RIGHT side



Units: kN,m

Stage No. 4 Excavate to elevation 19.90 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 12.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
4	25.70	19.90	Cant.	1.682	13.11	15.17	4.73	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
Limit State: Serviceability Limit State
Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.70	0.00	0.013	1.50E-03	0.0	0.0	
2	25.15	2.87	0.012	1.50E-03	0.8	0.3	
3	24.60	6.11	0.011	1.50E-03	3.3	1.4	
4	24.00	9.61	0.010	1.50E-03	8.0	4.8	
5	23.58	11.99	0.010	1.50E-03	12.6	9.2	
6	23.04	14.91	0.009	1.49E-03	19.8	18.0	
7	22.50	17.75	0.008	1.48E-03	28.6	31.0	
8	22.00	20.34	0.007	1.46E-03	38.1	47.7	
9	21.50	26.03	0.007	1.43E-03	49.7	69.5	
10	21.00	31.69	0.006	1.40E-03	64.1	97.9	
		23.12	0.006	1.40E-03	64.1	97.9	
11	20.73	26.08	0.006	1.37E-03	70.8	116.1	
12	20.17	32.22	0.005	1.30E-03	87.1	160.2	
13	19.90	35.17	0.005	1.25E-03	96.2	184.9	
14	19.60	3.59	0.004	1.20E-03	102.0	215.3	
15	19.00	-59.61	0.003	1.06E-03	85.2	277.1	
		-145.58	0.003	1.06E-03	85.2	277.1	
16	18.50	-119.26	0.003	9.28E-04	19.0	301.4	
17	18.00	-66.10	0.003	7.88E-04	-27.4	296.0	
18	17.40	-35.05	0.002	6.30E-04	-57.7	267.6	
19	16.80	-14.30	0.002	4.91E-04	-72.5	226.7	
20	16.20	5.19	0.002	3.77E-04	-75.2	180.6	
21	15.60	14.25	0.001	2.88E-04	-69.4	136.4	
22	15.00	17.21	0.001	2.23E-04	-60.0	97.3	
23	14.40	17.14	0.001	1.77E-04	-49.7	64.4	
24	13.80	16.49	0.001	1.49E-04	-39.6	37.7	
25	13.20	17.28	0.001	1.33E-04	-29.4	17.0	
26	12.80	24.04	0.001	1.29E-04	-21.2	6.6	
27	12.40	59.52	0.001	1.28E-04	-4.5	0.0	

(continued)

Stage No.4 Excavate to elevation 19.90 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	12.25	-0.24	0.001	0	-0.0	0.0	
29	10.93	0.11	0.001	0	-0.1	0.0	
30	9.60	0.20	0.001	0	0.1	0.0	
31	7.30	0.15	0.000	0	0.5	0.0	
32	5.00	-0.58	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12465
2	25.15	0.00	10.51	2.87	48.72	2.87	2.87a	12465
3	24.60	0.00	22.36	6.11	103.58	6.11	6.11a	12465
4	24.00	0.00	35.18	9.61	163.00	9.61	9.61a	12465
5	23.58	0.00	43.91	11.99	203.45	11.99	11.99a	12465
6	23.04	0.00	54.60	14.91	252.96	14.91	14.91a	12465
7	22.50	0.00	64.99	17.75	301.14	17.75	17.75a	12465
		0.00	64.99	17.75	301.16	17.75	17.75a	29917
8	22.00	0.00	74.48	20.34	345.13	20.34	20.34a	29917
9	21.50	4.30	79.54	21.73	368.57	21.73	26.03a	29917
10	21.00	8.61	84.50	23.08	391.55	23.08	31.69a	29917
		8.61	84.50	14.51	809.11	14.51	23.12a	99723
11	20.73	10.93	88.23	15.15	844.79	15.15	26.08a	99723
12	20.17	15.75	95.89	16.47	918.21	16.47	32.22a	99723
13	19.90	18.07	99.57	17.10	953.37	17.10	35.17a	99723
14	19.60	20.65	103.63	17.80	992.29	17.80	38.45a	99723
15	19.00	25.82	111.77	19.20	1070.21	19.20	45.01a	99723
		25.82	111.77	10.76	1003.07	10.76	36.58a	249307
16	18.50	30.12	118.73	12.08	1059.83	12.08	42.20a	249307
17	18.00	34.42	126.00	13.45	1119.15	13.45	47.87a	249307
18	17.40	39.58	135.26	15.20	1194.68	15.20	54.79a	249307
19	16.80	44.75	145.13	17.07	1275.12	18.78	63.53	249307
20	16.20	49.91	155.51	19.03	1359.78	30.54	80.45	249307
21	15.60	55.07	166.25	21.07	1447.42	37.66	92.73	249307
22	15.00	60.24	177.18	23.13	1536.55	42.11	102.34	249307
23	14.40	65.40	188.12	25.20	1625.77	45.28	110.68	249307
24	13.80	70.56	198.93	27.25	1713.92	48.30	118.86	249307
25	13.20	75.73	209.51	29.25	1800.17	52.14	127.86	249307
26	12.80	79.17	216.40	30.55	1856.34	57.69	136.86	249307
27	12.40	82.61	223.14	31.83	1911.35	78.86	161.47	249307
28	12.25	84.08	225.45	32.26	1930.20	48.39	132.47	249307
29	10.93	97.08	244.97	35.95	2089.37	55.03	152.11	249307
30	9.60	110.08	263.02	39.37	2236.57	61.13	171.21	249307
31	7.30	132.64	291.78	44.81	2471.08	71.56	204.20	249307
32	5.00	155.20	318.56	49.87	2689.52	85.58	240.78	249307

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

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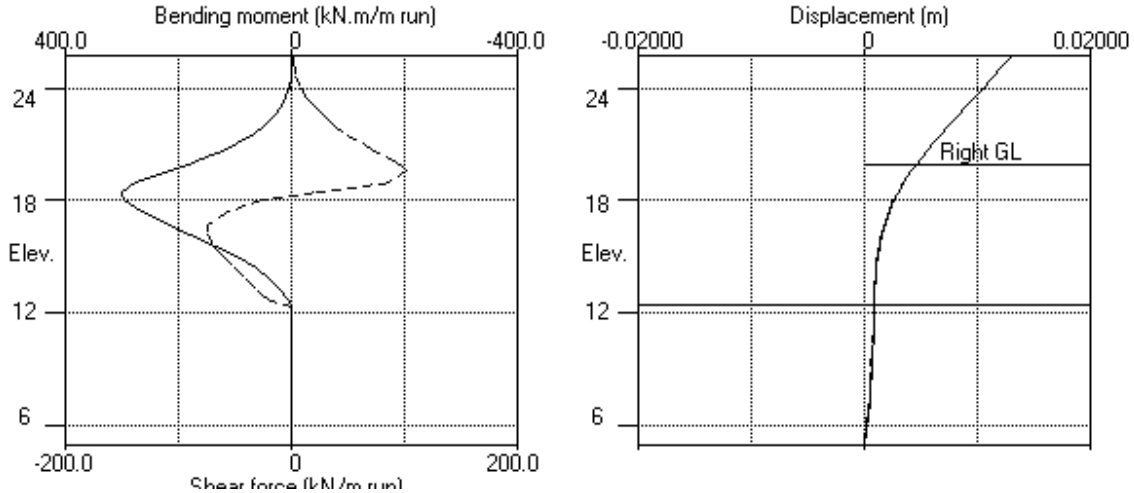
Stage No.4 Excavate to elevation 19.90 on RIGHT side

RIGHT side

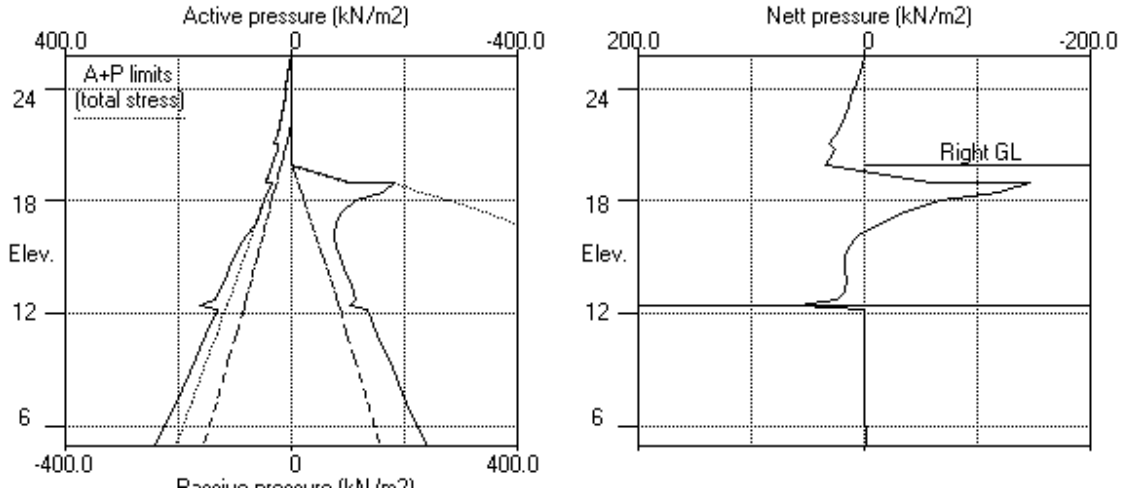
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	19.90	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	99789
14	19.60	3.30	3.30	0.57	31.56	31.56	34.86p	99789
15	19.00	9.91	9.89	1.70	94.71	94.71	104.62p	99789
		9.91	9.89	0.00	172.24	172.24	182.16p	249471
16	18.50	15.42	15.40	0.00	217.13	146.04	161.46	249471
17	18.00	20.93	20.91	0.00	262.12	93.05	113.97	249471
18	17.40	27.54	27.55	0.00	316.27	62.30	89.83	249471
19	16.80	34.15	34.22	0.00	370.66	43.68	77.83	249471
20	16.20	40.75	40.93	0.00	425.34	34.50	75.26	249471
21	15.60	47.36	47.67	0.00	480.35	31.12	78.48	249471
22	15.00	53.97	54.46	0.00	535.72	31.16	85.14	249471
23	14.40	60.58	61.30	1.21	591.48	32.95	93.53	249471
24	13.80	67.19	68.19	2.52	647.66	35.18	102.37	249471
25	13.20	73.80	75.13	3.83	704.27	36.79	110.58	249471
26	12.80	78.20	79.79	4.71	742.25	34.62	112.82	249471
27	12.40	82.61	84.47	5.60	780.43	19.33	101.94	249471
28	12.25	84.08	86.41	5.96	796.27	48.63	132.71	249471
29	10.93	97.08	103.71	9.24	937.39	54.92	152.00	249471
30	9.60	110.08	121.27	12.56	1080.55	60.94	171.02	249471
31	7.30	132.64	152.26	18.42	1333.29	71.40	204.05	249471
32	5.00	155.20	183.76	24.38	1590.19	86.16	241.37	249471

Note: 54.79 a Soil pressure at active limit
182.16 p Soil pressure at passive limit

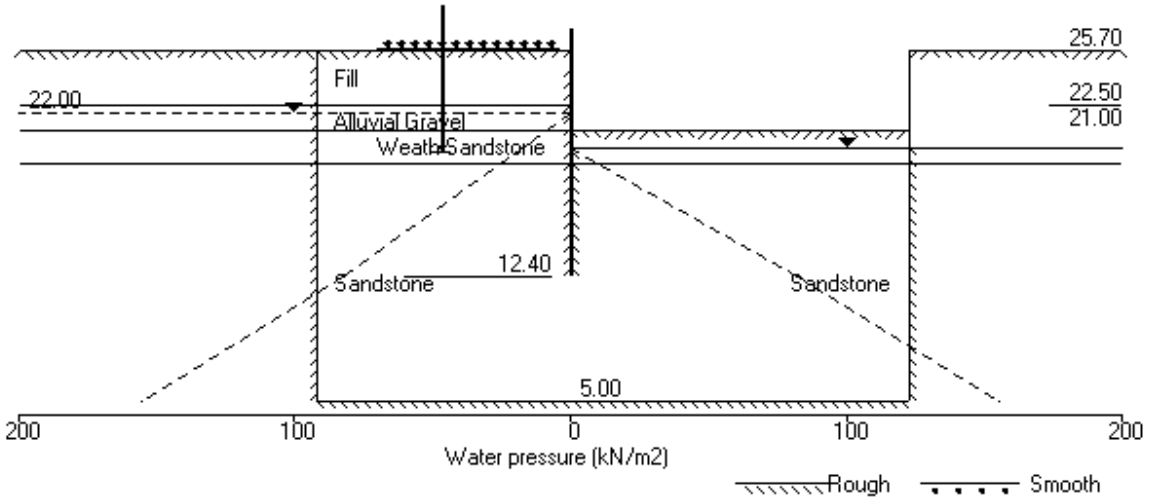
Stage No.4 Excav. to elev. 19.90 on RIGHT side



Stage No.4 Excav. to elev. 19.90 on RIGHT side



Stage No.5 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 5 Fill to elevation 21.00 on RIGHT side with soil type 5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 12.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
5	25.70	21.00	Cant.	4.406	12.75	19.78	1.22	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.70	0.00	0.013	1.51E-03	0.0	0.0	
2	25.15	3.20	0.012	1.51E-03	0.9	0.3	
3	24.60	6.41	0.011	1.51E-03	3.5	1.5	
4	24.00	9.91	0.010	1.51E-03	8.4	5.2	
5	23.58	12.31	0.010	1.50E-03	13.1	9.7	
6	23.04	15.27	0.009	1.50E-03	20.6	18.8	
7	22.50	18.18	0.008	1.48E-03	29.5	32.3	
		18.77	0.008	1.48E-03	29.5	32.3	
8	22.00	21.25	0.007	1.46E-03	39.5	49.6	
9	21.50	26.99	0.007	1.44E-03	51.6	72.3	
10	21.00	32.93	0.006	1.40E-03	66.6	101.8	
		27.27	0.006	1.40E-03	66.6	101.8	
11	20.73	26.71	0.005	1.37E-03	73.9	120.7	
12	20.17	22.94	0.005	1.29E-03	87.8	166.0	
13	19.90	19.24	0.004	1.25E-03	93.5	190.5	
		32.53	0.004	1.25E-03	93.5	190.5	
14	19.60	0.62	0.004	1.19E-03	98.4	219.9	
15	19.00	-61.77	0.003	1.05E-03	80.1	279.0	
		-139.04	0.003	1.05E-03	80.1	279.0	
16	18.50	-116.06	0.003	9.18E-04	16.3	301.7	
17	18.00	-64.20	0.002	7.79E-04	-28.7	295.3	
18	17.40	-33.90	0.002	6.21E-04	-58.2	266.5	
19	16.80	-13.69	0.002	4.83E-04	-72.4	225.5	
20	16.20	5.47	0.001	3.70E-04	-74.9	179.5	
21	15.60	14.30	0.001	2.81E-04	-69.0	135.6	
22	15.00	17.13	0.001	2.16E-04	-59.6	96.8	
23	14.40	16.98	0.001	1.71E-04	-49.3	64.1	
24	13.80	16.29	0.001	1.42E-04	-39.3	37.6	
25	13.20	17.07	0.001	1.27E-04	-29.3	16.9	

(continued)

Stage No.5 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	12.80	23.88	0.001	1.23E-04	-21.1	6.6	
27	12.40	59.49	0.001	1.22E-04	-4.5	0.0	
28	12.25	-0.25	0.001	0	-0.0	0.0	
29	10.93	0.10	0.001	0	-0.1	0.0	
30	9.60	0.17	0.001	0	0.1	0.0	
31	7.30	0.14	0.000	0	0.4	0.0	
32	5.00	-0.50	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12465
2	25.15	0.00	10.51	2.87	48.72	3.20	3.20	12465
3	24.60	0.00	22.36	6.11	103.58	6.41	6.41	12465
4	24.00	0.00	35.18	9.61	163.00	9.91	9.91	12465
5	23.58	0.00	43.91	11.99	203.45	12.31	12.31	12465
6	23.04	0.00	54.60	14.91	252.96	15.27	15.27	12465
7	22.50	0.00	64.99	17.75	301.14	18.18	18.18	12465
		0.00	64.99	17.75	301.16	18.77	18.77	29917
8	22.00	0.00	74.48	20.34	345.13	21.25	21.25	29917
9	21.50	4.30	79.54	21.73	368.57	22.69	26.99	29917
10	21.00	8.61	84.50	23.08	391.55	24.33	32.93	29917
		8.61	84.50	14.51	809.11	18.67	27.27	99723
11	20.73	10.93	88.23	15.15	844.79	18.43	29.36	99723
12	20.17	15.75	95.89	16.47	918.21	19.58	35.33	99723
13	19.90	18.07	99.57	17.10	953.37	20.18	38.25	99723
14	19.60	20.65	103.63	17.80	992.29	20.97	41.62	99723
15	19.00	25.82	111.77	19.20	1070.21	22.61	48.43	99723
		25.82	111.77	10.76	1003.07	19.30	45.12	249307
16	18.50	30.12	118.73	12.08	1059.83	18.81	48.92	249307
17	18.00	34.42	126.00	13.45	1119.15	19.49	53.91	249307
18	17.40	39.58	135.26	15.20	1194.68	20.84	60.43	249307
19	16.80	44.75	145.13	17.07	1275.12	24.14	68.89	249307
20	16.20	49.91	155.51	19.03	1359.78	35.73	85.64	249307
21	15.60	55.07	166.25	21.07	1447.42	42.73	97.81	249307
22	15.00	60.24	177.18	23.13	1536.55	47.11	107.34	249307
23	14.40	65.40	188.12	25.20	1625.77	50.23	115.63	249307
24	13.80	70.56	198.93	27.25	1713.92	53.23	123.79	249307
25	13.20	75.73	209.51	29.25	1800.17	57.05	132.78	249307
26	12.80	79.17	216.40	30.55	1856.34	62.62	141.79	249307
27	12.40	82.61	223.14	31.83	1911.35	83.84	166.45	249307
28	12.25	84.08	225.45	32.26	1930.20	53.37	137.46	249307
29	10.93	97.08	244.97	35.95	2089.37	59.98	157.06	249307
30	9.60	110.08	263.02	39.37	2236.57	66.02	176.10	249307
31	7.30	132.64	291.78	44.81	2471.08	76.31	208.95	249307
32	5.00	155.20	318.56	49.87	2689.52	89.47	244.67	249307

(continued)

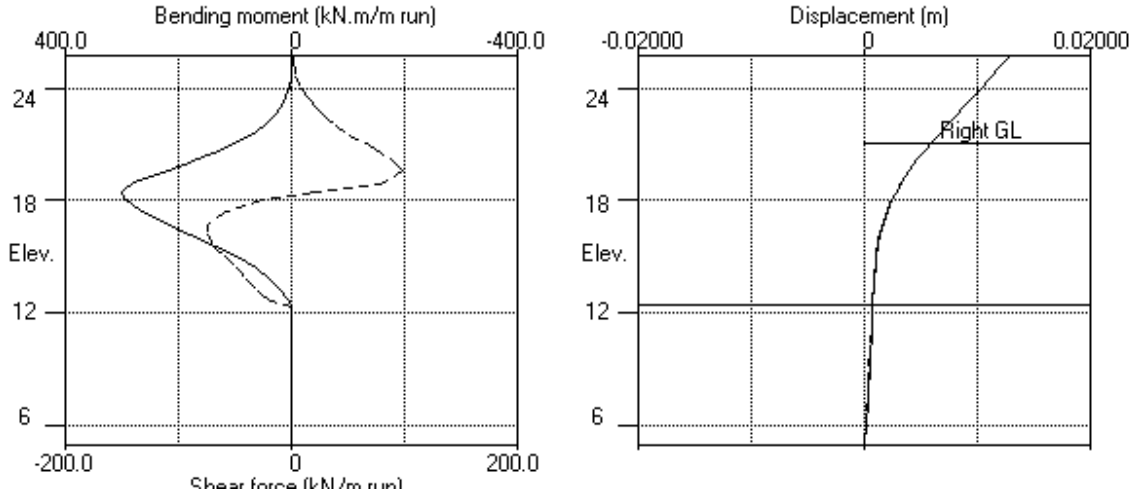
Stage No.5 Fill to elevation 21.00 on RIGHT side with soil type 5

RIGHT side

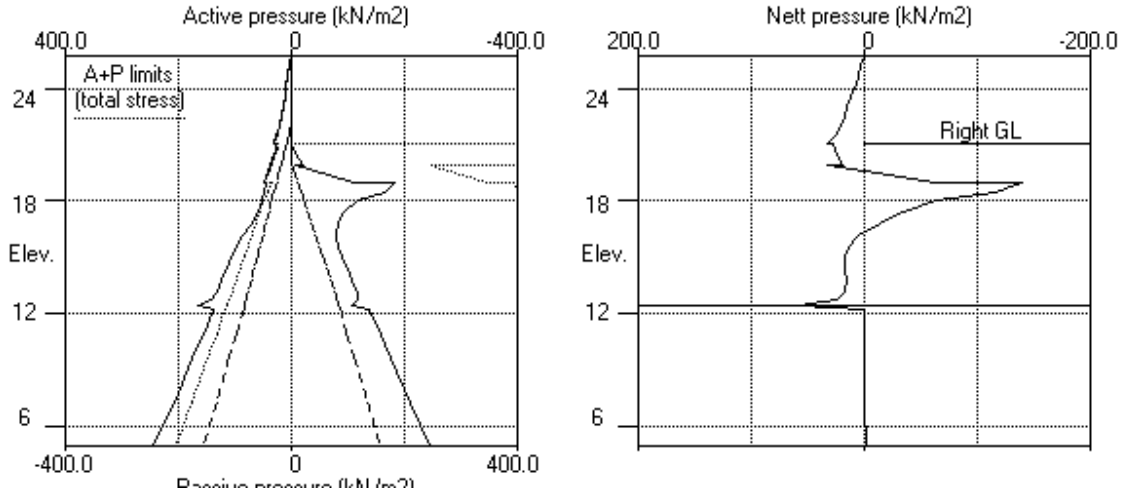
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	1190.00	0.00	0.00a	199538
11	20.73	Total>	6.32	2.65w	1196.32	2.65	2.65a	199538
12	20.17	Total>	19.42	8.14w	1209.42	12.38	12.38	199538
13	19.90	Total>	25.75	10.79w	1215.75	19.01	19.01	199538
		0.00	25.75	4.42	246.52	5.72	5.72	99769
14	19.60	3.30	29.05	4.99	278.14	37.69	41.00	99769
15	19.00	9.91	35.66	6.13	341.47	100.29	110.20	99769
		9.91	35.66	0.00	382.41	174.25	184.16	249422
16	18.50	15.42	41.19	0.00	427.48	149.56	164.98	249422
17	18.00	20.93	46.73	0.00	472.67	97.18	118.11	249422
18	17.40	27.54	53.40	0.00	527.11	66.80	94.33	249422
19	16.80	34.15	60.11	0.99	581.79	48.44	82.58	249422
20	16.20	40.75	66.85	2.26	636.75	39.42	80.17	249422
21	15.60	47.36	73.63	3.55	692.02	36.14	83.50	249422
22	15.00	53.97	80.44	4.84	747.60	36.25	90.22	249422
23	14.40	60.58	87.30	6.13	803.52	38.07	98.65	249422
24	13.80	67.19	94.20	7.44	859.77	40.31	107.50	249422
25	13.20	73.80	101.14	8.75	916.37	41.91	115.71	249422
26	12.80	78.20	105.79	9.63	954.30	39.71	117.91	249422
27	12.40	82.61	110.46	10.51	992.37	24.35	106.97	249422
28	12.25	84.08	112.39	10.88	1008.16	53.63	137.71	249422
29	10.93	97.08	129.60	14.13	1148.51	59.88	156.96	249422
30	9.60	110.08	146.99	17.42	1290.33	65.85	175.93	249422
31	7.30	132.64	177.53	23.20	1539.41	76.17	208.81	249422
32	5.00	155.20	208.40	29.04	1791.15	89.97	245.18	249422

Note: 2.65 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Stage No.5 Fill to elev. 21.00 on RIGHT side



Stage No.5 Fill to elev. 21.00 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 12.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
2	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
3	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
4	25.70	19.90	Cant.	1.682	13.11	15.17	4.73	L to R
5	25.70	21.00	Cant.	4.406	12.75	19.78	1.22	L to R
6	25.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: Serviceability Limit State

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

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment				Shear force			
				Calculated		Factored		Calculated		Factored	
no.	coord	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	25.70	0.013	0.000	0	-0	0	-0	0	0	0	0
2	25.15	0.012	0.000	0	-0	0	-0	1	-0	1	-1
3	24.60	0.011	0.000	2	-0	2	-1	4	-1	5	-1
4	24.00	0.010	0.000	5	-1	7	-1	8	-1	11	-2
5	23.58	0.010	0.000	10	-2	13	-2	14	-1	18	-2
6	23.04	0.009	0.000	19	-2	25	-3	21	-1	28	-2
7	22.50	0.008	0.000	32	-3	44	-4	30	-2	40	-2
8	22.00	0.007	0.000	50	-4	67	-5	44	-3	59	-4
9	21.50	0.007	0.000	72	-5	98	-7	61	-3	83	-4
10	21.00	0.006	0.000	108	-6	145	-8	82	-2	111	-2
11	20.73	0.006	0.000	131	-7	177	-9	92	-2	124	-2
12	20.17	0.005	0.000	178	-7	240	-10	94	-0	127	-0
13	19.90	0.005	0.000	198	-7	268	-10	96	0	130	0
14	19.60	0.004	0.000	224	-7	302	-9	102	0	138	0
15	19.00	0.003	0.000	279	-4	377	-6	85	0	115	0
16	18.50	0.003	0.000	302	-2	407	-3	19	0	26	0
17	18.00	0.003	0.000	296	-1	400	-1	2	-30	3	-41
18	17.40	0.002	0.000	268	0	361	0	1	-58	2	-79
19	16.80	0.002	0.000	227	0	306	0	1	-73	1	-98
20	16.20	0.002	0.000	181	0	244	0	0	-75	1	-102
21	15.60	0.001	0.000	136	0	184	0	0	-69	0	-94
22	15.00	0.001	0.000	97	0	131	0	0	-60	0	-81
23	14.40	0.001	0.000	64	0	87	0	0	-50	0	-67
24	13.80	0.001	0.000	38	0	51	0	0	-40	0	-53
25	13.20	0.001	0.000	17	0	23	0	0	-29	0	-40
26	12.80	0.001	0.000	7	0	9	0	0	-21	0	-29
27	12.40	0.001	0.000	0	-0	0	-0	0	-4	0	-6
28	12.25	0.001	0.000	0	0	0	0	0	-0	0	-0
29	10.93	0.001	0.000	0	0	0	0	0	-0	0	-0
30	9.60	0.001	0.000	0	0	0	0	0	-0	0	-0
31	7.30	0.000	0.000	0	0	0	0	0	0	1	0
32	5.00	0.000	0.000	0	0	0	0	0	0	0	0

Summary of results (continued)

Calculated Bending Moments and Prop 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	1	15.60	-7	20.17	1	-10	6	19.00	-3	21.50	8	-4
2	3	17.40	-5	20.17	4	-7	7	19.00	-2	22.00	9	-2
3	4	17.40	-4	20.17	6	-5	7	19.00	-1	22.00	10	-2
4	301	18.50	0	25.70	407	0	102	19.60	-75	16.20	138	-102
5	302	18.50	0	25.70	407	0	98	19.60	-75	16.20	133	-101
6	No calculation at this stage											
7	No calculation at this stage											
8	No calculation at this stage											
9	298	18.50	0	25.70	402	0	94	20.17	-73	16.20	127	-99

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.000	22.00	0.000	25.70	Apply water pressure profile no.1
2	0.000	25.70	0.000	25.70	Apply surcharge no.1 at elev. 25.70
3	0.000	25.70	0.000	25.70	Apply surcharge no.2 at elev. 19.60
4	0.013	25.70	0.000	25.70	Excav. to elev. 19.90 on RIGHT side
5	0.013	25.70	0.000	25.70	Fill to elev. 21.00 on RIGHT side
6	No calculation at this stage				Install prop no.4 at elev. 20.17
7	No calculation at this stage				Install prop no.3 at elev. 20.73
8	No calculation at this stage				Install prop no.2 at elev. 23.58
9	0.013	25.70	0.000	25.70	Apply water pressure profile no.3

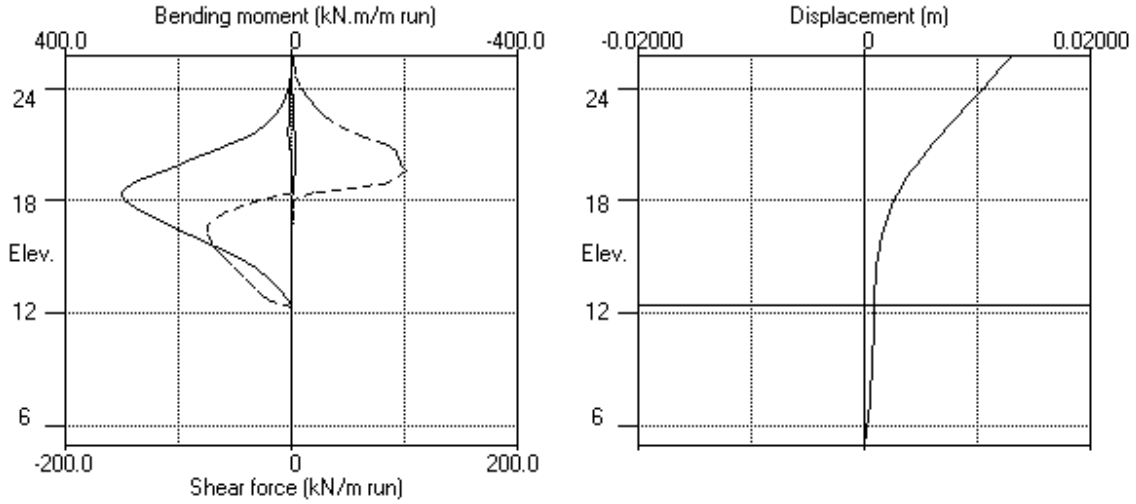
Summary of results (continued)

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

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 2 at elev. 23.58			Prop no. 3 at elev. 20.73			Prop no. 4 at elev. 20.17		
	--Calculated-- kN per m run	kN per prop	Factored kN per prop	--Calculated-- kN per m run	kN per prop	Factored kN per prop	--Calculated-- kN per m run	kN per prop	Factored kN per prop
9	7	7	10	18	18	24	23	23	31

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	25.70	1 Fill	1 Fill
2	22.50	2 Alluvial Gravel	2 Alluvial Gravel
3	21.00	3 Weath Sandstone	3 Weath Sandstone
4	19.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES (Unfactored SLS soil strengths)
Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

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	22.00	22.00	0.0	1	19.90	19.90	0.0	MC
2	1	23.00	23.00	0.0	1	19.40	19.40	0.0	WC
3	1	24.00	24.00	0.0	1	19.90	19.90	0.0	MC
4	1	24.70	24.70	0.0	1	19.90	19.90	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 12.40
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.038200 m4/m run
E.I = 1.0696E+06 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

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	25.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.30 Var
2	19.60	7.00(L)	50.00	1.00	600.00	=	N/A	1.00 P/U

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 water pressure profile no.2 (Worst Cred.)
2	Apply surcharge no.1 at elevation 25.70
3	Apply surcharge no.2 at elevation 19.60
4	Excavate to elevation 19.40 on RIGHT side
5	Fill to elevation 21.00 on RIGHT side with soil type 5
6	Install strut or anchor no.4 at elevation 20.17
7	Install strut or anchor no.3 at elevation 20.73
8	Install strut or anchor no.2 at elevation 23.58
9	Apply water pressure profile no.4 (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 = 5.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

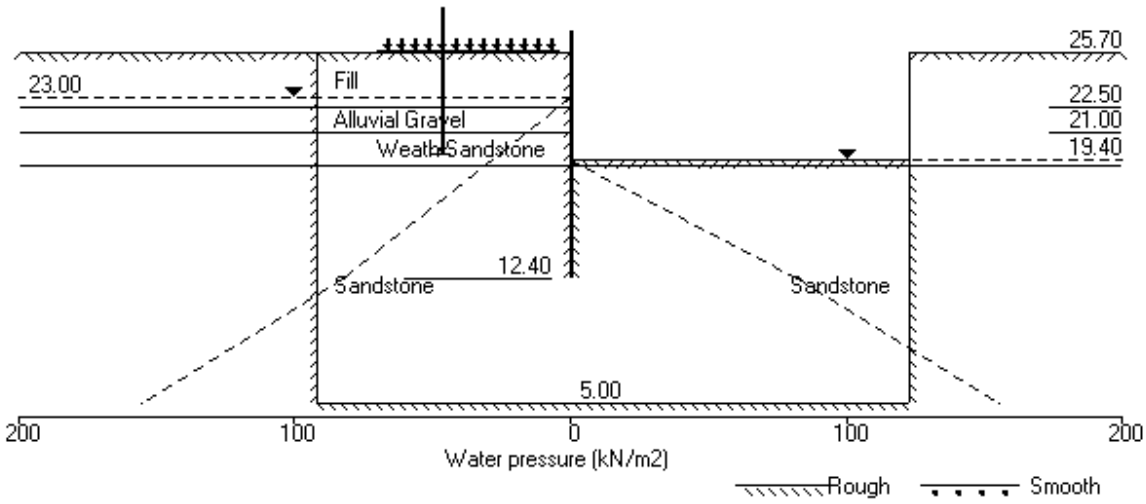
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side   - Rough
Rigid boundary on Right side   - Rough
Wall / soil interface   - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.2	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.70	Yes	Yes	Yes
3	Apply surcharge no.2 at elev. 19.60	Yes	Yes	Yes
4	Excav. to elev. 19.40 on RIGHT side	Yes	Yes	Yes
5	Fill to elev. 21.00 on RIGHT side	No	No	No
6	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
7	Install prop no.3 at elev. 20.73	No	No	No
8	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
9	Apply water pressure profile no.4	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.4 Excav. to elev. 19.40 on RIGHT side



Units: kN,m

Stage No. 4 Excavate to elevation 19.40 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall FoS for toe elev. = 12.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
4	25.70	19.40	Cant.	1.162	13.03	13.93	5.47	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	25.70	0.00	0.039	3.91E-03	0.0	0.0	
2	25.20	3.31	0.037	3.91E-03	0.8	0.2	
3	24.70	7.15	0.035	3.91E-03	3.4	1.3	
4	24.14	11.51	0.033	3.91E-03	8.7	4.6	
5	23.58	15.66	0.030	3.90E-03	16.3	11.6	
6	23.00	19.68	0.028	3.89E-03	26.5	23.9	
7	22.50	25.63	0.026	3.88E-03	37.8	40.0	
8	22.00	31.50	0.024	3.85E-03	52.1	62.4	
9	21.50	37.32	0.022	3.82E-03	69.3	92.6	
10	21.00	43.09	0.020	3.77E-03	89.4	132.2	
		33.96	0.020	3.77E-03	89.4	132.2	
11	20.73	36.98	0.019	3.73E-03	99.0	157.6	
12	20.17	43.23	0.017	3.63E-03	121.4	219.2	
13	19.90	46.23	0.016	3.57E-03	133.5	253.6	
14	19.60	49.56	0.015	3.49E-03	147.9	295.8	
15	19.40	51.78	0.015	3.44E-03	158.0	326.4	
16	19.00	27.27	0.013	3.30E-03	173.8	393.4	
		-31.54	0.013	3.30E-03	173.8	393.4	
17	18.50	-58.43	0.012	3.10E-03	151.3	476.4	
18	18.00	-85.27	0.010	2.86E-03	115.4	544.7	
19	17.40	-117.46	0.009	2.54E-03	54.6	598.5	
20	16.80	-149.63	0.007	2.20E-03	-25.5	610.1	
21	16.20	-100.78	0.006	1.87E-03	-100.6	567.8	
22	15.60	-53.77	0.005	1.57E-03	-147.0	489.2	
23	15.00	-22.48	0.004	1.33E-03	-169.9	391.3	
24	14.40	-0.79	0.003	1.14E-03	-176.9	285.3	
25	13.80	26.66	0.003	1.01E-03	-169.1	179.0	
26	13.20	69.05	0.002	9.37E-04	-140.4	82.3	
27	12.80	118.89	0.002	9.15E-04	-102.8	31.6	
28	12.40	287.38	0.001	9.10E-04	-21.6	-0.0	

(continued)

Stage No.4 Excavate to elevation 19.40 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
29	12.25	-0.23	0.002	0	-0.0	0.0	
30	10.93	0.11	0.001	0	-0.1	0.0	
31	9.60	0.22	0.001	0	0.1	0.0	
32	7.30	0.16	0.001	0	0.6	0.0	
33	5.00	-0.63	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses					Total earth pressure	Adjusted soil modulus
		Water press.	Vertic -al	Active limit	Passive limit	Earth pressure		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12465
2	25.20	0.00	9.63	3.31	32.36	3.31	3.31a	12465
3	24.70	0.00	20.83	7.15	69.99	7.15	7.15a	12465
4	24.14	0.00	33.54	11.51	112.71	11.51	11.51a	12465
5	23.58	0.00	45.61	15.66	153.25	15.66	15.66a	12465
6	23.00	0.00	57.35	19.68	192.70	19.68	19.68a	12465
7	22.50	3.90	63.31	21.73	212.73	21.73	25.63a	12465
		3.90	63.31	21.73	212.75	21.73	25.63a	29917
8	22.00	7.80	69.04	23.70	232.02	23.70	31.50a	29917
9	21.50	11.71	74.61	25.61	250.72	25.61	37.32a	29917
10	21.00	15.61	80.05	27.48	269.00	27.48	43.09a	29917
		15.61	80.05	18.36	476.10	18.36	33.96a	99723
11	20.73	17.71	84.03	19.27	499.74	19.27	36.98a	99723
12	20.17	22.08	92.19	21.14	548.32	21.14	43.23a	99723
13	19.90	24.19	96.10	22.04	571.54	22.04	46.23a	99723
14	19.60	26.53	100.42	23.03	597.23	23.03	49.56a	99723
15	19.40	28.09	103.29	23.69	614.30	23.69	51.78a	99723
16	19.00	31.21	109.05	25.01	648.57	25.01	56.22a	99723
		31.21	109.05	17.62	625.94	17.62	48.83a	249307
17	18.50	35.12	116.41	19.46	664.53	19.46	54.57a	249307
18	18.00	39.02	124.08	21.37	704.72	21.37	60.39a	249307
19	17.40	43.70	133.80	23.80	755.70	23.80	67.50a	249307
20	16.80	48.38	144.12	26.38	809.78	26.38	74.76a	249307
21	16.20	53.06	154.95	29.08	866.55	29.08	82.14a	249307
22	15.60	57.75	166.14	31.87	925.21	31.87	89.62a	249307
23	15.00	62.43	177.51	34.71	984.80	34.71	97.14a	249307
24	14.40	67.11	188.88	37.55	1044.43	37.55	104.66a	249307
25	13.80	71.79	200.13	40.36	1103.36	49.06	120.85	249307
26	13.20	76.47	211.13	43.10	1161.07	73.26	149.74	249307
27	12.80	79.59	218.31	44.90	1198.68	117.28	196.88	249307
28	12.40	82.72	225.34	46.65	1235.54	287.38	370.09	249307
29	12.25	84.19	227.64	47.23	1247.59	41.28	125.46A	249307
30	10.93	97.19	247.04	52.07	1349.30	49.68	146.87A	249307
31	9.60	110.18	264.98	56.55	1443.32	55.87	166.06A	249307
32	7.30	132.75	293.54	63.68	1593.07	67.07	199.82	249307
33	5.00	155.31	320.15	70.32	1732.56	83.01	238.32	249307

(continued)

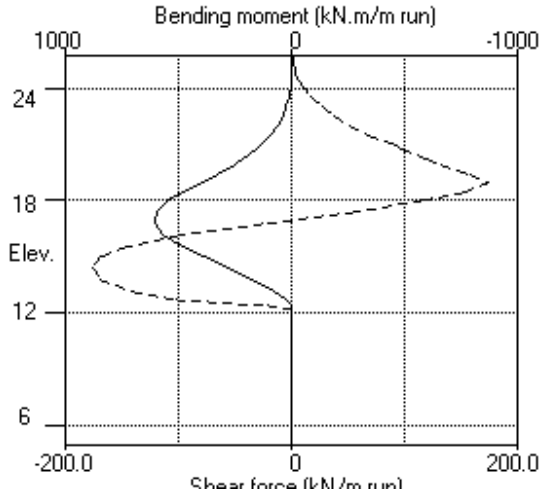
Stage No.4 Excavate to elevation 19.40 on RIGHT side

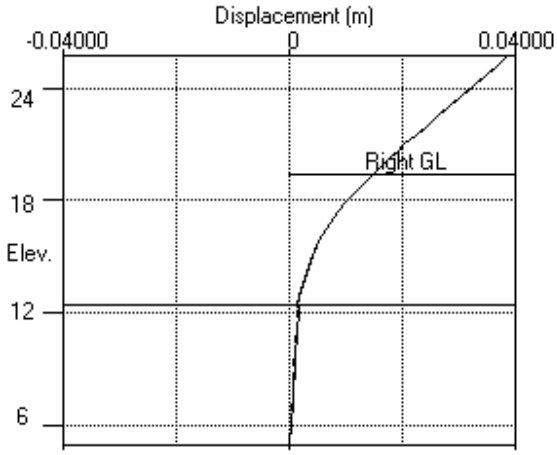
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	19.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	19.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	19.40	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	99796
16	19.00	4.73	4.07	0.93	24.23	24.23	28.96p	99796
		4.73	4.07	0.00	75.65	75.65	80.38p	249489
17	18.50	10.63	9.17	0.00	102.36	102.36	113.00p	249489
18	18.00	16.54	14.27	0.00	129.12	129.12	145.66p	249489
19	17.40	23.63	20.42	0.00	161.32	161.32	184.96p	249489
20	16.80	30.72	26.59	0.00	193.66	193.66	224.39p	249489
21	16.20	37.81	32.79	0.00	226.18	145.11	182.92	249489
22	15.60	44.90	39.03	0.14	258.90	98.48	143.38	249489
23	15.00	51.99	45.32	1.71	291.86	67.63	119.62	249489
24	14.40	59.08	51.66	3.29	325.08	46.37	105.45	249489
25	13.80	66.17	58.05	4.89	358.58	28.01	94.19	249489
26	13.20	73.26	64.49	6.50	392.37	7.42	80.69	249489
27	12.80	77.99	68.82	7.58	415.07	0.00	77.99A	249489
28	12.40	82.72	73.18	8.67	437.91	0.00	82.72A	249489
29	12.25	84.19	75.12	9.15	448.09	41.50	125.69	249489
30	10.93	97.19	92.43	13.47	538.84	49.57	146.76	249489
31	9.60	110.18	110.03	17.86	631.07	55.66	165.84	249489
32	7.30	132.75	141.17	25.64	794.32	66.92	199.66	249489
33	5.00	155.31	172.92	33.56	960.74	83.65	238.96	249489

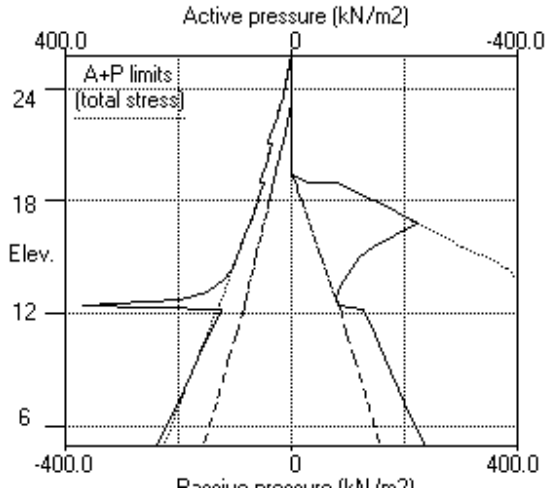
Note: 104.66 a Soil pressure at active limit
224.39 p Soil pressure at passive limit
82.72A Arching - soil pressure below active limit

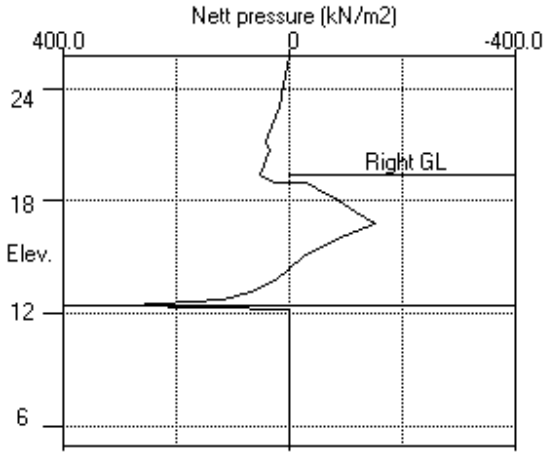
Stage No.4 Excav. to elev. 19.40 on RIGHT side



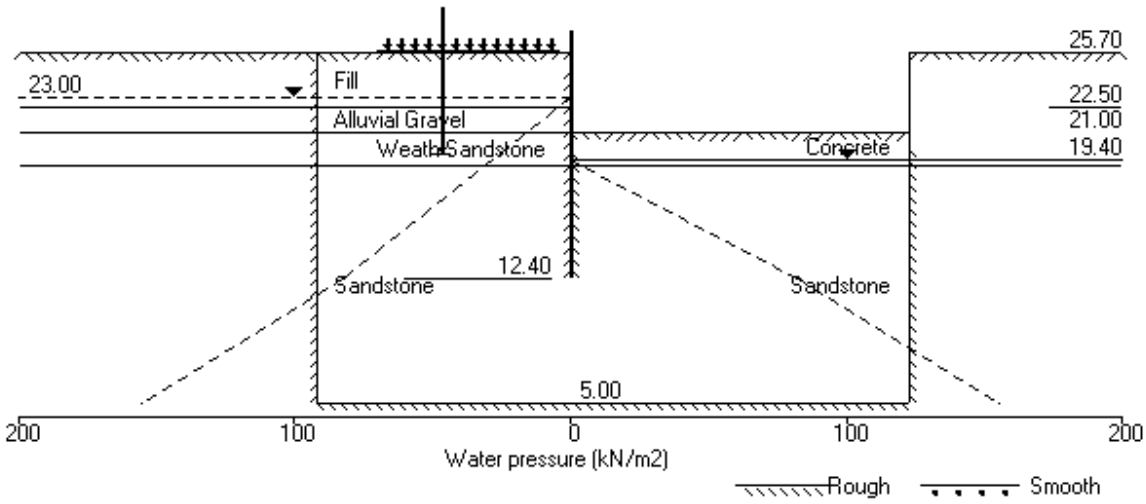


Stage No.4 Excav. to elev. 19.40 on RIGHT side





Stage No.5 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 5 Fill to elevation 21.00 on RIGHT side with soil type 5

