



**6a Grange Road
London
N6 4AP**

Geotechnical Planning Review

June 2026

J26113
Rev 3



Ground investigation | Geotechnical consultancy | Contaminated land assessment



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1	Final		11 June 2026	
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Part 1: Investigation Report

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2.

1.0 Introduction

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by Engineers HRW, to carry out a review of the planning information for 6a Grange Road, London, N6 4AP.

The work has been carried out by Catherine Everett, a BSc in Earth Science, MSc in Ground Investigation and Assessment, a Chartered Geologist (CGeol) and a Fellow of the Geological Society (FGS) with over 20 years' experience in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a Chartered Geologist (CGeol) and Fellow of the Geological Society (FGS) with some 40 years' experience in geotechnical engineering and engineering geology.

GEA has extensive experience of assessing the impact of basement developments in accordance with planning requirements, including in London Borough of Haringey and the adjacent London Borough of Camden. Over 25 projects have for example been completed by GEA within 750 m of 6a Grange Road.

1.1 Proposed Development

The proposed development is understood to comprise a new three-storey dwelling with a single basement level founding approximately 5.1 m below original ground level.

1.2 Brief

The proposed redevelopment of the site through the construction of a new house with a basement is subject to conditional planning permission (ref HGY/2024/1676). GEA has been commissioned to compete a high level review of the information that has been submitted in support of the planning application and discharge of Conditions 9 and 10, and also to review comments by others on the submitted information.

The purpose of this review comprises:

- A review of previous reports to provide an opinion on the adequacy of the site investigation
- A review of the scope of the basement impact assessment (BIA) together with the auditors' comments to check that the report complies with Local Authority planning requirements
- Comment on the suitability of WALLAP with regard to assessing ground movements
- An initial assessment of the validity of the ground movement trigger and action values
- Provide comment on concerns raised relating to groundwater
- Review and comment on the proposals for dewatering

1.3 Scope of Work

In order to meet the above objectives, the following reports were reviewed:

- A F Howland (AFH) Site Investigation Report (ref GNB/AFH/16.185, dated July 2016)
- Campbell Reith Basement Impact Assessment Audit (ref 13979-06-CRH-XX-XXGE-R-6a Grange Road BIA Audit-P4, dated October 2025)
- Create Consulting Engineers Basement Impact Assessment (BIA) (ref AW/VL/P22-2546/02 Rev. K. Dated 10th June 2025)
- Geotechnical Consulting Group (GCG) report on review of basement proposals (unreferenced, dated August 2025)



2.0 The Site

The site is in London Borough of Haringey, and a site walkover was undertaken by an engineer from GEA on 14 May 2026 in conjunction with the structural engineers. Ground level was noted to be approximately 1.0 m below original ground level and it is understood that piling will take place from this level.

The British Geological Survey (BGS) map of the area indicates that the site is underlain by Claygate Member, which is underlain by the London Clay Formation.

GEA has previously undertaken an investigation at nearby 14 View Road which proved the Claygate Member to 15 m, the maximum depth investigated. Groundwater was encountered as a seepage at a depth of 6.5 m below ground level.

3.0 Condition 9 Hydrogeological and Geotechnical Investigation

3.1 Adequacy of the Ground investigation

The 2016 AFH investigation comprised three boreholes to depths of between 9.45 m and 13.20 m. This investigation recorded the Claygate Member to comprise a series of soft to firm orange-brown occasionally gravelly clays, loose to medium dense grey silty fine sands and grey sandy silts, with occasional pockets of clay to the maximum depth investigated. During the fieldwork period, AFH recorded groundwater at depths of 3.2 m and 3.3 m in two locations. Subsequent monitoring of standpipes approximately three weeks later confirmed the water levels to be at 3.0 m to 3.2 m.

Given the size of the site, GEA consider that the scope of the investigation is sufficient both in terms of coverage and geotechnical data.

Groundwater was measured in the existing standpipes during the GEA walkover and found to be between 2.1 m and 2.6 m below reduced level which is commensurate with levels that were previously reported.

3.2 Groundwater Assessment and Flood Risk

The BIA includes an assessment from a qualified hydrogeologist which estimates that groundwater levels could potentially rise up to 350 mm on the southern (upgradient) perimeter and concludes that there will be no detrimental effect to nearby structures, including no flooding risk to the local environment.

As the Claygate Member extends beyond the toe of the secant wall, the effect on the global hydrology regime will be minimal.

The previous GEA ground investigation at 14 View Road (J06303) encountered Claygate to the maximum depth of investigation of 15.0 m with a seepage of water at a depth of 6.5 m.

Due to the variable nature of the Claygate Member, groundwater is often discontinuous and dependent on sandier fractions. The water is not continuous and has been encountered below the formation level of the basement.



The groundwater is flowing perpendicular to the basement and as such will be able to flow around the basement. The next nearest basement downstream is three properties to the north so the proposed basement will not have a negative effect on the groundwater regime or flood potential to this property. The property immediately to the south does not have a basement and therefore will not suffer any detrimental effect from the small potential increase in groundwater level. Additionally, the shallow foundations immediately to the south of the excavation will remain located above the ground water level and are considered to be bearing on the cohesive Claygate Member and are therefore not likely to experience any additional settlement due to this marginal rise in water level.

3.3 Dewatering Assessment

GCG's review of the dewatering concluded that the ground investigation did not encounter the underlying impermeable London Clay and therefore the proposed secant pile wall will not cut off the flow of water from the Claygate member. GCG also believe there may be erosion of the sands due to the dewatering leading to additional ground movement.

The secant wall will be of sufficient length to elongate the drainage path given the variability of the permeability of the Claygate. The AFH investigation has revealed a cohesive layer at approximately 9.0 m depth which should preclude the drawing up of fines from the toe of the pile at 11 m depth.

Dewatering would be limited to the basement box with no zone of influence outside the secant piled wall thereby reducing the risk of movement associated with dewatering activities during construction.

4.0 Condition 10 Updated GMA

4.1 Suitability of WALLAP

WALLAP is a proprietary software widely used for the design of embedded retaining walls and its application in this situation is deemed to be appropriate. Surcharge assumptions are appropriate.

It is understood that the concern around the modelling of the excavation in the installation and excavation phases stems from a greater load being applied to the southern side due to the sloping nature of the surrounding topography. Slopes can be modelled in WALLAP by placing a variable surcharge at ground level to mimic the presence of overburden.

The WALLAP output has been reviewed and the parameters used are generally considered to be suitably moderately conservative. The construction sequence is top down and therefore the excavation will be rigid upon installation of the capping beam prior to the bulk excavation. The deflections caused at each stage of the sequence are readily available in WALLAP and therefore it is possible to identify how much deflection is expected upon installation.

4.2 Ground Movement Trigger Values Assessment

The GMA has been based on the guidance within CIRIA C760 and the pile length is double the height of the maximum excavation. A worst case scenario looking at the installation of the longest piles has been adopted. Baseline monitoring is proposed prior to work starting.

GEA agree with the use of a traffic light system and the derivation of trigger levels by Create although clarity is required as to the action required between the amber and red trigger values as per Table 7.1. We would suggest amber is the full range between green and red.

The assessment concludes that the movement associated with the construction of the proposed basement can be limited to Burland Category 1 for all neighbouring properties.

GEA have undertaken a second WALLAP analysis as a check and have calculated deflections associated with the secant wall installation and excavation of the basement to be of a similar magnitude to those calculated by Create. The analysis included a slightly lower ground floor level of 107.32 m OD (middle of the slab) but the overall excavation level of 107.07 m OD remains unchanged. The results are appended.



5.0 Conclusions

GEA are satisfied that the scope and execution of the site investigation is sufficient to adequately determine the ground model and groundwater regime at this site.

WALLAP is considered to be an adequate and suitable program for calculating horizontal and vertical deflections due to installation and excavation of bored pile walls in this instance and the GMA assessment is appropriate for the ground model at this site.

The assessment of groundwater, flood risk and dewatering are considered to be appropriate and GEA confirm the view that the development will not increase flood risk or adversely affect the structural stability of neighbouring properties.

5.1 Review of the BIA

The conclusion of the BIA audit by Campbell Reith is that the BIA meets the requirements of the Local Authority. We have worked with Campbell Reith on a number of projects in Haringey and Camden and are satisfied that their reviews are rigorous and comprehensive.

GEA concur that the BIA satisfactorily demonstrates that the development will be constructed in such a way that it will;

-  maintain the structural stability of the building, neighbouring properties and adjoining highways and limit damage to neighbouring properties to Burland Category 1;
-  not increase flood risk to the property and nearby properties;
-  avoid adversely affecting drainage and run off or causing other damage to the water environment; and
-  avoid cumulative impacts upon structural stability or the water environment in the local area.



Appendix

WALLAP analysis – Check
WALLAP analysis – Alternate

Units: kN,m

INPUT DATA**SOIL PROFILE**

Stratum no.	Elevation of top of stratum	Soil types	
		Left side	Right side
1	112.30	1 Made Ground	1 Made Ground
2	111.30	2 Claygate - cohesive	2 Claygate - cohesive
3	110.00	3 Claygate - granular	3 Claygate - granular

SOIL PROPERTIES

-- Soil type --	Bulk density	Young's Modulus	At rest coeff.	Consol state.	Active limit	Passive limit	Cohesion
No. Description (Datum elev.)	kN/m3	Eh, kN/m2 (dEh/dy)	Ko (dKo/dy)	NC/OC (Nu)	Ka (Kac)	Kp (Kpc)	kN/m2 (dc/dy)
1 Made Ground	18.00	10000	0.500	NC (0.200)	0.406 (1.274)	2.464 (3.139)	35.00d
2 Claygate .. (111.30)	19.00	25000 (2500)	0.600	OC (0.490)	1.000 (2.000)	1.000 (2.000)	50.00u (5.000)
3 Claygate - granular	19.00	16000	0.500	OC (0.200)	0.333 (0.000)	3.000 (0.000)	

Additional soil parameters associated with Ka and Kp

--- parameters for Ka ---				--- parameters for Kp ---		
Soil	Wall	Back-		Soil	Wall	Back-
friction	adhesion	fill		friction	adhesion	fill
angle	coeff.	angle		angle	coeff.	angle
1 Made Ground	25.00	0.000	0.00	25.00	0.000	0.00
2 Claygate - cohesive	0.00	0.000	0.00	0.00	0.000	0.00
3 Claygate - granular	30.00	0.000	0.00	30.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

Initial water table elevation Left side Right side
 109.34 109.34

Automatic water pressure balancing at toe of wall : Yes

Water press.	Left side				Right side			
profile Point no.	Elev. m	Piezo elev. m	Water press. kN/m2		Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1 1	109.34	109.34	0.0		1 1	107.00	107.00	0.0 MC+WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
 Elevation of toe of wall = 101.30
 Maximum finite element length = 0.60 m
 Youngs modulus of wall E = 2.6000E+07 kN/m2
 Moment of inertia of wall I = 3.4000E-03 m4/m run
 E.I = 88400 kN.m2/m run
 Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Prop 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	110.84	1.00	0.300000	2.600E+07	4.00	0.00	0	Strut	No	R
2	109.15	3.00	0.050000	2.050E+08	4.00	0.00	0	Strut	No	R
3	107.32	1.00	0.500000	2.600E+07	4.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surcharge no.	Elev.	Distance	Length	Width	Surcharge (kN/m ²)		Surcharge Cat.	Soil type	Part fact.	Short Q reduc. fact.
		from wall	parallel to wall	perpend. to wall	Near edge	Far edge				
1	111.50	0.85 (L)	20.00	1.00	100.00	=	--	--	1.00-	--

Note: L = Left side, R = Right side

Limit State Categories: U = Permanent Unfavourable

F = Permanent Favourable

V = Variable (unfavourable)

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 111.50
2	Apply water pressure profile no.1 (Mod. Conserv.)
3	Change EI of wall to 88400 kN.m ² /m run Reset wall displacements to zero at this stage
4	Excavate to elevation 110.84 on RIGHT side
5	Install strut or anchor no.1 at elevation 110.84
6	Excavate to elevation 108.95 on RIGHT side
7	Install strut or anchor no.2 at elevation 109.15
8	Excavate to elevation 107.07 on RIGHT side
9	Install strut or anchor no.3 at elevation 107.32
10	Remove strut or anchor no.2 at elevation 109.15

LIMIT STATE PARAMETERS

Limit State: Serviceability Limit State

All loads and soil strengths are unfactored

FACTORS OF SAFETY and ANALYSIS OPTIONS

Limit State options: Serviceability Limit State

All loads and soil strengths are unfactored

Stability analysis:

Method of analysis - Strength Factor method

Factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:

Minimum equivalent fluid density = 5.00 kN/m³

Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:

Method - Subgrade reaction model using Influence Coefficients

Open Tension Crack analysis? - No

Non-linear Modulus Parameter (L) = 11.00 m

Boundary conditions:

