Ilyas Amlani

6A GRANGE ROAD, LONDON

Basement Impact Assessment

Revision K

Volume 3 of 3

Independent, multidisciplinary engineering
and environmental consultants

APPENDICES

APPENDIX H2

Ground Investigation Report

APPENDIX E: LABORATORY TESTING

Natural moisture content

Atterberg Limits

Particle size distribution

Determination of the undrained shear strength in triaxial compression without measurement of pore pressure

Total sulphur, sulphate content and pH value

A F Howland Associates
Geotechnical Engineers

Laboratory Test Results

Site : 6A Grange Road, London N6 4AP

Client : Lawrence Bent

Engineer : Create Consulting Engineers Limited

Job Number 16.185

Sheet 1 / 1

DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY AND LIQUIDITY INDEX

Borehole/ Trial Pit	Depth (m)	Sample	Natural Moisture Content %	Sample Passing 425µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Group Symbol	Laboratory Description
				Percentage %	Moisture Content %						
BH01	3.50	U2	29	100	29	42	19	23	0.43	CI	Firm orange brown becoming light grey sandy CLAY
BH01	9.40	D12	34	100	34	51	20	31	0.45	CH	Dark grey fine sandy CLAY with orangish brown staining
BH01	10.60	B6	35	100	35	47	19	28	0.57	CI	Mottled dark brown and black slightly organic silty CLAY
WS02	1.70	D2	21	97	22	44	19	25	0.12	CI	Mottled orangish brown and light grey silty CLAY with rare fine to medium gravel and rootlets.
WS02	8.00	D9	29	100	29	55	18	37	0.30	CH	Dark grey fine sandy silty CLAY

Method of Preparation : BS 1377:PART 1:1990:7.4 Preparation of samples for classification tests BS 1377:PART 2:1990:4.2 & 5.2 Sample preparations

Method of Test : BS 1377:PART 2:1990:3 Determination of moisture content 1990:4 Determination of the liquid limit BS 1377:PART 2:1990:5 Determination of the plastic limit and plasticity index

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Laboratory Test Results

Site : 6A Grange Road, London N6 4AP

Client : Lawrence Bent

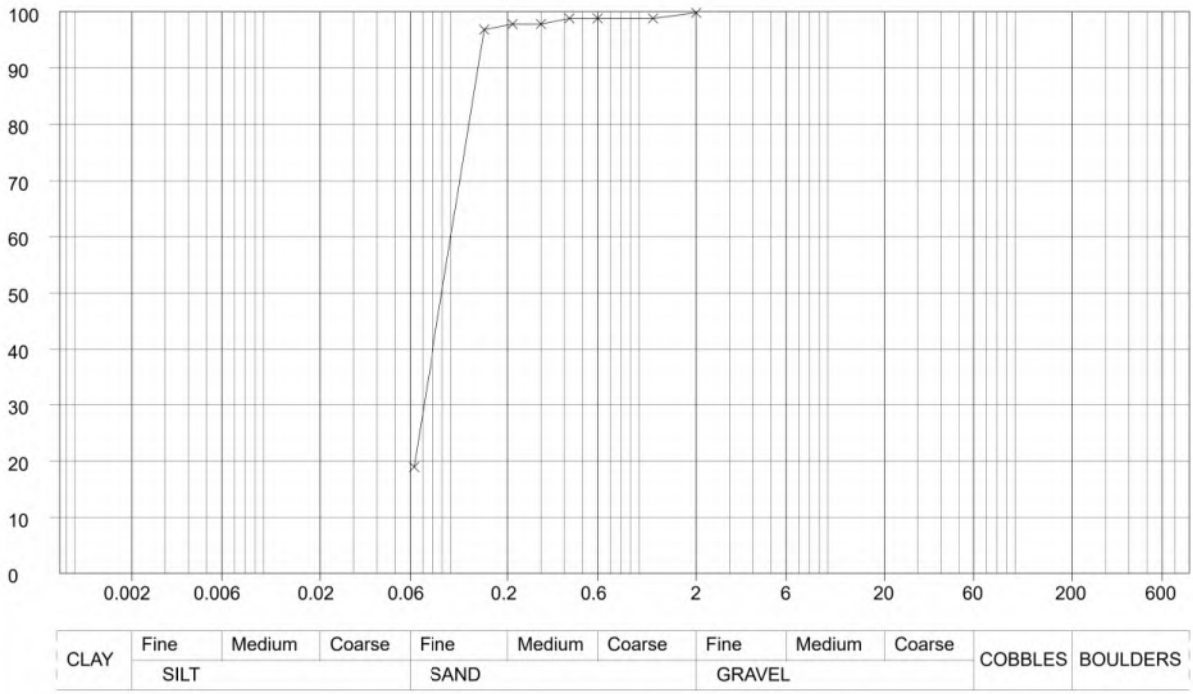
Engineer : Create Consulting Engineers Limited