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 12.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr-ation	Direction of failure
5	25.70	21.00	Cant.	3.793	12.70	19.65	1.35	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	25.70	0.00	0.038	3.92E-03	0.0	0.0	
2	25.20	3.74	0.037	3.92E-03	0.9	0.2	
3	24.70	7.54	0.035	3.92E-03	3.8	1.4	
4	24.14	11.91	0.032	3.92E-03	9.2	5.0	
5	23.58	16.08	0.030	3.91E-03	17.1	12.4	
6	23.00	20.16	0.028	3.90E-03	27.5	25.1	
7	22.50	26.21	0.026	3.89E-03	39.1	41.8	
		27.02	0.026	3.89E-03	39.1	41.8	
8	22.00	32.74	0.024	3.86E-03	54.0	65.0	
9	21.50	38.65	0.022	3.82E-03	71.9	96.4	
10	21.00	44.81	0.020	3.77E-03	92.8	137.4	
		39.70	0.020	3.77E-03	92.8	137.4	
11	20.73	38.93	0.019	3.73E-03	103.4	163.8	
12	20.17	38.09	0.017	3.63E-03	124.9	227.5	
13	19.90	35.66	0.016	3.57E-03	134.9	262.6	
14	19.60	32.51	0.015	3.49E-03	145.1	304.6	
15	19.40	29.50	0.014	3.43E-03	151.3	334.3	
		47.90	0.014	3.43E-03	151.3	334.3	
16	19.00	23.89	0.013	3.29E-03	165.7	398.4	
		-22.61	0.013	3.29E-03	165.7	398.4	
17	18.50	-53.69	0.011	3.09E-03	146.6	478.3	
18	18.00	-82.23	0.010	2.85E-03	112.6	544.9	
19	17.40	-115.48	0.008	2.53E-03	53.3	597.6	
20	16.80	-148.45	0.007	2.19E-03	-25.9	608.7	
21	16.20	-100.15	0.006	1.86E-03	-100.5	566.4	
22	15.60	-53.51	0.005	1.56E-03	-146.6	488.1	
23	15.00	-22.47	0.004	1.32E-03	-169.4	390.5	
24	14.40	-0.95	0.003	1.13E-03	-176.4	284.8	
25	13.80	26.42	0.002	1.00E-03	-168.7	178.7	
26	13.20	68.77	0.002	9.28E-04	-140.2	82.2	

(continued)

Stage No.5 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	12.80	118.63	0.002	9.06E-04	-102.7	31.6	
28	12.40	287.19	0.001	9.00E-04	-21.5	-0.0	
29	12.25	-0.24	0.001	0	-0.0	0.0	
30	10.93	0.10	0.001	0	-0.1	0.0	
31	9.60	0.18	0.001	0	0.1	0.0	
32	7.30	0.14	0.000	0	0.4	0.0	
33	5.00	-0.53	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12465
2	25.20	0.00	9.63	3.31	32.36	3.74	3.74	12465
3	24.70	0.00	20.83	7.15	69.99	7.54	7.54	12465
4	24.14	0.00	33.54	11.51	112.71	11.91	11.91	12465
5	23.58	0.00	45.61	15.66	153.25	16.08	16.08	12465
6	23.00	0.00	57.35	19.68	192.70	20.16	20.16	12465
7	22.50	3.90	63.31	21.73	212.73	22.31	26.21	12465
		3.90	63.31	21.73	212.75	23.11	27.02	29917
8	22.00	7.80	69.04	23.70	232.02	24.93	32.74	29917
9	21.50	11.71	74.61	25.61	250.72	26.94	38.65	29917
10	21.00	15.61	80.05	27.48	269.00	29.20	44.81	29917
		15.61	80.05	18.36	476.10	24.09	39.70	99723
11	20.73	17.71	84.03	19.27	499.74	23.86	41.57	99723
12	20.17	22.08	92.19	21.14	548.32	25.57	47.65	99723
13	19.90	24.19	96.10	22.04	571.54	26.50	50.69	99723
14	19.60	26.53	100.42	23.03	597.23	27.55	54.08	99723
15	19.40	28.09	103.29	23.69	614.30	28.39	56.49	99723
16	19.00	31.21	109.05	25.01	648.57	30.06	61.27	99723
		31.21	109.05	17.62	625.94	30.25	61.46	249307
17	18.50	35.12	116.41	19.46	664.53	29.46	64.58	249307
18	18.00	39.02	124.08	21.37	704.72	30.39	69.40	249307
19	17.40	43.70	133.80	23.80	755.70	32.22	75.92	249307
20	16.80	48.38	144.12	26.38	809.78	34.36	82.74	249307
21	16.20	53.06	154.95	29.08	866.55	36.77	89.83	249307
22	15.60	57.75	166.14	31.87	925.21	39.36	97.10	249307
23	15.00	62.43	177.51	34.71	984.80	42.06	104.49	249307
24	14.40	67.11	188.88	37.55	1044.43	44.81	111.92	249307
25	13.80	71.79	200.13	40.36	1103.36	56.26	128.06	249307
26	13.20	76.47	211.13	43.10	1161.07	80.44	156.91	249307
27	12.80	79.59	218.31	44.90	1198.68	124.46	204.05	249307
28	12.40	82.72	225.34	46.65	1235.54	294.57	377.29	249307
29	12.25	84.19	227.64	47.23	1247.59	48.55	132.74	249307
30	10.93	97.19	247.04	52.07	1349.30	56.90	154.09	249307
31	9.60	110.18	264.98	56.55	1443.32	63.00	173.19	249307
32	7.30	132.75	293.54	63.68	1593.07	74.02	206.77	249307
33	5.00	155.31	320.15	70.32	1732.56	88.71	244.02	249307

(continued)

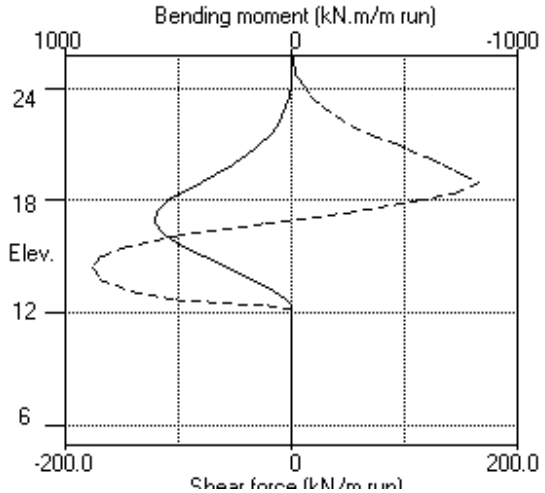
Stage No.5 Fill to elevation 21.00 on RIGHT side with soil type 5

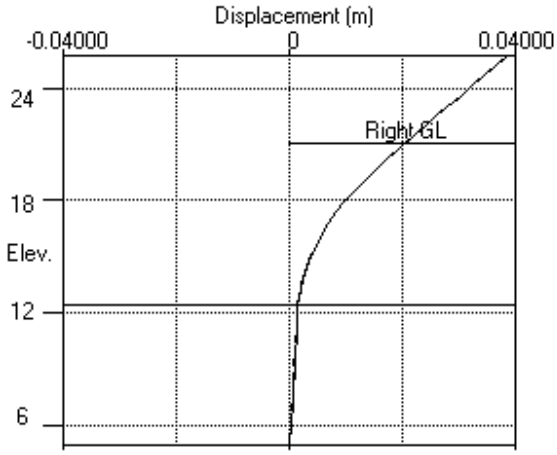
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	850.00	0.00	0.00a	199538
11	20.73	Total>	6.32	2.65w	856.32	2.65	2.65a	199538
12	20.17	Total>	19.42	8.14w	869.43	9.56	9.56	199538
13	19.90	Total>	25.75	10.79w	875.75	15.03	15.03	199538
14	19.60	Total>	32.77	13.73w	882.78	21.57	21.57	199538
15	19.40	Total>	37.46	15.70w	887.47	26.99	26.99	199538
		0.00	37.46	8.59	222.78	8.59	8.59a	99769
16	19.00	4.73	41.55	9.53	247.11	32.65	37.38	99769
		4.73	41.55	0.77	272.10	79.34	84.07	249422
17	18.50	10.63	46.67	2.05	298.96	107.63	118.27	249422
18	18.00	16.54	51.81	3.33	325.91	135.09	151.63	249422
19	17.40	23.63	58.01	4.88	358.38	167.76	191.40	249422
20	16.80	30.72	64.23	6.43	391.01	200.47	231.19	249422
21	16.20	37.81	70.49	7.99	423.81	152.17	189.98	249422
22	15.60	44.90	76.79	9.57	456.81	105.71	150.62	249422
23	15.00	51.99	83.12	11.15	490.02	74.97	126.96	249422
24	14.40	59.08	89.50	12.74	523.44	53.79	112.87	249422
25	13.80	66.17	95.91	14.34	557.08	35.46	101.64	249422
26	13.20	73.26	102.37	15.95	590.94	14.88	88.14A	249422
27	12.80	77.99	106.70	17.03	613.63	7.43	85.42A	249422
28	12.40	82.72	111.05	18.12	636.43	7.39	90.10A	249422
29	12.25	84.19	112.99	18.60	646.58	48.79	132.98	249422
30	10.93	97.19	130.20	22.90	736.79	56.80	153.99	249422
31	9.60	110.18	147.59	27.24	827.95	62.82	173.01	249422
32	7.30	132.75	178.13	34.87	988.06	73.88	206.63	249422
33	5.00	155.31	209.00	42.57	1149.87	89.23	244.54	249422

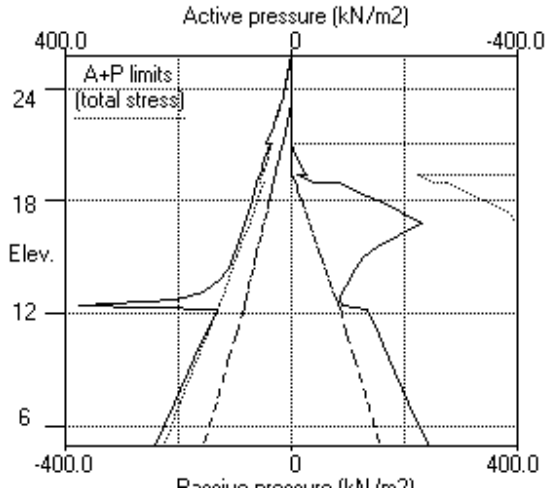
Note: 8.59 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
90.10A Arching - soil pressure below active limit

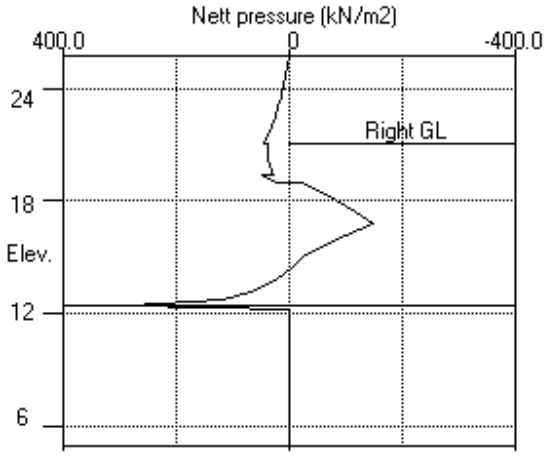
Stage No.5 Fill to elev. 21.00 on RIGHT side





Stage No.5 Fill to elev. 21.00 on RIGHT side





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.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 12.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
2	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
3	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
4	25.70	19.40	Cant.	1.162	13.03	13.93	5.47	L to R
5	25.70	21.00	Cant.	3.793	12.70	19.65	1.35	L to R
6	25.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: ULS DA1 Combination 2

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	25.70	0.039	0.000	0.0	0.0	0.0	0.0
2	25.20	0.037	0.000	0.2	-0.0	0.9	-0.6
3	24.70	0.035	0.000	1.4	-0.6	3.8	-1.7
4	24.14	0.033	0.000	5.1	-1.8	10.1	-2.4
5	23.58	0.030	0.000	13.7	-3.2	20.6	-2.8
6	23.00	0.028	0.000	25.1	-4.9	27.5	-3.5
7	22.50	0.026	0.000	41.8	-6.3	39.1	-3.6
8	22.00	0.024	0.000	65.0	-7.8	57.4	-3.3
9	21.50	0.022	0.000	96.4	-9.1	79.8	-1.6
10	21.00	0.020	0.000	140.7	-9.2	105.1	0.0
11	20.73	0.019	0.000	170.7	-9.0	117.6	0.0
12	20.17	0.017	0.000	234.8	-8.6	128.1	0.0
13	19.90	0.016	0.000	267.4	-8.1	134.9	0.0
14	19.60	0.015	0.000	307.3	-7.1	147.9	0.0
15	19.40	0.015	0.000	335.9	-6.0	158.0	0.0
16	19.00	0.013	0.000	398.4	-3.1	173.8	0.0
17	18.50	0.012	0.000	478.3	-0.1	151.3	0.0
18	18.00	0.010	0.000	544.9	0.0	115.4	0.0
19	17.40	0.009	0.000	598.5	0.0	54.6	-0.3
20	16.80	0.007	0.000	610.1	0.0	0.4	-25.9
21	16.20	0.006	0.000	567.8	0.0	0.0	-100.6
22	15.60	0.005	0.000	489.2	0.0	0.0	-147.0
23	15.00	0.004	0.000	391.3	0.0	0.0	-169.9
24	14.40	0.003	0.000	285.3	0.0	0.0	-176.9
25	13.80	0.003	0.000	179.0	0.0	0.0	-169.1
26	13.20	0.002	0.000	82.3	0.0	0.0	-140.4
27	12.80	0.002	0.000	31.6	0.0	0.0	-102.8
28	12.40	0.001	0.000	0.0	-0.0	0.0	-21.6
29	12.25	0.002	0.000	0.0	0.0	0.0	-0.0
30	10.93	0.001	0.000	0.0	0.0	0.0	-0.2
31	9.60	0.001	0.000	0.0	0.0	0.1	-0.1
32	7.30	0.001	0.000	0.0	0.0	0.6	0.0
33	5.00	0.000	0.000	0.0	0.0	0.0	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	2.7	16.80	-9.2	21.00	8.8	19.00	-3.6	22.50
2	5.6	17.40	-8.0	21.50	10.1	19.00	-2.9	23.00
3	7.3	17.40	-7.5	21.50	10.5	19.00	-2.8	23.00
4	610.1	16.80	-0.0	12.40	173.8	19.00	-176.9	14.40
5	608.7	16.80	-0.0	12.40	165.7	19.00	-176.4	14.40
6	No calculation at this stage							
7	No calculation at this stage							
8	No calculation at this stage							
9	606.7	16.80	-0.0	12.40	162.5	19.00	-175.8	14.40

Maximum and minimum displacement at each stage

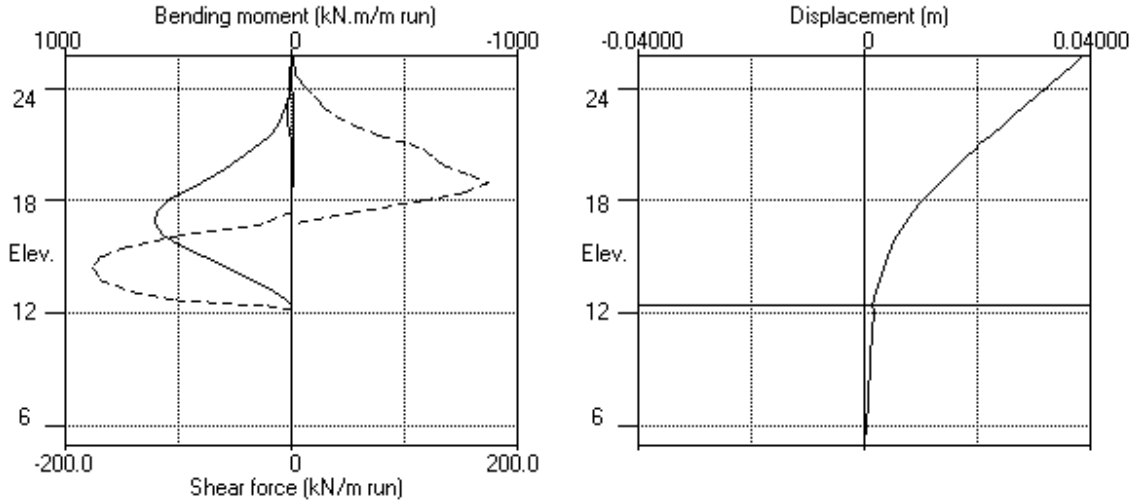
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.000	25.70	0.000	25.70	Apply water pressure profile no.2
2	0.001	25.70	0.000	25.70	Apply surcharge no.1 at elev. 25.70
3	0.001	25.70	0.000	25.70	Apply surcharge no.2 at elev. 19.60
4	0.039	25.70	0.000	25.70	Excav. to elev. 19.40 on RIGHT side
5	0.038	25.70	0.000	25.70	Fill to elev. 21.00 on RIGHT side
6	No calculation at this stage				Install prop no.4 at elev. 20.17
7	No calculation at this stage				Install prop no.3 at elev. 20.73
8	No calculation at this stage				Install prop no.2 at elev. 23.58
9	0.039	25.70	0.000	25.70	Apply water pressure profile no.4

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	--- Strut no. 2 --- at elev. 23.58		--- Strut no. 3 --- at elev. 20.73		--- Strut no. 4 --- at elev. 20.17	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
9	13.86	13.86	15.66	15.66	13.72	13.72

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	25.70	1 Fill	1 Fill
2	21.70	2 Alluvial Gravel	2 Alluvial Gravel
3	20.00	3 Weath Sandstone	3 Weath Sandstone
4	18.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES

Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

Water press. profile no.	Point no.	Left side Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Right side Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	22.00	22.00	0.0	1	19.90	19.90	0.0	MC
2	1	23.00	23.00	0.0	1	19.40	19.40	0.0	WC
3	1	24.00	24.00	0.0	1	19.40	19.40	0.0	MC
4	1	24.90	24.90	0.0	1	19.90	19.90	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 11.90
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.017300 m4/m run
E.I = 484400 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge ----- kN/m2 Near edge	Surcharge ----- kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	25.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.00 Var

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 water pressure profile no.1 (Mod. Conserv.)
2	Apply surcharge no.1 at elevation 25.70
3	Excavate to elevation 19.90 on RIGHT side
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Install strut or anchor no.4 at elevation 20.17
6	Install strut or anchor no.3 at elevation 20.73
7	Install strut or anchor no.2 at elevation 23.58
8	Apply water pressure profile no.3 (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 = 1.25

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

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough

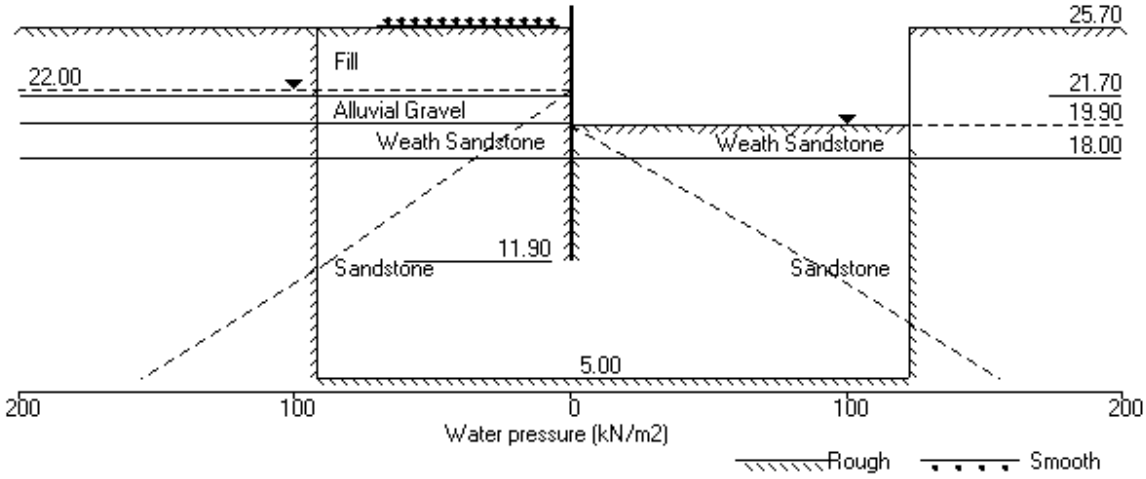
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.1	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.70	Yes	Yes	Yes
3	Excav. to elev. 19.90 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	No	No	No
5	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
6	Install prop no.3 at elev. 20.73	No	No	No
7	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
8	Apply water pressure profile no.3	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 19.90 on RIGHT side



Units: kN,m

Stage No. 3 Excavate to elevation 19.90 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 11.90 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
3	25.70	19.90	Cant.	1.682	12.79	14.69	5.21	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.70	0.00	0.028	3.39E-03	0.0	-0.0	
2	25.15	2.87	0.026	3.39E-03	0.8	0.3	
3	24.60	6.11	0.024	3.39E-03	3.3	1.4	
4	24.00	9.61	0.022	3.38E-03	8.0	4.9	
5	23.58	11.99	0.020	3.38E-03	12.6	9.2	
6	23.19	14.11	0.019	3.37E-03	17.6	15.1	
7	22.80	16.17	0.018	3.35E-03	23.5	23.1	
8	22.40	18.27	0.016	3.33E-03	30.4	33.9	
9	22.00	20.34	0.015	3.30E-03	38.1	47.6	
10	21.70	23.77	0.014	3.26E-03	44.7	60.0	
11	21.35	27.76	0.013	3.21E-03	53.7	77.2	
12	21.00	31.73	0.012	3.15E-03	64.1	97.8	
13	20.73	34.79	0.011	3.09E-03	73.1	116.3	
14	20.17	41.12	0.009	2.93E-03	94.4	163.1	
15	20.00	43.04	0.009	2.87E-03	101.5	179.8	
		33.50	0.009	2.87E-03	101.5	179.8	
16	19.90	34.60	0.009	2.83E-03	104.9	190.1	
17	19.40	-18.30	0.007	2.60E-03	109.0	246.4	
18	19.00	-60.65	0.006	2.38E-03	93.2	288.5	
19	18.60	-86.12	0.005	2.13E-03	63.9	321.0	
20	18.00	-69.67	0.004	1.72E-03	17.1	343.7	
		-214.14	0.004	1.72E-03	17.1	343.7	
21	17.40	-81.96	0.003	1.31E-03	-71.7	315.4	
22	16.80	-22.41	0.002	9.62E-04	-103.0	257.6	
23	16.20	21.77	0.002	6.84E-04	-103.2	191.7	
24	15.60	35.61	0.002	4.82E-04	-86.0	133.7	
25	15.00	34.69	0.001	3.44E-04	-64.9	88.4	
26	14.40	27.99	0.001	2.55E-04	-46.1	55.7	
27	13.80	20.17	0.001	2.00E-04	-31.6	33.0	

(continued)

Stage No.3 Excavate to elevation 19.90 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	13.20	13.77	0.001	1.69E-04	-21.5	17.6	
29	12.60	10.47	0.001	1.54E-04	-14.2	7.1	
30	12.25	12.65	0.001	1.50E-04	-10.1	2.8	
31	11.90	31.71	0.001	1.49E-04	-2.4	0.0	
32	11.75	0.23	0.001	0	0.0	0.0	
33	10.06	0.02	0.001	0	0.2	0.0	
34	8.38	0.02	0.000	0	0.3	0.0	
35	6.69	0.01	0.000	0	0.3	0.0	
36	5.00	-0.36	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12465
2	25.15	0.00	10.51	2.87	48.72	2.87	2.87a	12465
3	24.60	0.00	22.36	6.11	103.58	6.11	6.11a	12465
4	24.00	0.00	35.18	9.61	163.00	9.61	9.61a	12465
5	23.58	0.00	43.91	11.99	203.45	11.99	11.99a	12465
6	23.19	0.00	51.65	14.11	239.30	14.11	14.11a	12465
7	22.80	0.00	59.22	16.17	274.38	16.17	16.17a	12465
8	22.40	0.00	66.90	18.27	309.99	18.27	18.27a	12465
9	22.00	0.00	74.48	20.34	345.10	20.34	20.34a	12465
10	21.70	2.60	77.51	21.17	359.13	21.17	23.77a	12465
		2.60	77.51	21.17	359.16	21.17	23.77a	29915
11	21.35	5.64	80.99	22.12	375.30	22.12	27.76a	29915
12	21.00	8.67	84.43	23.06	391.24	23.06	31.73a	29915
13	20.73	11.01	87.06	23.78	403.42	23.78	34.79a	29915
14	20.17	15.87	92.45	25.25	428.40	25.25	41.12a	29915
15	20.00	17.34	94.08	25.70	435.92	25.70	43.04a	29915
		17.34	94.08	16.16	900.79	16.16	33.50a	99718
16	19.90	18.21	95.43	16.39	913.73	16.39	34.60a	99718
17	19.40	22.55	102.16	17.55	978.20	17.55	40.09a	99718
18	19.00	26.02	107.52	18.47	1029.49	18.47	44.48a	99718
19	18.60	29.48	112.85	19.38	1080.58	19.38	48.87a	99718
20	18.00	34.69	120.82	20.75	1156.89	20.75	55.44a	99718
		34.69	120.82	12.47	1076.90	12.47	47.16a	249295
21	17.40	39.89	128.76	13.97	1141.62	13.97	53.86a	249295
22	16.80	45.09	136.67	15.47	1206.12	15.47	60.56a	249295
23	16.20	50.30	144.55	16.96	1270.44	38.18	88.48	249295
24	15.60	55.50	152.42	18.45	1334.61	46.55	102.05	249295
25	15.00	60.70	160.28	19.94	1398.68	48.06	108.76	249295
26	14.40	65.91	168.12	21.42	1462.66	47.03	112.93	249295
27	13.80	71.11	175.96	22.90	1526.57	45.69	116.79	249295
28	13.20	76.31	183.79	24.38	1590.44	45.23	121.54	249295
29	12.60	81.52	191.62	25.86	1654.28	46.49	128.00	249295
30	12.25	84.55	196.18	26.73	1691.51	49.19	133.74	249295
31	11.90	87.59	200.75	27.59	1728.73	61.15	148.74	249295
32	11.75	89.06	202.53	27.93	1743.29	45.28	134.33	249295
33	10.06	105.61	222.62	31.73	1907.09	52.34	157.95	249295
34	8.38	122.17	242.72	35.53	2070.99	59.64	181.80	249295
35	6.69	138.72	262.84	39.33	2235.06	67.38	206.10	249295
36	5.00	155.27	282.98	43.14	2399.35	78.48	233.75	249295

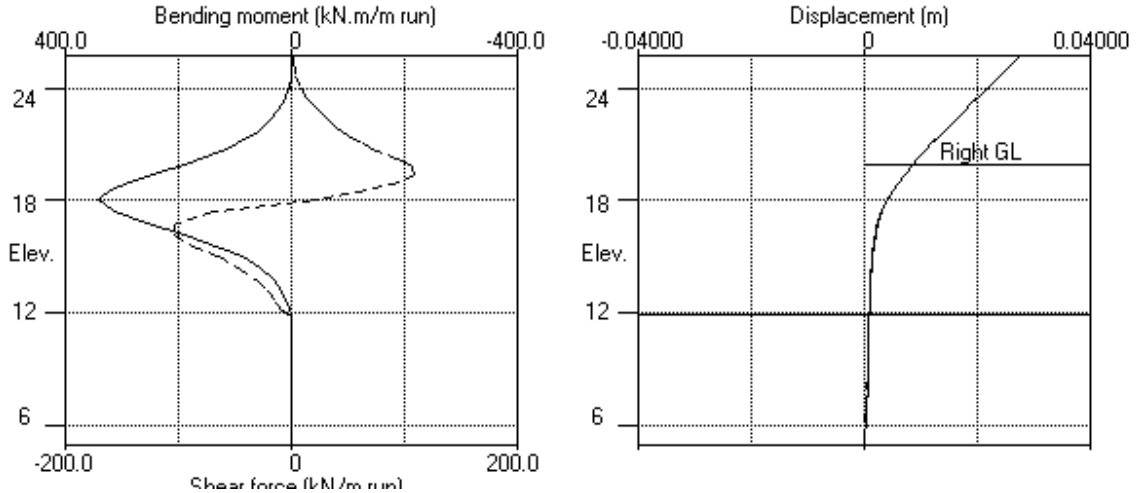
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Stage No.3 Excavate to elevation 19.90 on RIGHT side

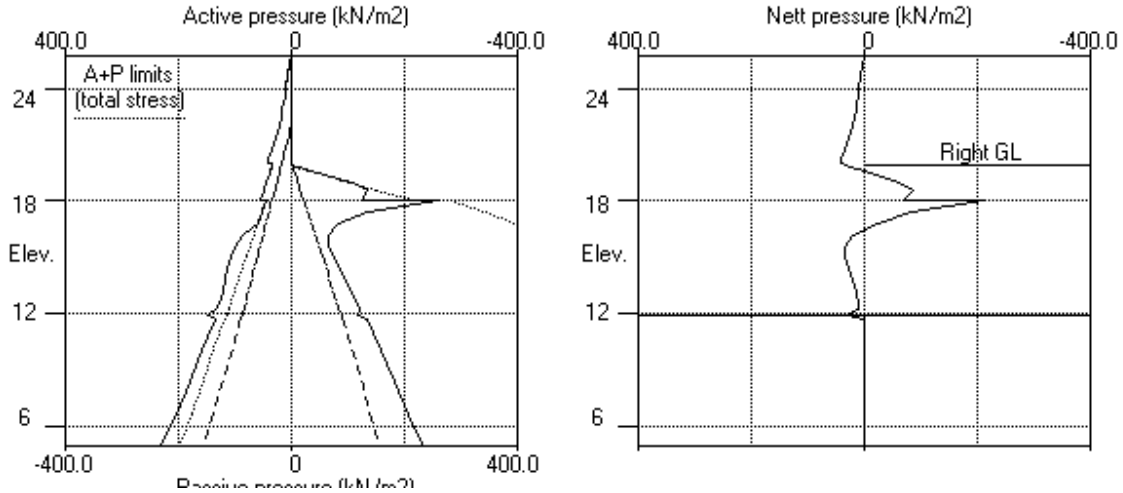
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.19	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	19.90	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	99779
17	19.40	5.47	5.53	0.95	52.92	52.92	58.39p	99779
18	19.00	9.85	9.95	1.71	95.28	95.28	105.13p	99779
19	18.60	14.23	14.38	2.47	137.69	120.75	134.98	99779
20	18.00	20.80	21.04	3.61	201.43	104.31	125.11	99779
		20.80	21.04	0.00	263.14	240.50	261.30	249447
21	17.40	27.37	27.71	0.00	317.60	108.45	135.82	249447
22	16.80	33.94	34.42	0.00	372.30	49.03	82.97	249447
23	16.20	40.51	41.16	0.00	427.27	26.20	66.71	249447
24	15.60	47.08	47.94	0.00	482.55	19.37	66.44	249447
25	15.00	53.65	54.76	0.00	538.19	20.43	74.07	249447
26	14.40	60.21	61.63	1.28	594.20	24.73	84.95	249447
27	13.80	66.78	68.55	2.59	650.62	29.84	96.63	249447
28	13.20	73.35	75.52	3.90	707.45	34.42	107.78	249447
29	12.60	79.92	82.54	5.23	764.70	37.61	117.53	249447
30	12.25	83.75	86.66	6.01	798.29	37.34	121.09	249447
31	11.90	87.59	90.79	6.79	832.03	29.44	117.02	249447
32	11.75	89.06	92.74	7.16	847.93	45.04	134.10	249447
33	10.06	105.61	114.89	11.35	1028.52	52.31	157.92	249447
34	8.38	122.17	137.40	15.61	1212.11	59.62	181.79	249447
35	6.69	138.72	160.22	19.92	1398.21	67.36	206.08	249447
36	5.00	155.27	183.28	24.29	1586.27	78.84	234.11	249447

Note: 60.56 a Soil pressure at active limit
105.13 p Soil pressure at passive limit

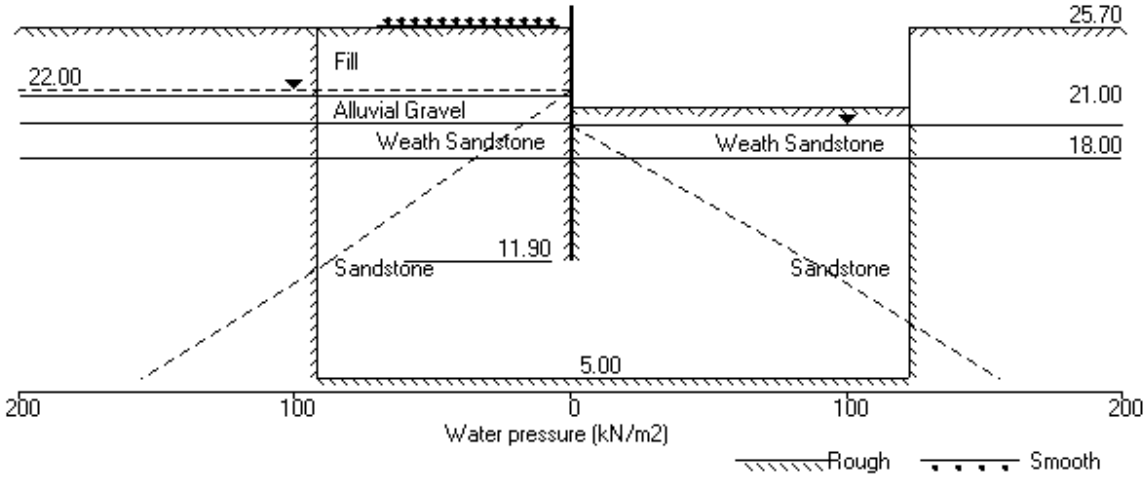
Stage No.3 Excav. to elev. 19.90 on RIGHT side



Stage No.3 Excav. to elev. 19.90 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 11.90** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
4	25.70	21.00	Cant.	4.466	12.48	19.57	1.43	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.70	0.00	0.027	3.40E-03	0.0	-0.0	
2	25.15	3.26	0.025	3.40E-03	0.9	0.3	
3	24.60	6.48	0.024	3.40E-03	3.6	1.6	
4	24.00	10.00	0.022	3.39E-03	8.5	5.2	
5	23.58	12.40	0.020	3.39E-03	13.3	9.9	
6	23.19	14.54	0.019	3.38E-03	18.5	16.0	
7	22.80	16.64	0.017	3.36E-03	24.5	24.4	
8	22.40	18.78	0.016	3.34E-03	31.6	35.6	
9	22.00	20.90	0.015	3.30E-03	39.6	49.9	
10	21.70	24.42	0.014	3.26E-03	46.4	62.8	
		25.33	0.014	3.26E-03	46.4	62.8	
11	21.35	29.13	0.013	3.21E-03	55.9	80.6	
12	21.00	33.10	0.012	3.15E-03	66.8	102.1	
13	20.73	33.59	0.011	3.08E-03	75.8	121.3	
14	20.17	32.52	0.009	2.92E-03	94.3	168.7	
15	20.00	32.20	0.009	2.86E-03	99.8	185.2	
		28.10	0.009	2.86E-03	99.8	185.2	
16	19.90	21.33	0.008	2.82E-03	102.3	195.3	
		34.28	0.008	2.82E-03	102.3	195.3	
17	19.40	-19.37	0.007	2.59E-03	106.0	250.3	
18	19.00	-61.93	0.006	2.36E-03	89.7	291.1	
19	18.60	-87.50	0.005	2.11E-03	59.9	322.1	
20	18.00	-70.84	0.004	1.70E-03	12.4	342.2	
		-205.09	0.004	1.70E-03	12.4	342.2	
21	17.40	-78.41	0.003	1.29E-03	-72.7	312.6	
22	16.80	-21.10	0.002	9.45E-04	-102.6	254.8	
23	16.20	22.09	0.002	6.70E-04	-102.3	189.4	
24	15.60	35.46	0.001	4.71E-04	-85.0	132.0	
25	15.00	34.37	0.001	3.35E-04	-64.0	87.3	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	14.40	27.63	0.001	2.47E-04	-45.4	55.0	
27	13.80	19.83	0.001	1.93E-04	-31.2	32.7	
28	13.20	13.48	0.001	1.62E-04	-21.2	17.5	
29	12.60	10.23	0.001	1.46E-04	-14.1	7.1	
30	12.25	12.49	0.001	1.43E-04	-10.1	2.8	
31	11.90	31.72	0.001	1.42E-04	-2.4	0.0	
32	11.75	0.22	0.001	0	0.0	0.0	
33	10.06	0.02	0.000	0	0.2	0.0	
34	8.38	0.01	0.000	0	0.2	0.0	
35	6.69	0.01	0.000	0	0.3	0.0	
36	5.00	-0.31	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertical	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12465
2	25.15	0.00	10.51	2.87	48.72	3.26	3.26	12465
3	24.60	0.00	22.36	6.11	103.58	6.48	6.48	12465
4	24.00	0.00	35.18	9.61	163.00	10.00	10.00	12465
5	23.58	0.00	43.91	11.99	203.45	12.40	12.40	12465
6	23.19	0.00	51.65	14.11	239.30	14.54	14.54	12465
7	22.80	0.00	59.22	16.17	274.38	16.64	16.64	12465
8	22.40	0.00	66.90	18.27	309.99	18.78	18.78	12465
9	22.00	0.00	74.48	20.34	345.10	20.90	20.90	12465
10	21.70	2.60	77.51	21.17	359.13	21.82	24.42	12465
		2.60	77.51	21.17	359.16	22.73	25.33	29915
11	21.35	5.64	80.99	22.12	375.30	23.49	29.13	29915
12	21.00	8.67	84.43	23.06	391.24	24.43	33.10	29915
13	20.73	11.01	87.06	23.78	403.42	25.23	36.24	29915
14	20.17	15.87	92.45	25.25	428.40	26.81	42.68	29915
15	20.00	17.34	94.08	25.70	435.92	28.02	45.37	29915
		17.34	94.08	16.16	900.79	23.92	41.26	99718
16	19.90	18.21	95.43	16.39	913.73	21.45	39.66	99718
17	19.40	22.55	102.16	17.55	978.20	21.97	44.52	99718
18	19.00	26.02	107.52	18.47	1029.49	22.49	48.51	99718
19	18.60	29.48	112.85	19.38	1080.58	23.25	52.74	99718
20	18.00	34.69	120.82	20.75	1156.89	24.68	59.37	99718
		34.69	120.82	12.47	1076.90	22.30	56.99	249295
21	17.40	39.89	128.76	13.97	1141.62	20.92	60.81	249295
22	16.80	45.09	136.67	15.47	1206.12	21.26	66.35	249295
23	16.20	50.30	144.55	16.96	1270.44	43.45	93.75	249295
24	15.60	55.50	152.42	18.45	1334.61	51.58	107.07	249295
25	15.00	60.70	160.28	19.94	1398.68	52.98	113.69	249295
26	14.40	65.91	168.12	21.42	1462.66	51.92	117.83	249295
27	13.80	71.11	175.96	22.90	1526.57	50.58	121.69	249295
28	13.20	76.31	183.79	24.38	1590.44	50.14	126.45	249295
29	12.60	81.52	191.62	25.86	1654.28	51.41	132.92	249295
30	12.25	84.55	196.18	26.73	1691.51	54.14	138.69	249295
31	11.90	87.59	200.75	27.59	1728.73	66.17	153.76	249295
32	11.75	89.06	202.53	27.93	1743.29	50.28	139.33	249295
33	10.06	105.61	222.62	31.73	1907.09	57.29	162.90	249295
34	8.38	122.17	242.72	35.53	2070.99	64.52	186.69	249295
35	6.69	138.72	262.84	39.33	2235.06	72.14	210.86	249295
36	5.00	155.27	282.98	43.14	2399.35	82.30	237.57	249295

(continued)

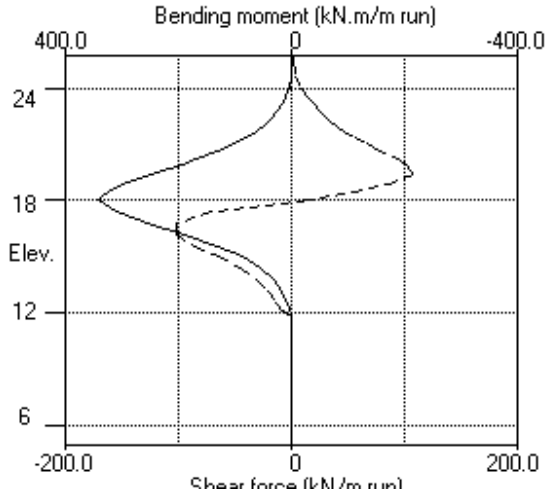
Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

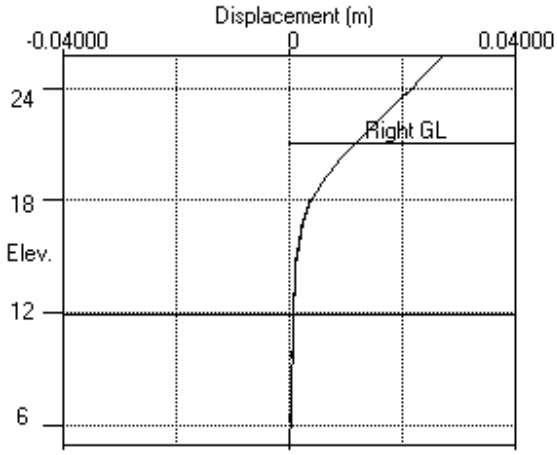
RIGHT side

Node no.	Y coord	Water press.	Effective stresses Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.19	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	1190.00	0.00	0.00a	199518
13	20.73	Total>	6.32	2.65w	1196.32	2.65	2.65a	199518
14	20.17	Total>	19.42	8.14w	1209.42	10.17	10.17	199518
15	20.00	Total>	23.40	9.81w	1213.40	13.16	13.16	199518
16	19.90	Total>	25.75	10.79w	1215.75	18.33	18.33	199518
		0.00	25.75	4.42	246.52	5.38	5.38	99759
17	19.40	5.47	31.28	5.37	299.55	58.41	63.89	99759
18	19.00	9.85	35.72	6.14	342.05	100.58	110.44	99759
19	18.60	14.23	40.17	6.90	384.62	126.01	140.24	99759
20	18.00	20.80	46.86	8.05	448.66	109.41	130.21	99759
		20.80	46.86	0.00	473.70	241.27	262.07	249397
21	17.40	27.37	53.57	0.00	528.46	111.85	139.22	249397
22	16.80	33.94	60.32	1.03	583.47	53.51	87.45	249397
23	16.20	40.51	67.10	2.31	638.76	31.15	71.66	249397
24	15.60	47.08	73.91	3.60	694.35	24.53	71.61	249397
25	15.00	53.65	80.77	4.90	750.26	25.67	79.32	249397
26	14.40	60.21	87.66	6.20	806.50	29.98	90.20	249397
27	13.80	66.78	94.60	7.51	863.08	35.07	101.86	249397
28	13.20	73.35	101.58	8.83	920.01	39.62	112.97	249397
29	12.60	79.92	108.61	10.16	977.28	42.77	122.69	249397
30	12.25	83.75	112.72	10.94	1010.84	42.45	126.20	249397
31	11.90	87.59	116.85	11.72	1044.51	34.46	122.04	249397
32	11.75	89.06	118.79	12.09	1060.37	50.06	139.11	249397
33	10.06	105.61	140.83	16.26	1240.11	57.27	162.89	249397
34	8.38	122.17	163.14	20.48	1422.02	64.51	186.67	249397
35	6.69	138.72	185.66	24.74	1605.67	72.14	210.86	249397
36	5.00	155.27	208.33	29.02	1790.58	82.61	237.89	249397

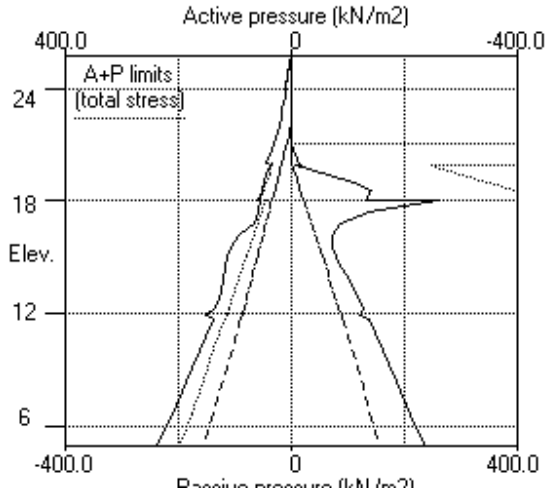
Note: 2.65 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

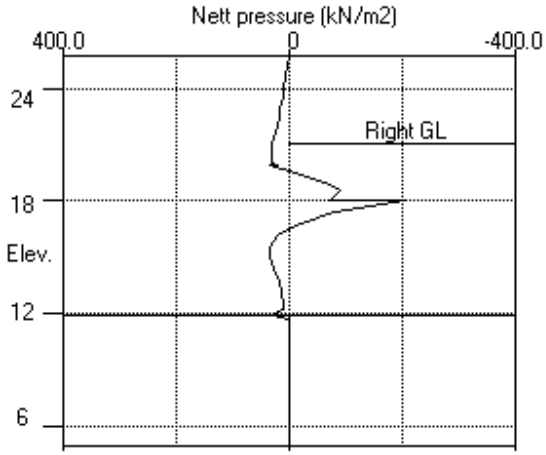
Stage No.4 Fill to elev. 21.00 on RIGHT side





Stage No.4 Fill to elev. 21.00 on RIGHT side





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.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 11.90** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
2	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
3	25.70	19.90	Cant.	1.682	12.79	14.69	5.21	L to R
4	25.70	21.00	Cant.	4.466	12.48	19.57	1.43	L to R
5	25.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: Serviceability Limit State

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

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment				Shear force			
				Calculated		Factored		Calculated		Factored	
no.	coord	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	25.70	0.028	0.000	0	-0	0	-0	0	0	0	0
2	25.15	0.026	0.000	0	-0	0	-0	1	-0	1	-1
3	24.60	0.024	0.000	2	-0	2	-1	4	-1	5	-2
4	24.00	0.022	0.000	5	-1	7	-2	9	-2	12	-2
5	23.58	0.020	0.000	10	-2	14	-3	14	-2	19	-3
6	23.19	0.019	0.000	16	-3	22	-4	19	-2	25	-3
7	22.80	0.018	0.000	24	-4	33	-5	25	-2	33	-3
8	22.40	0.016	0.000	36	-5	48	-6	32	-3	43	-3
9	22.00	0.015	0.000	50	-5	67	-7	44	-3	59	-4
10	21.70	0.014	0.000	63	-6	85	-8	54	-3	73	-4
11	21.35	0.013	0.000	82	-7	111	-9	67	-3	91	-4
12	21.00	0.012	0.000	108	-8	146	-10	82	-3	110	-3
13	20.73	0.011	0.000	132	-8	178	-11	94	-1	126	-2
14	20.17	0.009	0.000	182	-8	246	-11	103	0	139	0
15	20.00	0.009	0.000	195	-8	263	-10	102	0	137	0
16	19.90	0.009	0.000	203	-7	275	-10	105	0	142	0
17	19.40	0.007	0.000	251	-6	339	-7	109	0	147	0
18	19.00	0.006	0.000	291	-4	393	-5	93	0	126	0
19	18.60	0.005	0.000	322	-2	435	-3	64	0	86	0
20	18.00	0.004	0.000	344	0	464	0	17	0	23	0
21	17.40	0.003	0.000	315	0	426	0	2	-73	2	-98
22	16.80	0.002	0.000	258	0	348	0	0	-103	0	-139
23	16.20	0.002	0.000	192	0	259	0	0	-103	0	-139
24	15.60	0.002	0.000	134	0	180	0	0	-86	0	-116
25	15.00	0.001	0.000	88	0	119	0	0	-65	0	-88
26	14.40	0.001	0.000	56	0	75	0	0	-46	0	-62
27	13.80	0.001	0.000	33	0	45	0	0	-32	0	-43
28	13.20	0.001	0.000	18	0	24	0	0	-21	0	-29
29	12.60	0.001	0.000	7	0	10	0	0	-14	0	-19
30	12.25	0.001	0.000	3	0	4	0	0	-10	0	-14
31	11.90	0.001	0.000	0	0	0	0	0	-2	0	-3
32	11.75	0.001	0.000	0	0	0	0	0	0	0	0
33	10.06	0.001	0.000	0	0	0	0	0	0	0	0
34	8.38	0.000	0.000	0	0	0	0	0	0	0	0
35	6.69	0.000	0.000	0	0	0	0	0	0	0	0
36	5.00	0.000	0.000	0	0	0	0	0	0	0	0