Length of wall (normal to plane of analysis) = 1000.00 m

Width of excavation/fill on Left side of wall = 10.00 m

Width of excavation/fill on Right side of wall = 8.00 m

Distance to rigid boundary on Left side = 20.00 m

Distance to rigid boundary on Right side = 8.00 m

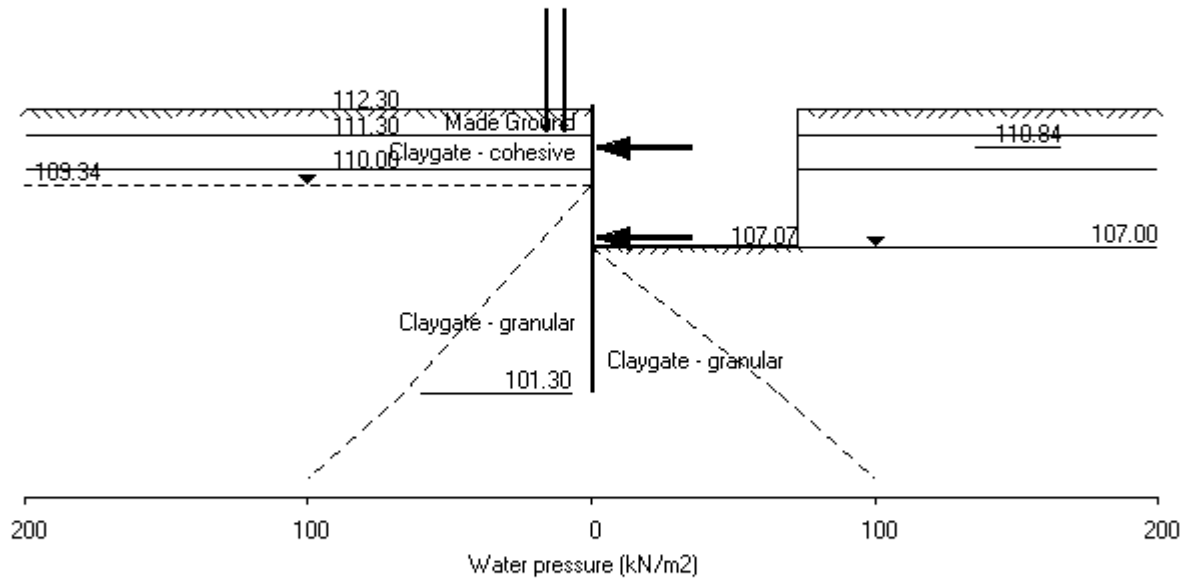
OUTPUT OPTIONS

Stage no.	Stage description	Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 111.50	Yes	Yes	Yes
2	Apply water pressure profile no.1	Yes	Yes	Yes
3	Change EI of wall to 88400kN.m2/m run	Yes	Yes	Yes
4	Excav. to elev. 110.84 on RIGHT side	Yes	Yes	Yes
5	Install prop no.1 at elev. 110.84	Yes	Yes	Yes
6	Excav. to elev. 108.95 on RIGHT side	Yes	Yes	Yes
7	Install prop no.2 at elev. 109.15	Yes	Yes	Yes
8	Excav. to elev. 107.07 on RIGHT side	Yes	Yes	Yes
9	Install prop no.3 at elev. 107.32	Yes	Yes	Yes
10	Remove prop no.2 at elev. 109.15	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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Units: kN,m

Stage No.10 Remove prop no.2 at elev. 109.15



Units: kN,m

Stage No. 4 Excavate to elevation 110.84 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

			FoS for toe elev. = 101.30		Toe elev. for FoS = 1.000			
<u>Stage</u>	<u>Ground level</u>		<u>Prop</u>	<u>Factor</u>	<u>Moment</u>	<u>Toe</u>	<u>Wall</u>	<u>Direction</u>
<u>No.</u>	<u>Act.</u>	<u>Pass.</u>	<u>Elev.</u>	<u>of</u>	<u>equilib.</u>	<u>elev.</u>	<u>Penetr</u>	<u>of</u>
				<u>Safety</u>	<u>at elev.</u>		<u>-ation</u>	<u>failure</u>
4	112.30	110.84	Cant.	<u>Conditions not suitable for FoS calc.</u>				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall**Analysis options**

Subgrade reaction model - Boussinesq Influence coefficients

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

Open Tension Crack analysis - No

Length of wall perpendicular to section = 1000.00m

Rigid boundaries: Left side 20.00m from wall

Right side 8.00m from wall

Limit State: Serviceability Limit State

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

*** Wall displacements reset to zero at stage 3

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m ²	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
1	112.30	0.00	0.002	3.33E-04	0.0	-0.0	
2	111.90	0.00	0.002	3.33E-04	0.0	0.0	
3	111.50	2.37	0.002	3.34E-04	0.5	0.3	
4	111.30	4.00	0.002	3.35E-04	1.1	0.4	
		5.00	0.002	3.35E-04	1.1	0.4	
5	110.84	7.30	0.002	3.31E-04	3.9	1.7	
		-12.64	0.002	3.31E-04	3.9	1.7	
6	110.42	-8.05	0.001	3.17E-04	-0.4	2.9	
7	110.00	-4.37	0.001	2.93E-04	-3.0	2.2	
		-2.17	0.001	2.93E-04	-3.0	2.2	
8	109.67	-2.51	0.001	2.71E-04	-3.8	1.1	
9	109.34	-3.43	0.001	2.49E-04	-4.8	-0.3	
10	109.15	-2.60	0.001	2.35E-04	-5.4	-1.3	
11	108.95	-1.85	0.001	2.21E-04	-5.8	-2.4	
12	108.48	-0.25	0.001	1.87E-04	-6.3	-5.2	
13	108.00	1.23	0.001	1.55E-04	-6.1	-8.2	
14	107.66	2.74	0.001	1.34E-04	-5.4	-10.0	
15	107.32	4.39	0.001	1.14E-04	-4.2	-11.7	
16	107.07	5.66	0.001	1.00E-04	-2.9	-12.6	
17	107.00	6.03	0.001	9.73E-05	-2.5	-12.8	
18	106.60	4.69	0.001	7.86E-05	-0.4	-13.3	
19	106.20	3.50	0.001	6.28E-05	1.3	-13.1	
20	105.60	2.02	0.001	4.44E-05	2.9	-11.9	
21	105.00	0.86	0.001	3.14E-05	3.8	-9.9	
22	104.40	-0.03	0.001	2.29E-05	4.0	-7.5	
23	103.80	-0.68	0.001	1.78E-05	3.8	-5.2	
24	103.20	-1.18	0.001	1.51E-05	3.3	-3.2	
25	102.60	-1.56	0.001	1.39E-05	2.5	-1.5	
26	102.00	-1.87	0.001	1.35E-05	1.4	-0.5	

(continued)

Stage No.4 Excavate to elevation 110.84 on RIGHT side

<u>Node no.</u>	<u>Y coord</u>	<u>Nett pressure</u> kN/m2	<u>Wall disp.</u> m	<u>Wall rotation</u> rad.	<u>Shear force</u> kN/m	<u>Bending moment</u> kN.m/m	<u>Prop forces</u> kN/m
27	101.65	-2.04	0.001	1.34E-05	0.7	-0.1	
28	101.30	-2.19	0.001	1.34E-05	0.0	-0.0	

LEFT side

<u>Node no.</u>	<u>Y coord</u>	<u>Water press.</u> kN/m2	<u>Vertic -al</u> kN/m2	<u>Effective stresses</u> <u>Active limit</u> kN/m2	<u>Passive limit</u> kN/m2	<u>Earth pressure</u> kN/m2	<u>Total earth pressure</u> kN/m2	<u>Coeff. of subgrade reaction</u> kN/m3
1	112.30	0.00	0.00	0.00	109.88	0.00	0.00a	2428
2	111.90	0.00	7.20	0.00	127.62	0.00	0.00a	2428
3	111.50	0.00	14.40	0.00	145.36	2.37	2.37	2428
4	111.30	0.00	18.47	0.00	155.37	4.00	4.00	2428
		Total>	18.47	5.00m	118.47	5.00	5.00a	9215
5	110.84	Total>	36.26	7.30m	140.86	7.30	7.30a	9639
6	110.42	Total>	55.40	9.40m	164.20	18.34	18.34	10026
7	110.00	Total>	70.33	11.50m	183.33	28.70	28.70	10413
		0.00	70.33	23.42	210.98	23.42	23.42a	3885
8	109.67	0.00	79.11	26.34	237.34	26.34	26.34a	3885
9	109.34	0.00	86.18	28.70	258.53	28.70	28.70a	3885
10	109.15	1.62	88.21	29.37	264.62	29.37	30.99a	3885
11	108.95	3.24	89.98	29.96	269.94	29.96	33.20a	3885
12	108.48	7.18	93.65	31.18	280.94	31.18	38.36a	3885
13	108.00	11.12	96.91	32.27	290.72	32.27	43.39a	3885
14	107.66	13.94	99.18	33.03	297.55	33.47	47.41	3885
15	107.32	16.76	101.48	33.79	304.45	34.79	51.55	3885
16	107.07	18.83	103.21	34.37	309.63	35.78	54.61	3885
17	107.00	19.41	103.70	34.53	311.09	36.06	55.48	3885
18	106.60	22.73	106.55	35.48	319.64	37.73	60.46	3885
19	106.20	26.05	109.50	36.46	328.50	39.47	65.52	3885
20	105.60	31.03	114.11	38.00	342.34	42.24	73.27	3885
21	105.00	36.01	118.93	39.60	356.80	45.19	81.20	3885
22	104.40	40.99	123.93	41.27	371.80	48.28	89.26	3885
23	103.80	45.97	129.09	42.99	387.27	51.49	97.45	3885
24	103.20	50.94	134.38	44.75	403.14	54.79	105.73	3885
25	102.60	55.92	139.79	46.55	419.37	58.15	114.07	3885
26	102.00	60.90	145.30	48.38	435.90	61.56	122.46	3885
27	101.65	63.80	148.56	49.47	445.67	63.56	127.36	3885
28	101.30	66.71	151.84	50.56	455.52	65.57	132.28	3885

RIGHT side

<u>Node no.</u>	<u>Y coord</u>	<u>Water press.</u> kN/m2	<u>Vertic -al</u> kN/m2	<u>Effective stresses</u> <u>Active limit</u> kN/m2	<u>Passive limit</u> kN/m2	<u>Earth pressure</u> kN/m2	<u>Total earth pressure</u> kN/m2	<u>Coeff. of subgrade reaction</u> kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	110.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	104.60	19.94	19.94	12452
6	110.42	Total>	7.98	2.10m	116.78	26.39	26.39	12952
7	110.00	Total>	15.97	4.20m	128.97	33.07	33.07	13452
		0.00	15.97	5.32	47.92	25.59	25.59	4785
8	109.67	0.00	22.26	7.41	66.79	28.85	28.85	4785
9	109.34	0.00	28.57	9.51	85.72	32.13	32.13	4785
10	109.15	0.00	32.31	10.76	96.92	33.59	33.59	4785

(continued)

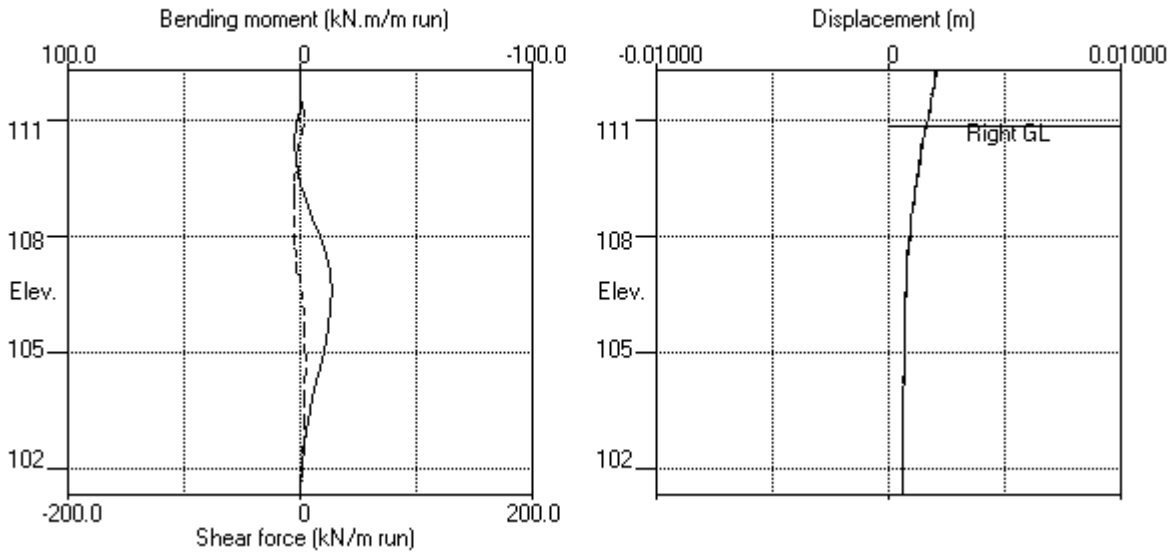
Stage No.4 Excavate to elevation 110.84 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>RIGHT side</u>					<u>Total</u> <u>earth</u> <u>pressure</u>	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u>
		<u>Water</u> <u>press.</u>	<u>Vertic</u> <u>-al</u>	<u>Effective</u> <u>Active</u> <u>limit</u>	<u>Effective</u> <u>Passive</u> <u>limit</u>	<u>Earth</u> <u>pressure</u>		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
11	108.95	0.00	36.05	12.00	108.15	35.05	35.05	4785
12	108.48	0.00	45.20	15.05	135.60	38.61	38.61	4785
13	108.00	0.00	54.40	18.12	163.20	42.16	42.16	4785
14	107.66	0.00	61.02	20.32	183.05	44.67	44.67	4785
15	107.32	0.00	67.66	22.53	202.98	47.15	47.15	4785
16	107.07	0.00	72.56	24.16	217.69	48.95	48.95	4785
17	107.00	0.00	73.94	24.62	221.81	49.45	49.45	4785
18	106.60	4.68	77.13	25.68	231.39	51.09	55.77	4785
19	106.20	9.36	80.36	26.76	241.07	52.66	62.02	4785
20	105.60	16.38	85.24	28.39	255.73	54.87	71.26	4785
21	105.00	23.41	90.18	30.03	270.54	56.93	80.34	4785
22	104.40	30.43	95.15	31.69	285.46	58.86	89.29	4785
23	103.80	37.45	100.15	33.35	300.46	60.69	98.14	4785
24	103.20	44.47	105.16	35.02	315.49	62.44	106.91	4785
25	102.60	51.49	110.18	36.69	330.54	64.14	115.63	4785
26	102.00	58.52	115.19	38.36	345.58	65.82	124.33	4785
27	101.65	62.61	118.11	39.33	354.34	66.79	129.40	4785
28	101.30	66.71	121.03	40.30	363.10	67.76	134.47	4785

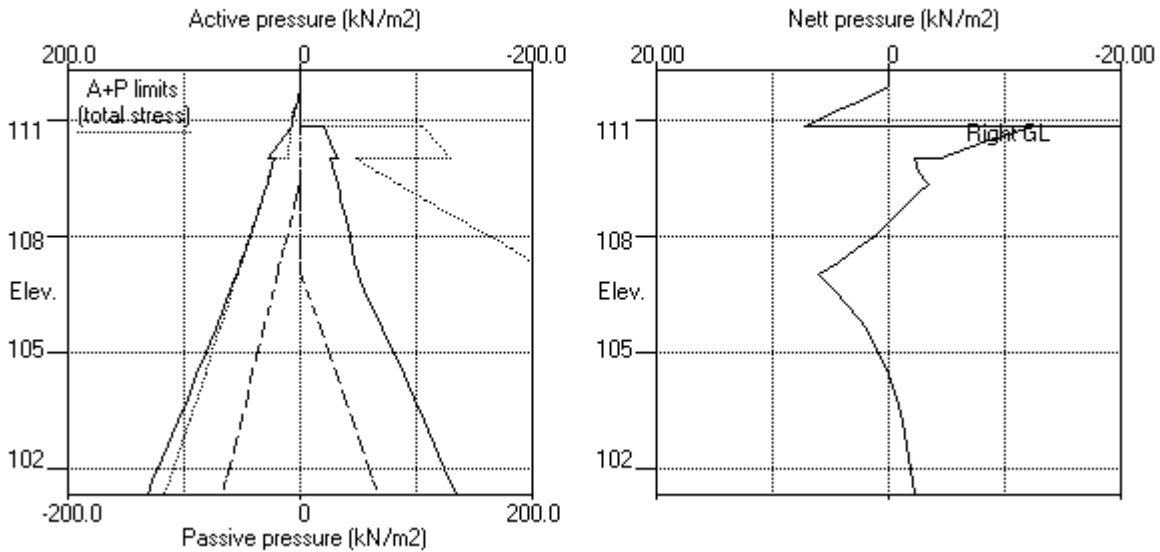
Note: 43.39 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Stage No.4 Excav. to elev. 110.84 on RIGHT side