Job Number 16.185

Sheet 1/5

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Laboratory Description
BH01	5.80	B3	Yellowish brown silty fine SAND



Sieve / Particle Size	% Passing
2 mm	100.0
1.18 mm	99.0
600 µm	99.0
425 µm	99.0
300 µm	98.0
212 µm	98.0
150 µm	97.0
63 µm	19.0

Grading Analysis	
D85	136.6 µm
D60	108.7 µm
D10	<63.0 µm
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	-
Gravel	-
Sand	81.0%
Silt	-
Clay	-

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 1990:7.4.5 Particle size tests

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

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Laboratory Test Results

Site : 6A Grange Road, London N6 4AP

Client : Lawrence Bent

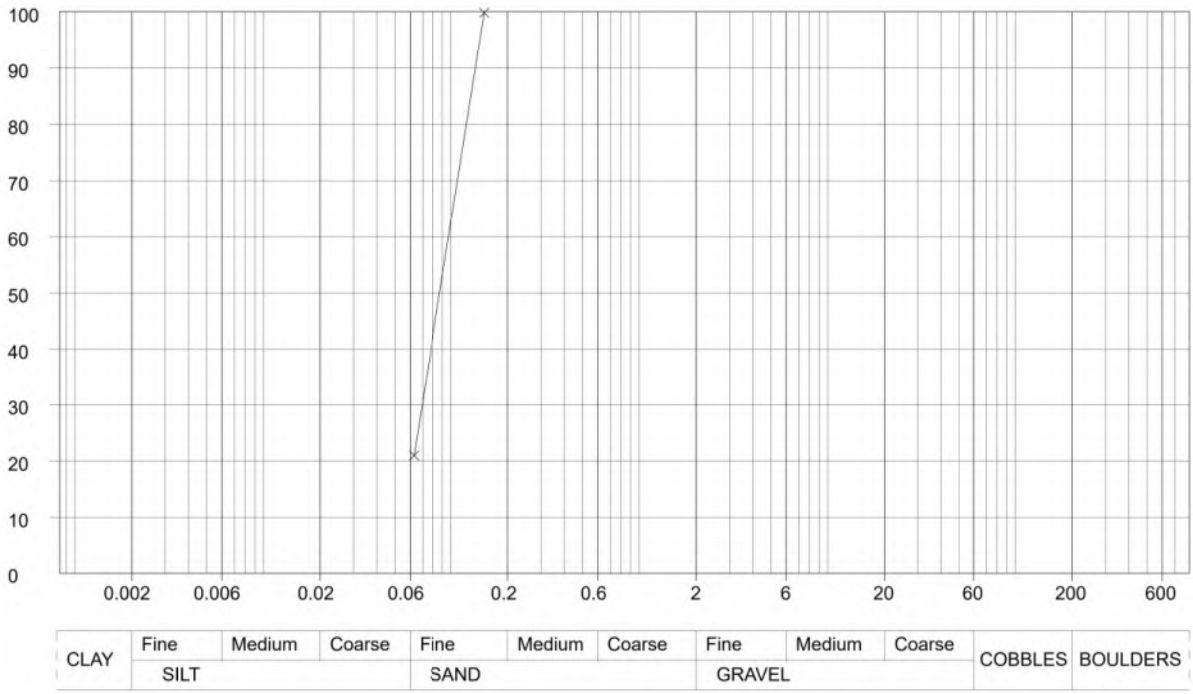
Engineer : Create Consulting Engineers Limited