Summary of results (continued)

Calculated Bending Moments and Prop 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 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	4	16.80	-8	20.73	5	-11	6	18.00	-3	21.35	9	-4
2	6	17.40	-8	20.73	8	-10	7	18.00	-2	22.00	9	-3
3	344	18.00	-0	25.70	464	-0	109	19.40	-103	16.20	147	-139
4	342	18.00	-0	25.70	462	-0	106	19.40	-103	16.80	143	-138
5	No calculation at this stage											
6	No calculation at this stage											
7	No calculation at this stage											
8	336	18.00	-0	25.70	453	-0	103	20.17	-100	16.80	139	-135

Maximum and minimum displacement at each stage

Stage no.	Displacement				
	maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.000	21.70	0.000	25.70	Apply water pressure profile no.1
2	0.000	25.70	0.000	25.70	Apply surcharge no.1 at elev. 25.70
3	0.028	25.70	0.000	25.70	Excav. to elev. 19.90 on RIGHT side
4	0.027	25.70	0.000	25.70	Fill to elev. 21.00 on RIGHT side
5	No calculation at this stage				Install prop no.4 at elev. 20.17
6	No calculation at this stage				Install prop no.3 at elev. 20.73
7	No calculation at this stage				Install prop no.2 at elev. 23.58
8	0.027	25.70	0.000	25.70	Apply water pressure profile no.3

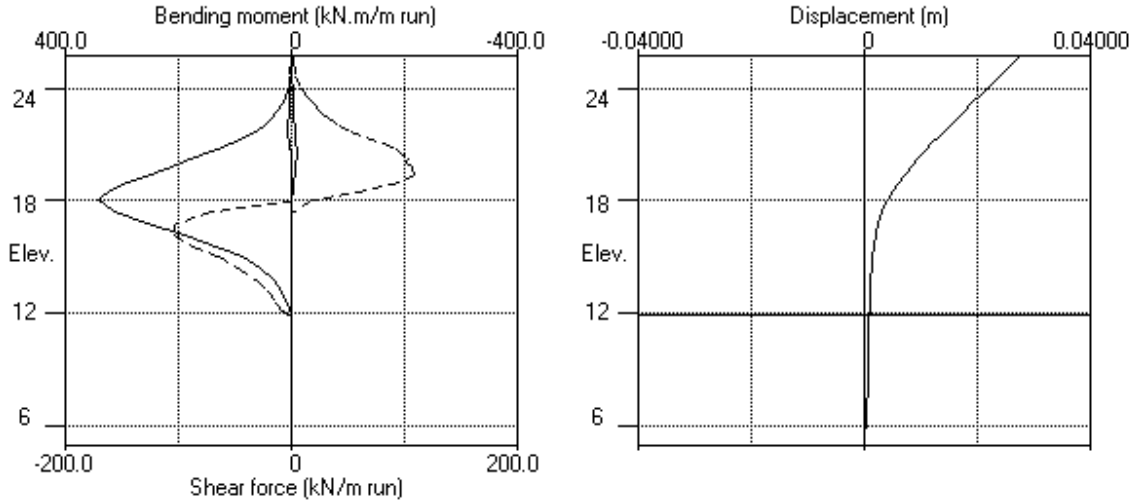
Summary of results (continued)

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

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 2 at elev. 23.58			Prop no. 3 at elev. 20.73			Prop no. 4 at elev. 20.17		
	--Calculated-- kN per m run	kN per prop	Factored kN per prop	--Calculated-- kN per m run	kN per prop	Factored kN per prop	--Calculated-- kN per m run	kN per prop	Factored kN per prop
8	7	7	10	16	16	21	29	29	39

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	25.70	1 Fill	1 Fill
2	21.70	2 Alluvial Gravel	2 Alluvial Gravel
3	20.00	3 Weath Sandstone	3 Weath Sandstone
4	18.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES (Unfactored SLS soil strengths)
Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

Water press. profile no.	Point no.	Left side Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Right side Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	22.00	22.00	0.0	1	19.90	19.90	0.0	MC
2	1	23.00	23.00	0.0	1	19.40	19.40	0.0	WC
3	1	24.00	24.00	0.0	1	19.40	19.40	0.0	MC
4	1	24.90	24.90	0.0	1	19.90	19.90	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 11.90
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.017300 m4/m run
E.I = 484400 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

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	25.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.30 Var

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 water pressure profile no.2 (Worst Cred.)
2	Apply surcharge no.1 at elevation 25.70
3	Excavate to elevation 19.40 on RIGHT side
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Install strut or anchor no.4 at elevation 20.17
6	Install strut or anchor no.3 at elevation 20.73
7	Install strut or anchor no.2 at elevation 23.58
8	Apply water pressure profile no.4 (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 = 5.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

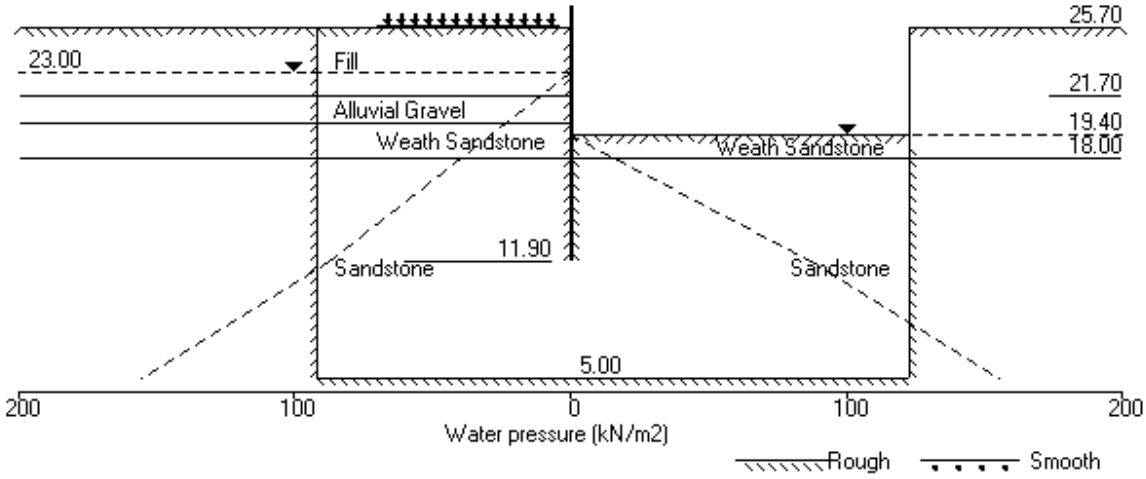
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.2	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.70	Yes	Yes	Yes
3	Excav. to elev. 19.40 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	No	No	No
5	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
6	Install prop no.3 at elev. 20.73	No	No	No
7	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
8	Apply water pressure profile no.4	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 19.40 on RIGHT side



Units: kN,m

Stage No. 3 Excavate to elevation 19.40 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall FoS for toe elev. = 11.90 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr-ation	Direction of failure
3	25.70	19.40	Cant.	1.155	12.69	13.35	6.05	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary

Right side 20.00 from wall — Rough boundary

Lower rigid boundary at elevation 5.00 — Rough boundary

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	Prop forces kN/m
1	25.70	0.00	0.091	9.37E-03	0.0	-0.0	
2	25.30	2.59	0.087	9.37E-03	0.5	0.1	
3	24.90	5.58	0.083	9.37E-03	2.2	0.7	
4	24.57	8.18	0.080	9.37E-03	4.4	1.7	
5	24.24	10.75	0.077	9.37E-03	7.6	3.7	
6	23.91	13.24	0.074	9.37E-03	11.5	6.9	
7	23.58	15.66	0.071	9.36E-03	16.3	11.5	
8	23.00	19.68	0.065	9.34E-03	26.5	23.8	
9	22.50	25.67	0.061	9.31E-03	37.8	39.8	
10	22.00	31.57	0.056	9.25E-03	52.1	62.2	
11	21.70	35.09	0.053	9.21E-03	62.1	79.4	
12	21.35	39.17	0.050	9.14E-03	75.1	103.3	
13	21.00	43.23	0.047	9.06E-03	89.6	132.1	
14	20.73	46.35	0.045	8.98E-03	101.6	157.9	
15	20.17	52.79	0.040	8.76E-03	129.4	222.5	
16	20.00	54.74	0.038	8.68E-03	138.5	245.3	
		44.45	0.038	8.68E-03	138.5	245.3	
17	19.90	45.57	0.037	8.62E-03	143.0	259.3	
18	19.40	51.16	0.033	8.32E-03	167.2	336.7	
19	19.00	26.46	0.030	8.01E-03	182.8	407.3	
20	18.60	1.73	0.027	7.64E-03	188.4	482.5	
21	18.00	-35.42	0.022	6.97E-03	178.3	595.7	
		-86.73	0.022	6.97E-03	178.3	595.7	
22	17.40	-119.45	0.018	6.18E-03	116.4	687.0	
23	16.80	-152.32	0.015	5.30E-03	34.9	735.3	
24	16.20	-185.36	0.012	4.39E-03	-66.4	728.7	
25	15.60	-115.85	0.010	3.54E-03	-156.8	655.4	
26	15.00	-38.70	0.008	2.79E-03	-203.1	540.3	
27	14.40	1.77	0.006	2.21E-03	-214.2	411.4	
28	13.80	33.21	0.005	1.78E-03	-203.7	283.0	

(continued)

Stage No.3 Excavate to elevation 19.40 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
29	13.20	55.78	0.004	1.50E-03	-177.0	166.7	
30	12.60	80.46	0.003	1.35E-03	-136.2	70.4	
31	12.25	123.51	0.003	1.31E-03	-100.5	27.6	
32	11.90	315.49	0.002	1.30E-03	-23.6	0.0	
33	11.75	0.25	0.002	0	0.0	0.0	
34	10.06	0.03	0.002	0	0.3	0.0	
35	8.38	0.02	0.001	0	0.3	0.0	
36	6.69	0.02	0.000	0	0.4	0.0	
37	5.00	-0.40	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12465
2	25.30	0.00	7.55	2.59	25.38	2.59	2.59a	12465
3	24.90	0.00	16.25	5.58	54.62	5.58	5.58a	12465
4	24.57	0.00	23.84	8.18	80.10	8.18	8.18a	12465
5	24.24	0.00	31.33	10.75	105.26	10.75	10.75a	12465
6	23.91	0.00	38.58	13.24	129.65	13.24	13.24a	12465
7	23.58	0.00	45.61	15.66	153.25	15.66	15.66a	12465
8	23.00	0.00	57.35	19.68	192.70	19.68	19.68a	12465
9	22.50	3.96	63.26	21.71	212.55	21.71	25.67a	12465
10	22.00	7.91	68.94	23.66	231.64	23.66	31.57a	12465
11	21.70	10.28	72.26	24.80	242.81	24.80	35.09a	12465
		10.28	72.26	24.80	242.83	24.80	35.09a	29915
12	21.35	13.05	76.08	26.11	255.65	26.11	39.17a	29915
13	21.00	15.82	79.84	27.40	268.28	27.41	43.23a	29915
14	20.73	17.96	82.70	28.39	277.91	28.39	46.35a	29915
15	20.17	22.39	88.57	30.40	297.62	30.40	52.79a	29915
16	20.00	23.73	90.33	31.01	303.55	31.01	54.74a	29915
		23.73	90.33	20.72	537.24	20.72	44.45a	99718
17	19.90	24.53	91.76	21.04	545.77	21.05	45.57a	99718
18	19.40	28.48	98.90	22.68	588.19	22.68	51.16a	99718
19	19.00	31.65	104.57	23.98	621.91	23.98	55.63a	99718
20	18.60	34.81	110.21	25.27	655.46	25.27	60.08a	99718
21	18.00	39.56	118.63	27.20	705.52	27.21	66.76a	99718
		39.56	118.63	20.01	676.13	20.01	59.57a	249295
22	17.40	44.30	127.00	22.10	720.03	22.10	66.41a	249295
23	16.80	49.05	135.34	24.18	763.74	24.18	73.23a	249295
24	16.20	53.80	143.65	26.26	807.30	26.26	80.05a	249295
25	15.60	58.54	151.93	28.33	850.74	28.33	86.87a	249295
26	15.00	63.29	160.20	30.39	894.09	30.39	93.68a	249295
27	14.40	68.04	168.46	32.45	937.37	32.45	100.49a	249295
28	13.80	72.78	176.71	34.51	980.60	46.87	119.66	249295
29	13.20	77.53	184.94	36.57	1023.78	59.39	136.92	249295
30	12.60	82.28	193.18	38.62	1066.94	77.80	160.08	249295
31	12.25	85.05	197.98	39.82	1092.11	122.18	207.23	249295
32	11.90	87.82	202.78	41.02	1117.28	315.49	403.31	249295
33	11.75	89.29	204.55	41.46	1126.57	34.83	124.12A	249295
34	10.06	105.84	224.49	46.44	1231.09	43.65	149.49A	249295
35	8.38	122.40	244.45	51.42	1335.70	51.55	173.94	249295
36	6.69	138.95	264.43	56.41	1440.45	60.98	199.93	249295
37	5.00	155.50	284.45	61.41	1545.39	75.21	230.71	249295

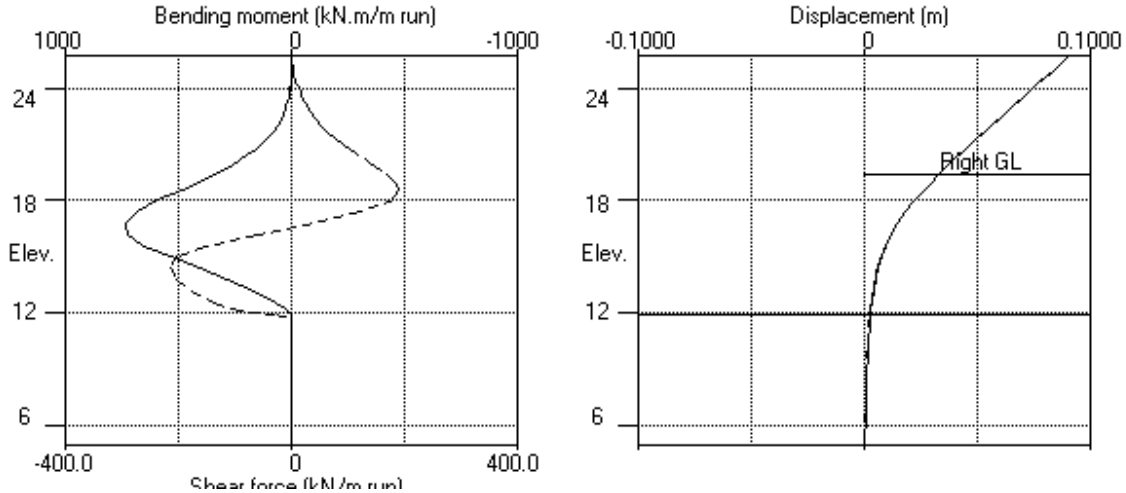
(continued)

Stage No.3 Excavate to elevation 19.40 on RIGHT side

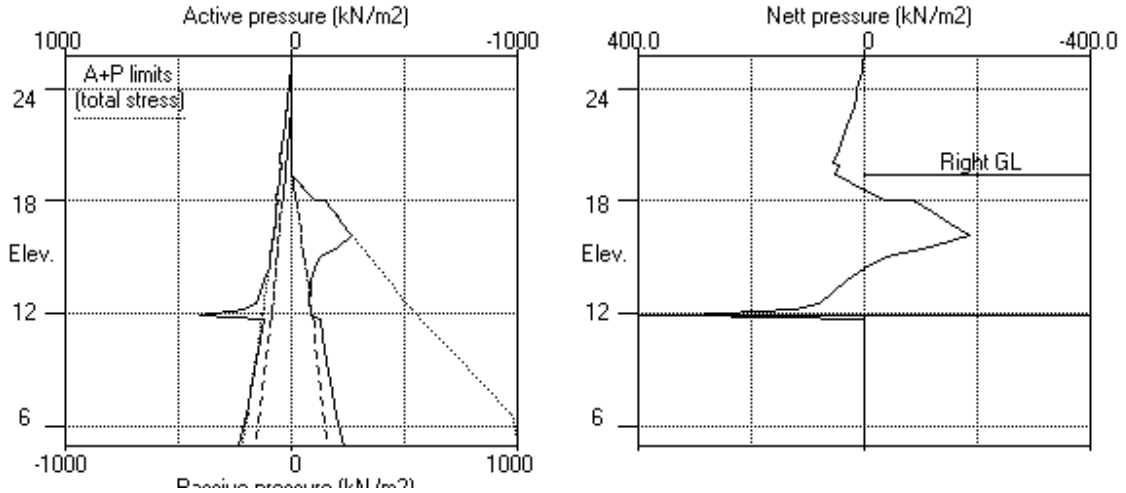
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.57	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	24.24	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	19.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	19.40	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	99789
19	19.00	4.68	4.12	0.94	24.49	24.48	29.17p	99789
20	18.60	9.37	8.24	1.89	48.98	48.98	58.35p	99789
21	18.00	16.39	14.42	3.31	85.79	85.79	102.18p	99789
		16.39	14.42	0.00	129.91	129.91	146.30p	249471
22	17.40	23.42	20.63	0.00	162.44	162.44	185.86p	249471
23	16.80	30.44	26.86	0.00	195.11	195.11	225.55p	249471
24	16.20	37.47	33.13	0.00	227.95	227.95	265.42p	249471
25	15.60	44.49	39.43	0.24	260.99	158.23	202.72	249471
26	15.00	51.52	45.78	1.82	294.26	80.86	132.38	249471
27	14.40	58.54	52.17	3.42	327.77	40.17	98.72	249471
28	13.80	65.57	58.62	5.03	361.57	20.88	86.44	249471
29	13.20	72.59	65.12	6.65	395.64	8.55	81.14	249471
30	12.60	79.62	71.67	8.29	430.01	0.00	79.62A	249471
31	12.25	83.72	75.53	9.25	450.20	0.00	83.72A	249471
32	11.90	87.82	79.40	10.22	470.50	0.00	87.82A	249471
33	11.75	89.29	81.35	10.70	480.72	34.58	123.87	249471
34	10.06	105.84	103.53	16.24	596.98	43.62	149.47	249471
35	8.38	122.40	126.13	21.88	715.46	51.53	173.92	249471
36	6.69	138.95	149.09	27.62	835.84	60.97	199.92	249471
37	5.00	155.50	172.34	33.42	957.72	75.61	231.11	249471

Note: 100.49 a Soil pressure at active limit
265.42 p Soil pressure at passive limit
87.82A Arching - soil pressure below active limit

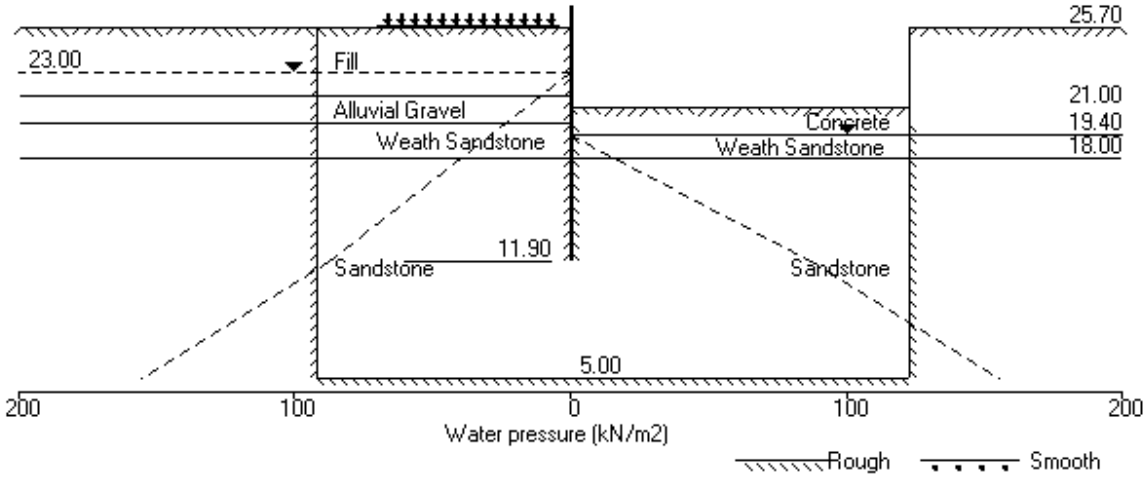
Stage No.3 Excav. to elev. 19.40 on RIGHT side



Stage No.3 Excav. to elev. 19.40 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.90** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr-ation	Direction of failure
4	25.70	21.00	Cant.	3.850	12.42	19.48	1.52	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	25.70	0.00	0.091	9.39E-03	0.0	-0.0	
2	25.30	3.09	0.087	9.39E-03	0.6	0.1	
3	24.90	6.04	0.083	9.39E-03	2.4	0.7	
4	24.57	8.65	0.080	9.39E-03	4.9	1.9	
5	24.24	11.24	0.077	9.39E-03	8.2	4.1	
6	23.91	13.76	0.074	9.38E-03	12.3	7.5	
7	23.58	16.20	0.071	9.38E-03	17.3	12.4	
8	23.00	20.28	0.065	9.36E-03	27.8	25.3	
9	22.50	26.33	0.060	9.32E-03	39.4	42.0	
10	22.00	32.32	0.056	9.27E-03	54.1	65.4	
11	21.70	35.96	0.053	9.22E-03	64.3	83.1	
		37.19	0.053	9.22E-03	64.3	83.1	
12	21.35	41.03	0.050	9.15E-03	78.0	108.0	
13	21.00	45.12	0.047	9.06E-03	93.1	137.9	
14	20.73	45.72	0.044	8.98E-03	105.4	164.6	
15	20.17	46.84	0.039	8.75E-03	131.3	230.5	
16	20.00	48.17	0.038	8.66E-03	139.3	253.5	
		45.44	0.038	8.66E-03	139.3	253.5	
17	19.90	41.68	0.037	8.61E-03	143.7	267.6	
18	19.40	32.36	0.033	8.29E-03	162.2	344.4	
		49.02	0.033	8.29E-03	162.2	344.4	
19	19.00	24.21	0.029	7.98E-03	176.9	412.8	
20	18.60	-0.19	0.026	7.61E-03	181.7	485.5	
21	18.00	-36.98	0.022	6.94E-03	170.5	594.3	
		-73.23	0.022	6.94E-03	170.5	594.3	
22	17.40	-113.89	0.018	6.15E-03	114.4	683.4	
23	16.80	-150.09	0.015	5.27E-03	35.2	731.4	
24	16.20	-184.67	0.012	4.37E-03	-65.2	725.4	
25	15.60	-115.92	0.009	3.52E-03	-155.4	652.9	
26	15.00	-39.09	0.007	2.78E-03	-201.9	538.6	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	14.40	1.30	0.006	2.19E-03	-213.3	410.3	
28	13.80	32.75	0.005	1.76E-03	-203.0	282.5	
29	13.20	55.36	0.004	1.49E-03	-176.6	166.5	
30	12.60	80.11	0.003	1.34E-03	-136.0	70.3	
31	12.25	123.25	0.002	1.30E-03	-100.4	27.6	
32	11.90	315.39	0.002	1.29E-03	-23.6	0.0	
33	11.75	0.24	0.002	0	0.0	0.0	
34	10.06	0.02	0.001	0	0.3	0.0	
35	8.38	0.01	0.001	0	0.3	0.0	
36	6.69	0.01	0.000	0	0.3	0.0	
37	5.00	-0.33	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12465
2	25.30	0.00	7.55	2.59	25.38	3.09	3.09	12465
3	24.90	0.00	16.25	5.58	54.62	6.04	6.04	12465
4	24.57	0.00	23.84	8.18	80.10	8.65	8.65	12465
5	24.24	0.00	31.33	10.75	105.26	11.24	11.24	12465
6	23.91	0.00	38.58	13.24	129.65	13.76	13.76	12465
7	23.58	0.00	45.61	15.66	153.25	16.20	16.20	12465
8	23.00	0.00	57.35	19.68	192.70	20.28	20.28	12465
9	22.50	3.96	63.26	21.71	212.55	22.38	26.33	12465
10	22.00	7.91	68.94	23.66	231.64	24.41	32.32	12465
11	21.70	10.28	72.26	24.80	242.81	25.68	35.96	12465
		10.28	72.26	24.80	242.83	26.91	37.19	29915
12	21.35	13.05	76.08	26.11	255.65	27.98	41.03	29915
13	21.00	15.82	79.84	27.40	268.28	29.29	45.12	29915
14	20.73	17.96	82.70	28.39	277.91	30.41	48.36	29915
15	20.17	22.39	88.57	30.40	297.62	32.59	54.98	29915
16	20.00	23.73	90.33	31.01	303.55	34.25	57.98	29915
		23.73	90.33	20.72	537.24	31.51	55.25	99718
17	19.90	24.53	91.76	21.04	545.77	28.27	52.79	99718
18	19.40	28.48	98.90	22.68	588.19	29.13	57.61	99718
19	19.00	31.65	104.57	23.98	621.91	29.95	61.60	99718
20	18.60	34.81	110.21	25.27	655.46	31.04	65.85	99718
21	18.00	39.56	118.63	27.20	705.52	33.05	72.61	99718
		39.56	118.63	20.01	676.13	34.63	74.19	249295
22	17.40	44.30	127.00	22.10	720.03	32.49	76.79	249295
23	16.80	49.05	135.34	24.18	763.74	32.82	81.87	249295
24	16.20	53.80	143.65	26.26	807.30	34.07	87.87	249295
25	15.60	58.54	151.93	28.33	850.74	35.73	94.27	249295
26	15.00	63.29	160.20	30.39	894.09	37.61	100.90	249295
27	14.40	68.04	168.46	32.45	937.37	39.61	107.64	249295
28	13.80	72.78	176.71	34.51	980.60	54.02	126.80	249295
29	13.20	77.53	184.94	36.57	1023.78	66.54	144.07	249295
30	12.60	82.28	193.18	38.62	1066.94	84.96	167.24	249295
31	12.25	85.05	197.98	39.82	1092.11	129.38	214.42	249295
32	11.90	87.82	202.78	41.02	1117.28	322.75	410.57	249295
33	11.75	89.29	204.55	41.46	1126.57	42.11	131.40	249295
34	10.06	105.84	224.49	46.44	1231.09	50.86	156.70	249295
35	8.38	122.40	244.45	51.42	1335.70	58.66	181.05	249295
36	6.69	138.95	264.43	56.41	1440.45	67.92	206.87	249295
37	5.00	155.50	284.45	61.41	1545.39	80.77	236.28	249295

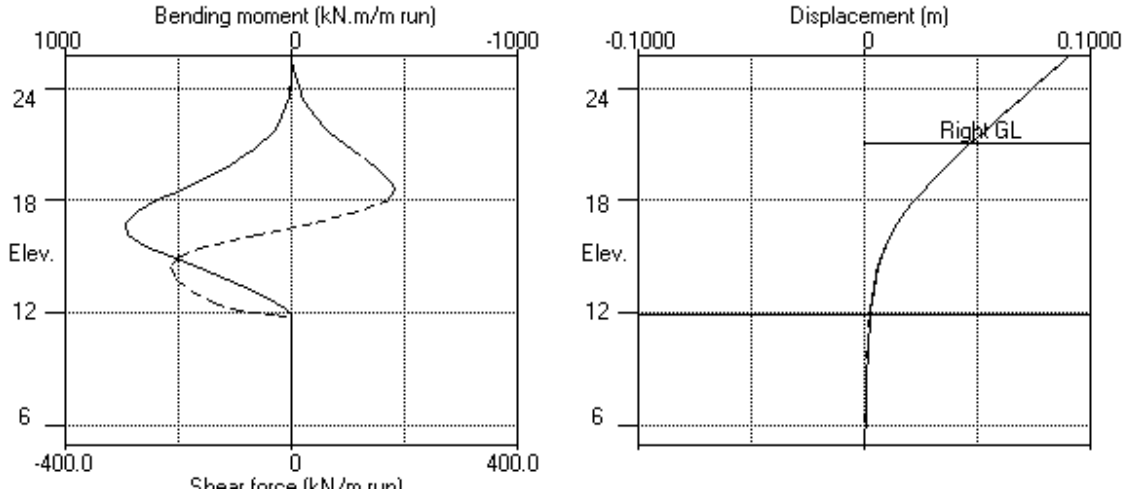
(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

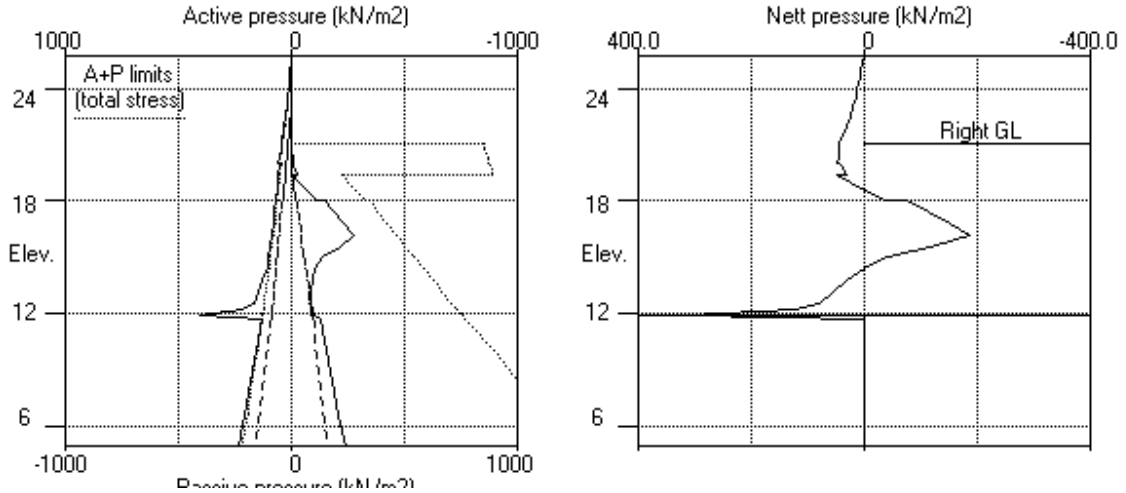
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.57	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	24.24	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	850.00	0.00	0.00a	199518
14	20.73	Total>	6.32	2.65w	856.32	2.65	2.65a	199518
15	20.17	Total>	19.42	8.14w	869.43	8.14	8.14a	199518
16	20.00	Total>	23.40	9.81w	873.41	9.81	9.81a	199518
17	19.90	Total>	25.75	10.79w	875.75	11.12	11.12	199518
18	19.40	Total>	37.46	15.70w	887.47	25.26	25.26	199518
		0.00	37.46	8.59	222.78	8.59	8.59a	99759
19	19.00	4.68	41.59	9.54	247.37	32.70	37.38	99759
20	18.60	9.37	45.73	10.49	272.00	56.67	66.04	99759
21	18.00	16.39	51.97	11.92	309.07	93.20	109.59	99759
		16.39	51.97	3.37	326.70	131.03	147.42	249397
22	17.40	23.42	58.22	4.93	359.51	167.26	190.68	249397
23	16.80	30.44	64.51	6.50	392.48	201.51	231.95	249397
24	16.20	37.47	70.84	8.08	425.62	235.08	272.54	249397
25	15.60	44.49	77.20	9.67	458.96	165.70	210.20	249397
26	15.00	51.52	83.60	11.27	492.51	88.47	139.99	249397
27	14.40	58.54	90.04	12.87	526.27	47.80	106.35	249397
28	13.80	65.57	96.52	14.49	560.25	28.48	94.05	249397
29	13.20	72.59	103.04	16.12	594.45	16.11	88.71A	249397
30	12.60	79.62	109.61	17.76	628.86	7.52	87.13A	249397
31	12.25	83.72	113.46	18.72	649.04	7.45	91.17A	249397
32	11.90	87.82	117.32	19.68	669.29	7.36	95.18A	249397
33	11.75	89.29	119.26	20.17	679.49	41.88	131.16	249397
34	10.06	105.84	141.30	25.67	795.02	50.85	156.69	249397
35	8.38	122.40	163.61	31.24	911.95	58.64	181.04	249397
36	6.69	138.95	186.13	36.86	1029.99	67.91	206.86	249397
37	5.00	155.50	208.80	42.52	1148.85	81.10	236.61	249397

Note: 8.59 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
95.18A Arching - soil pressure below active limit

Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.90** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
2	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
3	25.70	19.40	Cant.	1.155	12.69	13.35	6.05	L to R
4	25.70	21.00	Cant.	3.850	12.42	19.48	1.52	L to R
5	25.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: ULS DA1 Combination 2

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	25.70	0.091	0.000	0.0	-0.0	0.0	0.0
2	25.30	0.087	0.000	0.1	-0.0	0.6	-0.5
3	24.90	0.083	0.000	0.7	-0.4	2.5	-1.6
4	24.57	0.080	0.000	2.0	-1.1	5.2	-2.4
5	24.24	0.077	0.000	4.4	-2.0	9.4	-3.1
6	23.91	0.074	0.000	8.4	-3.1	15.1	-3.6
7	23.58	0.071	0.000	14.6	-4.4	22.2	-4.1
8	23.00	0.065	0.000	25.3	-7.0	27.8	-4.8
9	22.50	0.061	0.000	42.0	-9.4	39.4	-5.0
10	22.00	0.056	0.000	65.4	-11.3	57.5	-4.0
11	21.70	0.053	0.000	83.1	-11.9	70.8	-2.8
12	21.35	0.050	0.000	108.0	-12.4	88.0	-2.1
13	21.00	0.047	0.000	141.1	-12.7	106.5	-0.5
14	20.73	0.045	0.000	171.7	-12.6	121.1	0.0
15	20.17	0.040	0.000	237.8	-10.7	134.5	0.0
16	20.00	0.038	0.000	259.0	-9.5	139.3	0.0
17	19.90	0.037	0.000	272.1	-8.8	143.7	0.0
18	19.40	0.033	0.000	345.5	-5.9	167.2	0.0
19	19.00	0.030	0.000	412.8	-3.4	182.8	0.0
20	18.60	0.027	0.000	485.5	-0.5	188.4	0.0
21	18.00	0.022	0.000	595.7	0.0	178.3	0.0
22	17.40	0.018	0.000	687.0	0.0	116.4	0.0
23	16.80	0.015	0.000	735.3	0.0	35.9	-2.4
24	16.20	0.012	0.000	728.7	0.0	0.0	-66.4
25	15.60	0.010	0.000	655.4	0.0	0.0	-156.8
26	15.00	0.008	0.000	540.3	0.0	0.0	-203.1
27	14.40	0.006	0.000	411.4	0.0	0.0	-214.2
28	13.80	0.005	0.000	283.0	0.0	0.0	-203.7
29	13.20	0.004	0.000	166.7	0.0	0.0	-177.0
30	12.60	0.003	0.000	70.4	0.0	0.0	-136.2
31	12.25	0.003	0.000	27.6	0.0	0.0	-100.5
32	11.90	0.002	0.000	0.0	0.0	0.0	-23.6
33	11.75	0.002	0.000	0.0	0.0	0.0	-0.0
34	10.06	0.002	0.000	0.0	0.0	0.3	-0.0
35	8.38	0.001	0.000	0.0	0.0	0.3	-0.0
36	6.69	0.000	0.000	0.0	0.0	0.4	-0.0
37	5.00	0.000	0.000	0.0	0.0	0.0	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	7.2	17.40	-12.7	21.00	9.7	18.00	-5.0	22.50
2	10.5	17.40	-12.4	21.35	10.5	18.00	-4.8	23.00
3	735.3	16.80	-0.0	25.70	188.4	18.60	-214.2	14.40
4	731.4	16.80	-0.0	25.70	181.7	18.60	-213.3	14.40
5	No calculation at this stage							
6	No calculation at this stage							
7	No calculation at this stage							
8	729.8	16.80	-0.0	25.70	179.8	18.60	-212.9	14.40

Maximum and minimum displacement at each stage

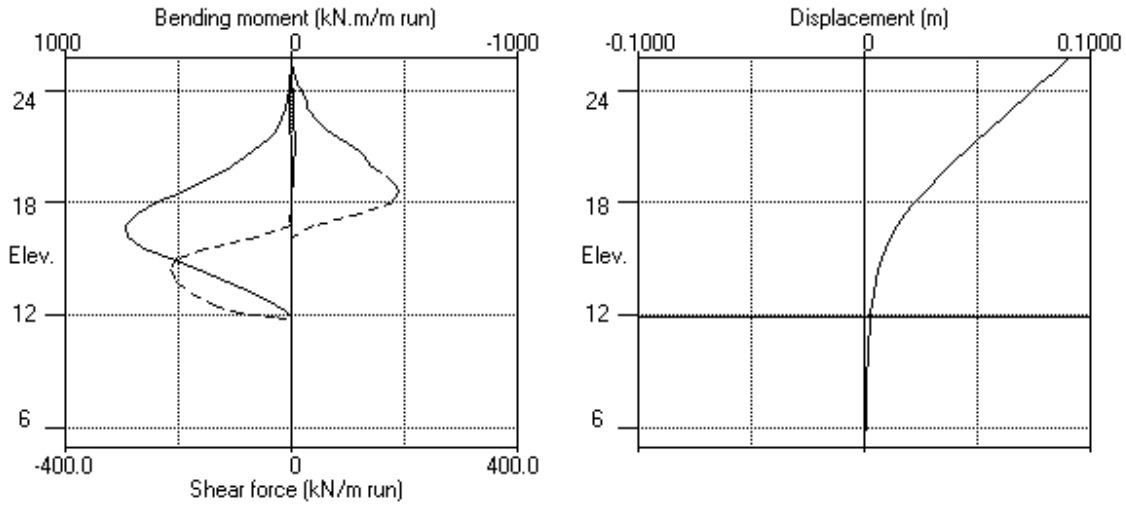
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.001	22.50	0.000	25.70	Apply water pressure profile no.2
2	0.001	25.70	0.000	25.70	Apply surcharge no.1 at elev. 25.70
3	0.091	25.70	0.000	25.70	Excav. to elev. 19.40 on RIGHT side
4	0.091	25.70	0.000	25.70	Fill to elev. 21.00 on RIGHT side
5	No calculation at this stage				Install prop no.4 at elev. 20.17
6	No calculation at this stage				Install prop no.3 at elev. 20.73
7	No calculation at this stage				Install prop no.2 at elev. 23.58
8	0.091	25.70	0.000	25.70	Apply water pressure profile no.4

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	--- Strut no. 2 --- at elev. 23.58		--- Strut no. 3 --- at elev. 20.73		--- Strut no. 4 --- at elev. 20.17	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
8	17.13	17.13	18.09	18.09	15.02	15.02

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	25.70	1 Fill	1 Fill
2	21.70	2 Alluvial Gravel	2 Alluvial Gravel
3	20.00	3 Weath Sandstone	3 Weath Sandstone
4	18.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES

Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

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	22.00	22.00	0.0	1	19.50	19.50	0.0	MC
2	1	23.00	23.00	0.0	1	19.00	19.00	0.0	WC
3	1	24.00	24.00	0.0	1	19.00	19.00	0.0	MC
4	1	24.90	24.90	0.0	1	19.50	19.50	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 11.40
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.038200 m4/m run
E.I = 1.0696E+06 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

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	25.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.00 Var

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 water pressure profile no.1 (Mod. Conserv.)
2	Apply surcharge no.1 at elevation 25.70
3	Excavate to elevation 19.50 on RIGHT side
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Install strut or anchor no.4 at elevation 20.17
6	Install strut or anchor no.3 at elevation 20.73
7	Install strut or anchor no.2 at elevation 23.58
8	Apply water pressure profile no.3 (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 = 1.25

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

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough

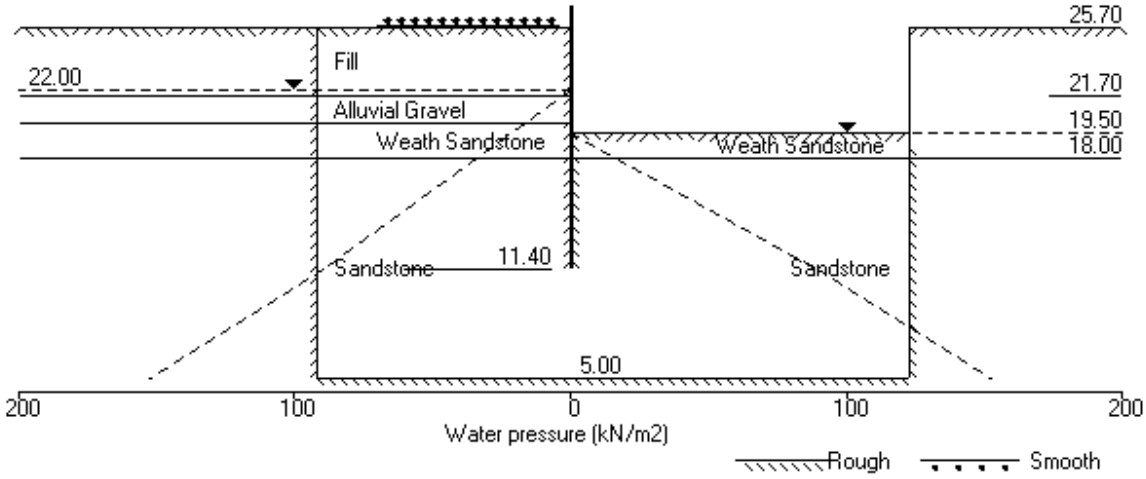
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.1	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.70	Yes	Yes	Yes
3	Excav. to elev. 19.50 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	No	No	No
5	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
6	Install prop no.3 at elev. 20.73	No	No	No
7	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
8	Apply water pressure profile no.3	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 19.50 on RIGHT side



Units: kN,m

Stage No. 3 Excavate to elevation 19.50 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 11.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
3	25.70	19.50	Cant.	1.624	12.28	14.00	5.50	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
Limit State: Serviceability Limit State
Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.70	0.00	0.020	2.16E-03	0.0	0.0	
2	25.15	2.87	0.018	2.16E-03	0.8	0.3	
3	24.60	6.11	0.017	2.16E-03	3.3	1.4	
4	24.00	9.61	0.016	2.16E-03	8.0	4.9	
5	23.58	11.99	0.015	2.15E-03	12.6	9.2	
6	23.19	14.11	0.014	2.15E-03	17.6	15.1	
7	22.80	16.17	0.013	2.14E-03	23.5	23.1	
8	22.40	18.27	0.012	2.13E-03	30.4	33.9	
9	22.00	20.34	0.012	2.12E-03	38.1	47.6	
10	21.70	23.73	0.011	2.10E-03	44.7	60.0	
11	21.35	27.68	0.010	2.08E-03	53.7	77.2	
12	21.00	31.61	0.009	2.05E-03	64.1	97.8	
13	20.73	34.63	0.009	2.02E-03	73.0	116.3	
14	20.17	40.89	0.008	1.95E-03	94.2	163.0	
15	20.00	42.79	0.007	1.92E-03	101.3	179.6	
		33.21	0.007	1.92E-03	101.3	179.6	
16	19.50	38.64	0.007	1.83E-03	119.3	234.6	
17	19.00	-13.60	0.006	1.70E-03	125.5	298.6	
18	18.50	-65.88	0.005	1.55E-03	105.6	359.6	
19	18.00	-72.84	0.004	1.37E-03	71.0	404.2	
		-194.90	0.004	1.37E-03	71.0	404.2	
20	17.40	-113.52	0.003	1.14E-03	-21.6	411.6	
21	16.80	-54.13	0.003	9.24E-04	-71.9	378.1	
22	16.20	-23.52	0.002	7.26E-04	-95.2	325.2	
23	15.60	2.25	0.002	5.61E-04	-101.5	263.8	
24	15.00	17.80	0.002	4.30E-04	-95.5	203.2	
25	14.40	23.33	0.001	3.31E-04	-83.2	149.1	
26	13.80	23.42	0.001	2.61E-04	-69.2	103.3	
27	13.20	21.39	0.001	2.13E-04	-55.7	65.9	

(continued)

Stage No.3 Excavate to elevation 19.50 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	12.60	19.77	0.001	1.84E-04	-43.4	36.3	
29	12.00	24.40	0.001	1.70E-04	-30.1	13.8	
30	11.40	60.79	0.001	1.67E-04	-4.6	-0.0	
31	11.25	0.23	0.001	0	0.0	0.0	
32	9.69	0.02	0.001	0	0.2	0.0	
33	8.13	0.02	0.000	0	0.2	0.0	
34	6.56	0.01	0.000	0	0.3	0.0	
35	5.00	-0.35	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.15	0.00	10.51	2.87	48.72	2.87	2.87a	12463
3	24.60	0.00	22.36	6.11	103.58	6.11	6.11a	12463
4	24.00	0.00	35.18	9.61	163.00	9.61	9.61a	12463
5	23.58	0.00	43.91	11.99	203.45	11.99	11.99a	12463
6	23.19	0.00	51.65	14.11	239.30	14.11	14.11a	12463
7	22.80	0.00	59.22	16.17	274.38	16.17	16.17a	12463
8	22.40	0.00	66.90	18.27	309.99	18.27	18.27a	12463
9	22.00	0.00	74.48	20.34	345.10	20.34	20.34a	12463
10	21.70	2.55	77.56	21.18	359.37	21.18	23.73a	12463
		2.55	77.56	21.19	359.40	21.19	23.74a	29912
11	21.35	5.52	81.11	22.15	375.83	22.15	27.68a	29912
12	21.00	8.50	84.61	23.11	392.05	23.11	31.61a	29912
13	20.73	10.79	87.28	23.84	404.44	23.84	34.63a	29912
14	20.17	15.55	92.77	25.34	429.87	25.34	40.89a	29912
15	20.00	17.00	94.42	25.79	437.52	25.79	42.79a	29912
		17.00	94.42	16.22	904.11	16.22	33.21a	99705
16	19.50	21.25	101.25	17.39	969.49	17.39	38.64a	99705
17	19.00	25.50	108.04	18.56	1034.47	18.56	44.05a	99705
18	18.50	29.74	114.79	19.72	1099.14	19.72	49.46a	99705
19	18.00	33.99	121.51	20.87	1163.53	20.87	54.87a	99705
		33.99	121.51	12.60	1082.56	12.60	46.60a	249264
20	17.40	39.09	129.55	14.12	1148.12	14.12	53.22a	249264
21	16.80	44.19	137.57	15.64	1213.47	15.64	59.83a	249264
22	16.20	49.29	145.56	17.15	1278.63	17.15	66.44a	249264
23	15.60	54.39	153.53	18.66	1343.66	28.16	82.55	249264
24	15.00	59.49	161.49	20.16	1408.57	37.94	97.43	249264
25	14.40	64.59	169.44	21.67	1473.40	43.09	107.67	249264
26	13.80	69.69	177.38	23.17	1538.16	45.77	115.46	249264
27	13.20	74.79	185.32	24.67	1602.88	47.59	122.37	249264
28	12.60	79.89	193.25	26.17	1667.56	49.74	129.63	249264
29	12.00	84.99	201.18	27.67	1732.23	55.07	140.05	249264
30	11.40	90.08	209.11	29.17	1796.88	77.22	167.31	249264
31	11.25	91.56	210.89	29.51	1811.44	46.57	138.12	249264
32	9.69	106.88	229.49	33.03	1963.12	53.32	160.20	249264
33	8.13	122.21	248.10	36.55	2114.90	60.13	182.34	249264
34	6.56	137.54	266.73	40.07	2266.84	67.34	204.88	249264
35	5.00	152.87	285.39	43.60	2418.97	78.32	231.19	249264