Stage No.4 Excav. to elev. 110.84 on RIGHT side



Units: kN,m

Stage No. 6 Excavate to elevation 108.95 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

<u>Stage</u> <u>No.</u>	<u>Ground level</u>		<u>Prop</u> <u>Elev.</u>	<u>FoS for toe</u> <u>elev. = 101.30</u>		<u>Toe elev. for</u> <u>FoS = 1.000</u>		<u>Direction</u> <u>of</u> <u>failure</u>
	<u>Act.</u>	<u>Pass.</u>		<u>Factor</u> <u>of</u> <u>Safety</u>	<u>Moment</u> <u>equilib.</u> <u>at elev.</u>	<u>Toe</u> <u>elev.</u>	<u>Wall</u> <u>Penetr</u> <u>-ation</u>	
6	112.30	108.95	110.84	2.660	n/a	107.28	1.67	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall**Analysis options**

Subgrade reaction model - Boussinesq Influence coefficients

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

Open Tension Crack analysis - No

Length of wall perpendicular to section = 1000.00m

Rigid boundaries: Left side 20.00m from wall

Right side 8.00m from wall

Limit State: Serviceability Limit State

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

*** Wall displacements reset to zero at stage 3

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m ²	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
1	112.30	11.31	0.000	-8.42E-04	0.0	-0.0	
2	111.90	8.20	0.001	-8.44E-04	3.9	0.9	
3	111.50	7.43	0.001	-8.52E-04	7.0	3.4	
4	111.30	7.49	0.001	-8.60E-04	8.5	4.9	
		17.26	0.001	-8.60E-04	8.5	4.9	
5	110.84	7.30	0.002	-8.99E-04	14.2	10.9	-61.4
		7.30	0.002	-8.99E-04	-47.3	10.9	
6	110.42	14.24	0.002	-9.11E-04	-42.7	-7.4	
7	110.00	20.59	0.002	-8.49E-04	-35.4	-23.7	
		23.42	0.002	-8.49E-04	-35.4	-23.7	
8	109.67	26.34	0.003	-7.56E-04	-27.2	-34.1	
9	109.34	28.70	0.003	-6.36E-04	-18.1	-41.5	
10	109.15	30.99	0.003	-5.57E-04	-12.3	-44.5	
11	108.95	33.20	0.003	-4.74E-04	-6.0	-46.3	
12	108.48	11.27	0.003	-2.80E-04	4.5	-46.2	
13	108.00	0.98	0.003	-1.08E-04	7.4	-42.8	
14	107.66	1.81	0.003	-5.90E-06	7.9	-40.2	
15	107.32	2.83	0.003	8.13E-05	8.7	-37.3	
16	107.07	3.69	0.003	1.35E-04	9.5	-35.1	
17	107.00	3.95	0.003	1.49E-04	9.8	-34.4	
18	106.60	2.05	0.003	2.18E-04	11.0	-30.2	
19	106.20	0.36	0.003	2.69E-04	11.5	-25.7	
20	105.60	-1.85	0.003	3.17E-04	11.0	-19.0	
21	105.00	-3.77	0.003	3.39E-04	9.3	-12.9	
22	104.40	-3.68	0.003	3.42E-04	7.1	-7.8	
23	103.80	-3.25	0.002	3.35E-04	5.0	-4.3	
24	103.20	-2.70	0.002	3.25E-04	3.2	-2.1	
25	102.60	-2.08	0.002	3.17E-04	1.8	-0.7	
26	102.00	-1.44	0.002	3.13E-04	0.7	-0.2	

Stage No.6 Excavate to elevation 108.95 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m2	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
27	101.65	-1.05	0.002	3.12E-04	0.3	-0.0	
28	101.30	-0.66	0.002	3.12E-04	-0.0	-0.0	
At elev. 110.84				Prop force =		61.4 kN/m run	

		LEFT side							
		Effective stresses					Total	Coeff. of	
Node	Y	Water	Vertic	Active	Passive	Earth	earth	subgrade	
no.	coord	press.	-al	limit	limit	pressure	pressure	reaction	
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3	
1	112.30	0.00	0.00	0.00	109.88	11.31	11.31	6629	
2	111.90	0.00	7.20	0.00	127.62	8.20	8.20	6629	
3	111.50	0.00	14.40	0.00	145.36	7.43	7.43	6629	
4	111.30	0.00	18.47	0.00	155.37	7.49	7.49	6629	
		Total>	18.47	5.00m	118.47	17.26	17.26	23322	
5	110.84	Total>	36.26	7.30m	140.86	7.30	7.30a	7135	
6	110.42	Total>	55.40	9.40m	164.20	14.24	14.24	7422	
7	110.00	Total>	70.33	11.50m	183.33	20.59	20.59	7708	
		0.00	70.33	23.42	210.98	23.42	23.42a	2662	
8	109.67	0.00	79.11	26.34	237.34	26.34	26.34a	2662	
9	109.34	0.00	86.18	28.70	258.53	28.70	28.70a	2662	
10	109.15	1.62	88.21	29.37	264.62	29.37	30.99a	2662	
11	108.95	3.24	89.98	29.96	269.94	29.96	33.20a	2662	
12	108.48	7.18	93.65	31.18	280.94	31.18	38.36a	2662	
13	108.00	11.12	96.91	32.27	290.72	32.27	43.39a	2662	
14	107.66	13.94	99.18	33.03	297.55	33.03	46.97a	2662	
15	107.32	16.76	101.48	33.79	304.45	33.79	50.55a	2662	
16	107.07	18.83	103.21	34.37	309.63	34.37	53.20a	2662	
17	107.00	19.41	103.70	34.53	311.09	34.53	53.95a	2662	
18	106.60	22.73	106.55	35.48	319.64	35.48	58.21a	2662	
19	106.20	26.05	109.50	36.46	328.50	36.46	62.52a	2662	
20	105.60	31.03	114.11	38.00	342.34	38.00	69.03a	2662	
21	105.00	36.01	118.93	39.60	356.80	39.60	75.61a	2662	
22	104.40	40.99	123.93	41.27	371.80	43.06	84.05	2662	
23	103.80	45.97	129.09	42.99	387.27	46.78	92.75	2662	
24	103.20	50.94	134.38	44.75	403.14	50.58	101.53	2662	
25	102.60	55.92	139.79	46.55	419.37	54.44	110.36	2662	
26	102.00	60.90	145.30	48.38	435.90	58.33	119.23	2662	
27	101.65	63.80	148.56	49.47	445.67	60.61	124.41	2662	
28	101.30	66.71	151.84	50.56	455.52	62.90	129.60	2662	

		RIGHT side						
Node no.	Y coord	Water press. kN/m2	Effective stresses			Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3	
			Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2			Earth pressure kN/m2
1	112.30	0.00	0.00	0.00	0.00	0.00	0.0	
2	111.90	0.00	0.00	0.00	0.00	0.00	0.0	
3	111.50	0.00	0.00	0.00	0.00	0.00	0.0	
4	111.30	0.00	0.00	0.00	0.00	0.00	0.0	
5	110.84	0.00	0.00	0.00	0.00	0.00	0.0	
6	110.42	0.00	0.00	0.00	0.00	0.00	0.0	
7	110.00	0.00	0.00	0.00	0.00	0.00	0.0	
8	109.67	0.00	0.00	0.00	0.00	0.00	0.0	
9	109.34	0.00	0.00	0.00	0.00	0.00	0.0	
10	109.15	0.00	0.00	0.00	0.00	0.00	0.0	
11	108.95	0.00	0.00	0.00	0.00	0.00	0.0	
		0.00	0.00	0.00	0.00	0.00	3752	

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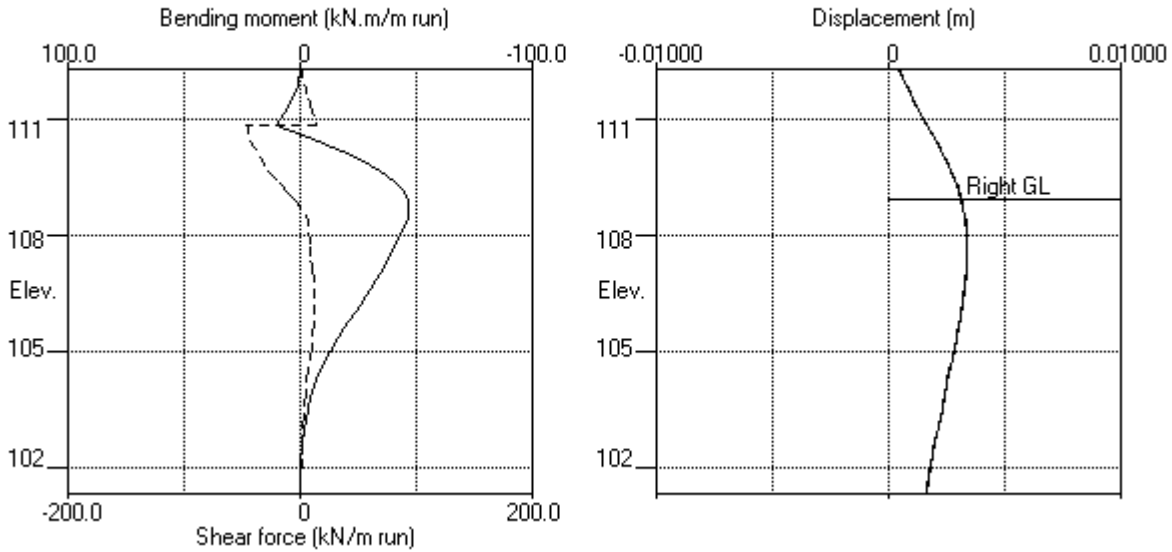
Stage No.6 Excavate to elevation 108.95 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>RIGHT side</u>					<u>Total</u> <u>earth</u> <u>pressure</u>	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u>
		<u>Water</u> <u>press.</u>	<u>Vertic</u> <u>-al</u>	<u>Effective</u> <u>Active</u> <u>limit</u>	<u>Effective</u> <u>Passive</u> <u>limit</u>	<u>Earth</u> <u>pressure</u>		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
12	108.48	0.00	9.03	3.01	27.09	27.09	27.09p	3752
13	108.00	0.00	18.09	6.03	54.28	42.41	42.41	3752
14	107.66	0.00	24.62	8.20	73.85	45.16	45.16	3752
15	107.32	0.00	31.18	10.38	93.55	47.73	47.73	3752
16	107.07	0.00	36.04	12.00	108.13	49.51	49.51	3752
17	107.00	0.00	37.41	12.46	112.23	50.00	50.00	3752
18	106.60	4.68	40.58	13.51	121.74	51.48	56.16	3752
19	106.20	9.36	43.83	14.60	131.50	52.80	62.16	3752
20	105.60	16.38	48.87	16.27	146.62	54.50	70.88	3752
21	105.00	23.41	54.10	18.02	162.31	55.97	79.38	3752
22	104.40	30.43	59.51	19.82	178.52	57.30	87.73	3752
23	103.80	37.45	65.06	21.66	195.18	58.54	95.99	3752
24	103.20	44.47	70.73	23.55	212.20	59.75	104.22	3752
25	102.60	51.49	76.49	25.47	229.48	60.95	112.44	3752
26	102.00	58.52	82.32	27.41	246.95	62.15	120.67	3752
27	101.65	62.61	85.73	28.55	257.19	62.85	125.46	3752
28	101.30	66.71	89.15	29.69	267.46	63.56	130.27	3752

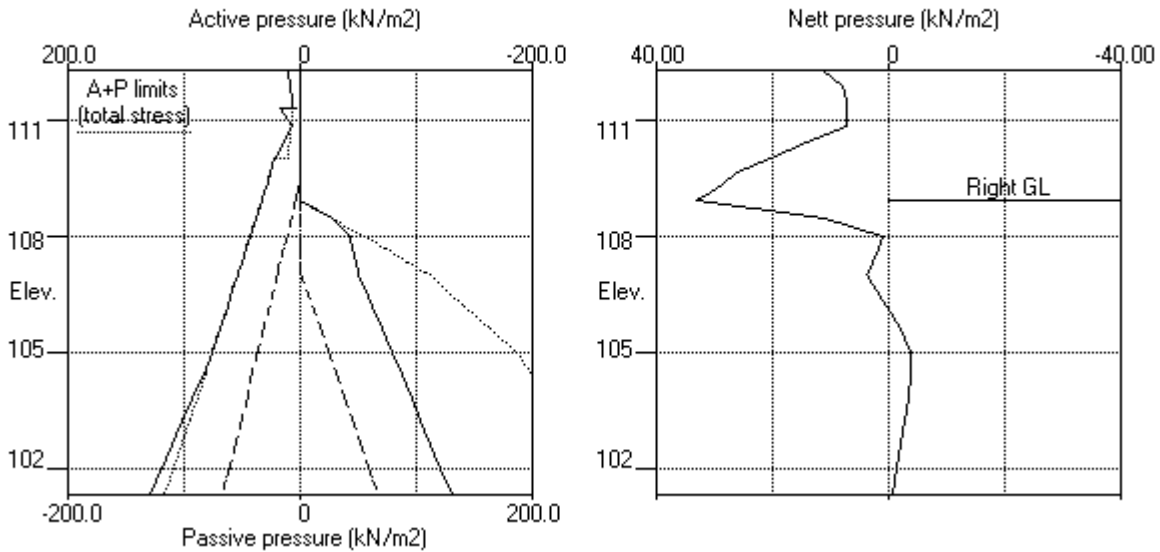
Note: 75.61 a Soil pressure at active limit
27.09 p Soil pressure at passive limit