Job Number 16.185

Sheet 2/5

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Laboratory Description
WS01	3.00	B3	Yellowish brown silty fine SAND



Sieve / Particle Size	% Passing
150 µm	100.0
63 µm	21.0

Grading Analysis	
D85	133.5 µm
D60	105.9 µm
D10	<63.0 µm
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	-
Gravel	-
Sand	79.0%
Silt	-
Clay	-

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 1990:7.4.5 Particle size tests

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

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Laboratory Test Results

Site : 6A Grange Road, London N6 4AP

Client : Lawrence Bent

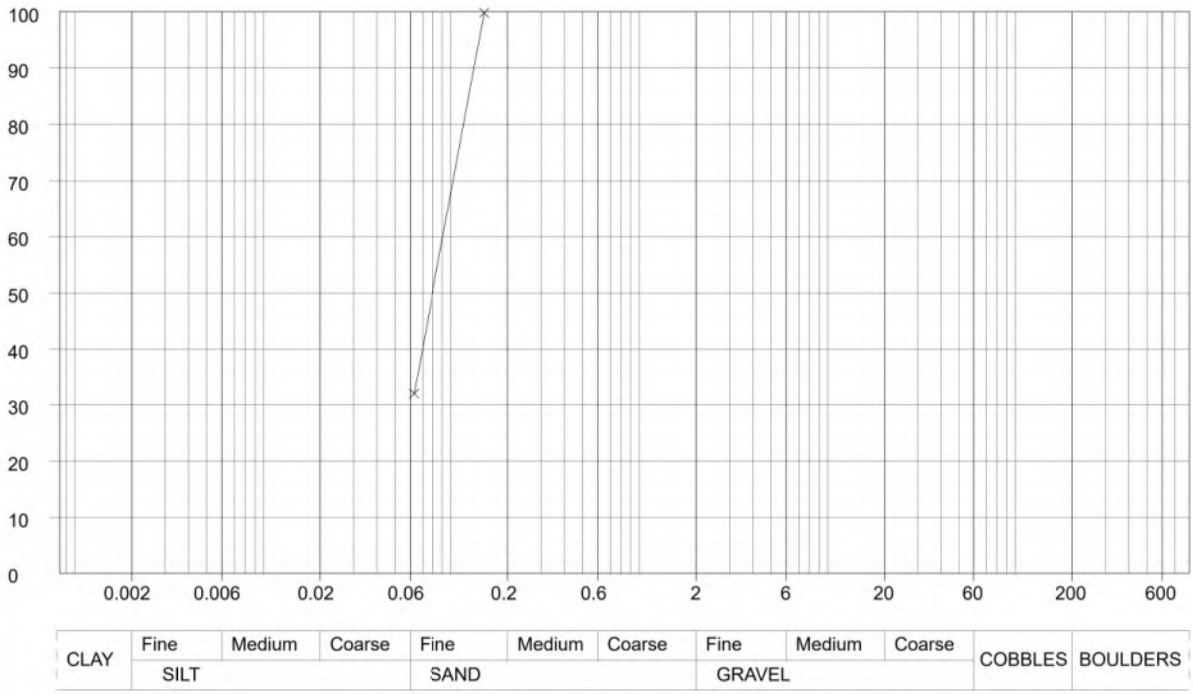
Engineer : Create Consulting Engineers Limited

Job Number 16.185

Sheet 3/5

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Laboratory Description
WS01	5.00	B5	Yellowish brown silty fine SAND