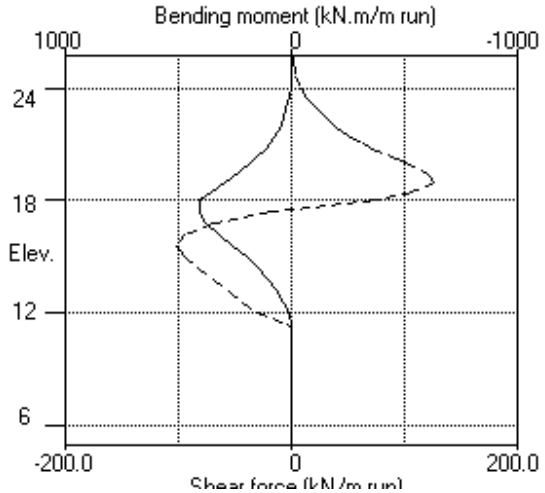
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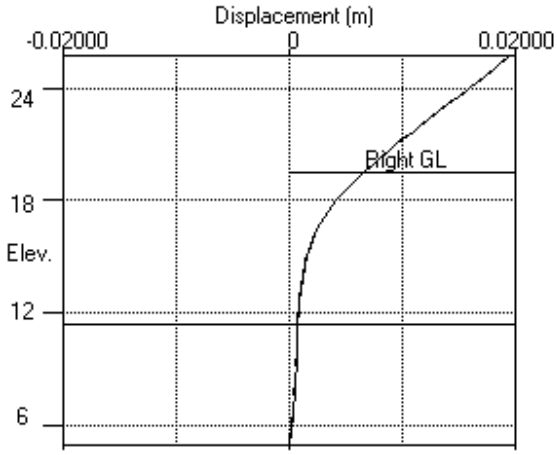
Stage No.3 Excavate to elevation 19.50 on RIGHT side

		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.19	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	19.50	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	99777
17	19.00	5.56	5.44	0.93	52.09	52.09	57.65p	99777
18	18.50	11.12	10.88	1.87	104.22	104.22	115.34p	99777
19	18.00	16.68	16.34	2.81	156.44	111.03	127.71	99777
		16.68	16.34	0.00	224.82	224.82	241.50p	249443
20	17.40	23.36	22.90	0.00	278.33	143.39	166.74	249443
21	16.80	30.03	29.49	0.00	332.06	83.93	113.96	249443
22	16.20	36.70	36.11	0.00	386.06	53.26	89.96	249443
23	15.60	43.37	42.77	0.00	440.36	36.92	80.29	249443
24	15.00	50.05	49.47	0.00	495.02	29.58	79.63	249443
25	14.40	56.72	56.22	0.25	550.08	27.62	84.34	249443
26	13.80	63.39	63.02	1.54	605.55	28.65	92.04	249443
27	13.20	70.07	69.88	2.84	661.46	30.92	100.98	249443
28	12.60	76.74	76.79	4.15	717.82	33.12	109.86	249443
29	12.00	83.41	83.76	5.46	774.65	32.24	115.65	249443
30	11.40	90.08	90.78	6.79	831.93	16.44	106.52	249443
31	11.25	91.56	92.74	7.16	847.93	46.34	137.89	249443
32	9.69	106.88	113.38	11.07	1016.21	53.30	160.18	249443
33	8.13	122.21	134.36	15.03	1187.29	60.11	182.32	249443
34	6.56	137.54	155.63	19.06	1360.76	67.33	204.87	249443
35	5.00	152.87	177.13	23.12	1536.12	78.67	231.54	249443

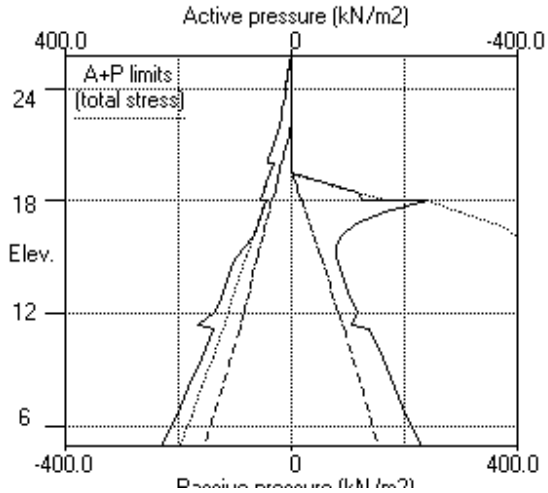
Note: 66.44 a Soil pressure at active limit
241.50 p Soil pressure at passive limit

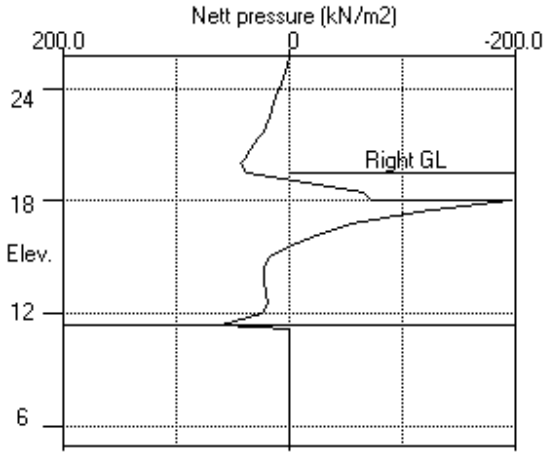
Stage No.3 Excav. to elev. 19.50 on RIGHT side



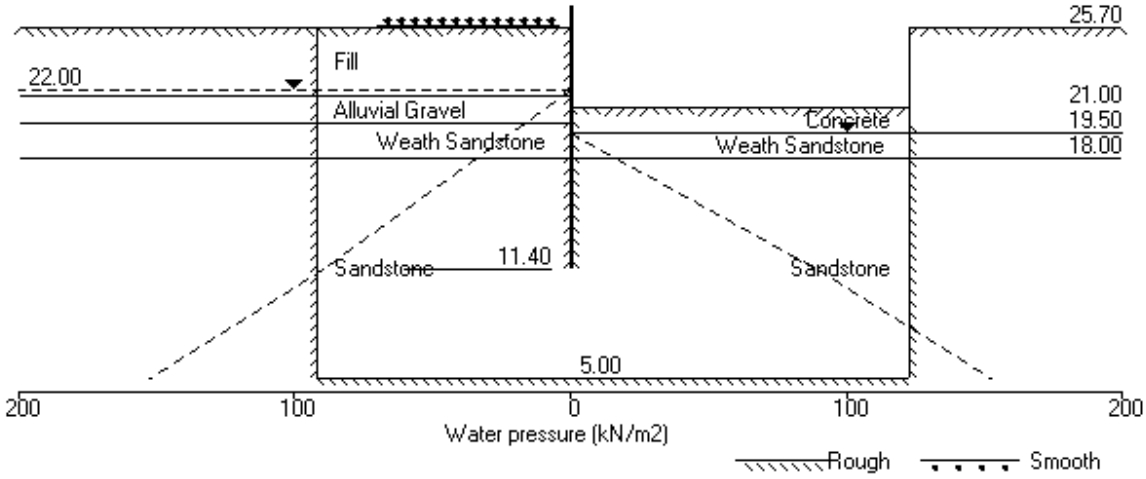


Stage No.3 Excav. to elev. 19.50 on RIGHT side





Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 11.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
4	25.70	21.00	Cant.	5.212	11.91	19.57	1.43	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
Limit State: Serviceability Limit State
Calculated Bending Moments and Prop 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	Prop forces kN/m
1	25.70	0.00	0.019	2.16E-03	0.0	0.0	
2	25.15	3.55	0.018	2.16E-03	1.0	0.3	
3	24.60	6.71	0.017	2.16E-03	3.8	1.7	
4	24.00	10.20	0.016	2.16E-03	8.9	5.5	
5	23.58	12.60	0.015	2.15E-03	13.7	10.3	
6	23.19	14.73	0.014	2.15E-03	19.0	16.7	
7	22.80	16.82	0.013	2.14E-03	25.1	25.2	
8	22.40	18.96	0.012	2.13E-03	32.3	36.7	
9	22.00	21.09	0.011	2.11E-03	40.3	51.3	
10	21.70	24.61	0.011	2.10E-03	47.1	64.3	
		25.84	0.011	2.10E-03	47.1	64.3	
11	21.35	29.45	0.010	2.07E-03	56.8	82.5	
12	21.00	33.34	0.009	2.04E-03	67.8	104.3	
13	20.73	33.79	0.009	2.01E-03	76.9	123.8	
14	20.17	34.52	0.008	1.94E-03	96.0	171.9	
15	20.00	34.54	0.007	1.91E-03	101.9	188.7	
		30.18	0.007	1.91E-03	101.9	188.7	
16	19.50	19.55	0.006	1.81E-03	114.3	243.1	
		37.11	0.006	1.81E-03	114.3	243.1	
17	19.00	-16.24	0.005	1.68E-03	119.5	304.5	
18	18.50	-68.15	0.005	1.52E-03	98.4	362.2	
19	18.00	-74.55	0.004	1.34E-03	62.7	402.8	
		-182.87	0.004	1.34E-03	62.7	402.8	
20	17.40	-108.02	0.003	1.12E-03	-24.5	407.5	
21	16.80	-51.35	0.002	9.02E-04	-72.3	373.3	
22	16.20	-22.16	0.002	7.08E-04	-94.4	320.5	
23	15.60	2.75	0.002	5.45E-04	-100.2	259.9	
24	15.00	17.79	0.001	4.16E-04	-94.1	200.2	
25	14.40	23.04	0.001	3.19E-04	-81.8	146.9	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	13.80	22.99	0.001	2.49E-04	-68.0	101.9	
27	13.20	20.90	0.001	2.02E-04	-54.8	65.1	
28	12.60	19.27	0.001	1.74E-04	-42.8	35.9	
29	12.00	23.94	0.001	1.60E-04	-29.8	13.7	
30	11.40	60.36	0.001	1.56E-04	-4.5	-0.0	
31	11.25	0.21	0.001	0	0.0	0.0	
32	9.69	0.01	0.000	0	0.2	0.0	
33	8.13	0.01	0.000	0	0.2	0.0	
34	6.56	0.01	0.000	0	0.2	0.0	
35	5.00	-0.29	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.15	0.00	10.51	2.87	48.72	3.55	3.55	12463
3	24.60	0.00	22.36	6.11	103.58	6.71	6.71	12463
4	24.00	0.00	35.18	9.61	163.00	10.20	10.20	12463
5	23.58	0.00	43.91	11.99	203.45	12.60	12.60	12463
6	23.19	0.00	51.65	14.11	239.30	14.73	14.73	12463
7	22.80	0.00	59.22	16.17	274.38	16.82	16.82	12463
8	22.40	0.00	66.90	18.27	309.99	18.96	18.96	12463
9	22.00	0.00	74.48	20.34	345.10	21.09	21.09	12463
10	21.70	2.55	77.56	21.18	359.37	22.06	24.61	12463
		2.55	77.56	21.19	359.40	23.29	25.84	29912
11	21.35	5.52	81.11	22.15	375.83	23.92	29.45	29912
12	21.00	8.50	84.61	23.11	392.05	24.84	33.34	29912
13	20.73	10.79	87.28	23.84	404.44	25.64	36.44	29912
14	20.17	15.55	92.77	25.34	429.87	27.27	42.82	29912
15	20.00	17.00	94.42	25.79	437.52	28.03	45.02	29912
		17.00	94.42	16.22	904.11	23.67	40.67	99705
16	19.50	21.25	101.25	17.39	969.49	23.10	44.34	99705
17	19.00	25.50	108.04	18.56	1034.47	23.76	49.26	99705
18	18.50	29.74	114.79	19.72	1099.14	24.82	54.56	99705
19	18.00	33.99	121.51	20.87	1163.53	26.20	60.19	99705
		33.99	121.51	12.60	1082.56	25.92	59.91	249264
20	17.40	39.09	129.55	14.12	1148.12	23.96	63.05	249264
21	16.80	44.19	137.57	15.64	1213.47	24.04	68.24	249264
22	16.20	49.29	145.56	17.15	1278.63	24.81	74.10	249264
23	15.60	54.39	153.53	18.66	1343.66	35.36	89.75	249264
24	15.00	59.49	161.49	20.16	1408.57	44.87	104.36	249264
25	14.40	64.59	169.44	21.67	1473.40	49.86	114.45	249264
26	13.80	69.69	177.38	23.17	1538.16	52.46	122.15	249264
27	13.20	74.79	185.32	24.67	1602.88	54.23	129.02	249264
28	12.60	79.89	193.25	26.17	1667.56	56.36	136.25	249264
29	12.00	84.99	201.18	27.67	1732.23	61.69	146.67	249264
30	11.40	90.08	209.11	29.17	1796.88	83.84	173.93	249264
31	11.25	91.56	210.89	29.51	1811.44	53.37	144.93	249264
32	9.69	106.88	229.49	33.03	1963.12	60.06	166.94	249264
33	8.13	122.21	248.10	36.55	2114.90	66.77	188.98	249264
34	6.56	137.54	266.73	40.07	2266.84	73.83	211.37	249264
35	5.00	152.87	285.39	43.60	2418.97	83.49	236.36	249264

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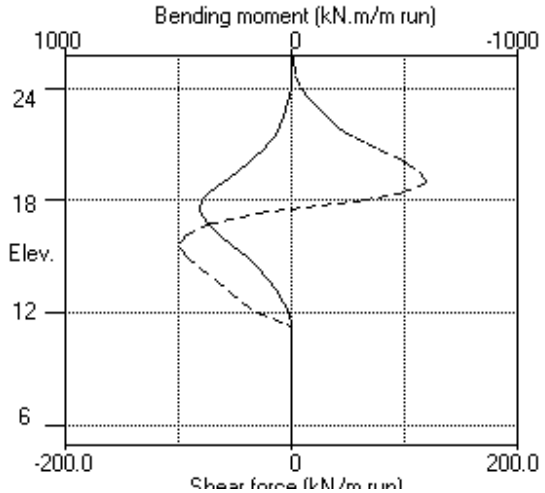
Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

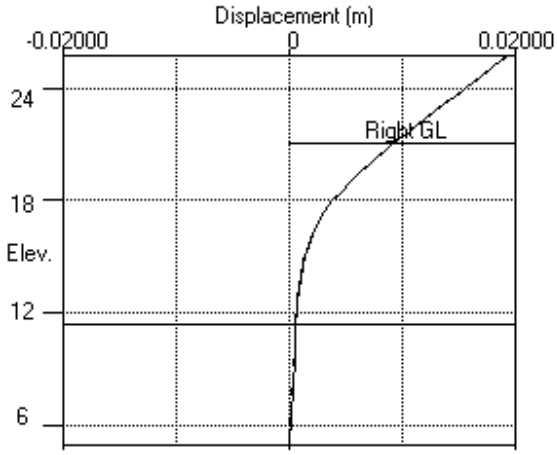
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.19	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	1190.00	0.00	0.00a	199503
13	20.73	Total>	6.32	2.65w	1196.32	2.65	2.65a	199503
14	20.17	Total>	19.42	8.14w	1209.42	8.30	8.30	199503
15	20.00	Total>	23.40	9.81w	1213.40	10.48	10.48	199503
16	19.50	Total>	35.12	14.71w	1225.12	24.79	24.79	199503
		0.00	35.12	6.03	336.23	7.23	7.23	99751
17	19.00	5.56	40.57	6.97	388.51	59.94	65.50	99751
18	18.50	11.12	46.05	7.91	440.91	111.59	122.71	99751
19	18.00	16.68	51.54	8.85	493.47	118.06	134.74	99751
		16.68	51.54	0.00	511.86	226.10	242.78	249378
20	17.40	23.36	58.15	0.62	565.78	147.72	171.07	249378
21	16.80	30.03	64.79	1.87	619.94	89.56	119.59	249378
22	16.20	36.70	71.46	3.14	674.38	59.56	96.26	249378
23	15.60	43.37	78.18	4.41	729.12	43.63	87.00	249378
24	15.00	50.05	84.93	5.68	784.18	36.52	86.57	249378
25	14.40	56.72	91.72	6.97	839.57	34.69	91.41	249378
26	13.80	63.39	98.55	8.26	895.31	35.77	99.16	249378
27	13.20	70.07	105.43	9.56	951.39	38.05	108.12	249378
28	12.60	76.74	112.35	10.87	1007.81	40.25	116.99	249378
29	12.00	83.41	119.31	12.19	1064.56	39.33	122.74	249378
30	11.40	90.08	126.31	13.51	1121.64	23.48	113.56	249378
31	11.25	91.56	128.26	13.88	1137.57	53.16	144.72	249378
32	9.69	106.88	148.74	17.75	1304.55	60.05	166.93	249378
33	8.13	122.21	169.43	21.67	1473.32	66.76	188.97	249378
34	6.56	137.54	190.30	25.61	1643.52	73.82	211.36	249378
35	5.00	152.87	211.30	29.59	1814.77	83.78	236.64	249378

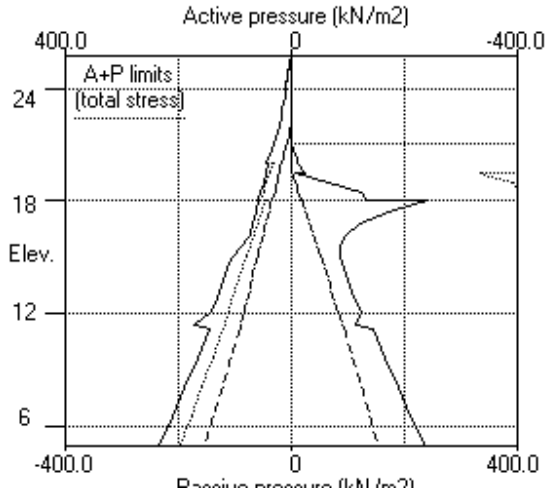
Note: 2.65 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

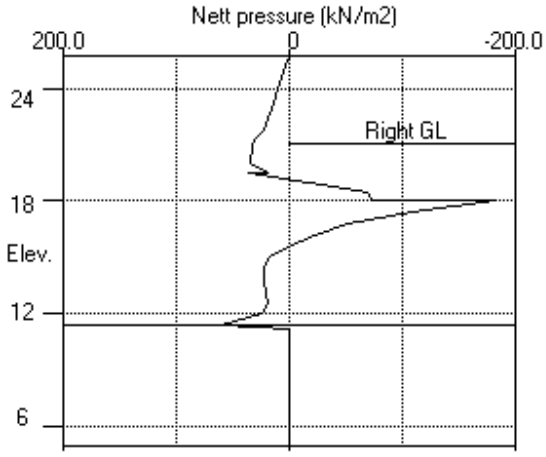
Stage No.4 Fill to elev. 21.00 on RIGHT side





Stage No.4 Fill to elev. 21.00 on RIGHT side





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.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
2	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
3	25.70	19.50	Cant.	1.624	12.28	14.00	5.50	L to R
4	25.70	21.00	Cant.	5.212	11.91	19.57	1.43	L to R
5	25.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	
1	25.70	0.020	0.000	0	-0	0	-0	0	0	0	0
2	25.15	0.018	0.000	0	0	0	0	1	-1	1	-1
3	24.60	0.017	0.000	2	-1	2	-1	4	-2	5	-2
4	24.00	0.016	0.000	6	-2	7	-2	9	-2	12	-3
5	23.58	0.015	0.000	10	-3	14	-4	14	-2	19	-3
6	23.19	0.014	0.000	17	-4	22	-5	19	-3	26	-3
7	22.80	0.013	0.000	25	-5	34	-6	25	-3	34	-4
8	22.40	0.012	0.000	37	-6	50	-8	34	-3	45	-4
9	22.00	0.012	0.000	51	-7	69	-9	46	-4	62	-5
10	21.70	0.011	0.000	65	-8	88	-10	56	-4	75	-5
11	21.35	0.010	0.000	87	-9	117	-12	69	-4	94	-6
12	21.00	0.009	0.000	114	-10	153	-14	84	-3	113	-5
13	20.73	0.009	0.000	138	-11	186	-15	96	-2	129	-3
14	20.17	0.008	0.000	189	-11	255	-15	104	0	140	0
15	20.00	0.007	0.000	202	-11	273	-15	102	0	138	0
16	19.50	0.007	0.000	247	-10	334	-13	119	0	161	0
17	19.00	0.006	0.000	304	-8	411	-10	126	0	169	0
18	18.50	0.005	0.000	362	-4	489	-6	106	0	143	0
19	18.00	0.004	0.000	404	-0	546	-0	71	0	96	0
20	17.40	0.003	0.000	412	0	556	0	4	-25	5	-33
21	16.80	0.003	0.000	378	0	510	0	1	-72	2	-98
22	16.20	0.002	0.000	325	0	439	0	0	-95	0	-128
23	15.60	0.002	0.000	264	0	356	0	0	-102	0	-137
24	15.00	0.002	0.000	203	0	274	0	0	-96	0	-129
25	14.40	0.001	0.000	149	0	201	0	0	-83	0	-112
26	13.80	0.001	0.000	103	0	139	0	0	-69	0	-93
27	13.20	0.001	0.000	66	0	89	0	0	-56	0	-75
28	12.60	0.001	0.000	36	0	49	0	0	-43	0	-59
29	12.00	0.001	0.000	14	0	19	0	0	-30	0	-41
30	11.40	0.001	0.000	0	-0	0	-0	0	-5	0	-6
31	11.25	0.001	0.000	0	0	0	0	0	0	0	0
32	9.69	0.001	0.000	0	0	0	0	0	0	0	0
33	8.13	0.000	0.000	0	0	0	0	0	0	0	0
34	6.56	0.000	0.000	0	0	0	0	0	0	0	0
35	5.00	0.000	0.000	0	0	0	0	0	0	0	0

Summary of results (continued)

Calculated Bending Moments and Prop 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					
no.	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	4	16.20	-11	20.17	6	-15	9	18.00	-4	21.35	12	-6
2	8	16.80	-10	20.73	11	-13	10	18.00	-3	22.00	13	-4
3	412	17.40	-0	11.40	556	-0	126	19.00	-102	15.60	169	-137
4	407	17.40	-0	11.40	550	-0	120	19.00	-100	15.60	161	-135
5	No calculation at this stage											
6	No calculation at this stage											
7	No calculation at this stage											
8	398	17.40	-0	11.40	538	-0	108	19.00	-98	15.60	146	-132

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.000	23.19	0.000	25.70	Apply water pressure profile no.1
2	0.001	25.70	0.000	25.70	Apply surcharge no.1 at elev. 25.70
3	0.020	25.70	0.000	25.70	Excav. to elev. 19.50 on RIGHT side
4	0.019	25.70	0.000	25.70	Fill to elev. 21.00 on RIGHT side
5	No calculation at this stage				Install prop no.4 at elev. 20.17
6	No calculation at this stage				Install prop no.3 at elev. 20.73
7	No calculation at this stage				Install prop no.2 at elev. 23.58
8	0.019	25.70	0.000	25.70	Apply water pressure profile no.3

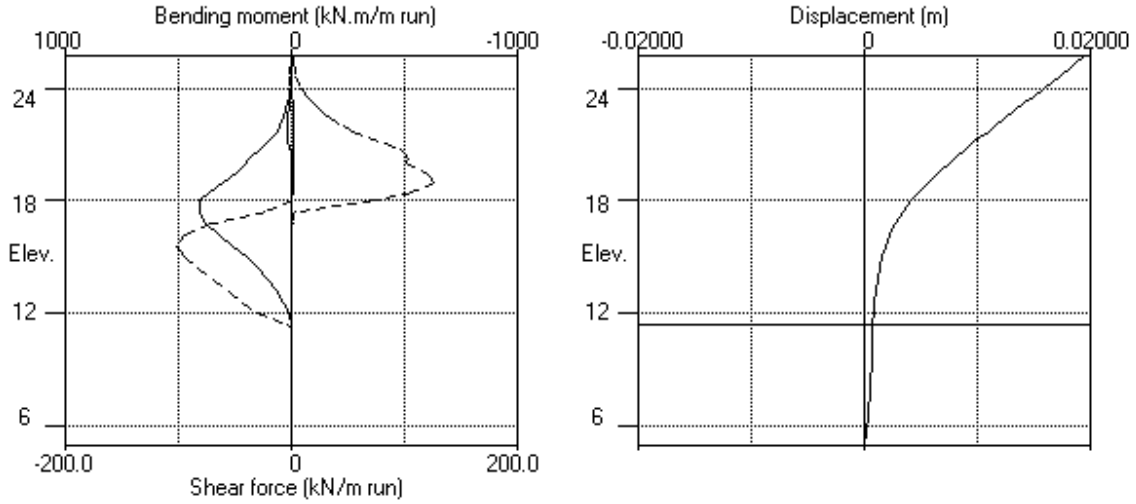
Summary of results (continued)

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

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 2 at elev. 23.58			Prop no. 3 at elev. 20.73			Prop no. 4 at elev. 20.17		
	--Calculated-- kN per m run	Factored kN per prop	Factored kN per prop	--Calculated-- kN per m run	Factored kN per prop	Factored kN per prop	--Calculated-- kN per m run	Factored kN per prop	Factored kN per prop
8	6	6	8	17	17	23	30	30	40

Bending moment, shear force, displacement envelopes



FOUNDATION PILING LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
Licensed from GEOSOLVE | Made by :
Data filename/Run ID: 21-1182_E1_Cant_900-1350_ULS2 |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
| Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	25.70	1 Fill	1 Fill
2	21.70	2 Alluvial Gravel	2 Alluvial Gravel
3	20.00	3 Weath Sandstone	3 Weath Sandstone
4	18.00	4 Sandstone	4 Sandstone

SOIL PROPERTIES (Unfactored SLS soil strengths)
Soil Properties File = 21-1182_Soils__SLS.dat

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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

Water press. profile no.	Point no.	Left side Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Right side Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	22.00	22.00	0.0	1	19.50	19.50	0.0	MC
2	1	23.00	23.00	0.0	1	19.00	19.00	0.0	WC
3	1	24.00	24.00	0.0	1	19.00	19.00	0.0	MC
4	1	24.70	24.70	0.0	1	19.50	19.50	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 11.40
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 0.038200 m4/m run
E.I = 1.0696E+06 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

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	25.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.30 Var

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 water pressure profile no.2 (Worst Cred.)
2	Apply surcharge no.1 at elevation 25.70
3	Excavate to elevation 19.00 on RIGHT side
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Install strut or anchor no.4 at elevation 20.17
6	Install strut or anchor no.3 at elevation 20.73
7	Install strut or anchor no.2 at elevation 23.58
8	Apply water pressure profile no.4 (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 = 5.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

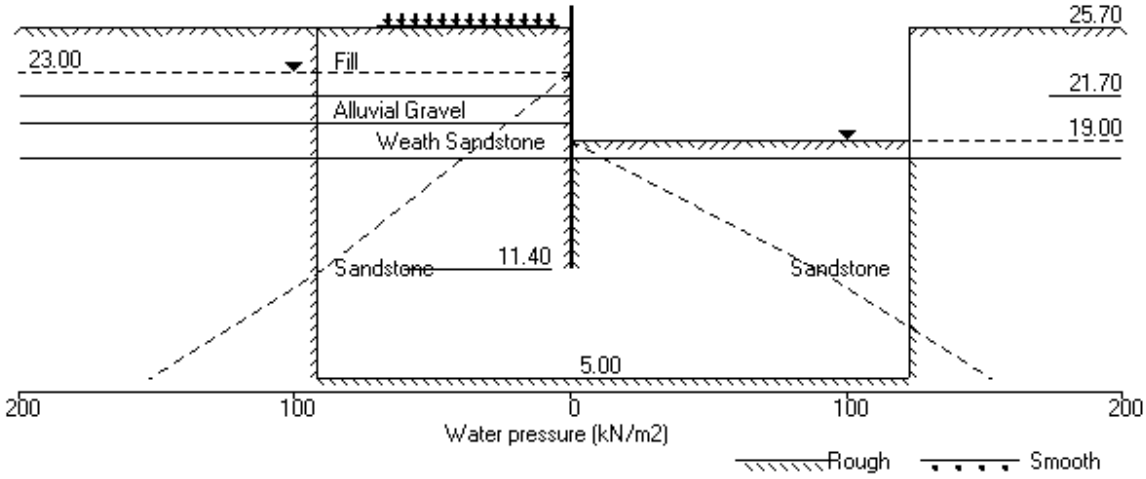
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.2	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 25.70	Yes	Yes	Yes
3	Excav. to elev. 19.00 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	No	No	No
5	Install prop no.4 at elev. 20.17	Yes	Yes	Yes
6	Install prop no.3 at elev. 20.73	No	No	No
7	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
8	Apply water pressure profile no.4	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 19.00 on RIGHT side



FOUNDATION PILING LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
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Data filename/Run ID: 21-1182_E1_Cant_900-1350_ULS2 |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
| Checked :

Units: kN,m

Stage No. 3 Excavate to elevation 19.00 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr-ation	Direction of failure
3	25.70	19.00	Cant.	1.126	12.18	12.67	6.33	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	25.70	0.00	0.061	5.74E-03	0.0	0.0	
2	25.20	3.31	0.058	5.74E-03	0.8	0.3	
3	24.70	7.15	0.055	5.74E-03	3.4	1.3	
4	24.14	11.51	0.052	5.73E-03	8.7	4.7	
5	23.58	15.66	0.048	5.73E-03	16.3	11.7	
6	23.00	19.68	0.045	5.72E-03	26.5	23.9	
7	22.50	25.62	0.042	5.71E-03	37.8	40.0	
8	22.00	31.48	0.039	5.68E-03	52.1	62.4	
9	21.70	34.96	0.038	5.66E-03	62.1	79.5	
10	21.35	39.01	0.036	5.63E-03	75.0	103.4	
11	21.00	43.04	0.034	5.59E-03	89.4	132.2	
12	20.73	46.13	0.032	5.56E-03	101.4	157.9	
13	20.17	52.52	0.029	5.46E-03	129.0	222.3	
14	20.00	54.46	0.028	5.42E-03	138.1	245.0	
		44.11	0.028	5.42E-03	138.1	245.0	
15	19.50	49.65	0.026	5.29E-03	161.6	319.7	
16	19.00	55.18	0.023	5.12E-03	187.8	406.9	
17	18.50	24.59	0.020	4.90E-03	207.7	507.1	
18	18.00	-6.04	0.018	4.64E-03	212.3	614.0	
		-60.35	0.018	4.64E-03	212.3	614.0	
19	17.40	-92.71	0.015	4.27E-03	166.4	730.4	
20	16.80	-125.19	0.013	3.83E-03	101.1	813.5	
21	16.20	-157.84	0.011	3.37E-03	16.2	851.5	
22	15.60	-182.66	0.009	2.89E-03	-86.0	832.7	
23	15.00	-104.16	0.007	2.45E-03	-172.0	748.1	
24	14.40	-51.30	0.006	2.06E-03	-218.7	626.0	
25	13.80	-15.80	0.005	1.75E-03	-238.8	485.4	
26	13.20	10.52	0.004	1.52E-03	-240.4	339.2	
27	12.60	61.26	0.003	1.37E-03	-218.9	196.8	
28	12.00	122.36	0.002	1.29E-03	-163.8	76.4	

(continued)

Stage No.3 Excavate to elevation 19.00 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
29	11.40	338.87	0.001	1.27E-03	-25.4	0.0	
30	11.25	0.24	0.002	0	0.0	0.0	
31	9.69	0.02	0.001	0	0.2	0.0	
32	8.13	0.02	0.001	0	0.3	0.0	
33	6.56	0.02	0.000	0	0.3	0.0	
34	5.00	-0.39	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.20	0.00	9.63	3.31	32.36	3.31	3.31a	12463
3	24.70	0.00	20.83	7.15	69.99	7.15	7.15a	12463
4	24.14	0.00	33.54	11.51	112.71	11.51	11.51a	12463
5	23.58	0.00	45.61	15.66	153.25	15.66	15.66a	12463
6	23.00	0.00	57.35	19.68	192.70	19.68	19.68a	12463
7	22.50	3.88	63.33	21.74	212.80	21.74	25.62a	12463
8	22.00	7.77	69.08	23.71	232.13	23.71	31.48a	12463
9	21.70	10.10	72.45	24.87	243.44	24.87	34.96a	12463
		10.10	72.45	24.87	243.46	24.87	34.97a	29912
10	21.35	12.81	76.32	26.20	256.45	26.20	39.01a	29912
11	21.00	15.53	80.13	27.50	269.25	27.50	43.04a	29912
12	20.73	17.63	83.03	28.50	279.02	28.50	46.13a	29912
13	20.17	21.98	88.98	30.54	299.00	30.54	52.52a	29912
14	20.00	23.30	90.77	31.16	305.01	31.16	54.46a	29912
		23.30	90.77	20.82	539.83	20.82	44.11a	99705
15	19.50	27.18	97.98	22.47	582.75	22.47	49.65a	99705
16	19.00	31.07	105.15	24.11	625.36	24.11	55.18a	99705
17	18.50	34.95	112.27	25.75	667.70	25.75	60.69a	99705
18	18.00	38.83	119.35	27.37	709.83	27.37	66.20a	99705
		38.83	119.35	20.19	679.94	20.19	59.02a	249264
19	17.40	43.49	127.81	22.30	724.29	22.30	65.79a	249264
20	16.80	48.15	136.24	24.41	768.45	24.41	72.56a	249264
21	16.20	52.81	144.63	26.50	812.47	26.50	79.31a	249264
22	15.60	57.47	153.01	28.59	856.37	28.59	86.06a	249264
23	15.00	62.13	161.36	30.68	900.18	30.68	92.81a	249264
24	14.40	66.79	169.71	32.76	943.91	32.76	99.55a	249264
25	13.80	71.45	178.04	34.84	987.59	34.84	106.29a	249264
26	13.20	76.11	186.37	36.92	1031.24	36.92	113.03a	249264
27	12.60	80.77	194.69	39.00	1074.85	64.09	144.86	249264
28	12.00	85.43	203.00	41.08	1118.45	119.91	205.34	249264
29	11.40	90.09	211.32	43.15	1162.04	338.87	428.95	249264
30	11.25	91.56	213.09	43.59	1171.33	37.26	128.82A	249264
31	9.69	106.89	231.56	48.20	1268.13	46.36	153.24A	249264
32	8.13	122.22	250.04	52.82	1365.00	53.69	175.91	249264
33	6.56	137.54	268.54	57.44	1462.02	62.19	199.74	249264
34	5.00	152.87	287.08	62.06	1559.18	75.72	228.59	249264

(continued)

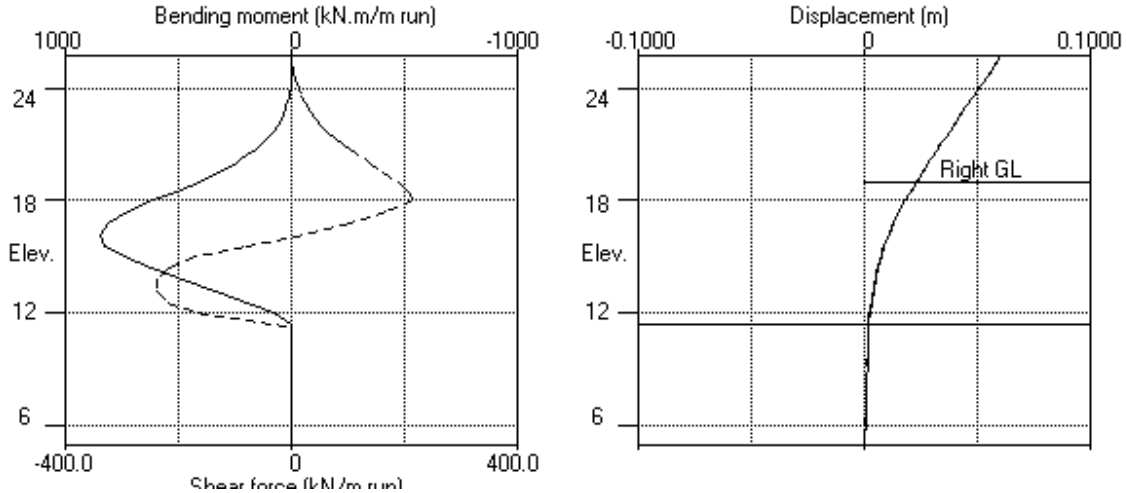
Stage No.3 Excavate to elevation 19.00 on RIGHT side

RIGHT side

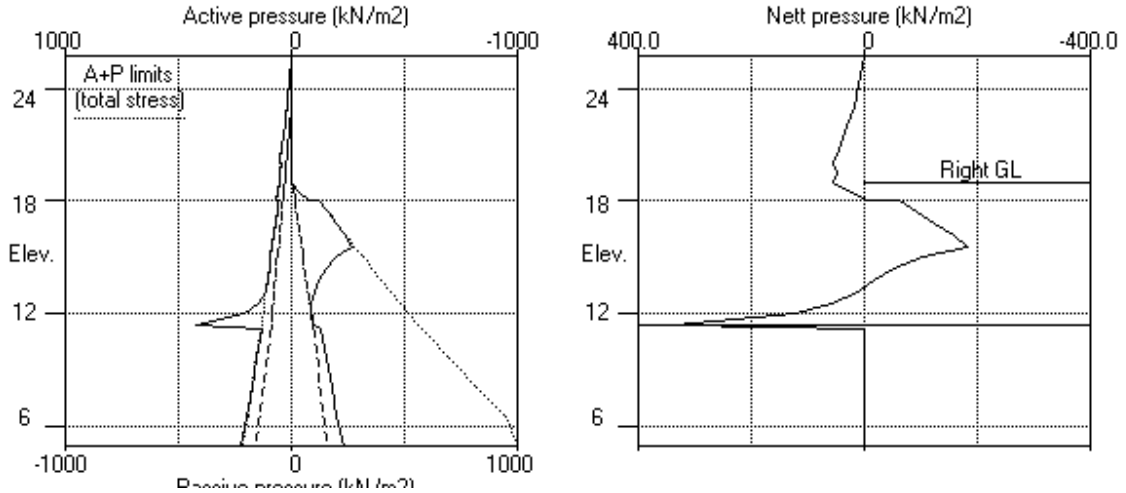
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	20.73	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	20.17	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	19.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	19.00	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	99787
17	18.50	5.93	5.07	1.16	30.18	30.18	36.10p	99787
18	18.00	11.85	10.15	2.33	60.38	60.38	72.24p	99787
		11.85	10.15	0.00	107.52	107.52	119.37p	249469
19	17.40	18.97	16.26	0.00	139.54	139.53	158.50p	249469
20	16.80	26.08	22.39	0.00	171.67	171.67	197.75p	249469
21	16.20	33.19	28.55	0.00	203.96	203.96	237.15p	249469
22	15.60	40.30	34.75	0.00	236.45	228.42	268.72	249469
23	15.00	47.41	40.99	0.63	269.16	149.56	196.97	249469
24	14.40	54.53	47.28	2.20	302.13	96.32	150.85	249469
25	13.80	61.64	53.62	3.78	335.37	60.45	122.09	249469
26	13.20	68.75	60.02	5.38	368.92	33.76	102.51	249469
27	12.60	75.86	66.48	6.99	402.77	7.74	83.60	249469
28	12.00	82.98	73.00	8.62	436.95	0.00	82.98A	249469
29	11.40	90.09	79.58	10.26	471.45	0.00	90.09A	249469
30	11.25	91.56	81.54	10.75	481.73	37.01	128.57	249469
31	9.69	106.89	102.20	15.91	590.03	46.33	153.22	249469
32	8.13	122.22	123.25	21.16	700.38	53.67	175.89	249469
33	6.56	137.54	144.64	26.50	812.50	62.18	199.72	249469
34	5.00	152.87	166.31	31.91	926.08	76.10	228.98	249469

Note: 113.03 a Soil pressure at active limit
237.15 p Soil pressure at passive limit
90.09A Arching - soil pressure below active limit

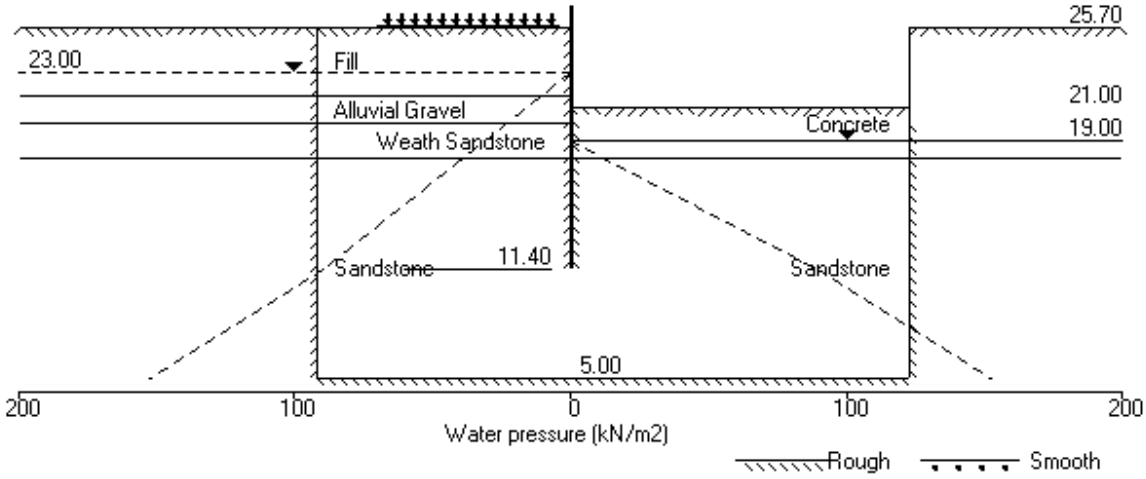
Stage No.3 Excav. to elev. 19.00 on RIGHT side



Stage No.3 Excav. to elev. 19.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
4	25.70	21.00	Cant.	4.327	11.90	19.48	1.52	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	25.70	0.00	0.060	5.74E-03	0.0	0.0	
2	25.20	4.17	0.057	5.74E-03	1.0	0.3	
3	24.70	7.92	0.054	5.74E-03	4.1	1.5	
4	24.14	12.27	0.051	5.74E-03	9.7	5.4	
5	23.58	16.43	0.048	5.73E-03	17.8	13.1	
6	23.00	20.50	0.045	5.72E-03	28.4	26.3	
7	22.50	26.50	0.042	5.71E-03	40.2	43.4	
8	22.00	32.44	0.039	5.68E-03	54.9	67.2	
9	21.70	36.10	0.037	5.66E-03	65.2	85.2	
		37.70	0.037	5.66E-03	65.2	85.2	
10	21.35	41.33	0.035	5.63E-03	79.0	110.4	
11	21.00	45.32	0.033	5.59E-03	94.2	140.6	
12	20.73	45.87	0.032	5.55E-03	106.5	167.7	
13	20.17	46.94	0.029	5.44E-03	132.5	234.3	
14	20.00	47.62	0.028	5.40E-03	140.5	257.5	
		44.22	0.028	5.40E-03	140.5	257.5	
15	19.50	38.48	0.025	5.27E-03	161.2	332.9	
16	19.00	29.72	0.022	5.09E-03	178.3	418.0	
		51.58	0.022	5.09E-03	178.3	418.0	
17	18.50	21.49	0.020	4.87E-03	196.5	513.0	
18	18.00	-8.08	0.018	4.61E-03	199.9	613.9	
		-43.73	0.018	4.61E-03	199.9	613.9	
19	17.40	-84.72	0.015	4.23E-03	161.3	725.9	
20	16.80	-120.91	0.013	3.80E-03	99.7	807.4	
21	16.20	-155.59	0.010	3.34E-03	16.7	845.3	
22	15.60	-181.69	0.009	2.87E-03	-84.5	827.2	
23	15.00	-103.96	0.007	2.43E-03	-170.2	743.7	
24	14.40	-51.55	0.006	2.05E-03	-216.8	622.8	
25	13.80	-16.29	0.004	1.74E-03	-237.2	483.3	
26	13.20	9.90	0.004	1.51E-03	-239.1	337.9	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	12.60	60.59	0.003	1.36E-03	-218.0	196.1	
28	12.00	121.69	0.002	1.28E-03	-163.3	76.2	
29	11.40	338.05	0.001	1.26E-03	-25.3	0.0	
30	11.25	0.22	0.001	0	0.0	0.0	
31	9.69	0.01	0.001	0	0.2	0.0	
32	8.13	0.01	0.001	0	0.2	0.0	
33	6.56	0.01	0.000	0	0.2	0.0	
34	5.00	-0.30	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	12463
2	25.20	0.00	9.63	3.31	32.36	4.17	4.17	12463
3	24.70	0.00	20.83	7.15	69.99	7.92	7.92	12463
4	24.14	0.00	33.54	11.51	112.71	12.27	12.27	12463
5	23.58	0.00	45.61	15.66	153.25	16.43	16.43	12463
6	23.00	0.00	57.35	19.68	192.70	20.50	20.50	12463
7	22.50	3.88	63.33	21.74	212.80	22.61	26.50	12463
8	22.00	7.77	69.08	23.71	232.13	24.68	32.44	12463
9	21.70	10.10	72.45	24.87	243.44	26.01	36.10	12463
		10.10	72.45	24.87	243.46	27.61	37.70	29912
10	21.35	12.81	76.32	26.20	256.45	28.51	41.33	29912
11	21.00	15.53	80.13	27.50	269.25	29.78	45.32	29912
12	20.73	17.63	83.03	28.50	279.02	30.89	48.52	29912
13	20.17	21.98	88.98	30.54	299.00	33.11	55.09	29912
14	20.00	23.30	90.77	31.16	305.01	34.13	57.43	29912
		23.30	90.77	20.82	539.83	30.73	54.03	99705
15	19.50	27.18	97.98	22.47	582.75	30.19	57.37	99705
16	19.00	31.07	105.15	24.11	625.36	31.25	62.32	99705
17	18.50	34.95	112.27	25.75	667.70	32.78	67.73	99705
18	18.00	38.83	119.35	27.37	709.83	34.71	73.54	99705
		38.83	119.35	20.19	679.94	38.53	77.36	249264
19	17.40	43.49	127.81	22.30	724.29	35.89	79.38	249264
20	16.80	48.15	136.24	24.41	768.45	35.98	84.13	249264
21	16.20	52.81	144.63	26.50	812.47	36.99	89.80	249264
22	15.60	57.47	153.01	28.59	856.37	38.39	95.86	249264
23	15.00	62.13	161.36	30.68	900.18	40.06	102.19	249264
24	14.40	66.79	169.71	32.76	943.91	41.89	108.68	249264
25	13.80	71.45	178.04	34.84	987.59	43.83	115.27	249264
26	13.20	76.11	186.37	36.92	1031.24	45.82	121.93	249264
27	12.60	80.77	194.69	39.00	1074.85	72.94	153.71	249264
28	12.00	85.43	203.00	41.08	1118.45	128.73	214.16	249264
29	11.40	90.09	211.32	43.15	1162.04	347.58	437.67	249264
30	11.25	91.56	213.09	43.59	1171.33	46.35	137.91	249264
31	9.69	106.89	231.56	48.20	1268.13	55.36	162.25	249264
32	8.13	122.22	250.04	52.82	1365.00	62.57	184.79	249264
33	6.56	137.54	268.54	57.44	1462.02	70.86	208.41	249264
34	5.00	152.87	287.08	62.06	1559.18	82.62	235.50	249264

