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Groundwater Drawdown and Settlement Assessment at 538 Karangahape Road, Auckland City

Rev B **15 November 2023** **Job No. 20111**

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GROUNDWATER DRAWDOWN AND SETTLEMENT ASSESSMENT AT 538 KARANGAHAPE ROAD, AUCKLAND CITY

Job Number:	20111
Name of Project:	538 Karangahape Road, Auckland City
Client:	James Kirkpatrick Ltd
Author:	Michael Chan, Geotechnical Engineer, MEngNZ
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Author Signature:	
Reviewer Signature:	
Authoriser Signature:	

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Appendices:

1.0 Introduction and Scope

Soil & Rock Consultants (S&RC) were engaged by James Kirkpatrick Limited to carry out a detailed settlement assessment at 538 Karangahape Road, Auckland City, with regard to the proposed boundary excavations. This report provides a summary of our detailed settlement assessment in support of a Resource Consent application to Auckland Council and is informed by the requirements of a Restricted Discretionary Activity in accordance with Section E7 of the AUP (OIP).

As such, in accordance with Section E7.8.2 of the AUP (OIP), the objective of this assessment is to demonstrate the proposal avoids, remedies or mitigates any ground settlement that may cause distress, including reducing the ability of an existing building or structure to meet the relevant requirements of the Building Act 2004 or the New Zealand Building Code, to existing:

(i) buildings;
(ii) structures; and
(iii) services including roads, pavements, power, gas, electricity, water supply and wastewater networks and fibre optic cables.

For this assessment, we have assumed a soldier pile wall solution will be adopted to provide temporary support along the basement excavations along the property boundaries. The poles are to remain in place as part of the permanent structure and will be supported by the basement concrete floor slabs prior to completion of construction, i.e. top-down construction.

Accordingly, S&RC has undertaken the following scope of work:

1. Review of existing S&RC reporting pertaining to retaining walls.
2. Review of the drawing sets provided to us.
3. Analysis and assessment of ground settlement behind the proposed basement walls based on a preliminary soldier pile wall design solution and the effect of the basement excavations on neighbouring properties.

1.1 Limitations

This report has been prepared by S&RC the sole benefit of our Client, James Kirkpatrick Ltd, in respect to 538 Karangahape Road, Auckland City, and the brief given to us. This report may be used by the client's appointed consultants and can be relied upon by Auckland Council to support both a Resource Consent and Building Consent application for the proposal. The data and/or opinions contained in this report may not be used by any other party or for any other purpose without our prior review and agreement.

2.0 Previous Reporting

S&RC have issued a geotechnical investigation report at the subject site titled *"Geotechnical Investigation for Proposed Multi-level Commercial Building at 538 Karangahape Road, Newton"*, Rev. A, dated 22 August 2023, Ref. 20111. That report is herein referred to as the GIR.

The findings, geotechnical constraints and design recommendations provided in that report are summarised as follows:

- Fill was encountered to a maximum depth of 5.9m bpgl within our machine boreholes, associated with existing retaining.
- Natural soils comprised stiff to very stiff weathered Waitemata Group soils underlain by Waitemata Group rock at depth.
- The site is deemed Class C – "Shallow Soil Site" (NZS1170.5:2004)
- In terms of soil expansivity, the soils present are considered to lie in 'Expansive Soil Class H – Highly Expansive' in accordance with B1/AS1
- The proposed development is outside the 'Permitted Activity' criteria of E7.6.1.6 and E7.6.1.10 of the AUP and therefore a detailed assessment of dewatering and settlement effects of the basement excavation against the relevant criteria in Section E7.8.2 of the AUP is required to support Resource Consent application.

2.1 Groundwater Monitoring and Compliance

The following fieldwork was undertaken to assist with the hydrogeological assessment during preparation of the GIR:

- Visual Appraisal of the site.
- Drilling of three machine boreholes (MB04 to MB06 inclusive).
- Installation of piezometers in each borehole (labelled PZ04 to PZ06, respectively).
- Follow-up groundwater level measurements from 6th July to 21st July and assessment of those levels against rainfall response.

Groundwater levels were modelled using the maximum groundwater elevations recorded during the monitoring period, exclusive of an anomalous result recorded in PZ05 on 21 July and the levels recorded on 6 July which are inferred to have still been stabilising following drilling as outlined in Section 5.0 of the GIR. The PZ05 result recorded on 13 July was elevated by 0.3m based on similar rises recorded in PZ04 and PZ06 between 13 and 21 July.

A temporary excavation level of 0.5m below the FFL was inferred to be required for slab preparation. The modelled groundwater elevations were then compared to the inferred temporary excavation levels for the proposed development. The floor level of the lower basement level (B2) is slightly lower in the northern corner of the development, and this was accounted for in our assessment.

The results of our groundwater monitoring in relation to the proposed structure are presented in the GIR and reiterated in Table 1 and the resulting groundwater contours are shown in Figure 1.

Table 1 – Groundwater Elevations, Finished Floor Levels and Estimated Excavation Levels

Piezometer Location	Modelled Groundwater Elevation (mRL)	Basement 02 Finished Floor Level (mRL)	Temporary Excavation Level (mRL)	Groundwater Depth Above Excavation (m)
PZ04	65.6	64.0	63.5	2.1
PZ05	63.2	63.6	63.1	0.1
PZ06	62.8	64.0	63.5	-0.7

The appended "Typical Details 3" by Enovate Consultants, drawing No. S402, Project No. 22-0034, dated 10 October 2023 was received following our GIR and indicates a temporary cut level of 62.65mRL, 800mm below B2 finished floor level. That cut level is adopted in this assessment and therefore the above tabulated temporary excavation levels have been superseded herein.

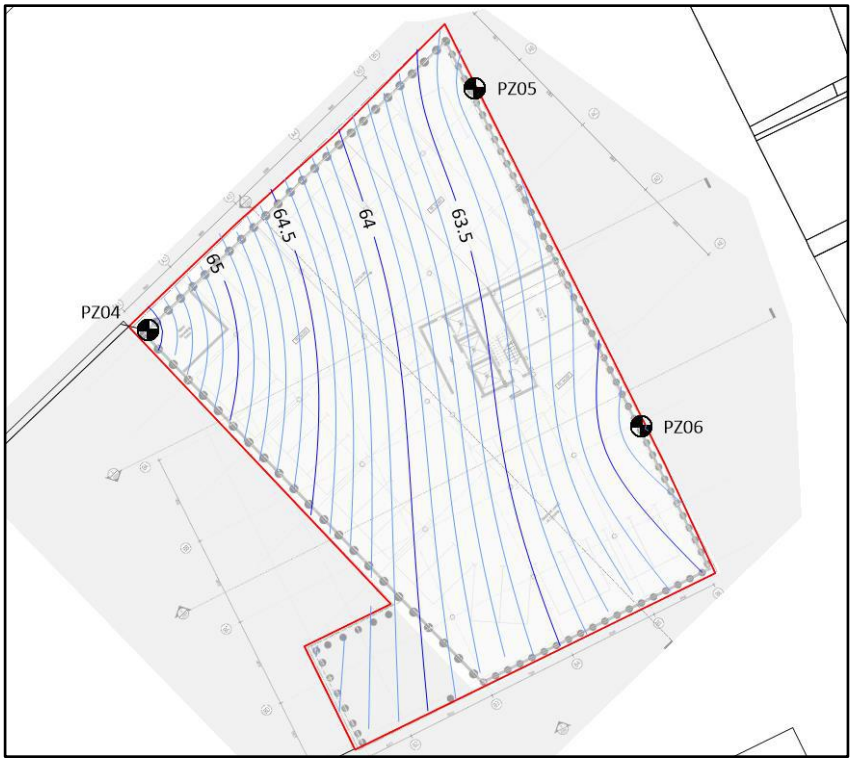


Figure 1: Groundwater Elevation vs. Proposed Basement

3.0 Assessment of Effects

3.1 Critical Sections and Assumptions

Three critical sections have been identified based on the drawings provided to us in Appendix A, inferred geological sections, distance to neighbouring structures, and groundwater elevations. For continuity with the GIR, these sections are named Sections C to E.

Settlement effects on the neighbouring properties were assessed through the critical sections as outlined below. A critical section alignment plan is presented in Appendix B.

- **Critical Section C.** This section was selected to target the potential settlement effects to the west of the basement excavation on the neighbouring building at 582 Karangahape Road. The existing ground level is taken as the underside of the basement foundations based on design drawings available in the Property File.
- **Critical Section D.** This section was selected to target the potential settlement effects to the north of the basement excavation on the Karangahape Road footpath, road reserve, and neighbouring services through the inferred deepest excavation.
- **Critical Section E.** This section was selected to target the potential settlement effects to the southeast of the basement excavations Gundry Street road reserve, footpath and watermain.

For the purpose of assessment through sections C to E, we have assumed top-down construction using a steel-reinforced concrete soldier pile wall as a temporary support solution. The soldier pile wall will be incorporated into the permanent retaining wall.

It is assumed that a construction berm will remain between the B1 and B2 floors until the B1 floor is installed to prop the soldier pile walls prior to final excavation of the B2 basement as shown on “Typical Details 3” by Enovate Consultants, drawing no. S402, Project No. 22-0034, dated 10 October 2023. The design cut level of 62.65mRL is also shown on that detail, which takes into account the excavation beneath the B2 floor slab to install the ground beam beneath it.

The site topography precludes gravity drainage at the lower basement level, and it is therefore assumed that the basement excavations will be permanently tanked from basement floor levels B1 (upper at 67.00mRL) to B2 (lower at 64.05mRL). As such, the groundwater regime is expected to return to near pre-development state once the permanent walls are constructed.

As shown in Figure 1, groundwater is expected to be encountered above the finished floor level of the B2 basement. Based on our groundwater monitoring, negligible drawdown is expected through Critical Section E (150mm during temporary excavation) and the finished construction will be permanently tanked, and therefore any drawdown induced settlement through Section E is considered negligible.

3.2 Ground Model

Soil Permeability - Drawdown

In-situ hydraulic (falling head) testing was conducted by S&RC in PZ06 in October 2023 using digital down-hole level loggers. The piezometer was rapidly filled and the falling groundwater level continuously measured until a static water level was achieved (to at least 90% of the initial groundwater level). The recorded data was analysed within the Aqtesolv software package under the Bouwer & Rice and Hvorslev methods to calculate the hydraulic conductivity average. The results of the analyses are presented in Table 2 and the outputs attached in Appendix C.

Table 2 – Hydraulic Permeability Testing Results

Piezometers	Bouwer & Rice Method m/sec	Hvorslev Method m/sec
PZ06	1.25E-9	3.92E-9
Average Hydraulic Conductivity	2.59E-9	

The temporary excavation level 62.65mRL is within the weathered Waitemata Group Soils, therefore we have conservatively assumed that the hydraulic permeability is homogeneous for drawdown modelling.

Soil Strength Parameters – WALLAP

The soil parameters recommended in Table 7 of the GIR have been adopted for our assessment with the exception of the modulus of elasticity for Waitemata Group Rock which has been conservatively reduced as per the WALLAP outputs in Appendix D of this report.

3.3 Groundwater Drawdown

An assessment of potential dewatering effects arising from the proposed cut/excavation was undertaken for Critical Sections C and D. A worst-case scenario drawdown effect has been adopted for the planned dewatering by adopting groundwater levels considered at or near the seasonal-high.

Drawdown has been analysed adopting the average hydraulic conductivity (K) value of $2.59E^{-9}$ m/s.

Predicted drawdown has been calculated via Steady-State Finite Element Analysis using the RocScience Inc. SLIDE2 software. Total head back-analysis has been undertaken beyond the site in order to reproduce the measured groundwater levels within the site. The analysis extends some 50m beyond the excavation with the existing ground levels taken from Auckland Council contour data and our understanding of the neighbouring building's basement level at 582 Karangahape Road based on drawings available in the Property File.

Calculated drawdown depths across the critical sections are presented in Table 3.

Table 3 – Estimated Drawdown vs. Horizontal Distance from Wall

Distance From Cut (m)	Drawdown (m)	
	C-C' To Southwest	D-D' To Northwest
0.0	2.9	1.4
1.0	2.7	1.3
2.0	2.5	1.2
3.0	2.3	1.1
4.0	2.2	1.0
5.0	2.1	1.1
10.0	1.6	0.8

As shown in Table 3, maximum estimated groundwater drawdown through the critical sections as a result of the basement excavation is 2.9m through Section C-C'. Negligible drawdown effects i.e., less than 5mm of vertical settlement, are estimated beyond 10m from the excavation through Section C-C', and less through Section D-D'.

3.3.1 Consolidation Settlements due to Groundwater Drawdown

For the assessment of consolidation settlement, we have assumed the weathered Waitemata Group soils to be compressible and the transitional Waitemata Group material to be incompressible. The results of the assessment outlined in Section 3.3 of this report have been adopted to determine the predicted drawdown induced consolidation settlement component of the settlement analyses (refer Appendix E).

The increase in effective stress resulting from lowered groundwater may induce consolidation settlements within compressible soils within and below the drawdown zone. For the purpose of this assessment, one-dimensional consolidation settlement has been calculated using the below equation:

$\Delta S = m_v \times \Delta\sigma' \times \Delta H$;

where: ΔS = consolidation settlement

m_v= coefficient of compressibility = 1 / M; where: M = stiffness modulus

$M = E \times \frac{(1-\vartheta)}{(1+\vartheta)\times(1-2\vartheta)}$; where ϑ = Poisson's ratio

$\Delta\sigma'$ = change in effective stress due to groundwater drawdown

ΔH = thickness of the compressible layer

A summary of the groundwater drawdown assessment results, including consolidation settlements, is presented in Tables 4 and 5. Consolidation settlement calculations are attached in Appendix E.

Table 4 – Groundwater Drawdown Assessment Results for Critical Section C

Observed Area	Distance from Excavation [m]	Calculated Consolidation Settlement [mm]
No. 582 K Road Building (Near Edge)	0.0	6.6
No. 582 K Road Building (Far Edge)	35.5	1.5

Table 5 – Groundwater Drawdown Assessment Results for Critical Section D

Observed Area	Distance from Excavation [m]	Calculated Consolidation Settlement [mm]
Site Boundary / K Road Footpath	0.0	0.9
Water Pipe – 250 CI	4.7	0.6
Water Main – 630 CLS	8.8	0.5
Water Main – 525 UNDEF	18.6	0.3
537 K Road Building (Near Edge)	27.4	0.2

3.4 Mechanical Settlements due to Wall Deflections (WALLAP Analysis

For this assessment, the following structural design limiting criteria have been considered:

(i) Factor of Safety greater than 1.5 for embedment maintained during and post-construction,
(ii) Strain (deflection) less than 2% of maximum retained height

At this preliminary stage of the project the retaining wall members have been assumed to comprise 750ø steel-reinforced concrete piles at 1.5m centres (i.e. 2D spacing).

Specific detailed design of the wall is excluded from the scope of this (deflection) assessment, and it should be noted that member sizes may be amended once final load demand has been assessed (i.e., loads may be greater or smaller than the serviceability load conditions analysed herein). Detailed design is the responsibility of the wall designer and will be completed during the detailed design phase of the project prior to Building Consent.

To determine horizontal deflections for the proposed wall during construction (temporary support), we have completed a staged analysis using the Geosolve software package WALLAP. WALLAP uses a single dimension finite element model to analyse each stage.

The mechanically induced settlement assessment was carried out using the Hsieh and Ou method (1998) for concave and spandrel deflection profiles.

The following assumptions were adopted and utilised for the design:

- A long-term serviceability (SLS) surcharge of 1.0G + 0.7Q (164kPa) has been applied where adjacent to 582 Karangahape Road (where G=150kPa and Q=20kPa) for Section C as advised by Enovate Consultants.
- A long-term serviceability (SLS) surcharge (1.0G) of 12kPa has been applied where adjacent to Road Reserves for Sections D and E.
- An unfactored Young's Modulus, E, of 31,685 MPa has been adopted for concrete as advised by Enovate Consultants.
- Cracked section factors of 0.7 and 0.5 have been applied to pile stiffness (EI) for short-term and long-term serviceability cases respectively.
- Pre-development groundwater levels are adopted from Section 3.3 of this report and as shown on Figure 1 above.
- The Waitemata Group rock profile has been linearly interpolated between boreholes.

The staging used in the temporary support (deflection) analysis model includes the following stages and the application for each construction stage section is presented in Table 6:

- Application of surcharges modelling nearby existing structures and/or Council-prescribed boundary surcharges.
- Installation of a soldier pile wall (via changing wall stiffness to 100%).
- Installation of temporary propping where applicable.
- Groundwater drawdown on left (neighbour's) side of wall due of temporary drainage.
- Excavation of construction berm on right hand (basement) side of wall where applicable.
- Installation of permanent B1 floor propping
- Reduce wall stiffness to 70% (short-term crack factored)
- Excavation of proposed cut level
- Removal of temporary propping where applicable
- Installation of permanent GF floor propping where applicable
- Reduction of wall stiffness to 50% (long-term crack factored)

Table 6 – Construction Stage Application Requirements

Stage	Application Requirement		
	C-C'	D-D'	E-E'
Surcharge Application	Yes	Yes	Yes
Installation of Wall Pile	Yes	Yes	Yes
Temporary GF Propping	Yes	No	No
Groundwater Drawdown	Yes	Yes	No
Construction Berm Excavation	Yes	Yes	No
Installation of Permanent B1 Floor Propping	Yes	Yes	No
Installation of Permanent GF Floor Propping	Yes	No	No

3.4.1 WALLAP and Mechanical Deflection Results

A summary of the details and results of WALLAP analyses is presented in Table 7. Settlement calculations and WALLAP output sheets are provided in Appendix D.

Table 7 – WALLAP Details – SLS 1G+0.7Q

Element	Section C	Section D	Section E
Total Excavation Depth / Design Retained Height (m)	5.8	8.2	4.4
Pile Diameter (mm)	750	750	750
Spacing (m)	1.5	1.5	1.5
Minimum Pile Length (m)	11.0	18.4	11.0
Wall Unfactored Moment of Inertia, I (m^4/m of wall)	0.010350	0.010350	0.010350
Young's Modulus of Concrete, E (kPa)	3.169E+07	3.169E+07	3.169E+07
Maximum Bending Moment (kNm per m of wall)	126.4	119.6	52.3
Maximum Shear Force (kN per m of wall)	106.0	94.9	29.2
Maximum Bending Moment (kNm per pile)	189.6	179.4	78.5
Maximum Shear Force (kN per pile)	159.0	142.4	43.8
Calculated Min. Factor of Safety rounded to 1D.P. (1)	1.5 (11)	1.5 (6)	1.5 (5)
Maximum Pile Displacement (mm)	14	17	14
Mechanical Settlement Immediately behind Wall (mm)	4.4	10.6	8.8
Maximum B1 Prop Load (kN/m)	175.7	147.6	1.9
Maximum Temporary GF Prop Load (kN/prop)	40.95	N/A	N/A
Maximum GF Prop Load (kN/m)	slack	N/A	N/A

(1) Number in brackets refers to critical construction stage

3.5 Total Ground Movement

The magnitude of combined settlement relates to both the deflection of the proposed wall along the property boundaries as well as groundwater drawdown effects. The expected settlement of the proposed structure has been compared against limiting settlement documented criteria as listed below:

(i) Within Burland Damage Category 2 (10mm to 50mm of vertical settlement and 1 in 500 to 1 in 200 for differential settlement

(ii) NZTA Guidelines in respect to potential damage to roads - no more than 20mm total vertical settlement and 1 in 500 differential settlements for adjacent driveways,

(iii) CIRIA PR 30 1996 Appendix F, for maximum differential settlement of 1 in 140 for cast iron pipes and brittle utilities with a diameter of 200mm or greater (conservative).

Limiting settlement criteria for Burland (1995) is presented in Table 8.

Table 8 – Approximate Equivalent Ground Settlement and Slopes (Burland 1995)

Category of Damage	Description of Degree of Damage	Max. 'Gradient' of Ground	Maximum Settlement of Building (mm)
1	Negligible to Very Slight	Less than 1:500	Less than 10mm
2	Slight	1:500 to 1:200	10mm to 50mm
3	Moderate	1:200 to 1:50	50mm to 75mm
4	Severe	Greater than 1:50	Greater than 75mm

The estimated total and differential settlements (i.e., maximum 'gradient' of ground) behind the excavations for impacted boundaries and structures are summarised in Tables 9 to 11.

Table 9 – Vertical Ground Settlements for Critical Section C

Observed Area	Distance from Excavation (m)	Total Vertical Settlement (mm)	Max 'Gradient' of Ground
Site Boundary / No. 582 Basement (Near Edge)	0.0	11.1	1:500
Maximum settlement	3.0	14.0	
No. 582 Basement (Far Edge)	35.5	1.5	

Table 10 – Vertical Ground Settlements for Critical Section D

Observed Area	Distance from Excavation (m)	Total Vertical Settlement (mm)	Max 'Gradient' of Ground
Site Boundary / Karangahape Road Footpath	0.0	11.2	1:950
Water Pipe – 250 CI	4.7	5.9	
Water Main – 630 CLS	8.8	2.6	
Water Main – 525 UNDEF	18.6	0.8	
537 K Road Building (Near Edge)	27.4	0.3	

Table 11 – Vertical Ground Settlements for Critical Section E

Observed Area	Distance from Excavation (m)	Total Vertical Settlement (mm)	Max 'Gradient' of Ground
Site Boundary / Abbey Street Footpath / Water Pipe 200 CI	0.0	8.8	1:900
Abbey St Carriageway (Near Edge)	2.2	6.2	
Water Main – 100 UNDEF	11.1	0.8	
Abbey St Carriageway (Far Edge)	12.6	0.6	
3 Abbey St Building (Near Edge)	15.5	0.3	

3.6 Conclusions

The settlement outputs are attached in Appendix E. The results of the Assessment of Effects with respect to neighbouring structures are discussed below.

3.6.1 Existing Buildings

The neighbouring building at 582 Karangahape Road is estimated to be subject to a maximum combined vertical settlement of 14mm and differential settlements of up to 1:500. The degree of damage is therefore classified as *Damage Category 2: Slight*. It should be noted that the total settlement exceeds *Damage Category 1* by only 4mm and the differential settlement does not exceed the criteria of that category.

In our experience any settlement observed at the time of construction is typically much lower than that estimated, particularly if construction is undertaken in summer as is typical. Further, soil strength parameters have been selected with a conservative bias, particularly with respect to soil stiffness, resulting in conservative total mechanical settlement outputs.

In addition, measured groundwater levels adopted in the drawdown analysis are considered at or near the seasonal high, as such, the consolidation settlement components are very conservative in this regard. Realistically, the prevailing groundwater levels are likely to be much lower and most of the modelled consolidation is expected to have occurred previously given typical seasonal variation and the topographical and geological setting, i.e., being an East Coast Bays Formation ridgeline.

Furthermore, we understand the neighbouring building has recently undergone seismic strengthening, which may also contribute to its ability to tolerate any residual settlements compared to other buildings of its age.

We therefore consider that damage occurring as a result of any 'actual' settlement will be less than minor. In any case, we recommend a Groundwater & Settlement Monitoring & Contingency Plan (GSMCP) is required as outlined in Section 5.0 below.

3.6.2 Existing Services

Maximum differential settlements over the boundary are flatter than 1 in 900. Hence, both mechanical and consolidation settlement effects of the proposed development on the public and private services are considered negligible. Although we do not have as-built service locations, based on the above, effects on neighbouring private services are also considered negligible.

3.6.3 Existing Roading and Pavements

Similar to the above, all estimated settlements are less than the requirements of the NZTA guidelines. i.e., less than 20mm total vertical settlement and 1 in 500 differential settlements for adjacent driveways. The effects on existing roading are therefore considered negligible.

4.0 Construction Methodology

We recommend, and have assumed in our assessments above, a top-down construction methodology is adopted i.e., soldier piles are installed prior to excavation to support the neighbouring properties from instability prior to permanent walls being installed. Floor propping of the B1 basement is required to ensure an adequate factor of safety is maintained and wall deflections are limited during construction.

Temporary propping prior to the construction berm excavation (and deeper excavations) will also be required near ground floor level to support the southwestern boundary excavations where adjacent to No. 582 neighbouring basement to minimise deflections as detailed in Section 3.4.1 of this report.

Our assumed construction methodology for excavations is outlined below:

- Installation of boundary soldier pile walls
- Installation of temporary brace propping near GF (southwestern boundary).
- Bulk excavation with construction berm remaining (southwestern and northwestern boundaries).
- Installation of permanent B2 columns and B1 steelwork and slab to prop soldier pile wall.
- Removal of construction berm and excavation of proposed cut level below B2 once B1 slab is fully cured.
- Installation of remaining B2 foundations, waterproofing/tanking and shotcrete from B2 to B1, installation of drainage, steel and shotcrete from B1 to GF.
- Removal of temporary brace propping (southwestern boundary).
- Construction of permanent GF slab.

Groundwater inflow should be controlled via sumps and pumps during temporary excavation.

We expect that design liaison between the structural engineer and S&RC and a review of the above construction methodology for each boundary excavation will be required at detailed design stage to ensure that excavation effects on neighbouring properties remain minimised.

5.0 Groundwater and Settlement Monitoring & Contingency Plan

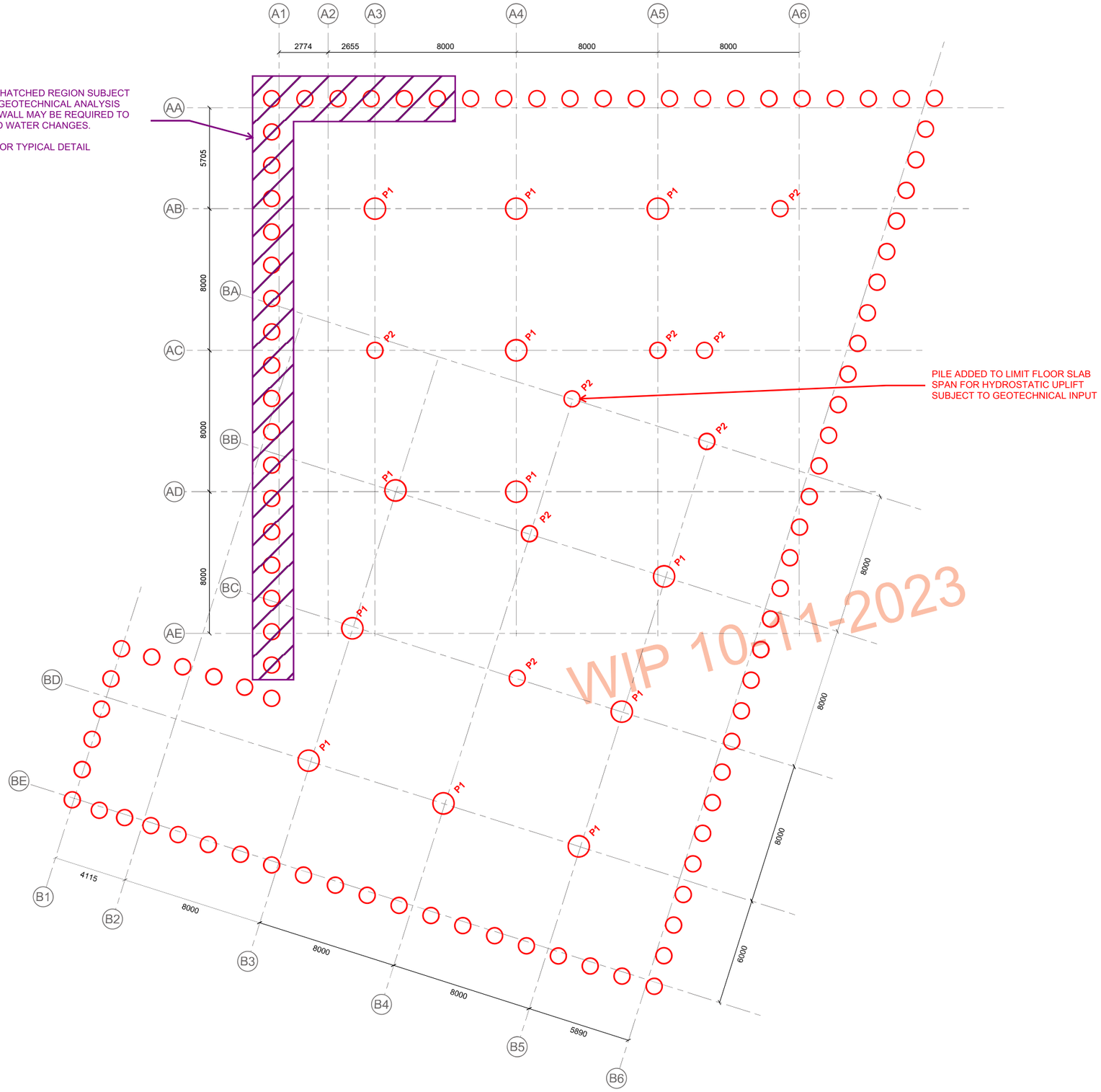
A Groundwater & Settlement Monitoring & Contingency Plan (GSMCP) is required to establish monitoring requirements for the development such that any excavation effects to neighbouring properties remain within the estimated parameters and a contingency plan is laid out to mitigate adverse effects beyond those expected to occur.

A draft GMSCP will be prepared by S&RC as a separate document and a finalised GSMCP will be provided following issue of Consent by Council or via iterative liaison with Council regarding draft consent conditions.

End of Report Text - Appendices Follow

Appendix A

Enovate Consultants Drawings



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REV	DATE	REVISION DESCRIPTION	ISSUED BY
B	10.10.23	50% PRELIMINARY	MN
A	26.06.23	CONCEPT	MN

ENGINEERS: JT, AM
TECHNICIANS: JT, AM
CHECKED BY: MN
APPROVED BY: MN

PROJECT:
538 KARANGAHAPE ROAD
AUCKLAND

DRAWING TITLE:
PILE PLAN

REMARKS:

COUNCIL APPROVAL

DRAWING STATUS:
50% PRELIMINARY

PROJECT No.	SHEET No.	REV
22-0034	S90	B

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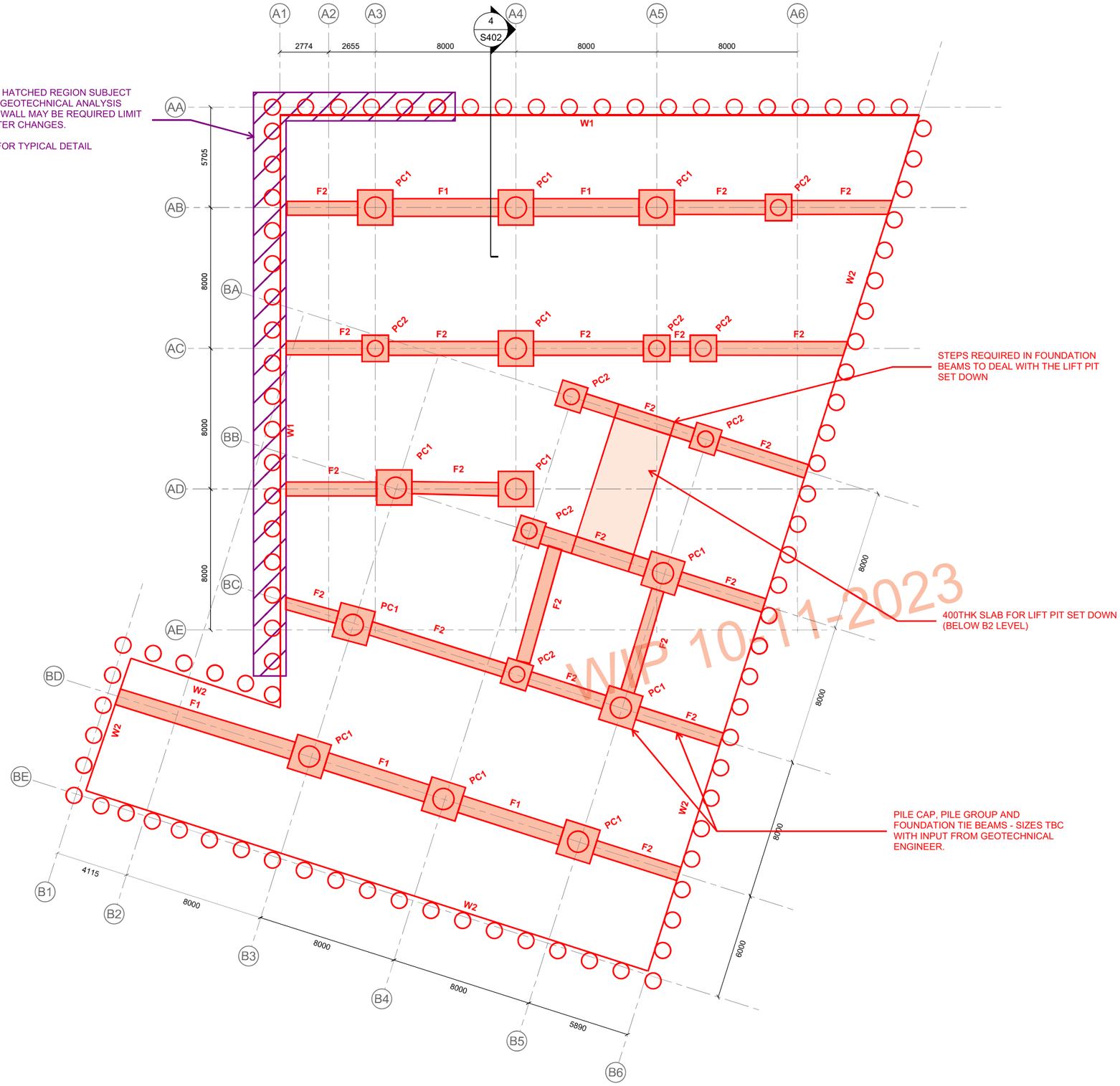

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REV	DATE	REVISION DESCRIPTION	ISSUED BY
B	10.10.23	50% PRELIMINARY	MN
A	26.06.23	CONCEPT	MN

ENGINEERS: JT, AM
TECHNICIANS: JT, AM
CHECKED BY: MN
APPROVED BY: MN

PROJECT: 538 KARANGAHAPE ROAD AUCKLAND
DRAWING TITLE: FOUNDATION PLAN

REMARKS:

DRAWING STATUS: 50% PRELIMINARY

PROJECT No.	SHEET No.	REV
22-0034	S91	B

COUNCIL APPROVAL
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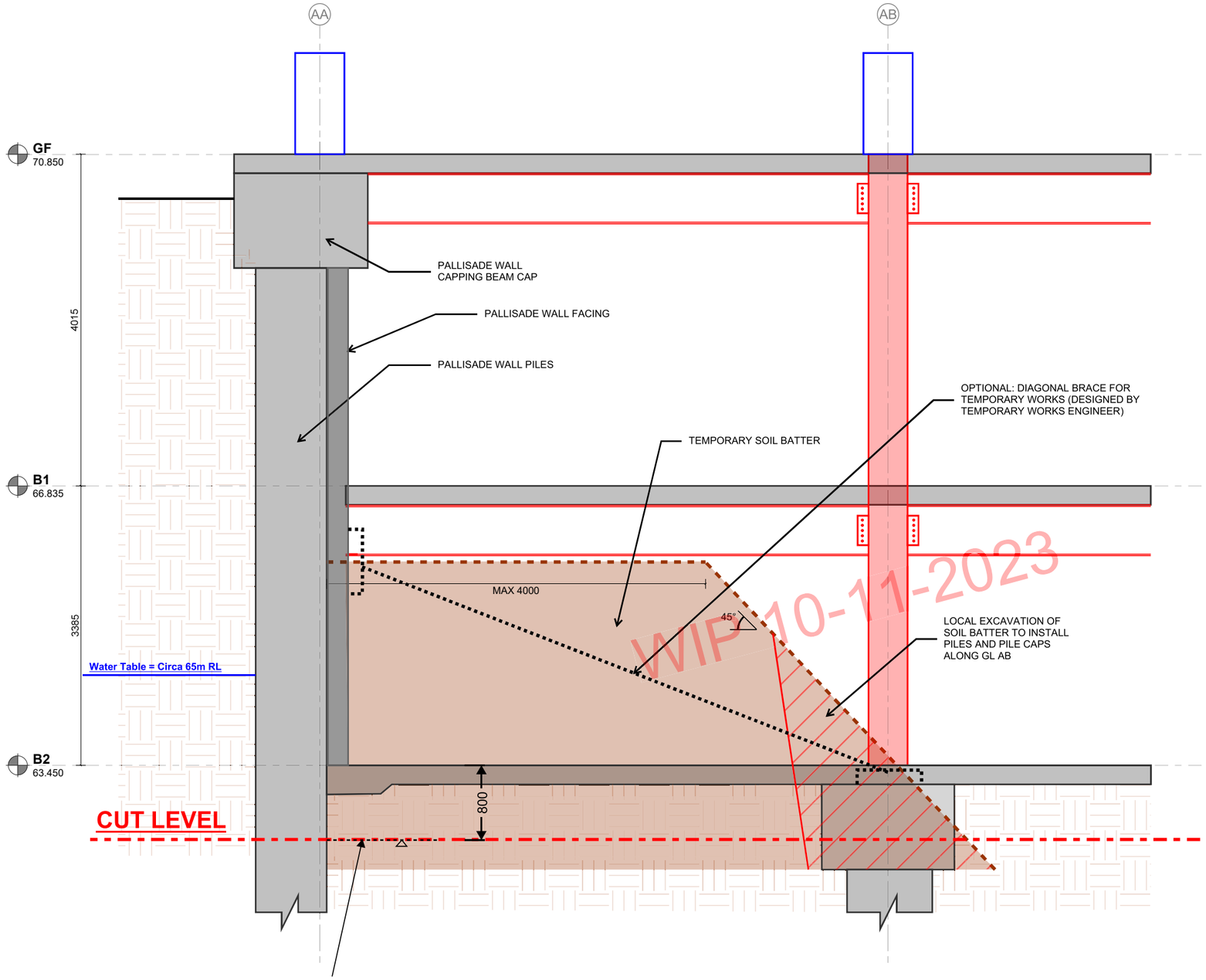

4 / - BASEMENT CONSTRUCTION SEQUNCE

SCALE 1:50

Assumed Construction Sequence for Basement

1.) Install palisade wall piles

2.) Excavate down to the cut level ensuring that a batter is left against the palisade wall as shown to limit the temporary retained height of the palisade wall

3.) Install all other piles and pile caps. Local excavation of the batter can be done in order to install the piles and pile caps along GL AB. Foundation beams and most of the B2 Slab can also be installed (other than on GL AB as this would compromise the soil batter)

4.) Erect B2 columns and B1 Steelwork, pour level 1 floor to provide permanent propping of the Palisade Wall

5.) Upon B1 slab reaching full strength, remove temporary soil batter, install Palisade Wall facing along GL AA, install foundation beams along GL AB and complete B2 Slab.