Sieve / Particle Size	% Passing
150 µm	100.0
63 µm	32.0

Grading Analysis	
D85	130.8 µm
D60	98.8 µm
D10	<63.0 µm
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	-
Gravel	-
Sand	68.0%
Silt	-
Clay	-

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 1990:7.4.5 Particle size tests

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

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Laboratory Test Results

Site : 6A Grange Road, London N6 4AP

Client : Lawrence Bent

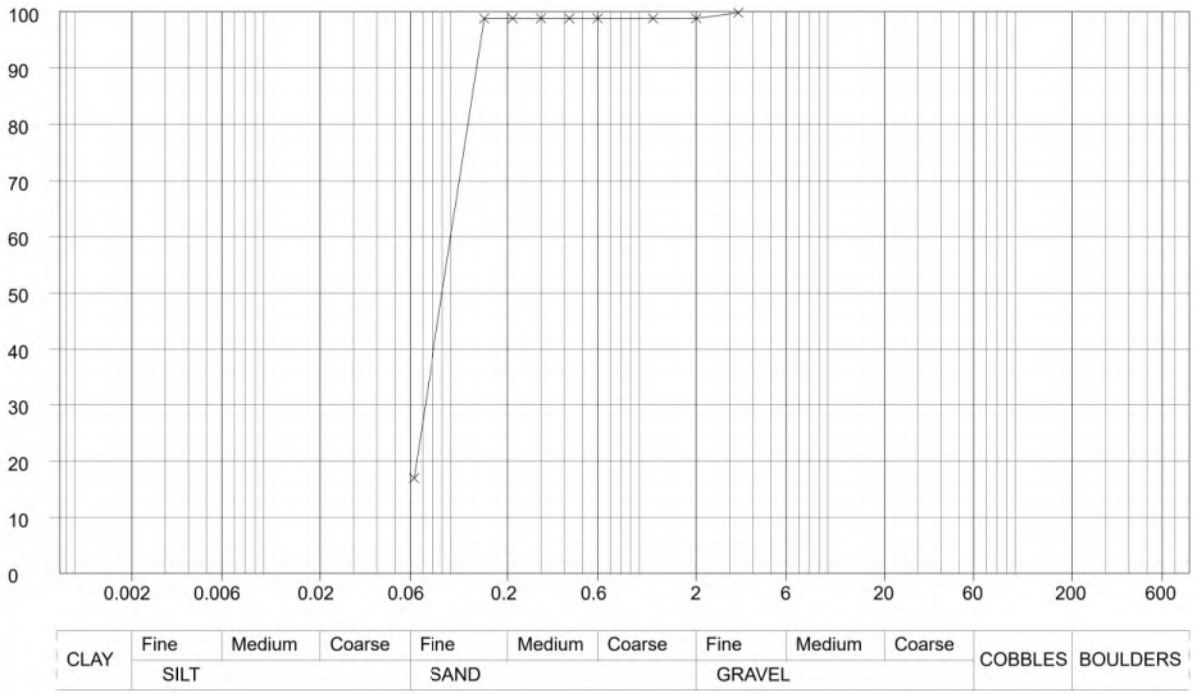
Engineer : Create Consulting Engineers Limited

Job Number 16.185

Sheet 4/5

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Laboratory Description
WS02	2.50	B2	Yellowish brown silty clayey fine SAND



Sieve / Particle Size	% Passing
3.35 mm	100.0
2 mm	99.0
1.18 mm	99.0
600 µm	99.0
425 µm	99.0
300 µm	99.0
212 µm	99.0
150 µm	99.0
63 µm	17.0

Grading Analysis	
D85	135.1 µm
D60	108.6 µm
D10	<63.0 µm
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	-
Gravel	1.0%
Sand	82.0%
Silt	-
Clay	-

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 1990:7.4.5 Particle size tests