(continued)

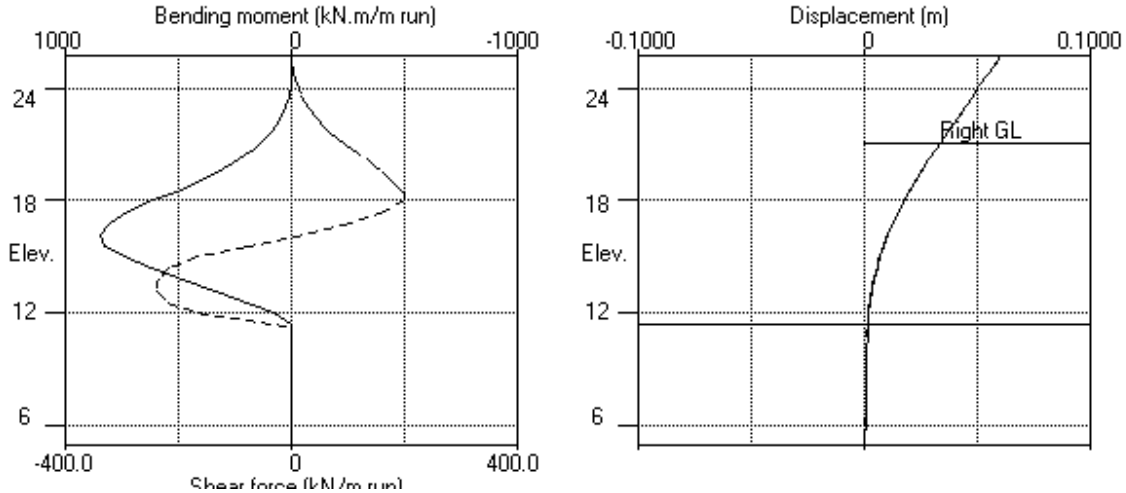
Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

RIGHT side

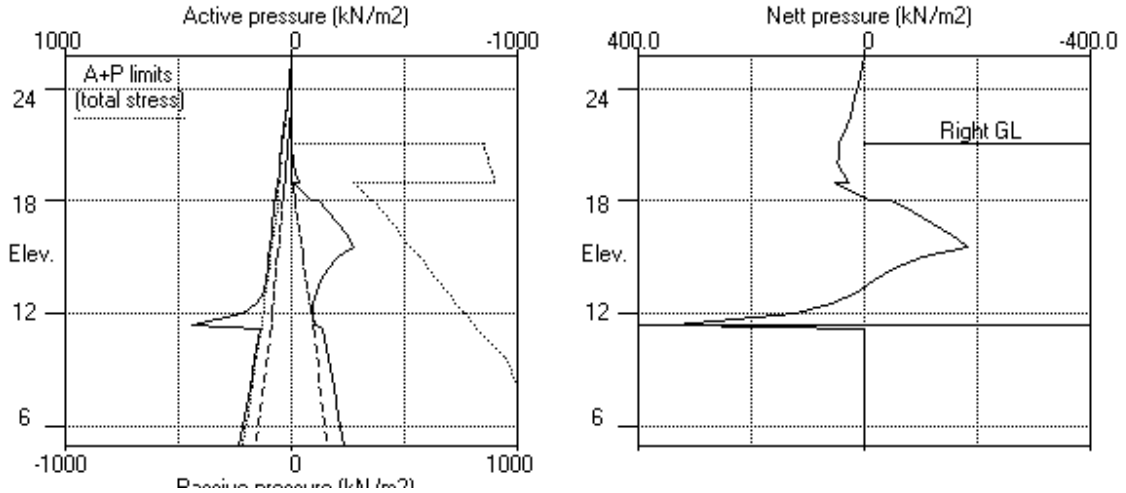
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	25.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	25.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	24.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	24.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	21.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	21.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	850.00	0.00	0.00a	199503
12	20.73	Total>	6.32	2.65w	856.32	2.65	2.65a	199503
13	20.17	Total>	19.42	8.14w	869.43	8.14	8.14a	199503
14	20.00	Total>	23.40	9.81w	873.41	9.81	9.81a	199503
15	19.50	Total>	35.12	14.71w	885.12	18.90	18.90	199503
16	19.00	Total>	46.84	19.62w	896.85	32.60	32.60	199503
		0.00	46.84	10.74	278.55	10.74	10.74a	99751
17	18.50	5.93	51.94	11.91	308.92	40.31	46.24	99751
18	18.00	11.85	57.06	13.09	339.39	69.77	81.62	99751
		11.85	57.06	4.64	353.43	109.23	121.09	249378
19	17.40	18.97	63.24	6.18	385.78	145.13	164.10	249378
20	16.80	26.08	69.44	7.73	418.29	178.97	205.04	249378
21	16.20	33.19	75.67	9.29	450.98	212.20	245.39	249378
22	15.60	40.30	81.95	10.85	483.86	237.25	277.55	249378
23	15.00	47.41	88.26	12.43	516.95	158.74	206.15	249378
24	14.40	54.53	94.61	14.02	550.26	105.70	160.23	249378
25	13.80	61.64	101.01	15.61	583.78	69.93	131.57	249378
26	13.20	68.75	107.44	17.22	617.52	43.28	112.03	249378
27	12.60	75.86	113.92	18.84	651.48	17.26	93.12A	249378
28	12.00	82.98	120.44	20.46	685.66	9.49	92.47A	249378
29	11.40	90.09	127.00	22.10	720.05	9.53	99.62A	249378
30	11.25	91.56	128.96	22.59	730.29	46.12	137.68	249378
31	9.69	106.89	149.43	27.70	837.62	55.35	162.24	249378
32	8.13	122.22	170.13	32.87	946.10	62.56	184.78	249378
33	6.56	137.54	191.00	38.08	1055.51	70.86	208.40	249378
34	5.00	152.87	212.00	43.32	1165.59	82.93	235.80	249378

Note: 10.74 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
99.62A Arching - soil pressure below active limit

Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 11.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
1	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
2	25.70	25.70	Cant.	Conditions not suitable for FoS calc.				
3	25.70	19.00	Cant.	1.126	12.18	12.67	6.33	L to R
4	25.70	21.00	Cant.	4.327	11.90	19.48	1.52	L to R
5	25.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: ULS DA1 Combination 2

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	25.70	0.061	0.000	0.0	0.0	0.0	0.0
2	25.20	0.058	0.000	0.3	-0.0	1.0	-0.8
3	24.70	0.055	0.000	1.5	-0.8	4.1	-2.3
4	24.14	0.052	0.000	5.5	-2.4	10.6	-3.6
5	23.58	0.048	0.000	14.4	-4.8	21.3	-4.5
6	23.00	0.045	0.000	26.3	-7.6	28.4	-5.3
7	22.50	0.042	0.000	43.4	-10.2	40.2	-5.7
8	22.00	0.039	0.000	67.2	-12.3	58.6	-4.8
9	21.70	0.038	0.000	85.2	-13.3	71.6	-3.6
10	21.35	0.036	0.000	110.5	-14.5	88.6	-2.8
11	21.00	0.034	0.000	144.7	-15.2	107.0	-1.2
12	20.73	0.032	0.000	175.4	-15.3	121.5	0.0
13	20.17	0.029	0.000	242.6	-13.6	136.1	0.0
14	20.00	0.028	0.000	263.9	-12.5	140.5	0.0
15	19.50	0.026	0.000	334.8	-9.6	161.6	0.0
16	19.00	0.023	0.000	418.0	-6.5	187.8	0.0
17	18.50	0.020	0.000	513.0	-2.1	207.7	0.0
18	18.00	0.018	0.000	614.0	0.0	212.3	0.0
19	17.40	0.015	0.000	730.4	0.0	166.4	0.0
20	16.80	0.013	0.000	813.5	0.0	101.1	-0.9
21	16.20	0.011	0.000	851.5	0.0	17.4	-2.7
22	15.60	0.009	0.000	832.7	0.0	0.0	-86.0
23	15.00	0.007	0.000	748.1	0.0	0.0	-172.0
24	14.40	0.006	0.000	626.0	0.0	0.0	-218.7
25	13.80	0.005	0.000	485.4	0.0	0.0	-238.8
26	13.20	0.004	0.000	339.2	0.0	0.0	-240.4
27	12.60	0.003	0.000	196.8	0.0	0.0	-218.9
28	12.00	0.002	0.000	76.4	0.0	0.0	-163.8
29	11.40	0.001	0.000	0.0	-0.0	0.0	-25.4
30	11.25	0.002	0.000	0.0	0.0	0.0	0.0
31	9.69	0.001	0.000	0.0	0.0	0.2	0.0
32	8.13	0.001	0.000	0.0	0.0	0.3	0.0
33	6.56	0.000	0.000	0.0	0.0	0.3	0.0
34	5.00	0.000	0.000	0.0	0.0	0.0	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	8.9	16.80	-15.3	20.73	12.6	18.00	-5.7	22.50
2	13.9	16.80	-13.7	21.00	13.6	18.00	-5.2	23.00
3	851.5	16.20	0.0	25.70	212.3	18.00	-240.4	13.20
4	845.3	16.20	0.0	25.70	199.9	18.00	-239.1	13.20
5	No calculation at this stage							
6	No calculation at this stage							
7	No calculation at this stage							
8	843.3	16.20	0.0	25.70	199.3	18.00	-238.7	13.20

Maximum and minimum displacement at each stage

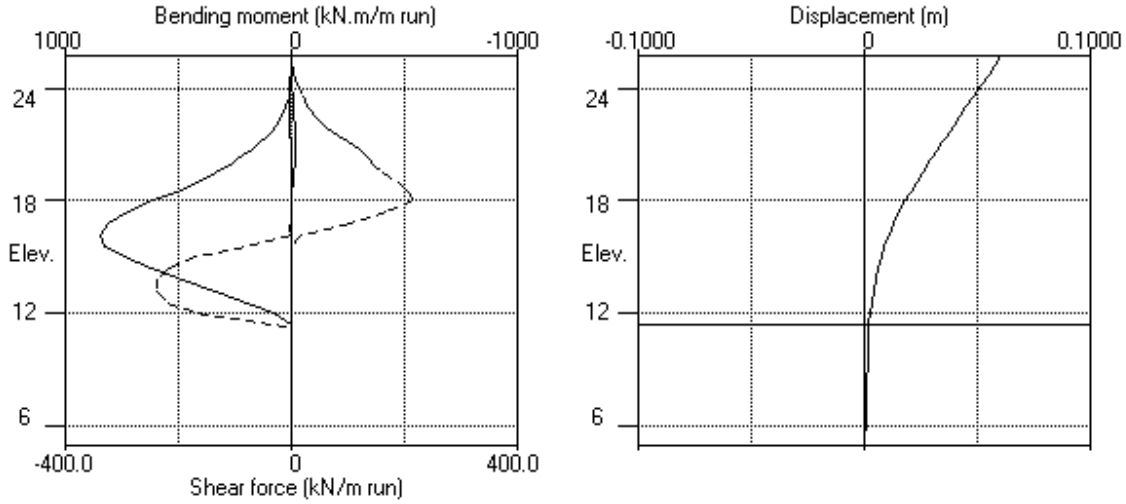
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.001	25.70	0.000	25.70	Apply water pressure profile no.2
2	0.001	25.70	0.000	25.70	Apply surcharge no.1 at elev. 25.70
3	0.061	25.70	0.000	25.70	Excav. to elev. 19.00 on RIGHT side
4	0.060	25.70	0.000	25.70	Fill to elev. 21.00 on RIGHT side
5	No calculation at this stage				Install prop no.4 at elev. 20.17
6	No calculation at this stage				Install prop no.3 at elev. 20.73
7	No calculation at this stage				Install prop no.2 at elev. 23.58
8	0.060	25.70	0.000	25.70	Apply water pressure profile no.4

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	--- Strut no. 2 --- at elev. 23.58		--- Strut no. 3 --- at elev. 20.73		--- Strut no. 4 --- at elev. 20.17	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
8	13.61	13.61	16.32	16.32	15.99	15.99

Bending moment, shear force, displacement envelopes



FOUNDATION PILING LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
Licensed from GEOSOLVE | Made by :
Data filename/Run ID: 21-1182_K_Cant_600-950__SLS |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
| Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	23.70	1 Fill	1 Fill
2	22.50	2 Alluvial Gravel	2 Alluvial Gravel
3	20.50	3 Weath Sandstone	3 Weath Sandstone
4	18.50	4 Sandstone	4 Sandstone

SOIL PROPERTIES

Soil Properties File = 21-1182_Soils__SLS.dat

-- 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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

Additional soil parameters associated with Ka and Kp

		--- parameters for Ka ---			--- parameters for Kp ---		
------- Soil type -------		Soil friction	Wall adhesion	Back-fill	Soil friction	Wall adhesion	Back-fill
No.	Description	angle	coeff.	angle	angle	coeff.	angle
1	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

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	22.00	22.00	0.0	1	18.60	18.60	0.0	MC
2	1	22.70	22.70	0.0	1	18.10	18.10	0.0	WC
3	1	22.70	22.70	0.0	1	18.60	18.60	0.0	MC
4	1	22.70	22.70	0.0	1	18.10	18.10	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 14.70
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 8.3000E-03 m4/m run
E.I = 232400 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	23.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.00 Var

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 water pressure profile no.1 (Mod. Conserv.)
2	Apply surcharge no.1 at elevation 23.70
3	Excavate to elevation 20.65 on RIGHT side Toe of berm at elevation 18.60 Width of top of berm = 4.00 Width of toe of berm = 5.00
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Excavate to elevation 19.40 on RIGHT side
6	Fill to elevation 21.00 on RIGHT side with soil type 5
7	Install strut or anchor no.5 at elevation 20.83
8	Install strut or anchor no.2 at elevation 23.58
9	Apply water pressure profile no.3 (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 = 1.25

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

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m

Elevation of rigid lower boundary = 5.00

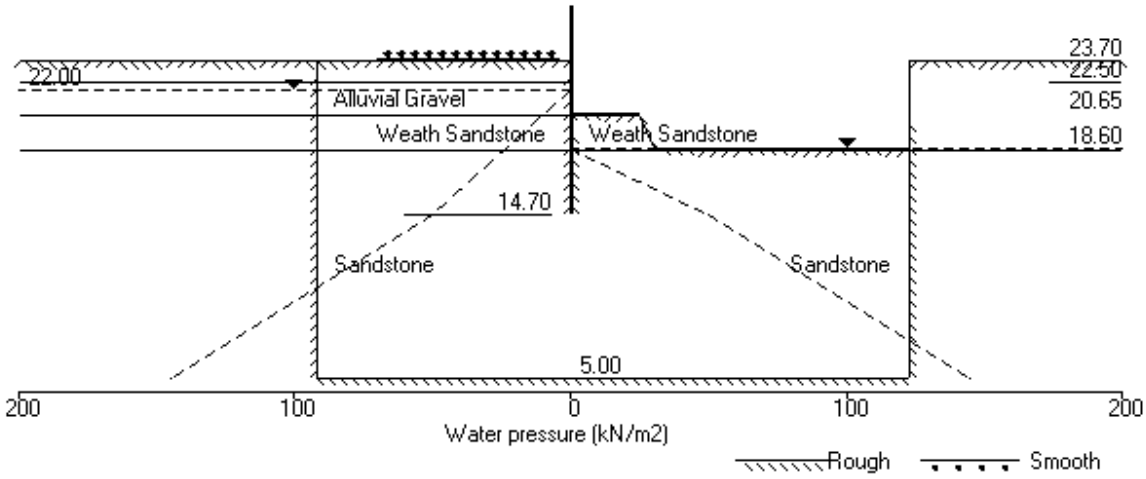
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.1	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 23.70	Yes	Yes	Yes
3	Excav. to elev. 20.65 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	Yes	Yes	Yes
5	Excav. to elev. 19.40 on RIGHT side	Yes	Yes	Yes
6	Fill to elev. 21.00 on RIGHT side	No	No	No
7	Install prop no.5 at elev. 20.83	Yes	Yes	Yes
8	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
9	Apply water pressure profile no.3	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 20.65 on RIGHT side



Units: kN,m

Stage No. 3 Excavate to elevation 20.65 on RIGHT side
Toe of berm at elevation 18.60
Width of top of berm = 4.00
Width of toe of berm = 5.00

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 14.70 Factor of Safety	FoS for toe elev. = 14.70 Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr-ation	Direction of failure
3	23.70	20.65	Cant.	1.818	15.09	17.62	3.03	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
Limit State: Serviceability Limit State
Calculated Bending Moments and Prop 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	Prop forces kN/m
1	23.70	0.00	0.006	9.93E-04	0.0	0.0	
2	23.58	0.62	0.006	9.93E-04	0.0	0.0	
3	23.14	2.94	0.005	9.93E-04	0.8	0.2	
4	22.70	5.51	0.005	9.92E-04	2.7	1.0	
5	22.50	6.70	0.004	9.91E-04	3.9	1.6	
6	22.00	9.61	0.004	9.84E-04	8.0	4.6	
7	21.50	14.89	0.003	9.68E-04	14.1	10.1	
8	21.00	20.08	0.003	9.37E-04	22.8	19.2	
9	20.83	21.88	0.003	9.21E-04	26.5	23.5	
10	20.65	23.67	0.003	9.01E-04	30.5	28.5	
11	20.50	12.69	0.003	8.81E-04	33.2	33.3	
		-6.20	0.003	8.81E-04	33.2	33.3	
12	20.00	-46.50	0.002	7.92E-04	20.0	49.3	
13	19.70	-24.04	0.002	7.26E-04	9.5	53.2	
14	19.40	-13.56	0.002	6.56E-04	3.8	55.0	
15	19.00	-6.25	0.001	5.61E-04	-0.1	55.5	
16	18.60	-3.96	0.001	4.66E-04	-2.2	55.0	
17	18.50	-3.74	0.001	4.43E-04	-2.6	54.7	
		-46.78	0.001	4.43E-04	-2.6	54.7	
18	18.00	-18.38	0.001	3.33E-04	-18.9	47.5	
19	17.50	2.74	0.001	2.43E-04	-22.8	35.7	
20	17.00	9.05	0.001	1.78E-04	-19.8	24.6	
21	16.50	9.33	0.001	1.35E-04	-15.2	15.7	
22	16.00	7.40	0.001	1.08E-04	-11.0	9.2	
23	15.50	5.41	0.001	9.37E-05	-7.8	4.5	
24	15.10	5.98	0.001	8.82E-05	-5.6	1.8	

(continued)

Stage No.3 Excavate to elevation 20.65 on RIGHT side
Toe of berm at elevation 18.60
Width of top of berm = 4.00
Width of toe of berm = 5.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
25	14.70	16.64	0.000	8.67E-05	-1.0	0.0	
26	14.57	0.08	0.000	0	0.0	0.0	
27	13.29	0.01	0.000	0	0.1	0.0	
28	12.00	0.08	0.000	0	0.1	0.0	
29	10.00	0.02	0.000	0	0.2	0.0	
30	8.00	-0.05	0.000	0	0.2	0.0	
31	6.50	0.00	0.000	0	0.1	0.0	
32	5.00	-0.20	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.62	10.47	0.62	0.62a	12474
3	23.14	0.00	10.77	2.94	49.92	2.94	2.94a	12474
4	22.70	0.00	20.18	5.51	93.48	5.51	5.51a	12474
5	22.50	0.00	24.53	6.70	113.65	6.70	6.70a	12474
		0.00	24.53	6.70	113.66	6.70	6.70a	29938
6	22.00	0.00	35.18	9.61	163.02	9.61	9.61a	29938
7	21.50	3.42	42.01	11.47	194.65	11.47	14.89a	29938
8	21.00	6.83	48.50	13.25	224.72	13.25	20.08a	29938
9	20.83	8.03	50.71	13.85	234.97	13.85	21.88a	29938
10	20.65	9.22	52.89	14.45	245.09	14.45	23.67a	29938
11	20.50	10.25	54.75	14.95	253.67	14.95	25.20a	29938
		10.25	54.75	9.40	524.20	9.40	19.65a	99795
12	20.00	13.66	62.82	10.79	601.50	10.79	24.45a	99795
13	19.70	15.71	67.60	11.61	647.27	11.61	27.32a	99795
14	19.40	17.76	72.34	12.42	692.67	12.42	30.19a	99795
15	19.00	20.50	78.61	13.50	752.71	13.50	34.00a	99795
16	18.60	23.23	84.83	14.57	812.29	14.57	37.80a	99795
17	18.50	23.91	86.38	14.84	827.12	14.84	38.75a	99795
		23.91	86.38	5.96	796.03	5.96	29.87a	249486
18	18.00	27.33	94.09	7.42	858.91	7.42	34.74a	249486
19	17.50	30.74	101.75	8.87	921.39	19.72	50.47	249486
20	17.00	34.16	109.37	10.31	983.53	25.88	60.04	249486
21	16.50	37.58	116.96	11.74	1045.40	29.18	66.76	249486
22	16.00	40.99	124.52	13.17	1107.04	31.48	72.47	249486
23	15.50	44.41	132.05	14.60	1168.49	33.83	78.23	249486
24	15.10	47.14	138.07	15.73	1217.54	36.77	83.91	249486
25	14.70	49.87	144.07	16.87	1266.49	45.22	95.09	249486
26	14.57	51.10	145.57	17.15	1278.74	36.93	88.03	249486
27	13.29	63.73	160.99	20.07	1404.52	42.15	105.88	249486
28	12.00	76.36	176.36	22.98	1529.85	47.39	123.75	249486
29	10.00	95.98	200.18	27.48	1724.11	55.60	151.58	249486
30	8.00	115.60	223.99	31.99	1918.25	63.90	179.50	249486
31	6.50	130.32	241.85	35.36	2063.93	70.35	200.66	249486
32	5.00	145.03	259.73	38.75	2209.75	78.64	223.67	249486

(continued)

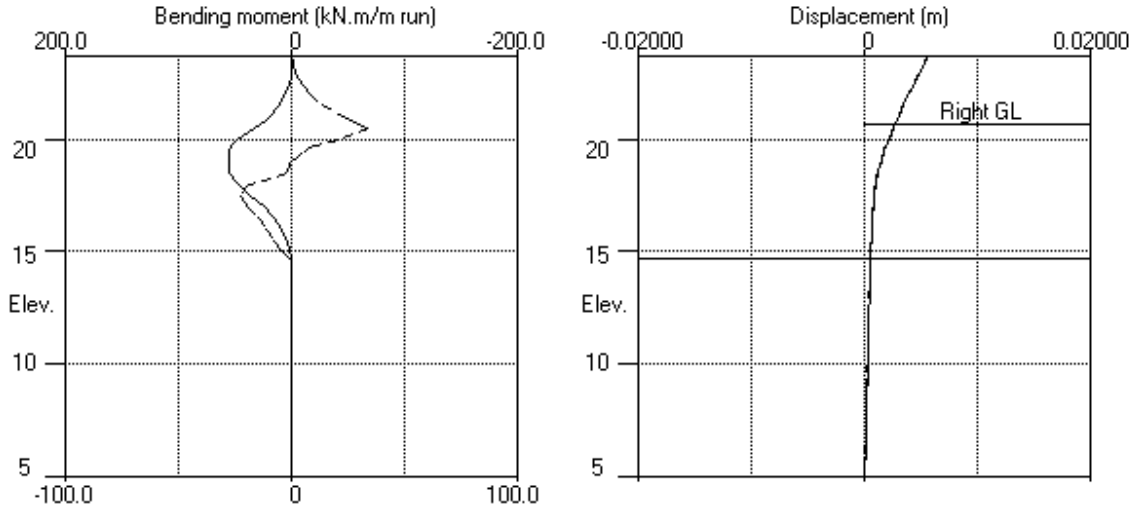
Stage No.3 Excavate to elevation 20.65 on RIGHT side
Toe of berm at elevation 18.60
Width of top of berm = 4.00
Width of toe of berm = 5.00

RIGHT side

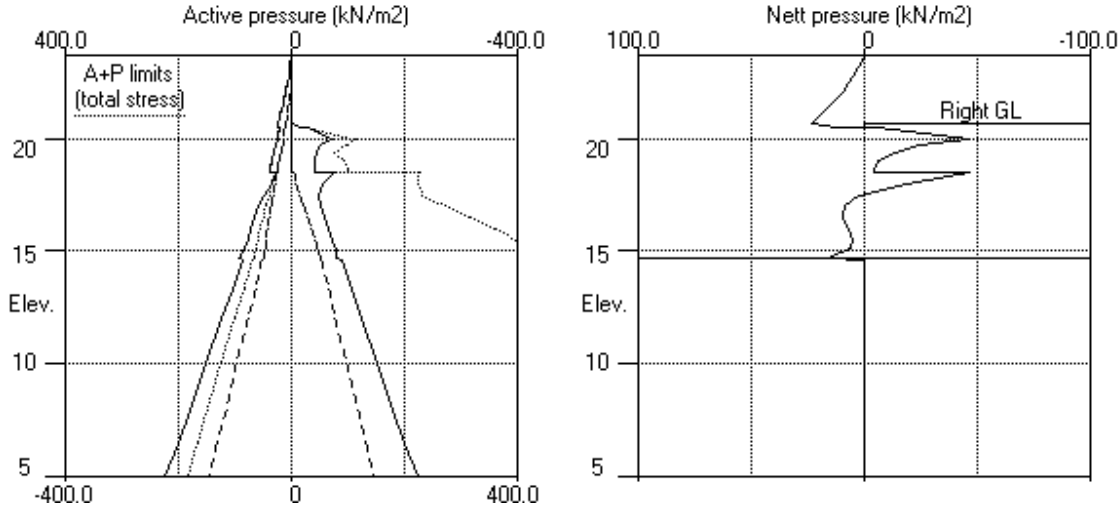
Node no.	Y coord	Effective stresses: Water press.	Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	20.83	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	20.65	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	29945
11	20.50	0.00	2.70	0.74	12.51	12.51	12.51p	29945
		0.00	2.70	0.46	25.85	25.85	25.85p	99816
12	20.00	0.00	13.70	2.35	114.21	70.95	70.95	99816
13	19.70	0.00	20.30	3.49	94.52b	51.36	51.36	99816
14	19.40	0.00	26.91	4.62	75.92b	43.75	43.75	99816
15	19.00	0.00	35.71	6.13	93.37b	40.25	40.25	99816
16	18.60	0.00	44.52	7.65	101.19b	41.76	41.76	99816
17	18.50	1.28	45.45	7.81	48.94b	41.21	42.49	99816
		1.28	45.45	0.00	225.97b	75.38	76.66	249539
18	18.00	7.67	50.08	0.00	217.02b	45.45	53.12	249539
19	17.50	14.07	54.72	0.00	215.33b	33.66	47.72	249539
20	17.00	20.46	59.38	0.85	253.34b	30.53	50.99	249539
21	16.50	26.85	64.04	1.73	291.44b	30.57	57.43	249539
22	16.00	33.25	68.73	2.62	329.67b	31.83	65.07	249539
23	15.50	39.64	73.43	3.51	366.26b	33.18	72.83	249539
24	15.10	44.76	77.20	4.22	398.88b	33.17	77.93	249539
25	14.70	49.87	80.98	4.94	427.84b	28.57	78.45	249539
26	14.57	51.10	82.54	5.23	475.27b	36.86	87.95	249539
27	13.29	63.73	98.64	8.28	582.77b	42.13	105.86	249539
28	12.00	76.36	114.87	11.35	725.72b	47.31	123.67	249539
29	10.00	95.98	140.32	16.16	922.17b	55.58	151.56	249539
30	8.00	115.60	166.02	21.02	1126.87b	63.95	179.55	249539
31	6.50	130.32	185.43	24.69	1291.38b	70.34	200.66	249539
32	5.00	145.03	204.91	28.38	1436.32b	78.84	223.87	249539

Note: 34.74 a Soil pressure at active limit
25.85 p Soil pressure at passive limit
1436.32 b Passive limit reduced because of berm

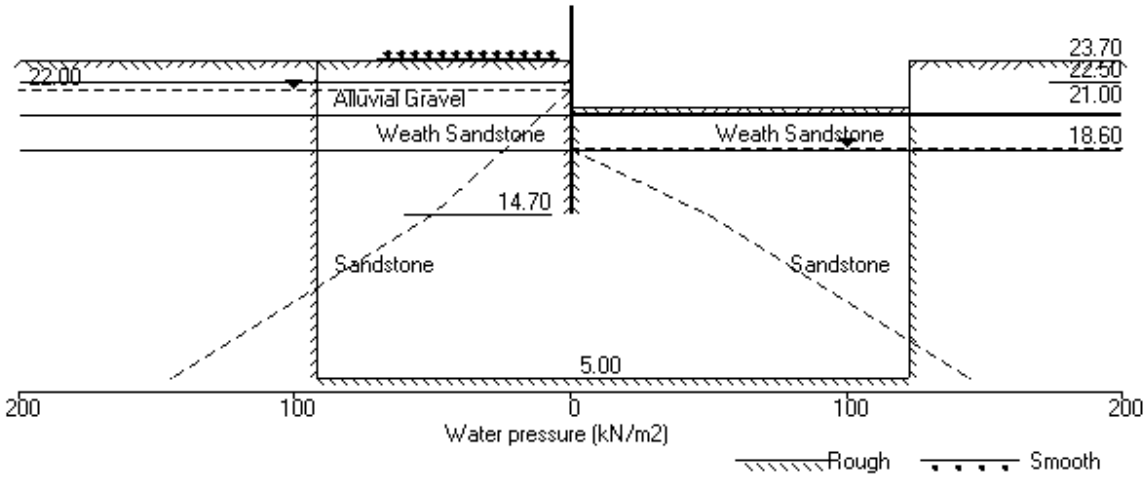
Stage No.3 Excav. to elev. 20.65 on RIGHT side



Stage No.3 Excav. to elev. 20.65 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
4	23.70	21.00	Cant.	4.841	15.16	20.09	0.91	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	23.70	0.00	0.006	9.96E-04	0.0	0.0	
2	23.58	0.77	0.005	9.96E-04	0.0	0.0	
3	23.14	3.08	0.005	9.96E-04	0.9	0.2	
4	22.70	5.65	0.005	9.94E-04	2.8	1.0	
5	22.50	6.85	0.004	9.93E-04	4.0	1.7	
		7.07	0.004	9.93E-04	4.0	1.7	
6	22.00	9.94	0.004	9.86E-04	8.3	4.8	
7	21.50	15.24	0.003	9.70E-04	14.6	10.5	
8	21.00	20.46	0.003	9.37E-04	23.5	20.0	
9	20.83	20.57	0.003	9.20E-04	27.1	24.4	
10	20.65	17.94	0.003	9.00E-04	30.5	29.4	
		21.87	0.003	9.00E-04	30.5	29.4	
11	20.50	11.50	0.002	8.79E-04	33.0	34.2	
		-6.07	0.002	8.79E-04	33.0	34.2	
12	20.00	-46.85	0.002	7.89E-04	19.8	50.0	
13	19.70	-24.52	0.002	7.22E-04	9.0	53.9	
14	19.40	-14.11	0.002	6.51E-04	3.3	55.5	
15	19.00	-6.86	0.001	5.55E-04	-0.9	55.7	
16	18.60	-4.52	0.001	4.60E-04	-3.2	54.9	
17	18.50	-4.23	0.001	4.37E-04	-3.7	54.5	
		-44.20	0.001	4.37E-04	-3.7	54.5	
18	18.00	-17.44	0.001	3.27E-04	-19.1	47.1	
19	17.50	3.06	0.001	2.39E-04	-22.7	35.3	
20	17.00	9.11	0.001	1.75E-04	-19.6	24.3	
21	16.50	9.29	0.001	1.32E-04	-15.0	15.5	
22	16.00	7.31	0.001	1.06E-04	-10.9	9.1	
23	15.50	5.32	0.001	9.15E-05	-7.7	4.5	
24	15.10	5.87	0.000	8.61E-05	-5.5	1.8	
25	14.70	16.39	0.000	8.46E-05	-1.0	0.0	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	14.57	0.07	0.000	0	0.0	0.0	
27	13.29	0.01	0.000	0	0.1	0.0	
28	12.00	0.08	0.000	0	0.1	0.0	
29	10.00	0.01	0.000	0	0.2	0.0	
30	8.00	-0.05	0.000	0	0.2	0.0	
31	6.50	0.00	0.000	0	0.1	0.0	
32	5.00	-0.18	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.62	10.47	0.77	0.77	12474
3	23.14	0.00	10.77	2.94	49.92	3.08	3.08	12474
4	22.70	0.00	20.18	5.51	93.48	5.65	5.65	12474
5	22.50	0.00	24.53	6.70	113.65	6.85	6.85	12474
		0.00	24.53	6.70	113.66	7.07	7.07	29938
6	22.00	0.00	35.18	9.61	163.02	9.94	9.94	29938
7	21.50	3.42	42.01	11.47	194.65	11.82	15.24	29938
8	21.00	6.83	48.50	13.25	224.72	13.62	20.46	29938
9	20.83	8.03	50.71	13.85	234.97	14.26	22.29	29938
10	20.65	9.22	52.89	14.45	245.09	14.88	24.10	29938
11	20.50	10.25	54.75	14.95	253.67	15.44	25.69	29938
		10.25	54.75	9.40	524.20	11.02	21.26	99795
12	20.00	13.66	62.82	10.79	601.50	12.08	25.74	99795
13	19.70	15.71	67.60	11.61	647.27	12.80	28.51	99795
14	19.40	17.76	72.34	12.42	692.67	13.57	31.33	99795
15	19.00	20.50	78.61	13.50	752.71	14.61	35.11	99795
16	18.60	23.23	84.83	14.57	812.29	15.69	38.92	99795
17	18.50	23.91	86.38	14.84	827.12	16.00	39.91	99795
		23.91	86.38	5.96	796.03	8.87	32.78	249486
18	18.00	27.33	94.09	7.42	858.91	9.48	36.81	249486
19	17.50	30.74	101.75	8.87	921.39	21.48	52.22	249486
20	17.00	34.16	109.37	10.31	983.53	27.51	61.67	249486
21	16.50	37.58	116.96	11.74	1045.40	30.76	68.33	249486
22	16.00	40.99	124.52	13.17	1107.04	33.03	74.02	249486
23	15.50	44.41	132.05	14.60	1168.49	35.38	79.78	249486
24	15.10	47.14	138.07	15.73	1217.54	38.31	85.45	249486
25	14.70	49.87	144.07	16.87	1266.49	46.68	96.55	249486
26	14.57	51.10	145.57	17.15	1278.74	38.52	89.62	249486
27	13.29	63.73	160.99	20.07	1404.52	43.73	107.46	249486
28	12.00	76.36	176.36	22.98	1529.85	48.96	125.32	249486
29	10.00	95.98	200.18	27.48	1724.11	57.14	153.12	249486
30	8.00	115.60	223.99	31.99	1918.25	65.41	181.01	249486
31	6.50	130.32	241.85	35.36	2063.93	71.82	202.13	249486
32	5.00	145.03	259.73	38.75	2209.75	79.80	224.83	249486

(continued)

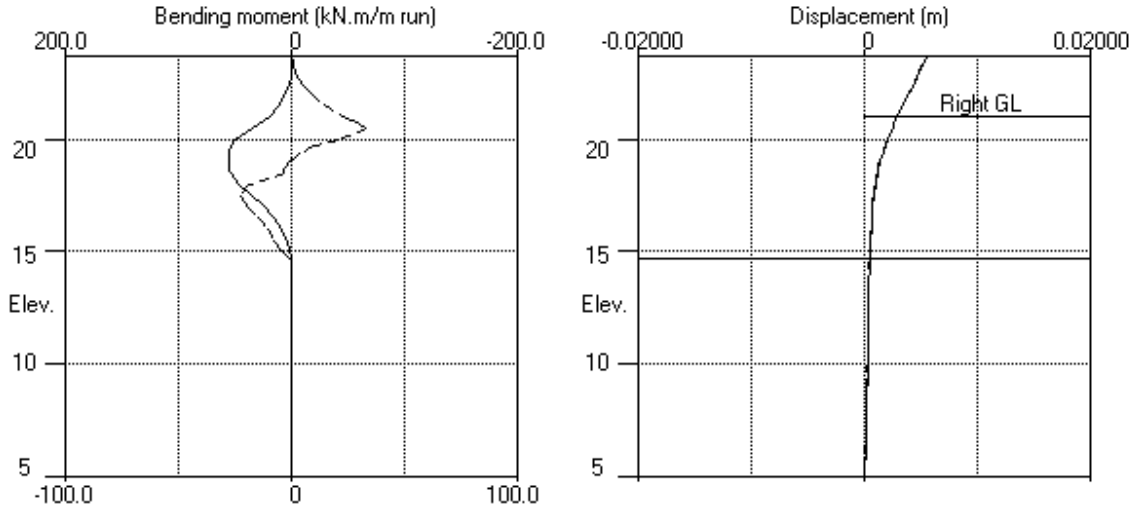
Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

RIGHT side

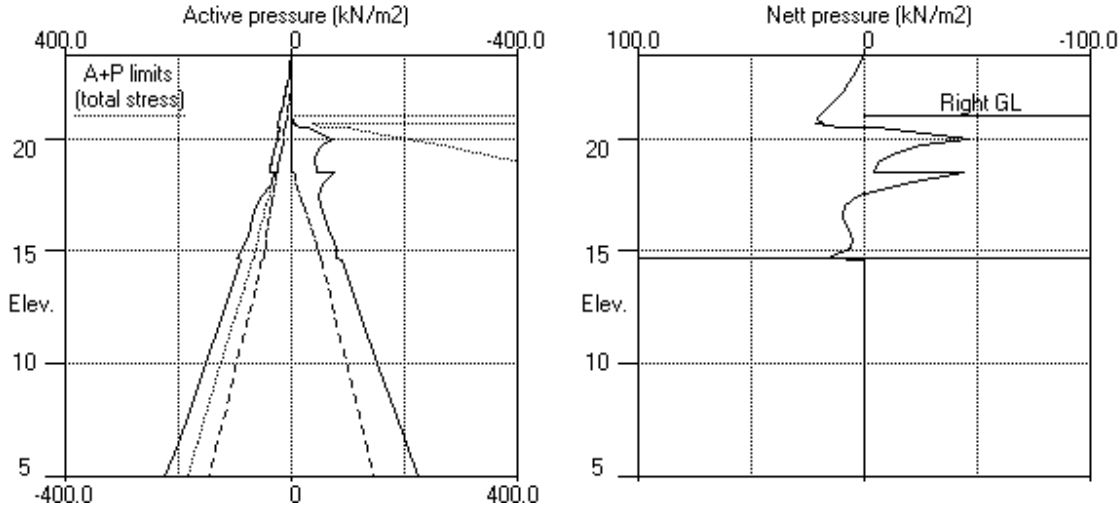
Node no.	Y coord	Water press.	Effective stresses Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	1190.00	0.00	0.00a	199620
9	20.83	Total>	4.10	1.72w	1194.10	1.72	1.72a	199620
10	20.65	Total>	8.19	3.43w	1198.19	6.16	6.16	199620
		0.00	8.19	2.24	37.95	2.24	2.24a	29943
11	20.50	0.00	10.89	2.97	50.46	14.18	14.18	29943
		0.00	10.89	1.87	104.28	27.33	27.33	99810
12	20.00	0.00	21.89	3.76	209.63	72.59	72.59	99810
13	19.70	0.00	28.50	4.89	272.85	53.03	53.03	99810
14	19.40	0.00	35.10	6.03	336.10	45.44	45.44	99810
15	19.00	0.00	43.91	7.54	420.45	41.96	41.96	99810
16	18.60	0.00	52.73	9.06	504.85	43.44	43.44	99810
17	18.50	1.28	53.65	9.21	513.72	42.87	44.15	99810
		1.28	53.65	0.00	529.11	75.71	76.99	249525
18	18.00	7.67	58.28	0.64	566.91	46.58	54.25	249525
19	17.50	14.07	62.93	1.52	604.79	35.10	49.16	249525
20	17.00	20.46	67.59	2.40	642.76	32.10	52.56	249525
21	16.50	26.85	72.26	3.29	680.85	32.19	59.05	249525
22	16.00	33.25	76.94	4.17	719.05	33.46	66.71	249525
23	15.50	39.64	81.64	5.06	757.37	34.82	74.46	249525
24	15.10	44.76	85.41	5.78	788.12	34.82	79.57	249525
25	14.70	49.87	89.19	6.49	818.96	30.28	80.16	249525
26	14.57	51.10	90.75	6.78	831.65	38.45	89.54	249525
27	13.29	63.73	106.84	9.83	962.85	43.72	107.45	249525
28	12.00	76.36	123.03	12.89	1094.95	48.88	125.24	249525
29	10.00	95.98	148.40	17.69	1301.83	57.13	153.11	249525
30	8.00	115.60	173.98	22.53	1510.46	65.46	181.06	249525
31	6.50	130.32	193.28	26.18	1667.82	71.81	202.13	249525
32	5.00	145.03	212.64	29.84	1825.73	79.99	225.02	249525

Note: 2.24 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

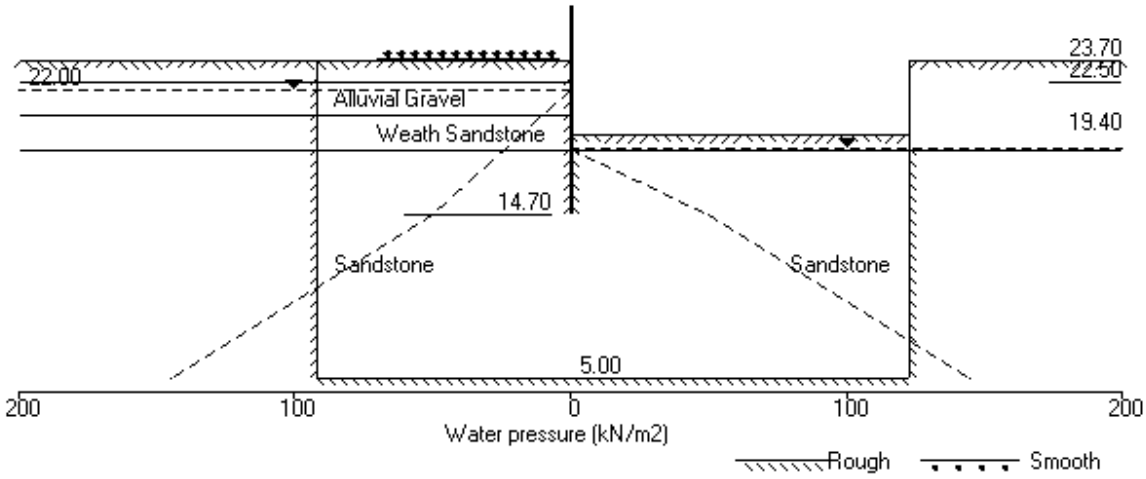
Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.5 Excav. to elev. 19.40 on RIGHT side



Units: kN,m

Stage No. 5 Excavate to elevation 19.40 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
5	23.70	19.40	Cant.	1.606	15.23	16.24	3.16	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	23.70	0.00	0.013	2.09E-03	0.0	0.0	
2	23.58	0.62	0.013	2.09E-03	0.0	0.0	
3	23.14	2.94	0.012	2.09E-03	0.8	0.2	
4	22.70	5.51	0.011	2.09E-03	2.7	1.0	
5	22.50	6.70	0.010	2.09E-03	3.9	1.6	
6	22.00	9.61	0.009	2.08E-03	8.0	4.6	
7	21.50	14.89	0.008	2.06E-03	14.1	10.1	
8	21.00	20.08	0.007	2.03E-03	22.8	19.2	
9	20.83	21.88	0.007	2.02E-03	26.5	23.5	
10	20.65	23.67	0.007	2.00E-03	30.5	28.5	
11	20.50	25.20	0.006	1.98E-03	34.2	33.4	
		19.65	0.006	1.98E-03	34.2	33.4	
12	20.00	24.45	0.005	1.88E-03	45.2	54.9	
13	19.70	27.32	0.005	1.80E-03	52.9	69.3	
14	19.40	30.19	0.004	1.70E-03	61.6	86.3	
15	19.00	-50.27	0.004	1.53E-03	57.6	112.5	
16	18.60	-56.19	0.003	1.32E-03	36.3	131.5	
17	18.50	-46.42	0.003	1.26E-03	31.1	134.9	
		-165.96	0.003	1.26E-03	31.1	134.9	
18	18.00	-69.37	0.002	9.82E-04	-27.7	129.6	
19	17.50	-22.32	0.002	7.27E-04	-50.6	107.0	
20	17.00	9.82	0.002	5.27E-04	-53.7	78.9	
21	16.50	19.48	0.001	3.85E-04	-46.4	53.1	
22	16.00	19.15	0.001	2.93E-04	-36.8	32.3	
23	15.50	16.80	0.001	2.41E-04	-27.8	16.2	
24	15.10	21.27	0.001	2.21E-04	-20.2	6.4	
25	14.70	60.61	0.001	2.16E-04	-3.8	0.0	
26	14.57	0.08	0.001	0	0.0	0.0	
27	13.29	0.01	0.001	0	0.1	0.0	

(continued)