PROCESS WILL BE SIMILAR ALONG GL A2

ALL TO BE CONFIRMED BY GEOTECH ENGINEER

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B	10.10.23	50% PRELIMINARY	MN
A	26.06.23	CONCEPT	MN

ENGINEERS: JT, AM
TECHNICIANS: JT, AM
CHECKED BY: MN
APPROVED BY: MN

PROJECT: 538 KARANGAHAPE ROAD AUCKLAND

DRAWING TITLE: TYPICAL DETAILS 3

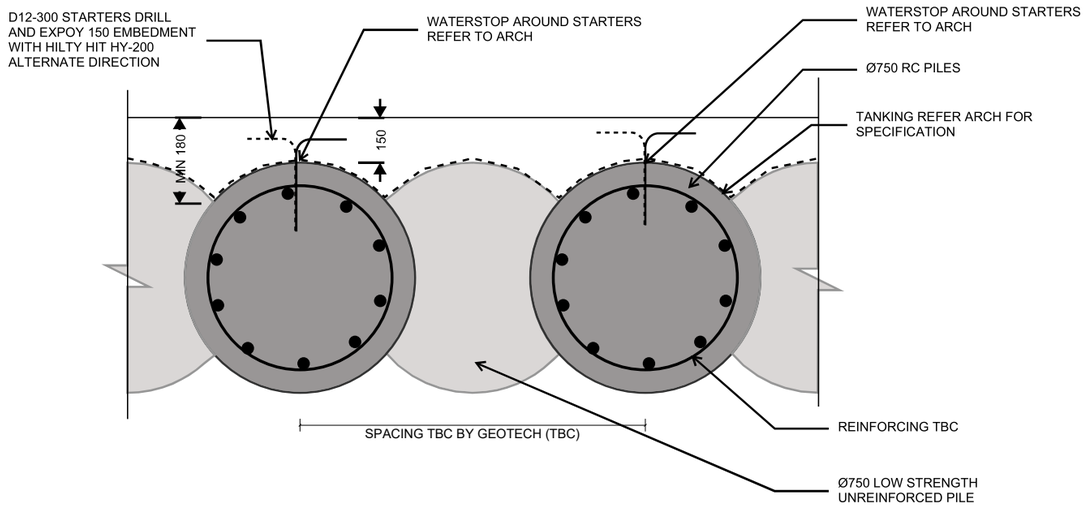
REMARKS:

COUNCIL APPROVAL

DRAWING STATUS: 50% PRELIMINARY

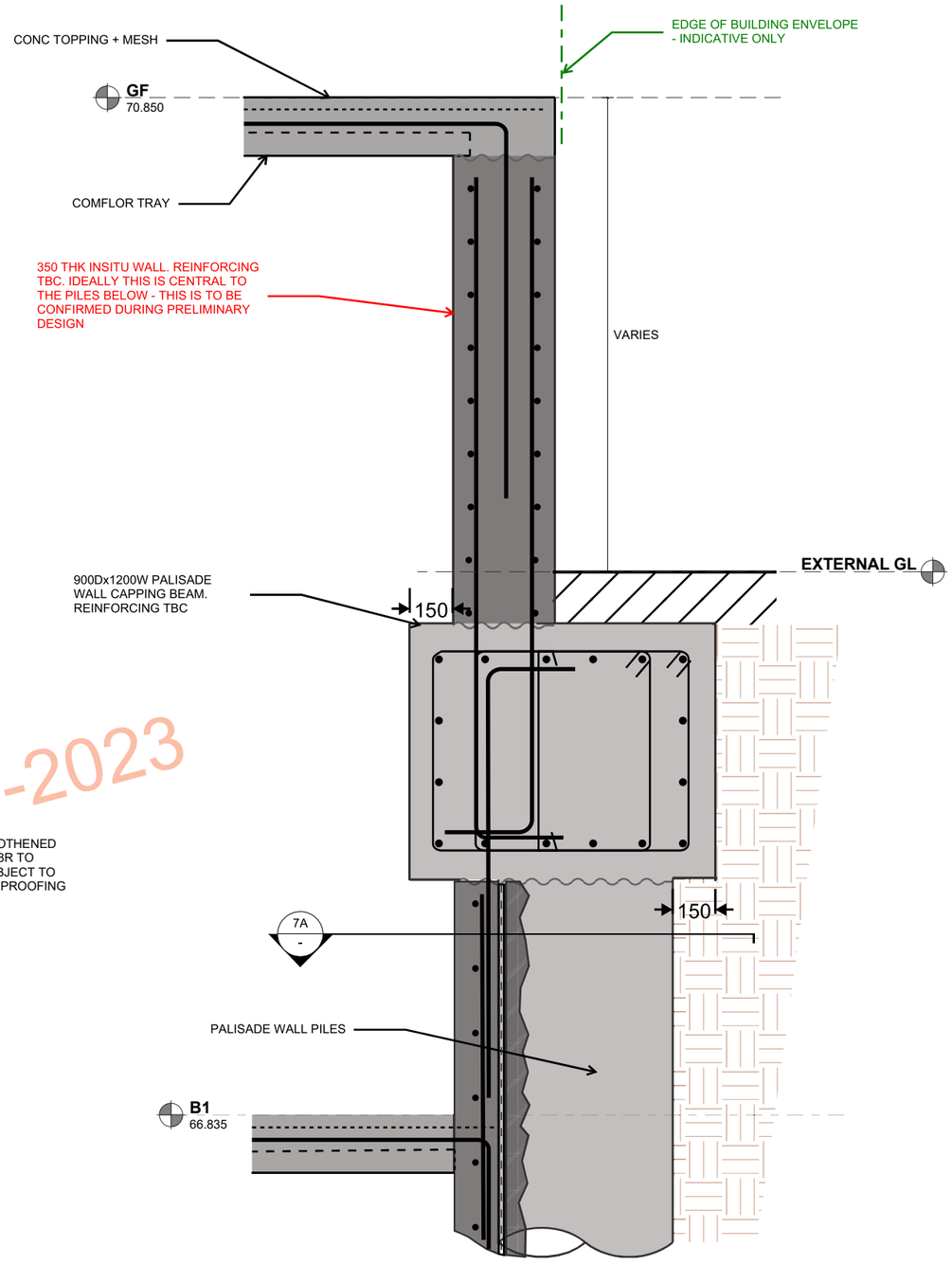
PROJECT No. 22-0034 | SHEET No. S402 | REV B

SHEET SIZE: A3 (297x420)
SCALE: AS INDICATED



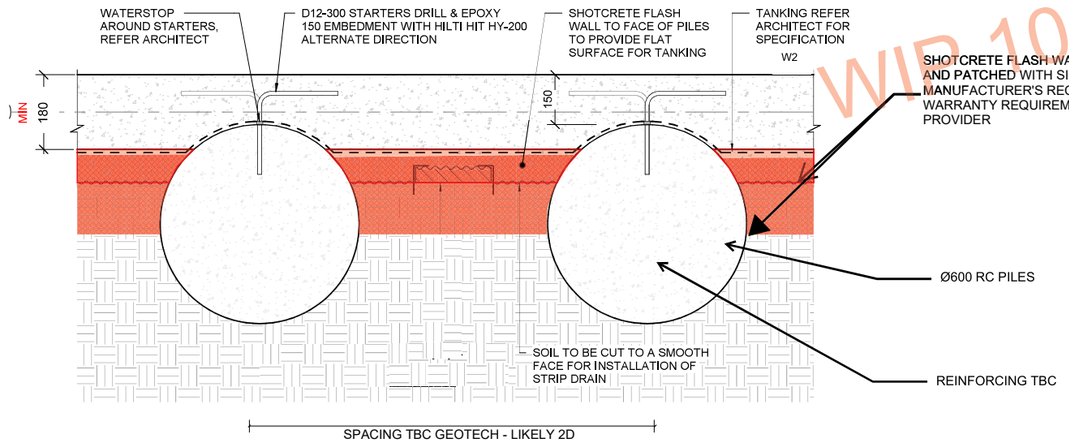
6 / - SECANT PILE WALL

SCALE 1:20



7 / - PALLISADE PILE WALL WITH INSITU WALL

SCALE 1:20



7A / - PALLISADE PILE WALL WITH INSITU WALL

SCALE 1:20

ENOVATE CONSULTANTS
AON CENTRE, LEVEL 12,
29 CUSTOMS STREET WEST,
AUCKLAND CITY, 1010
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TEL: +64 9 320 3060
EMAIL: contact@enovate.co.nz
WEBSITE: www.enovate.co.nz

CLIENT: JAMES KIRKPATRICK GROUP LTD

REV	DATE	REVISION DESCRIPTION	ISSUED BY
B	10.10.23	50% PRELIMINARY	MN
A	26.06.23	CONCEPT	MN

ENGINEERS: JT, AM
TECHNICIANS: JT, AM
CHECKED BY: MN
APPROVED BY: MN

PROJECT: 538 KARANGAHAPE ROAD AUCKLAND

DRAWING TITLE: TYPICAL DETAILS 4

REMARKS:

DRAWING STATUS: 50% PRELIMINARY

PROJECT No.	SHEET No.	REV
22-0034	S403	B

COUNCIL APPROVAL

SHEET SIZE: A3 (297x420)

SCALE: AS INDICATED

Appendix B

Critical Section Alignment Plan

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DRAWING NO:	**20111/1**
DATE:	October 2023
DRAWN:	M.CHAN
SCALE:	NTS

CRITICAL SECTION PLAN
538 KARANGAHAPE ROAD, NEWTON

Key:

- MB01 S&RC Borehole Locations 03 Jul 2023
- CPT01 S&RC CPT Locations 03 Jul 2023
- A A' Critical Section Alignment

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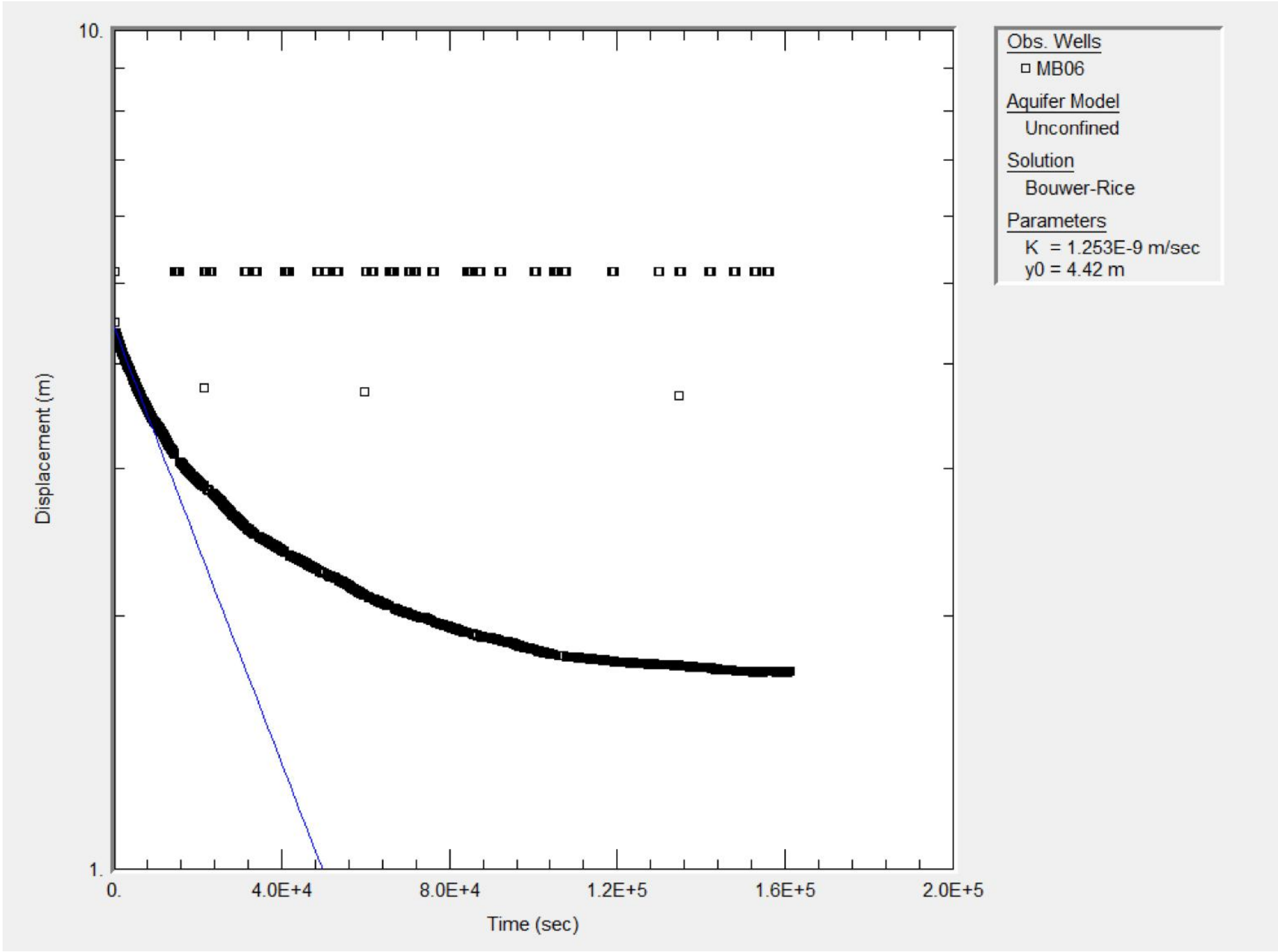
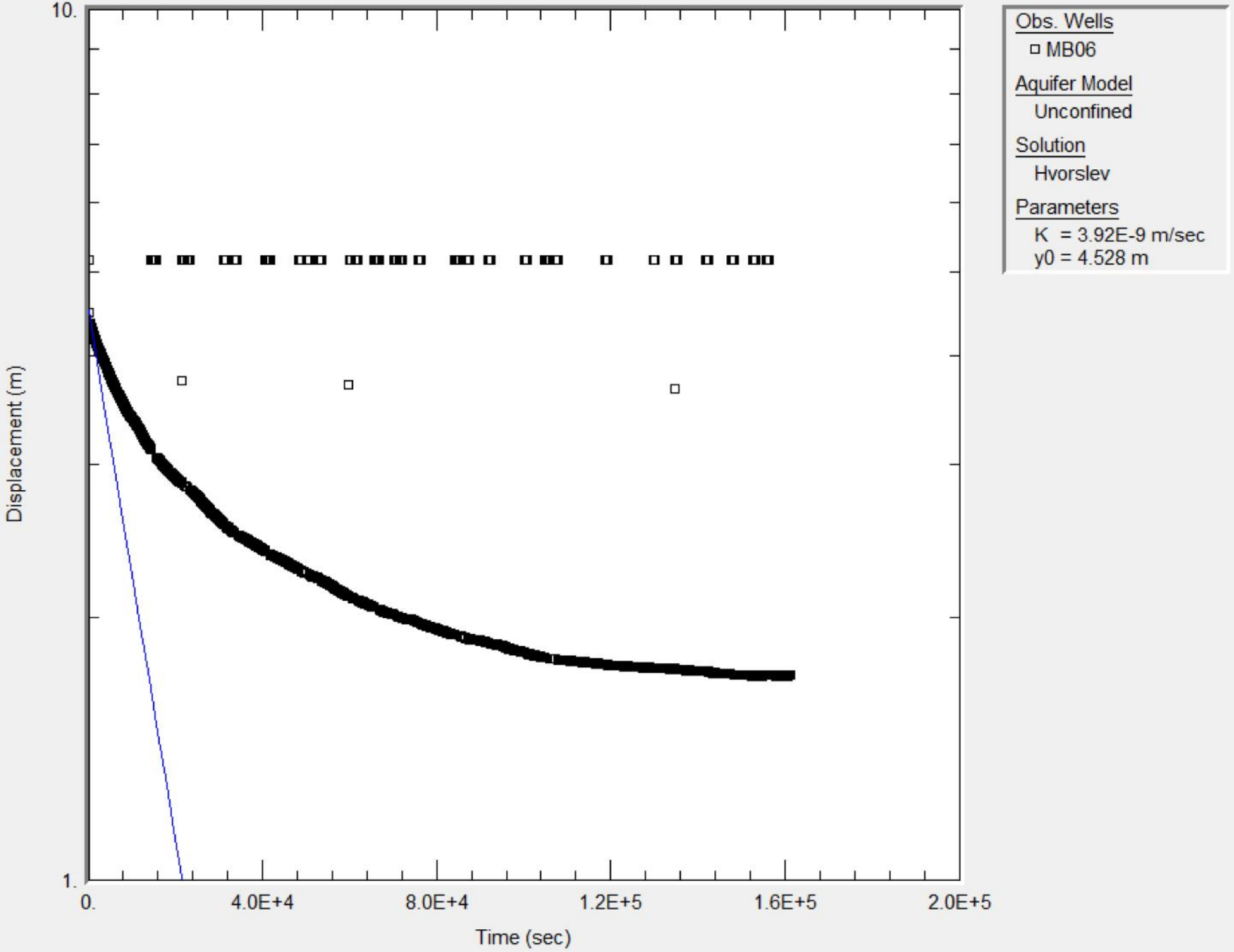
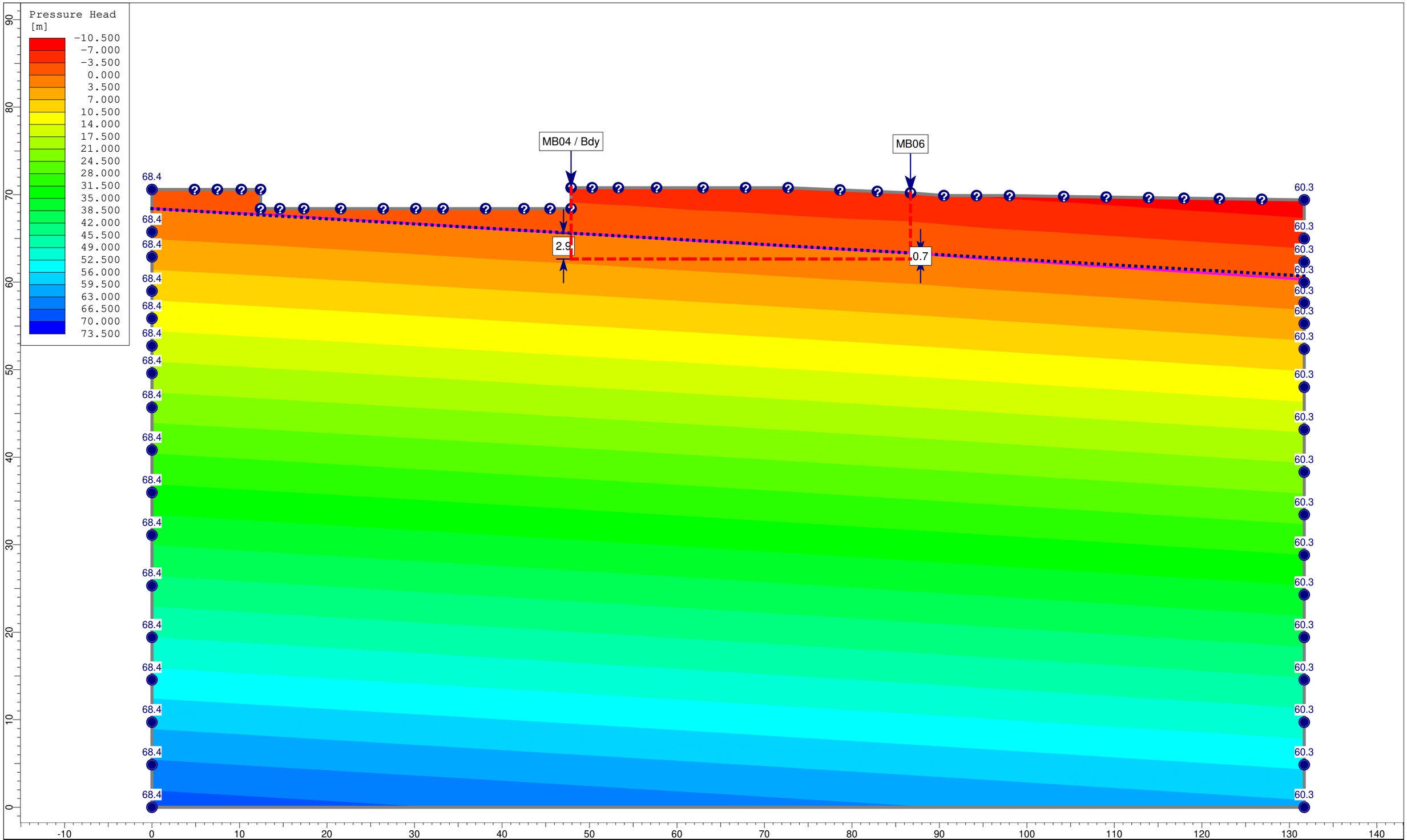
Appendix C

Permeability Testing & Drawdown Outputs


10.
1.
Displacement (m)
0.
4.0E+4
8.0E+4
1.2E+5
1.6E+5
2.0E+5
Time (sec)
Obs. Wells
MB06
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 1.253E-9 m/sec
y0 = 4.42 m


10.
1.
Displacement (m)
0.
4.0E+4
8.0E+4
1.2E+5
1.6E+5
2.0E+5
Time (sec)
Obs. Wells
MB06
Aquifer Model
Unconfined
Solution
Hvorslev
Parameters
K = 3.92E-9 m/sec
y0 = 4.528 m



Soil&Rock Consultants

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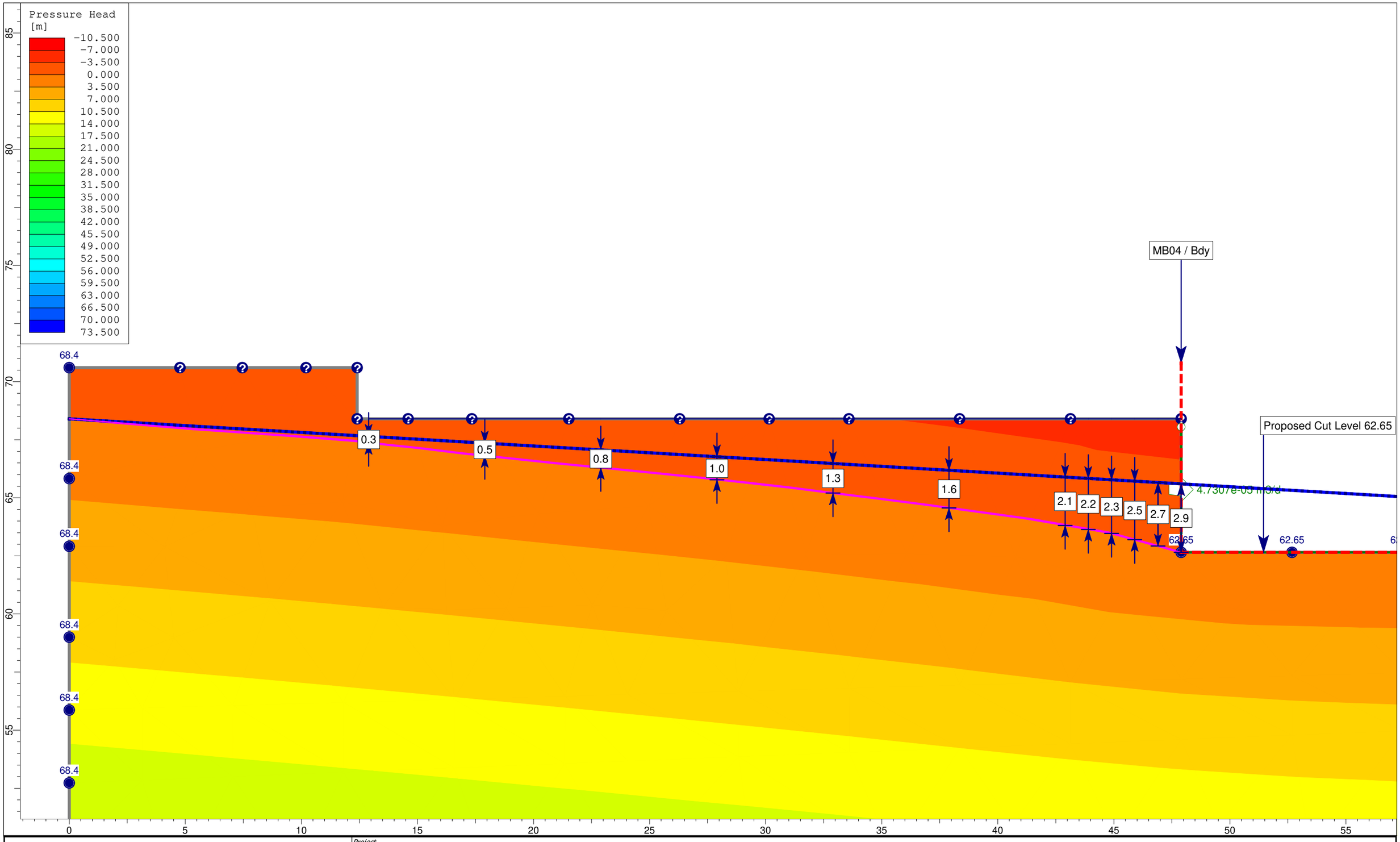
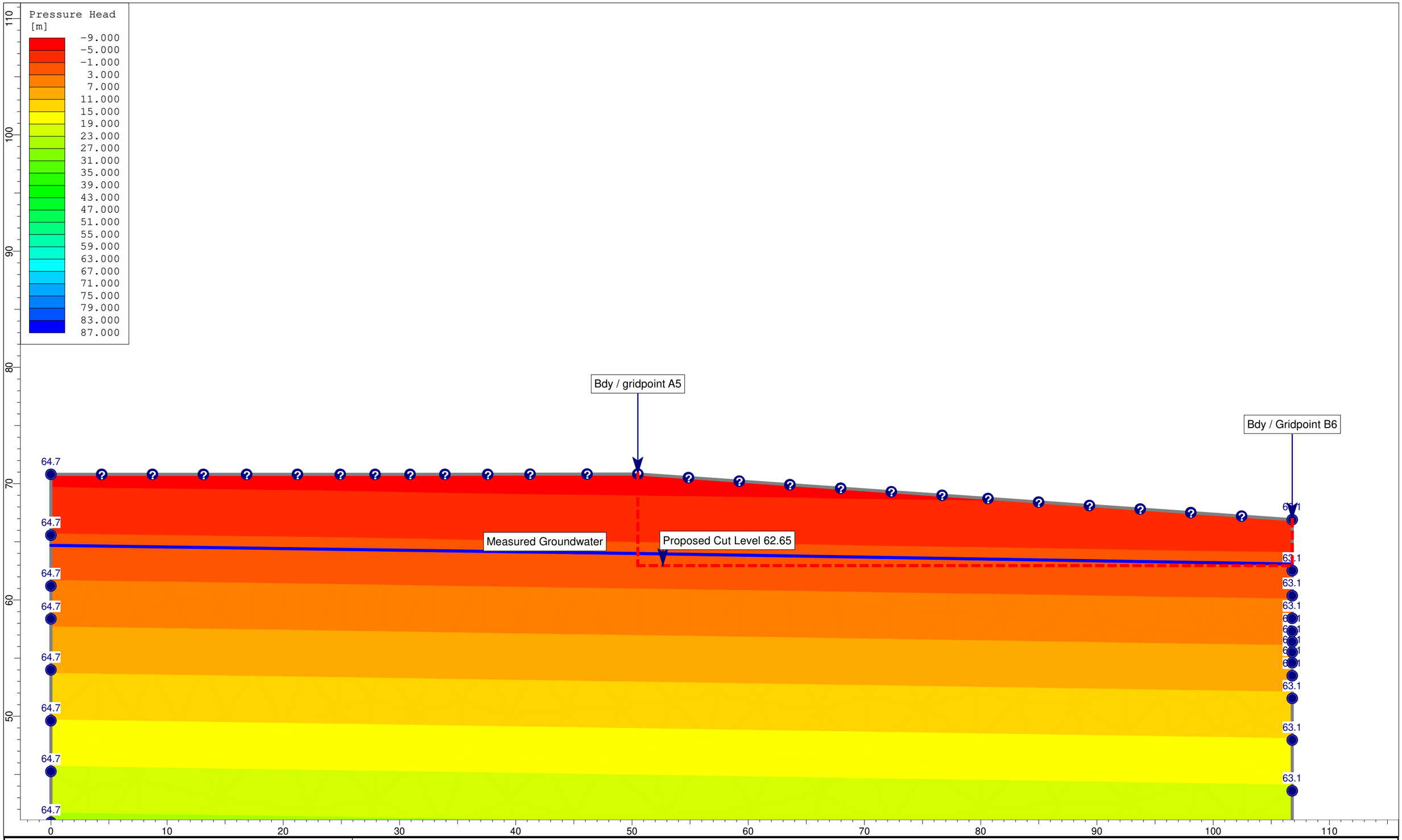
SLIDEINTERPRET 9.016

Project	538 Karangahape Road, Auckland City		
Group	20111 - C-C' Measured Groundwater	*Scenario*	Master Scenario
Drawn By	MC	*Company*	Soil & Rock Consultants
Date	Oct 2023	*Scale*	1:400



Soil&Rock Consultants — Your responsive & cost-effective engineers	*Project*	538 Karangahape Road, Auckland City	
	Group	20111 - C-C' Drawdown	*Scenario* Master Scenario
	Drawn By	MC	*Company* Soil & Rock Consultants
	Date	Oct 2023	*Scale* 1:150

SLIDEINTERPRET 9.016



Soil&Rock Consultants

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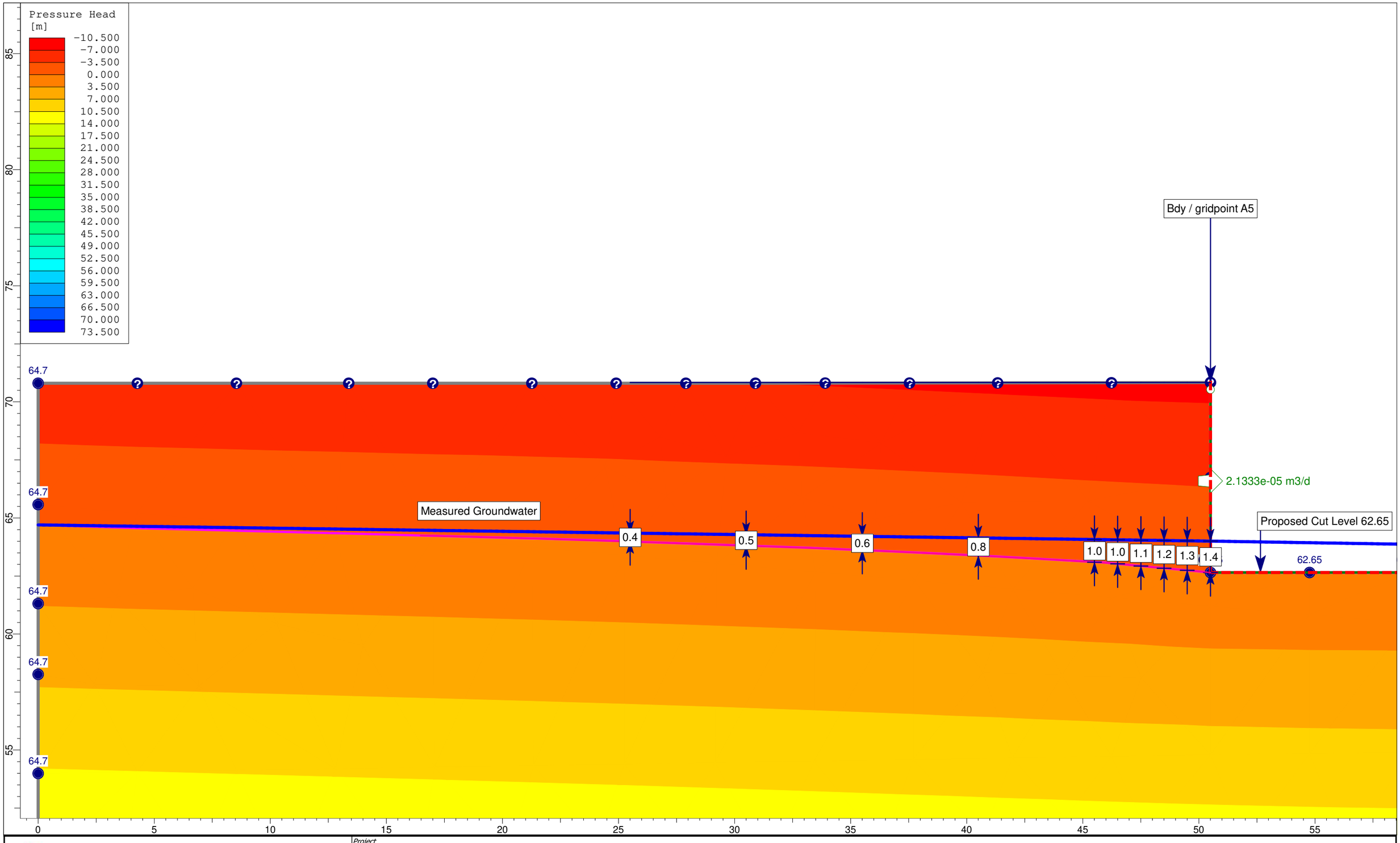
SLIDEINTERPRET 9.016