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

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Laboratory Test Results

Site : 6A Grange Road, London N6 4AP

Client : Lawrence Bent

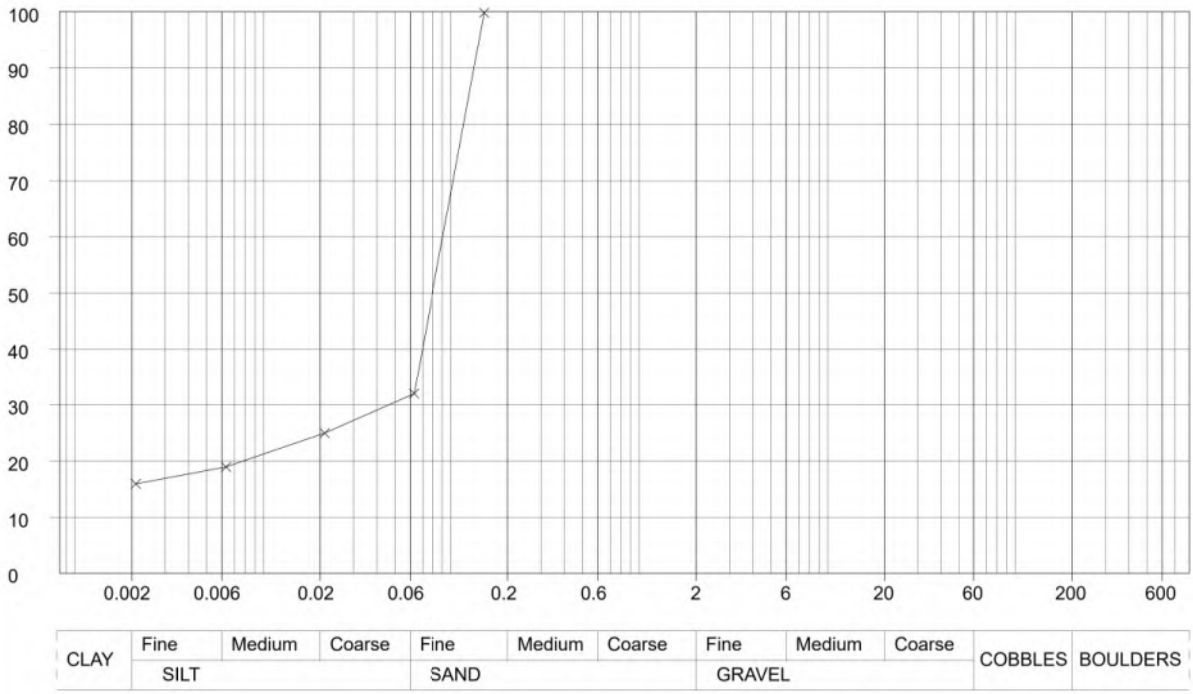
Engineer : Create Consulting Engineers Limited

Job Number 16.185

Sheet 5/5

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Laboratory Description
WS02	5.00	B5	Yellowish brown silty fine SAND



Sieve / Particle Size	% Passing
150 µm	100.0
63 µm	32.0
21.1 µm	25.0
6.32 µm	19.0
2.1 µm	16.0

Grading Analysis	
D85	130.8 µm
D60	98.8 µm
D10	<2.1 µm
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	-
Gravel	-
Sand	68.3%
Silt	15.8%
Clay	15.9%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 1990:7.4.5 Particle size tests

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

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Laboratory Test Results

Site : 6A Grange Road, London N6 4AP

Client : Lawrence Bent

Engineer : Create Consulting Engineers Limited

Job Number 16.185

Sheet 1 / 1

DETERMINATION OF DENSITY, MOISTURE CONTENT AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole/ Trial Pit	Depth (m)	Sample	Moisture Content %	Bulk Density (Mg/m³)	Dry Density (Mg/m³)	Cell Pressure (kN/m²)	Deviator Stress (kN/m²)	Apparent Cohesion (kN/m²)	Angle of Shearing Resistance (degrees)	Laboratory Description
BH01	1.50	U1	20	1.89	1.57	30	96	48		Firm light brown sandy CLAY
BH01	3.50	U2	29	1.89	1.47	70	125	63		Firm orange brown becoming light grey sandy CLAY
WS01	1.20	U1	24	1.99	1.60	24	175	88		Firm multicoloured slightly sandy CLAY with rare rootlets. Sand is fine