Stage No.5 Excavate to elevation 19.40 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	12.00	0.10	0.001	0	0.1	0.0	
29	10.00	0.03	0.000	0	0.3	0.0	
30	8.00	-0.06	0.000	0	0.2	0.0	
31	6.50	0.01	0.000	0	0.2	0.0	
32	5.00	-0.26	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.62	10.47	0.62	0.62a	12474
3	23.14	0.00	10.77	2.94	49.92	2.94	2.94a	12474
4	22.70	0.00	20.18	5.51	93.48	5.51	5.51a	12474
5	22.50	0.00	24.53	6.70	113.65	6.70	6.70a	12474
		0.00	24.53	6.70	113.66	6.70	6.70a	29938
6	22.00	0.00	35.18	9.61	163.02	9.61	9.61a	29938
7	21.50	3.42	42.01	11.47	194.65	11.47	14.89a	29938
8	21.00	6.83	48.50	13.25	224.72	13.25	20.08a	29938
9	20.83	8.03	50.71	13.85	234.97	13.85	21.88a	29938
10	20.65	9.22	52.89	14.45	245.09	14.45	23.67a	29938
11	20.50	10.25	54.75	14.95	253.67	14.95	25.20a	29938
		10.25	54.75	9.40	524.20	9.40	19.65a	99795
12	20.00	13.66	62.82	10.79	601.50	10.79	24.45a	99795
13	19.70	15.71	67.60	11.61	647.27	11.61	27.32a	99795
14	19.40	17.76	72.34	12.42	692.67	12.42	30.19a	99795
15	19.00	20.50	78.61	13.50	752.71	13.50	34.00a	99795
16	18.60	23.23	84.83	14.57	812.29	14.57	37.80a	99795
17	18.50	23.91	86.38	14.84	827.12	14.84	38.75a	99795
		23.91	86.38	5.96	796.03	5.96	29.87a	249486
18	18.00	27.33	94.09	7.42	858.91	7.42	34.74a	249486
19	17.50	30.74	101.75	8.87	921.39	9.99	40.74	249486
20	17.00	34.16	109.37	10.31	983.53	26.48	60.64	249486
21	16.50	37.58	116.96	11.74	1045.40	32.77	70.35	249486
22	16.00	40.99	124.52	13.17	1107.04	34.70	75.69	249486
23	15.50	44.41	132.05	14.60	1168.49	36.07	80.48	249486
24	15.10	47.14	138.07	15.73	1217.54	40.32	87.46	249486
25	14.70	49.87	144.07	16.87	1266.49	63.73	113.60	249486
26	14.57	51.10	145.57	17.15	1278.74	31.97	83.07	249486
27	13.29	63.73	160.99	20.07	1404.52	36.99	100.72	249486
28	12.00	76.36	176.36	22.98	1529.85	41.85	118.21	249486
29	10.00	95.98	200.18	27.48	1724.11	49.95	145.93	249486
30	8.00	115.60	223.99	31.99	1918.25	58.35	173.95	249486
31	6.50	130.32	241.85	35.36	2063.93	65.07	195.39	249486
32	5.00	145.03	259.73	38.75	2209.75	74.57	219.61	249486

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0

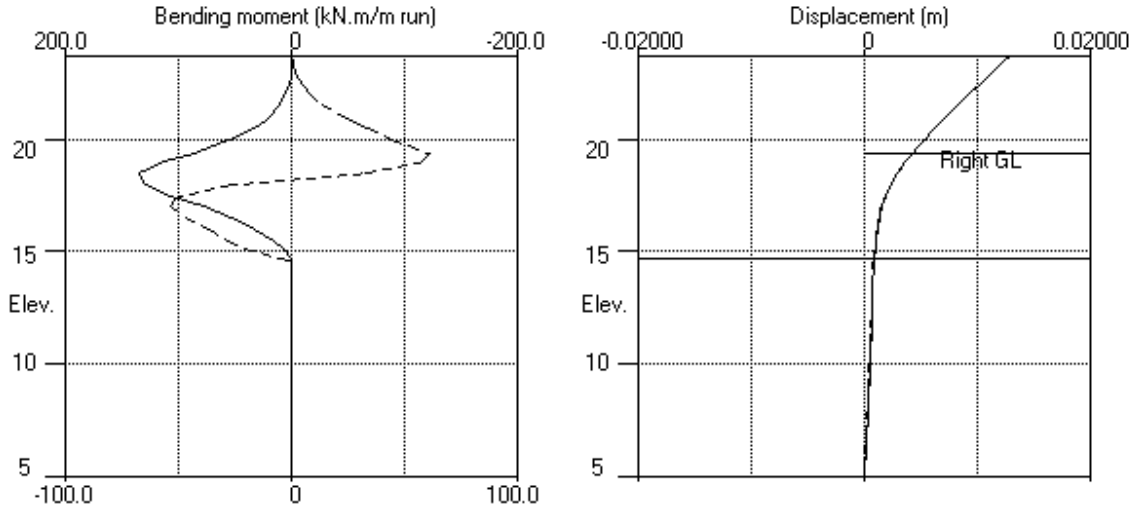
(continued)

Stage No.5 Excavate to elevation 19.40 on RIGHT side

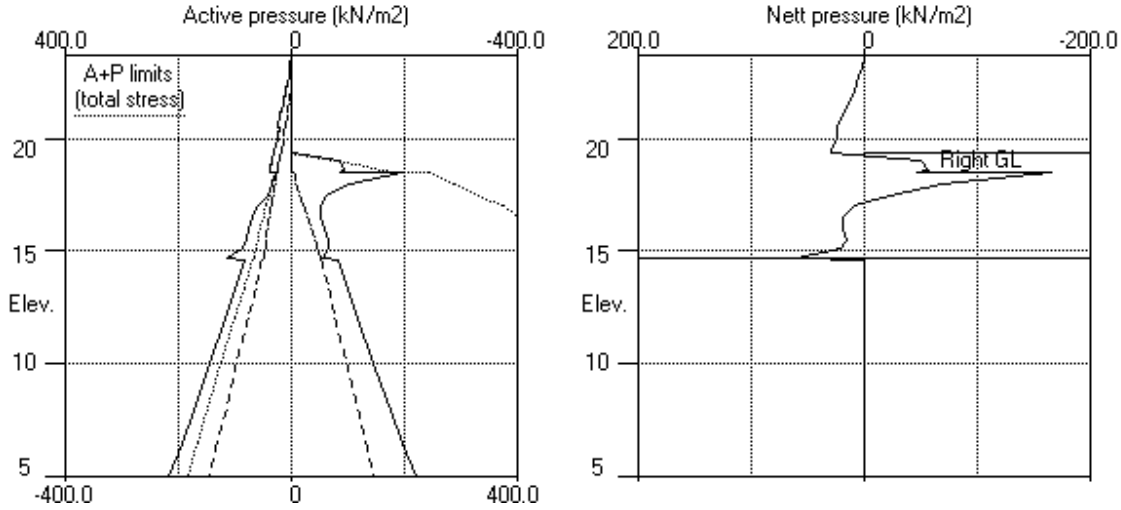
		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
5	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	20.83	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	20.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	20.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	19.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	19.40	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	99838
15	19.00	0.00	8.80	1.51	84.26	84.26	84.26p	99838
16	18.60	0.00	17.60	3.02	168.55	93.99	93.99	99838
17	18.50	1.28	18.52	3.18	177.37	83.89	85.17	99838
		1.28	18.52	0.00	242.65	194.55	195.83	249596
18	18.00	7.67	23.14	0.00	280.28	96.44	104.11	249596
19	17.50	14.07	27.76	0.00	317.99	48.99	63.06	249596
20	17.00	20.46	32.40	0.00	355.79	30.36	50.82	249596
21	16.50	26.85	37.05	0.00	393.72	24.02	50.87	249596
22	16.00	33.25	41.72	0.00	431.78	23.30	56.54	249596
23	15.50	39.64	46.40	0.00	470.01	24.04	63.68	249596
24	15.10	44.76	50.17	0.00	500.72	21.44	66.19	249596
25	14.70	49.87	53.95	0.00	531.55	3.12	52.99	249596
26	14.57	51.10	55.51	0.12	544.24	31.89	82.99	249596
27	13.29	63.73	71.64	3.17	675.78	36.97	100.70	249596
28	12.00	76.36	87.95	6.25	808.80	41.75	118.11	249596
29	10.00	95.98	113.65	11.12	1018.44	49.92	145.90	249596
30	8.00	115.60	139.77	16.06	1231.47	58.41	174.01	249596
31	6.50	130.32	159.60	19.81	1393.11	65.06	195.38	249596
32	5.00	145.03	179.57	23.58	1556.03	74.83	219.86	249596

Note: 34.74 a Soil pressure at active limit
84.26 p Soil pressure at passive limit

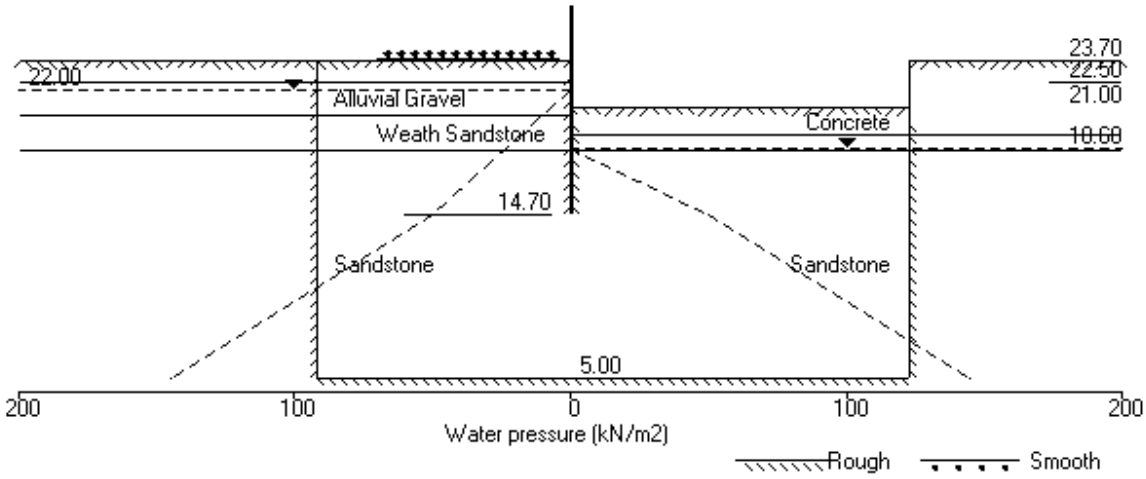
Stage No.5 Excav. to elev. 19.40 on RIGHT side



Stage No.5 Excav. to elev. 19.40 on RIGHT side



Stage No.6 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 6 Fill to elevation 21.00 on RIGHT side with soil type 5

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 14.70 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.250 Toe elev.	Wall Penetr -ation	Direction of failure
6	23.70	21.00	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 100.00m

2-D finite element model. Active limit arching modelled.

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

Open Tension Crack analysis - No

Rigid boundaries:	Left side 15.00 from wall	Rough boundary
	Right side 20.00 from wall	Rough boundary
Lower rigid boundary at elevation 5.00		Rough boundary

Limit State: Serviceability Limit State

Calculated Bending Moments and Prop 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	Prop forces kN/m
1	23.70	0.00	0.013	2.11E-03	0.0	0.0	
2	23.58	1.15	0.012	2.11E-03	0.1	0.0	
3	23.14	3.43	0.011	2.11E-03	1.1	0.3	
4	22.70	6.03	0.010	2.11E-03	3.1	1.2	
5	22.50	7.30	0.010	2.10E-03	4.5	2.0	
		8.15	0.010	2.10E-03	4.5	2.0	
6	22.00	10.95	0.009	2.10E-03	9.3	5.4	
7	21.50	16.37	0.008	2.08E-03	16.1	11.7	
8	21.00	21.72	0.007	2.04E-03	25.6	22.0	
9	20.83	21.96	0.007	2.02E-03	29.4	26.8	
10	20.65	22.16	0.006	2.00E-03	33.3	32.3	
11	20.50	22.46	0.006	1.98E-03	36.6	37.5	
		21.97	0.006	1.98E-03	36.6	37.5	
12	20.00	20.40	0.005	1.87E-03	47.2	60.1	
13	19.70	16.45	0.004	1.79E-03	52.8	74.8	
14	19.40	10.44	0.004	1.68E-03	56.8	91.2	
		28.74	0.004	1.68E-03	56.8	91.2	
15	19.00	-52.76	0.003	1.50E-03	52.0	115.4	
16	18.60	-58.03	0.003	1.29E-03	29.8	132.0	
17	18.50	-48.02	0.003	1.23E-03	24.5	134.7	
		-152.58	0.003	1.23E-03	24.5	134.7	
18	18.00	-63.88	0.002	9.54E-04	-29.6	127.8	
19	17.50	-20.10	0.002	7.03E-04	-50.6	104.9	
20	17.00	10.56	0.001	5.08E-04	-53.0	77.0	
21	16.50	19.51	0.001	3.69E-04	-45.5	51.8	
22	16.00	18.89	0.001	2.80E-04	-35.9	31.4	
23	15.50	16.42	0.001	2.29E-04	-27.0	15.8	
24	15.10	20.68	0.001	2.10E-04	-19.6	6.2	
25	14.70	58.96	0.001	2.04E-04	-3.7	0.0	

(continued)

Stage No.6 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	14.57	0.07	0.001	0	0.0	0.0	
27	13.29	0.01	0.001	0	0.1	0.0	
28	12.00	0.08	0.000	0	0.1	0.0	
29	10.00	0.01	0.000	0	0.2	0.0	
30	8.00	-0.05	0.000	0	0.2	0.0	
31	6.50	0.00	0.000	0	0.1	0.0	
32	5.00	-0.18	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.62	10.47	1.15	1.15	12474
3	23.14	0.00	10.77	2.94	49.92	3.43	3.43	12474
4	22.70	0.00	20.18	5.51	93.48	6.03	6.03	12474
5	22.50	0.00	24.53	6.70	113.65	7.30	7.30	12474
		0.00	24.53	6.70	113.66	8.15	8.15	29938
6	22.00	0.00	35.18	9.61	163.02	10.95	10.95	29938
7	21.50	3.42	42.01	11.47	194.65	12.95	16.37	29938
8	21.00	6.83	48.50	13.25	224.72	14.89	21.72	29938
9	20.83	8.03	50.71	13.85	234.97	15.64	23.67	29938
10	20.65	9.22	52.89	14.45	245.09	16.37	25.59	29938
11	20.50	10.25	54.75	14.95	253.67	17.12	27.37	29938
		10.25	54.75	9.40	524.20	16.63	26.88	99795
12	20.00	13.66	62.82	10.79	601.50	16.93	30.59	99795
13	19.70	15.71	67.60	11.61	647.27	17.58	33.29	99795
14	19.40	17.76	72.34	12.42	692.67	18.26	36.02	99795
15	19.00	20.50	78.61	13.50	752.71	19.18	39.68	99795
16	18.60	23.23	84.83	14.57	812.29	20.29	43.52	99795
17	18.50	23.91	86.38	14.84	827.12	20.71	44.62	99795
		23.91	86.38	5.96	796.03	20.65	44.56	249486
18	18.00	27.33	94.09	7.42	858.91	17.80	45.13	249486
19	17.50	30.74	101.75	8.87	921.39	18.62	49.37	249486
20	17.00	34.16	109.37	10.31	983.53	34.31	68.47	249486
21	16.50	37.58	116.96	11.74	1045.40	40.21	77.78	249486
22	16.00	40.99	124.52	13.17	1107.04	41.96	82.95	249486
23	15.50	44.41	132.05	14.60	1168.49	43.25	87.66	249486
24	15.10	47.14	138.07	15.73	1217.54	47.37	94.52	249486
25	14.70	49.87	144.07	16.87	1266.49	70.20	120.08	249486
26	14.57	51.10	145.57	17.15	1278.74	39.29	90.39	249486
27	13.29	63.73	160.99	20.07	1404.52	44.25	107.98	249486
28	12.00	76.36	176.36	22.98	1529.85	49.04	125.40	249486
29	10.00	95.98	200.18	27.48	1724.11	57.03	153.01	249486
30	8.00	115.60	223.99	31.99	1918.25	65.28	180.88	249486
31	6.50	130.32	241.85	35.36	2063.93	71.81	202.13	249486
32	5.00	145.03	259.73	38.75	2209.75	79.91	224.94	249486

(continued)

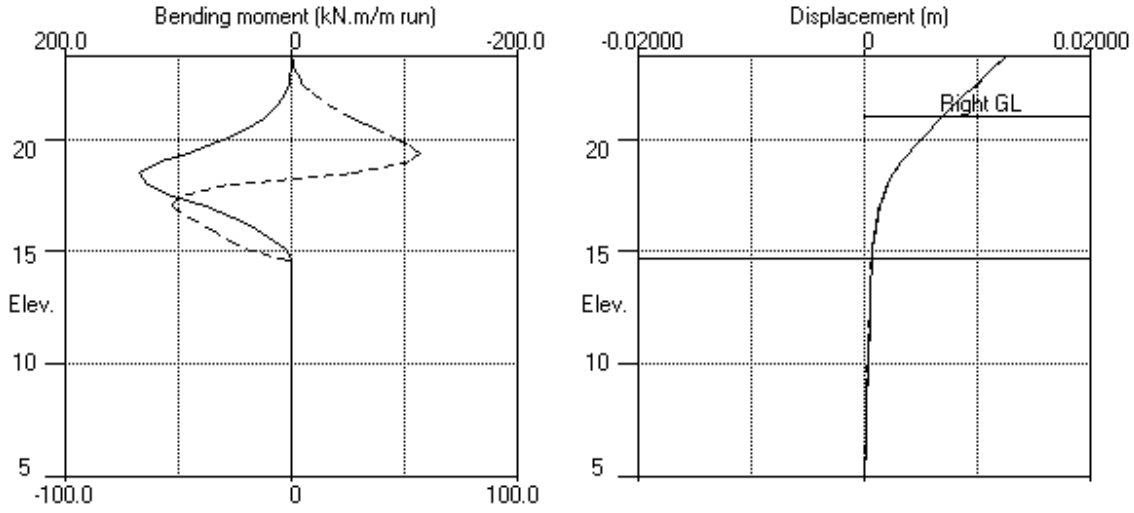
Stage No.6 Fill to elevation 21.00 on RIGHT side with soil type 5

RIGHT side

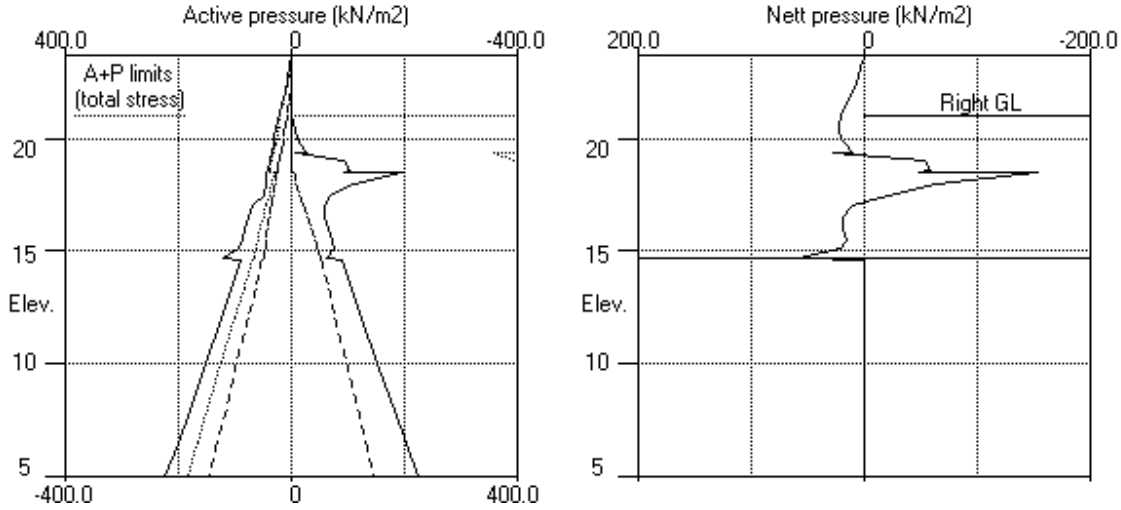
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	1190.00	0.00	0.00a	199620
9	20.83	Total>	4.10	1.72w	1194.10	1.72	1.72a	199620
10	20.65	Total>	8.19	3.43w	1198.19	3.43	3.43a	199620
11	20.50	Total>	11.70	4.90w	1201.70	4.91	4.91a	199620
12	20.00	Total>	23.40	9.81w	1213.40	10.19	10.19	199620
13	19.70	Total>	30.43	12.75w	1220.43	16.84	16.84	199620
14	19.40	Total>	37.45	15.70w	1227.45	25.58	25.58	199620
		0.00	37.45	6.43	358.60	7.28	7.28	99810
15	19.00	0.00	46.26	7.95	442.95	92.44	92.44	99810
16	18.60	0.00	55.08	9.46	527.36	101.55	101.55	99810
17	18.50	1.28	56.00	9.62	536.22	91.36	92.64	99810
		1.28	56.00	0.21	548.28	195.86	197.14	249525
18	18.00	7.67	60.63	1.09	586.07	101.33	109.01	249525
19	17.50	14.07	65.28	1.97	623.95	55.40	69.47	249525
20	17.00	20.46	69.94	2.85	661.93	37.45	57.91	249525
21	16.50	26.85	74.61	3.73	700.01	31.42	58.27	249525
22	16.00	33.25	79.29	4.62	738.21	30.81	64.06	249525
23	15.50	39.64	83.99	5.51	776.54	31.59	71.23	249525
24	15.10	44.76	87.76	6.22	807.29	29.08	73.84	249525
25	14.70	49.87	91.54	6.94	838.12	11.24	61.12	249525
26	14.57	51.10	93.10	7.23	850.81	39.21	90.31	249525
27	13.29	63.73	109.19	10.27	982.01	44.24	107.97	249525
28	12.00	76.36	125.38	13.34	1114.11	48.96	125.32	249525
29	10.00	95.98	150.75	18.13	1321.00	57.01	152.99	249525
30	8.00	115.60	176.33	22.97	1529.62	65.33	180.93	249525
31	6.50	130.32	195.63	26.62	1686.98	71.81	202.12	249525
32	5.00	145.03	214.99	30.28	1844.89	80.09	225.12	249525

Note: 4.91 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Stage No.6 Fill to elev. 21.00 on RIGHT side



Stage No.6 Fill to elev. 21.00 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.250** Toe elev.	Wall Penetr -ation	Direction of failure
1	23.70	23.70	Cant.	Conditions not suitable for FoS calc.				
2	23.70	23.70	Cant.	Conditions not suitable for FoS calc.				
3	23.70	20.65	Cant.	1.818	15.09	17.62	3.03	L to R
4	23.70	21.00	Cant.	4.841	15.16	20.09	0.91	L to R
5	23.70	19.40	Cant.	1.606	15.23	16.24	3.16	L to R
6	23.70	21.00	Cant.	Conditions not suitable for FoS calc.				
7	23.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: Serviceability Limit State

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

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment				Shear force			
				Calculated		Factored		Calculated		Factored	
no.	coord	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	23.70	0.013	0.000	0	0	0	0	0	0	0	0
2	23.58	0.013	0.000	0	-0	0	-0	0	-1	0	-1
3	23.14	0.012	0.000	0	-0	0	-0	1	-1	1	-1
4	22.70	0.011	0.000	1	-0	2	-1	3	-1	4	-1
5	22.50	0.010	0.000	2	-1	3	-1	4	-1	6	-1
6	22.00	0.009	0.000	5	-1	7	-2	10	-2	13	-3
7	21.50	0.008	0.000	12	-3	16	-3	18	-2	25	-3
8	21.00	0.007	0.000	23	-4	32	-5	29	-1	40	-2
9	20.83	0.007	0.000	29	-4	39	-5	34	-1	46	-1
10	20.65	0.007	0.000	34	-4	46	-5	33	-0	45	-0
11	20.50	0.006	0.000	39	-4	52	-5	37	0	49	0
12	20.00	0.005	0.000	60	-4	81	-5	47	-1	64	-1
13	19.70	0.005	0.000	75	-4	101	-5	53	-0	71	-0
14	19.40	0.004	0.000	91	-4	123	-5	62	0	83	0
15	19.00	0.004	0.000	115	-3	156	-5	58	-1	78	-1
16	18.60	0.003	0.000	132	-2	178	-3	36	-3	49	-4
17	18.50	0.003	0.000	135	-2	182	-2	31	-4	42	-5
18	18.00	0.002	0.000	130	-0	175	-0	2	-30	3	-40
19	17.50	0.002	0.000	107	0	145	0	1	-51	1	-68
20	17.00	0.002	0.000	79	0	106	0	0	-54	1	-73
21	16.50	0.001	0.000	53	0	72	0	0	-46	0	-63
22	16.00	0.001	0.000	32	0	44	0	0	-37	0	-50
23	15.50	0.001	0.000	16	0	22	0	0	-28	0	-37
24	15.10	0.001	0.000	6	0	9	0	0	-20	0	-27
25	14.70	0.001	0.000	0	0	0	0	0	-4	0	-5
26	14.57	0.001	0.000	0	0	0	0	0	-0	0	-0
27	13.29	0.001	0.000	0	0	0	0	0	-0	0	-0
28	12.00	0.001	0.000	0	0	0	0	0	-0	0	-0
29	10.00	0.000	0.000	0	0	0	0	0	-0	0	-0
30	8.00	0.000	0.000	0	0	0	0	0	-0	0	-0
31	6.50	0.000	0.000	0	0	0	0	0	-0	0	-0
32	5.00	0.000	0.000	0	0	0	0	0	-0	0	-0

Summary of results (continued)

Calculated Bending Moments and Prop 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	1	16.50	-4	19.40	1	-5	5	18.50	-2	21.50	7	-3
2	1	17.00	-4	19.70	1	-5	6	18.50	-2	21.50	8	-3
3	55	19.00	0	23.70	75	0	33	20.50	-23	17.50	45	-31
4	56	19.00	0	23.70	75	0	33	20.50	-23	17.50	45	-31
5	135	18.50	0	23.70	182	0	62	19.40	-54	17.00	83	-73
6	135	18.50	0	23.70	182	0	57	19.40	-53	17.00	77	-72
7	No calculation at this stage											
8	No calculation at this stage											
9	134	18.50	-0	23.14	181	-0	56	19.40	-53	17.00	76	-71

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.000	20.83	0.000	23.70	Apply water pressure profile no.1
2	0.000	21.50	0.000	23.70	Apply surcharge no.1 at elev. 23.70
3	0.006	23.70	0.000	23.70	Excav. to elev. 20.65 on RIGHT side
4	0.006	23.70	0.000	23.70	Fill to elev. 21.00 on RIGHT side
5	0.013	23.70	0.000	23.70	Excav. to elev. 19.40 on RIGHT side
6	0.013	23.70	0.000	23.70	Fill to elev. 21.00 on RIGHT side
7	No calculation at this stage				Install prop no.5 at elev. 20.83
8	No calculation at this stage				Install prop no.2 at elev. 23.58
9	0.013	23.70	0.000	23.70	Apply water pressure profile no.3

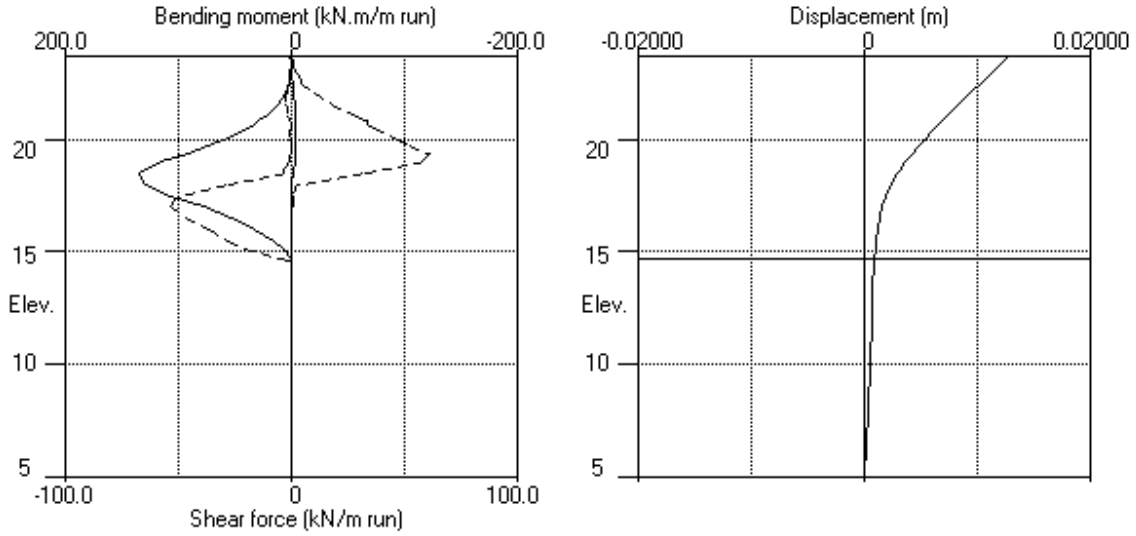
Summary of results (continued)

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

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 2 at elev. 23.58			Prop no. 5 at elev. 20.83		
	--Calculated-- kN per m run	Factored kN per prop	Factored kN per prop	--Calculated-- kN per m run	Factored kN per prop	Factored kN per prop
9	1	1	1	8	8	11

Bending moment, shear force, displacement envelopes



Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	23.70	1 Fill	1 Fill
2	22.50	2 Alluvial Gravel	2 Alluvial Gravel
3	20.50	3 Weath Sandstone	3 Weath Sandstone
4	18.50	4 Sandstone	4 Sandstone

SOIL PROPERTIES (Unfactored SLS soil strengths)
Soil Properties File = 21-1182_Soils__SLS.dat

-- 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	Fill	18.00	12500	0.500	OC (0.200)	0.273 (0.000)	4.633 (0.000)	
2	Alluvial Gravel	18.00	30000	0.500	OC (0.200)	0.273 (0.000)	4.634 (0.000)	
3	Weath Sandstone	22.00	100000	0.357	OC (0.250)	0.172 (0.000)	9.575 (0.000)	
4	Sandstone	22.00	250000	0.331	OC (0.270)	0.189 (1.038)	8.155 (9.158)	10.00d
5	Concrete	23.40	200000	1.000	OC (0.490)	1.000 (2.380)	1.000 (2.380)	500.0u

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	Fill	30.00	1.000	0.00	30.00	0.631	0.00
2	Alluvial Gravel	30.00	1.000	0.00	30.00	0.631	0.00
3	Weath Sandstone	40.00	1.000	0.00	40.00	0.599	0.00
4	Sandstone	38.00	1.000	0.00	38.00	0.606	0.00
5	Concrete	0.00	0.484	0.00	0.00	0.483	0.00

GROUND WATER CONDITIONS

Density of water = 9.810 kN/m3

	Left side	Right side
Initial water table elevation	22.00	22.00

Automatic water pressure balancing at toe of wall : Yes

Water press. profile no.	Point no.	Left side Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Right side Elev. m	Piezo elev. m	Water press. kN/m2	
1	1	22.00	22.00	0.0	1	18.60	18.60	0.0	MC
2	1	22.70	22.70	0.0	1	18.10	18.10	0.0	WC
3	1	22.70	22.70	0.0	1	18.60	18.60	0.0	MC
4	1	22.70	22.70	0.0	1	18.10	18.10	0.0	WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 14.70
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 8.3000E-03 m4/m run
E.I = 232400 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	26.70	1.00	0.400000	2.500E+07	5.00	0.00	0	Strut	No	R
2	23.58	1.00	0.250000	2.500E+07	5.00	0.00	0	Strut	No	R
3	20.73	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	No	R
4	20.17	1.00	0.550000	2.500E+07	5.00	0.00	0	Strut	Yes	R
5	20.83	1.00	0.350000	2.500E+07	5.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	23.70	1.00(L)	50.00	10.00	12.00	=	N/A	1.30 Var

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 water pressure profile no.2 (Worst Cred.)
2	Apply surcharge no.1 at elevation 23.70
3	Excavate to elevation 20.65 on RIGHT side Toe of berm at elevation 18.10 Width of top of berm = 4.00 Width of toe of berm = 5.00
4	Fill to elevation 21.00 on RIGHT side with soil type 5
5	Excavate to elevation 18.90 on RIGHT side
6	Fill to elevation 21.00 on RIGHT side with soil type 5
7	Install strut or anchor no.5 at elevation 20.83
8	Install strut or anchor no.2 at elevation 23.58
9	Apply water pressure profile no.4 (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 = 5.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 8.000 m

Boundary conditions:

Length of wall (normal to plane of analysis) = 100.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 15.00 m
Distance to rigid boundary on Right side = 20.00 m
Elevation of rigid lower boundary = 5.00

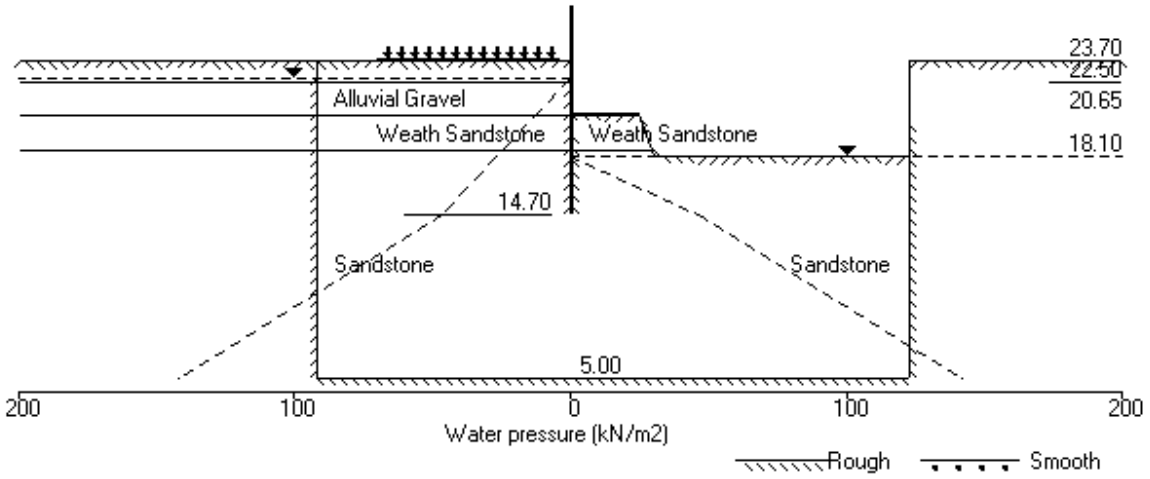
Lower rigid boundary at elevation 5.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Rough

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply water pressure profile no.2	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 23.70	Yes	Yes	Yes
3	Excav. to elev. 20.65 on RIGHT side	Yes	Yes	Yes
4	Fill to elev. 21.00 on RIGHT side	Yes	Yes	Yes
5	Excav. to elev. 18.90 on RIGHT side	Yes	Yes	Yes
6	Fill to elev. 21.00 on RIGHT side	No	No	No
7	Install prop no.5 at elev. 20.83	Yes	Yes	Yes
8	Install prop no.2 at elev. 23.58	Yes	Yes	Yes
9	Apply water pressure profile no.4	No	No	No
*	Summary output	Yes	-	Yes

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Stage No.3 Excav. to elev. 20.65 on RIGHT side



Units: kN,m

Stage No. 3 Excavate to elevation 20.65 on RIGHT side
Toe of berm at elevation 18.10
Width of top of berm = 4.00
Width of toe of berm = 5.00

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr-ation	Direction of failure
3	23.70	20.65	Cant.	1.313	15.00	17.22	3.43	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	23.70	0.00	0.009	1.60E-03	0.0	-0.0	
2	23.58	0.78	0.009	1.60E-03	0.0	0.0	
3	23.14	3.77	0.008	1.60E-03	1.0	0.2	
4	22.70	7.15	0.008	1.59E-03	3.4	1.2	
5	22.50	9.49	0.007	1.59E-03	5.1	2.0	
6	22.00	15.24	0.006	1.58E-03	11.3	6.1	
7	21.50	20.80	0.006	1.56E-03	20.3	13.8	
8	21.00	26.22	0.005	1.52E-03	32.0	26.8	
9	20.83	28.09	0.005	1.50E-03	36.8	32.9	
10	20.65	29.94	0.004	1.47E-03	41.9	39.7	
11	20.50	22.45	0.004	1.44E-03	45.8	46.3	
		9.28	0.004	1.44E-03	45.8	46.3	
12	20.00	-39.44	0.003	1.32E-03	38.3	70.5	
13	19.50	-40.13	0.003	1.15E-03	18.4	84.8	
14	19.20	-23.27	0.003	1.04E-03	8.9	88.5	
15	18.90	-16.00	0.002	9.26E-04	3.0	90.1	
16	18.50	-15.27	0.002	7.71E-04	-3.3	90.1	
		-84.98	0.002	7.71E-04	-3.3	90.1	
17	18.10	-32.38	0.002	6.23E-04	-26.8	82.0	
18	17.80	-11.11	0.001	5.23E-04	-33.3	72.5	
19	17.50	0.03	0.001	4.37E-04	-34.9	62.0	
20	17.00	10.34	0.001	3.22E-04	-32.4	44.4	
21	16.50	13.25	0.001	2.43E-04	-26.5	29.4	
22	16.00	11.47	0.001	1.92E-04	-20.3	17.7	
23	15.50	9.14	0.001	1.63E-04	-15.1	8.9	
24	15.10	11.31	0.001	1.52E-04	-11.0	3.6	
25	14.70	33.40	0.001	1.49E-04	-2.1	0.0	

(continued)

Stage No.3 Excavate to elevation 20.65 on RIGHT side
Toe of berm at elevation 18.10
Width of top of berm = 4.00
Width of toe of berm = 5.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
26	14.57	0.08	0.001	0	0.0	0.0	
27	13.29	0.01	0.001	0	0.1	0.0	
28	12.00	0.09	0.000	0	0.1	0.0	
29	10.00	0.02	0.000	0	0.2	0.0	
30	8.00	-0.06	0.000	0	0.2	0.0	
31	6.50	0.00	0.000	0	0.2	0.0	
32	5.00	-0.21	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.78	7.60	0.78	0.78a	12474
3	23.14	0.00	10.97	3.77	36.86	3.77	3.77a	12474
4	22.70	0.00	20.83	7.15	69.99	7.15	7.15a	12474
5	22.50	1.17	24.24	8.32	81.44	8.32	9.49a	12474
		1.17	24.24	8.32	81.45	8.32	9.49a	29938
6	22.00	4.10	32.46	11.14	109.07	11.14	15.24a	29938
7	21.50	7.02	40.15	13.78	134.91	13.78	20.80a	29938
8	21.00	9.95	47.40	16.27	159.29	16.27	26.22a	29938
9	20.83	10.97	49.86	17.12	167.55	17.12	28.09a	29938
10	20.65	12.00	52.28	17.95	175.70	17.95	29.94a	29938
11	20.50	12.87	54.34	18.65	182.60	18.65	31.53a	29938
		12.87	54.34	12.46	323.17	12.46	25.33a	99795
12	20.00	15.80	63.05	14.46	374.98	14.46	30.26a	99795
13	19.50	18.73	71.59	16.42	425.79	16.42	35.14a	99795
14	19.20	20.48	76.65	17.58	455.90	17.58	38.06a	99795
15	18.90	22.24	81.68	18.73	485.78	18.73	40.97a	99795
16	18.50	24.58	88.32	20.26	525.31	20.26	44.83a	99795
		24.58	88.32	12.45	517.29	12.45	37.02a	249486
17	18.10	26.92	94.92	14.09	551.87	14.09	41.01a	249486
18	17.80	28.67	99.84	15.32	577.65	15.32	43.99a	249486
19	17.50	30.43	104.74	16.54	603.33	17.92	48.35	249486
20	17.00	33.35	112.86	18.57	645.90	26.39	59.74	249486
21	16.50	36.28	120.93	20.59	688.24	31.26	67.54	249486
22	16.00	39.21	128.98	22.59	730.39	33.95	73.16	249486
23	15.50	42.13	136.99	24.59	772.39	36.50	78.63	249486
24	15.10	44.47	143.38	26.19	805.88	40.51	84.98	249486
25	14.70	46.81	149.75	27.78	839.31	55.38	102.20	249486
26	14.57	48.04	151.25	28.15	847.14	38.26	86.30	249486
27	13.29	60.67	166.59	31.98	927.57	43.49	104.16	249486
28	12.00	73.30	181.86	35.80	1007.62	48.68	121.98	249486
29	10.00	92.92	205.51	41.70	1131.60	56.87	149.79	249486
30	8.00	112.54	229.15	47.60	1255.49	65.18	177.72	249486
31	6.50	127.25	246.88	52.03	1348.47	71.68	198.93	249486
32	5.00	141.97	264.64	56.46	1441.56	80.08	222.05	249486

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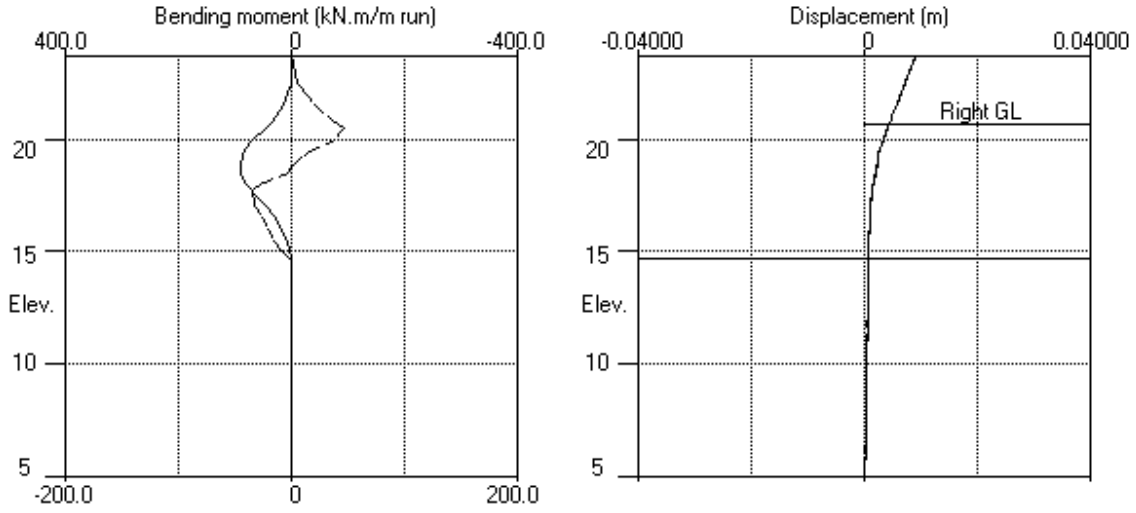
Stage No.3 Excavate to elevation 20.65 on RIGHT side
Toe of berm at elevation 18.10
Width of top of berm = 4.00
Width of toe of berm = 5.00

		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	20.83	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	20.65	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	29945
11	20.50	0.00	2.70	0.93	9.07	9.07	9.07p	29945
		0.00	2.70	0.62	16.06	16.06	16.06p	99816
12	20.00	0.00	13.70	3.14	69.70	69.70	69.70p	99816
13	19.50	0.00	24.70	5.67	86.94b	75.27	75.27	99816
14	19.20	0.00	31.31	7.18	73.42b	61.33	61.33	99816
15	18.90	0.00	37.92	8.70	75.37b	56.97	56.97	99816
16	18.50	0.00	46.73	10.72	80.21b	60.10	60.10	99816
		0.00	46.73	2.06	133.47b	122.00	122.00	249539
17	18.10	0.00	55.55	4.26	126.26b	73.39	73.39	249539
18	17.80	4.13	58.04	4.88	97.28b	50.97	55.11	249539
19	17.50	8.26	60.53	5.51	113.33b	40.06	48.32	249539
20	17.00	15.15	64.69	6.55	132.06b	34.25	49.40	249539
21	16.50	22.03	68.87	7.59	153.98b	32.26	54.29	249539
22	16.00	28.91	73.06	8.64	175.98b	32.77	61.69	249539
23	15.50	35.80	77.27	9.69	196.82b	33.69	69.49	249539
24	15.10	41.31	80.65	10.53	215.83b	32.37	73.67	249539
25	14.70	46.81	84.04	11.38	233.19b	21.98	68.79	249539
26	14.57	48.04	85.60	11.77	270.45b	38.18	86.22	249539
27	13.29	60.67	101.70	15.79	336.17b	43.48	104.15	249539
28	12.00	73.30	117.93	19.84	429.60b	48.60	121.89	249539
29	10.00	92.92	143.38	26.19	554.25b	56.85	149.77	249539
30	8.00	112.54	169.08	32.61	685.09b	65.24	177.77	249539
31	6.50	127.25	188.49	37.45	791.76b	71.67	198.93	249539
32	5.00	141.97	207.97	42.32	882.81b	80.29	222.26	249539

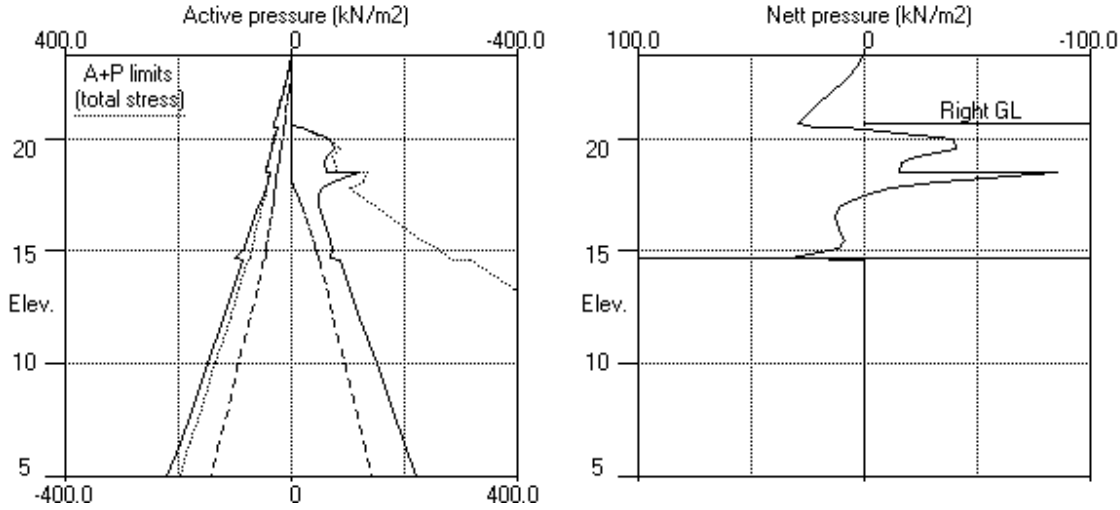
Note: 43.99 a Soil pressure at active limit
69.70 p Soil pressure at passive limit
882.81 b Passive limit reduced because of berm