Project	538 Karangahape Road, Auckland City		
Group	20111 - D-D' Measured Groundwater	*Scenario*	Master Scenario
Drawn By	MC	*Company*	Soil & Rock Consultants
Date	Nov 2023	*Scale*	1:300



Soil&Rock Consultants — Your responsive & cost-effective engineers	*Project*	538 Karangahape Road, Auckland City	
	Group	D-D' Drawdown	*Scenario* Master Scenario
	Drawn By	MC	*Company* Soil & Rock Consultants
	Date	Nov 2023	*Scale* 1:150

SLIDEINTERPRET 9.016

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Appendix D

WALLAP Outputs

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side		Soil types Right side	
1	68.40	2	WWGS	2	WWGS
2	57.20	3	Transitional WG	3	Transitional WG
3	54.60	4	Waitemata Group Rock	4	Waitemata Group Rock

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Fill	18.00	9000	0.500	OC (0.200)	0.285 (1.238)	4.288 (5.694)	5.000d
2	WWGS	18.00	24000	0.500	OC (0.200)	0.285 (1.238)	4.288 (5.694)	7.000d
3	Transition-al WG	19.00	45000	0.470	OC (0.200)	0.262 (1.182)	4.845 (6.154)	12.00d
4	Waitemata Group Rock	19.00	150000	0.412	OC (0.200)	0.219 (1.075)	6.289 (7.279)	30.00d

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	0.631	0.00	30.00	0.464	0.00
2	WWGS	30.00	0.631	0.00	30.00	0.464	0.00
3	Transitional WG	32.00	0.625	0.00	32.00	0.459	0.00
4	Waitemata Group Rock	36.00	0.613	0.00	36.00	0.447	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	65.60	65.60

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	65.60	65.60	0.0	1	62.65	62.65	0.0

WALL PROPERTIES

Type of structure = Soldier Pile Wall
Soldier Pile width = 0.75 m
Soldier Pile spacing = 1.50 m
Passive mobilisation factor = 3.00
Elevation of toe of wall = 57.40
Maximum finite element length = 0.80 m
Youngs modulus of wall E = 3.1685E+07 kN/m2
Moment of inertia of wall I = 0.010350 m4/m run
= 0.015525 m4 per pile
E.I = 327940 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	66.84	1.00	0.150000	3.169E+07	0.10	0.00	0	Strut	No	R
2	70.00	1.00	0.020400	2.000E+08	0.10	0.00	0	Strut	No	R
3	70.85	1.00	0.150000	3.169E+07	0.10	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	68.40	0.00(L)	50.00	1.00	164.00	=	N/A	N/A
2	68.40	1.00(L)	50.00	20.00	8.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 1.0000E-04 kN.m2/m run Yield moment not defined No adjustments to wall displacements
2	Apply surcharge no.1 at elevation 68.40 No analysis at this stage
3	Apply surcharge no.2 at elevation 68.40 No analysis at this stage
4	Change EI of wall to 327940 kN.m2/m run Yield moment not defined Reset wall displacements to zero at this stage
5	Install strut or anchor no.2 at elevation 70.00
6	Apply water pressure profile no.1 No analysis at this stage
7	Excavate to elevation 66.04 on RIGHT side Toe of berm at elevation 62.65 Width of top of berm = 4.00 Width of toe of berm = 7.40
8	Change EI of wall to 229558 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value
9	Install strut or anchor no.1 at elevation 66.84
10	Excavate to elevation 62.65 on RIGHT side
11	Remove strut or anchor no.2 at elevation 70.00
12	Install strut or anchor no.3 at elevation 70.85
13	Change EI of wall to 163970 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value

FACTORS OF SAFETY and ANALYSIS OPTIONS

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

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

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 0 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 m

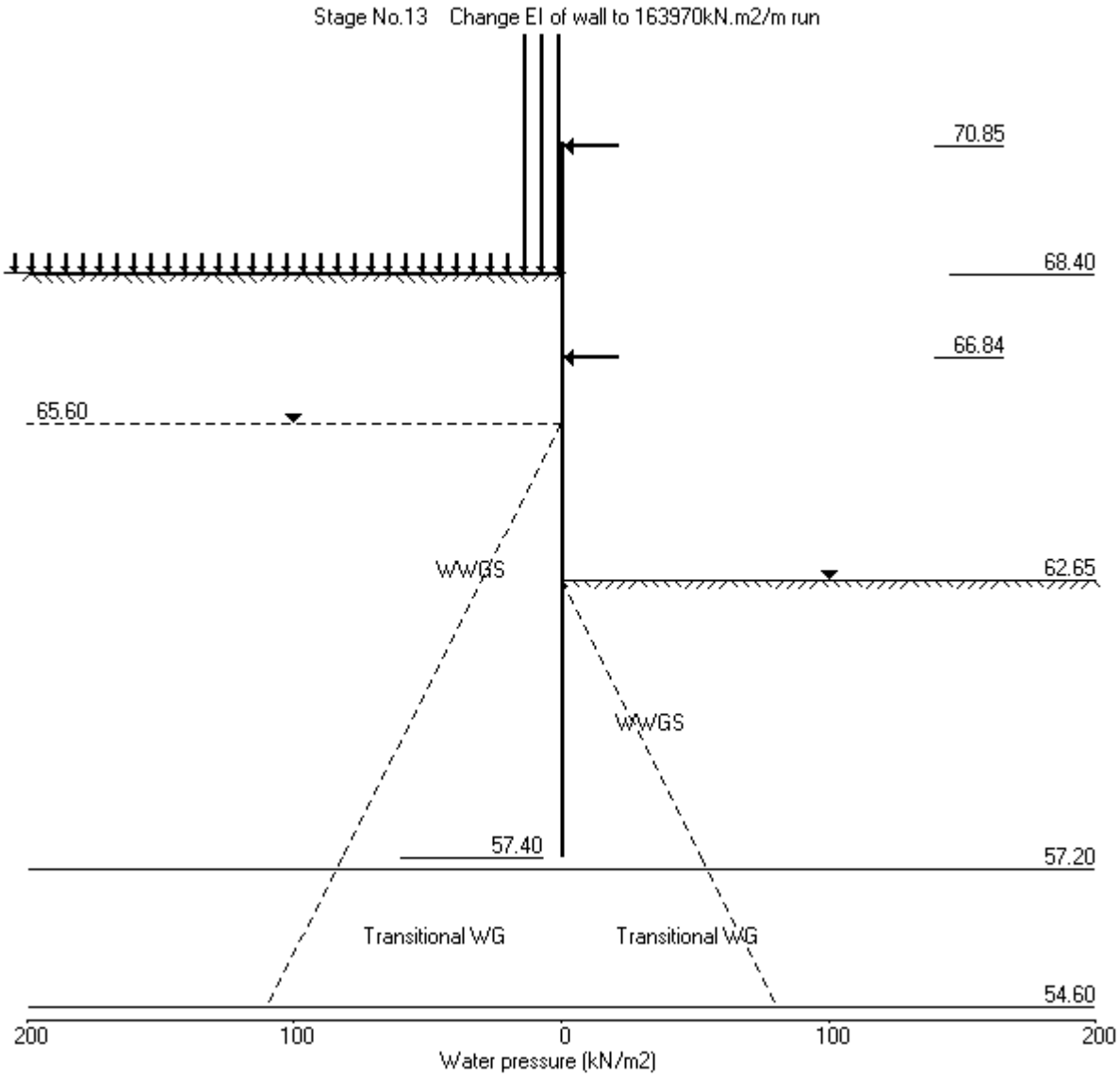
Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

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

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 1.0000E-04kN.m2/m	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 68.40	No	No	No
3	Apply surcharge no.2 at elev. 68.40	No	No	No
4	Change EI of wall to 327940kN.m2/m run	No	No	No
5	Install prop no.2 at elev. 70.00	No	No	No
6	Apply water pressure profile no.1	No	No	No
7	Excav. to elev. 66.04 on RIGHT side	No	No	No
8	Change EI of wall to 229558kN.m2/m run	No	No	No
9	Install prop no.1 at elev. 66.84	No	No	No
10	Excav. to elev. 62.65 on RIGHT side	No	No	No
11	Remove prop no.2 at elev. 70.00	Yes	Yes	Yes
12	Install prop no.3 at elev. 70.85	Yes	Yes	Yes
13	Change EI of wall to 163970kN.m2/m run	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m


Stage No.13 Change EI of wall to 163970kN.m2/m run
70.85
68.40
66.84
65.60
WWGS
62.65
WWGS
57.40
57.20
Transitional WG
Transitional WG
54.60
200
100
0
100
200
Water pressure (kN/m2)

Units: kN,m

Stage No. 1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements

STABILITY ANALYSIS of Soldier Pile 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. = 57.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	68.40	68.40	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

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	EI of wall kN.m2/m
1	70.85	0.00	0.000	1.43E-19	0.0	0.0		0
2	70.43	0.00	0.000	1.43E-19	0.0	-0.0		0
3	70.00	0.00	0.000	1.43E-19	0.0	0.0		0
4	69.20	0.00	0.000	1.43E-19	0.0	-0.0		0
5	68.40	0.00	-0.000	1.43E-19	0.0	-0.0		0
6	67.62	0.00	0.000	-2.87E-19	0.0	0.0		0
7	66.84	0.00	-0.000	1.00E-18	0.0	-0.0		0
8	66.04	0.00	0.000	-3.78E-18	0.0	0.0		0
9	65.60	0.00	-0.000	1.11E-17	0.0	-0.0		0
10	64.80	0.00	0.000	-9.54E-16	0.0	0.0		0
11	64.00	0.00	0.000	2.13E-16	0.0	-0.0		0
12	63.33	0.00	0.000	9.39E-16	0.0	0.0		0
13	62.65	0.00	-0.000	2.87E-16	0.0	-0.0		0
14	62.13	0.00	0.000	-9.23E-16	0.0	0.0		0
15	61.60	0.00	0.000	-4.61E-15	0.0	0.0		0
16	60.80	0.00	0.000	2.97E-16	0.0	-0.0		0
17	60.00	0.00	0.000	-3.22E-17	0.0	0.0		0
18	59.20	0.00	0.000	-4.52E-15	0.0	-0.0		0
19	58.40	-0.00	0.000	7.07E-16	-0.0	-0.0		0
20	57.90	0.00	0.000	4.77E-15	-0.0	-0.0		0
21	57.40	0.00	0.000	8.07E-15	-0.0	-0.0		---

(continued)

Stage No.1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	0.00	0.00a	107020
6	67.62	0.00	14.04	0.00	100.06	7.02	7.02	19278
7	66.84	0.00	28.08	0.00	160.26	14.04	14.04	23397
8	66.04	0.00	42.48	3.45	222.00	21.24	21.24	20618
9	65.60	0.00	50.40	5.71	255.96	25.20	25.20	36198
10	64.80	8.00	56.80	7.53	283.40	28.40	36.40	10122
11	64.00	16.00	63.20	9.36	310.84	31.60	47.60	10122
12	63.33	22.75	68.60	10.90	334.00	34.30	57.05	10122
13	62.65	29.50	74.00	12.44	357.15	37.00	66.50	150210
14	62.13	34.75	78.20	13.64	375.16	39.10	73.85	4172
15	61.60	40.00	82.40	14.83	393.17	41.20	81.20	4172
16	60.80	48.00	88.80	16.66	420.61	44.40	92.40	4172
17	60.00	56.00	95.20	18.49	448.05	47.60	103.60	4172
18	59.20	64.00	101.60	20.31	475.49	50.80	114.80	4172
19	58.40	72.00	108.00	22.14	502.93	54.00	126.00	4172
20	57.90	77.00	112.00	23.28	520.08	56.00	133.00	4172
21	57.40	82.00	116.00	24.42	537.23	58.00	140.00	4172

RIGHT side

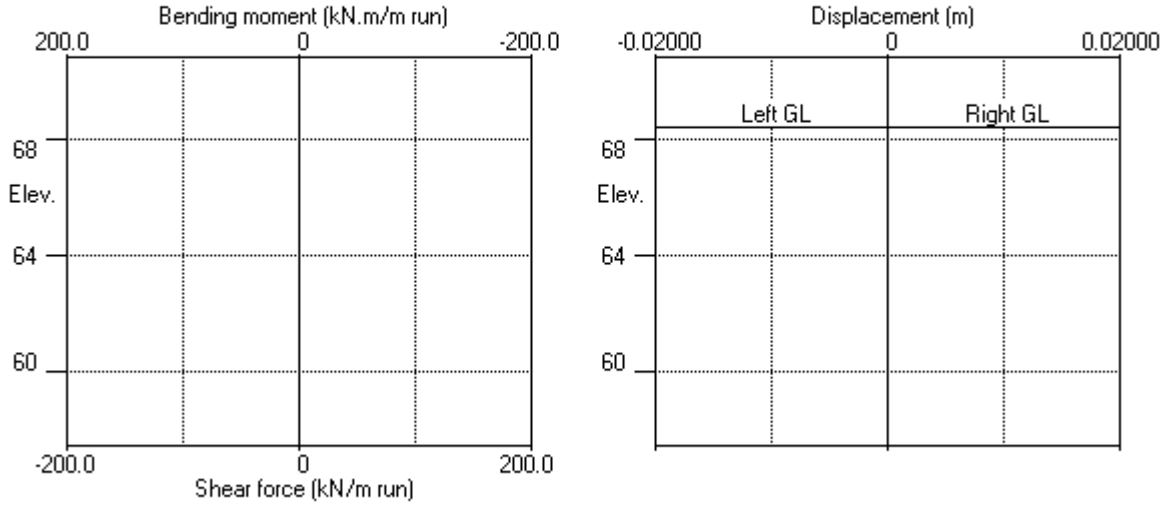
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	0.00	0.00a	107020
6	67.62	0.00	14.04	0.00	100.06	7.02	7.02	19278
7	66.84	0.00	28.08	0.00	160.26	14.04	14.04	23397
8	66.04	0.00	42.48	3.45	222.00	21.24	21.24	20618
9	65.60	0.00	50.40	5.71	255.96	25.20	25.20	36198
10	64.80	8.00	56.80	7.53	283.40	28.40	36.40	10122
11	64.00	16.00	63.20	9.36	310.84	31.60	47.60	10122
12	63.33	22.75	68.60	10.90	334.00	34.30	57.05	10122
13	62.65	29.50	74.00	12.44	357.15	37.00	66.50	150210
14	62.13	34.75	78.20	13.64	375.16	39.10	73.85	4172
15	61.60	40.00	82.40	14.83	393.17	41.20	81.20	4172
16	60.80	48.00	88.80	16.66	420.61	44.40	92.40	4172
17	60.00	56.00	95.20	18.49	448.05	47.60	103.60	4172
18	59.20	64.00	101.60	20.31	475.49	50.80	114.80	4172
19	58.40	72.00	108.00	22.14	502.93	54.00	126.00	4172
20	57.90	77.00	112.00	23.28	520.08	56.00	133.00	4172
21	57.40	82.00	116.00	24.42	537.23	58.00	140.00	4172

(continued)

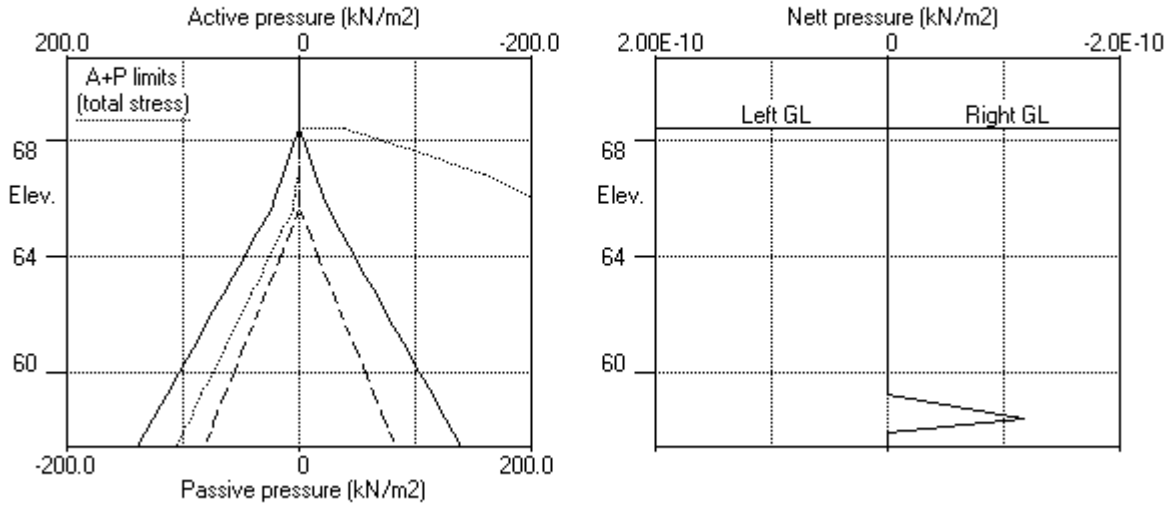
Stage No.1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements
Note: 0.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.1 Change EI of wall to 1.0000E-04kN.m2/m run



Stage No.1 Change EI of wall to 1.0000E-04kN.m2/m run



Units: kN,m

Stage No. 4 Change EI of wall to 327940 kN.m2/m run
Yield moment not defined
Reset wall displacements to zero at this stage

STABILITY ANALYSIS of Soldier Pile 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. = 57.40** Factor of Safety	**FoS for toe elev. = 57.40** Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
4	68.40	68.40	Cant.	3.081	59.12	65.82	2.58	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 4

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	EI of wall kN.m2/m
1	70.85	0.00	0.007	7.99E-04	0.0	0.0		327940
2	70.43	0.00	0.007	7.99E-04	0.0	0.0		327940
3	70.00	0.00	0.007	7.99E-04	0.0	0.0		327940
4	69.20	0.00	0.006	7.99E-04	0.0	-0.0		327940
5	68.40	0.00	0.005	7.99E-04	0.0	-0.0		327940
		16.34	0.005	7.99E-04	0.0	-0.0		
6	67.62	10.89	0.005	7.94E-04	10.6	4.2		327940
7	66.84	-0.03	0.004	7.72E-04	14.9	14.4		327940
8	66.04	-7.40	0.003	7.21E-04	11.9	26.7		327940
9	65.60	-7.31	0.003	6.83E-04	8.6	31.1		327940
10	64.80	-6.28	0.003	6.01E-04	3.2	35.4		327940
11	64.00	-4.78	0.002	5.15E-04	-1.2	35.7		327940
12	63.33	-3.47	0.002	4.43E-04	-4.0	33.7		327940
13	62.65	-2.25	0.002	3.78E-04	-5.9	30.1		327940
14	62.13	-1.39	0.001	3.32E-04	-6.9	26.6		327940
15	61.60	-0.61	0.001	2.93E-04	-7.4	22.8		327940
16	60.80	0.41	0.001	2.45E-04	-7.5	16.6		327940
17	60.00	1.30	0.001	2.11E-04	-6.8	10.7		327940
18	59.20	2.12	0.001	1.92E-04	-5.4	5.6		327940
19	58.40	2.91	0.000	1.83E-04	-3.4	1.9		327940
20	57.90	3.42	0.000	1.81E-04	-1.8	0.5		327940
21	57.40	3.94	0.000	1.80E-04	-0.0	-0.0		---

(continued)

Stage No.4 Change EI of wall to 327940 kN.m2/m run
Yield moment not defined
Reset wall displacements to zero at this stage

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	164.00	38.11	743.04	38.11	38.11a	4163
6	67.62	0.00	160.41	37.08	727.65	37.08	37.08a	4163
7	66.84	0.00	137.81	30.64	630.74	30.64	30.64a	4163
8	66.04	0.00	125.95	27.26	579.90	27.98	27.98	4163
9	65.60	0.00	123.91	26.67	571.14	30.73	30.73	4163
10	64.80	8.00	117.29	24.78	542.75	32.82	40.82	4163
11	64.00	16.00	114.80	24.07	532.08	35.66	51.66	4163
12	63.33	22.75	86.10	15.89	409.03	38.32	61.07	4163
13	62.65	29.50	114.01	23.85	528.72	41.09	70.59	4163
14	62.13	34.75	94.48	18.28	444.95	43.28	78.03	4163
15	61.60	40.00	119.00	25.27	550.09	45.47	85.47	4163
16	60.80	48.00	107.74	22.06	501.83	48.80	96.80	4163
17	60.00	56.00	126.27	27.35	581.27	52.14	108.14	4163
18	59.20	64.00	130.57	28.57	599.71	55.48	119.48	4163
19	58.40	72.00	135.17	29.89	619.44	58.85	130.85	4163
20	57.90	77.00	138.17	30.74	632.30	60.98	137.98	4163
21	57.40	82.00	141.25	31.62	645.49	63.13	145.13	4163

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	21.77	21.77	4163
6	67.62	0.00	14.04	0.00	100.06	26.20	26.20	4163
7	66.84	0.00	28.08	0.00	160.26	30.67	30.67	4163
8	66.04	0.00	42.48	3.45	222.00	35.37	35.37	4163
9	65.60	0.00	50.40	5.71	255.96	38.04	38.04	4163
10	64.80	8.00	56.80	7.53	283.40	39.10	47.10	4163
11	64.00	16.00	63.20	9.36	310.84	40.44	56.44	4163
12	63.33	22.75	68.60	10.90	334.00	41.79	64.54	4163
13	62.65	29.50	74.00	12.44	357.15	43.34	72.84	4163
14	62.13	34.75	78.20	13.64	375.16	44.66	79.41	4163
15	61.60	40.00	82.40	14.83	393.17	46.08	86.08	4163
16	60.80	48.00	88.80	16.66	420.61	48.39	96.39	4163
17	60.00	56.00	95.20	18.49	448.05	50.83	106.83	4163
18	59.20	64.00	101.60	20.31	475.49	53.36	117.36	4163
19	58.40	72.00	108.00	22.14	502.93	55.94	127.94	4163
20	57.90	77.00	112.00	23.28	520.08	57.56	134.56	4163
21	57.40	82.00	116.00	24.42	537.23	59.18	141.18	4163

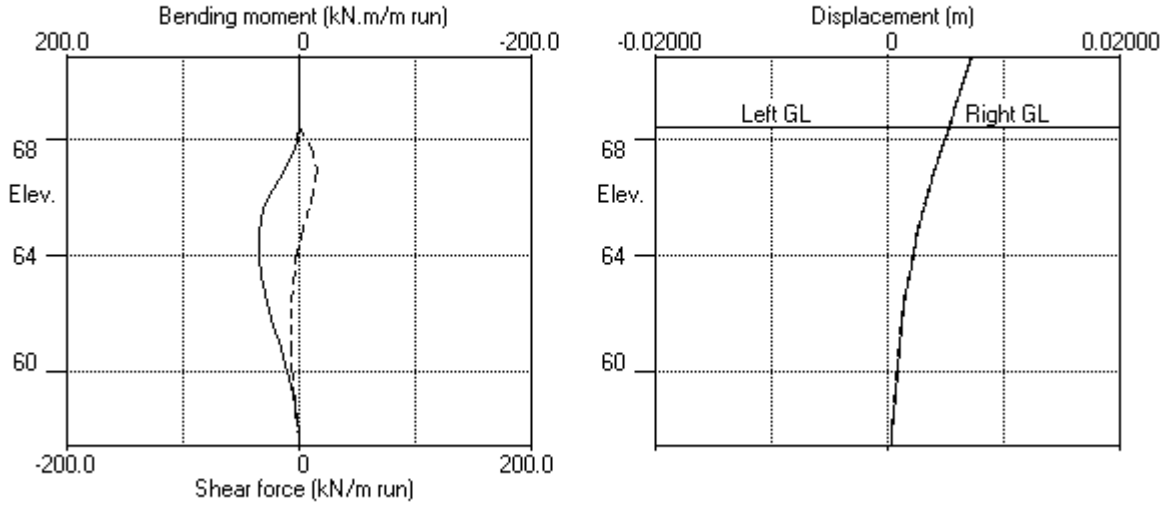
(continued)

Stage No.4 Change EI of wall to 327940 kN.m2/m run
Yield moment not defined
Reset wall displacements to zero at this stage

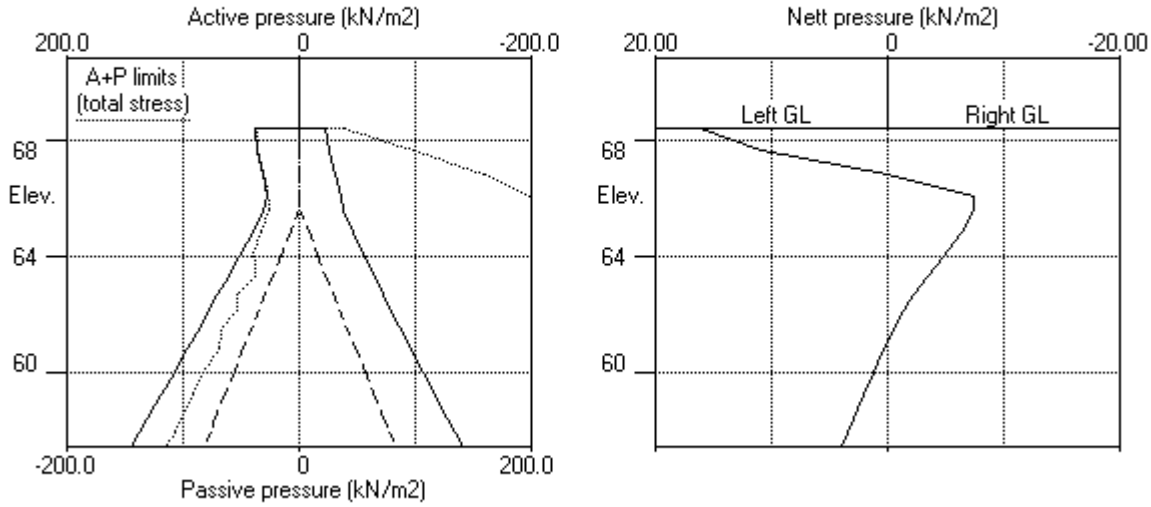
Note: 30.64a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.4 Change EI of wall to 327940kN.m2/m run



Stage No.4 Change EI of wall to 327940kN.m2/m run



Units: kN,m

Stage No. 7 Excavate to elevation 66.04 on RIGHT side
Toe of berm at elevation 62.65
Width of top of berm = 4.00
Width of toe of berm = 7.40

STABILITY ANALYSIS of Soldier Pile 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. = 57.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
7	68.40	66.04	70.00	1.738	n/a	59.56	6.48	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 4

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	70.85	0.00	0.006	-7.99E-04	0.0	0.0		327940
2	70.43	0.00	0.006	-7.99E-04	0.0	0.0		327940
3	70.00	0.00	0.007	-7.99E-04	0.0	0.0	-41.0	327940
		0.00	0.007	-7.99E-04	-41.0	-0.0		
4	69.20	0.00	0.007	-7.59E-04	-41.0	-32.8		327940
5	68.40	0.00	0.008	-6.39E-04	-41.0	-65.5		327940
		38.11	0.008	-6.39E-04	-41.0	-65.5		
6	67.62	37.08	0.008	-4.59E-04	-11.6	-86.2		327940
7	66.84	30.64	0.008	-2.55E-04	14.8	-84.9		327940
8	66.04	27.26	0.009	-7.59E-05	37.9	-62.4		327940
		-10.52	0.009	-7.59E-05	37.9	-62.4		
9	65.60	-14.60	0.009	-2.59E-06	32.4	-46.9		327940
10	64.80	-12.76	0.009	8.61E-05	21.5	-25.8		327940
		-12.32	0.009	8.61E-05	21.5	-25.8		
11	64.00	-9.72	0.008	1.31E-04	12.7	-11.0		327940
12	63.33	-7.73	0.008	1.46E-04	6.8	-3.5		327940
13	62.65	-2.32	0.008	1.50E-04	3.4	-0.4		327940
14	62.13	-2.00	0.008	1.49E-04	2.2	1.0		327940
15	61.60	-1.66	0.008	1.47E-04	1.3	1.9		327940
16	60.80	-1.14	0.008	1.42E-04	0.2	2.3		327940
17	60.00	-0.63	0.008	1.36E-04	-0.6	2.0		327940
18	59.20	-0.12	0.008	1.33E-04	-0.9	1.3		327940
19	58.40	0.40	0.008	1.30E-04	-0.7	0.5		327940
20	57.90	0.74	0.008	1.30E-04	-0.5	0.1		327940
21	57.40	1.10	0.008	1.30E-04	0.0	-0.0		---

At elev. 70.00 Prop force = 41.0 kN/m run

(continued)

Stage No.7 Excavate to elevation 66.04 on RIGHT side
Toe of berm at elevation 62.65
Width of top of berm = 4.00
Width of toe of berm = 7.40

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	164.00	38.11	743.04	38.11	38.11a	2354
6	67.62	0.00	160.41	37.08	727.65	37.08	37.08a	2354
7	66.84	0.00	137.81	30.64	630.74	30.64	30.64a	2354
8	66.04	0.00	125.95	27.26	579.90	27.26	27.26a	2354
9	65.60	0.00	123.91	26.67	571.14	26.67	26.67a	2354
10	64.80	8.00	117.29	24.78	542.75	24.78	32.78a	2354
11	64.00	16.00	114.80	24.07	532.08	24.07	40.07a	2354
12	63.33	22.75	86.10	15.89	409.03	22.93	45.68	2354
13	62.65	29.50	114.01	23.85	528.72	25.29	54.79	2354
14	62.13	34.75	94.48	18.28	444.95	27.22	61.97	2354
15	61.60	40.00	119.00	25.27	550.09	29.20	69.20	2354
16	60.80	48.00	107.74	22.06	501.83	32.31	80.31	2354
17	60.00	56.00	126.27	27.35	581.27	35.48	91.48	2354
18	59.20	64.00	130.57	28.57	599.71	38.70	102.70	2354
19	58.40	72.00	135.17	29.89	619.44	41.96	113.96	2354
20	57.90	77.00	138.17	30.74	632.30	44.03	121.03	2354
21	57.40	82.00	141.25	31.62	645.49	46.12	128.12	2354

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	67.62	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	66.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	37.78	37.78	2531
9	65.60	0.00	7.92	0.00	73.82	41.27	41.27	2531
		0.00	7.92	0.00	62.80b	41.27	41.27	2531
10	64.80	0.00	22.32	0.00	115.34b	45.54	45.54	2531
		0.00	22.32	0.00	45.10b	45.10	45.10p	2531
11	64.00	0.00	36.74	1.81	65.66b	49.79	49.79	2531
		0.00	36.74	1.81	64.00b	49.79	49.79	2531
12	63.33	0.00	48.91	5.28	80.93b	53.42	53.42	2531
		0.00	48.91	5.28	84.66b	53.42	53.42	2531
13	62.65	0.00	61.10	8.76	102.39b	57.11	57.11	2531
		0.00	61.10	8.76	90.23b	57.11	57.11	2531
14	62.13	5.25	65.35	9.97	95.67b	58.72	63.97	2531
		5.25	65.35	9.97	108.10b	58.72	63.97	2531
15	61.60	10.50	69.61	11.19	114.26b	60.37	70.87	2531
		10.50	69.61	11.19	128.95b	60.37	70.87	2531

(continued)

Stage No.7 Excavate to elevation 66.04 on RIGHT side
Toe of berm at elevation 62.65
Width of top of berm = 4.00
Width of toe of berm = 7.40

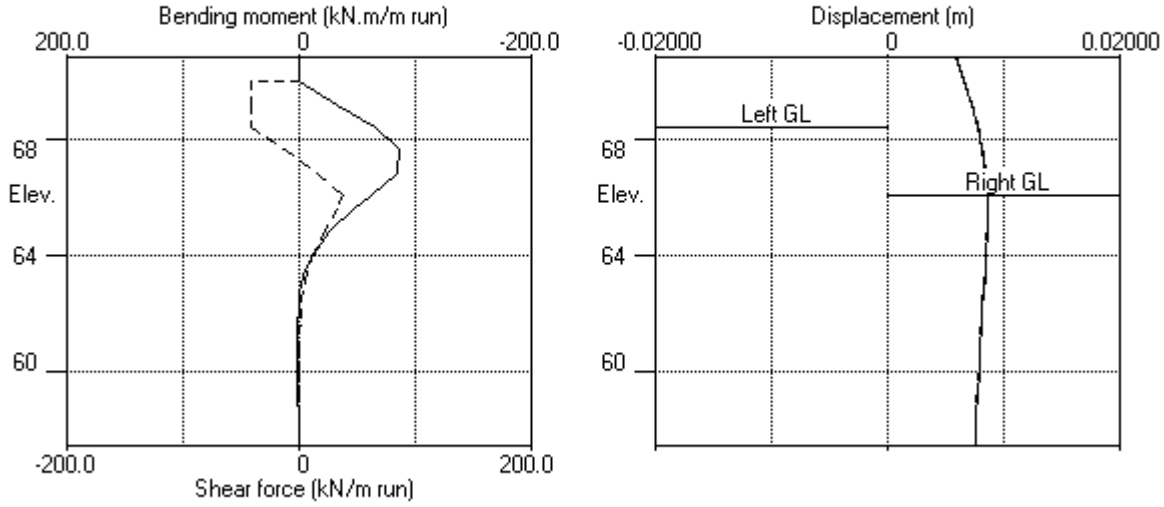
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
16	60.80	18.50	76.12	13.04	139.59b	62.95	81.45	2531
		18.50	76.12	13.04	156.28b	62.95	81.45	2531
17	60.00	26.50	82.67	14.91	168.26b	65.61	92.11	2531
		26.50	82.67	14.91	183.84b	65.61	92.11	2531
18	59.20	34.50	89.25	16.79	197.00b	68.32	102.82	2531
		34.50	89.25	16.79	211.62b	68.32	102.82	2531
19	58.40	42.50	95.87	18.68	225.84b	71.06	113.56	2531
		42.50	95.87	18.68	237.16b	71.06	113.56	2531
20	57.90	47.50	100.03	19.86	246.53b	72.79	120.29	2531
		47.50	100.03	19.86	254.84b	72.79	120.29	2531
21	57.40	52.50	104.20	21.05	264.56b	74.52	127.02	2531