Method of Preparation : BS 1377:PART 1:1990:7.4.2 Moisture content 1990: Preparation of undisturbed samples for testing BS 1377:PART 2:1990:7.2

Method of Test : BS 1377:PART 2:1990:3 Determination of moisture content 1990:7 Determination of density BS 1377:PART 7:1990:8 Undrained shear strength 1990:9 Multistage loading

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Laboratory Test Results

Site : 6A Grange Road, London N6 4AP

Client : Lawrence Bent

Engineer : Create Consulting Engineers Limited

Job Number 16.185

Sheet 1 / 1

DETERMINATION OF pH, SULPHATE CONTENT AND TOTAL SULPHUR OF SOIL AND GROUNDWATER

Borehole/ Trial Pit	Depth (m)	Sample	Concentration of Soluble Sulphate			Total Sulphur %	Percentage of sample passing 2mm Sieve %	pH	Classification	Laboratory Description
			Soil		Groundwater g /l					
			Total S04 %	S03 in 2:1 water:soil g /l						
BH01	3.00	D6	0.03	0.06		0.01		5.0	DS-1	Brown sandy CLAY
BH01	3.19	W1P			0.27			6.0	DS-1	Water sample
WS01	4.00	D6		0.04				5.9	DS-1	Brown silty SAND
WS02	3.00	D3		0.01				5.1	DS-1	Brown silty SAND

Method of Preparation : BS 1377:PART 1:1990:7.5 Preparation of soil for chemical tests BS 1377:PART 3:1990:5.2, 5.3, 5.4 & 9.4

Method of Test : Laboratory in-house methods based on BS1377: Part 3 for contents of water soluble sulphate, total sulphate and pH.

Remarks : Classification relates to Design Sulphate Class of BRE Special Digest 1 (2005)

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APPENDIX F: DRAWINGS

Drawing 16.185/1	Site Location Plan
Drawing 16.185/2	Exploratory Hole Location Plan
Figure 16.185/3	Nominal Section
Figure 16.185/4	A-Line Plot
Figure 16.185/5a	N-Value and Cohesion Plot
Figure 16.185/5b	Undrained Shear Strength Plot
Figure 16.185/6	Particle Size Distribution

North

Circle indicates approximate location of site

Scale 1: 50,000 @ A4

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Site: 6A Grange Road, London N6 4AP

SITE LOCATION PLAN

Client : Lawrence Bent

Date : July 2016 **Dwg :** 16.185/1

Key:

- Borehole location and reference
- Trial pit location and reference
- Window sample location and reference

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Rev	Date	Revision Description	Drwn	Chkd

A F Howland Associates
Geotechnical Engineers

A F Howland Associates Ltd
The Old Exchange
Newmarket Road
Cringleford
Norwich
NR4 6UF
Tel: 01603 250754 Fax: 01603 250749
web: www.howland.co.uk
mail: admin@howland.co.uk