Units: kN,m

Stage No.6 Excav. to elev. 108.95 on RIGHT side



Stage No.6 Excav. to elev. 108.95 on RIGHT side



Units: kN,m

Stage No. 8 Excavate to elevation 107.07 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

<u>Stage</u> <u>No.</u>	<u>Ground level</u>		<u>Prop</u> <u>Elev.</u>	<u>FoS for toe</u> <u>elev. = 101.30</u>		<u>Toe elev. for</u> <u>FoS = 1.000</u>		<u>Direction</u> <u>of</u> <u>failure</u>
	<u>Act.</u>	<u>Pass.</u>		<u>Factor</u> <u>of</u> <u>Safety</u>	<u>Moment</u> <u>at elev.</u>	<u>Toe</u> <u>elev.</u>	<u>Wall</u> <u>Penetr</u> <u>-ation</u>	
8	112.30	107.07		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall**Analysis options**

Subgrade reaction model - Boussinesq Influence coefficients

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

Open Tension Crack analysis - No

Length of wall perpendicular to section = 1000.00m

Rigid boundaries: Left side 20.00m from wall

Right side 8.00m from wall

Limit State: Serviceability Limit State

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

*** Wall displacements reset to zero at stage 3

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m ²	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
1	112.30	10.17	0.001	-6.77E-04	0.0	-0.0	
2	111.90	7.53	0.001	-6.79E-04	3.5	0.8	
3	111.50	7.24	0.001	-6.86E-04	6.5	3.1	
4	111.30	7.53	0.001	-6.93E-04	8.0	4.5	
		17.41	0.001	-6.93E-04	8.0	4.5	
5	110.84	8.91	0.002	-7.30E-04	14.0	10.3	slack
6	110.42	17.20	0.002	-8.00E-04	19.5	17.8	
7	110.00	23.92	0.002	-9.20E-04	28.1	27.9	
		24.74	0.002	-9.20E-04	28.1	27.9	
8	109.67	27.17	0.003	-1.06E-03	36.7	38.6	
9	109.34	28.70	0.003	-1.25E-03	45.9	52.3	
10	109.15	30.99	0.003	-1.39E-03	51.7	61.8	-163.3
		30.99	0.003	-1.39E-03	-111.6	61.8	
11	108.95	33.20	0.003	-1.52E-03	-105.3	40.6	
12	108.48	38.36	0.004	-1.67E-03	-88.3	-5.4	
13	108.00	43.39	0.005	-1.61E-03	-68.9	-42.5	
14	107.66	46.97	0.006	-1.46E-03	-53.5	-63.3	
15	107.32	50.55	0.006	-1.25E-03	-37.0	-78.7	
16	107.07	53.20	0.006	-1.06E-03	-24.0	-86.3	
17	107.00	49.96	0.006	-1.01E-03	-20.4	-87.9	
18	106.60	40.76	0.007	-6.82E-04	-2.2	-92.3	
19	106.20	31.49	0.007	-3.45E-04	12.2	-90.2	
20	105.60	17.26	0.007	1.22E-04	26.8	-78.1	
21	105.00	2.43	0.007	5.03E-04	32.7	-59.9	
22	104.40	-11.40	0.006	7.73E-04	30.0	-39.5	
23	103.80	-11.66	0.006	9.39E-04	23.1	-23.8	
24	103.20	-11.56	0.005	1.03E-03	16.2	-12.3	
25	102.60	-11.22	0.005	1.07E-03	9.3	-4.4	
26	102.00	-7.49	0.004	1.08E-03	3.7	-1.0	

Stage No.8 Excavate to elevation 107.07 on RIGHT side

At elev. 110.84 The prop is slack
At elev. 109.15 Prop force = 163.3 kN/m run

[illegible]

(continued)

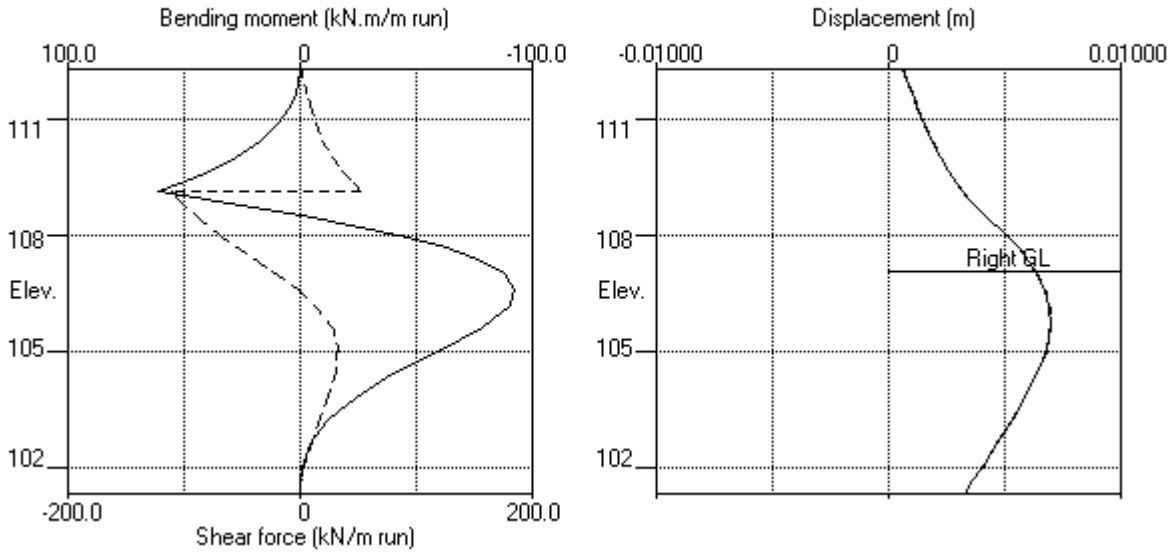
Stage No.8 Excavate to elevation 107.07 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>RIGHT side</u>					<u>Total</u> <u>earth</u> <u>pressure</u>	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u>
		<u>Water</u> <u>press.</u>	<u>Vertic</u> <u>-al</u>	<u>Effective</u> <u>Active</u> <u>limit</u>	<u>Effective</u> <u>Passive</u> <u>limit</u>	<u>Earth</u> <u>pressure</u>		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
11	108.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	108.48	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	108.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	107.66	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	107.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	107.07	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	4024
17	107.00	0.00	1.33	0.44	3.99	3.99	3.99p	4024
18	106.60	4.68	4.26	1.42	12.77	12.77	17.45p	4024
19	106.20	9.36	7.22	2.40	21.66	21.66	31.02p	4024
20	105.60	16.38	11.79	3.93	35.38	35.38	51.77p	4024
21	105.00	23.41	16.59	5.53	49.78	49.78	73.18p	4024
22	104.40	30.43	21.67	7.22	65.01	63.23	93.66	4024
23	103.80	37.45	27.05	9.01	81.14	63.16	100.61	4024
24	103.20	44.47	32.73	10.90	98.18	62.78	107.25	4024
25	102.60	51.49	38.68	12.88	116.04	62.26	113.75	4024
26	102.00	58.52	44.87	14.94	134.62	61.71	120.23	4024
27	101.65	62.61	48.58	16.18	145.74	61.40	124.02	4024
28	101.30	66.71	52.34	17.43	157.02	61.11	127.82	4024

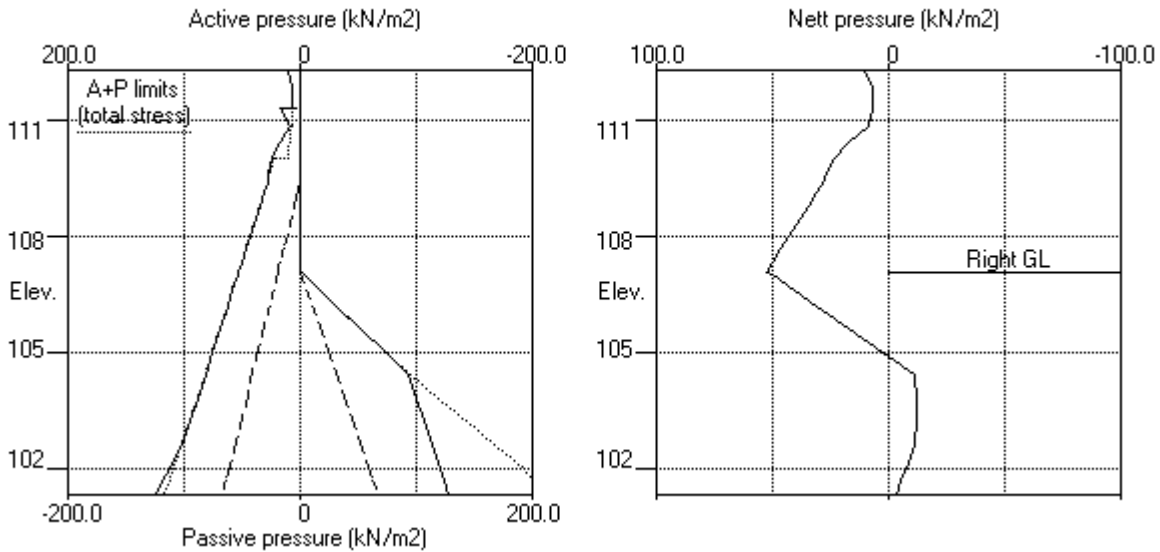
Note: 95.69 a Soil pressure at active limit
73.18 p Soil pressure at passive limit

Units: kN,m

Stage No.8 Excav. to elev. 107.07 on RIGHT side



Stage No.8 Excav. to elev. 107.07 on RIGHT side



| Sheet No.

Job No. J26113

| Made by : CE

1

| Date: 3-06-2026

| Checked :

Summary of results

Limit State: Serviceability Limit State

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

		FoS for toe		Toe elev. for				
		elev. = 101.30		FoS = 1.000				
<u>Stage</u>	<u>Ground level</u>	<u>Prop</u>	<u>Factor</u>	<u>Moment</u>	<u>Toe</u>	<u>Wall</u>	<u>Direction</u>	
<u>No.</u>	<u>Act.</u>	<u>Pass.</u>	<u>Elev.</u>	<u>of</u>	<u>equilib.</u>	<u>elev.</u>	<u>Penetr</u>	
				<u>Safety</u>	<u>at elev.</u>		<u>-ation</u>	
							<u>of</u>	
							<u>failure</u>	
1	112.30	112.30	Cant.	<u>Conditions not suitable for FoS calc.</u>				
2	112.30	112.30	Cant.	<u>Conditions not suitable for FoS calc.</u>				
3	112.30	112.30		No analysis at this stage				
4	112.30	110.84	Cant.	<u>Conditions not suitable for FoS calc.</u>				
5	112.30	110.84		No analysis at this stage				
6	112.30	108.95	110.84	2.660	n/a	107.28	1.67	L to R
7	112.30	108.95		No analysis at this stage				
<u>All remaining stages have more than one prop - FoS calculation n/a</u>								

Units: kN,m

Summary of results**BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall****Analysis options**

Subgrade reaction model - Boussinesq Influence coefficients

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

Open Tension Crack analysis - No

Length of wall perpendicular to section = 1000.00m

Rigid boundaries: Left side 20.00m from wall

Right side 8.00m from wall

Limit State: Serviceability Limit State

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

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment				Shear force			
				Calculated		Factored		Calculated		Factored	
		max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
		m	m	kN.m/m		kN.m/m		kN/m		kN/m	
1	112.30	0.002	-0.001	0	-0	0	-0	0	0	0	0
2	111.90	0.002	-0.000	1	-0	2	-0	5	-1	7	-1
3	111.50	0.002	0.000	4	-0	6	-1	9	-1	12	-2
4	111.30	0.002	0.000	6	-1	8	-1	11	-2	14	-2
5	110.84	0.002	0.000	14	-2	18	-3	17	-53	23	-72
6	110.42	0.002	0.000	18	-7	24	-10	20	-49	26	-66
7	110.00	0.003	0.000	28	-26	38	-36	28	-44	38	-60
8	109.67	0.004	0.000	39	-40	52	-54	37	-36	50	-48
9	109.34	0.004	0.000	52	-50	71	-68	46	-27	62	-36
10	109.15	0.004	0.000	62	-55	83	-74	52	-112	70	-151
11	108.95	0.005	0.000	41	-58	55	-79	0	-105	0	-142
12	108.48	0.005	0.000	0	-61	0	-83	5	-88	6	-119
13	108.00	0.006	0.000	0	-55	0	-75	22	-69	29	-93
14	107.66	0.006	0.000	0	-63	0	-85	37	-54	50	-72
15	107.32	0.006	0.000	0	-79	0	-106	54	-55	72	-75
16	107.07	0.006	0.000	0	-86	0	-117	10	-42	13	-57
17	107.00	0.006	0.000	0	-88	0	-119	10	-39	13	-52
18	106.60	0.007	0.000	0	-92	0	-125	11	-19	15	-26
19	106.20	0.007	0.000	0	-90	0	-122	12	-4	16	-5
20	105.60	0.007	0.000	0	-78	0	-105	27	0	36	0
21	105.00	0.007	0.000	0	-60	0	-81	33	0	44	0
22	104.40	0.006	0.000	0	-40	0	-53	30	0	41	0
23	103.80	0.006	0.000	0	-24	0	-32	23	0	31	0
24	103.20	0.005	0.000	0	-12	0	-17	16	0	22	0
25	102.60	0.005	0.000	0	-4	0	-6	9	0	13	0
26	102.00	0.004	0.000	0	-1	0	-1	4	-0	5	-0
27	101.65	0.004	0.000	0	-0	0	-0	1	-0	2	-0
28	101.30	0.003	0.000	0	-0	0	-0	0	-0	0	-0

Summary of results (continued)

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

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment				Shear force					
	Calculated		Factored		Calculated		Factored			
	max.	elev.	min.	elev.	max.	min.	max.	elev.	min.	elev.
	kN.m/m		kN.m/m		kN.m/m		kN/m		kN/m	
1	0	102.60	-7	109.15	0	-9	2	107.07	-5	110.84
2	1	111.30	-17	107.00	1	-23	5	105.00	-6	108.95
3	No calculation at this stage									
4	3	110.42	-13	106.60	4	-18	4	104.40	-6	108.48
5	No calculation at this stage									
6	11	110.84	-46	108.95	15	-63	14	110.84	-47	110.84
7	No calculation at this stage									
8	62	109.15	-92	106.60	83	-125	52	109.15	-112	109.15
9	No calculation at this stage									
10	14	110.84	-61	108.48	18	-83	54	107.32	-55	107.32