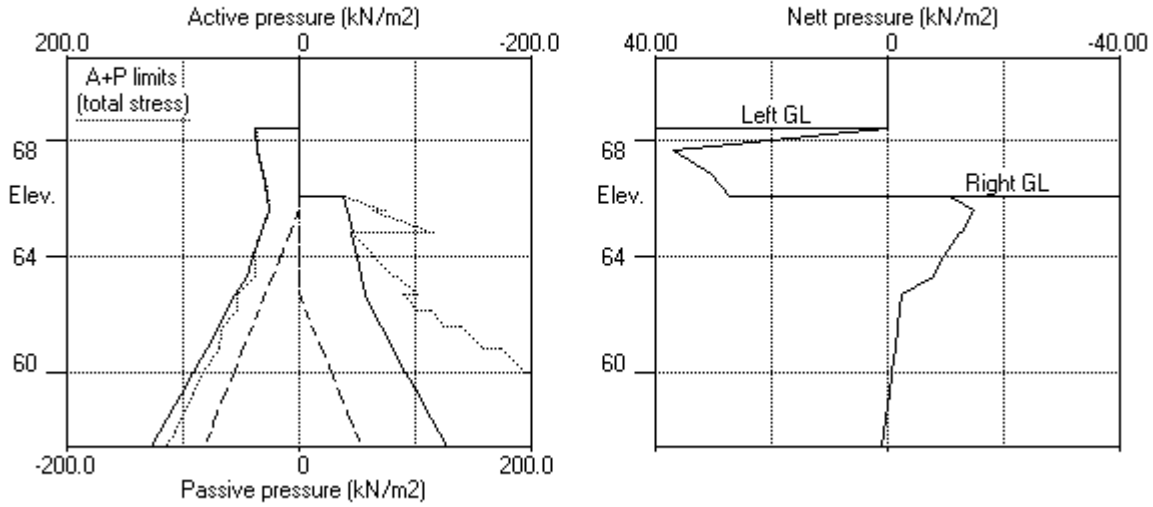
Note: 40.07a Soil pressure at active limit
45.10p Soil pressure at passive limit
264.56b Passive limit reduced because of berm

Units: kN,m

Stage No.7 Excav. to elev. 66.04 on RIGHT side



Stage No.7 Excav. to elev. 66.04 on RIGHT side



Units: kN,m

Stage No. 8 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 57.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
8	68.40	66.04	70.00	1.738	n/a	59.56	6.48	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 4

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	70.85	0.00	0.006	-9.80E-04	0.0	0.0		229558
2	70.43	0.00	0.006	-9.80E-04	0.0	0.0		229558
3	70.00	0.00	0.007	-9.80E-04	0.0	0.0	-39.2	229558
		0.00	0.007	-9.80E-04	-39.2	-0.0		
4	69.20	0.00	0.007	-9.26E-04	-39.2	-31.7		229558
5	68.40	0.00	0.008	-7.62E-04	-39.2	-63.3		229558
		38.11	0.008	-7.62E-04	-39.2	-63.3		
6	67.62	37.08	0.008	-5.16E-04	-9.8	-83.0		229558
7	66.84	30.64	0.009	-2.42E-04	16.6	-80.6		229558
8	66.04	27.26	0.009	-7.98E-06	39.7	-57.0		229558
		-12.60	0.009	-7.98E-06	39.7	-57.0		
9	65.60	-16.46	0.009	8.27E-05	33.3	-41.1		229558
10	64.80	-14.12	0.009	1.82E-04	21.1	-19.8		229558
		-12.32	0.009	1.82E-04	21.1	-19.8		
11	64.00	-10.58	0.009	2.20E-04	11.9	-5.2		229558
12	63.33	-8.51	0.008	2.20E-04	5.5	1.7		229558
13	62.65	-2.63	0.008	2.07E-04	1.7	4.1		229558
14	62.13	-2.02	0.008	1.94E-04	0.5	4.8		229558
15	61.60	-1.51	0.008	1.81E-04	-0.4	5.0		229558
16	60.80	-0.83	0.008	1.62E-04	-1.3	4.4		229558
17	60.00	-0.22	0.008	1.47E-04	-1.8	3.2		229558
18	59.20	0.33	0.008	1.37E-04	-1.7	1.9		229558
19	58.40	0.88	0.008	1.32E-04	-1.2	0.7		229558
20	57.90	1.23	0.008	1.31E-04	-0.7	0.2		229558
21	57.40	1.59	0.007	1.31E-04	0.0	-0.0		---

At elev. 70.00 Prop force = 39.2 kN/m run

(continued)

Stage No.8 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	164.00	38.11	743.04	38.11	38.11a	3899
6	67.62	0.00	160.41	37.08	727.65	37.08	37.08a	3899
7	66.84	0.00	137.81	30.64	630.74	30.64	30.64a	3899
8	66.04	0.00	125.95	27.26	579.90	27.26	27.26a	3899
9	65.60	0.00	123.91	26.67	571.14	26.67	26.67a	3899
10	64.80	8.00	117.29	24.78	542.75	24.78	32.78a	3899
11	64.00	16.00	114.80	24.07	532.08	24.07	40.07a	3899
12	63.33	22.75	86.10	15.89	409.03	22.65	45.40	3899
13	62.65	29.50	114.01	23.85	528.72	25.17	54.67	3899
14	62.13	34.75	94.48	18.28	444.95	27.21	61.96	3899
15	61.60	40.00	119.00	25.27	550.09	29.28	69.28	4005
16	60.80	48.00	107.74	22.06	501.83	32.47	80.47	4005
17	60.00	56.00	126.27	27.35	581.27	35.68	91.68	4005
18	59.20	64.00	130.57	28.57	599.71	38.92	102.92	4005
19	58.40	72.00	135.17	29.89	619.44	42.20	114.20	4005
20	57.90	77.00	138.17	30.74	632.30	44.27	121.27	4005
21	57.40	82.00	141.25	31.62	645.49	46.36	128.36	4005

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	67.62	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	66.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	6665
9	65.60	0.00	7.92	0.00	73.82	43.13	43.13	6665
		0.00	7.92	0.00	62.80b	43.13	43.13	6665
10	64.80	0.00	22.32	0.00	115.34b	46.90	46.90	6665
		0.00	22.32	0.00	45.10b	45.10	45.10p	6665
11	64.00	0.00	36.74	1.81	65.66b	50.65	50.65	6665
		0.00	36.74	1.81	64.00b	50.65	50.65	6665
12	63.33	0.00	48.91	5.28	80.93b	53.91	53.91	6665
		0.00	48.91	5.28	84.66b	53.91	53.91	6665
13	62.65	0.00	61.10	8.76	102.39b	57.30	57.30	6665
		0.00	61.10	8.76	90.23b	57.30	57.30	6665
14	62.13	5.25	65.35	9.97	95.67b	58.73	63.98	6665
		5.25	65.35	9.97	108.10b	58.73	63.98	6665
15	61.60	10.50	69.61	11.19	114.26b	60.29	70.79	4005
		10.50	69.61	11.19	128.95b	60.29	70.79	4005
16	60.80	18.50	76.12	13.04	139.59b	62.79	81.29	4005
		18.50	76.12	13.04	156.28b	62.79	81.29	4005

(continued)

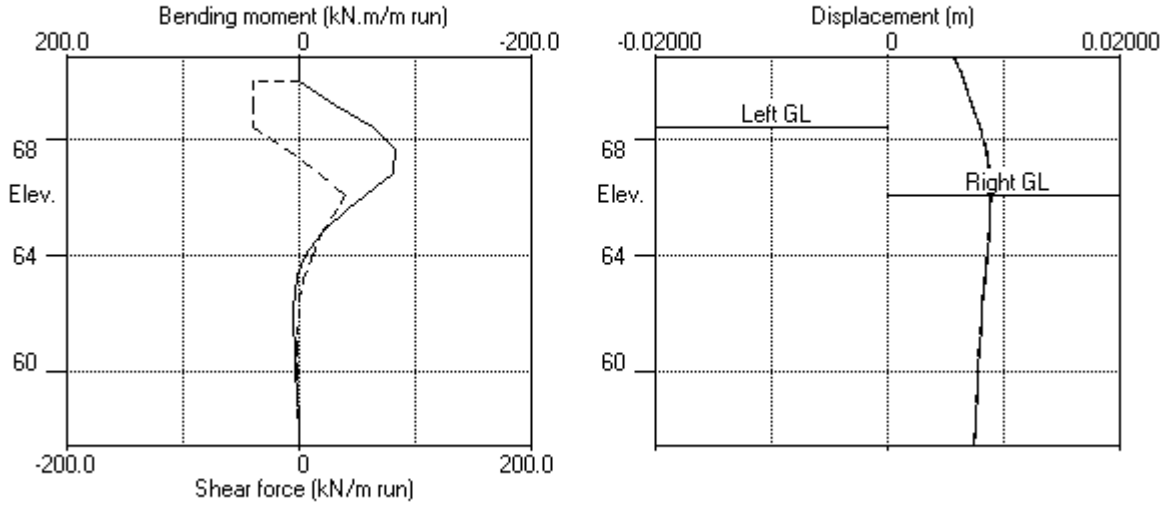
Stage No.8 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
17	60.00	26.50	82.67	14.91	168.26b	65.40	91.90	4005
		26.50	82.67	14.91	183.84b	65.40	91.90	4005
18	59.20	34.50	89.25	16.79	197.00b	68.09	102.59	4005
		34.50	89.25	16.79	211.62b	68.09	102.59	4005
19	58.40	42.50	95.87	18.68	225.84b	70.83	113.33	4005
		42.50	95.87	18.68	237.16b	70.83	113.33	4005
20	57.90	47.50	100.03	19.86	246.53b	72.55	120.05	4005
		47.50	100.03	19.86	254.84b	72.55	120.05	4005
21	57.40	52.50	104.20	21.05	264.56b	74.28	126.78	4005

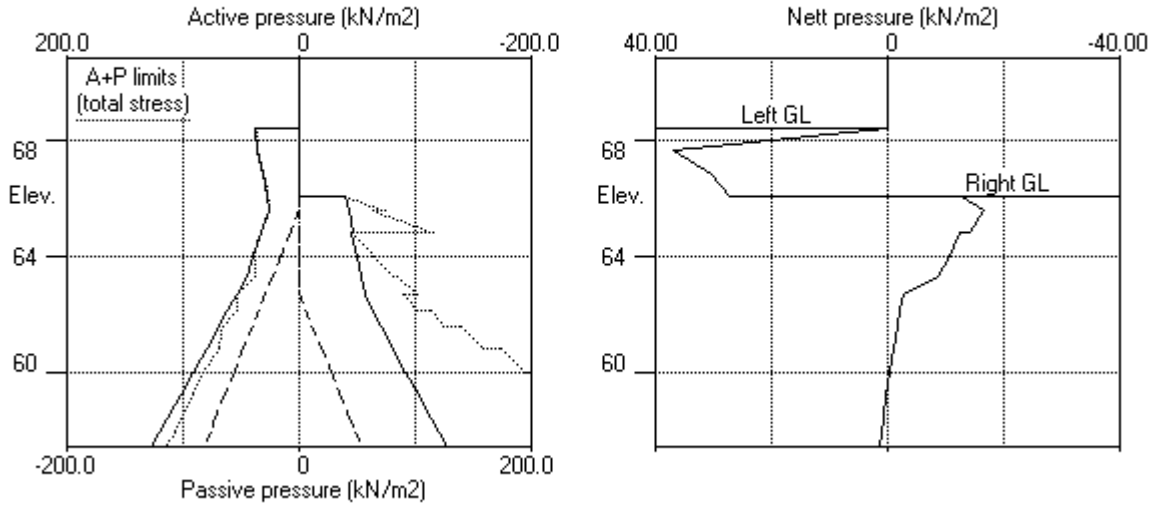
Note: 40.07a Soil pressure at active limit
45.10p Soil pressure at passive limit
264.56b Passive limit reduced because of berm

Units: kN,m

Stage No.8 Change EI of wall to 229558kN.m2/m run



Stage No.8 Change EI of wall to 229558kN.m2/m run



Units: kN,m

Stage No. 10 Excavate to elevation 62.65 on RIGHT side

STABILITY ANALYSIS of Soldier Pile 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. = 57.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr -ation	Direction of failure
10	68.40	62.65		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 4

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	70.85	0.00	0.003	-1.33E-03	0.0	0.0		229558
2	70.43	0.00	0.004	-1.33E-03	0.0	0.0		229558
3	70.00	0.00	0.004	-1.33E-03	0.0	0.0	0.0	229558
4	69.20	0.00	0.006	-1.33E-03	0.0	-0.3		229558
5	68.40	0.00	0.007	-1.33E-03	0.0	-0.7		229558
		52.62	0.007	-1.33E-03	0.0	-0.7		
6	67.62	45.73	0.008	-1.36E-03	38.4	14.7		229558
7	66.84	30.64	0.009	-1.48E-03	68.1	57.3	-174.2	229558
		30.64	0.009	-1.48E-03	-106.0	57.3		
8	66.04	27.26	0.010	-1.56E-03	-82.9	-17.2		229558
9	65.60	26.67	0.011	-1.49E-03	-71.0	-51.3		229558
10	64.80	32.78	0.012	-1.24E-03	-47.2	-99.3		229558
11	64.00	40.07	0.013	-8.59E-04	-18.1	-124.4		229558
12	63.33	38.64	0.013	-4.95E-04	8.5	-126.4		229558
13	62.65	53.35	0.013	-1.51E-04	39.5	-110.7		229558
		13.49	0.013	-1.51E-04	39.5	-110.7		
14	62.13	-10.09	0.013	7.40E-05	40.4	-89.0		229558
15	61.60	-7.20	0.013	2.51E-04	35.9	-68.1		229558
16	60.80	-12.41	0.013	4.41E-04	28.0	-42.2		229558
17	60.00	-8.80	0.013	5.53E-04	19.5	-23.4		229558
18	59.20	-9.08	0.012	6.11E-04	12.4	-10.6		229558
19	58.40	-7.58	0.012	6.34E-04	5.7	-2.4		229558
20	57.90	-5.73	0.011	6.37E-04	2.4	-0.5		229558
21	57.40	-3.87	0.011	6.37E-04	0.0	-0.0		---

At elev. 70.00 The prop is slack
At elev. 66.84 Prop force = 174.2 kN/m run

(continued)

Stage No.10 Excavate to elevation 62.65 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	164.00	38.11	743.04	52.62	52.62	10776
6	67.62	0.00	160.41	37.08	727.65	45.73	45.73	10776
7	66.84	0.00	137.81	30.64	630.74	30.64	30.64a	2674
8	66.04	0.00	125.95	27.26	579.90	27.26	27.26a	2674
9	65.60	0.00	123.91	26.67	571.14	26.67	26.67a	2674
10	64.80	8.00	117.29	24.78	542.75	24.78	32.78a	2674
11	64.00	16.00	114.80	24.07	532.08	24.07	40.07a	2674
12	63.33	22.75	86.10	15.89	409.03	15.89	38.64a	2674
13	62.65	29.50	114.01	23.85	528.72	23.85	53.35a	2674
14	62.13	34.75	94.48	18.28	444.95	18.28	53.03a	2674
15	61.60	40.00	119.00	25.27	550.09	25.27	65.27a	2674
16	60.80	48.00	107.74	22.06	501.83	22.06	70.06a	2674
17	60.00	56.00	126.27	27.35	581.27	27.35	83.35a	2674
18	59.20	64.00	130.57	28.57	599.71	28.57	92.57a	2674
19	58.40	72.00	135.17	29.89	619.44	31.51	103.51	2674
20	57.90	77.00	138.17	30.74	632.30	34.25	111.25	2674
21	57.40	82.00	141.25	31.62	645.49	37.02	119.02	2674

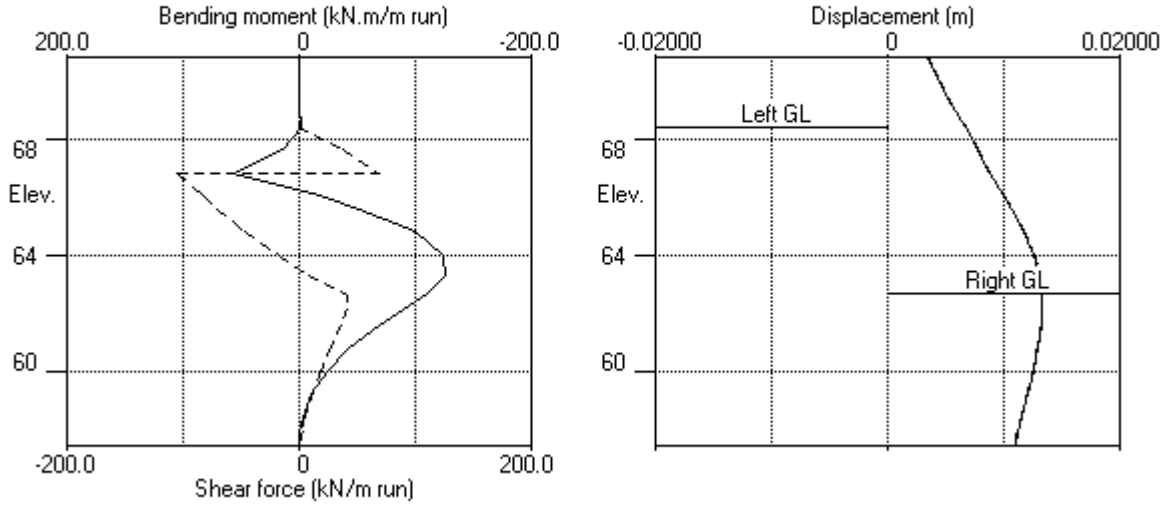
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	67.62	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	66.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	65.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	64.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	64.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	63.33	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	62.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	3282
14	62.13	5.25	4.20	0.00	57.87	57.87	63.12p	3282
15	61.60	10.50	8.41	0.00	75.90	61.97	72.47	3282
16	60.80	18.50	14.83	0.00	103.47	63.97	82.47	3282
17	60.00	26.50	21.30	0.00	131.19	65.65	92.15	3282
18	59.20	34.50	27.82	0.00	159.13	67.15	101.65	3282
19	58.40	42.50	34.40	1.14	187.36	68.59	111.09	3282
20	57.90	47.50	38.55	2.33	205.16	69.48	116.98	3282
21	57.40	52.50	42.73	3.52	223.09	70.38	122.88	3282

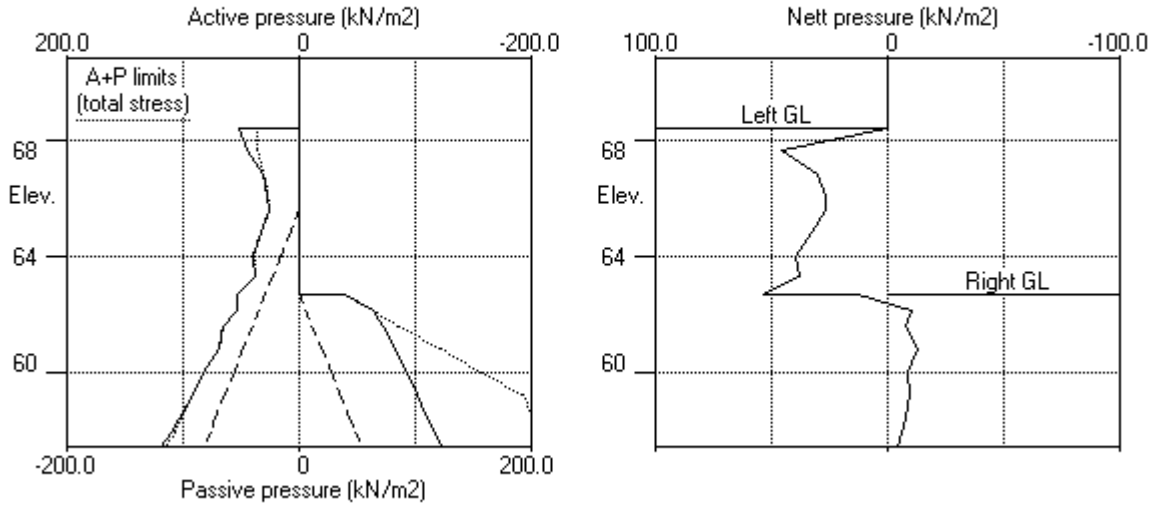
Note: 92.57a Soil pressure at active limit
63.12p Soil pressure at passive limit

Units: kN,m

Stage No.10 Excav. to elev. 62.65 on RIGHT side



Stage No.10 Excav. to elev. 62.65 on RIGHT side



Units: kN,m

Stage No. 13 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile 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. = 57.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
13	68.40	62.65		More than one prop.	No FoS calc.			

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 4

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	70.85	0.00	0.003	-1.52E-03	0.0	0.0	0.0	163970
2	70.43	0.00	0.003	-1.52E-03	0.0	0.0		163970
3	70.00	0.00	0.004	-1.52E-03	0.0	0.0		163970
4	69.20	0.00	0.005	-1.52E-03	0.0	-0.3		163970
5	68.40	0.00	0.006	-1.52E-03	0.0	-0.5		163970
		56.37	0.006	-1.52E-03	0.0	-0.5		
6	67.62	47.75	0.007	-1.56E-03	40.6	15.8		163970
7	66.84	30.64	0.009	-1.75E-03	71.2	60.3	-175.7	163970
		30.64	0.009	-1.75E-03	-104.5	60.3		
8	66.04	27.26	0.010	-1.87E-03	-81.3	-13.2		163970
9	65.60	26.67	0.011	-1.80E-03	-69.5	-46.6		163970
10	64.80	32.78	0.012	-1.47E-03	-45.7	-93.7		163970
11	64.00	40.07	0.013	-9.72E-04	-16.5	-117.8		163970
12	63.33	38.64	0.014	-4.97E-04	10.0	-119.0		163970
13	62.65	53.35	0.014	-5.50E-05	41.1	-102.5		163970
		13.49	0.014	-5.50E-05	41.1	-102.5		
14	62.13	-10.09	0.014	2.27E-04	42.0	-80.3		163970
15	61.60	-10.62	0.014	4.39E-04	36.5	-58.8		163970
16	60.80	-14.88	0.013	6.48E-04	26.3	-33.4		163970
17	60.00	-10.30	0.013	7.56E-04	16.3	-16.2		163970
18	59.20	-9.64	0.012	8.01E-04	8.3	-6.0		163970
19	58.40	-6.20	0.012	8.12E-04	2.0	-0.5		163970
20	57.90	-1.95	0.011	8.11E-04	-0.1	0.1		163970
21	57.40	2.27	0.011	8.11E-04	0.0	-0.0		---

At elev. 70.85 The prop is slack
At elev. 66.84 Prop force = 175.7 kN/m run

(continued)

Stage No.13 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	164.00	38.11	743.04	56.37	56.37	11414
6	67.62	0.00	160.41	37.08	727.65	47.75	47.75	11414
7	66.84	0.00	137.81	30.64	630.74	30.64	30.64a	3410
8	66.04	0.00	125.95	27.26	579.90	27.26	27.26a	3410
9	65.60	0.00	123.91	26.67	571.14	26.67	26.67a	3410
10	64.80	8.00	117.29	24.78	542.75	24.78	32.78a	3410
11	64.00	16.00	114.80	24.07	532.08	24.07	40.07a	3410
12	63.33	22.75	86.10	15.89	409.03	15.89	38.64a	3410
13	62.65	29.50	114.01	23.85	528.72	23.85	53.35a	3410
14	62.13	34.75	94.48	18.28	444.95	18.28	53.03a	3410
15	61.60	40.00	119.00	25.27	550.09	25.27	65.27a	3410
16	60.80	48.00	107.74	22.06	501.83	22.06	70.06a	3410
17	60.00	56.00	126.27	27.35	581.27	27.35	83.35a	3410
18	59.20	64.00	130.57	28.57	599.71	28.57	92.57a	3410
19	58.40	72.00	135.17	29.89	619.44	32.20	104.20	13572
20	57.90	77.00	138.17	30.74	632.30	36.14	113.14	13572
21	57.40	82.00	141.25	31.62	645.49	40.09	122.09	13572

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.43	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	67.62	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	66.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	65.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	64.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	64.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	63.33	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	62.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	5908
14	62.13	5.25	4.20	0.00	57.87	57.87	63.12p	5908
15	61.60	10.50	8.41	0.00	75.90	65.39	75.89	5908
16	60.80	18.50	14.83	0.00	103.47	66.44	84.94	5908
17	60.00	26.50	21.30	0.00	131.19	67.14	93.64	5908
18	59.20	34.50	27.82	0.00	159.13	67.72	102.22	5908
19	58.40	42.50	34.40	1.14	187.36	67.89	110.39	13572
20	57.90	47.50	38.55	2.33	205.16	67.59	115.09	13572
21	57.40	52.50	42.73	3.52	223.09	67.31	119.81	13572

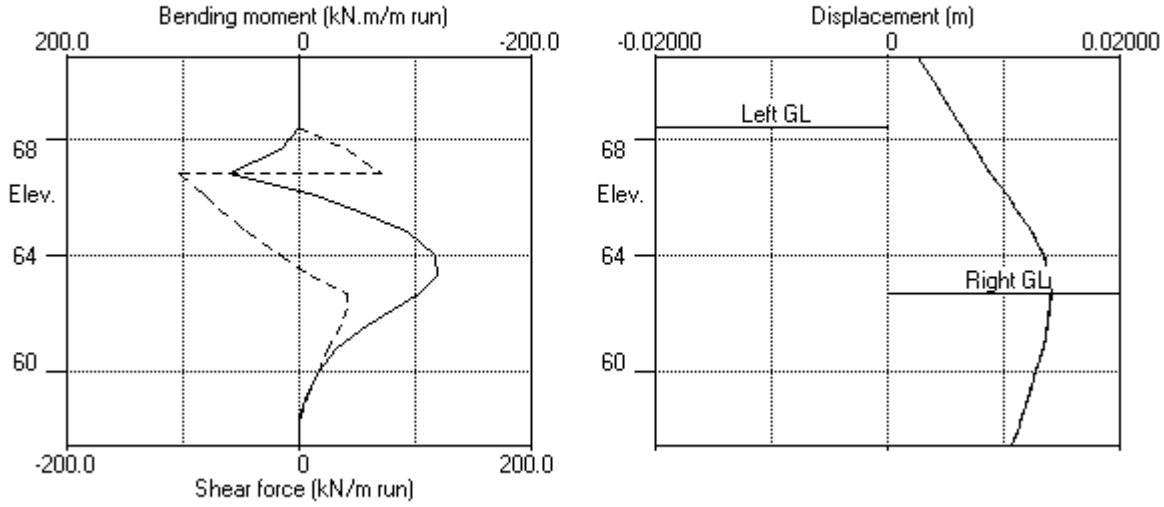
(continued)

Stage No.13 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

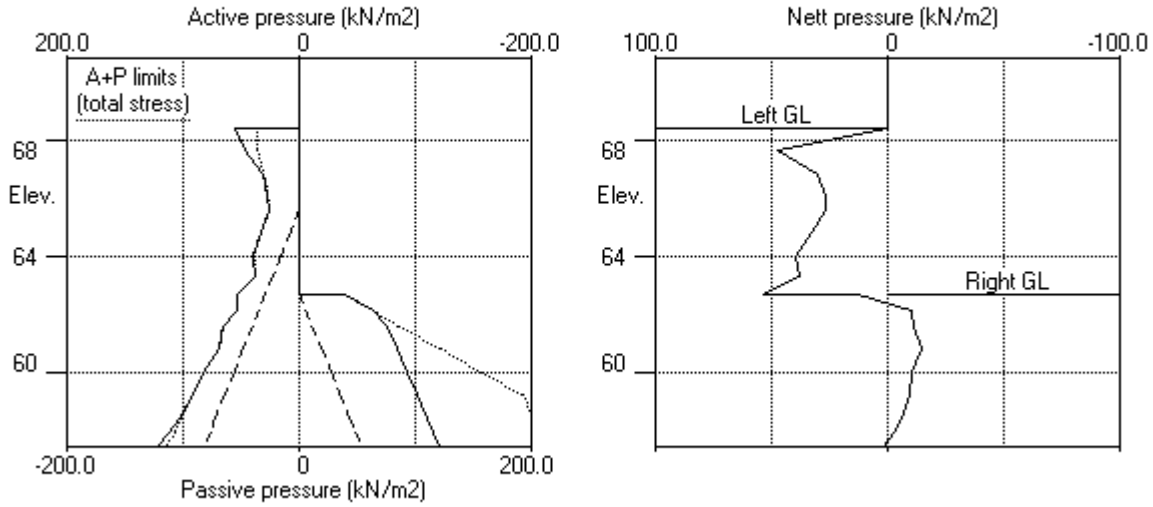
Note: 92.57a Soil pressure at active limit
63.12p Soil pressure at passive limit

Units: kN,m

Stage No.13 Change EI of wall to 163970kN.m2/m run



Stage No.13 Change EI of wall to 163970kN.m2/m run



Units: kN,m

Summary of results

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 57.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	68.40	68.40	Cant.	Conditions not suitable for FoS calc.				
2	68.40	68.40		No analysis at this stage				
3	68.40	68.40		No analysis at this stage				
4	68.40	68.40	Cant.	3.081	59.12	65.82	2.58	L to R
5	68.40	68.40		No analysis at this stage				
6	68.40	68.40		No analysis at this stage				
7	68.40	66.04	70.00	1.738	n/a	59.56	6.48	L to R
8	68.40	66.04	70.00	1.738	n/a	59.56	6.48	L to R
9	68.40	66.04		No analysis at this stage				
10	68.40	62.65		More than one prop. No FoS calc.				
11	68.40	62.65	66.84	1.458	n/a	***	***	L to R
12	68.40	62.65		No analysis at this stage				
13	68.40	62.65		More than one prop. No FoS calc.				