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Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
Licensed from GEOSOLVE | Made by :
Data filename/Run ID: 21-1182_K_Cant_600-950_ULS2 |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
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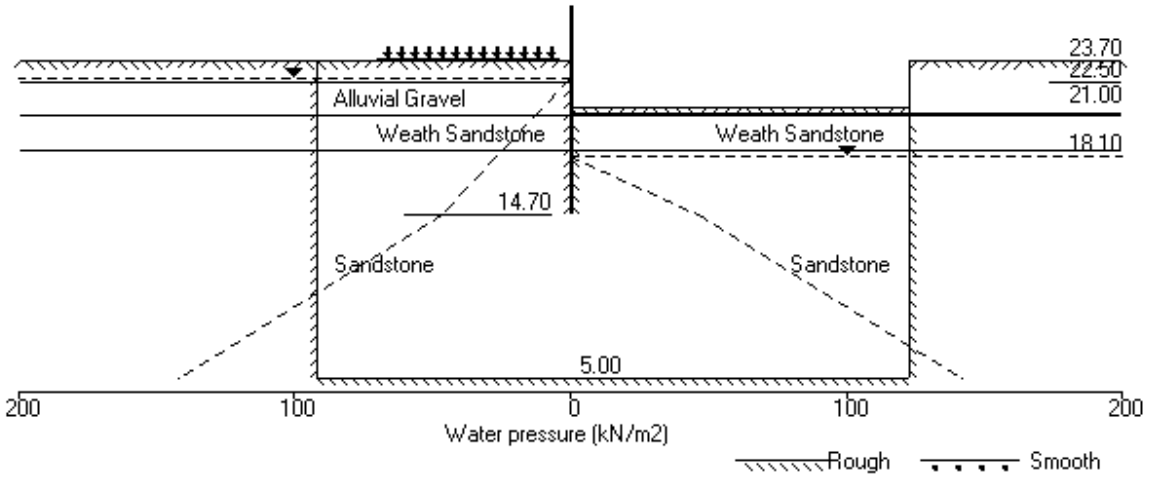
Stage No.3 Excav. to elev. 20.65 on RIGHT side



Stage No.3 Excav. to elev. 20.65 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 4 Fill to elevation 21.00 on RIGHT side with soil type 5

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall FoS for toe elev. = 14.70 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
4	23.70	21.00	Cant.	3.613	15.21	20.06	0.94	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	23.70	0.00	0.009	1.60E-03	0.0	-0.0	
2	23.58	0.93	0.009	1.60E-03	0.1	0.0	
3	23.14	3.90	0.008	1.60E-03	1.1	0.2	
4	22.70	7.29	0.008	1.60E-03	3.6	1.2	
5	22.50	9.65	0.007	1.59E-03	5.3	2.1	
		9.87	0.007	1.59E-03	5.3	2.1	
6	22.00	15.57	0.006	1.59E-03	11.6	6.3	
7	21.50	21.16	0.006	1.56E-03	20.8	14.3	
8	21.00	26.60	0.005	1.52E-03	32.7	27.6	
9	20.83	26.78	0.005	1.50E-03	37.4	33.7	
10	20.65	24.23	0.004	1.47E-03	41.9	40.6	
		27.57	0.004	1.47E-03	41.9	40.6	
11	20.50	21.27	0.004	1.44E-03	45.5	47.2	
		9.44	0.004	1.44E-03	45.5	47.2	
12	20.00	-39.79	0.003	1.31E-03	37.9	71.2	
13	19.50	-40.63	0.003	1.14E-03	17.8	85.3	
14	19.20	-23.85	0.002	1.03E-03	8.2	88.9	
15	18.90	-16.58	0.002	9.20E-04	2.1	90.3	
16	18.50	-15.68	0.002	7.65E-04	-4.3	89.8	
		-82.21	0.002	7.65E-04	-4.3	89.8	
17	18.10	-31.20	0.002	6.18E-04	-27.0	81.6	
18	17.80	-10.54	0.001	5.18E-04	-33.3	72.0	
19	17.50	0.30	0.001	4.32E-04	-34.8	61.5	
20	17.00	10.40	0.001	3.19E-04	-32.2	44.1	
21	16.50	13.20	0.001	2.40E-04	-26.2	29.2	
22	16.00	11.39	0.001	1.90E-04	-20.1	17.6	
23	15.50	9.05	0.001	1.61E-04	-15.0	8.9	
24	15.10	11.20	0.001	1.50E-04	-10.9	3.5	
25	14.70	33.15	0.001	1.47E-04	-2.1	0.0	
26	14.57	0.08	0.001	0	0.0	0.0	

(continued)

Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	13.29	0.01	0.000	0	0.1	0.0	
28	12.00	0.08	0.000	0	0.1	0.0	
29	10.00	0.01	0.000	0	0.2	0.0	
30	8.00	-0.06	0.000	0	0.2	0.0	
31	6.50	0.00	0.000	0	0.1	0.0	
32	5.00	-0.20	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.78	7.60	0.93	0.93	12474
3	23.14	0.00	10.97	3.77	36.86	3.90	3.90	12474
4	22.70	0.00	20.83	7.15	69.99	7.29	7.29	12474
5	22.50	1.17	24.24	8.32	81.44	8.48	9.65	12474
		1.17	24.24	8.32	81.45	8.70	9.87	29938
6	22.00	4.10	32.46	11.14	109.07	11.48	15.57	29938
7	21.50	7.02	40.15	13.78	134.91	14.14	21.16	29938
8	21.00	9.95	47.40	16.27	159.29	16.65	26.60	29938
9	20.83	10.97	49.86	17.12	167.55	17.53	28.50	29938
10	20.65	12.00	52.28	17.95	175.70	18.39	30.38	29938
11	20.50	12.87	54.34	18.65	182.60	19.14	32.01	29938
		12.87	54.34	12.46	323.17	14.09	26.96	99795
12	20.00	15.80	63.05	14.46	374.98	15.74	31.54	99795
13	19.50	18.73	71.59	16.42	425.79	17.59	36.32	99795
14	19.20	20.48	76.65	17.58	455.90	18.70	39.18	99795
15	18.90	22.24	81.68	18.73	485.78	19.85	42.08	99795
16	18.50	24.58	88.32	20.26	525.31	21.46	46.04	99795
		24.58	88.32	12.45	517.29	15.45	40.03	249486
17	18.10	26.92	94.92	14.09	551.87	16.28	43.20	249486
18	17.80	28.67	99.84	15.32	577.65	17.21	45.88	249486
19	17.50	30.43	104.74	16.54	603.33	19.65	50.08	249486
20	17.00	33.35	112.86	18.57	645.90	28.01	61.37	249486
21	16.50	36.28	120.93	20.59	688.24	32.83	69.11	249486
22	16.00	39.21	128.98	22.59	730.39	35.51	74.71	249486
23	15.50	42.13	136.99	24.59	772.39	38.05	80.18	249486
24	15.10	44.47	143.38	26.19	805.88	42.05	86.52	249486
25	14.70	46.81	149.75	27.78	839.31	56.84	103.65	249486
26	14.57	48.04	151.25	28.15	847.14	39.85	87.89	249486
27	13.29	60.67	166.59	31.98	927.57	45.07	105.74	249486
28	12.00	73.30	181.86	35.80	1007.62	50.25	123.55	249486
29	10.00	92.92	205.51	41.70	1131.60	58.41	151.33	249486
30	8.00	112.54	229.15	47.60	1255.49	66.69	179.23	249486
31	6.50	127.25	246.88	52.03	1348.47	73.15	200.40	249486
32	5.00	141.97	264.64	56.46	1441.56	81.24	223.21	249486

(continued)

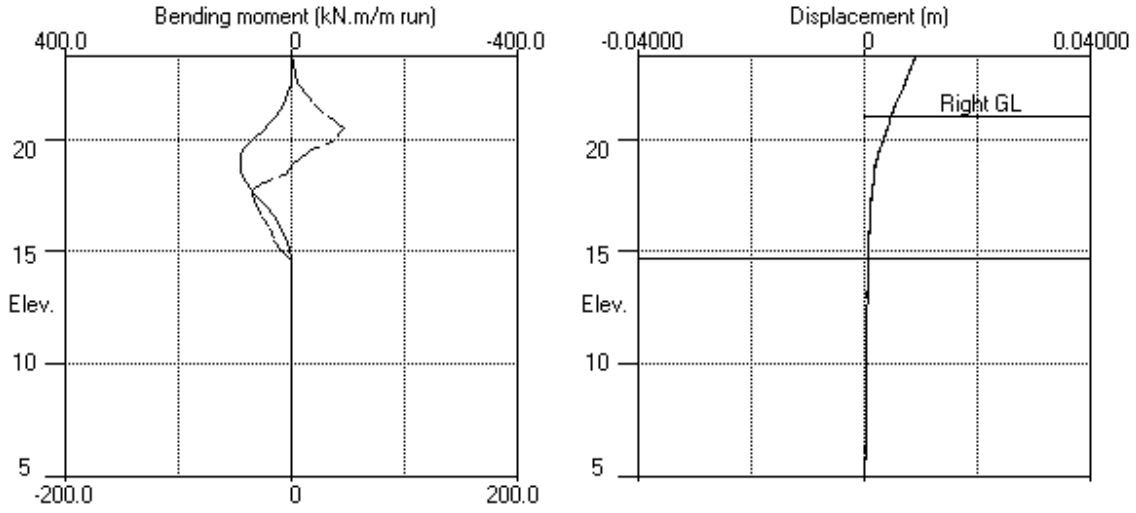
Stage No.4 Fill to elevation 21.00 on RIGHT side with soil type 5

RIGHT side

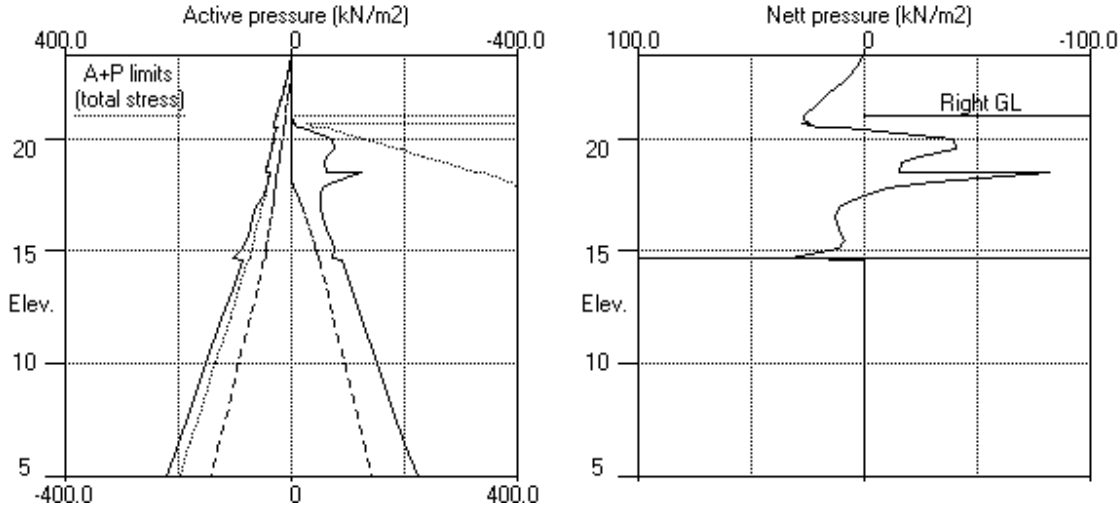
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	850.00	0.00	0.00a	199620
9	20.83	Total>	4.10	1.72w	854.10	1.72	1.72a	199620
10	20.65	Total>	8.19	3.43w	858.19	6.15	6.15	199620
		0.00	8.19	2.81	27.52	2.81	2.81a	29943
11	20.50	0.00	10.89	3.74	36.60	10.74	10.74	29943
		0.00	10.89	2.50	64.77	17.52	17.52	99810
12	20.00	0.00	21.89	5.02	130.21	71.33	71.33	99810
13	19.50	0.00	32.90	7.54	195.66	76.95	76.95	99810
14	19.20	0.00	39.50	9.06	234.95	63.03	63.03	99810
15	18.90	0.00	46.11	10.58	274.26	58.66	58.66	99810
16	18.50	0.00	54.93	12.60	326.69	61.72	61.72	99810
		0.00	54.93	4.11	342.24	122.24	122.24	249525
17	18.10	0.00	63.75	6.31	388.48	74.40	74.40	249525
18	17.80	4.13	66.24	6.93	401.54	52.29	56.42	249525
19	17.50	8.26	68.74	7.56	414.61	41.52	49.78	249525
20	17.00	15.15	72.90	8.60	436.45	35.82	50.96	249525
21	16.50	22.03	77.08	9.64	458.36	33.88	55.91	249525
22	16.00	28.91	81.28	10.69	480.35	34.41	63.32	249525
23	15.50	35.80	85.49	11.74	502.41	35.33	71.13	249525
24	15.10	41.31	88.86	12.58	520.12	34.01	75.32	249525
25	14.70	46.81	92.25	13.43	537.89	23.69	70.50	249525
26	14.57	48.04	93.81	13.81	546.04	39.77	87.81	249525
27	13.29	60.67	109.90	17.83	630.38	45.06	105.73	249525
28	12.00	73.30	126.10	21.88	715.29	50.16	123.46	249525
29	10.00	92.92	151.46	28.21	848.27	58.39	151.31	249525
30	8.00	112.54	177.05	34.59	982.38	66.74	179.28	249525
31	6.50	127.25	196.34	39.41	1083.52	73.14	200.40	249525
32	5.00	141.97	215.70	44.25	1185.03	81.44	223.41	249525

Note: 2.81 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

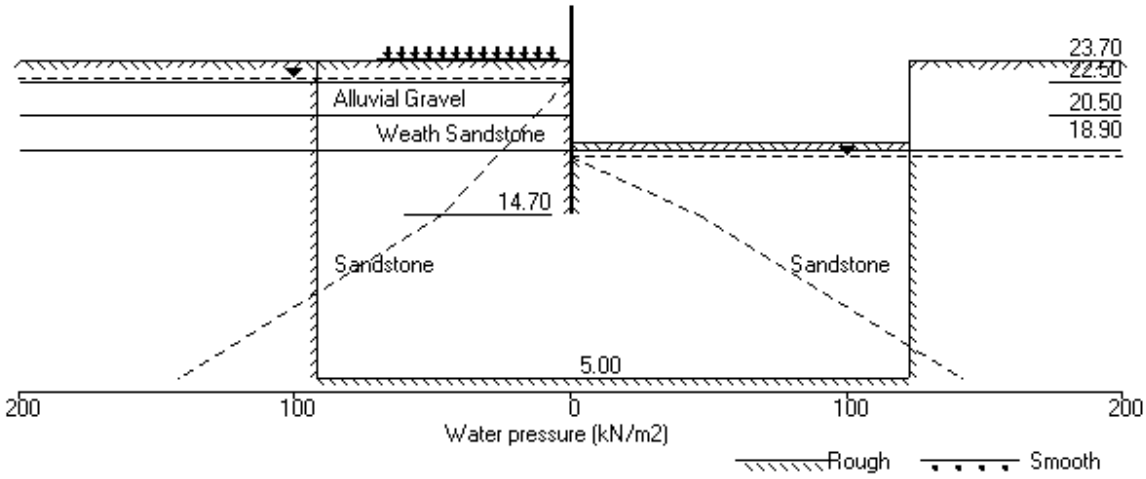
Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.4 Fill to elev. 21.00 on RIGHT side



Stage No.5 Excav. to elev. 18.90 on RIGHT side



FOUNDATION PILING LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1182.21
Licensed from GEOSOLVE | Made by :
Data filename/Run ID: 21-1182_K_Cant_600-950_ULS2 |
Soil properties file: 21-1182_Soils__SLS.dat |
Plot C, Trinity Islands | Date:13-11-2025
| Checked :

Units: kN,m

Stage No. 5 Excavate to elevation 18.90 on RIGHT side

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr-ation	Direction of failure
5	23.70	18.90	Cant.	1.097	15.16	15.32	3.58	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	23.70	0.00	0.036	5.17E-03	0.0	0.0	
2	23.58	0.78	0.036	5.17E-03	0.0	0.0	
3	23.14	3.77	0.033	5.17E-03	1.0	0.2	
4	22.70	7.15	0.031	5.17E-03	3.4	1.2	
5	22.50	9.49	0.030	5.17E-03	5.1	2.0	
6	22.00	15.24	0.028	5.16E-03	11.3	6.1	
7	21.50	20.80	0.025	5.14E-03	20.3	13.8	
8	21.00	26.22	0.022	5.09E-03	32.0	26.8	
9	20.83	28.09	0.022	5.07E-03	36.8	32.8	
10	20.65	29.94	0.021	5.04E-03	41.9	39.7	
11	20.50	31.53	0.020	5.02E-03	46.5	46.3	
		25.33	0.020	5.02E-03	46.5	46.3	
12	20.00	30.26	0.017	4.89E-03	60.4	75.1	
13	19.50	35.14	0.015	4.69E-03	76.7	109.4	
14	19.20	38.06	0.014	4.53E-03	87.7	133.8	
15	18.90	40.97	0.012	4.34E-03	99.6	161.8	
16	18.50	-7.51	0.011	4.02E-03	106.3	203.8	
		-63.40	0.011	4.02E-03	106.3	203.8	
17	18.10	-105.56	0.009	3.64E-03	72.5	241.1	
18	17.80	-119.67	0.008	3.32E-03	38.7	258.1	
19	17.50	-133.81	0.007	2.98E-03	0.7	264.3	
20	17.00	-126.10	0.006	2.43E-03	-64.3	247.8	
21	16.50	-56.05	0.005	1.95E-03	-109.9	199.7	
22	16.00	-9.02	0.004	1.59E-03	-126.1	137.7	
23	15.50	38.49	0.003	1.36E-03	-118.8	73.4	
24	15.10	97.29	0.003	1.27E-03	-91.6	28.9	
25	14.70	274.84	0.002	1.25E-03	-17.2	0.0	
26	14.57	0.09	0.002	0	0.0	0.0	
27	13.29	0.02	0.002	0	0.1	0.0	
28	12.00	0.11	0.001	0	0.2	0.0	

(continued)

Stage No.5 Excavate to elevation 18.90 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
29	10.00	0.03	0.001	0	0.3	0.0	
30	8.00	-0.07	0.000	0	0.3	0.0	
31	6.50	0.01	0.000	0	0.2	0.0	
32	5.00	-0.29	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.78	7.60	0.78	0.78a	12474
3	23.14	0.00	10.97	3.77	36.86	3.77	3.77a	12474
4	22.70	0.00	20.83	7.15	69.99	7.15	7.15a	12474
5	22.50	1.17	24.24	8.32	81.44	8.32	9.49a	12474
		1.17	24.24	8.32	81.45	8.32	9.49a	29938
6	22.00	4.10	32.46	11.14	109.07	11.14	15.24a	29938
7	21.50	7.02	40.15	13.78	134.91	13.78	20.80a	29938
8	21.00	9.95	47.40	16.27	159.29	16.27	26.22a	29938
9	20.83	10.97	49.86	17.12	167.55	17.12	28.09a	29938
10	20.65	12.00	52.28	17.95	175.70	17.95	29.94a	29938
11	20.50	12.87	54.34	18.65	182.60	18.65	31.53a	29938
		12.87	54.34	12.46	323.17	12.46	25.33a	99795
12	20.00	15.80	63.05	14.46	374.98	14.46	30.26a	99795
13	19.50	18.73	71.59	16.42	425.79	16.42	35.14a	99795
14	19.20	20.48	76.65	17.58	455.90	17.58	38.06a	99795
15	18.90	22.24	81.68	18.73	485.78	18.73	40.97a	99795
16	18.50	24.58	88.32	20.26	525.31	20.26	44.83a	99795
		24.58	88.32	12.45	517.29	12.45	37.02a	249486
17	18.10	26.92	94.92	14.09	551.87	14.09	41.01a	249486
18	17.80	28.67	99.84	15.32	577.65	15.32	43.99a	249486
19	17.50	30.43	104.74	16.54	603.33	16.54	46.97a	249486
20	17.00	33.35	112.86	18.57	645.90	18.57	51.92a	249486
21	16.50	36.28	120.93	20.59	688.24	20.59	56.87a	249486
22	16.00	39.21	128.98	22.59	730.39	30.01	69.22	249486
23	15.50	42.13	136.99	24.59	772.39	53.15	95.28	249486
24	15.10	44.47	143.38	26.19	805.88	94.12	138.59	249486
25	14.70	46.81	149.75	27.78	839.31	274.84	321.66	249486
26	14.57	48.04	151.25	28.15	847.14	31.12	79.16	249486
27	13.29	60.67	166.59	31.98	927.57	36.46	97.13	249486
28	12.00	73.30	181.86	35.80	1007.62	39.55	112.85	249486
29	10.00	92.92	205.51	41.70	1131.60	46.92	139.84	249486
30	8.00	112.54	229.15	47.60	1255.49	55.33	167.87	249486
31	6.50	127.25	246.88	52.03	1348.47	62.69	189.95	249486
32	5.00	141.97	264.64	56.46	1441.56	73.60	215.57	249486

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0

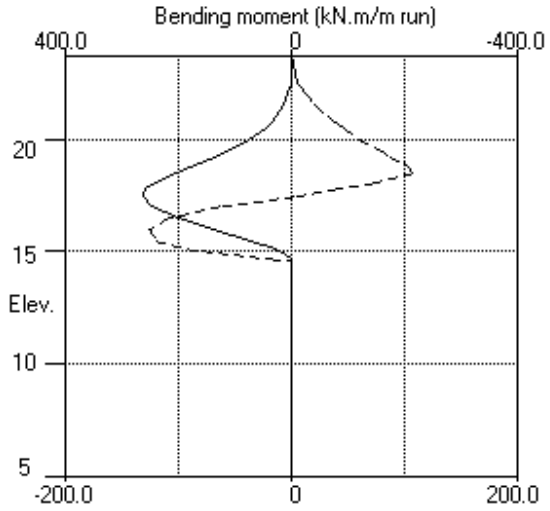
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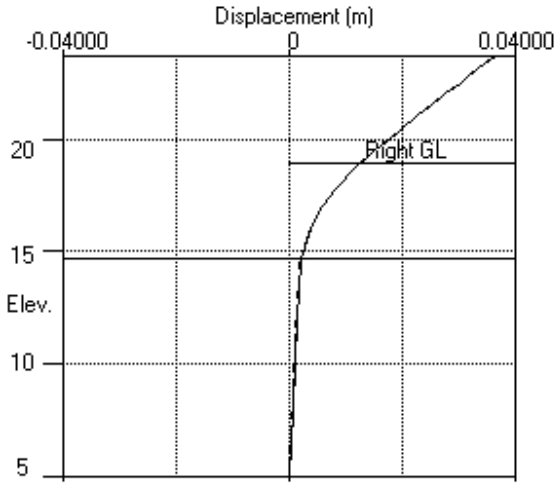
Stage No.5 Excavate to elevation 18.90 on RIGHT side

		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	20.83	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	20.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	20.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	19.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	19.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	18.90	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	99848
16	18.50	0.00	8.80	2.02	52.34	52.34	52.34p	99848
		0.00	8.80	0.00	100.43	100.43	100.43p	249619
17	18.10	0.00	17.60	0.00	146.57	146.57	146.57p	249619
18	17.80	4.13	20.08	0.00	159.53	159.53	163.66p	249619
19	17.50	8.26	22.55	0.00	172.52	172.52	180.78p	249619
20	17.00	15.15	26.69	0.00	194.20	162.87	178.02	249619
21	16.50	22.03	30.84	0.00	215.95	90.88	112.91	249619
22	16.00	28.91	35.00	0.00	237.78	49.32	78.23	249619
23	15.50	35.80	39.19	0.18	259.73	21.00	56.80	249619
24	15.10	41.31	42.55	1.02	277.36	0.00	41.31A	249619
25	14.70	46.81	45.93	1.86	295.08	0.00	46.81A	249619
26	14.57	48.04	47.49	2.25	303.23	31.04	79.08	249619
27	13.29	60.67	63.60	6.27	387.69	36.45	97.12	249619
28	12.00	73.30	79.91	10.35	473.20	39.44	112.74	249619
29	10.00	92.92	105.67	16.78	608.23	46.89	139.81	249619
30	8.00	112.54	131.92	23.33	745.80	55.40	167.94	249619
31	6.50	127.25	151.88	28.31	850.43	62.68	189.94	249619
32	5.00	141.97	172.03	33.34	956.06	73.90	215.87	249619

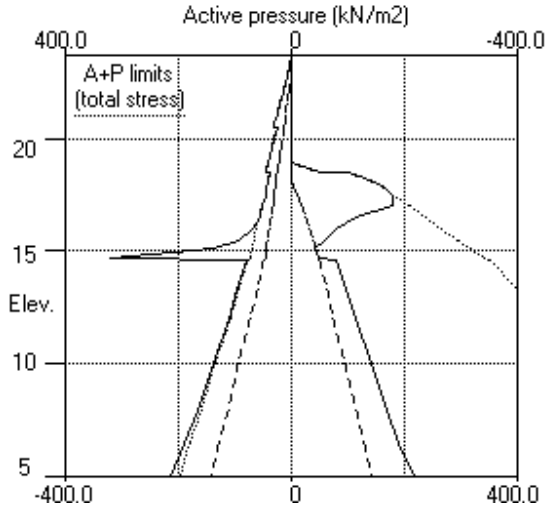
Note: 56.87 a Soil pressure at active limit
180.78 p Soil pressure at passive limit
46.81A Arching - soil pressure below active limit

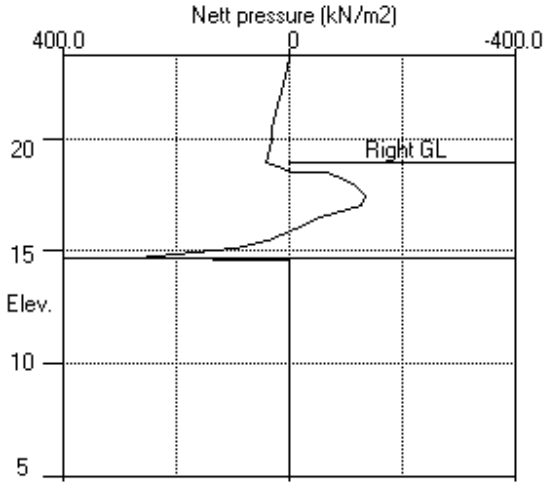
Stage No.5 Excav. to elev. 18.90 on RIGHT side



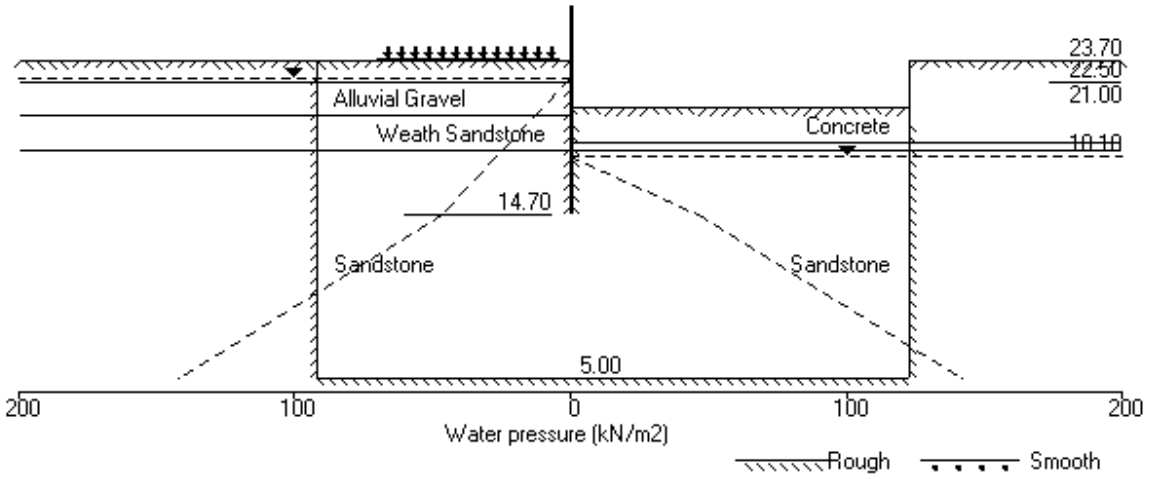


Stage No.5 Excav. to elev. 18.90 on RIGHT side





Stage No.6 Fill to elev. 21.00 on RIGHT side



Units: kN,m

Stage No. 6 Fill to elevation 21.00 on RIGHT side with soil type 5

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	Overall FoS for toe elev. = 14.70 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
6	23.70	21.00	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall Rough boundary
Right side 20.00 from wall Rough boundary
Lower rigid boundary at elevation 5.00 Rough boundary
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	Prop forces kN/m
1	23.70	0.00	0.036	5.20E-03	0.0	0.0	
2	23.58	1.34	0.035	5.20E-03	0.1	0.0	
3	23.14	4.29	0.033	5.20E-03	1.3	0.3	
4	22.70	7.73	0.031	5.20E-03	3.9	1.4	
5	22.50	10.17	0.030	5.20E-03	5.7	2.4	
		11.13	0.030	5.20E-03	5.7	2.4	
6	22.00	16.80	0.027	5.19E-03	12.7	6.9	
7	21.50	22.56	0.025	5.16E-03	22.6	15.6	
8	21.00	28.20	0.022	5.12E-03	35.3	30.0	
9	20.83	28.55	0.021	5.09E-03	40.2	36.6	
10	20.65	28.85	0.020	5.06E-03	45.2	44.0	
11	20.50	29.27	0.020	5.03E-03	49.6	51.1	
12	20.00	28.18	0.017	4.89E-03	64.0	81.5	
13	19.50	25.93	0.015	4.67E-03	77.5	116.8	
14	19.20	21.99	0.013	4.51E-03	84.7	140.9	
15	18.90	16.47	0.012	4.31E-03	90.4	167.2	
		37.52	0.012	4.31E-03	90.4	167.2	
16	18.50	-9.21	0.010	3.99E-03	96.1	205.2	
		-44.86	0.010	3.99E-03	96.1	205.2	
17	18.10	-95.82	0.009	3.60E-03	68.0	240.0	
18	17.80	-113.84	0.008	3.28E-03	36.5	256.1	
19	17.50	-130.31	0.007	2.95E-03	-0.1	261.9	
20	17.00	-124.43	0.005	2.40E-03	-63.8	245.4	
21	16.50	-55.56	0.004	1.93E-03	-108.8	197.9	
22	16.00	-9.11	0.003	1.57E-03	-124.9	136.5	
23	15.50	38.11	0.003	1.34E-03	-117.7	72.7	
24	15.10	96.50	0.002	1.26E-03	-90.8	28.6	
25	14.70	272.30	0.002	1.23E-03	-17.0	0.0	
26	14.57	0.08	0.002	0	0.0	0.0	
27	13.29	0.01	0.001	0	0.1	0.0	

(continued)

Stage No.6 Fill to elevation 21.00 on RIGHT side with soil type 5

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
28	12.00	0.08	0.001	0	0.1	0.0	
29	10.00	0.01	0.001	0	0.2	0.0	
30	8.00	-0.06	0.000	0	0.2	0.0	
31	6.50	0.00	0.000	0	0.2	0.0	
32	5.00	-0.20	0.000	0	0.0	0.0	

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	12474
2	23.58	0.00	2.26	0.78	7.60	1.34	1.34	12474
3	23.14	0.00	10.97	3.77	36.86	4.29	4.29	12474
4	22.70	0.00	20.83	7.15	69.99	7.73	7.73	12474
5	22.50	1.17	24.24	8.32	81.44	9.00	10.17	12474
		1.17	24.24	8.32	81.45	9.96	11.13	29938
6	22.00	4.10	32.46	11.14	109.07	12.70	16.80	29938
7	21.50	7.02	40.15	13.78	134.91	15.54	22.56	29938
8	21.00	9.95	47.40	16.27	159.29	18.25	28.20	29938
9	20.83	10.97	49.86	17.12	167.55	19.30	30.27	29938
10	20.65	12.00	52.28	17.95	175.70	20.29	32.29	29938
11	20.50	12.87	54.34	18.65	182.60	21.31	34.18	29938
		12.87	54.34	12.46	323.17	21.31	34.18	99795
12	20.00	15.80	63.05	14.46	374.98	22.19	37.99	99795
13	19.50	18.73	71.59	16.42	425.79	24.18	42.90	99795
14	19.20	20.48	76.65	17.58	455.90	25.36	45.84	99795
15	18.90	22.24	81.68	18.73	485.78	26.56	48.80	99795
16	18.50	24.58	88.32	20.26	525.31	28.56	53.13	99795
		24.58	88.32	12.45	517.29	33.20	57.78	249486
17	18.10	26.92	94.92	14.09	551.87	29.40	56.32	249486
18	17.80	28.67	99.84	15.32	577.65	28.41	57.08	249486
19	17.50	30.43	104.74	16.54	603.33	28.31	58.74	249486
20	17.00	33.35	112.86	18.57	645.90	29.31	62.66	249486
21	16.50	36.28	120.93	20.59	688.24	30.64	66.92	249486
22	16.00	39.21	128.98	22.59	730.39	39.72	78.93	249486
23	15.50	42.13	136.99	24.59	772.39	62.67	104.80	249486
24	15.10	44.47	143.38	26.19	805.88	103.41	147.88	249486
25	14.70	46.81	149.75	27.78	839.31	283.18	329.99	249486
26	14.57	48.04	151.25	28.15	847.14	40.76	88.80	249486
27	13.29	60.67	166.59	31.98	927.57	46.03	106.70	249486
28	12.00	73.30	181.86	35.80	1007.62	49.01	122.31	249486
29	10.00	92.92	205.51	41.70	1131.60	56.23	149.15	249486
30	8.00	112.54	229.15	47.60	1255.49	64.46	177.00	249486
31	6.50	127.25	246.88	52.03	1348.47	71.58	198.83	249486
32	5.00	141.97	264.64	56.46	1441.56	80.63	222.60	249486

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	23.58	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	23.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0

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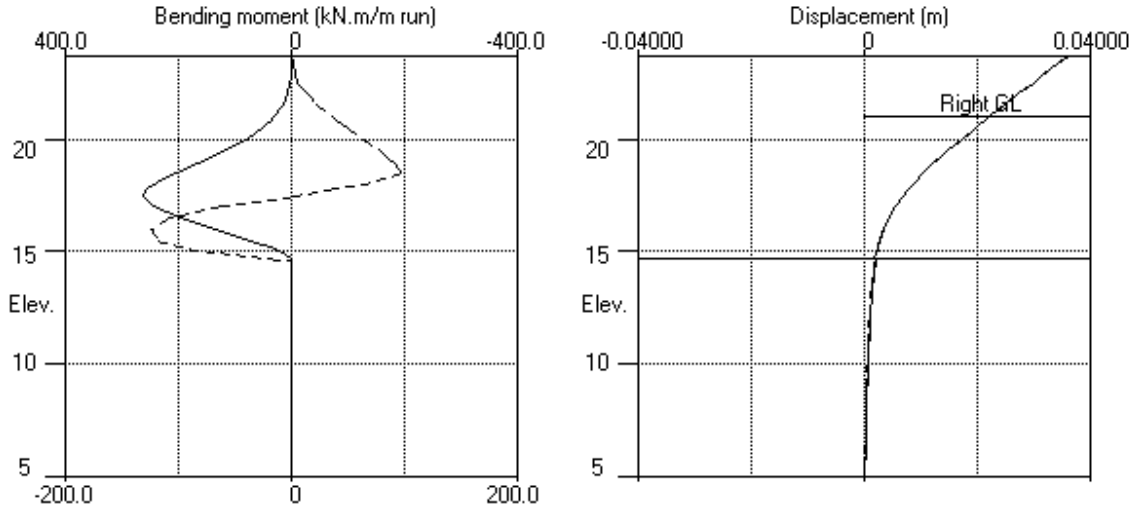
Stage No.6 Fill to elevation 21.00 on RIGHT side with soil type 5

RIGHT side

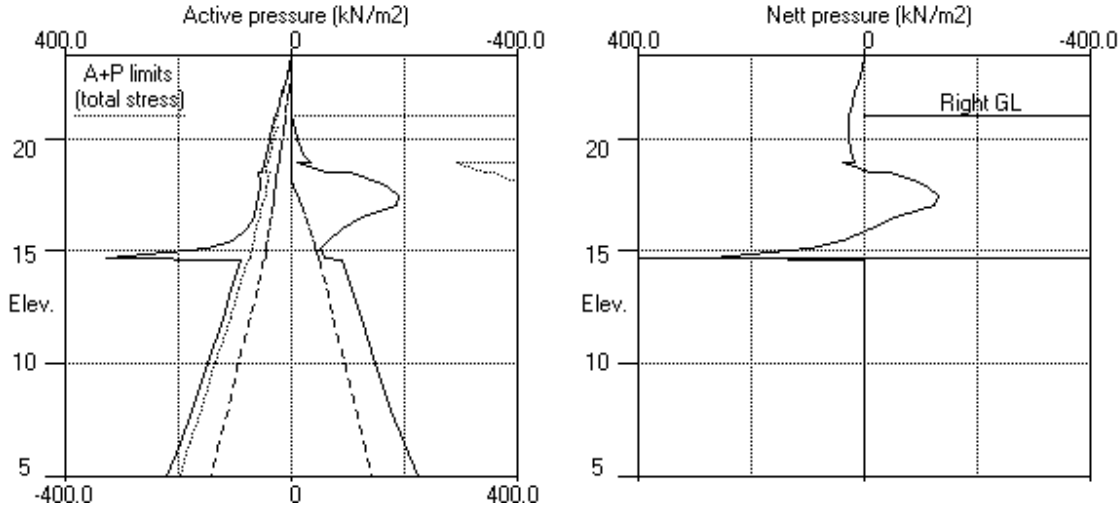
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
5	22.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	850.00	0.00	0.00a	199620
9	20.83	Total>	4.10	1.72w	854.10	1.72	1.72a	199620
10	20.65	Total>	8.19	3.43w	858.19	3.43	3.43a	199620
11	20.50	Total>	11.70	4.90w	861.70	4.91	4.91a	199620
12	20.00	Total>	23.40	9.81w	873.41	9.81	9.81a	199620
13	19.50	Total>	35.11	14.71w	885.12	16.98	16.98	199620
14	19.20	Total>	42.13	17.66w	892.14	23.85	23.85	199620
15	18.90	Total>	49.16	20.60w	899.18	32.32	32.32	199620
		0.00	49.16	11.27	292.40	11.27	11.27a	99810
16	18.50	0.00	57.98	13.30	344.83	62.34	62.34	99810
		0.00	57.98	4.87	358.23	102.64	102.64	249525
17	18.10	0.00	66.80	7.07	404.47	152.14	152.14	249525
18	17.80	4.13	69.29	7.69	417.52	166.79	170.92	249525
19	17.50	8.26	71.79	8.32	430.60	180.79	189.05	249525
20	17.00	15.15	75.95	9.36	452.44	171.94	187.09	249525
21	16.50	22.03	80.13	10.40	474.35	100.46	122.48	249525
22	16.00	28.91	84.33	11.45	496.34	59.12	88.03	249525
23	15.50	35.80	88.54	12.50	518.40	30.90	66.69	249525
24	15.10	41.31	91.91	13.34	536.11	10.08	51.38A	249525
25	14.70	46.81	95.30	14.19	553.88	10.88	57.69A	249525
26	14.57	48.04	96.86	14.58	562.03	40.68	88.72	249525
27	13.29	60.67	112.95	18.59	646.37	46.02	106.69	249525
28	12.00	73.30	129.15	22.64	731.28	48.93	122.23	249525
29	10.00	92.92	154.51	28.97	864.26	56.22	149.14	249525
30	8.00	112.54	180.10	35.36	998.36	64.52	177.06	249525
31	6.50	127.25	199.39	40.17	1099.51	71.57	198.83	249525
32	5.00	141.97	218.75	45.01	1201.01	80.83	222.80	249525

Note: 11.27 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
57.69A Arching - soil pressure below active limit

Stage No.6 Fill to elev. 21.00 on RIGHT side



Stage No.6 Fill to elev. 21.00 on RIGHT side



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.	Ground level Act.	Pass.	Prop Elev.	Overall **FoS for toe elev. = 14.70** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
1	23.70	23.70	Cant.	Conditions not suitable for FoS calc.				
2	23.70	23.70	Cant.	Conditions not suitable for FoS calc.				
3	23.70	20.65	Cant.	1.313	15.00	17.22	3.43	L to R
4	23.70	21.00	Cant.	3.613	15.21	20.06	0.94	L to R
5	23.70	18.90	Cant.	1.097	15.16	15.32	3.58	L to R
6	23.70	21.00	Cant.	Conditions not suitable for FoS calc.				
7	23.70	21.00		No analysis at this stage				

All remaining stages have more than one prop - 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 = 100.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 15.00 from wall — Rough boundary
Right side 20.00 from wall — Rough boundary
Lower rigid boundary at elevation 5.00 — Rough boundary

Limit State: ULS DA1 Combination 2

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	23.70	0.036	0.000	0.0	-0.0	0.0	0.0
2	23.58	0.036	0.000	0.0	-0.0	0.1	-0.1
3	23.14	0.033	0.000	0.3	-0.2	1.3	-0.8
4	22.70	0.031	0.000	1.4	-0.7	3.9	-1.5
5	22.50	0.030	0.000	2.4	-1.0	5.7	-1.7
6	22.00	0.028	0.000	6.9	-2.2	12.7	-2.5
7	21.50	0.025	0.000	15.6	-3.3	22.6	-1.9
8	21.00	0.022	0.000	30.0	-3.9	35.3	-0.4
9	20.83	0.022	0.000	36.6	-3.8	40.2	0.0
10	20.65	0.021	0.000	44.0	-3.6	45.2	0.0
11	20.50	0.020	0.000	51.1	-3.3	49.6	0.0
12	20.00	0.017	0.000	81.5	-2.8	64.0	0.0
13	19.50	0.015	0.000	116.8	-2.7	77.5	0.0
14	19.20	0.014	0.000	140.9	-2.5	87.7	0.0
15	18.90	0.012	0.000	167.2	-2.0	99.6	0.0
16	18.50	0.011	0.000	205.2	-0.7	106.3	-4.3
17	18.10	0.009	0.000	241.1	0.0	72.5	-27.0
18	17.80	0.008	0.000	258.1	0.0	38.7	-33.3
19	17.50	0.007	0.000	264.3	0.0	0.7	-34.9
20	17.00	0.006	0.000	247.8	0.0	0.3	-64.3
21	16.50	0.005	0.000	199.7	0.0	0.2	-109.9
22	16.00	0.004	0.000	137.7	0.0	0.1	-126.1
23	15.50	0.003	0.000	73.4	0.0	0.0	-118.8
24	15.10	0.003	0.000	28.9	0.0	0.0	-91.6
25	14.70	0.002	0.000	0.0	0.0	0.0	-17.2
26	14.57	0.002	0.000	0.0	0.0	0.0	0.0
27	13.29	0.002	0.000	0.0	0.0	0.1	0.0
28	12.00	0.001	0.000	0.0	0.0	0.2	0.0
29	10.00	0.001	0.000	0.0	0.0	0.3	0.0
30	8.00	0.000	0.000	0.0	0.0	0.3	0.0
31	6.50	0.000	0.000	0.0	0.0	0.2	0.0
32	5.00	0.000	0.000	0.0	0.0	0.0	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	0.6	16.50	-3.4	20.83	4.3	18.50	-2.2	22.00
2	1.1	17.50	-3.9	21.00	5.3	18.50	-2.5	22.00
3	90.1	18.90	-0.0	23.70	45.8	20.50	-34.9	17.50
4	90.3	18.90	-0.0	23.70	45.5	20.50	-34.8	17.50
5	264.3	17.50	0.0	23.70	106.3	18.50	-126.1	16.00
6	261.9	17.50	0.0	23.70	96.1	18.50	-124.9	16.00
7	No calculation at this stage							
8	No calculation at this stage							
9	261.9	17.50	0.0	23.70	96.1	18.50	-124.9	16.00

Maximum and minimum displacement at each stage

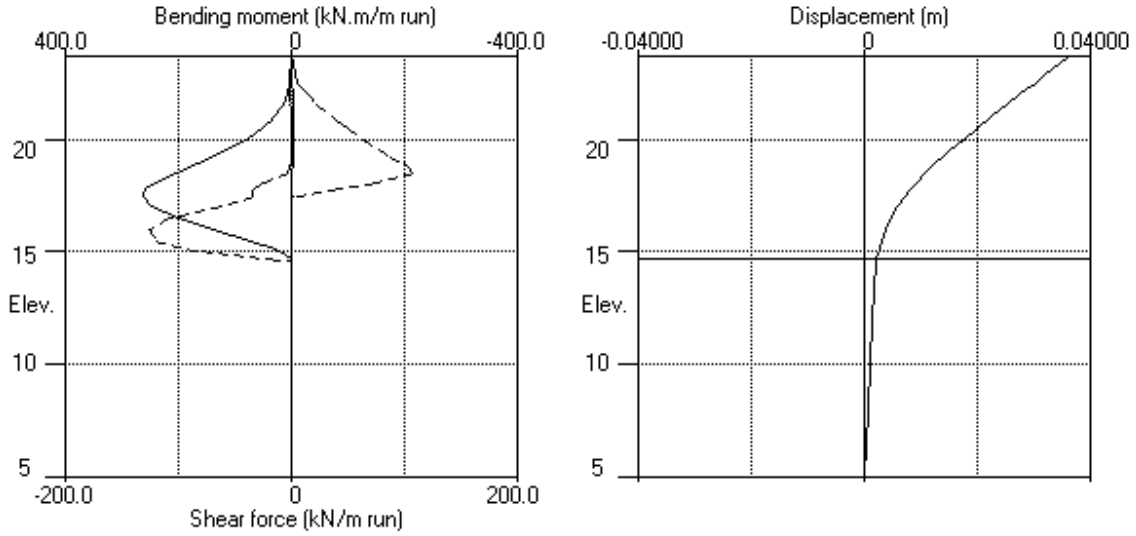
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.000	22.50	0.000	23.70	Apply water pressure profile no.2
2	0.000	23.70	0.000	23.70	Apply surcharge no.1 at elev. 23.70
3	0.009	23.70	0.000	23.70	Excav. to elev. 20.65 on RIGHT side
4	0.009	23.70	0.000	23.70	Fill to elev. 21.00 on RIGHT side
5	0.036	23.70	0.000	23.70	Excav. to elev. 18.90 on RIGHT side
6	0.036	23.70	0.000	23.70	Fill to elev. 21.00 on RIGHT side
7	No calculation at this stage				Install prop no.5 at elev. 20.83
8	No calculation at this stage				Install prop no.2 at elev. 23.58
9	0.036	23.70	0.000	23.70	Apply water pressure profile no.4

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	Strut no. 2 at elev. 23.58 kN/m run	Strut no. 2 at elev. 23.58 kN/prop	Strut no. 5 at elev. 20.83 kN/m run	Strut no. 5 at elev. 20.83 kN/prop
9	0.00	0.00	0.00	0.00

Bending moment, shear force, displacement envelopes



Company:	Foundation Piling Limited	*RoundCol 20000104* Ó *1999 Techno Consultants*	
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		Made by	*Date*	*Page No*
Project:	Plot C, Trinity Islands, Manchester	TPK	November 13, 2025	
Client:		*Checked*	*Job No*	*Revision*
Element:	600 dia 6H25	JRP	21.1182a	P06

Results Displayed for Load Case 1 **Load Reference:** **Data Store No** 002

fcu N/mm²	g_{mc}	Ecu
40	1.65	0.0035

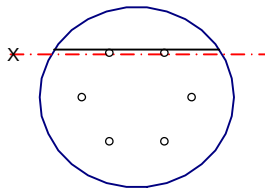
fy N/mm²	g_{ms}	Esu
500	1.15	0.00217

Section Dia mm	Number and Position of Steel Bars	Cover to cg
600	6	130

.67fcu/g_{mc}	fy/g_{ms}	E_s for Steel
16.2424	434.7826	200 kN/mm²

X-direction Stability	End Conditions At Top	At Bottom
(•) Braced	(•) Rigid	( ) Rigid
( ) Unbraced	( ) Semi Rigid	(•) Semi Rigid
Braced	( ) Pinned	( ) Pinned
	( ) Free	*Semi Rigid*
	Rigid	

Height Lo (m)	Height Factor ß (Table 3.19)
1.000	0.8



Effective Height Lex (m)	Slenderness to 3.8.1.3 Ratio	Status	Max Lo/h Allowed
0.800	Lex/h=1.33	**Short**	60 >1.7 hence OK

Design Data Summary

h_s/h	0.5667	Steel dia h_s
$N/h^2\ f_{cu}$	0.0000	340
100Asc/Ac	1.0419	>0.4% & <6%OK
p fy/f_{cu}	13.0242	
$M/h^3\ f_{cu}$	0.0285	
N_{uz} kN	5873.31	
$N_{bal\ xx}$ kN	1799.07	
$M_{bal\ xx}$ kNm	387.76	
NA x-N_{balxx} mm	287.08	

Deflection Moments to Clause 3.8.3

K_x (Eq 33)	$ß_{a\ x}$ (Eq34)	$a_{u\ x}$ mm	$a_{uav\ x}$ mm	$M_{add\ x}$=$Na_{u\ x}$
1.0000	0.0009	0.5333		0.0000

Applied Axial Load, kN & Moments, kNm N, kN	BM at Ends	Applied M_{xx} kNm	Notional BM Ne_{min} (h/20<=20)	*Design BM Mx kNm
	M_2 (>=M_1)		0	
	M_1 @ 2nd end	0	*Bending: Single Curvature*	

Critical Initial Moment Mi=M2 = 0.00 kNm

* *Design Moment=M2; Slenderness<15, Hence Madd=0*

Steel Areas & Position (from Top Mid Point)

Area mm²	X-dist mm	Y-dist mm
491	85.00	152.78
491	170.00	300.00
491	85.00	447.22
491	-85.00	447.22
491	-170.00	300.00
491	-85.00	152.78

As=2946 *for 25 bars* Max=170.00 Max=447.22

Max dia=25 mm Min dia=25 mm Cover=117 mm

Neutral Axis x mm	Stress Block Depth 0.9x mm
157.880	142.09

Steel Strain, Stress, Force and Moment (about mid depth)

Strain	Es*Strain	f_s used N/mm²	Fs kN	BM kNm
0.000113163	22.63	22.63	11.11	1.64
-0.003150608	-630.12	-434.78	-213.48	
-0.006414379	-1282.88	-434.78	-213.48	31.43
-0.006414379	-1282.88	-434.78	-213.48	31.43
-0.003150608	-630.12	-434.78	-213.48	0.00
0.000113163	22.63	22.63	11.11	1.64
		å	**-831.69**	**66.13**

Concrete Stress Block Size, Centroid, Force Magnitude & Moment

Chord mm	Area mm²	cg from top mm	Fc kN	BM kNm
510.16	51204.62	83.92	**831.69**	**179.71**

Available Section Capacity: **0.00** **245.84**

Required Design Capacity: **0.00** **0.00**

Design Mx=0.00 kNm < 245.84 kNm Hence OK

Applied Loading Cases:

Load Case No Display	Load Case Reference	Axial Load N, kN	a_{uav} mm	Initial End Moments Mx_2 kNm	Mx_1 kNm	Available BMx* kNm	Required Mtx* kNm	Strength Check
(•) Case 1						245.84		OK
( ) Case 2						245.84		OK
( ) Case 3						245.84		OK
( ) Case 4						245.84		OK
( ) Case 5						245.84		OK
( ) Case 6						245.84		OK

Note: The moment of steel and concrete forces is taken and summed up about the mid depth.