Maximum and minimum displacement at each stage

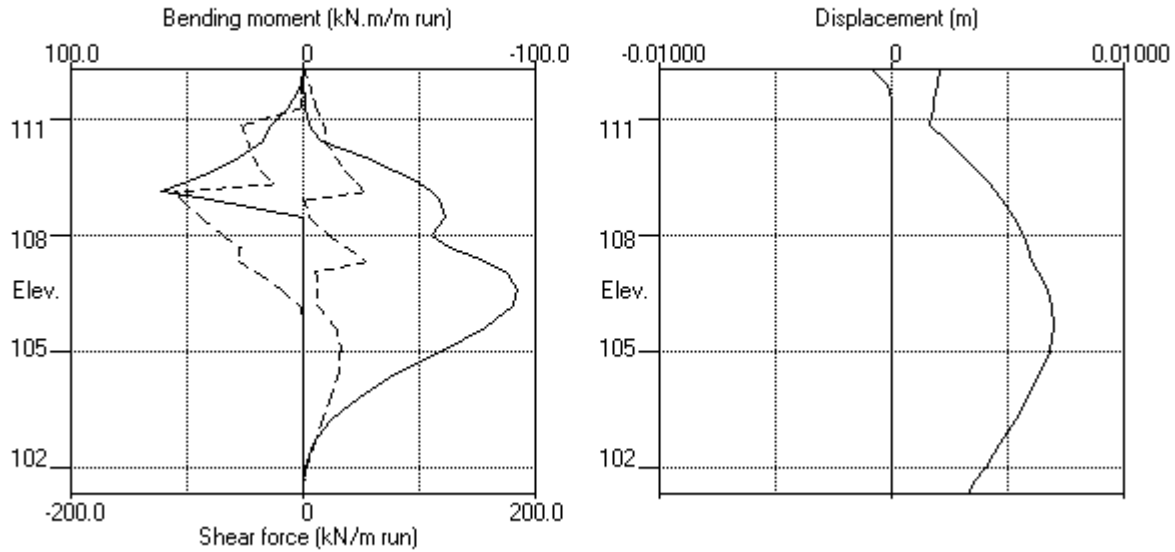
Stage no.	Displacement				Stage description
	maximum	elev.	minimum	elev.	
	m		m		
1	0.001	108.00	0.000	112.30	Apply surcharge no.1 at elev. 111.50
2	0.002	106.60	0.000	112.30	Apply water pressure profile no.1
3	Wall displacements reset to zero				Change EI of wall to 88400kN.m ² /m run
4	0.002	112.30	0.000	112.30	Excav. to elev. 110.84 on RIGHT side
5	No calculation at this stage				Install prop no.1 at elev. 110.84
6	0.003	107.66	0.000	112.30	Excav. to elev. 108.95 on RIGHT side
7	No calculation at this stage				Install prop no.2 at elev. 109.15
8	0.007	105.60	0.000	112.30	Excav. to elev. 107.07 on RIGHT side
9	No calculation at this stage				Install prop no.3 at elev. 107.32
10	0.006	106.20	-0.001	112.30	Remove prop no.2 at elev. 109.15

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 1			Prop no. 2			Prop no. 3		
	at elev. 110.84			at elev. 109.15			at elev. 107.32		
	--Calculated--	Factored		--Calculated--	Factored		--Calculated--	Factored	
	kN per	kN per	kN per	kN per	kN per	kN per	kN per	kN per	kN per
	m run	prop	prop	m run	prop	prop	m run	prop	prop
6	61	61	83	---	---	---	---	---	---
8	-101	-101	-136	163	490	661	---	---	---
10	71	71	95	---	---	---	109	109	147

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	112.30	1 Made Ground	1 Made Ground
2	111.30	2 Claygate - cohesive	2 Claygate - cohesive
3	110.00	3 Claygate - granular	3 Claygate - granular

SOIL PROPERTIES

-- Soil type --	Bulk density	Young's Modulus	At rest coeff.	Consol state.	Active limit	Passive limit	Cohesion
No. Description (Datum elev.)	kN/m3	Eh, kN/m2 (dEh/dy)	Ko (dKo/dy)	NC/OC (Nu)	Ka (Kac)	Kp (Kpc)	kN/m2 (dc/dy)
1 Made Ground	18.00	10000	0.500	NC (0.200)	0.406 (1.274)	2.464 (3.139)	35.00d
2 Claygate .. (111.30)	19.00	25000 (2500)	0.600	OC (0.490)	1.000 (2.000)	1.000 (2.000)	50.00u (5.000)
3 Claygate - granular	19.00	16000	0.500	OC (0.200)	0.333 (0.000)	3.000 (0.000)	

Additional soil parameters associated with Ka and Kp

--- parameters for Ka ---				--- parameters for Kp ---			
Soil	Wall	Back-		Soil	Wall	Back-	
friction	adhesion	fill		friction	adhesion	fill	
angle	coeff.	angle		angle	coeff.	angle	
1 Made Ground	25.00	0.000	0.00	25.00	0.000	0.00	
2 Claygate - cohesive	0.00	0.000	0.00	0.00	0.000	0.00	
3 Claygate - granular	30.00	0.000	0.00	30.00	0.000	0.00	

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	109.34	109.34

Automatic water pressure balancing at toe of wall : Yes

Water press.	Left side				Right side			
profile Point no.	Elev. m	Piezo elev. m	Water press. kN/m2		Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1 1	109.34	109.34	0.0		1 1	107.00	107.00	0.0 MC+WC

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 101.30
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 2.6000E+07 kN/m2
Moment of inertia of wall I = 3.4000E-03 m4/m run
E.I = 88400 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Prop 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	110.84	1.00	0.300000	2.600E+07	4.00	0.00	0	Strut	No	R
2	109.15	3.00	0.050000	2.050E+08	4.00	0.00	0	Strut	No	R
3	107.32	1.00	0.500000	2.600E+07	4.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surcharge no.	Elev.	Distance	Length	Width	Surcharge (kN/m2)		Surcharge Cat.	Soil type	Part fact.	Short Q reduc. fact.
		from wall	parallel to wall	perpend. to wall	Near edge	Far edge				
1	111.50	0.85 (L)	20.00	1.00	100.00	=	--	--	1.00-	--

Note: L = Left side, R = Right side

Limit State Categories: U = Permanent Unfavourable
F = Permanent Favourable
V = Variable (unfavourable)

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 111.50
2	Apply water pressure profile no.1 (Mod. Conserv.)
3	Change EI of wall to 88400 kN.m2/m run Reset wall displacements to zero at this stage
4	Excavate to elevation 110.84 on RIGHT side
5	Install strut or anchor no.1 at elevation 110.84
6	Excavate to elevation 108.95 on RIGHT side
7	Excavate to elevation 107.07 on RIGHT side
8	Install strut or anchor no.3 at elevation 107.32

LIMIT STATE PARAMETERS

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

FACTORS OF SAFETY and ANALYSIS OPTIONS

Limit State options: Serviceability Limit State
All loads and soil strengths are unfactored
Stability analysis:
Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.00

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

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 11.00 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 m

Width of excavation/fill on Left side of wall = 10.00 m
Width of excavation/fill on Right side of wall = 8.00 m

Distance to rigid boundary on Left side = 20.00 m
Distance to rigid boundary on Right side = 8.00 m

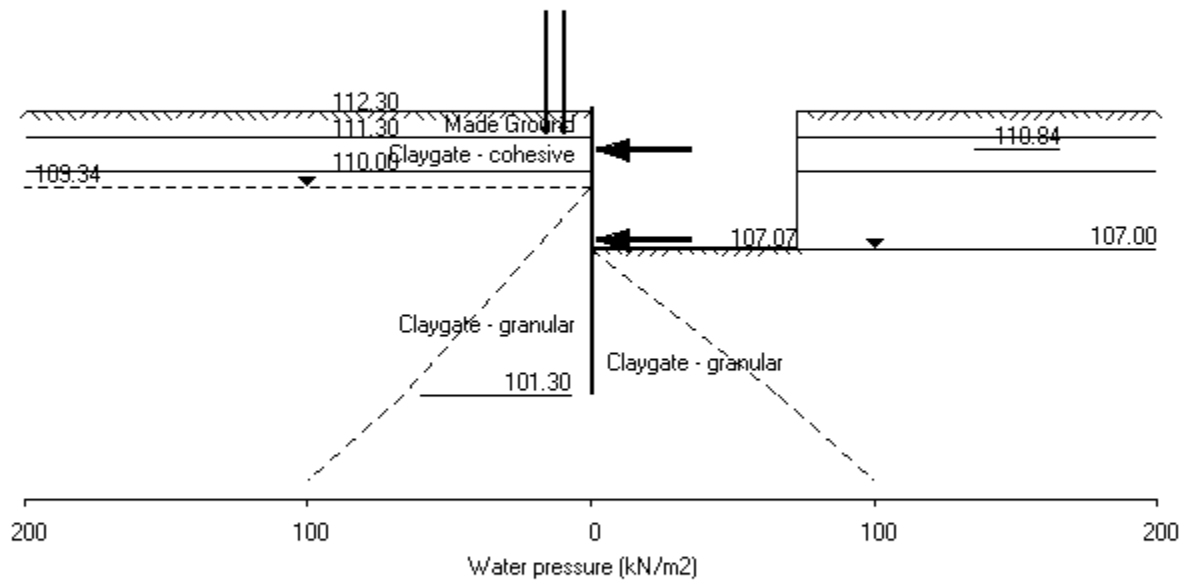
OUTPUT OPTIONS

Stage no.	Stage description	Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 111.50	Yes	Yes	Yes
2	Apply water pressure profile no.1	Yes	Yes	Yes
3	Change EI of wall to 88400kN.m2/m run	Yes	Yes	Yes
4	Excav. to elev. 110.84 on RIGHT side	Yes	Yes	Yes
5	Install prop no.1 at elev. 110.84	Yes	Yes	Yes
6	Excav. to elev. 108.95 on RIGHT side	Yes	Yes	Yes
7	Excav. to elev. 107.07 on RIGHT side	Yes	Yes	Yes
8	Install prop no.3 at elev. 107.32	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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Units: kN,m

Stage No.8 Install prop no.3 at elev. 107.32



Units: kN,m

Stage No. 4 Excavate to elevation 110.84 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

			FoS for toe elev. = 101.30		Toe elev. for FoS = 1.000			
<u>Stage</u>	<u>Ground level</u>		<u>Prop</u>	<u>Factor</u>	<u>Moment</u>	<u>Toe</u>	<u>Wall</u>	<u>Direction</u>
<u>No.</u>	<u>Act.</u>	<u>Pass.</u>	<u>Elev.</u>	<u>of</u>	<u>equilib.</u>	<u>elev.</u>	<u>Penetr</u>	<u>of</u>
				<u>Safety</u>	<u>at elev.</u>		<u>-ation</u>	<u>failure</u>
4	112.30	110.84	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall**Analysis options**

Subgrade reaction model - Boussinesq Influence coefficients

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

Open Tension Crack analysis - No

Length of wall perpendicular to section = 1000.00m

Rigid boundaries: Left side 20.00m from wall

Right side 8.00m from wall

Limit State: Serviceability Limit State

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

*** Wall displacements reset to zero at stage 3

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m ²	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
1	112.30	0.00	0.002	3.33E-04	0.0	0.0	
2	111.90	0.00	0.002	3.33E-04	0.0	0.0	
3	111.50	2.37	0.002	3.34E-04	0.5	0.3	
4	111.30	4.00	0.002	3.35E-04	1.1	0.4	
		5.00	0.002	3.35E-04	1.1	0.4	
5	110.84	7.30	0.002	3.31E-04	3.9	1.7	
		-12.63	0.002	3.31E-04	3.9	1.7	
6	110.42	-8.05	0.001	3.17E-04	-0.4	2.9	
7	110.00	-4.36	0.001	2.93E-04	-3.0	2.2	
		-2.17	0.001	2.93E-04	-3.0	2.2	
8	109.67	-2.50	0.001	2.71E-04	-3.8	1.1	
9	109.34	-3.43	0.001	2.48E-04	-4.8	-0.3	
10	108.95	-1.85	0.001	2.21E-04	-5.8	-2.3	
11	108.48	-0.25	0.001	1.87E-04	-6.3	-5.2	
12	108.00	1.23	0.001	1.55E-04	-6.1	-8.2	
13	107.66	2.74	0.001	1.34E-04	-5.4	-10.0	
14	107.32	4.39	0.001	1.14E-04	-4.2	-11.7	
15	107.07	5.66	0.001	1.00E-04	-2.9	-12.6	
16	107.00	6.03	0.001	9.73E-05	-2.5	-12.8	
17	106.60	4.69	0.001	7.86E-05	-0.4	-13.3	
18	106.20	3.50	0.001	6.28E-05	1.3	-13.1	
19	105.60	2.02	0.001	4.44E-05	2.9	-11.9	
20	105.00	0.86	0.001	3.14E-05	3.8	-9.9	
21	104.40	-0.03	0.001	2.29E-05	4.0	-7.5	
22	103.80	-0.68	0.001	1.78E-05	3.8	-5.2	
23	103.20	-1.18	0.001	1.51E-05	3.3	-3.2	
24	102.60	-1.56	0.001	1.39E-05	2.5	-1.5	
25	102.00	-1.87	0.001	1.35E-05	1.4	-0.5	
26	101.65	-2.04	0.001	1.34E-05	0.7	-0.1	

(continued)

Stage No.4 Excavate to elevation 110.84 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m2	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
27	101.30	-2.19	0.001	1.34E-05	0.0	-0.0	