Legend: *** Result not found

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

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	70.85	0.007	0.000	0.0	0.0	0.0	0.0
2	70.43	0.007	0.000	0.0	-0.0	0.0	0.0
3	70.00	0.007	0.000	0.0	-0.0	0.0	-41.0
4	69.20	0.007	0.000	0.0	-32.8	0.0	-41.0
5	68.40	0.008	0.000	0.0	-65.5	0.0	-41.0
6	67.62	0.008	0.000	15.8	-86.2	40.6	-11.6
7	66.84	0.009	0.000	60.3	-84.9	71.2	-106.0
8	66.04	0.010	0.000	26.7	-62.4	39.7	-82.9
9	65.60	0.011	0.000	31.1	-51.3	33.3	-71.0
10	64.80	0.012	0.000	35.4	-99.3	21.5	-47.2
11	64.00	0.013	0.000	35.7	-124.4	12.7	-18.1
12	63.33	0.014	0.000	33.7	-126.4	10.0	-4.0
13	62.65	0.014	0.000	30.1	-110.7	41.1	-5.9
14	62.13	0.014	0.000	26.6	-89.0	42.0	-6.9
15	61.60	0.014	0.000	22.8	-68.1	36.5	-7.4
16	60.80	0.013	0.000	16.6	-42.2	28.0	-7.5
17	60.00	0.013	0.000	10.7	-23.4	19.5	-6.8
18	59.20	0.012	0.000	5.6	-10.6	12.4	-5.4
19	58.40	0.012	0.000	1.9	-2.4	5.7	-3.4
20	57.90	0.011	0.000	0.5	-0.5	2.4	-1.8
21	57.40	0.011	0.000	0.0	-0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	0.0	60.00	-0.0	60.80	0.0	67.62	-0.0	57.90
2	No calculation at this stage							
3	No calculation at this stage							
4	35.7	64.00	-0.0	68.40	14.9	66.84	-7.5	60.80
5	No calculation at this stage							
6	No calculation at this stage							
7	2.3	60.80	-86.2	67.62	37.9	66.04	-41.0	70.00
8	5.0	61.60	-83.0	67.62	39.7	66.04	-39.2	70.00
9	No calculation at this stage							
10	57.3	66.84	-126.4	63.33	68.1	66.84	-106.0	66.84
11	57.3	66.84	-126.4	63.33	68.1	66.84	-106.0	66.84
12	No calculation at this stage							
13	60.3	66.84	-119.0	63.33	71.2	66.84	-104.5	66.84

Summary of results (continued)

Maximum and minimum displacement at each stage

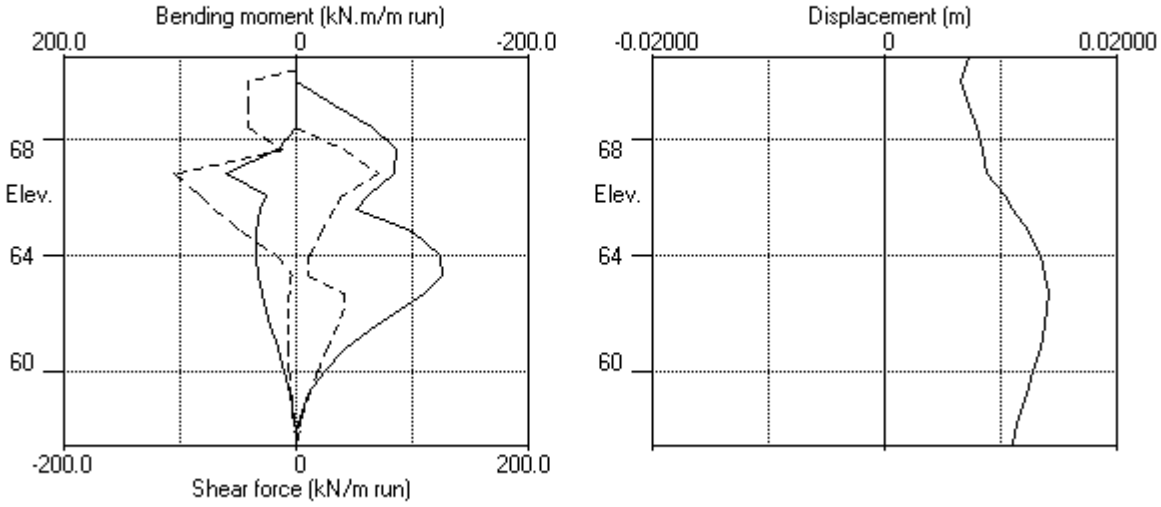
Stage no.	Displacement maximum (m)	elev.	minimum (m)	elev.	Stage description
1	0.000	58.40	-0.000	62.65	Change EI of wall to 1.0000E-04kN.m2/m run
2	No calculation at this stage				Apply surcharge no.1 at elev. 68.40
3	No calculation at this stage				Apply surcharge no.2 at elev. 68.40
4	0.007	70.85	0.000	70.85	Change EI of wall to 327940kN.m2/m run
5	No calculation at this stage				Install prop no.2 at elev. 70.00
6	No calculation at this stage				Apply water pressure profile no.1
7	0.009	65.60	0.000	70.85	Excav. to elev. 66.04 on RIGHT side
8	0.009	66.04	0.000	70.85	Change EI of wall to 229558kN.m2/m run
9	No calculation at this stage				Install prop no.1 at elev. 66.84
10	0.013	62.13	0.000	70.85	Excav. to elev. 62.65 on RIGHT side
11	0.013	62.13	0.000	70.85	Remove prop no.2 at elev. 70.00
12	No calculation at this stage				Install prop no.3 at elev. 70.85
13	0.014	62.65	0.000	70.85	Change EI of wall to 163970kN.m2/m run

Prop forces at each stage (horizontal components)

Stage no.	Strut no. 1 at elev. 66.84		Strut no. 2 at elev. 70.00		Strut no. 3 at elev. 70.85	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
7	---	---	40.95	40.95	---	---
8	---	---	39.17	39.17	---	---
10	174.18	174.18	slack	slack	---	---
11	174.18	174.18	---	---	---	---
13	175.65	175.65	---	---	slack	slack

Units: kN,m

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	70.80	2 WWGS	2 WWGS
2	61.20	3 Transitional WG	3 Transitional WG
3	54.80	4 Waitemata Group Rock	4 Waitemata Group Rock

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Fill	18.00	9000	0.500	OC (0.200)	0.285 (1.238)	4.288 (5.694)	5.000d
2	WWGS	18.00	24000	0.500	OC (0.200)	0.285 (1.238)	4.288 (5.694)	7.000d
3	Transition-al WG	19.00	45000	0.470	OC (0.200)	0.262 (1.182)	4.845 (6.154)	12.00d
4	Waitemata Group Rock	19.00	150000	0.412	OC (0.200)	0.219 (1.075)	6.289 (7.279)	30.00d

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	0.631	0.00	30.00	0.464	0.00
2	WWGS	30.00	0.631	0.00	30.00	0.464	0.00
3	Transitional WG	32.00	0.625	0.00	32.00	0.459	0.00
4	Waitemata Group Rock	36.00	0.613	0.00	36.00	0.447	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	64.00	64.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	64.00	64.00	0.0	1	62.65	62.65	0.0

WALL PROPERTIES

Type of structure = Soldier Pile Wall
Soldier Pile width = 0.75 m
Soldier Pile spacing = 1.50 m
Passive mobilisation factor = 3.00
Elevation of toe of wall = 56.40
Maximum finite element length = 0.80 m
Youngs modulus of wall E = 3.1685E+07 kN/m2
Moment of inertia of wall I = 0.010350 m4/m run
= 0.015525 m4 per pile
E.I = 327940 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	66.84	1.00	0.150000	3.169E+07	0.10	0.00	0	Strut	Yes	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	70.80	0.00(L)	50.00	50.00	12.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 1.0000E-04 kN.m2/m run Yield moment not defined No adjustments to wall displacements
2	Apply surcharge no.1 at elevation 70.80 No analysis at this stage
3	Change EI of wall to 327940 kN.m2/m run Yield moment not defined Reset wall displacements to zero at this stage
4	Apply water pressure profile no.1 No analysis at this stage
5	Excavate to elevation 66.04 on RIGHT side Toe of berm at elevation 62.65 Width of top of berm = 4.00 Width of toe of berm = 7.40
6	Change EI of wall to 229558 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value
7	Install strut or anchor no.1 at elevation 66.84
8	Excavate to elevation 62.65 on RIGHT side
9	Change EI of wall to 163970 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value

FACTORS OF SAFETY and ANALYSIS OPTIONS

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

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

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 0 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 m

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

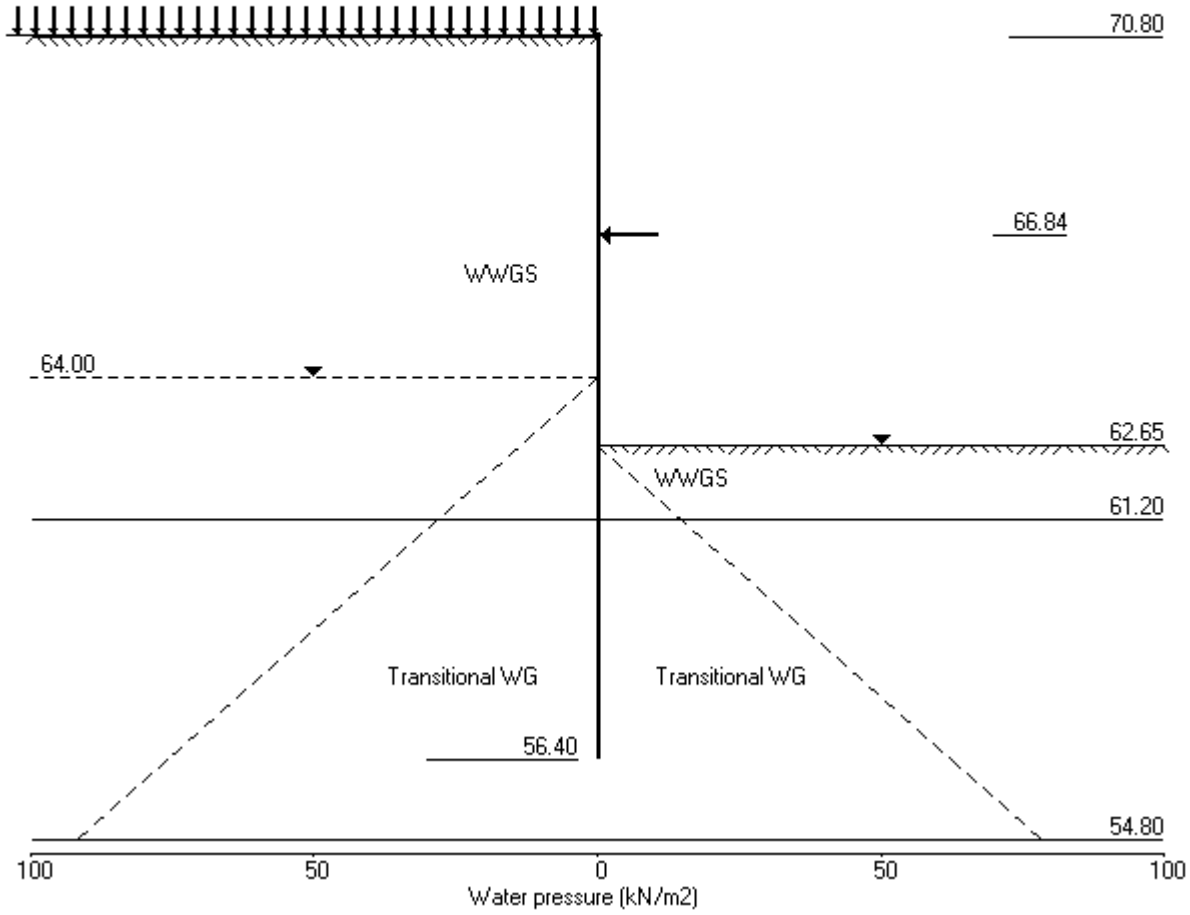
Distance to rigid boundary on Left side = 20.00 m
Distance to rigid boundary on Right side = 20.00 m

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 1.0000E-04kN.m2/m	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 70.80	No	No	No
3	Change EI of wall to 327940kN.m2/m run	No	No	No
4	Apply water pressure profile no.1	No	No	No
5	Excav. to elev. 66.04 on RIGHT side	No	No	No
6	Change EI of wall to 229558kN.m2/m run	Yes	Yes	Yes
7	Install prop no.1 at elev. 66.84	Yes	Yes	Yes
8	Excav. to elev. 62.65 on RIGHT side	Yes	Yes	Yes
9	Change EI of wall to 163970kN.m2/m run	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No.9 Change EI of wall to 163970kN.m2/m run



Units: kN,m

Stage No. 1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements

STABILITY ANALYSIS of Soldier Pile 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. = 56.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	70.80	70.80	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

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	EI of wall kN.m2/m
1	70.80	-0.00	0.000	-1.57E-21	0.0	0.0		0
2	70.20	0.00	-0.000	3.141E-21	-0.0	-0.0		0
3	69.60	0.00	0.000	-1.09E-20	-0.0	0.0		0
4	68.80	0.00	-0.000	4.71E-20	-0.0	-0.0		0
5	68.00	0.00	0.000	-1.77E-19	-0.0	0.0		0
6	67.42	0.00	-0.000	5.78E-19	-0.0	-0.0		0
7	66.84	0.00	0.000	-2.13E-18	-0.0	0.0		0
8	66.04	0.00	-0.000	9.36E-18	-0.0	-0.0		0
9	65.42	0.00	0.000	-3.15E-17	-0.0	0.0		0
10	64.80	0.00	-0.000	1.16E-16	-0.0	-0.0		0
11	64.00	0.00	0.000	-2.01E-15	-0.0	0.0		0
12	63.33	0.00	0.000	-1.81E-17	-0.0	-0.0		0
13	62.65	0.00	0.000	1.98E-15	-0.0	0.0		0
14	61.93	0.00	-0.000	-6.01E-17	-0.0	-0.0		0
15	61.20	0.00	0.000	1.58E-17	-0.0	0.0		0
16	60.60	0.00	0.000	-8.26E-18	-0.0	0.0		0
17	60.00	0.00	-0.000	1.71E-17	-0.0	-0.0		0
18	59.20	0.00	0.000	-6.92E-17	-0.0	0.0		0
19	58.40	0.00	-0.000	2.59E-16	-0.0	-0.0		0
20	57.60	0.00	0.000	-2.49E-15	-0.0	0.0		0
21	57.00	0.00	0.000	-2.43E-15	-0.0	-0.0		0
22	56.40	-0.00	0.000	3.08E-17	-0.0	0.0		---

(continued)

Stage No.1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	0.00	0.00	39.86	0.00	0.00a	146191
2	70.20	0.00	10.80	0.00	86.17	5.40	5.40	22551
3	69.60	0.00	21.60	0.00	132.48	10.80	10.80	24980
4	68.80	0.00	36.00	1.60	194.22	18.00	18.00	22237
5	68.00	0.00	50.40	5.71	255.96	25.20	25.20	20087
6	67.42	0.00	60.84	8.69	300.72	30.42	30.42	23299
7	66.84	0.00	71.28	11.66	345.49	35.64	35.64	29966
8	66.04	0.00	85.68	15.77	407.23	42.84	42.84	19925
9	65.42	0.00	96.84	18.95	455.08	48.42	48.42	25293
10	64.80	0.00	108.00	22.14	502.93	54.00	54.00	29427
11	64.00	0.00	122.40	26.24	564.67	61.20	61.20	10979
12	63.33	6.75	127.80	27.78	587.83	63.90	70.65	10979
13	62.65	13.50	133.20	29.32	610.98	66.60	80.10	10979
14	61.93	20.75	139.00	30.98	635.85	69.50	90.25	22826
15	61.20	28.00	144.80	32.63	660.72	72.40	100.40	23812
		28.00	144.80	23.69	775.42	68.06	96.06	44647
16	60.60	34.00	150.20	25.10	801.58	70.59	104.59	44647
17	60.00	40.00	155.60	26.51	827.75	73.13	113.13	38636
18	59.20	48.00	162.80	28.39	862.63	76.52	124.52	41367
19	58.40	56.00	170.00	30.28	897.52	79.90	135.90	43380
20	57.60	64.00	177.20	32.16	932.40	83.28	147.28	20459
21	57.00	70.00	182.60	33.57	958.57	85.82	155.82	20459
22	56.40	76.00	188.00	34.98	984.73	88.36	164.36	20459

RIGHT side

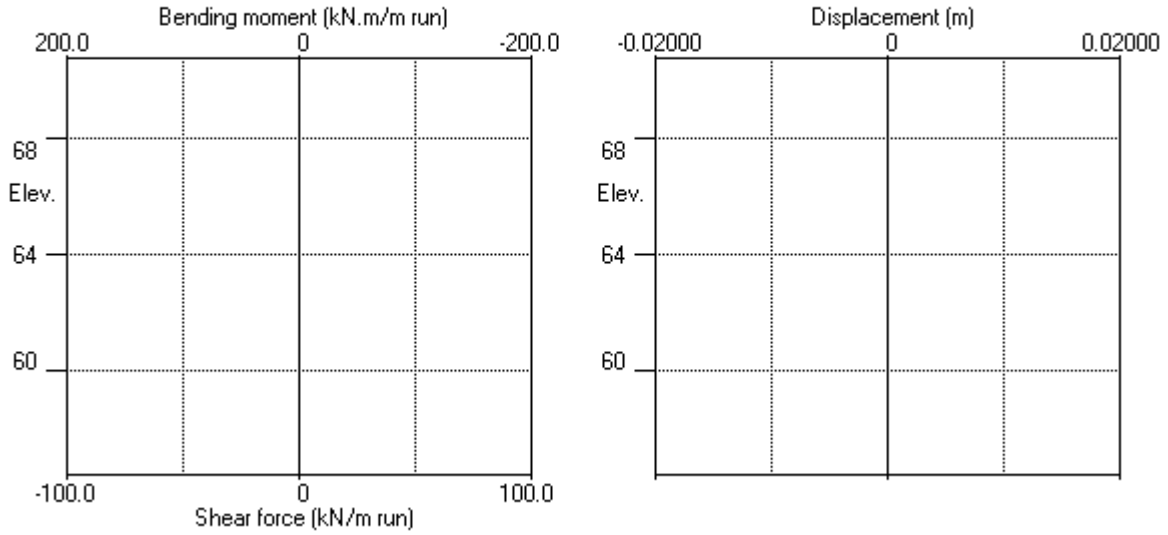
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	0.00	0.00	39.86	0.00	0.00a	146191
2	70.20	0.00	10.80	0.00	86.17	5.40	5.40	22551
3	69.60	0.00	21.60	0.00	132.48	10.80	10.80	24980
4	68.80	0.00	36.00	1.60	194.22	18.00	18.00	22237
5	68.00	0.00	50.40	5.71	255.96	25.20	25.20	20087
6	67.42	0.00	60.84	8.69	300.72	30.42	30.42	23299
7	66.84	0.00	71.28	11.66	345.49	35.64	35.64	29966
8	66.04	0.00	85.68	15.77	407.23	42.84	42.84	19925
9	65.42	0.00	96.84	18.95	455.08	48.42	48.42	25293
10	64.80	0.00	108.00	22.14	502.93	54.00	54.00	29427
11	64.00	0.00	122.40	26.24	564.67	61.20	61.20	10979
12	63.33	6.75	127.80	27.78	587.83	63.90	70.65	10979
13	62.65	13.50	133.20	29.32	610.98	66.60	80.10	10979
14	61.93	20.75	139.00	30.98	635.85	69.50	90.25	22826
15	61.20	28.00	144.80	32.63	660.72	72.40	100.40	23812
		28.00	144.80	23.69	775.42	68.06	96.06	44647
16	60.60	34.00	150.20	25.10	801.58	70.59	104.59	44647
17	60.00	40.00	155.60	26.51	827.75	73.13	113.13	38636
18	59.20	48.00	162.80	28.39	862.63	76.52	124.52	41367
19	58.40	56.00	170.00	30.28	897.52	79.90	135.90	43380
20	57.60	64.00	177.20	32.16	932.40	83.28	147.28	20459
21	57.00	70.00	182.60	33.57	958.57	85.82	155.82	20459
22	56.40	76.00	188.00	34.98	984.73	88.36	164.36	20459

(continued)

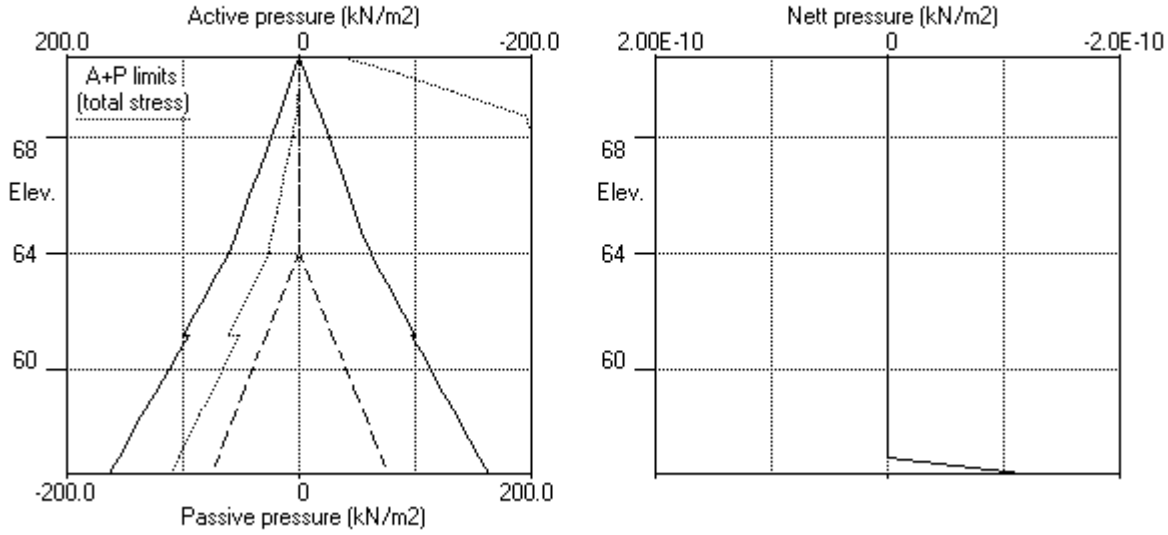
Stage No.1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements
Note: 0.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.1 Change EI of wall to 1.0000E-04kN.m2/m run



Stage No.1 Change EI of wall to 1.0000E-04kN.m2/m run



Units: kN,m

Stage No. 5 Excavate to elevation 66.04 on RIGHT side
Toe of berm at elevation 62.65
Width of top of berm = 4.00
Width of toe of berm = 7.40

STABILITY ANALYSIS of Soldier Pile 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. = 56.40 Factor of Safety	FoS for toe elev. = 56.40 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
5	70.80	66.04	Cant.	1.498	57.00	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	70.80	0.00	0.015	1.60E-03	0.0	0.0		327940
2	70.20	0.00	0.015	1.60E-03	0.0	-0.0		327940
3	69.60	0.92	0.014	1.60E-03	0.3	0.1		327940
4	68.80	5.02	0.012	1.60E-03	2.7	1.0		327940
5	68.00	9.13	0.011	1.59E-03	8.3	5.2		327940
6	67.42	12.10	0.010	1.57E-03	14.5	11.7		327940
7	66.84	15.08	0.009	1.54E-03	22.4	22.3		327940
8	66.04	19.18	0.008	1.46E-03	36.1	45.4		327940
		-20.68	0.008	1.46E-03	36.1	45.4		
9	65.42	-28.57	0.007	1.36E-03	20.8	66.7		327940
10	64.80	-22.57	0.006	1.22E-03	4.9	74.1		327940
		-9.50	0.006	1.22E-03	4.9	74.1		
11	64.00	-15.79	0.005	1.04E-03	-5.2	76.3		327940
12	63.33	-5.86	0.005	8.93E-04	-12.5	69.6		327940
13	62.65	3.34	0.004	7.59E-04	-13.3	60.3		327940
14	61.93	7.07	0.004	6.35E-04	-9.6	51.5		327940
15	61.20	10.16	0.003	5.27E-04	-3.3	46.4		327940
		-11.02	0.003	5.27E-04	-3.3	46.4		
16	60.60	-6.98	0.003	4.46E-04	-8.7	42.4		327940
17	60.00	-3.60	0.003	3.74E-04	-11.9	35.9		327940
18	59.20	0.05	0.002	3.00E-04	-13.3	25.2		327940
19	58.40	2.99	0.002	2.51E-04	-12.1	14.6		327940
20	57.60	5.51	0.002	2.26E-04	-8.7	5.9		327940
21	57.00	7.25	0.002	2.20E-04	-4.9	1.6		327940
22	56.40	8.96	0.002	2.18E-04	0.0	-0.0		---

(continued)

Stage No.5 Excavate to elevation 66.04 on RIGHT side
Toe of berm at elevation 62.65
Width of top of berm = 4.00
Width of toe of berm = 7.40

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	12.00	0.00	91.31	0.00	0.00a	3406
2	70.20	0.00	22.80	0.00	137.62	0.00	0.00a	3406
3	69.60	0.00	33.60	0.92	183.92	0.92	0.92a	3406
4	68.80	0.00	48.00	5.02	245.66	5.02	5.02a	3406
5	68.00	0.00	62.39	9.13	307.38	9.13	9.13a	3406
6	67.42	0.00	72.83	12.10	352.12	12.10	12.10a	3406
7	66.84	0.00	83.26	15.08	396.85	15.08	15.08a	3406
8	66.04	0.00	97.64	19.18	458.53	19.18	19.18a	3406
9	65.42	0.00	108.79	22.36	506.31	27.28	27.28	3406
10	64.80	0.00	119.93	25.54	554.08	35.59	35.59	3406
11	64.00	0.00	134.30	29.64	615.70	45.88	45.88	3406
12	63.33	6.75	139.67	31.17	638.72	50.80	57.55	3406
13	62.65	13.50	145.03	32.70	661.72	55.38	68.88	3406
14	61.93	20.75	150.79	34.34	686.40	59.99	80.74	3406
15	61.20	28.00	156.54	35.98	711.05	64.31	92.31	3406
		28.00	156.54	26.76	832.29	50.33	78.33	6387
16	60.60	34.00	161.89	28.16	858.23	54.72	88.72	6387
17	60.00	40.00	167.24	29.55	884.15	58.81	98.81	6387
18	59.20	48.00	174.37	31.42	918.68	63.89	111.89	6387
19	58.40	56.00	181.49	33.28	953.18	68.66	124.66	6387
20	57.60	64.00	188.60	35.14	987.64	73.23	137.23	6387
21	57.00	70.00	193.93	36.53	1013.47	76.61	146.61	6387
22	56.40	76.00	199.26	37.93	1039.28	79.97	155.97	6387

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	69.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	68.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	67.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	66.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	4074
9	65.42	0.00	11.16	0.00	87.72	55.85	55.85	4074
		0.00	11.16	0.00	71.86b	55.85	55.85	4074
10	64.80	0.00	22.33	0.00	111.09b	58.16	58.16	4074
		0.00	22.33	0.00	45.09b	45.09	45.09p	4074
11	64.00	0.00	36.76	1.82	65.67b	61.67	61.67	4074
		0.00	36.76	1.82	63.99b	61.67	61.67	4074
12	63.33	0.00	48.96	5.30	80.94b	63.41	63.41	4074
		0.00	48.96	5.30	84.64b	63.41	63.41	4074
13	62.65	0.00	61.19	8.79	102.41b	65.55	65.55	4074
		0.00	61.19	8.79	92.67b	65.55	65.55	4074
14	61.93	7.25	67.12	10.48	100.47b	66.43	73.68	4074
		7.25	67.12	10.48	117.50b	66.43	73.68	4074
15	61.20	14.50	73.10	12.18	126.70b	67.65	82.15	4074
		14.50	73.10	4.94	286.23b	74.84	89.34	7638

(continued)

Stage No.5 Excavate to elevation 66.04 on RIGHT side
Toe of berm at elevation 62.65
Width of top of berm = 4.00
Width of toe of berm = 7.40

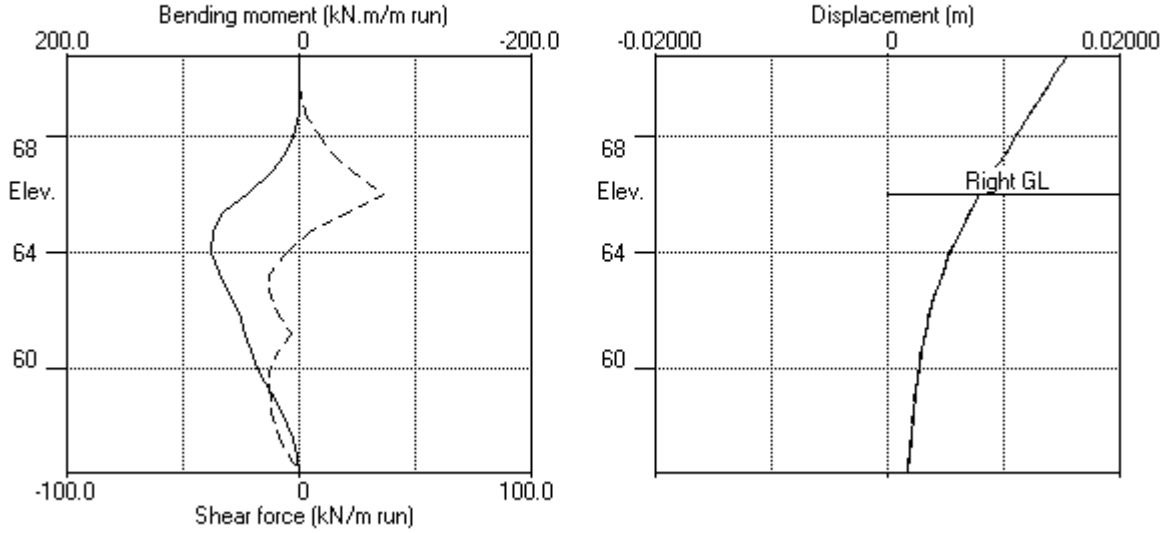
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
16	60.60	20.50	78.69	6.40	304.35b	75.20	95.70	7638
		20.50	78.69	6.40	217.98b	75.20	95.70	7638
17	60.00	26.50	84.32	7.87	231.05b	75.92	102.42	7638
		26.50	84.32	7.87	247.10b	75.92	102.42	7638
18	59.20	34.50	91.89	9.85	265.89b	77.34	111.84	7638
		34.50	91.89	9.85	283.25b	77.34	111.84	7638
19	58.40	42.50	99.54	11.85	303.47b	79.16	121.66	7638
		42.50	99.54	11.85	319.84b	79.16	121.66	7638
20	57.60	50.50	107.26	13.87	341.36b	81.23	131.73	7638
		50.50	107.26	13.87	354.99b	81.23	131.73	7638
21	57.00	56.50	113.10	15.40	371.92b	82.85	139.35	7638
		56.50	113.10	15.40	383.07b	82.85	139.35	7638
22	56.40	62.50	118.98	16.93	400.63b	84.51	147.01	7638

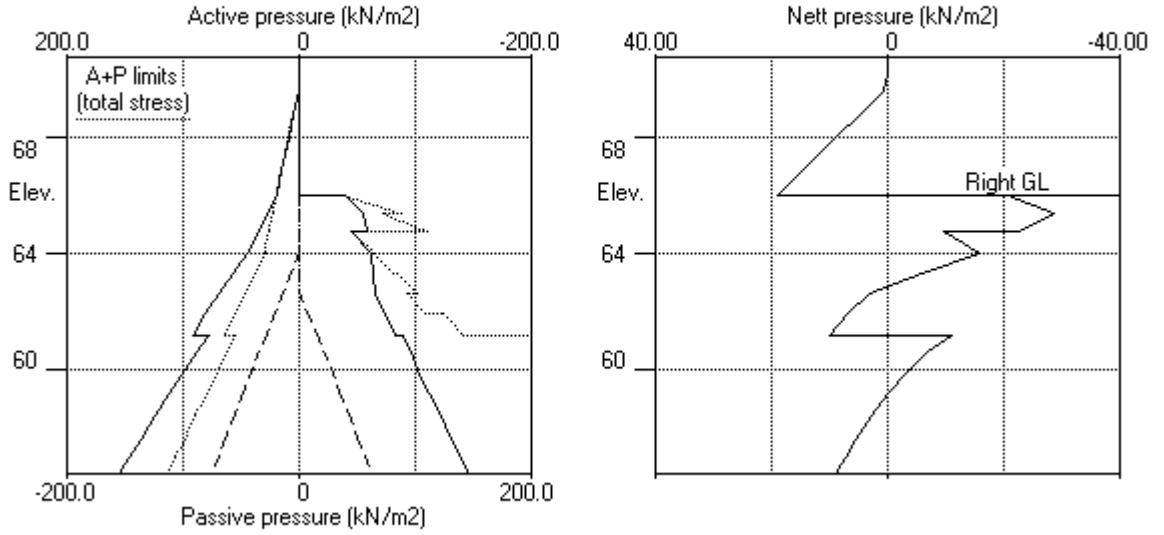
Note: 19.18a Soil pressure at active limit
45.09p Soil pressure at passive limit
400.63b Passive limit reduced because of berm

Units: kN,m

Stage No.5 Excav. to elev. 66.04 on RIGHT side



Stage No.5 Excav. to elev. 66.04 on RIGHT side



Units: kN,m

Stage No. 6 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile 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. = 56.40 Factor of Safety	FoS for toe elev. = 56.40 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
6	70.80	66.04	Cant.	1.498	57.00	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	70.80	0.00	0.017	1.94E-03	0.0	0.0		229558
2	70.20	0.00	0.016	1.94E-03	0.0	-0.0		229558
3	69.60	0.92	0.015	1.94E-03	0.3	0.1		229558
4	68.80	5.02	0.014	1.94E-03	2.7	1.0		229558
5	68.00	9.13	0.012	1.93E-03	8.3	5.2		229558
6	67.42	12.10	0.011	1.91E-03	14.5	11.7		229558
7	66.84	15.08	0.010	1.87E-03	22.4	22.3		229558
8	66.04	19.18	0.008	1.75E-03	36.1	45.4		229558
		-20.68	0.008	1.75E-03	36.1	45.4		
9	65.42	-32.30	0.007	1.60E-03	19.6	66.7		229558
10	64.80	-24.02	0.006	1.41E-03	2.2	73.0		229558
		-9.90	0.006	1.41E-03	2.2	73.0		
11	64.00	-15.51	0.005	1.16E-03	-8.0	73.4		229558
12	63.33	-5.13	0.005	9.60E-04	-15.0	65.3		229558
13	62.65	4.31	0.004	7.87E-04	-15.2	54.8		229558
14	61.93	8.11	0.004	6.35E-04	-10.7	45.1		229558
15	61.20	11.15	0.003	5.08E-04	-3.8	39.6		229558
		-9.17	0.003	5.08E-04	-3.8	39.6		
16	60.60	-5.35	0.003	4.14E-04	-8.1	35.7		229558
17	60.00	-2.28	0.003	3.34E-04	-10.4	29.7		229558
18	59.20	0.88	0.002	2.53E-04	-11.0	20.3		229558
19	58.40	3.27	0.002	2.02E-04	-9.3	11.3		229558
20	57.60	4.65	0.002	1.78E-04	-6.1	4.3		229558
21	57.00	5.12	0.002	1.71E-04	-3.2	1.1		229558
22	56.40	5.55	0.002	1.70E-04	0.0	-0.0		---

(continued)

Stage No.6 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	12.00	0.00	91.31	0.00	0.00a	4743
2	70.20	0.00	22.80	0.00	137.62	0.00	0.00a	4743
3	69.60	0.00	33.60	0.92	183.92	0.92	0.92a	4743
4	68.80	0.00	48.00	5.02	245.66	5.02	5.02a	4743
5	68.00	0.00	62.39	9.13	307.38	9.13	9.13a	4743
6	67.42	0.00	72.83	12.10	352.12	12.10	12.10a	4743
7	66.84	0.00	83.26	15.08	396.85	15.08	15.08a	4743
8	66.04	0.00	97.64	19.18	458.53	19.18	19.18a	4743
9	65.42	0.00	108.79	22.36	506.31	26.25	26.25	4743
10	64.80	0.00	119.93	25.54	554.08	35.19	35.19	4743
11	64.00	0.00	134.30	29.64	615.70	46.02	46.02	3760
12	63.33	6.75	139.67	31.17	638.72	51.16	57.91	3760
13	62.65	13.50	145.03	32.70	661.72	55.87	69.37	3760
14	61.93	20.75	150.79	34.34	686.40	60.51	81.26	3760
15	61.20	28.00	156.54	35.98	711.05	64.81	92.81	3760
		28.00	156.54	26.76	832.29	51.25	79.25	7050
16	60.60	34.00	161.89	28.16	858.23	55.53	89.53	7050
17	60.00	40.00	167.24	29.55	884.15	59.47	99.47	7050
18	59.20	48.00	174.37	31.42	918.68	64.31	112.31	7050
19	58.40	56.00	181.49	33.28	953.18	68.80	124.80	7050
20	57.60	64.00	188.60	35.14	987.64	72.81	136.81	22077
21	57.00	70.00	193.93	36.53	1013.47	75.54	145.54	22077
22	56.40	76.00	199.26	37.93	1039.28	78.26	154.26	22077

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	69.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	68.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	67.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	66.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	12343
9	65.42	0.00	11.16	0.00	87.72	58.54	58.54	12343
		0.00	11.16	0.00	71.86b	58.54	58.54	12343
10	64.80	0.00	22.33	0.00	111.09b	59.21	59.21	12343
		0.00	22.33	0.00	45.09b	45.09	45.09p	12343
11	64.00	0.00	36.76	1.82	65.67b	61.53	61.53	3760
		0.00	36.76	1.82	63.99b	61.53	61.53	3760
12	63.33	0.00	48.96	5.30	80.94b	63.04	63.04	3760
		0.00	48.96	5.30	84.64b	63.04	63.04	3760
13	62.65	0.00	61.19	8.79	102.41b	65.06	65.06	3760
		0.00	61.19	8.79	92.67b	65.06	65.06	3760
14	61.93	7.25	67.12	10.48	100.47b	65.90	73.15	3760
		7.25	67.12	10.48	117.50b	65.90	73.15	3760
15	61.20	14.50	73.10	12.18	126.70b	67.16	81.66	3760
		14.50	73.10	4.94	286.23b	73.92	88.42	7050

(continued)

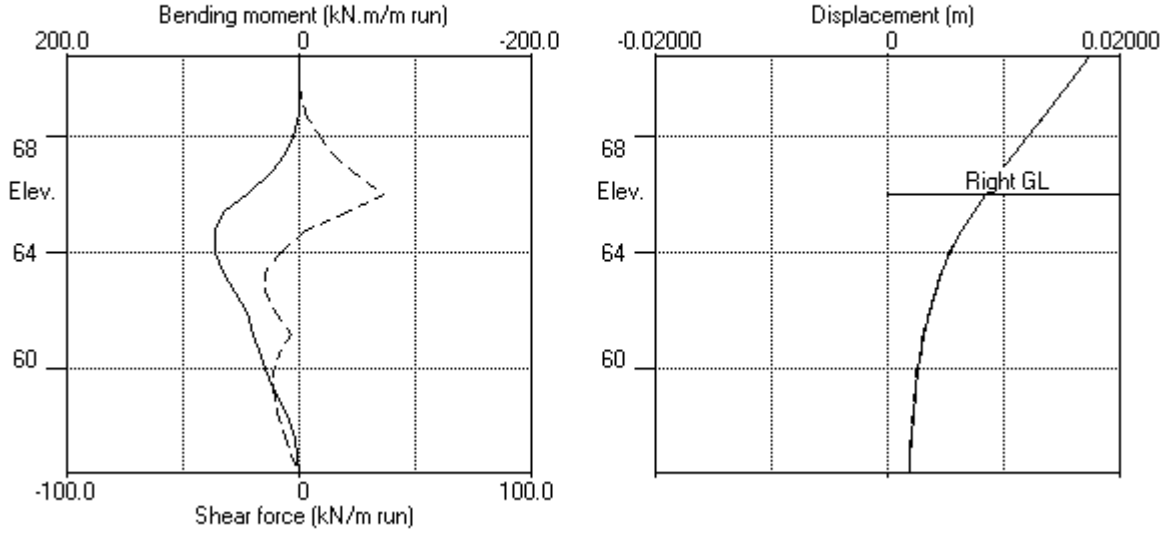
Stage No.6 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
16	60.60	20.50	78.69	6.40	304.35b	74.38	94.88	7050
		20.50	78.69	6.40	217.98b	74.38	94.88	7050
17	60.00	26.50	84.32	7.87	231.05b	75.25	101.75	7050
		26.50	84.32	7.87	247.10b	75.25	101.75	7050
18	59.20	34.50	91.89	9.85	265.89b	76.93	111.43	7050
		34.50	91.89	9.85	283.25b	76.93	111.43	7050
19	58.40	42.50	99.54	11.85	303.47b	79.02	121.52	7050
		42.50	99.54	11.85	319.84b	79.02	121.52	7050
20	57.60	50.50	107.26	13.87	341.36b	81.65	132.15	22077
		50.50	107.26	13.87	354.99b	81.65	132.15	22077
21	57.00	56.50	113.10	15.40	371.92b	83.92	140.42	22077
		56.50	113.10	15.40	383.07b	83.92	140.42	22077
22	56.40	62.50	118.98	16.93	400.63b	86.21	148.71	22077