APPENDIX 2
Reinforcement Design

Company:	Foundation Piling Limited	RoundCol 20000104 © 1999 Techno Consultants	
Address:		User Registration No:	Unregistered Copy
		Made by	Date	Page No
Project:	Plot C, Trinity Islands, Manchester	TPK	November 13, 2025	
Client:		Checked	Job No	Revision
Element:	750 dia 8H32	JRP	21.1182a	P06

Results Displayed for Load Case 1 **Load Reference:** **Data Store No** 016

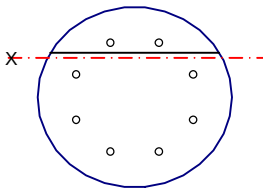
fcu N/mm²	g_{mc}	Ecu
40	1.65	0.0035

fy N/mm²	g_{ms}	Esu
500	1.15	0.00217

Section Dia mm	Number and Position of Steel Bars	Cover to cg
750	8	130

.67fcu/g_{mc}	fy/g_{ms}	E_s for Steel
16.2424	434.7826	200 kN/mm²

X-direction Stability	End Conditions At Top	At Bottom
Braced	Rigid	Rigid
Unbraced	Semi Rigid	Semi Rigid
Braced	Pinned	Pinned
	Free	*Semi Rigid*
Height Lo (m)	*Rigid*	Height Factor ß (Table 3.19)
1.000		0.8



Effective Height Lex (m)	Slenderness to 3.8.1.3 Ratio	Status	Max Lo/h Allowed
0.800	Lex/h=1.07	**Short**	60 >1.3 hence OK

Design Data Summary

h_s/h	0.6533	Steel dia h_s
$N/h^2 f_{cu}$	0.0000	490
100Asc/Ac	1.4559	>0.4% & <6%OK
p fy/f_{cu}	18.1988	
$M/h^3 f_{cu}$	0.0380	
N_{uz} kN	9972.20	
$N_{bal\ xx}$ kN	3038.43	
$M_{bal\ xx}$ kNm	925.02	
NA x-N_{balxx} mm	370.95	

Deflection Moments to Clause 3.8.3

K_x (Eq 33)	ß$_{a\,x}$ (Eq34)	$a_{u\,x}$ mm	$a_{uav\,x}$ mm	$M_{add\,x}$=$Na_{u\,x}$
1.0000	0.0006	0.4267		0.0000

Applied Axial Load, kN & Moments, kNm			Notional BM	*Design BM
N, kN	BM at Ends	Applied M_{xx} kNm	Ne_{min} (h/20<=20)	**Mx kNm**
	M_2 (>=M_1)		0	
	M_1 @ 2$_{nd}$ end	0	*Bending: Single Curvature*	

Critical Initial Moment Mi=M2 = 0.00 kNm

* *Design Moment=M2; Slenderness<15, Hence Madd=0*

Steel Areas & Position (from Top Mid Point)

Area mm²	X-dist mm	Y-dist mm
804	93.76	148.65
804	226.35	281.24
804	226.35	468.76
804	93.76	601.35
804	-93.76	601.35
804	-226.35	468.76
804	-226.35	281.24
804	-93.76	148.65

As=6432 *for 25 bars*	Max=226.35	Max=601.35
Max dia=32 mm	Neutral	Stress Block
Min dia=32 mm	Axis x mm	Depth 0.9x mm
Cover=114 mm	211.595	190.44

Steel Strain, Stress, Force and Moment (about mid depth)

Strain	Es*Strain	f_s used N/mm²	Fs kN	BM kNm
0.001041188	208.24	208.24	167.42	37.90
-0.001152034	-230.41	-230.41	-185.25	-17.37
-0.004253718	-850.74	-434.78	-349.57	32.77
-0.00644694	-1289.39	-434.78	-349.57	79.12
-0.00644694	-1289.39	-434.78	-349.57	79.12
-0.004253718	-850.74	-434.78	-349.57	32.77
-0.001152034	-230.41	-230.41	-185.25	-17.37
0.001041188	208.24	208.24	167.42	37.90
			å	**-1,433.91**	**264.85**

Concrete Stress Block Size, Centroid, Force Magnitude & Moment

Chord mm	Area mm²	cg from top mm	Fc kN	BM kNm
652.87	88281.58	112.31	**1,433.91**	**376.67**

Available Section Capacity:	**0.00**	**641.52**
Required Design Capacity:	**0.00**	**0.00**

Design Mx=0.00 kNm < 641.52 kNm Hence OK

Applied Loading Cases:

Load Case No Display	Load Case Reference	Axial Load N, kN	a_{uav} mm	Initial End Moments Mx_2 kNm	Mx_1 kNm	Available BMx* kNm	Required Mtx* kNm	Strength Check
Case 1						641.52		OK
Case 2						641.52		OK
Case 3						641.52		OK
Case 4						641.52		OK
Case 5						641.52		OK
Case 6						641.52		OK

Note: The moment of steel and concrete forces is taken and summed up about the mid depth.

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Address:		User Registration No:	Unregistered Copy
		Made by	Date	Page No
Project:	Plot C, Trinity Islands, Manchester	TPK	November 13, 2025	
Client:		Checked	Job No	Revision
Element:	750 dia 8H40	JRP	21.1182a	P06

Results Displayed for Load Case 1 **Load Reference:** **Data Store No** 017

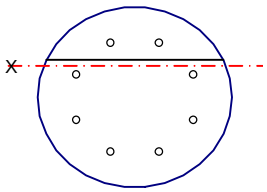
fcu N/mm²	g_{mc}	Ecu
40	1.65	0.0035

fy N/mm²	g_{ms}	Esu
500	1.15	0.00217

Section Dia mm	Number and Position of Steel Bars	Cover to cg
750	8	130

.67fcu/g_{mc}	fy/g_{ms}	E_s for Steel
16.2424	434.7826	200 kN/mm²

X-direction Stability	End Conditions At Top	At Bottom
Braced	Rigid	Rigid
Unbraced	Semi Rigid	Semi Rigid
Braced	Pinned	Pinned
	Free	*Semi Rigid*
Height Lo (m)	*Rigid*	Height Factor ß (Table 3.19)
1.000		0.8



Effective Height Lex (m)	Slenderness to 3.8.1.3 Ratio	Status	Max Lo/h Allowed
0.800	Lex/h=1.07	**Short**	60 >1.3 hence OK

Design Data Summary

h_s/h	0.6533	Steel dia h_s
$N/h^2\ f_{cu}$	0.0000	490
100Asc/Ac	2.2762	>0.4% & <6%OK
p fy/f_{cu}	28.4527	
$M/h^3\ f_{cu}$	0.0541	
N_{uz} kN	11547.86	
$N_{bal\ xx}$ kN	3010.71	
$M_{bal\ xx}$ kNm	1130.27	
NA x-N_{balxx} mm	370.95	

Deflection Moments to Clause 3.8.3

K_x (Eq 33)	ß$_{a\ x}$ (Eq34)	$a_{u\ x}$ mm	$a_{uav\ x}$ mm	$M_{add\ x}$=$Na_{u\ x}$
1.0000	0.0006	0.4267		0.0000

Applied Axial Load, kN & Moments, kNm			Notional BM	*Design BM
N, kN	BM at Ends	Applied M_{xx} kNm	Ne_{min} (h/20<=20)	**Mx kNm**
	M_2 (>=M_1)		0	
	M_1 @ 2$_{nd}$ end	0	*Bending: Single Curvature*	

Critical Initial Moment Mi=M2 = 0.00 kNm

* *Design Moment=M2; Slenderness<15, Hence Madd=0*

Steel Areas & Position (from Top Mid Point)

Area mm²	X-dist mm	Y-dist mm
1257	93.76	148.65
1257	226.35	281.24
1257	226.35	468.76
1257	93.76	601.35
1257	-93.76	601.35
1257	-226.35	468.76
1257	-226.35	281.24
1257	-93.76	148.65

As=10056 *for 25 bars*	Max=226.35	Max=601.35
Max dia=40 mm	Neutral	Stress Block
Min dia=40 mm	Axis x mm	Depth 0.9x mm
Cover=110 mm	244.730	220.26

Steel Strain, Stress, Force and Moment (about mid depth)

Strain	Es*Strain	f_s used N/mm²	Fs kN	BM kNm
0.001374093	274.82	274.82	345.45	78.19
-0.000522183	-104.44	-104.44	-131.28	-12.31
-0.003203923	-640.78	-434.78	-546.52	51.24
-0.005100199	-1020.04	-434.78	-546.52	123.71
-0.005100199	-1020.04	-434.78	-546.52	123.71
-0.003203923	-640.78	-434.78	-546.52	51.24
-0.000522183	-104.44	-104.44	-131.28	-12.31
0.001374093	274.82	274.82	345.45	78.19
		å	**-1,757.75**	**481.66**

Concrete Stress Block Size, Centroid, Force Magnitude & Moment

Chord mm	Area mm²	cg from top mm	Fc kN	BM kNm
683.17	108219.37	129.47	**1,757.74**	**431.57**

Available Section Capacity:	**0.00**	**913.23**
Required Design Capacity:	**0.00**	**0.00**

Design Mx=0.00 kNm < 913.23 kNm Hence OK

Applied Loading Cases:

Load Case No Display	Load Case Reference	Axial Load N, kN	a_{uav} mm	Initial End Moments Mx_2 kNm	Mx_1 kNm	Available BMx* kNm	Required Mtx* kNm	Strength Check
Case 1						913.23		OK
Case 2						913.23		OK
Case 3						913.23		OK
Case 4						913.23		OK
Case 5						913.23		OK
Case 6						913.23		OK

Note: The moment of steel and concrete forces is taken and summed up about the mid depth.

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Address:		User Registration No:	Unregistered Copy
		Made by	Date	Page No
Project:	Plot C, Trinity Islands, Manchester	TPK	November 13, 2025	
Client:		Checked	Job No	Revision
Element:	900 dia 8H32	JRP	21.1182a	P06

Results Displayed for Load Case 1 **Load Reference:** **Data Store No** 026

fcu N/mm²	g_{mc}	Ecu
40	1.65	0.0035

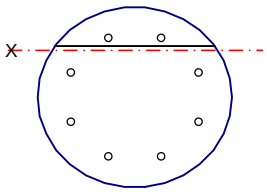
fy N/mm²	g_{ms}	Esu
500	1.15	0.00217

Section Dia mm	Number and Position of Steel Bars	Cover to cg
900	8	130

.67fcu/g_{mc}	fy/g_{ms}	E_s for Steel
16.2424	434.7826	200 kN/mm²

X-direction Stability	End Conditions At Top	At Bottom
(•) Braced	(•) Rigid	( ) Rigid
( ) Unbraced	( ) Semi Rigid	(•) Semi Rigid
Braced	( ) Pinned	( ) Pinned
	( ) Free	*Semi Rigid*
	Rigid	

Height Lo (m)	Height Factor ß (Table 3.19)
1.000	0.8



Effective Height Lex (m)	Slenderness to 3.8.1.3 Ratio	Status	Max Lo/h Allowed
0.800	Lex/h=0.89	**Short**	60 >1.1 hence OK

Design Data Summary

h_s/h	0.7111	Steel dia h_s
$N/h^2\ f_{cu}$	0.0000	640
100Asc/Ac	1.0110	>0.4% & <6%OK
p fy/f_{cu}	12.6381	
$M/h^3\ f_{cu}$	0.0298	
N_{uz} kN	13129.51	
$N_{bal\ xx}$ kN	4688.93	
$M_{bal\ xx}$ kNm	1464.03	
NA x-N_{balxx} mm	459.95	

Deflection Moments to Clause 3.8.3

K_x (Eq 33)	$ß_{a\ x}$ (Eq34)	$a_{u\ x}$ mm	$a_{uav\ x}$ mm	$M_{add\ x}$=$Na_{u\ x}$
1.0000	0.0004	0.3556		0.0000

Applied Axial Load, kN & Moments, kNm			Notional BM	*Design BM
N, kN	BM at Ends	Applied M_{xx} kNm	Ne_{min} (h/20<=20)	**Mx kNm**
	M_2 (>=M_1)		0	
	M_1 @ 2_{nd} end	0	*Bending: Single Curvature*	

Critical Initial Moment Mi=M2 = 0.00 kNm

* *Design Moment=M2; Slenderness<15, Hence Madd=0*

Steel Areas & Position (from Top Mid Point)

Area mm²	X-dist mm	Y-dist mm
804	122.46	154.36
804	295.64	327.54
804	295.64	572.46
804	122.46	745.64
804	-122.46	745.64
804	-295.64	572.46
804	-295.64	327.54
804	-122.46	154.36

As=6432 *for 25 bars*	Max=295.64	Max=745.64
Max dia=32 mm Min dia=32 mm Cover=114 mm	Neutral Axis x mm	Stress Block Depth 0.9x mm
	216.724	195.05

Steel Strain, Stress, Force and Moment (about mid depth)

Strain	Es*Strain	f_s used N/mm²	Fs kN	BM kNm
0.001007179	201.44	201.44	161.95	47.88
-0.001789645	-357.93	-357.93	-287.77	-35.24
-0.005744951	-1148.99	-434.78	-349.57	42.81
-0.008541774	-1708.35	-434.78	-349.57	103.35
-0.008541774	-1708.35	-434.78	-349.57	103.35
-0.005744951	-1148.99	-434.78	-349.57	42.81
-0.001789645	-357.93	-357.93	-287.77	-35.24
0.001007179	201.44	201.44	161.95	47.88
		å	**-1,649.90**	**317.59**

Concrete Stress Block Size, Centroid, Force Magnitude & Moment

Chord mm	Area mm²	cg from top mm	Fc kN	BM kNm
741.62	101579.72	115.37	**1,649.90**	**552.10**
		Available Section Capacity:	**0.00**	**869.69**
		Required Design Capacity:	**0.00**	**0.00**

Design Mx=0.00 kNm < 869.69 kNm Hence OK

Applied Loading Cases:

Load Case No Display	Load Case Reference	Axial Load N, kN	a_{uav} mm	Initial End Moments Mx_2 kNm	Mx_1 kNm	Available BMx* kNm	Required Mtx* kNm	Strength Check
(•) Case 1						869.69		OK
( ) Case 2						869.69		OK
( ) Case 3						869.69		OK
( ) Case 4						869.69		OK
( ) Case 5						869.69		OK
( ) Case 6						869.69		OK

Note: The moment of steel and concrete forces is taken and summed up about the mid depth.

Company:	Foundation Piling Limited	RoundCol 20000104 © 1999 Techno Consultants		
Address:		User Registration No:	Unregistered Copy	
		Made by	Date	Page No
Project:	Plot C, Trinity Islands, Manchester	TPK	November 13, 2025	
Client:		Checked	Job No	Revision
Element:	900 dia 8H40	JRP	21.1182a	P06

Results Displayed for Load Case 1 **Load Reference:** **Data Store No** 027

fcu N/mm^2	g_{mc}	Ecu
40	1.65	0.0035

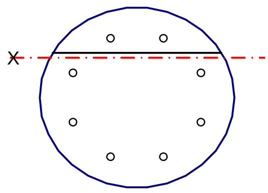
fy N/mm^2	g_{ms}	Esu
500	1.15	0.00217

Section Dia mm	Number and Position of Steel Bars	Cover to cg
900	8	130

$.67fcu/g_{mc}$	fy/g_{ms}	E_s for Steel
16.2424	434.7826	200 kN/mm^2

X-direction Stability	End Conditions At Top	End Conditions At Bottom
(●) Braced	(●) Rigid	( ) Rigid
( ) Unbraced	( ) Semi Rigid	(●) Semi Rigid
Braced	( ) Pinned	( ) Pinned
	( ) Free	*Semi Rigid*

Height Lo (m)	*Rigid*	Height Factor ß (Table 3.19)
1.000		0.8



Effective Height Lex (m)	Slenderness to 3.8.1.3 Ratio	Status	Max Lo/h Allowed
0.800	Lex/h=0.89	**Short**	60 >1.1 hence OK

Design Data Summary

h_s/h	0.7111	Steel dia h_s
$N/h^2 f_{cu}$	0.0000	640
100Asc/Ac	1.5807	>0.4% & <6%OK
$p\ fy/f_{cu}$	19.7588	
$M/h^3 f_{cu}$	0.0424	
N_{uz} kN	14705.16	
$N_{bal\ xx}$ kN	4716.39	
$M_{bal\ xx}$ kNm	1738.30	
NA x-N_{balxx} mm	459.95	

Deflection Moments to Clause 3.8.3

K_x (Eq 33)	$ß_{a\ x}$ (Eq34)	$a_{u\ x}$ mm	$a_{uav\ x}$ mm	$M_{add\ x}=Na_{u\ x}$
1.0000	0.0004	0.3556		0.0000

Applied Axial Load, kN & Moments, kNm N, kN	BM at Ends	Applied M_{xx} kNm	Notional BM Ne_{min} (h/20<=20)	*Design BM Mx kNm
	M_2 (>=M_1)		0	
	M_1 @ 2_{nd} end	0	*Bending: Single Curvature*	

Critical Initial Moment Mi=M2 = 0.00 kNm

* *Design Moment=M2; Slenderness<15, Hence Madd=0*

Steel Areas & Position (from Top Mid Point) Area mm^2	X-dist mm	Y-dist mm	Steel Strain, Stress, Force and Moment (about mid depth) Strain	Es*Strain	f_s used N/mm^2	Fs kN	BM kNm
1257	122.46	154.36	0.001352291	270.46	270.46	339.97	100.51
1257	295.64	327.54	-0.001057334	-211.47	-211.47	-265.81	-32.55
1257	295.64	572.46	-0.004465058	-893.01	-434.78	-546.52	66.93
1257	122.46	745.64	-0.006874682	-1374.94	-434.78	-546.52	161.57
1257	-122.46	745.64	-0.006874682	-1374.94	-434.78	-546.52	161.57
1257	-295.64	572.46	-0.004465058	-893.01	-434.78	-546.52	66.93
1257	-295.64	327.54	-0.001057334	-211.47	-211.47	-265.81	-32.55
1257	-122.46	154.36	0.001352291	270.46	270.46	339.97	100.51
As=10056 *for 25 bars*	Max=295.64	Max=745.64			å	**-2,037.78**	**592.92**

Max dia=40 mm Min dia=40 mm	Neutral Axis x mm	Stress Block Depth 0.9x mm
Cover=110 mm	251.549	226.39

Concrete Stress Block Size, Centroid, Force Magnitude & Moment

Chord mm	Area mm^2	cg from top mm	Fc kN	BM kNm
781.03	125460.43	133.55	**2,037.78**	**644.86**
		Available Section Capacity:	**0.00**	**1,237.78**
		Required Design Capacity:	**0.00**	**0.00**

Design Mx=0.00 kNm < 1,237.78 kNm Hence OK

Applied Loading Cases:

Load Case No Display	Load Case Reference	Axial Load N, kN	a_{uav} mm	Initial End Moments Mx_2 kNm	Mx_1 kNm	Available BMx^* kNm	Required Mtx^* kNm	Strength Check
(●) Case 1						1237.78		OK
( ) Case 2						1237.78		OK
( ) Case 3						1237.78		OK
( ) Case 4						1237.78		OK
( ) Case 5						1237.78		OK
( ) Case 6						1237.78		OK

Note: The moment of steel and concrete forces is taken and summed up about the mid depth.

APPENDIX 3
Design Summary

21.1182 - Trinity Islands (Plot C), Manchester
Design Summary (rev P06)
13/11/2025

Elevation	Design Section	Contig / Secant	Pile Diameter	Pile Spacing	Temporary Propping	Temporary Berm	TOCB Capping Beam (assumed)	SLS Excavation Level Adj. Wall	SLS Retained Height (to TOCB)	Pile Toe Level	Pile Length (Max)	Bending Moment		Anticipated Deflection (at TOCB)	45° zone of influence line, to boundary or adjacent structure			Pile Reinforcement (Main)
												ULS (per m)	Design (per pile)		Distance	Elevation	Anticipated Deflection	
			(mm)	(mm)			(mOD)	(mOD)	(m)	(mOD)	(m)	(kNm/m)	(kNm)	(mm)	(m)	(mOD)	(mm)	
Rail	A	Secant	900	1350	N		25.900	19.200	6.7	11.900	14.0	850	1148	10-15	see TN3	11.9	0-5	8H40 x 14m
									or alternate:	11.900	14.0							8H40 x 14m
										12.900	13.0							8H40 x 13m
Rail / Water St	D1	Secant	900	1350	N		25.700	19.900	5.8	12.400	13.5	610	824	5-10	see TN3	12.7	0-5	8H40 x 13.5m
									or alternate:	12.400	13.5							8H40 x 13.5m
										13.400	12.5							8H32 x 12.5m
Water St	D2	Contig	750	900	N		25.700	19.900	5.8	11.900	14.0	735	662	15-20	2.0	23.7	10-15	8H40 x 14m
									or alternate:	11.900	14.0							8H32 x 14m
										12.900	13.0							8H40 x 13m
Water St	E1	Secant	900	1350	N		25.700	19.500	6.2	11.400	14.5	851	1149	10-15	2.0	23.7	5-10	8H40 x 14.5m
									or alternate:	11.400	14.5							8H40 x 14.5m
										12.400	13.5							8H40 x 13.5m
Water St	E2	Contig	750	900	N		25.700	19.500	6.2	11.400	14.5	851	766	20-25	2.0	23.7	15-20	8H40 x 14.5m
									or alternate:	11.400	14.5							8H40 x 14.5m
										12.400	13.5							8H40 x 13.5m
Irwell	J	Contig	600	750	N		23.700	20.400	3.3	14.700	9.0	278	209	5-10				6H25 x 9m
									or alternate:	14.700	9.0							6H25 x 9m
										15.700	8.0							6H25 x 8m
Irwell	K	Secant	600	950	N	Y	23.700	19.400	4.3	14.700	9.0	264	251	5-10				8H25 x 9m

Notes:
All secant piles will be taken to depth required for groundwater cut off as a minimum (designed by others; currently 14.0mOD). Any extensions for groundwater cut off will be unreinforced.
Excavation depths do not consider local excavations for pad foundations. It is assumed that these will be excavated to a "hit and miss" sequence and not left open overnight.
Anticipated deflections are approximated from 60% of WALLAP calculated deflections.
Reinforcement stated is maximum provision at elevation of maximum bending moment and may be reduced locally to suit bending moment distribution.

APPENDIX 4
Plan of Design Sections

21.1182a – Trinity Islands (Plot C1)

Design Formation Levels

P06 13/11/25



Formation Levels

- 18.30
- 18.60
- 19.20
- 19.40

Reference drawings:

Foundations –
C1-B2-[]-G210-PL-B2-0002
C1-B2-[]-G210-PL-B2-0003

Slabs –
C1-B2-[]-G200-PL-B2-0002
C1-B2-[]-G200-PL-B2-0003

21.1182a – Trinity Islands (Plot C1)

Design Capping Beam Levels

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Reference drawings:

Capping Beams –
C1-B2-[]-G210-PL-XX-0005
C1-B2-[]-G210-PL-XX-0006

21.1182a – Trinity Islands (Plot C1)

Assumed Design Constraints (tbc)

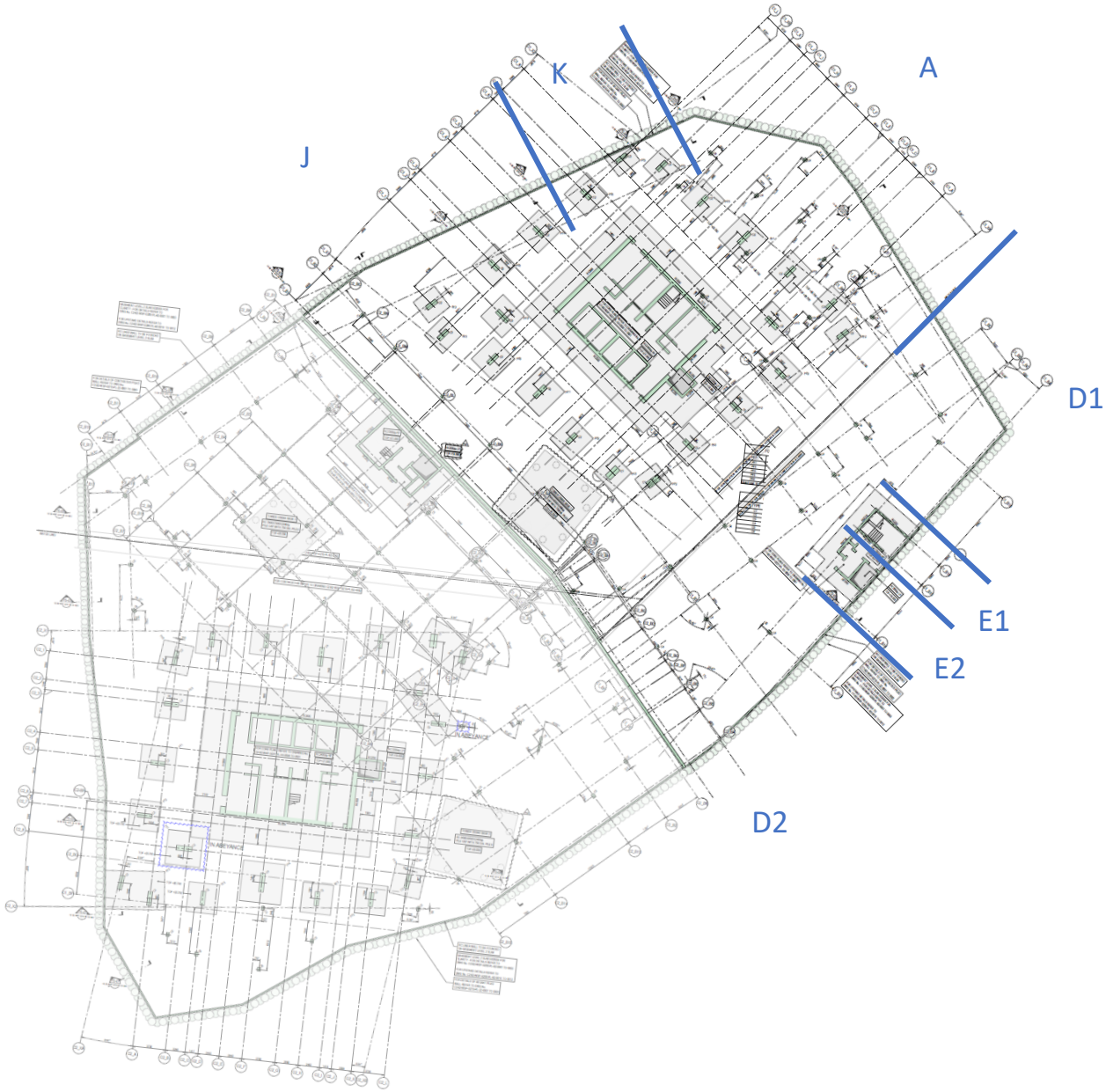
P06 13/11/25



21.1182a – Trinity Islands (Plot C1)

Design Sections

P06 13/11/25



21.1182a – Trinity Islands (Plot C1)

Boreholes

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Key:

Blue - Base of made ground

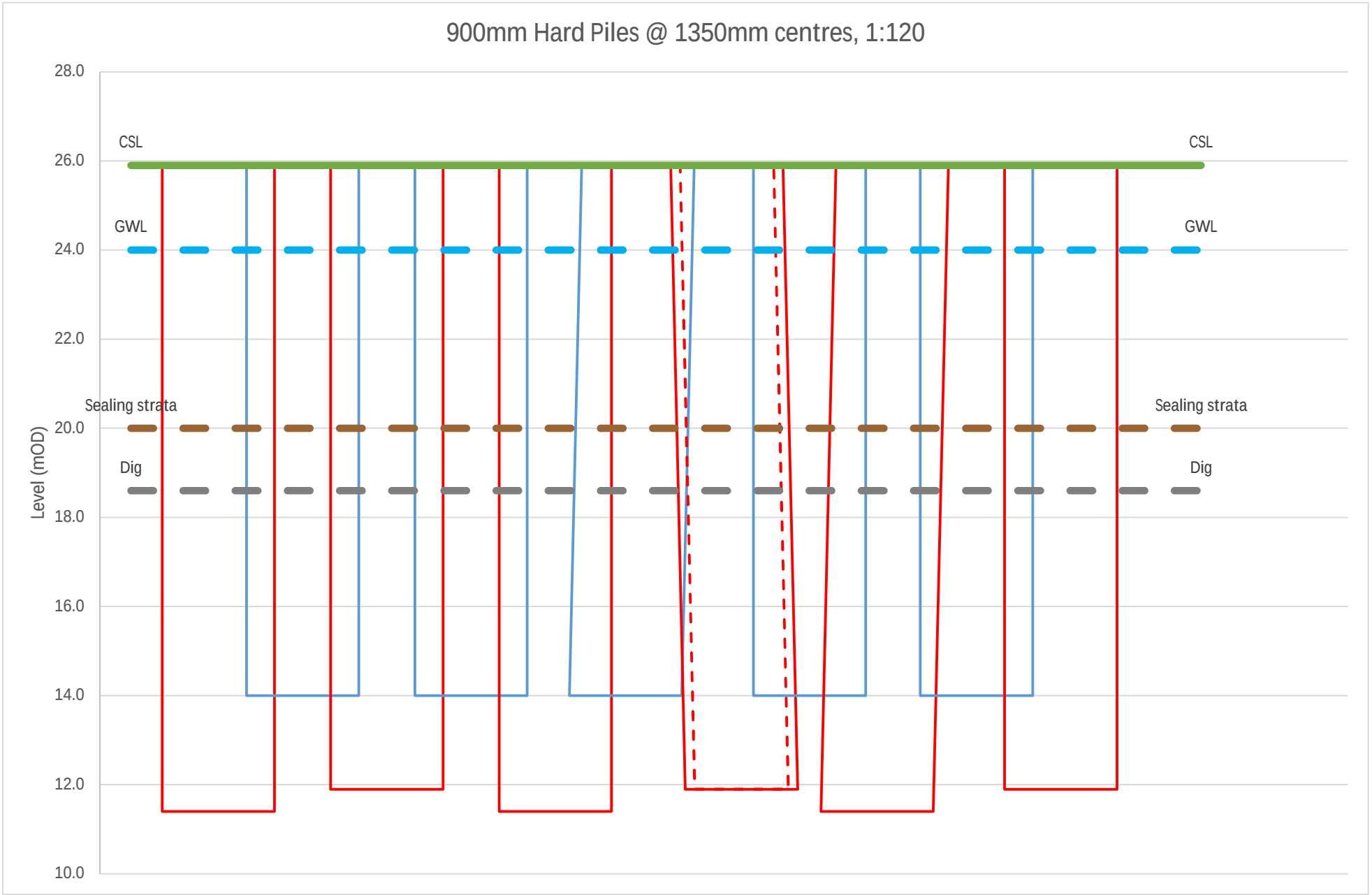
Green - Base of clay

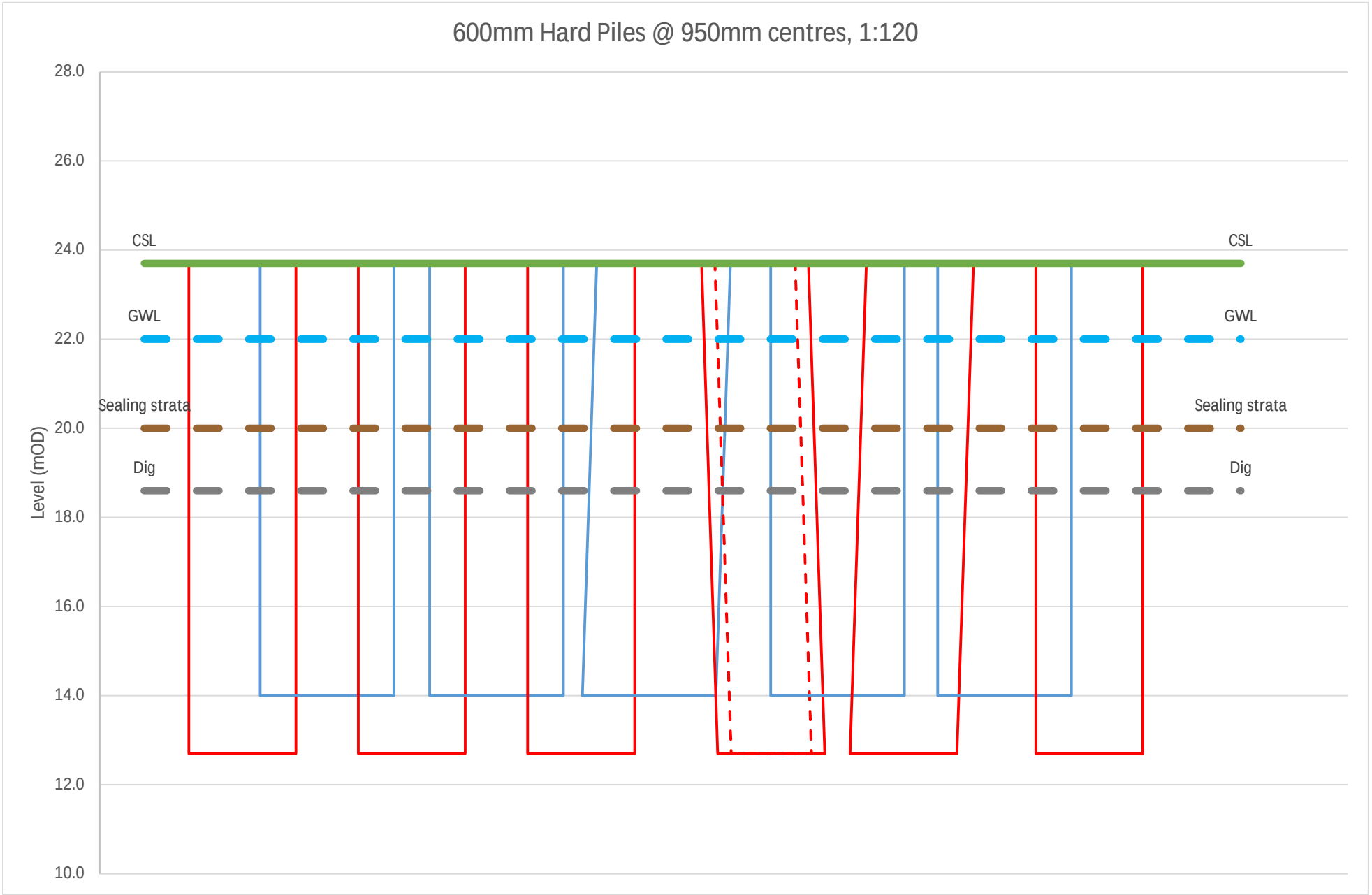
Red - Base of sand / gravel

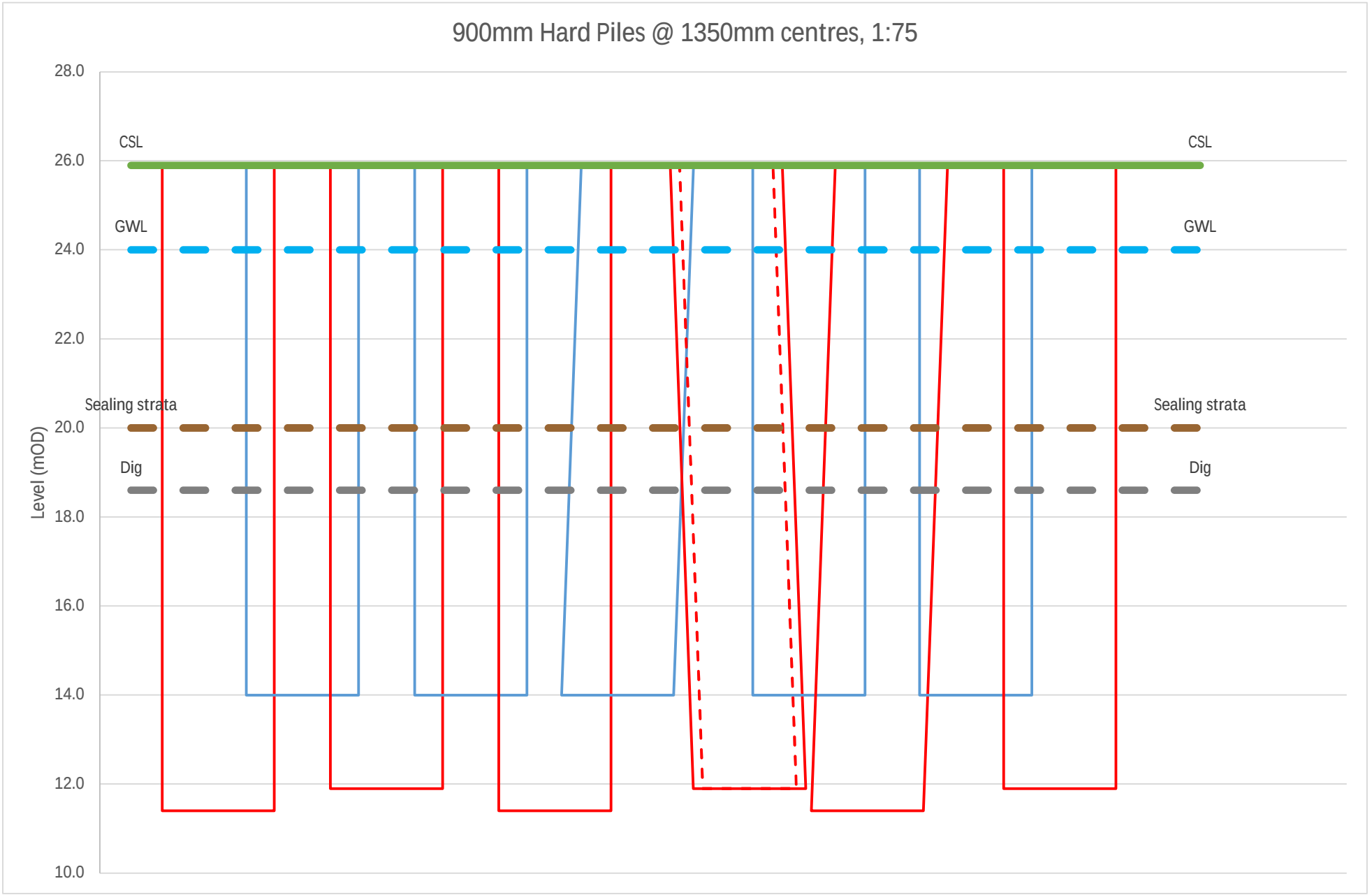
Lowest value is also top of sandstone.

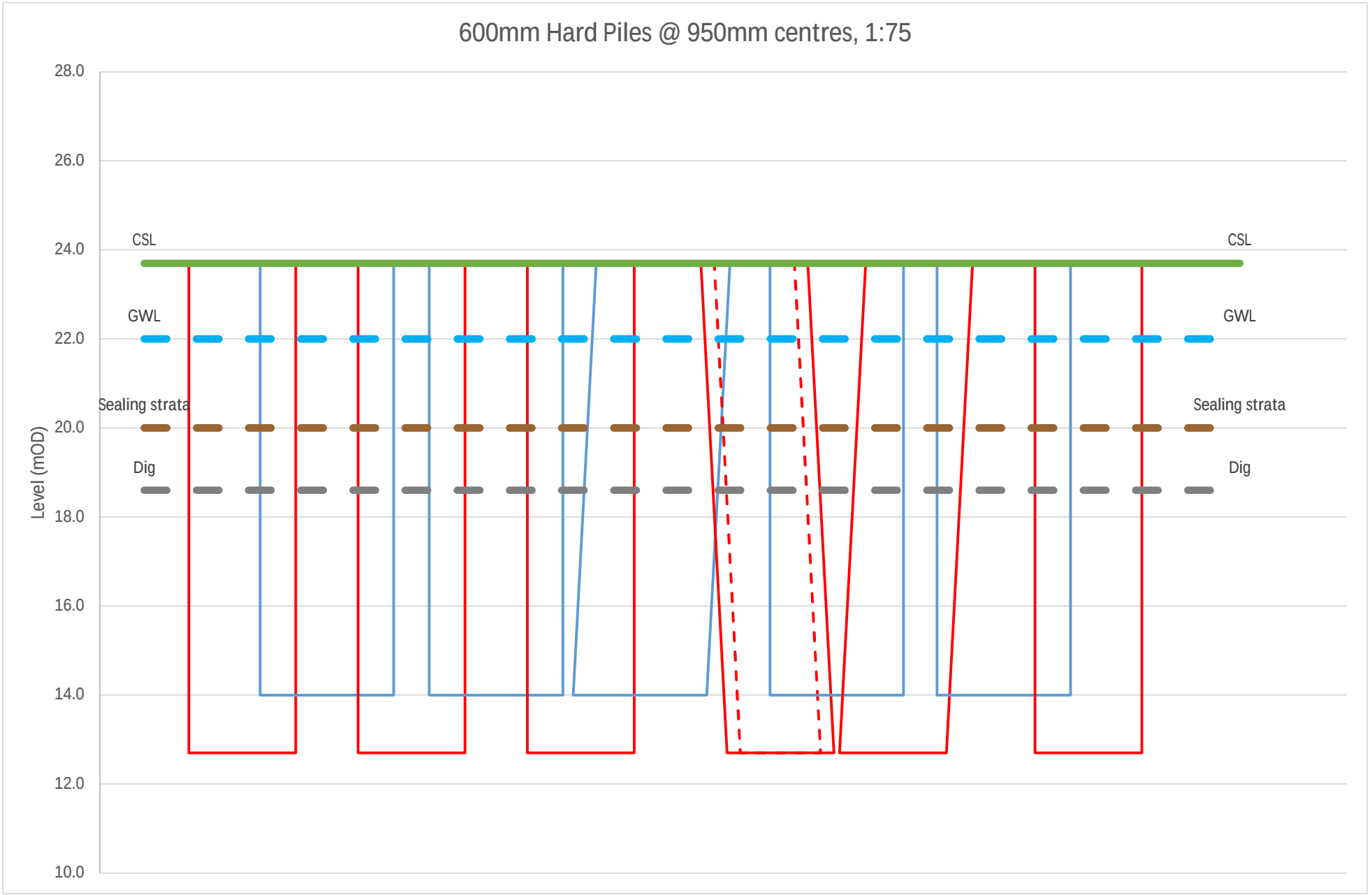


APPENDIX 5
Secant Pile Geometry & Tolerances


900mm Hard Piles @ 1350mm centres, 1:120
Level (mOD)
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
CSL
CSL
GWL
GWL
Sealing strata
Sealing strata
Dig
Dig


600mm Hard Piles @ 950mm centres, 1:120
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
Level (mOD)
CSL
GWL
Sealing strata
Dig
CSL
GWL
Sealing strata
Dig


900mm Hard Piles @ 1350mm centres, 1:75
Level (mOD)
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
CSL
CSL
GWL
GWL
Sealing strata
Sealing strata
Dig
Dig


600mm Hard Piles @ 950mm centres, 1:75
Level (mOD)
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
CSL
CSL
GWL
GWL
Sealing strata
Sealing strata
Dig
Dig