LEFT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Water</u> <u>press.</u> kN/m2	<u>Effective stresses</u>				<u>Total</u> <u>earth</u> <u>pressure</u> kN/m2	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u> kN/m3
			<u>Vertic</u> <u>-al</u> kN/m2	<u>Active</u> <u>limit</u> kN/m2	<u>Passive</u> <u>limit</u> kN/m2	<u>Earth</u> <u>pressure</u> kN/m2		
1	112.30	0.00	0.00	0.00	109.88	0.00	0.00a	2428
2	111.90	0.00	7.20	0.00	127.62	0.00	0.00a	2428
3	111.50	0.00	14.40	0.00	145.36	2.37	2.37	2428
4	111.30	0.00	18.47	0.00	155.37	4.00	4.00	2428
		Total>	18.47	5.00m	118.47	5.00	5.00a	9215
5	110.84	Total>	36.26	7.30m	140.86	7.30	7.30a	9639
6	110.42	Total>	55.40	9.40m	164.20	18.34	18.34	10026
7	110.00	Total>	70.33	11.50m	183.33	28.70	28.70	10413
		0.00	70.33	23.42	210.98	23.42	23.42a	3885
8	109.67	0.00	79.11	26.34	237.34	26.34	26.34a	3885
9	109.34	0.00	86.18	28.70	258.53	28.70	28.70a	3885
10	108.95	3.24	89.98	29.96	269.94	29.96	33.20a	3885
11	108.48	7.18	93.65	31.18	280.94	31.18	38.36a	3885
12	108.00	11.12	96.91	32.27	290.72	32.27	43.39a	3885
13	107.66	13.94	99.18	33.03	297.55	33.48	47.41	3885
14	107.32	16.76	101.48	33.79	304.45	34.79	51.55	3885
15	107.07	18.83	103.21	34.37	309.63	35.78	54.61	3885
16	107.00	19.41	103.70	34.53	311.09	36.06	55.48	3885
17	106.60	22.73	106.55	35.48	319.64	37.73	60.46	3885
18	106.20	26.05	109.50	36.46	328.50	39.47	65.53	3885
19	105.60	31.03	114.11	38.00	342.34	42.24	73.28	3885
20	105.00	36.01	118.93	39.60	356.80	45.19	81.20	3885
21	104.40	40.99	123.93	41.27	371.80	48.28	89.26	3885
22	103.80	45.97	129.09	42.99	387.27	51.49	97.45	3885
23	103.20	50.94	134.38	44.75	403.14	54.79	105.73	3885
24	102.60	55.92	139.79	46.55	419.37	58.15	114.07	3885
25	102.00	60.90	145.30	48.38	435.90	61.56	122.46	3885
26	101.65	63.80	148.56	49.47	445.67	63.56	127.36	3885
27	101.30	66.71	151.84	50.56	455.52	65.57	132.28	3885

RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Water</u> <u>press.</u> kN/m2	<u>Effective stresses</u>				<u>Total</u> <u>earth</u> <u>pressure</u> kN/m2	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u> kN/m3
			<u>Vertic</u> <u>-al</u> kN/m2	<u>Active</u> <u>limit</u> kN/m2	<u>Passive</u> <u>limit</u> kN/m2	<u>Earth</u> <u>pressure</u> kN/m2		
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	110.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	104.60	19.93	19.93	12451
6	110.42	Total>	7.98	2.10m	116.78	26.39	26.39	12951
7	110.00	Total>	15.97	4.20m	128.97	33.06	33.06	13451
		0.00	15.97	5.32	47.92	25.59	25.59	4785
8	109.67	0.00	22.26	7.41	66.79	28.85	28.85	4785
9	109.34	0.00	28.57	9.51	85.72	32.13	32.13	4785
10	108.95	0.00	36.05	12.00	108.15	35.05	35.05	4785
11	108.48	0.00	45.20	15.05	135.60	38.61	38.61	4785
12	108.00	0.00	54.40	18.12	163.20	42.16	42.16	4785

(continued)

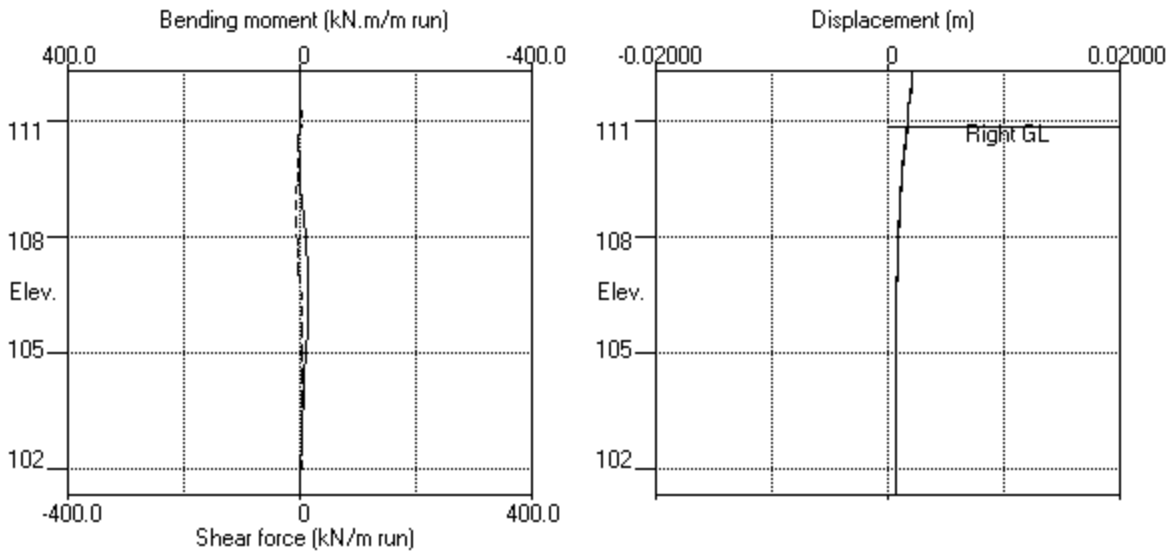
Stage No.4 Excavate to elevation 110.84 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>RIGHT side</u> <u>Effective stresses</u>					<u>Total</u> <u>earth</u> <u>pressure</u>	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u>
		<u>Water</u> <u>press.</u>	<u>Vertic</u> <u>-al</u>	<u>Active</u> <u>limit</u>	<u>Passive</u> <u>limit</u>	<u>Earth</u> <u>pressure</u>		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
13	107.66	0.00	61.02	20.32	183.05	44.67	44.67	4785
14	107.32	0.00	67.66	22.53	202.98	47.15	47.15	4785
15	107.07	0.00	72.56	24.16	217.69	48.95	48.95	4785
16	107.00	0.00	73.94	24.62	221.81	49.45	49.45	4785
17	106.60	4.68	77.13	25.68	231.39	51.09	55.77	4785
18	106.20	9.36	80.36	26.76	241.07	52.66	62.02	4785
19	105.60	16.38	85.24	28.39	255.73	54.87	71.26	4785
20	105.00	23.41	90.18	30.03	270.54	56.93	80.34	4785
21	104.40	30.43	95.15	31.69	285.46	58.86	89.29	4785
22	103.80	37.45	100.15	33.35	300.46	60.69	98.13	4785
23	103.20	44.47	105.16	35.02	315.49	62.43	106.91	4785
24	102.60	51.49	110.18	36.69	330.54	64.14	115.63	4785
25	102.00	58.52	115.19	38.36	345.58	65.82	124.33	4785
26	101.65	62.61	118.11	39.33	354.34	66.79	129.40	4785
27	101.30	66.71	121.03	40.30	363.10	67.76	134.47	4785

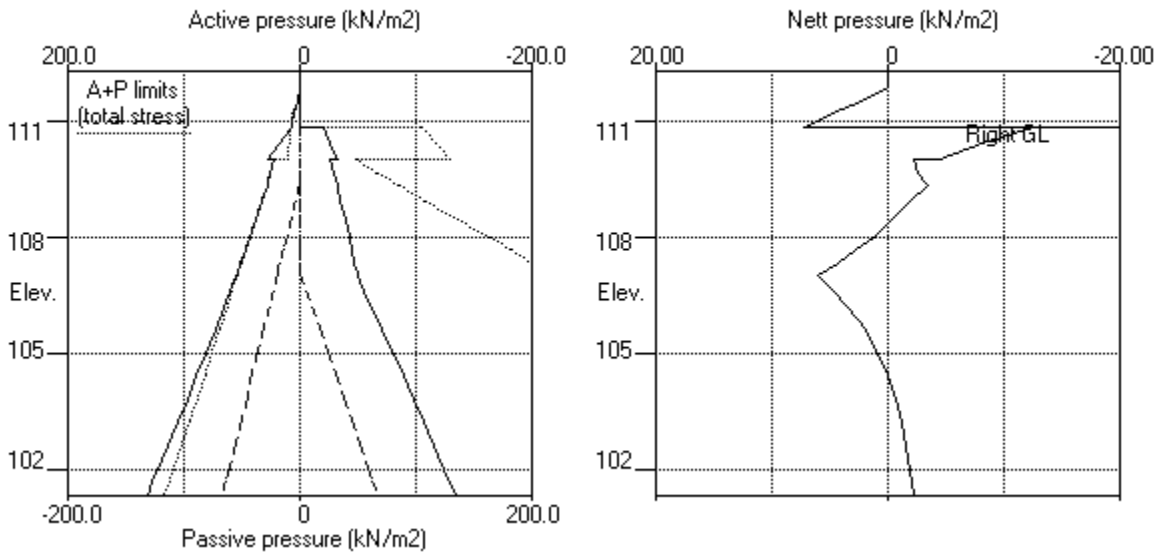
Note: 43.39 a Soil pressure at active limit
 123.45 p Soil pressure at passive limit

Units: kN,m

Stage No.4 Excav. to elev. 110.84 on RIGHT side



Stage No.4 Excav. to elev. 110.84 on RIGHT side



Units: kN,m

Stage No. 6 Excavate to elevation 108.95 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

<u>Stage</u> <u>No.</u>	<u>Ground level</u>		<u>Prop</u> <u>Elev.</u>	<u>FoS for toe</u> <u>elev. = 101.30</u>		<u>Toe elev. for</u> <u>FoS = 1.000</u>		<u>Direction</u> <u>of</u> <u>failure</u>
	<u>Act.</u>	<u>Pass.</u>		<u>Factor</u> <u>of</u> <u>Safety</u>	<u>Moment</u> <u>equilib.</u> <u>at elev.</u>	<u>Toe</u> <u>elev.</u>	<u>Wall</u> <u>Penetr</u> <u>-ation</u>	
6	112.30	108.95	110.84	2.660	n/a	107.28	1.67	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Subgrade reaction model - Boussinesq Influence coefficients

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

Open Tension Crack analysis - No

Length of wall perpendicular to section = 1000.00m

Rigid boundaries: Left side 20.00m from wall

Right side 8.00m from wall

Limit State: Serviceability Limit State

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

*** Wall displacements reset to zero at stage 3

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m ²	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
1	112.30	11.31	0.000	-8.41E-04	0.0	-0.0	
2	111.90	8.19	0.001	-8.43E-04	3.9	0.9	
3	111.50	7.43	0.001	-8.51E-04	7.0	3.4	
4	111.30	7.49	0.001	-8.59E-04	8.5	4.9	
		17.25	0.001	-8.59E-04	8.5	4.9	
5	110.84	7.30	0.002	-8.98E-04	14.2	10.9	-61.4
		7.30	0.002	-8.98E-04	-47.3	10.9	
6	110.42	14.25	0.002	-9.10E-04	-42.7	-7.4	
7	110.00	20.60	0.002	-8.48E-04	-35.4	-23.7	
		23.42	0.002	-8.48E-04	-35.4	-23.7	
8	109.67	26.34	0.003	-7.55E-04	-27.2	-34.1	
9	109.34	28.70	0.003	-6.35E-04	-18.1	-41.5	
10	108.95	33.20	0.003	-4.75E-04	-6.0	-46.3	
11	108.48	11.27	0.003	-2.80E-04	4.5	-46.2	
12	108.00	0.98	0.003	-1.09E-04	7.4	-42.8	
13	107.66	1.82	0.003	-6.31E-06	7.9	-40.2	
14	107.32	2.83	0.003	8.09E-05	8.7	-37.3	
15	107.07	3.69	0.003	1.35E-04	9.5	-35.1	
16	107.00	3.95	0.003	1.49E-04	9.8	-34.4	
17	106.60	2.05	0.003	2.18E-04	11.0	-30.2	
18	106.20	0.36	0.003	2.69E-04	11.5	-25.7	
19	105.60	-1.85	0.003	3.17E-04	11.0	-19.0	
20	105.00	-3.77	0.003	3.39E-04	9.3	-12.9	
21	104.40	-3.68	0.003	3.42E-04	7.1	-7.8	
22	103.80	-3.25	0.002	3.35E-04	5.0	-4.4	
23	103.20	-2.70	0.002	3.25E-04	3.2	-2.1	
24	102.60	-2.09	0.002	3.17E-04	1.8	-0.7	
25	102.00	-1.44	0.002	3.13E-04	0.7	-0.2	
26	101.65	-1.05	0.002	3.12E-04	0.3	-0.0	

(continued)

Stage No.6 Excavate to elevation 108.95 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m2	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
27	101.30	-0.66	0.002	3.12E-04	0.0	-0.0	
At elev. 110.84				Prop force =	61.4	kN/m run	

LEFT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Water</u> <u>press.</u> kN/m2	<u>Vertic</u> <u>-al</u> kN/m2	<u>Effective stresses</u>		<u>Earth</u> <u>pressure</u> kN/m2	<u>Total</u> <u>earth</u> <u>pressure</u> kN/m2	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u> kN/m3
				<u>Active</u> <u>limit</u> kN/m2	<u>Passive</u> <u>limit</u> kN/m2			
1	112.30	0.00	0.00	0.00	109.88	11.31	11.31	6629
2	111.90	0.00	7.20	0.00	127.62	8.19	8.19	6629
3	111.50	0.00	14.40	0.00	145.36	7.43	7.43	6629
4	111.30	0.00	18.47	0.00	155.37	7.49	7.49	6629
		Total>	18.47	5.00m	118.47	17.25	17.25	23322
5	110.84	Total>	36.26	7.30m	140.86	7.30	7.30a	7135
6	110.42	Total>	55.40	9.40m	164.20	14.25	14.25	7422
7	110.00	Total>	70.33	11.50m	183.33	20.60	20.60	7708
		0.00	70.33	23.42	210.98	23.42	23.42a	2662
8	109.67	0.00	79.11	26.34	237.34	26.34	26.34a	2662
9	109.34	0.00	86.18	28.70	258.53	28.70	28.70a	2662
10	108.95	3.24	89.98	29.96	269.94	29.96	33.20a	2662
11	108.48	7.18	93.65	31.18	280.94	31.18	38.36a	2662
12	108.00	11.12	96.91	32.27	290.72	32.27	43.39a	2662
13	107.66	13.94	99.18	33.03	297.55	33.03	46.97a	2662
14	107.32	16.76	101.48	33.79	304.45	33.79	50.55a	2662
15	107.07	18.83	103.21	34.37	309.63	34.37	53.20a	2662
16	107.00	19.41	103.70	34.53	311.09	34.53	53.95a	2662
17	106.60	22.73	106.55	35.48	319.64	35.48	58.21a	2662
18	106.20	26.05	109.50	36.46	328.50	36.46	62.52a	2662
19	105.60	31.03	114.11	38.00	342.34	38.00	69.03a	2662
20	105.00	36.01	118.93	39.60	356.80	39.60	75.61a	2662
21	104.40	40.99	123.93	41.27	371.80	43.06	84.05	2662
22	103.80	45.97	129.09	42.99	387.27	46.78	92.75	2662
23	103.20	50.94	134.38	44.75	403.14	50.58	101.53	2662
24	102.60	55.92	139.79	46.55	419.37	54.44	110.36	2662
25	102.00	60.90	145.30	48.38	435.90	58.33	119.23	2662
26	101.65	63.80	148.56	49.47	445.67	60.61	124.41	2662
27	101.30	66.71	151.84	50.56	455.52	62.90	129.60	2662

RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Water</u> <u>press.</u> kN/m2	<u>Vertic</u> <u>-al</u> kN/m2	<u>Effective stresses</u>		<u>Earth</u> <u>pressure</u> kN/m2	<u>Total</u> <u>earth</u> <u>pressure</u> kN/m2	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u> kN/m3
				<u>Active</u> <u>limit</u> kN/m2	<u>Passive</u> <u>limit</u> kN/m2			
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	110.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	110.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.67	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	109.34	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	108.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	3752
11	108.48	0.00	9.03	3.01	27.09	27.09	27.09p	3752
12	108.00	0.00	18.09	6.03	54.28	42.40	42.40	3752

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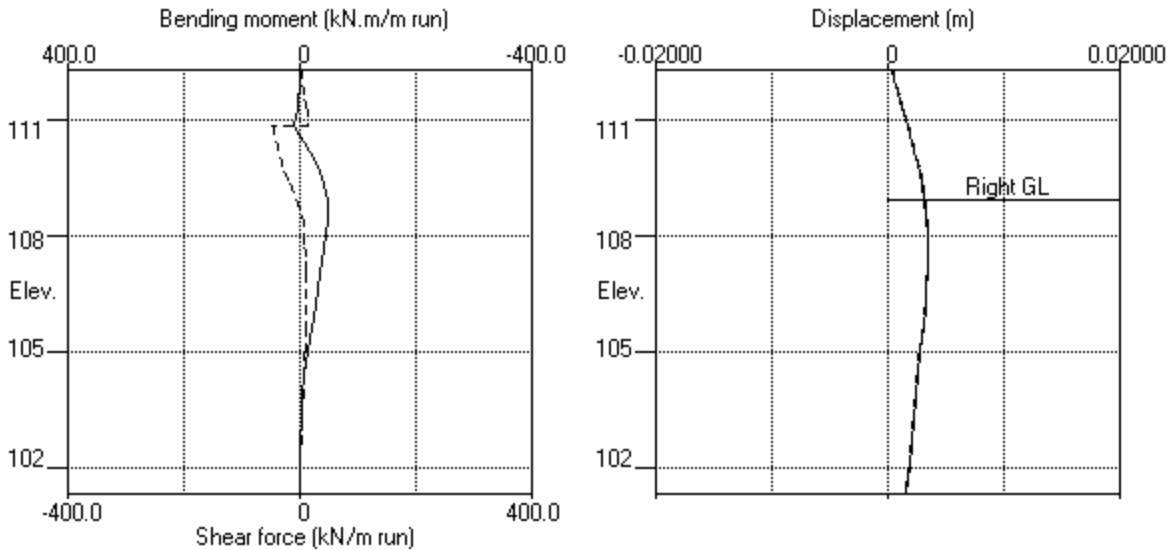
Stage No.6 Excavate to elevation 108.95 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>RIGHT side</u> <u>Effective stresses</u>					<u>Total</u> <u>earth</u> <u>pressure</u>	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u>
		<u>Water</u> <u>press.</u>	<u>Vertic</u> <u>-al</u>	<u>Active</u> <u>limit</u>	<u>Passive</u> <u>limit</u>	<u>Earth</u> <u>pressure</u>		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
13	107.66	0.00	24.62	8.20	73.85	45.15	45.15	3752
14	107.32	0.00	31.18	10.38	93.55	47.72	47.72	3752
15	107.07	0.00	36.04	12.00	108.13	49.51	49.51	3752
16	107.00	0.00	37.41	12.46	112.23	49.99	49.99	3752
17	106.60	4.68	40.58	13.51	121.74	51.48	56.16	3752
18	106.20	9.36	43.83	14.60	131.50	52.79	62.16	3752
19	105.60	16.38	48.87	16.27	146.62	54.50	70.88	3752
20	105.00	23.41	54.10	18.02	162.31	55.97	79.38	3752
21	104.40	30.43	59.51	19.82	178.52	57.30	87.73	3752
22	103.80	37.45	65.06	21.66	195.18	58.54	95.99	3752
23	103.20	44.47	70.73	23.55	212.20	59.75	104.22	3752
24	102.60	51.49	76.49	25.47	229.48	60.95	112.44	3752
25	102.00	58.52	82.32	27.41	246.95	62.15	120.67	3752
26	101.65	62.61	85.73	28.55	257.19	62.85	125.47	3752
27	101.30	66.71	89.15	29.69	267.46	63.56	130.27	3752

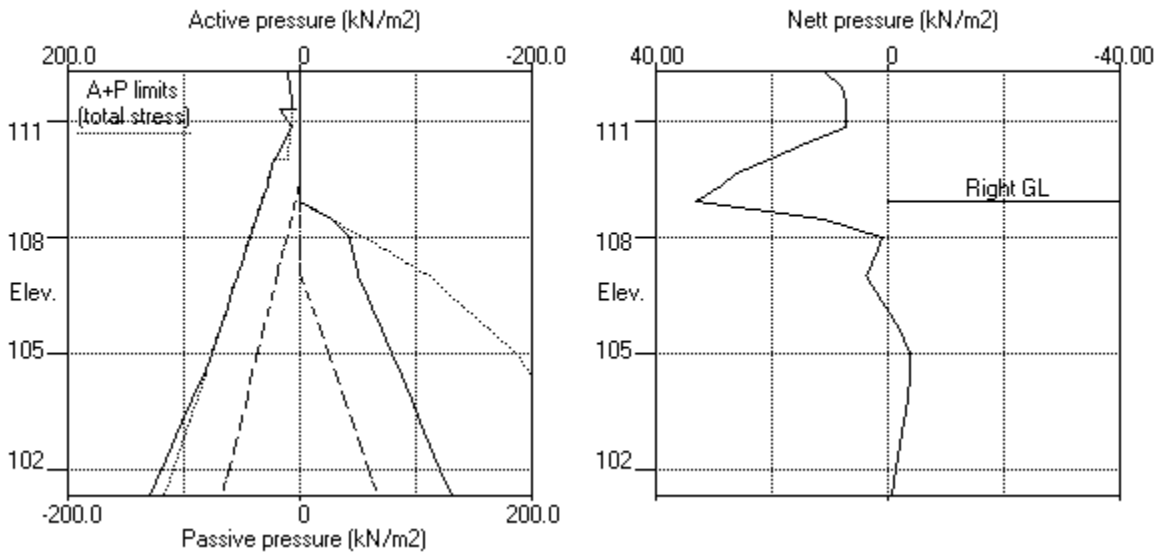
Note: 75.61 a Soil pressure at active limit
27.09 p Soil pressure at passive limit

Units: kN,m

Stage No.6 Excav. to elev. 108.95 on RIGHT side



Stage No.6 Excav. to elev. 108.95 on RIGHT side



Units: kN,m

Stage No. 7 Excavate to elevation 107.07 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

<u>Stage</u> <u>No.</u>	<u>Ground level</u>		<u>Prop</u> <u>Elev.</u>	<u>FoS for toe</u> <u>elev. = 101.30</u>		<u>Toe elev. for</u> <u>FoS = 1.000</u>		<u>Direction</u> <u>of</u> <u>failure</u>
	<u>Act.</u>	<u>Pass.</u>		<u>Factor</u> <u>of</u> <u>Safety</u>	<u>Moment</u> <u>equilib.</u> <u>at elev.</u>	<u>Toe</u> <u>elev.</u>	<u>Wall</u> <u>Penetr</u> <u>-ation</u>	
7	112.30	107.07	110.84	1.241	n/a	102.62	4.45	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Subgrade reaction model - Boussinesq Influence coefficients

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

Open Tension Crack analysis - No

Length of wall perpendicular to section = 1000.00m

Rigid boundaries: Left side 20.00m from wall

Right side 8.00m from wall

Limit State: Serviceability Limit State

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

*** Wall displacements reset to zero at stage 3

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m2	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
1	112.30	54.22	-0.006	-5.28E-03	0.0	-0.0	
2	111.90	39.39	-0.004	-5.29E-03	18.7	4.3	
3	111.50	26.88	-0.002	-5.33E-03	32.0	15.2	
4	111.30	21.00	-0.001	-5.37E-03	36.8	22.2	
		64.83	-0.001	-5.37E-03	36.8	22.2	
5	110.84	7.30	0.002	-5.55E-03	53.4	46.2	-164.4
		7.30	0.002	-5.55E-03	-111.1	46.2	
6	110.42	9.40	0.004	-5.67E-03	-107.6	0.9	
7	110.00	11.50	0.006	-5.58E-03	-103.2	-43.2	
		23.42	0.006	-5.58E-03	-103.2	-43.2	
8	109.67	26.34	0.008	-5.37E-03	-95.0	-75.9	
9	109.34	28.70	0.010	-5.05E-03	-85.9	-105.7	
10	108.95	33.20	0.012	-4.55E-03	-73.8	-136.9	
11	108.48	38.36	0.014	-3.79E-03	-56.8	-168.0	
12	108.00	43.39	0.015	-2.89E-03	-37.4	-190.1	
13	107.66	46.97	0.016	-2.20E-03	-22.0	-200.2	
14	107.32	50.55	0.017	-1.48E-03	-5.5	-204.9	
15	107.07	53.20	0.017	-9.53E-04	7.5	-204.6	
16	107.00	49.96	0.017	-8.05E-04	11.1	-204.0	
17	106.60	40.76	0.017	2.16E-05	29.3	-195.8	
18	106.20	31.49	0.017	7.98E-04	43.7	-181.1	
19	105.60	17.26	0.016	1.81E-03	58.3	-150.1	
20	105.00	2.43	0.015	2.62E-03	64.2	-113.0	
21	104.40	-13.18	0.013	3.19E-03	61.0	-74.8	
22	103.80	-29.64	0.011	3.54E-03	48.2	-41.7	
23	103.20	-30.97	0.009	3.70E-03	30.0	-16.4	
24	102.60	-23.06	0.007	3.76E-03	13.8	-4.2	
25	102.00	-13.43	0.005	3.76E-03	2.8	0.2	
26	101.65	-4.05	0.003	3.76E-03	-0.2	0.4	

Stage No.7 Excavate to elevation 107.07 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>Nett</u> <u>pressure</u> kN/m2	<u>Wall</u> <u>disp.</u> m	<u>Wall</u> <u>rotation</u> rad.	<u>Shear</u> <u>force</u> kN/m	<u>Bending</u> <u>moment</u> kN.m/m	<u>Prop</u> <u>forces</u> kN/m
27	101.30	5.32	0.002	3.76E-03	0.0	-0.0	
At elev. 110.84				Prop force = 164.4 kN/m run			

		LEFT side							
		Effective stresses					Total	Coeff. of	
Node	Y	Water	Vertic	Active	Passive	Earth	earth	subgrade	
no.	coord	press.	-al	limit	limit	pressure	pressure	reaction	
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3	
1	112.30	0.00	0.00	0.00	109.88	54.22	54.22	6581	
2	111.90	0.00	7.20	0.00	127.62	39.39	39.39	6581	
3	111.50	0.00	14.40	0.00	145.36	26.88	26.88	6581	
4	111.30	0.00	18.47	0.00	155.37	21.00	21.00	6581	
		Total>	18.47	5.00m	118.47	64.83	64.83	23159	
5	110.84	Total>	36.26	7.30m	140.86	7.30	7.30a	7621	
6	110.42	Total>	55.40	9.40m	164.20	9.40	9.40a	7927	
7	110.00	Total>	70.33	11.50m	183.33	11.50	11.50a	8233	
		0.00	70.33	23.42	210.98	23.42	23.42a	2916	
8	109.67	0.00	79.11	26.34	237.34	26.34	26.34a	2916	
9	109.34	0.00	86.18	28.70	258.53	28.70	28.70a	2916	
10	108.95	3.24	89.98	29.96	269.94	29.96	33.20a	2916	
11	108.48	7.18	93.65	31.18	280.94	31.18	38.36a	2916	
12	108.00	11.12	96.91	32.27	290.72	32.27	43.39a	2916	
13	107.66	13.94	99.18	33.03	297.55	33.03	46.97a	2916	
14	107.32	16.76	101.48	33.79	304.45	33.79	50.55a	2916	
15	107.07	18.83	103.21	34.37	309.63	34.37	53.20a	2916	
16	107.00	19.41	103.70	34.53	311.09	34.53	53.95a	2916	
17	106.60	22.73	106.55	35.48	319.64	35.48	58.21a	2916	
18	106.20	26.05	109.50	36.46	328.50	36.46	62.52a	2916	
19	105.60	31.03	114.11	38.00	342.34	38.00	69.03a	2916	
20	105.00	36.01	118.93	39.60	356.80	39.60	75.61a	2916	
21	104.40	40.99	123.93	41.27	371.80	41.27	82.26a	2916	
22	103.80	45.97	129.09	42.99	387.27	42.99	88.95a	2916	
23	103.20	50.94	134.38	44.75	403.14	44.75	95.69a	2916	
24	102.60	55.92	139.79	46.55	419.37	46.55	102.47a	2916	
25	102.00	60.90	145.30	48.38	435.90	50.03	110.93	2916	
26	101.65	63.80	148.56	49.47	445.67	55.83	119.64	2916	
27	101.30	66.71	151.84	50.56	455.52	61.64	128.35	2916	