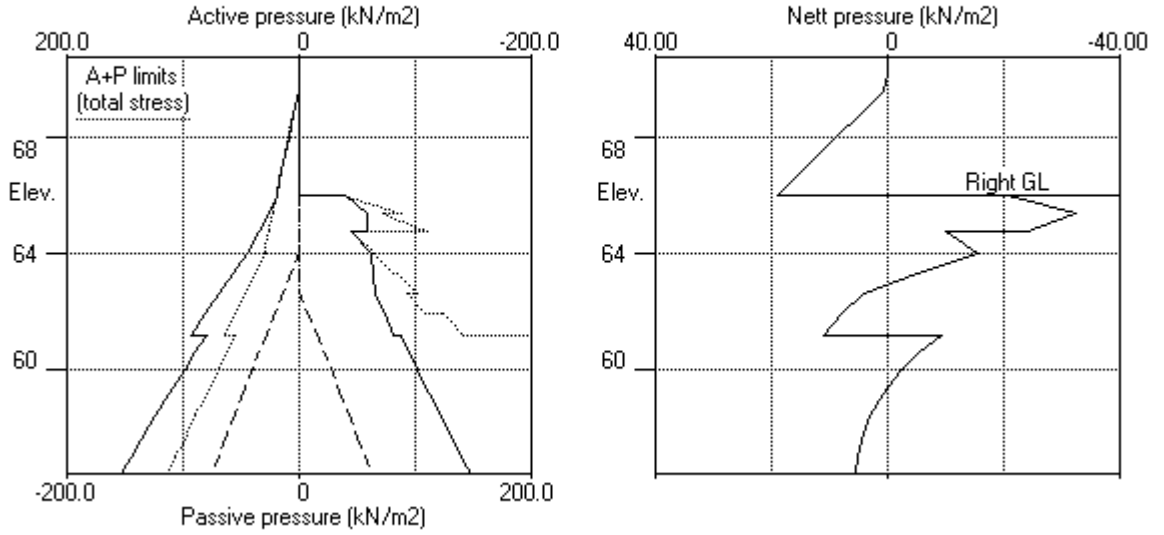
Note: 19.18a Soil pressure at active limit
45.09p Soil pressure at passive limit
400.63b Passive limit reduced because of berm

Units: kN,m

Stage No.6 Change EI of wall to 229558kN.m2/m run



Stage No.6 Change EI of wall to 229558kN.m2/m run



Units: kN,m

Stage No. 8 Excavate to elevation 62.65 on RIGHT side

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 56.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
8	70.80	62.65	66.84	1.852	n/a	58.65	4.00	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	70.80	16.99	0.014	1.32E-03	0.0	0.0		229558
2	70.20	14.96	0.014	1.32E-03	9.6	3.1		229558
3	69.60	13.81	0.013	1.30E-03	18.2	11.6		229558
4	68.80	14.98	0.012	1.23E-03	29.7	31.0		229558
5	68.00	15.67	0.011	1.07E-03	42.0	60.0		229558
6	67.42	15.67	0.010	8.86E-04	51.1	87.2		229558
7	66.84	15.08	0.010	6.25E-04	60.0	119.6	-154.9	229558
		15.08	0.010	6.25E-04	-94.9	119.6		
8	66.04	19.18	0.009	3.31E-04	-81.2	49.0		229558
9	65.42	22.36	0.009	2.57E-04	-68.3	6.2		229558
10	64.80	27.32	0.009	2.91E-04	-52.9	-31.3		229558
11	64.00	36.02	0.009	4.54E-04	-27.5	-61.2		229558
12	63.33	46.93	0.008	6.51E-04	0.4	-70.7		229558
13	62.65	58.15	0.008	8.46E-04	35.9	-58.8		229558
		18.29	0.008	8.46E-04	35.9	-58.8		
14	61.93	-1.49	0.007	9.91E-04	42.0	-29.8		229558
15	61.20	3.32	0.007	1.04E-03	42.7	1.6		229558
		-37.28	0.007	1.04E-03	42.7	1.6		
16	60.60	-29.03	0.006	1.01E-03	22.8	20.5		229558
17	60.00	-21.19	0.005	9.59E-04	7.7	28.8		229558
18	59.20	-11.63	0.005	8.66E-04	-5.4	27.8		229558
19	58.40	-3.05	0.004	7.89E-04	-11.3	19.2		229558
20	57.60	4.24	0.003	7.43E-04	-10.8	8.7		229558
21	57.00	9.03	0.003	7.29E-04	-6.8	2.6		229558
22	56.40	13.74	0.002	7.26E-04	0.0	0.0		---

At elev. 66.84 Prop force = 154.9 kN/m run

(continued)

Stage No.8 Excavate to elevation 62.65 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	12.00	0.00	91.31	16.99	16.99	5452
2	70.20	0.00	22.80	0.00	137.62	14.96	14.96	5452
3	69.60	0.00	33.60	0.92	183.92	13.81	13.81	5452
4	68.80	0.00	48.00	5.02	245.66	14.98	14.98	5452
5	68.00	0.00	62.39	9.13	307.38	15.67	15.67	5452
6	67.42	0.00	72.83	12.10	352.12	15.67	15.67	5452
7	66.84	0.00	83.26	15.08	396.85	15.08	15.08a	2883
8	66.04	0.00	97.64	19.18	458.53	19.18	19.18a	2883
9	65.42	0.00	108.79	22.36	506.31	22.36	22.36a	2883
10	64.80	0.00	119.93	25.54	554.08	27.32	27.32	2883
11	64.00	0.00	134.30	29.64	615.70	36.02	36.02	2883
12	63.33	6.75	139.67	31.17	638.72	40.18	46.93	2883
13	62.65	13.50	145.03	32.70	661.72	44.65	58.15	2883
14	61.93	20.75	150.79	34.34	686.40	49.75	70.50	2883
15	61.20	28.00	156.54	35.98	711.05	54.99	82.99	2883
		28.00	156.54	26.76	832.29	32.85	60.85	5405
16	60.60	34.00	161.89	28.16	858.23	39.00	73.00	5405
17	60.00	40.00	167.24	29.55	884.15	44.94	84.94	5405
18	59.20	48.00	174.37	31.42	918.68	52.46	100.46	5405
19	58.40	56.00	181.49	33.28	953.18	59.55	115.55	5405
20	57.60	64.00	188.60	35.14	987.64	66.04	130.04	5405
21	57.00	70.00	193.93	36.53	1013.47	70.59	140.59	5405
22	56.40	76.00	199.26	37.93	1039.28	75.12	151.12	5405

RIGHT side

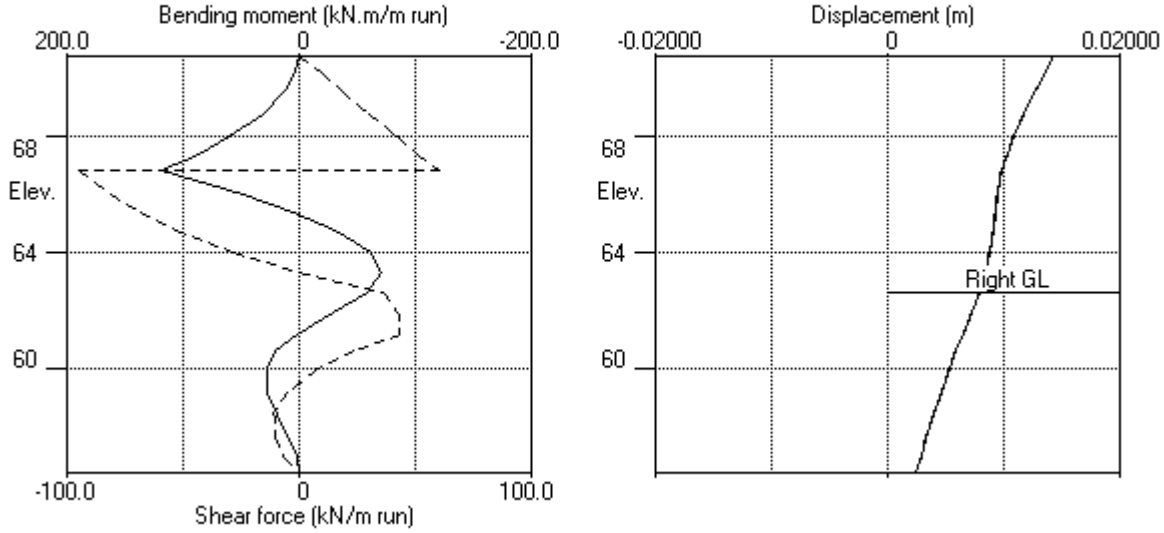
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	69.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	68.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	67.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	66.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	65.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	64.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	64.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	63.33	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	62.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	3931
14	61.93	7.25	5.80	0.00	64.74	64.74	71.99p	3931
15	61.20	14.50	11.62	0.00	89.70	65.17	79.67	3931
		14.50	11.62	0.00	130.16	83.64	98.14	7370
16	60.60	20.50	17.07	0.00	156.53	81.53	102.03	7370
17	60.00	26.50	22.54	0.00	183.06	79.63	106.13	7370
18	59.20	34.50	29.91	0.00	218.75	77.59	112.09	7370
19	58.40	42.50	37.37	0.00	254.89	76.09	118.59	7370
20	57.60	50.50	44.93	0.00	291.54	75.30	125.80	7370
21	57.00	56.50	50.68	0.00	319.39	75.06	131.56	7370
22	56.40	62.50	56.50	0.59	347.59	74.88	137.38	7370

(continued)

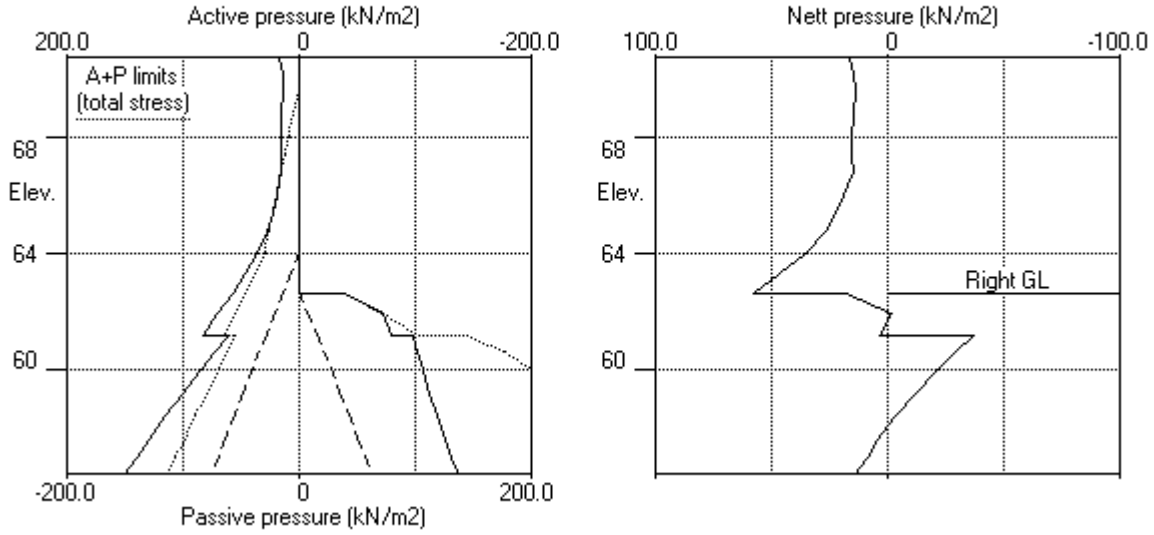
Stage No.8 Excavate to elevation 62.65 on RIGHT side
Note: 22.36a Soil pressure at active limit
71.99p Soil pressure at passive limit

Units: kN,m

Stage No.8 Excav. to elev. 62.65 on RIGHT side



Stage No.8 Excav. to elev. 62.65 on RIGHT side



Units: kN,m

Stage No. 9 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile 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. = 56.40** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
9	70.80	62.65	66.84	1.852	n/a	58.65	4.00	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	70.80	14.50	0.015	1.44E-03	0.0	0.0		163970
2	70.20	13.06	0.014	1.44E-03	8.3	2.7		163970
3	69.60	12.49	0.013	1.41E-03	15.9	10.3		163970
4	68.80	14.37	0.012	1.32E-03	26.7	28.0		163970
5	68.00	15.60	0.011	1.13E-03	38.7	55.0		163970
6	67.42	15.90	0.010	8.98E-04	47.8	80.6		163970
7	66.84	15.14	0.010	5.65E-04	56.8	111.6	-147.6	163970
		15.14	0.010	5.65E-04	-90.8	111.6		
8	66.04	19.18	0.010	1.96E-04	-77.0	43.5		163970
9	65.42	22.36	0.009	1.13E-04	-64.2	2.7		163970
10	64.80	26.32	0.009	1.73E-04	-49.1	-32.8		163970
11	64.00	34.75	0.009	4.04E-04	-24.6	-60.7		163970
12	63.33	45.62	0.009	6.73E-04	2.5	-69.0		163970
13	62.65	56.99	0.008	9.33E-04	37.1	-56.3		163970
		17.13	0.008	9.33E-04	37.1	-56.3		
14	61.93	-2.34	0.007	1.11E-03	42.5	-26.9		163970
15	61.20	1.82	0.007	1.17E-03	42.3	4.6		163970
		-40.09	0.007	1.17E-03	42.3	4.6		
16	60.60	-30.18	0.006	1.12E-03	21.2	22.9		163970
17	60.00	-21.11	0.005	1.02E-03	5.8	30.3		163970
18	59.20	-10.75	0.005	8.91E-04	-6.9	28.3		163970
19	58.40	-2.07	0.004	7.79E-04	-12.0	19.1		163970
20	57.60	4.88	0.003	7.15E-04	-10.9	8.4		163970
21	57.00	9.26	0.003	6.96E-04	-6.7	2.5		163970
22	56.40	13.00	0.002	6.92E-04	0.0	0.0		---

At elev. 66.84 Prop force = 147.6 kN/m run

(continued)

Stage No.9 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	12.00	0.00	91.31	14.50	14.50	8301
2	70.20	0.00	22.80	0.00	137.62	13.06	13.06	8301
3	69.60	0.00	33.60	0.92	183.92	12.49	12.49	8301
4	68.80	0.00	48.00	5.02	245.66	14.37	14.37	8301
5	68.00	0.00	62.39	9.13	307.38	15.60	15.60	8301
6	67.42	0.00	72.83	12.10	352.12	15.90	15.90	18067
7	66.84	0.00	83.26	15.08	396.85	15.14	15.14	383914
8	66.04	0.00	97.64	19.18	458.53	19.18	19.18a	3914
9	65.42	0.00	108.79	22.36	506.31	22.36	22.36a	3914
10	64.80	0.00	119.93	25.54	554.08	26.32	26.32	3914
11	64.00	0.00	134.30	29.64	615.70	34.75	34.75	3914
12	63.33	6.75	139.67	31.17	638.72	38.87	45.62	3914
13	62.65	13.50	145.03	32.70	661.72	43.49	56.99	3914
14	61.93	20.75	150.79	34.34	686.40	48.91	69.66	3914
15	61.20	28.00	156.54	35.98	711.05	54.52	82.52	3914
		28.00	156.54	26.76	832.29	31.97	59.97	7339
16	60.60	34.00	161.89	28.16	858.23	38.63	72.63	7339
17	60.00	40.00	167.24	29.55	884.15	44.98	84.98	10795
18	59.20	48.00	174.37	31.42	918.68	52.90	100.90	10795
19	58.40	56.00	181.49	33.28	953.18	60.04	116.04	10795
20	57.60	64.00	188.60	35.14	987.64	66.36	130.36	10795
21	57.00	70.00	193.93	36.53	1013.47	70.71	140.71	10795
22	56.40	76.00	199.26	37.93	1039.28	74.75	150.75	39771

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	70.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	70.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	69.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	68.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	68.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	67.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	66.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	65.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	64.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	64.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	63.33	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	62.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	8536
14	61.93	7.25	5.80	0.00	64.74	64.74	71.99p	8536
15	61.20	14.50	11.62	0.00	89.70	66.20	80.70	8536
		14.50	11.62	0.00	130.16	85.56	100.06	16005
16	60.60	20.50	17.07	0.00	156.53	82.32	102.82	16005
17	60.00	26.50	22.54	0.00	183.06	79.59	106.09	10795
18	59.20	34.50	29.91	0.00	218.75	77.15	111.65	10795
19	58.40	42.50	37.37	0.00	254.89	75.61	118.11	10795
20	57.60	50.50	44.93	0.00	291.54	74.98	125.48	10795
21	57.00	56.50	50.68	0.00	319.39	74.95	131.45	10795

(continued)

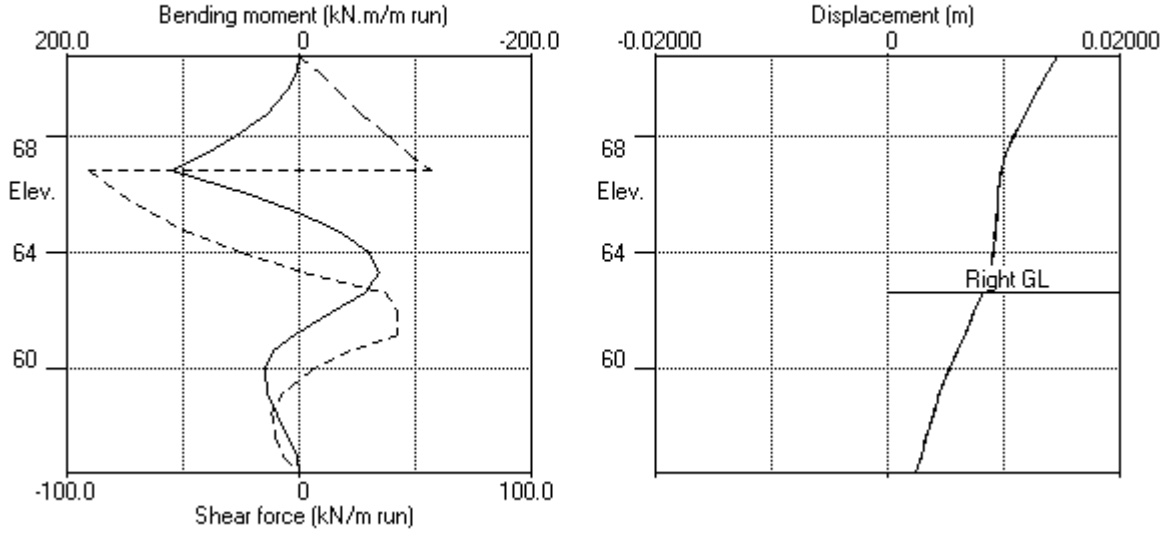
Stage No.9 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
22	56.40	62.50	56.50	0.59	347.59	75.25	137.75	39771

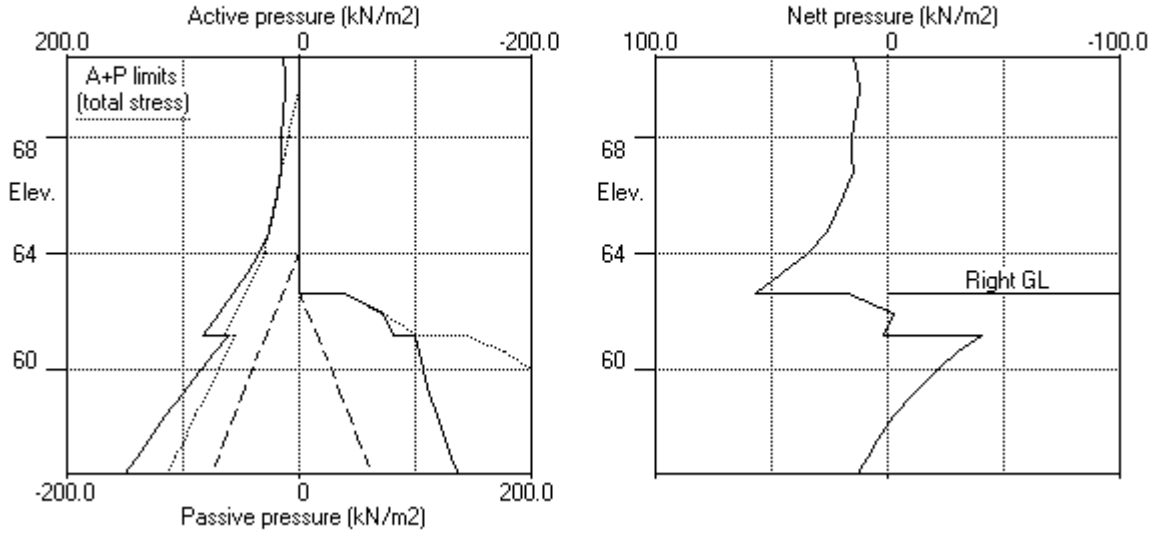
Note: 22.36a Soil pressure at active limit
71.99p Soil pressure at passive limit

Units: kN,m

Stage No.9 Change EI of wall to 163970kN.m2/m run



Stage No.9 Change EI of wall to 163970kN.m2/m run



Units: kN,m

Summary of results

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 56.40 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	70.80	70.80	Cant.	Conditions not suitable for FoS calc.				
2	70.80	70.80		No analysis at this stage				
3	70.80	70.80		No analysis at this stage				
4	70.80	70.80		No analysis at this stage				
5	70.80	66.04	Cant.	1.498	57.00	***	***	L to R
6	70.80	66.04	Cant.	1.498	57.00	***	***	L to R
7	70.80	66.04		No analysis at this stage				
8	70.80	62.65	66.84	1.852	n/a	58.65	4.00	L to R
9	70.80	62.65	66.84	1.852	n/a	58.65	4.00	L to R

Legend: *** Result not found

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

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	70.80	0.017	0.000	0.0	0.0	0.0	0.0
2	70.20	0.016	0.000	3.1	-0.0	9.6	-0.0
3	69.60	0.015	0.000	11.6	0.0	18.2	-0.0
4	68.80	0.014	0.000	31.0	-0.0	29.7	-0.0
5	68.00	0.012	0.000	60.0	0.0	42.0	-0.0
6	67.42	0.011	0.000	87.2	-0.0	51.1	-0.0
7	66.84	0.010	0.000	119.6	0.0	60.0	-94.9
8	66.04	0.010	0.000	49.0	-0.0	36.1	-81.2
9	65.42	0.009	0.000	66.7	0.0	20.8	-68.3
10	64.80	0.009	0.000	74.1	-32.8	4.9	-52.9
11	64.00	0.009	0.000	76.3	-61.2	0.0	-27.5
12	63.33	0.009	0.000	69.6	-70.7	2.5	-15.0
13	62.65	0.008	0.000	60.3	-58.8	37.1	-15.2
14	61.93	0.007	0.000	51.5	-29.8	42.5	-10.7
15	61.20	0.007	0.000	46.4	0.0	42.7	-3.8
16	60.60	0.006	0.000	42.4	0.0	22.8	-8.7
17	60.00	0.005	0.000	35.9	-0.0	7.7	-11.9
18	59.20	0.005	0.000	28.3	0.0	0.0	-13.3
19	58.40	0.004	0.000	19.2	-0.0	0.0	-12.1
20	57.60	0.003	0.000	8.7	0.0	0.0	-10.9
21	57.00	0.003	0.000	2.6	-0.0	0.0	-6.8
22	56.40	0.002	0.000	0.0	-0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	0.0	57.60	-0.0	63.33	0.0	70.80	-0.0	56.40
2	No calculation at this stage							
3	No calculation at this stage							
4	No calculation at this stage							
5	76.3	64.00	-0.0	70.20	36.1	66.04	-13.3	62.65
6	73.4	64.00	-0.0	70.20	36.1	66.04	-15.2	62.65
7	No calculation at this stage							
8	119.6	66.84	-70.7	63.33	60.0	66.84	-94.9	66.84
9	111.6	66.84	-69.0	63.33	56.8	66.84	-90.8	66.84

Summary of results (continued)

Maximum and minimum displacement at each stage

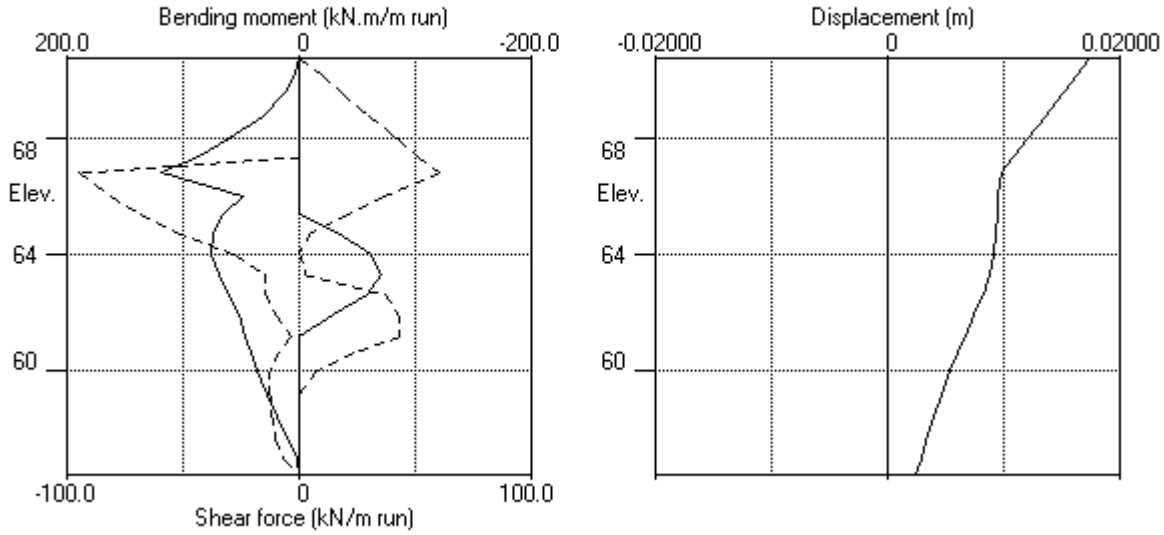
Stage no.	Displacement maximum (m)	elev.	minimum (m)	elev.	Stage description
1	0.000	56.40	-0.000	61.93	Change EI of wall to 1.0000E-04kN.m2/m run
2	No calculation at this stage				Apply surcharge no.1 at elev. 70.80
3	Wall displacements reset to zero				Change EI of wall to 327940kN.m2/m run
4	No calculation at this stage				Apply water pressure profile no.1
5	0.015	70.80	0.000	70.80	Excav. to elev. 66.04 on RIGHT side
6	0.017	70.80	0.000	70.80	Change EI of wall to 229558kN.m2/m run
7	No calculation at this stage				Install prop no.1 at elev. 66.84
8	0.014	70.80	0.000	70.80	Excav. to elev. 62.65 on RIGHT side
9	0.015	70.80	0.000	70.80	Change EI of wall to 163970kN.m2/m run

Prop forces at each stage (horizontal components)

Stage no.	--- Strut no. 1 --- at elev. 66.84	
	kN/m run	kN/prop
8	154.86	154.86
9	147.56	147.56

Units: kN,m

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	67.00	2 WWGS	2 WWGS
2	56.40	3 Transitional WG	3 Transitional WG
3	55.50	4 Waitemata Group Rock	4 Waitemata Group Rock

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Fill	18.00	9000	0.500	OC (0.200)	0.285 (1.238)	4.288 (5.694)	5.000d
2	WWGS	18.00	24000	0.500	OC (0.200)	0.285 (1.238)	4.288 (5.694)	7.000d
3	Transition-al WG	19.00	45000	0.470	OC (0.200)	0.262 (1.182)	4.845 (6.154)	12.00d
4	Waitemata Group Rock	19.00	150000	0.412	OC (0.200)	0.219 (1.075)	6.289 (7.279)	30.00d

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	0.631	0.00	30.00	0.464	0.00
2	WWGS	30.00	0.631	0.00	30.00	0.464	0.00
3	Transitional WG	32.00	0.625	0.00	32.00	0.459	0.00
4	Waitemata Group Rock	36.00	0.613	0.00	36.00	0.447	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	63.10	63.10

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	63.10	63.10	0.0	1	62.65	62.65	0.0

WALL PROPERTIES

Type of structure = Soldier Pile Wall
Soldier Pile width = 0.75 m
Soldier Pile spacing = 1.50 m
Passive mobilisation factor = 3.00
Elevation of toe of wall = 56.00
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 3.1685E+07 kN/m2
Moment of inertia of wall I = 0.010350 m4/m run
= 0.015525 m4 per pile
E.I = 327940 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	66.84	1.00	0.150000	3.169E+07	0.10	0.00	0	Strut	Yes	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	67.00	0.00(L)	50.00	50.00	12.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 1.0000E-04 kN.m2/m run Yield moment not defined No adjustments to wall displacements
2	Apply surcharge no.1 at elevation 67.00 No analysis at this stage
3	Change EI of wall to 327940 kN.m2/m run Yield moment not defined Reset wall displacements to zero at this stage
4	Apply water pressure profile no.1 No analysis at this stage
5	Excavate to elevation 62.65 on RIGHT side
6	Change EI of wall to 229558 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value
7	Install strut or anchor no.1 at elevation 66.84
8	Change EI of wall to 163970 kN.m2/m run Yield moment not defined Allow wall to relax with new modulus value

FACTORS OF SAFETY and ANALYSIS OPTIONS

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

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

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 0 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 m

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

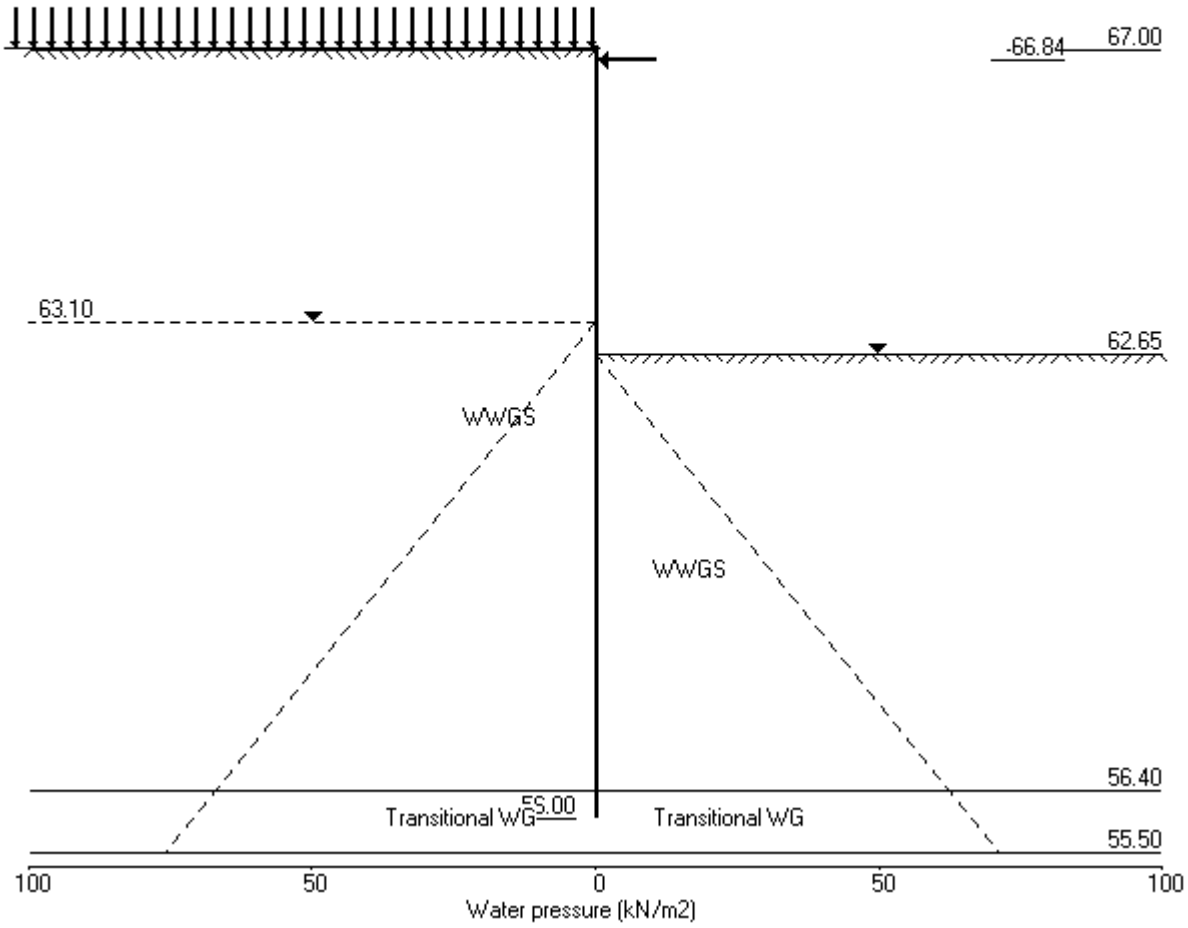
Distance to rigid boundary on Left side = 20.00 m
Distance to rigid boundary on Right side = 20.00 m

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 1.0000E-04kN.m2/m	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 67.00	No	No	No
3	Change EI of wall to 327940kN.m2/m run	No	No	No
4	Apply water pressure profile no.1	No	No	No
5	Excav. to elev. 62.65 on RIGHT side	Yes	Yes	Yes
6	Change EI of wall to 229558kN.m2/m run	Yes	Yes	Yes
7	Install prop no.1 at elev. 66.84	Yes	Yes	Yes
8	Change EI of wall to 163970kN.m2/m run	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No.8 Change EI of wall to 163970kN.m2/m run



Units: kN,m

Stage No. 1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements

STABILITY ANALYSIS of Soldier Pile 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. = 56.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	67.00	67.00	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

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	EI of wall kN.m2/m
1	67.00	-0.00	0.000	-2.63E-21	0.0	0.0		0
2	66.84	0.00	-0.000	5.278E-21	-0.0	-0.0		0
3	66.42	0.00	0.000	-3.13E-20	-0.0	0.0		0
4	66.00	0.00	-0.000	1.20E-19	-0.0	-0.0		0
5	65.40	0.00	0.000	-5.38E-19	-0.0	0.0		0
6	64.80	0.00	-0.000	2.03E-18	-0.0	-0.0		0
7	64.20	0.00	0.000	-7.59E-18	-0.0	0.0		0
8	63.65	0.00	-0.000	2.72E-17	-0.0	-0.0		0
9	63.10	0.00	0.000	-1.01E-16	-0.0	0.0		0
10	62.65	0.00	-0.000	3.46E-16	-0.0	-0.0		0
11	62.23	0.00	0.000	-1.25E-15	-0.0	0.0		0
12	61.80	0.00	0.000	-7.76E-15	-0.0	0.0		0
13	61.20	0.00	0.000	4.09E-16	-0.0	-0.0		0
14	60.60	0.00	0.000	-1.09E-16	-0.0	0.0		0
15	60.00	0.00	0.000	2.69E-17	-0.0	-0.0		0
16	59.40	0.00	0.000	7.51E-15	-0.0	0.0		0
17	58.80	0.00	0.000	-7.55E-15	-0.0	0.0		0
18	58.20	0.00	0.000	-7.38E-15	-0.0	-0.0		0
19	57.60	-0.00	0.000	-4.95E-16	-0.0	0.0		0
20	57.00	0.00	0.000	1.84E-15	-0.0	-0.0		0
21	56.40	0.00	0.000	4.79E-15	-0.0	0.0		0
22	56.00	-0.00	0.000	4.62E-15	-0.0	-0.0		---

(continued)

Stage No.1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	67.00	0.00	0.00	0.00	39.86	0.00	0.00a	109798
2	66.84	0.00	2.88	0.00	52.21	1.44	1.44	85195
3	66.42	0.00	10.44	0.00	84.62	5.22	5.22	30901
4	66.00	0.00	18.00	0.00	117.04	9.00	9.00	34275
5	65.40	0.00	28.80	0.00	163.35	14.40	14.40	25718
6	64.80	0.00	39.60	2.63	209.65	19.80	19.80	26098
7	64.20	0.00	50.40	5.71	255.96	25.20	25.20	25193
8	63.65	0.00	60.30	8.53	298.41	30.15	30.15	28695
9	63.10	0.00	70.20	11.36	340.86	35.10	35.10	28148
10	62.65	4.50	73.80	12.38	356.29	36.90	41.40	26639
11	62.23	8.75	77.20	13.35	370.87	38.60	47.35	3226
12	61.80	13.00	80.60	14.32	385.45	40.30	53.30	3226
13	61.20	19.00	85.40	15.69	406.03	42.70	61.70	3226
14	60.60	25.00	90.20	17.06	426.61	45.10	70.10	3226
15	60.00	31.00	95.00	18.43	447.19	47.50	78.50	3226
16	59.40	37.00	99.80	19.80	467.77	49.90	86.90	3226
17	58.80	43.00	104.60	21.17	488.35	52.30	95.30	3226
18	58.20	49.00	109.40	22.54	508.93	54.70	103.70	3226
19	57.60	55.00	114.20	23.90	529.52	57.10	112.10	3226
20	57.00	61.00	119.00	25.27	550.10	59.50	120.50	3226
21	56.40	67.00	123.80	26.64	570.68	61.90	128.90	3226
		67.00	123.80	18.19	673.67	58.19	125.19	6049
22	56.00	71.00	127.40	19.14	691.11	59.88	130.88	6049

RIGHT side

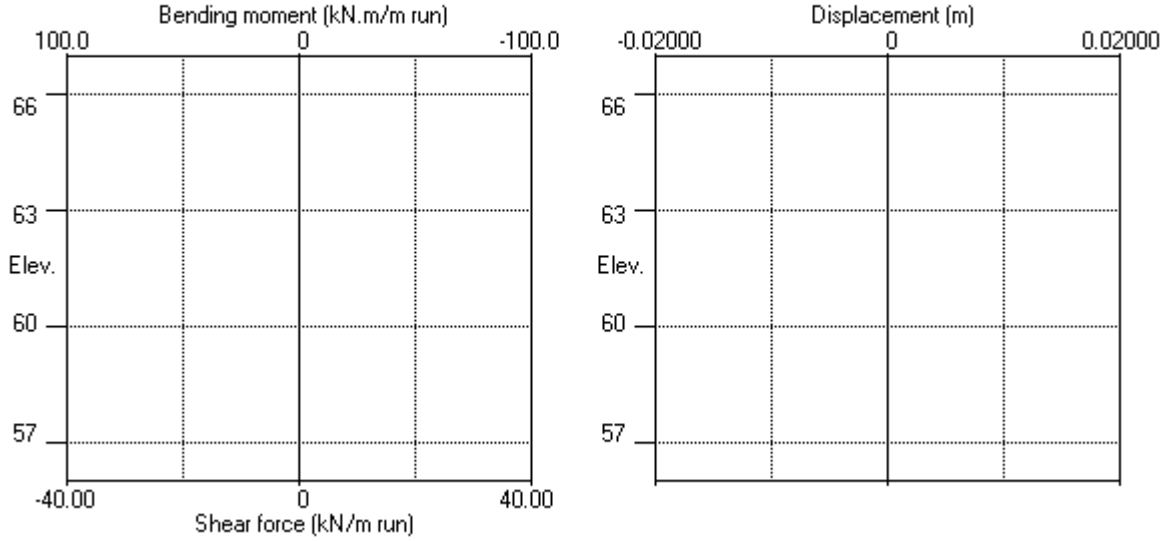
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	67.00	0.00	0.00	0.00	39.86	0.00	0.00a	109798
2	66.84	0.00	2.88	0.00	52.21	1.44	1.44	85195
3	66.42	0.00	10.44	0.00	84.62	5.22	5.22	30901
4	66.00	0.00	18.00	0.00	117.04	9.00	9.00	34275
5	65.40	0.00	28.80	0.00	163.35	14.40	14.40	25718
6	64.80	0.00	39.60	2.63	209.65	19.80	19.80	26098
7	64.20	0.00	50.40	5.71	255.96	25.20	25.20	25193
8	63.65	0.00	60.30	8.53	298.41	30.15	30.15	28695
9	63.10	0.00	70.20	11.36	340.86	35.10	35.10	28148
10	62.65	4.50	73.80	12.38	356.29	36.90	41.40	26639
11	62.23	8.75	77.20	13.35	370.87	38.60	47.35	3226
12	61.80	13.00	80.60	14.32	385.45	40.30	53.30	3226
13	61.20	19.00	85.40	15.69	406.03	42.70	61.70	3226
14	60.60	25.00	90.20	17.06	426.61	45.10	70.10	3226
15	60.00	31.00	95.00	18.43	447.19	47.50	78.50	3226
16	59.40	37.00	99.80	19.80	467.77	49.90	86.90	3226
17	58.80	43.00	104.60	21.17	488.35	52.30	95.30	3226
18	58.20	49.00	109.40	22.54	508.93	54.70	103.70	3226
19	57.60	55.00	114.20	23.90	529.52	57.10	112.10	3226
20	57.00	61.00	119.00	25.27	550.10	59.50	120.50	3226
21	56.40	67.00	123.80	26.64	570.68	61.90	128.90	3226
		67.00	123.80	18.19	673.67	58.19	125.19	6049
22	56.00	71.00	127.40	19.14	691.11	59.88	130.88	6049

(continued)

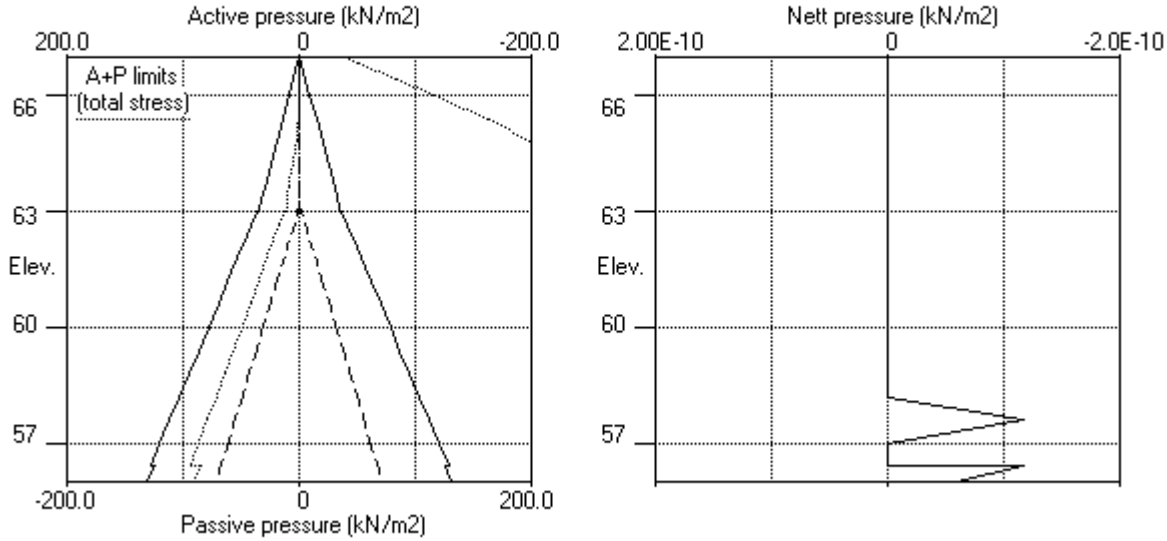
Stage No.1 Change EI of wall to 1.0000E-04 kN.m2/m run
Yield moment not defined
No adjustments to wall displacements
Note: 0.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.1 Change EI of wall to 1.0000E-04kN.m2/m run



Stage No.1 Change EI of wall to 1.0000E-04kN.m2/m run



Units: kN,m

Stage No. 5 Excavate to elevation 62.65 on RIGHT side

STABILITY ANALYSIS of Soldier Pile 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. = 56.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
5	67.00	62.65	Cant.	1.475	56.49	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	67.00	0.00	0.013	1.31E-03	0.0	-0.0		327940
2	66.84	0.00	0.013	1.31E-03	0.0	0.0		327940
3	66.42	0.00	0.012	1.31E-03	0.0	-0.0		327940
4	66.00	0.00	0.011	1.31E-03	0.0	-0.0		327940
5	65.40	2.97	0.011	1.31E-03	0.9	0.2		327940
6	64.80	6.05	0.010	1.31E-03	3.6	1.4		327940
7	64.20	9.13	0.009	1.30E-03	8.1	4.9		327940
8	63.65	11.95	0.008	1.29E-03	13.9	10.9		327940
9	63.10	14.77	0.008	1.27E-03	21.3	20.5		327940
10	62.65	20.30	0.007	1.23E-03	29.2	31.8		327940
		-19.56	0.007	1.23E-03	29.2	31.8		
11	62.23	-23.39	0.007	1.18E-03	20.1	43.8		327940
12	61.80	-19.73	0.006	1.12E-03	10.9	50.2		327940
13	61.20	-14.91	0.005	1.02E-03	0.5	53.2		327940
14	60.60	-10.52	0.005	9.34E-04	-7.1	50.8		327940
15	60.00	-6.54	0.004	8.47E-04	-12.2	44.6		327940
16	59.40	-2.94	0.004	7.73E-04	-15.1	36.1		327940
17	58.80	0.36	0.003	7.16E-04	-15.9	26.5		327940
18	58.20	3.44	0.003	6.76E-04	-14.7	17.0		327940
19	57.60	6.37	0.003	6.53E-04	-11.8	8.8		327940
20	57.00	9.21	0.002	6.42E-04	-7.1	2.9		327940
21	56.40	12.01	0.002	6.39E-04	-0.7	0.3		327940
		0.08	0.002	6.39E-04	-0.7	0.3		
22	56.00	3.61	0.002	6.39E-04	0.0	-0.0		---

(continued)

Stage No.5 Excavate to elevation 62.65 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	67.00	0.00	12.00	0.00	91.31	0.00	0.00a	3392
2	66.84	0.00	14.88	0.00	103.66	0.00	0.00a	3392
3	66.42	0.00	22.44	0.00	136.07	0.00	0.00a	3392
4	66.00	0.00	30.00	0.00	168.49	0.00	0.00a	3392
5	65.40	0.00	40.80	2.97	214.79	2.97	2.97a	3392
6	64.80	0.00	51.60	6.05	261.09	6.05	6.05a	3392
7	64.20	0.00	62.39	9.13	307.38	9.13	9.13a	3392
8	63.65	0.00	72.29	11.95	349.81	11.95	11.95a	3392
9	63.10	0.00	82.18	14.77	392.22	14.77	14.77a	3392
10	62.65	4.50	85.77	15.80	407.63	15.80	20.30a	3392
11	62.23	8.75	89.16	16.76	422.17	19.19	27.94	3392
12	61.80	13.00	92.55	17.73	436.70	22.55	35.55	3392
13	61.20	19.00	97.34	19.09	457.21	27.14	46.14	3392
14	60.60	25.00	102.12	20.46	477.70	31.53	56.53	3392
15	60.00	31.00	106.89	21.82	498.18	35.74	66.74	3392
16	59.40	37.00	111.66	23.18	518.64	39.78	76.78	3392
17	58.80	43.00	116.43	24.54	539.08	43.68	86.68	3392
18	58.20	49.00	121.19	25.90	559.50	47.49	96.49	3392
19	57.60	55.00	125.95	27.26	579.91	51.23	106.23	3392
20	57.00	61.00	130.71	28.61	600.30	54.93	115.93	3392
21	56.40	67.00	135.46	29.97	620.67	58.63	125.63	3392
		67.00	135.46	21.24	730.16	49.50	116.50	6360
22	56.00	71.00	139.02	22.18	747.44	52.81	123.81	6360

RIGHT side

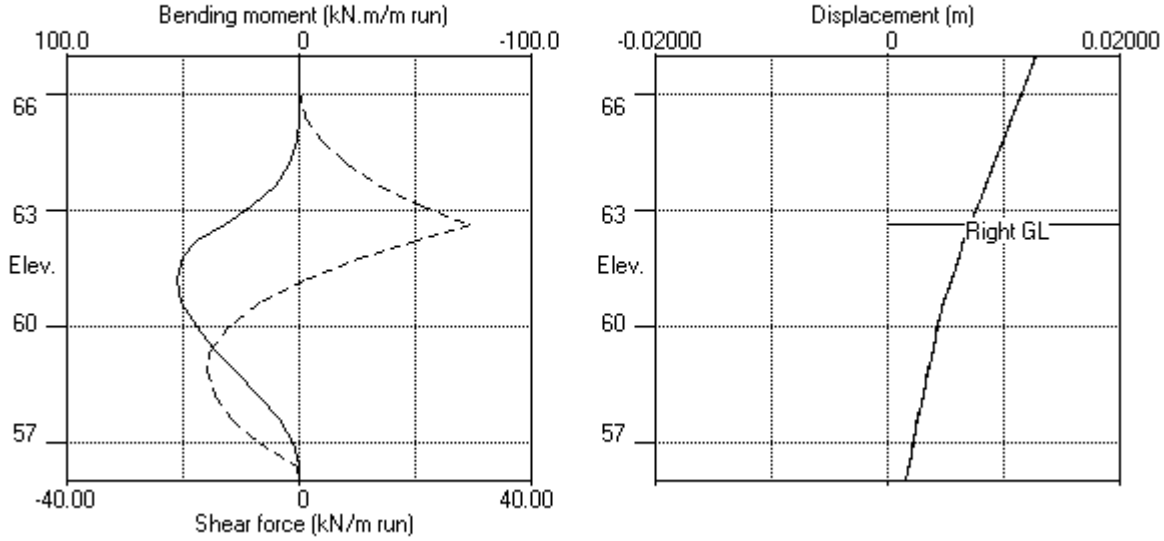
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	67.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	66.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	66.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	65.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	64.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	64.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	63.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	63.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	62.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	4077
11	62.23	4.25	3.40	0.00	54.44	47.08	51.33	4077
12	61.80	8.50	6.80	0.00	69.03	46.78	55.28	4077
13	61.20	14.50	11.61	0.00	89.65	46.55	61.05	4077
14	60.60	20.50	16.44	0.00	110.33	46.55	67.05	4077
15	60.00	26.50	21.28	0.00	131.08	46.78	73.28	4077
16	59.40	32.50	26.14	0.00	151.93	47.22	79.72	4077
17	58.80	38.50	31.03	0.18	172.89	47.82	86.32	4077
18	58.20	44.50	35.95	1.59	193.98	48.55	93.05	4077
19	57.60	50.50	40.90	3.00	215.21	49.36	99.86	4077
20	57.00	56.50	45.88	4.42	236.59	50.23	106.73	4077
21	56.40	62.50	50.91	5.85	258.13	51.12	113.62	4077
		62.50	50.91	0.00	320.49	53.91	116.41	7645
22	56.00	66.50	54.68	0.12	338.76	53.69	120.19	7645

(continued)

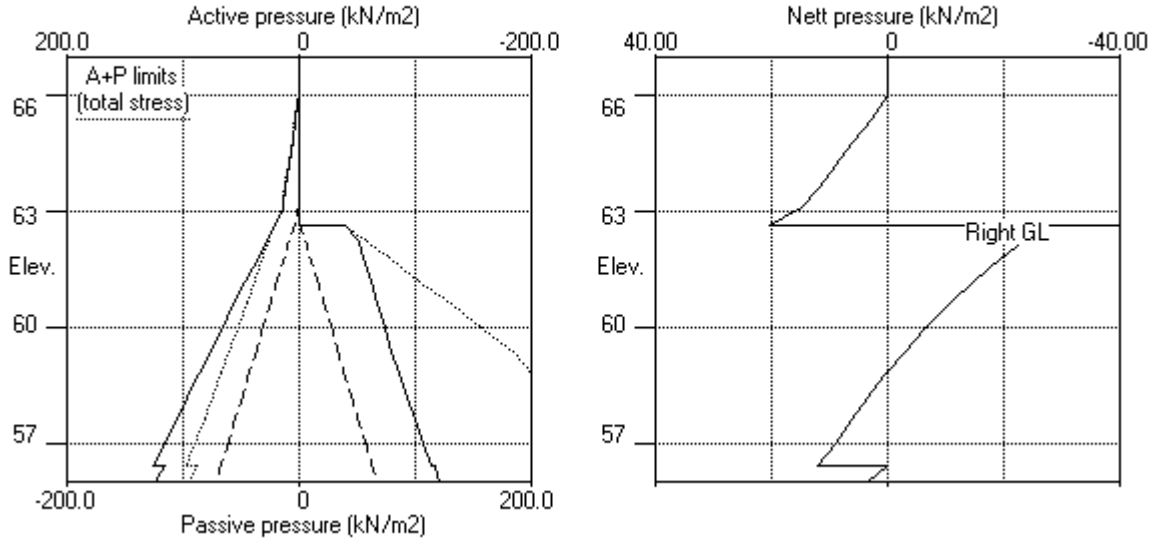
Stage No.5 Excavate to elevation 62.65 on RIGHT side
Note: 20.30a Soil pressure at active limit
39.86p Soil pressure at passive limit

Units: kN,m

Stage No.5 Excav. to elev. 62.65 on RIGHT side



Stage No.5 Excav. to elev. 62.65 on RIGHT side



Units: kN,m

Stage No. 6 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile 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. = 56.00 Factor of Safety	FoS for toe elev. = 56.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
6	67.00	62.65	Cant.	1.475	56.49	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	67.00	0.00	0.014	1.52E-03	0.0	-0.0		229558
2	66.84	0.00	0.014	1.52E-03	0.0	0.0		229558
3	66.42	0.00	0.013	1.52E-03	0.0	-0.0		229558
4	66.00	0.00	0.012	1.52E-03	0.0	-0.0		229558
5	65.40	2.97	0.011	1.52E-03	0.9	0.2		229558
6	64.80	6.05	0.010	1.52E-03	3.6	1.4		229558
7	64.20	9.13	0.010	1.51E-03	8.1	4.9		229558
8	63.65	11.95	0.009	1.49E-03	13.9	10.9		229558
9	63.10	14.77	0.008	1.45E-03	21.3	20.5		229558
10	62.65	20.30	0.007	1.40E-03	29.2	31.8		229558
		-19.56	0.007	1.40E-03	29.2	31.8		
11	62.23	-25.44	0.007	1.33E-03	19.6	43.8		229558
12	61.80	-20.54	0.006	1.24E-03	9.8	49.9		229558
13	61.20	-14.68	0.005	1.11E-03	-0.7	52.3		229558
14	60.60	-9.92	0.005	9.83E-04	-8.1	49.4		229558
15	60.00	-5.76	0.004	8.64E-04	-12.8	42.8		229558
16	59.40	-2.14	0.004	7.65E-04	-15.2	34.2		229558
17	58.80	1.06	0.003	6.89E-04	-15.5	24.7		229558
18	58.20	3.96	0.003	6.38E-04	-14.0	15.5		229558
19	57.60	6.66	0.003	6.09E-04	-10.8	7.7		229558
20	57.00	9.25	0.002	5.97E-04	-6.0	2.2		229558
21	56.40	11.20	0.002	5.94E-04	0.1	0.1		229558
		-1.43	0.002	5.94E-04	0.1	0.1		
22	56.00	0.89	0.002	5.94E-04	0.0	-0.0		---

(continued)

Stage No.6 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	67.00	0.00	12.00	0.00	91.31	0.00	0.00a	5174
2	66.84	0.00	14.88	0.00	103.66	0.00	0.00a	5174
3	66.42	0.00	22.44	0.00	136.07	0.00	0.00a	5174
4	66.00	0.00	30.00	0.00	168.49	0.00	0.00a	5174
5	65.40	0.00	40.80	2.97	214.79	2.97	2.97a	5174
6	64.80	0.00	51.60	6.05	261.09	6.05	6.05a	5174
7	64.20	0.00	62.39	9.13	307.38	9.13	9.13a	5174
8	63.65	0.00	72.29	11.95	349.81	11.95	11.95a	5174
9	63.10	0.00	82.18	14.77	392.22	14.77	14.77a	5174
10	62.65	4.50	85.77	15.80	407.63	15.80	20.30a	5174
11	62.23	8.75	89.16	16.76	422.17	18.69	27.44	5174
12	61.80	13.00	92.55	17.73	436.70	22.35	35.35	5174
13	61.20	19.00	97.34	19.09	457.21	27.25	46.25	4626
14	60.60	25.00	102.12	20.46	477.70	31.83	56.83	4626
15	60.00	31.00	106.89	21.82	498.18	36.13	67.13	4626
16	59.40	37.00	111.66	23.18	518.64	40.18	77.18	4626
17	58.80	43.00	116.43	24.54	539.08	44.03	87.03	4626
18	58.20	49.00	121.19	25.90	559.50	47.75	96.75	4626
19	57.60	55.00	125.95	27.26	579.91	51.37	106.37	4626
20	57.00	61.00	130.71	28.61	600.30	54.96	115.96	4626
21	56.40	67.00	135.46	29.97	620.67	58.22	125.22	18019
		67.00	135.46	21.24	730.16	48.74	115.74	33786
22	56.00	71.00	139.02	22.18	747.44	51.44	122.44	33786

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	67.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	66.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	66.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	65.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	64.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	64.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	63.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	63.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	62.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.86	39.86p	16051
11	62.23	4.25	3.40	0.00	54.44	48.63	52.88	16051
12	61.80	8.50	6.80	0.00	69.03	47.39	55.89	16051
13	61.20	14.50	11.61	0.00	89.65	46.43	60.93	4626
14	60.60	20.50	16.44	0.00	110.33	46.25	66.75	4626
15	60.00	26.50	21.28	0.00	131.08	46.39	72.89	4626
16	59.40	32.50	26.14	0.00	151.93	46.82	79.32	4626
17	58.80	38.50	31.03	0.18	172.89	47.47	85.97	4626
18	58.20	44.50	35.95	1.59	193.98	48.29	92.79	4626
19	57.60	50.50	40.90	3.00	215.21	49.22	99.72	4626
20	57.00	56.50	45.88	4.42	236.59	50.21	106.71	4626
21	56.40	62.50	50.91	5.85	258.13	51.52	114.02	18019
		62.50	50.91	0.00	320.49	54.67	117.17	33786

(continued)

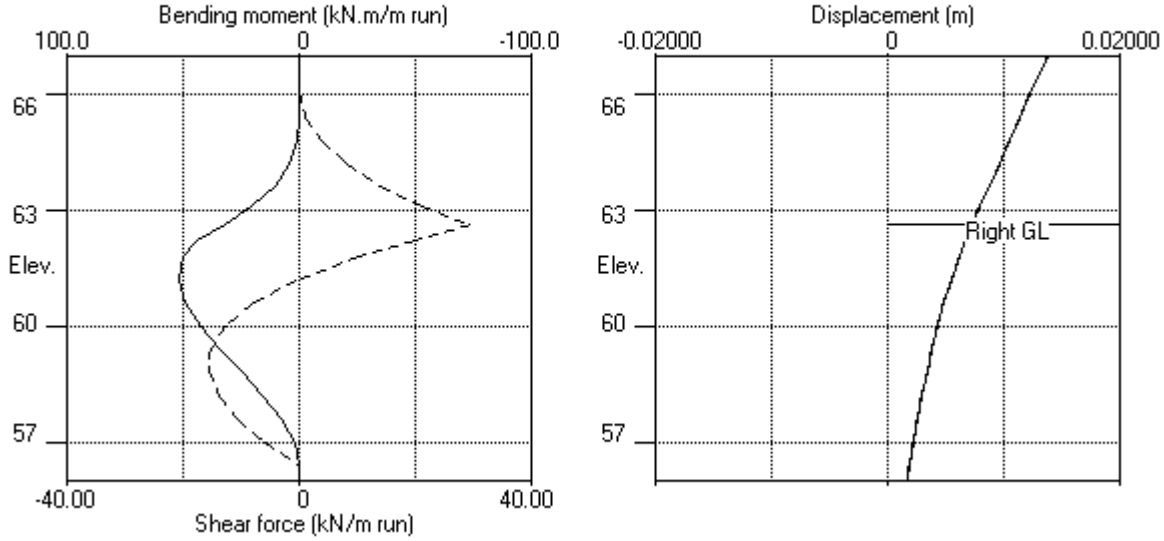
Stage No.6 Change EI of wall to 229558 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
22	56.00	66.50	54.68	0.12	338.76	55.05	121.55	33786

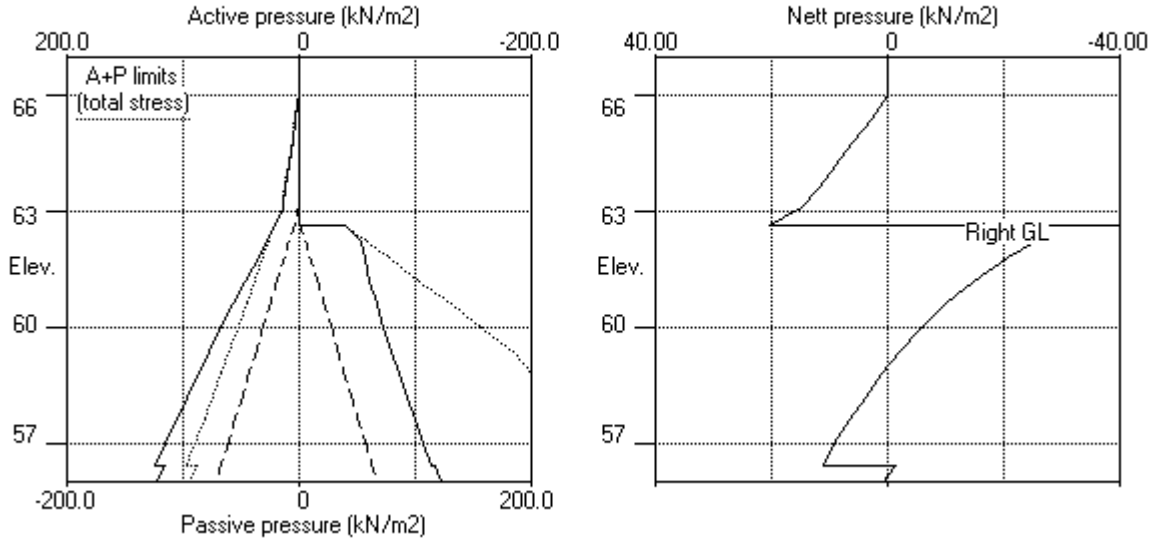
Note: 20.30a Soil pressure at active limit
39.86p Soil pressure at passive limit

Units: kN,m

Stage No.6 Change EI of wall to 229558kN.m2/m run



Stage No.6 Change EI of wall to 229558kN.m2/m run



Units: kN,m

Stage No. 8 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

STABILITY ANALYSIS of Soldier Pile Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = 56.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
8	67.00	62.65	66.84	2.300	n/a	59.95	2.70	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall
Analysis options
Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	67.00	0.02	0.014	1.52E-03	0.0	-0.0		163970
2	66.84	0.00	0.014	1.52E-03	0.0	0.0	-1.8	163970
		0.00	0.014	1.52E-03	-1.8	0.0		
3	66.42	0.00	0.013	1.52E-03	-1.8	-0.6		163970
4	66.00	0.00	0.012	1.52E-03	-1.8	-1.2		163970
5	65.40	2.98	0.011	1.53E-03	-1.0	-1.9		163970
6	64.80	6.10	0.010	1.54E-03	1.8	-1.5		163970
7	64.20	9.24	0.010	1.54E-03	6.4	1.1		163970
8	63.65	12.14	0.009	1.53E-03	12.3	6.4		163970
9	63.10	15.06	0.008	1.50E-03	19.7	15.3		163970
10	62.65	20.66	0.007	1.45E-03	27.8	26.0		163970
		-18.80	0.007	1.45E-03	27.8	26.0		
11	62.23	-24.53	0.007	1.37E-03	18.6	37.6		163970
12	61.80	-19.51	0.006	1.27E-03	9.2	43.4		163970
13	61.20	-13.58	0.005	1.12E-03	-0.7	45.6		163970
14	60.60	-8.85	0.005	9.66E-04	-7.5	42.8		163970
15	60.00	-4.82	0.004	8.28E-04	-11.5	36.7		163970
16	59.40	-1.39	0.004	7.16E-04	-13.4	28.7		163970
17	58.80	1.56	0.003	6.33E-04	-13.4	20.2		163970
18	58.20	4.19	0.003	5.79E-04	-11.6	12.1		163970
19	57.60	6.54	0.003	5.52E-04	-8.4	5.4		163970
20	57.00	8.39	0.002	5.42E-04	-3.9	1.1		163970
21	56.40	9.63	0.002	5.41E-04	1.5	-0.1		163970
		-4.38	0.002	5.41E-04	1.5	-0.1		
22	56.00	-2.93	0.002	5.42E-04	0.0	-0.0		---

At elev. 66.84 Prop force = 1.8 kN/m run

(continued)

Stage No.8 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	67.00	0.00	12.00	0.00	91.31	0.02	0.02	89385
2	66.84	0.00	14.88	0.00	103.66	0.00	0.00a	17142
3	66.42	0.00	22.44	0.00	136.07	0.00	0.00a	17142
4	66.00	0.00	30.00	0.00	168.49	0.00	0.00a	17142
5	65.40	0.00	40.80	2.97	214.79	2.98	2.98	3698
6	64.80	0.00	51.60	6.05	261.09	6.10	6.10	3698
7	64.20	0.00	62.39	9.13	307.38	9.24	9.24	3698
8	63.65	0.00	72.29	11.95	349.81	12.14	12.14	3698
9	63.10	0.00	82.18	14.77	392.22	15.06	15.06	3698
10	62.65	4.50	85.77	15.80	407.63	16.16	20.66	3698
11	62.23	8.75	89.16	16.76	422.17	19.12	27.87	3698
12	61.80	13.00	92.55	17.73	436.70	22.84	35.84	3698
13	61.20	19.00	97.34	19.09	457.21	27.78	46.78	3698
14	60.60	25.00	102.12	20.46	477.70	32.34	57.34	3698
15	60.00	31.00	106.89	21.82	498.18	36.58	67.58	3698
16	59.40	37.00	111.66	23.18	518.64	40.53	77.53	3698
17	58.80	43.00	116.43	24.54	539.08	44.27	87.27	3698
18	58.20	49.00	121.19	25.90	559.50	47.86	96.86	3698
19	57.60	55.00	125.95	27.26	579.91	51.31	106.31	11059
20	57.00	61.00	130.71	28.61	600.30	54.52	115.52	11059
21	56.40	67.00	135.46	29.97	620.67	57.44	124.44	11059
		67.00	135.46	21.24	730.16	47.26	114.26	20736
22	56.00	71.00	139.02	22.18	747.44	49.53	120.53	20736

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	67.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	66.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	66.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	66.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	65.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	64.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	64.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	63.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	63.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	62.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	39.86	39.46	39.46	4032
11	62.23	4.25	3.40	0.00	54.44	48.15	52.40	4032
12	61.80	8.50	6.80	0.00	69.03	46.85	55.35	4032
13	61.20	14.50	11.61	0.00	89.65	45.86	60.36	4032
14	60.60	20.50	16.44	0.00	110.33	45.69	66.19	4032
15	60.00	26.50	21.28	0.00	131.08	45.90	72.40	4032
16	59.40	32.50	26.14	0.00	151.93	46.43	78.93	4032
17	58.80	38.50	31.03	0.18	172.89	47.21	85.71	4032
18	58.20	44.50	35.95	1.59	193.98	48.17	92.67	4032
19	57.60	50.50	40.90	3.00	215.21	49.28	99.78	11059
20	57.00	56.50	45.88	4.42	236.59	50.64	107.14	11059
21	56.40	62.50	50.91	5.85	258.13	52.31	114.81	11059
		62.50	50.91	0.00	320.49	56.14	118.64	20736

(continued)

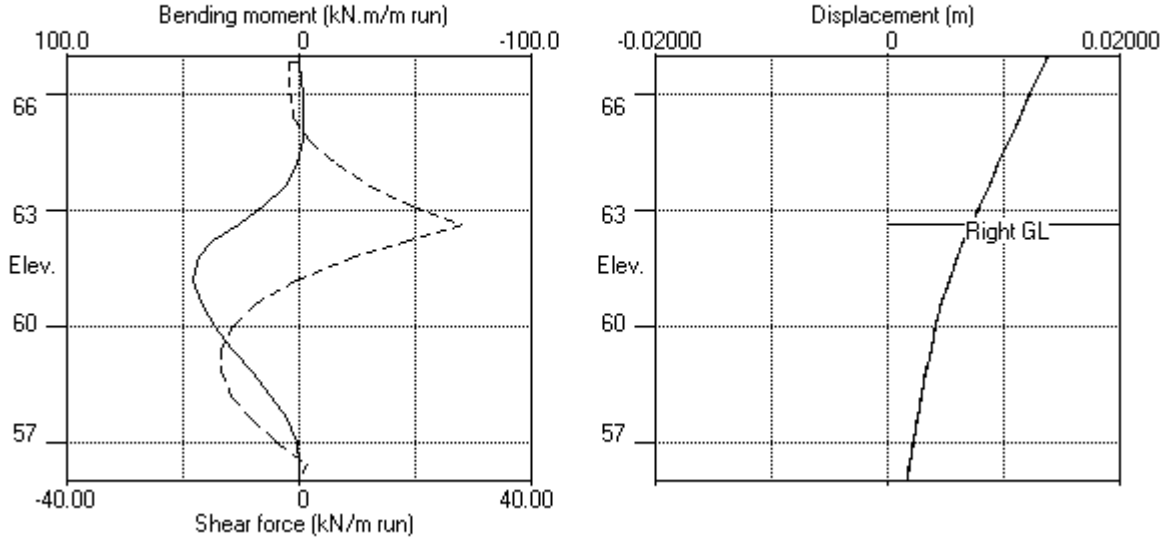
Stage No.8 Change EI of wall to 163970 kN.m2/m run
Yield moment not defined
Allow wall to relax with new modulus value