		RIGHT side						
			<u>Effective stresses</u>				<u>Total</u>	<u>Coeff. of</u>
<u>Node</u>	<u>Y</u>	<u>Water</u>	<u>Vertic</u>	<u>Active</u>	<u>Passive</u>	<u>Earth</u>	<u>earth</u>	<u>subgrade</u>
<u>no.</u>	<u>coord</u>	<u>press.</u>	<u>-al</u>	<u>limit</u>	<u>limit</u>	<u>pressure</u>	<u>pressure</u>	<u>reaction</u>
		kN/m ²	kN/m ²	kN/m ²	kN/m ²	kN/m ²	kN/m ²	kN/m ³
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	110.84	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	110.42	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.67	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	109.34	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	108.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.48	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	108.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	107.66	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

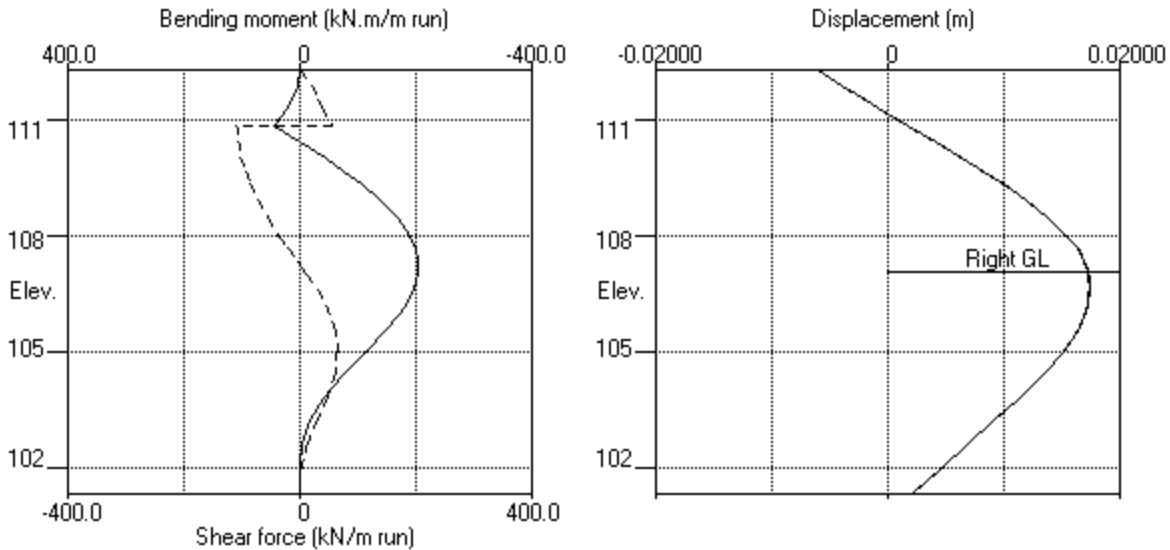
Stage No.7 Excavate to elevation 107.07 on RIGHT side

<u>Node</u> <u>no.</u>	<u>Y</u> <u>coord</u>	<u>RIGHT side</u>					<u>Total</u> <u>earth</u> <u>pressure</u>	<u>Coeff. of</u> <u>subgrade</u> <u>reaction</u>
		<u>Water</u> <u>press.</u>	<u>Vertic</u> <u>-al</u>	<u>Effective</u> <u>Active</u> <u>limit</u>	<u>Effective</u> <u>Passive</u> <u>limit</u>	<u>Earth</u> <u>pressure</u>		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
14	107.32	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	107.07	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	4584
16	107.00	0.00	1.33	0.44	3.99	3.99	3.99p	4584
17	106.60	4.68	4.26	1.42	12.77	12.77	17.45p	4584
18	106.20	9.36	7.22	2.40	21.66	21.66	31.02p	4584
19	105.60	16.38	11.79	3.93	35.38	35.38	51.77p	4584
20	105.00	23.41	16.59	5.53	49.78	49.78	73.18p	4584
21	104.40	30.43	21.67	7.22	65.01	65.01	95.43p	4584
22	103.80	37.45	27.05	9.01	81.14	81.14	118.59p	4584
23	103.20	44.47	32.73	10.90	98.18	82.19	126.66	4584
24	102.60	51.49	38.68	12.88	116.04	74.04	125.53	4584
25	102.00	58.52	44.87	14.94	134.62	65.84	124.35	4584
26	101.65	62.61	48.58	16.18	145.74	61.07	123.69	4584
27	101.30	66.71	52.34	17.43	157.02	56.33	123.03	4584

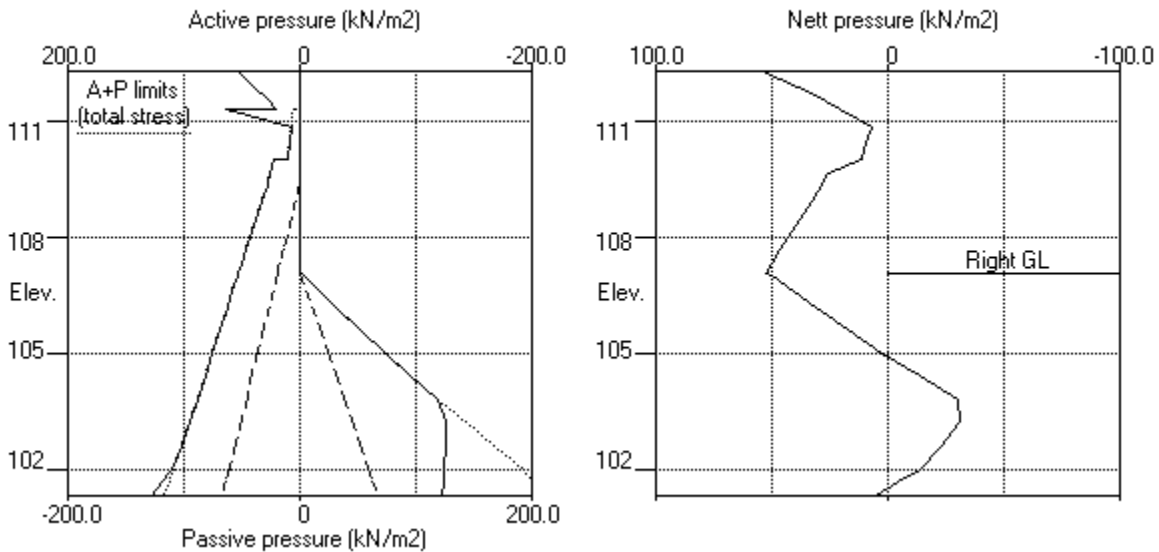
Note: 102.47 a Soil pressure at active limit
 118.59 p Soil pressure at passive limit

Units: kN,m

Stage No.7 Excav. to elev. 107.07 on RIGHT side



Stage No.7 Excav. to elev. 107.07 on RIGHT side



Units: kN,m

Summary of results**LIMIT STATE PARAMETERS**

Limit State: Serviceability Limit State

All loads and soil strengths are unfactored

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

			FoS for toe		Toe elev. for			
			elev. = 101.30		FoS = 1.000			
<u>Stage</u>	<u>Ground level</u>		<u>Prop</u>	<u>Factor</u>	<u>Moment</u>	<u>Toe</u>	<u>Wall</u>	<u>Direction</u>
<u>No.</u>	<u>Act.</u>	<u>Pass.</u>	<u>Elev.</u>	<u>of</u>	<u>equilib.</u>	<u>elev.</u>	<u>Penetr</u>	<u>of</u>
				<u>Safety</u>	<u>at elev.</u>		<u>-ation</u>	<u>failure</u>
1	112.30	112.30	Cant.	<u>Conditions not suitable for FoS calc.</u>				
2	112.30	112.30	Cant.	<u>Conditions not suitable for FoS calc.</u>				
3	112.30	112.30		No analysis at this stage				
4	112.30	110.84	Cant.	<u>Conditions not suitable for FoS calc.</u>				
5	112.30	110.84		No analysis at this stage				
6	112.30	108.95	110.84	2.660	n/a	107.28	1.67	L to R
7	112.30	107.07	110.84	1.241	n/a	102.62	4.45	L to R
8	112.30	107.07		<u>More than one prop. No FoS calc.</u>				

Units: kN,m

Summary of results**BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall****Analysis options**

Subgrade reaction model - Boussinesq Influence coefficients

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

Open Tension Crack analysis - No

Length of wall perpendicular to section = 1000.00m

Rigid boundaries: Left side 20.00m from wall

Right side 8.00m from wall

Limit State: Serviceability Limit State

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

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement		Bending moment				Shear force			
		max.	min.	Calculated		Factored		Calculated		Factored	
				max.	min.	max.	min.	max.	min.	max.	min.
		m	m	kN.m/m		kN.m/m		kN/m	kN/m	kN/m	kN/m
1	112.30	0.002	-0.006	0	-0	0	-0	0	0	0	0
2	111.90	0.002	-0.004	4	-0	6	-0	19	-1	25	-1
3	111.50	0.002	-0.002	15	-0	21	-1	32	-1	43	-2
4	111.30	0.002	-0.001	22	-1	30	-1	37	-2	50	-2
5	110.84	0.002	0.000	46	-2	62	-3	53	-111	72	-150
6	110.42	0.004	0.000	3	-7	4	-10	0	-108	0	-145
7	110.00	0.006	0.000	2	-43	3	-58	0	-103	0	-139
8	109.67	0.008	0.000	1	-76	2	-102	0	-95	0	-128
9	109.34	0.010	0.000	0	-106	0	-143	0	-86	0	-116
10	108.95	0.012	0.000	0	-137	0	-185	0	-74	0	-100
11	108.48	0.014	0.000	0	-168	0	-227	5	-57	6	-77
12	108.00	0.015	0.000	0	-190	0	-257	7	-37	10	-50
13	107.66	0.016	0.000	0	-200	0	-270	8	-22	11	-30
14	107.32	0.017	0.000	0	-205	0	-277	9	-5	12	-7
15	107.07	0.017	0.000	0	-205	0	-276	10	-3	13	-4
16	107.00	0.017	0.000	0	-204	0	-275	11	-3	15	-3
17	106.60	0.017	0.000	0	-196	0	-264	29	-0	40	-0
18	106.20	0.017	0.000	0	-181	0	-244	44	0	59	0
19	105.60	0.016	0.000	0	-150	0	-203	58	0	79	0
20	105.00	0.015	0.000	0	-113	0	-153	64	0	87	0
21	104.40	0.013	0.000	0	-75	0	-101	61	0	82	0
22	103.80	0.011	0.000	0	-42	0	-56	48	0	65	0
23	103.20	0.009	0.000	0	-16	0	-22	30	0	40	0
24	102.60	0.007	0.000	0	-4	0	-6	14	0	19	0
25	102.00	0.005	0.000	0	-0	0	-1	3	-0	4	-0
26	101.65	0.003	0.000	0	-0	0	-0	1	-0	1	-0
27	101.30	0.002	0.000	0	-0	0	-0	0	0	0	0

Summary of results (continued)

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

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment				Shear force			
	Calculated		Factored		Calculated		Factored	
	max.	elev.	min.	elev.	max.	elev.	min.	elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	0	102.60	-7	108.95	0	-9	2	107.07
2	1	111.30	-17	107.00	1	-23	5	105.00
3	No calculation at this stage							
4	3	110.42	-13	106.60	4	-18	4	104.40
5	No calculation at this stage							
6	11	110.84	-46	108.95	15	-63	14	110.84
7	46	110.84	-205	107.32	62	-277	64	105.00
8	46	110.84	-205	107.32	62	-277	64	105.00

Maximum and minimum displacement at each stage

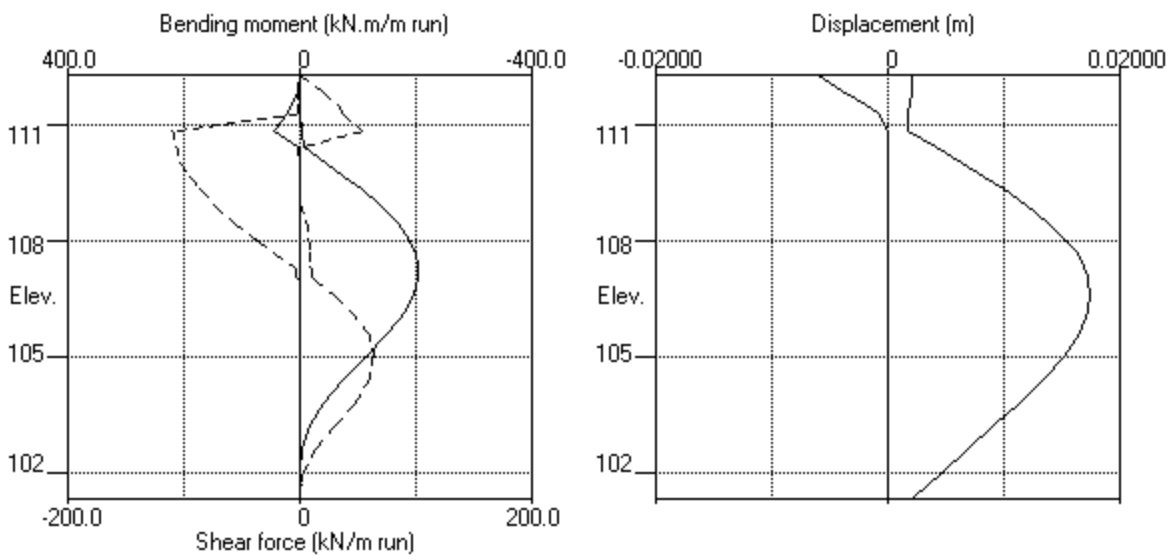
Stage no.	Displacement				Stage description
	maximum	elev.	minimum	elev.	
	m		m		
1	0.001	108.00	0.000	112.30	Apply surcharge no.1 at elev. 111.50
2	0.002	106.60	0.000	112.30	Apply water pressure profile no.1
3	Wall displacements reset to zero				Change EI of wall to 88400kN.m2/m run
4	0.002	112.30	0.000	112.30	Excav. to elev. 110.84 on RIGHT side
5	No calculation at this stage				Install prop no.1 at elev. 110.84
6	0.003	107.66	0.000	112.30	Excav. to elev. 108.95 on RIGHT side
7	0.017	106.60	-0.006	112.30	Excav. to elev. 107.07 on RIGHT side
8	0.017	106.60	-0.006	112.30	Install prop no.3 at elev. 107.32

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 1			Prop no. 3		
	at elev. 110.84			at elev. 107.32		
	--Calculated--	Factored		--Calculated--	Factored	
	kN per	kN per	kN per	kN per	kN per	kN per
	m run	prop	prop	m run	prop	prop
6	61	61	83	---	---	---
7	164	164	222	---	---	---
8	164	164	222	0	0	0

Units: kN,m

Bending moment, shear force, displacement envelopes





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