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
22	56.00	66.50	54.68	0.12	338.76	56.96	123.46	20736

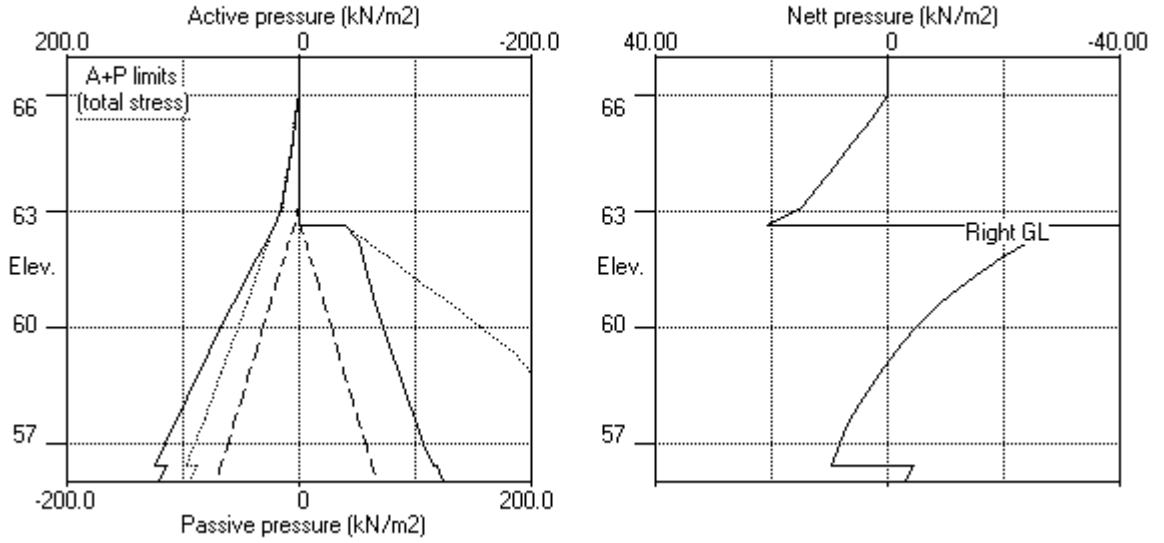
Note: 0.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.8 Change EI of wall to 163970kN.m2/m run



Stage No.8 Change EI of wall to 163970kN.m2/m run



Units: kN,m

Summary of results

STABILITY ANALYSIS of Soldier Pile 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. = 56.00 Factor of Safety	FoS for toe elev. = 56.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
1	67.00	67.00	Cant.	Conditions not suitable for FoS calc.				
2	67.00	67.00		No analysis at this stage				
3	67.00	67.00		No analysis at this stage				
4	67.00	67.00		No analysis at this stage				
5	67.00	62.65	Cant.	1.475	56.49	***	***	L to R
6	67.00	62.65	Cant.	1.475	56.49	***	***	L to R
7	67.00	62.65		No analysis at this stage				
8	67.00	62.65	66.84	2.300	n/a	59.95	2.70	L to R

Legend: *** Result not found

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Soldier Pile Wall

Analysis options

Soldier Pile width = 0.75m; spacing = 1.50m
Passive mobilisation factor = 3.000
Length of wall perpendicular to section = 20.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

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	67.00	0.014	0.000	0.0	-0.0	0.0	0.0
2	66.84	0.014	0.000	0.0	-0.0	0.0	-1.8
3	66.42	0.013	0.000	0.0	-0.6	0.0	-1.8
4	66.00	0.012	0.000	0.0	-1.2	0.0	-1.8
5	65.40	0.011	0.000	0.2	-1.9	0.9	-1.0
6	64.80	0.010	0.000	1.4	-1.5	3.6	-0.0
7	64.20	0.010	0.000	4.9	0.0	8.1	-0.0
8	63.65	0.009	0.000	10.9	-0.0	13.9	-0.0
9	63.10	0.008	0.000	20.5	0.0	21.3	-0.0
10	62.65	0.007	0.000	31.8	-0.0	29.2	-0.0
11	62.23	0.007	0.000	43.8	0.0	20.1	-0.0
12	61.80	0.006	0.000	50.2	0.0	10.9	-0.0
13	61.20	0.005	0.000	53.2	-0.0	0.5	-0.7
14	60.60	0.005	0.000	50.8	0.0	0.0	-8.1
15	60.00	0.004	0.000	44.6	-0.0	0.0	-12.8
16	59.40	0.004	0.000	36.1	0.0	0.0	-15.2
17	58.80	0.003	0.000	26.5	0.0	0.0	-15.9
18	58.20	0.003	0.000	17.0	-0.0	0.0	-14.7
19	57.60	0.003	0.000	8.8	0.0	0.0	-11.8
20	57.00	0.002	0.000	2.9	-0.0	0.0	-7.1
21	56.40	0.002	0.000	0.3	-0.1	1.5	-0.7
22	56.00	0.002	0.000	0.0	-0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	0.0	60.60	-0.0	60.00	0.0	67.00	-0.0	56.00
2	No calculation at this stage							
3	No calculation at this stage							
4	No calculation at this stage							
5	53.2	61.20	-0.0	66.00	29.2	62.65	-15.9	58.80
6	52.3	61.20	-0.0	66.00	29.2	62.65	-15.5	58.80
7	No calculation at this stage							
8	45.6	61.20	-1.9	65.40	27.8	62.65	-13.4	59.40

Summary of results (continued)

Maximum and minimum displacement at each stage

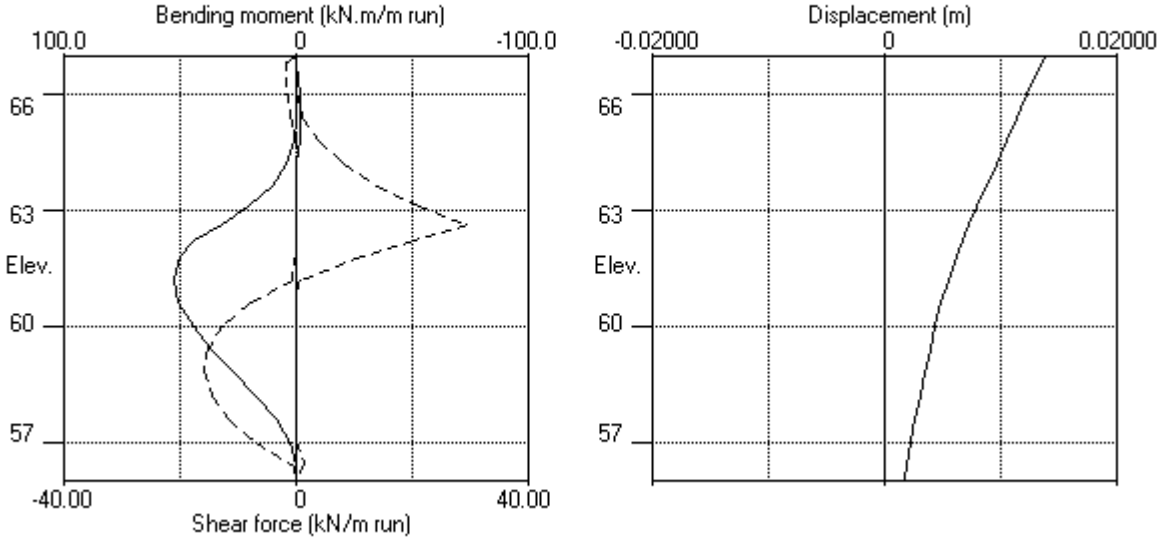
Stage no.	Displacement maximum (m)	elev.	minimum (m)	elev.	Stage description
1	0.000	57.60	-0.000	62.65	Change EI of wall to 1.0000E-04kN.m2/m run
2	No calculation at this stage				Apply surcharge no.1 at elev. 67.00
3	Wall displacements reset to zero				Change EI of wall to 327940kN.m2/m run
4	No calculation at this stage				Apply water pressure profile no.1
5	0.013	67.00	0.000	67.00	Excav. to elev. 62.65 on RIGHT side
6	0.014	67.00	0.000	67.00	Change EI of wall to 229558kN.m2/m run
7	No calculation at this stage				Install prop no.1 at elev. 66.84
8	0.014	67.00	0.000	67.00	Change EI of wall to 163970kN.m2/m run

Prop forces at each stage (horizontal components)

Stage no.	--- Strut no. 1 --- at elev. 66.84 kN/m run	kN/prop
8	1.85	1.85

Units: kN,m

Bending moment, shear force, displacement envelopes



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Appendix E

Settlement Calculations and Outputs

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Project No	Sheet No.	Rev
20111	1	B

Calculation Sheet

Project : **538 Karangahape Rd, Newton** Made by **MC**

Location : **Section C-C' - Grid AB** Date Nov-23

1. It is assumed that the dewatering has occurred prior to commencing excavation.

2. It is assumed that there will not be any change in total pressure in the soil,
thus the change in effective stress of the soil should be equal to the change in pore water pressure.

Settlement, Sd = dσ' x dH x m_v => dσ'= increase in effective vertical stress due to GW drawdown

dH = the thickness of soil layer

m_v = the coefficient of volume compressibility = 1/M' => M' = stiffness modulus = $\frac{E \times (1-\vartheta)}{(1+\vartheta)(1-2\vartheta)}$,

where E = Young's modulus

ϑ = Poisson's ratio

Weathered Waitemata Group (Above Drawdown Zone)

Ground Level (RL) = 68.4
Initial Groundwater Level (RL) = 65.6
Layer thickness (m) = 2.8

E (MPa) = 24
ϑ (-) = 0.2
M (mPa) = 26.67
m_v (m2/MN) = 0.0375

Distance from excavation (m)	0.0	1.0	2.0	3.0	4.0	5.0	50.0
Groundwater drawdown (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg Increase vertical stress, dσ' (kPa)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Settlement, Sd (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Weathered Waitemata Group Soils (Within Drawdown Zone)

Initial Groundwater Level (RL) = 65.6
Base of Drawdown (RL) = 62.7
Layer thickness (m) = 2.9

E (MPa) = 24
ϑ (-) = 0.2
M (mPa) = 26.67
m_v (m2/MN) = 0.0375

Distance from excavation (m)	0.0	1.0	2.0	3.0	4.0	5.0	50.0
Groundwater drawdown (m)	2.90	2.70	2.50	2.30	2.20	2.10	0.00
Avg Increase vertical stress, dσ' (kPa)	14.2	13.2	12.3	11.3	10.8	10.3	0.0
Settlement, Sd (mm)	0.8	0.7	0.7	0.6	0.6	0.6	0.0

Weathered Waitemata Group Soils (Below Drawdown Zone)

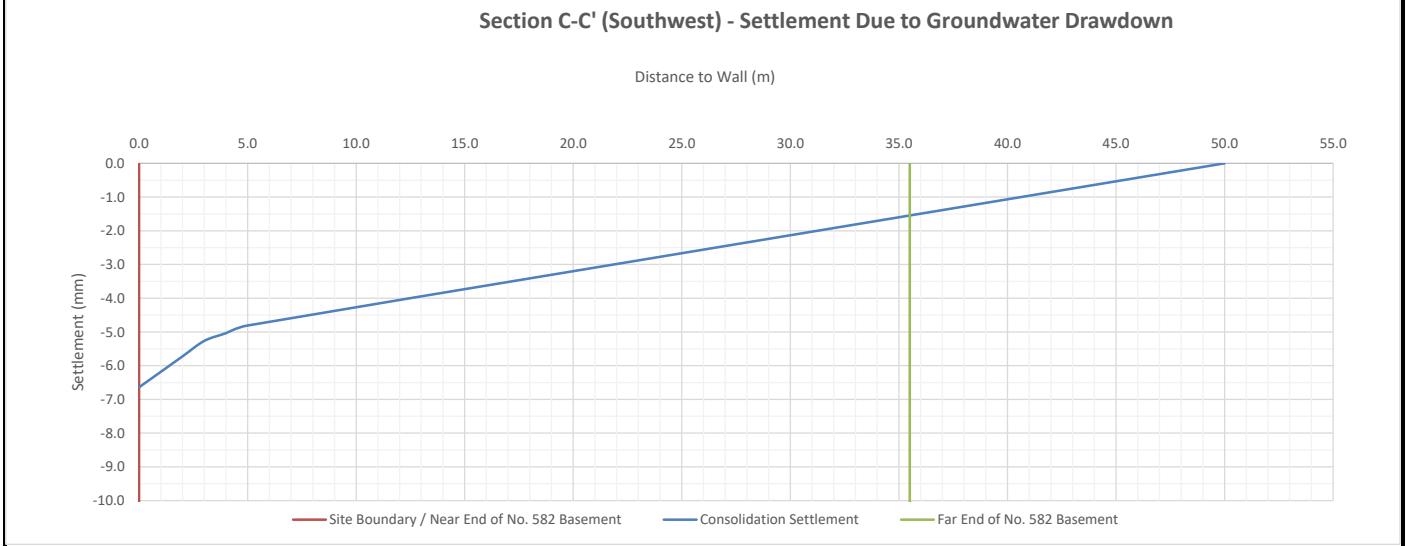
Base of Drawdown(RL) = 62.7
Top of Incompressible Layer (RL) = 57.2
Layer thickness (m) = 5.5

E (MPa) = 24
ϑ (-) = 0.2
M (mPa) = 26.67
m_v (m2/MN) = 0.0375

Distance from excavation (m)	0.0	1.0	2.0	3.0	4.0	5.0	50.0
Groundwater drawdown (m)	2.90	2.70	2.50	2.30	2.20	2.10	0.00
Increase vertical stress dσ' (kPa)	28.4	26.5	24.5	22.6	21.6	20.6	0.0
Settlement, Sd (mm)	5.9	5.5	5.1	4.7	4.5	4.2	0.0

TOTAL :

Distance from excavation (m)	0.0	1.0	2.0	3.0	4.0	5.0	50.0
Settlement, Sd (mm)	-6.6	-6.2	-5.7	-5.3	-5.0	-4.8	0.0



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Project No	Sheet No.	Rev
20111	2	B

Calculation Sheet

Project : **538 Karangahape Rd, Newton** Made by **MC**

Location : **Section D-D' - Grid A5** Date Nov-23

1. It is assumed that the dewatering has occurred prior to commencing excavation.

2. It is assumed that there will not be any change in total pressure in the soil,
thus the change in effective stress of the soil should be equal to the change in pore water pressure.

Settlement, Sd = dσ' x dH x m_v => dσ'= increase in effective vertical stress due to GW drawdown

dH = the thickness of soil layer

m_v = the coefficient of volume compressibility = 1/M' => M' = stiffness modulus = $\frac{E \times (1-\vartheta)}{(1+\vartheta)(1-2\vartheta)}$,

where E = Young's modulus

ϑ = Poisson's ratio

Weathered Waitemata Group (Above Drawdown Zone)

Ground Level (RL) = 70.8
Initial Groundwater Level (RL) = 64
Layer thickness (m) = 6.8

E (MPa) = 24
ϑ (-) = 0.2
M (mPa) = 26.67
m_v (m2/MN) = 0.0375

Distance from excavation (m)	0.0	2.0	4.0	10.0	15.0	20.0	50.0
Groundwater drawdown (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg Increase vertical stress, dσ' (kPa)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Settlement, Sd (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Weathered Waitemata Group Soils (Within Drawdown Zone)

Initial Groundwater Level (RL) = 64
Base of Drawdown (RL) 62.6
Layer thickness (m) = 1.4

E (MPa) = 24
ϑ (-) = 0.2
M (mPa) = 26.67
m_v (m2/MN) = 0.0375

Distance from excavation (m)	0.0	2.0	4.0	10.0	15.0	20.0	50.0
Groundwater drawdown (m)	1.40	1.20	1.00	0.80	0.60	0.50	0.00
Avg Increase vertical stress, dσ' (kPa)	6.9	5.9	4.9	3.9	2.9	2.5	0.0
Settlement, Sd (mm)	0.2	0.2	0.1	0.1	0.1	0.1	0.0

Weathered Waitemata Group Soils (Below Drawdown Zone)

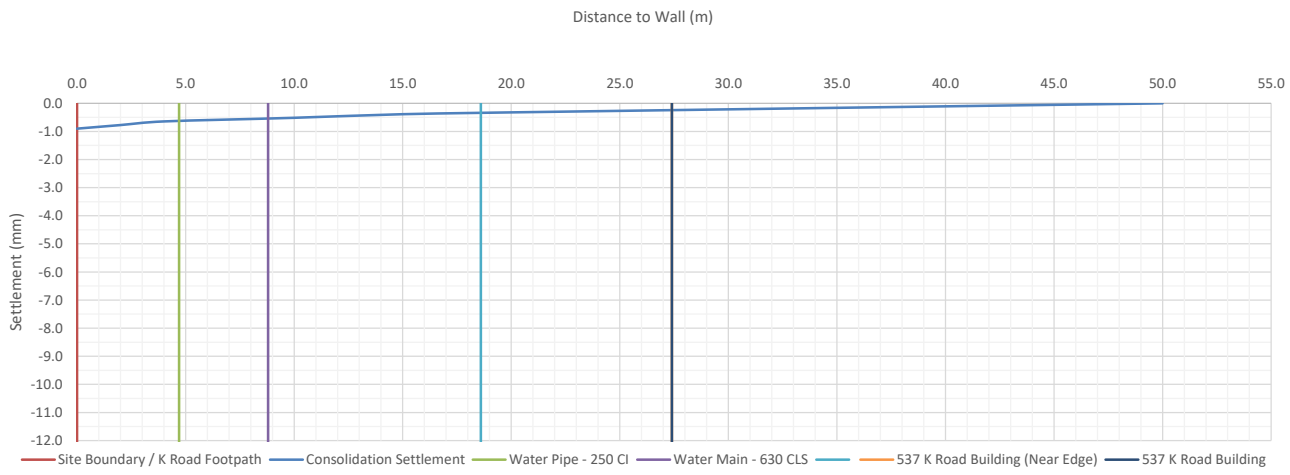
Base of Drawdown(RL) = 62.6
Top of Incompressible Layer (RL) = 61.2
Layer thickness (m) = 1.4

E (MPa) = 24
ϑ (-) = 0.2
M (mPa) = 26.67
m_v (m2/MN) = 0.0375

Distance from excavation (m)	0.0	2.0	4.0	10.0	15.0	20.0	50.0
Groundwater drawdown (m)	1.40	1.20	1.00	0.80	0.60	0.50	0.00
Increase vertical stress dσ' (kPa)	13.7	11.8	9.8	7.8	5.9	4.9	0.0
Settlement, Sd (mm)	0.7	0.6	0.5	0.4	0.3	0.3	0.0

TOTAL :

Distance from excavation (m)	0.0	2.0	4.0	10.0	15.0	20.0	50.0
Settlement, Sd (mm)	-0.9	-0.8	-0.6	-0.5	-0.4	-0.3	0.0



For Short-term

Section	H_e [m]	H_g [m]	$PIZ_1 = \min(2H_e, H_g)$ [m]	H_f [m]	B [m]	$PIZ_2 = \min(H_f, B)$ [m]	$PIZ = \max(PIZ_1, PIZ_2)$ [m]	$D_m = PIZ/3$ [m]	A_c [m^2]	A_s [m^2]	$1.6A_c$ [m^2]	δ_{hm} [mm]	Deformation Type
C-C'	5.8	11.2	11.2	0	20.0	0	11.2	3.73	0.000	0.146	0.000	14.0	Concave Type

Concave Type	Sand		Stiff to very hard clays		Soft to medium clays	
Section	$\delta_{vm} = 0.5\delta_{hm}$		$\delta_{vm} = 0.625\delta_{hm}$		$\delta_{vm} = 0.75\delta_{hm}$	
	X	Y	X	Y	X	Y
C-C'	0.0	3.50	0.0	4.38	0.0	5.25
	3.7	7.00	3.7	8.75	3.7	10.50
	11.2	1.17	11.2	1.46	11.2	1.75
	33.6	0.00	33.6	0.00	33.6	0.00

H_e = Excavation Depth

H_g = Hard Soil Depth

H_f = Depth of Soft Clay Bottom

B = Excavation Width

PIZ = Primary Influence Zone

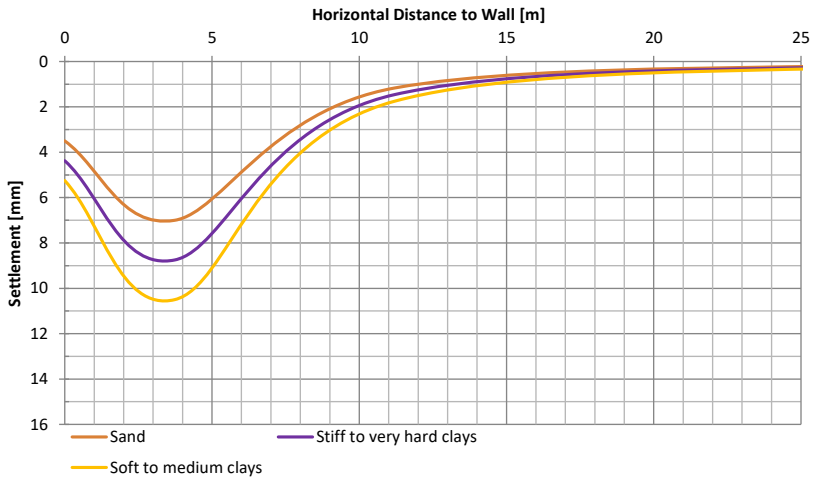
D_m = Location of Maximum Settlement

A_c = Area of Cantilever Component

A_s = Area of Total Wall Movement

δ_{hm} = Maximum Settlement

Section C-C' - Estimated Short-Term Ground Deformation Profile



For Short-term

Section	H_e [m]	H_g [m]	$PIZ_1 = min(2H_e, H_g)$ [m]	H_f [m]	B [m]	$PIZ_2 = min(H_f, B)$ [m]	$PIZ = max(PIZ_1, PIZ_2)$ [m]	$D_m = PIZ/3$ [m]	A_c [m^2]	A_s [m^2]	$1.6A_c$ [m^2]	δ_{hm} [mm]	Deformation Type
D-D'	8.2	9.6	9.6	0	20.0	0	9.6	3.20	0.137	-0.008	0.219	17.0	Spandrel Type

Spandrel Type

Section	$\delta_{vm} = 0.5\delta_{hm}$		$\delta_{vm} = 0.625\delta_{hm}$		$\delta_{vm} = 0.75\delta_{hm}$	
	X	Y	X	Y	X	Y
D-D'	0.0	8.5	0.0	10.6	0.0	12.8
	9.6	1.4	9.6	1.8	9.6	2.1
	28.8	0.0	28.8	0.0	28.8	0.0

H_e = Excavation Depth

H_g = Hard Soil Depth

H_f = Depth of Soft Clay Bottom

B = Excavation Width

PIZ = Primary Influence Zone

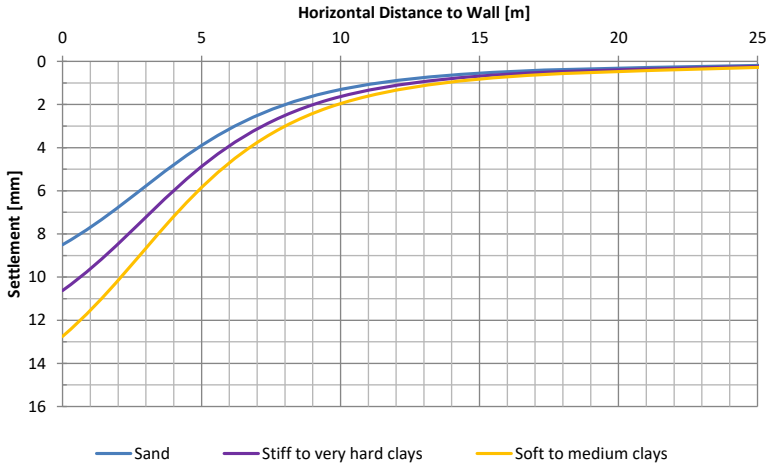
D_m = Location of Maximum Settlement = 0m

A_c = Area of Cantilever Component

A_s = Area of Total Wall Movement-Ac

δ_{hm} = Maximum Settlement

Section D-D' - Estimated Short-Term Ground Deformation Profile



For Short-term

Section	H_e [m]	H_g [m]	$PIZ_1 = min(2H_e, H_g)$ [m]	H_f [m]	B [m]	$PIZ_2 = min(H_f, B)$ [m]	$PIZ = max(PIZ_1, PIZ_2)$ [m]	$D_m = PIZ/3$ [m]	A_c [m^2]	A_s [m^2]	$1.6A_c$ [m^2]	δ_{hm} [mm]	Deformation Type
E-E'	4.3	10.6	8.2	0	20	0	8.2	2.73	0.088	-0.013	0.141	14.0	Spandrel Type

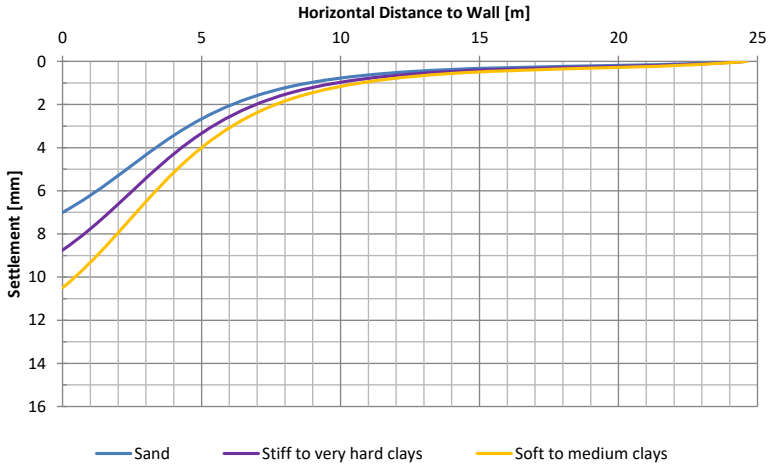
Spandrel Type

Section	$\delta_{vm} = 0.5\delta_{hm}$		$\delta_{vm} = 0.625\delta_{hm}$		$\delta_{vm} = 0.75\delta_{hm}$	
	X	Y	X	Y	X	Y
E-E'	0.0	7.0	0.0	8.8	0.0	10.5
	8.2	1.2	8.2	1.5	8.2	1.8
	24.6	0.0	24.6	0.0	24.6	0.0

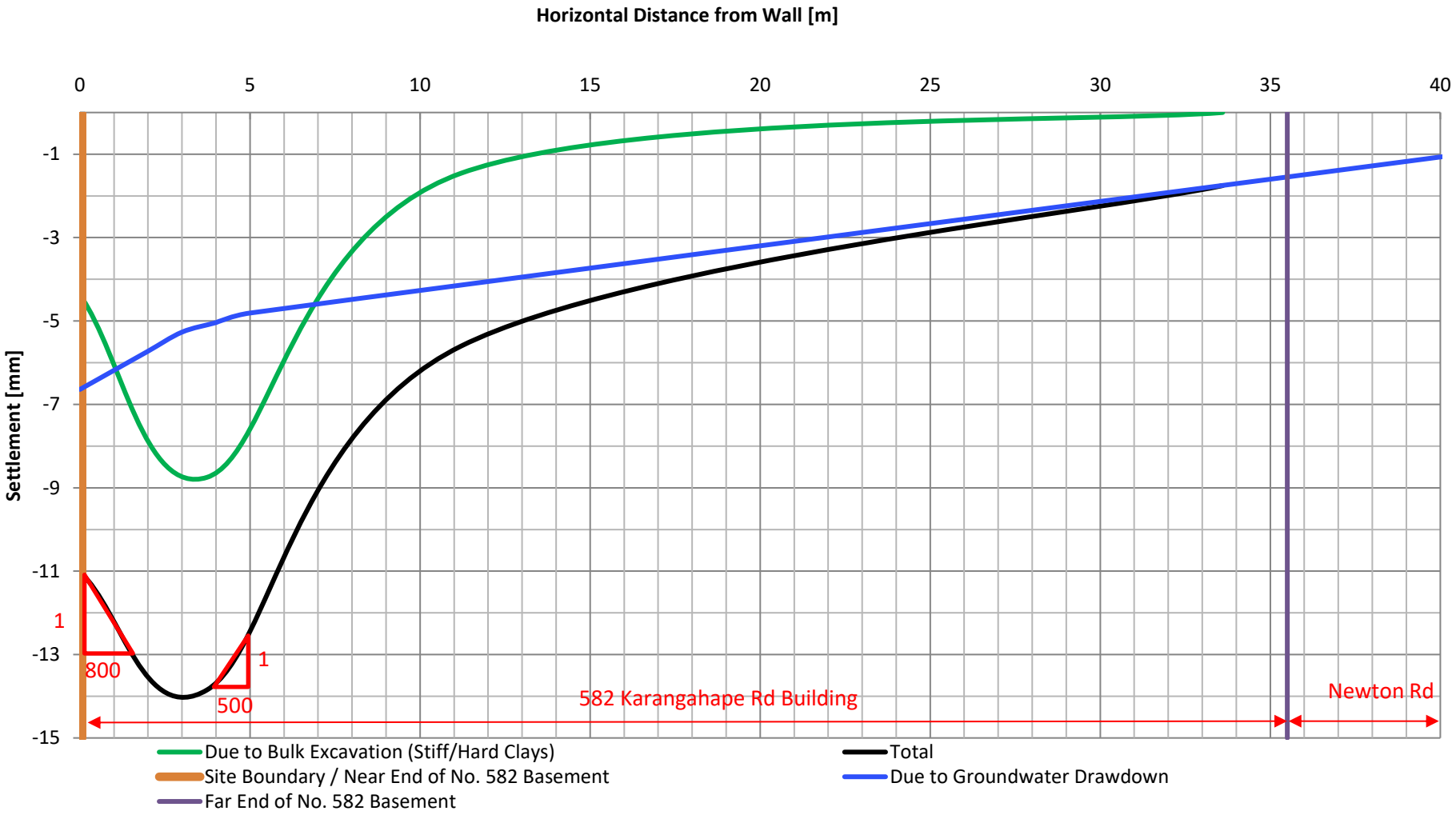
H_e = Excavation Depth
H_g = Hard Soil Depth
H_f = Depth of Soft Clay Bottom
B = Excavation Width
PIZ = Primary Influence Zone
D_m = Location of Maximum Settlement = 0m

A_c = Area of Cantilever Component
A_s = Area of Total Wall Movement-Ac
δ_{hm} = Maximum Settlement

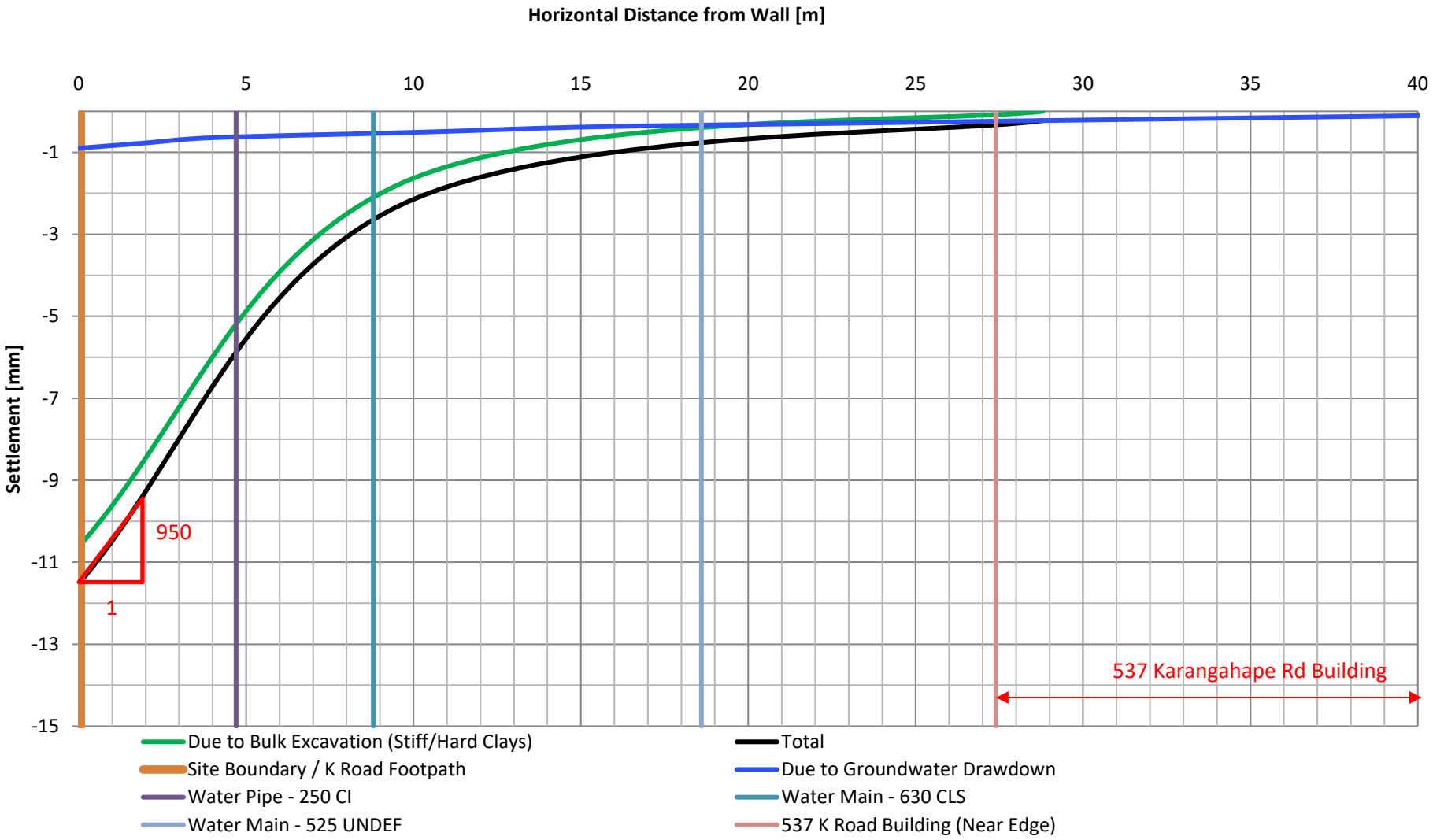
Section D-D' - Estimated Short-Term Ground Deformation Profile



Section C-C'
Estimated Total Settlement vs. Distance from Excavation



Section D-D'
Estimated Total Settlement vs. Distance from Excavation



Section E-E'
Estimated Total Settlement vs. Distance from Excavation