Client: Lawrence Bent

Site:
6A Grange Road, London N6 4AP

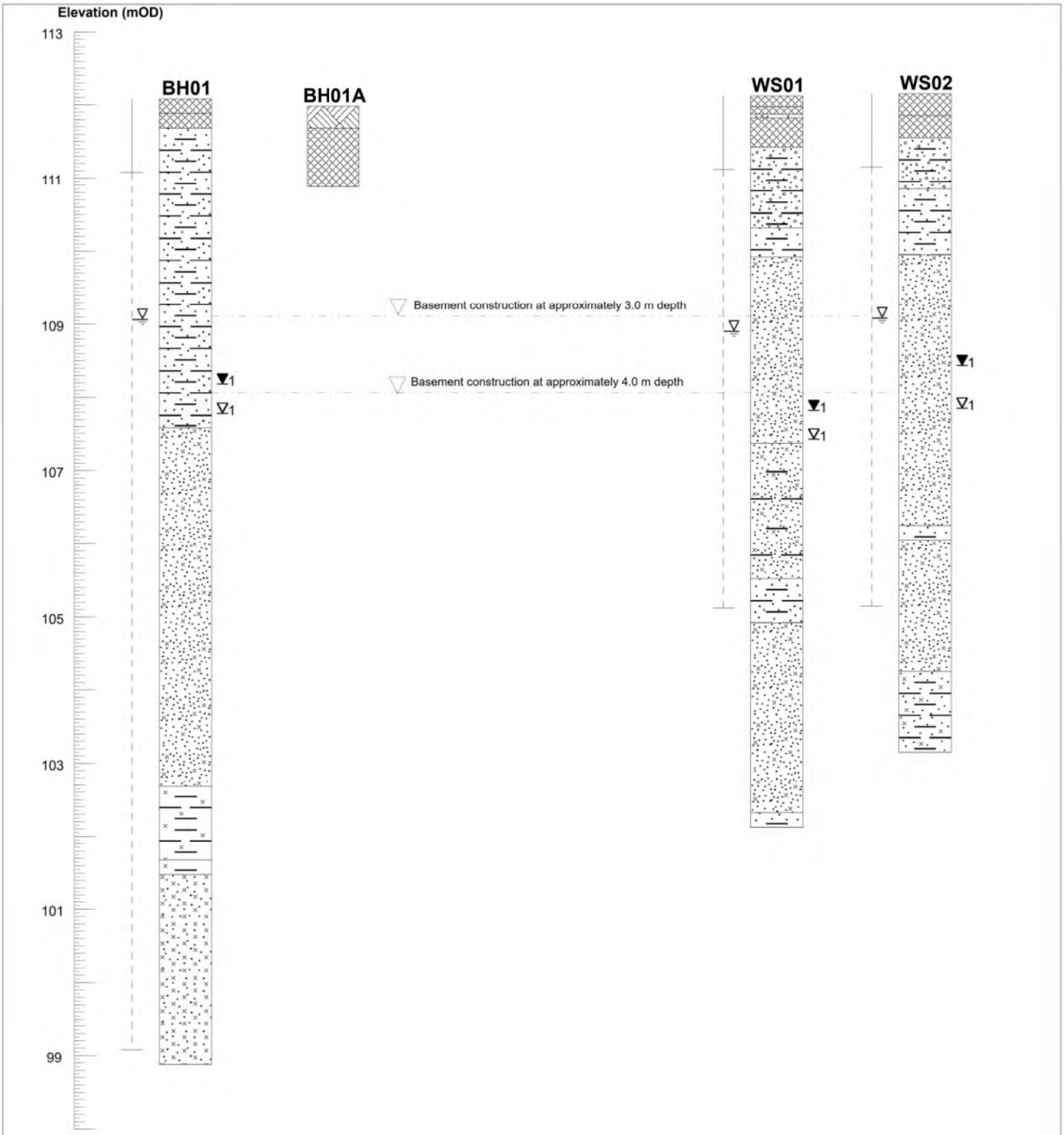
Job No.: 16.185

Drawing Title:
EXPLORATORY HOLE LOCATION PLAN

Date: July 2016

Drawing No: 16.185/2

Scale: 1:400 @ A4



Key

- Groundwater Strike
- Strike Rise Level
- Highest recorded piezo level
- Piezometer Tip
- Slotted Standpipe
- TOPSOIL
- MADE GROUND
- CONCRETE
- Silty CLAY
- Sandy CLAY
- Silty sandy CLAY
- Sandy gravelly CLAY
- Sandy SILT
- Silty SAND
- Clayey silty SAND

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Nominal Section

Site	Date Drawn	Date Checked	Sheet	Job Number
6A Grange Road, London N6 4AP	04/07/2016		1/1	16.185
Client	**Drawn By**	**Checked By**	**Scale**	**Figure No.**
Lawrence Bent	GNB		1:75[V]	16.185/3

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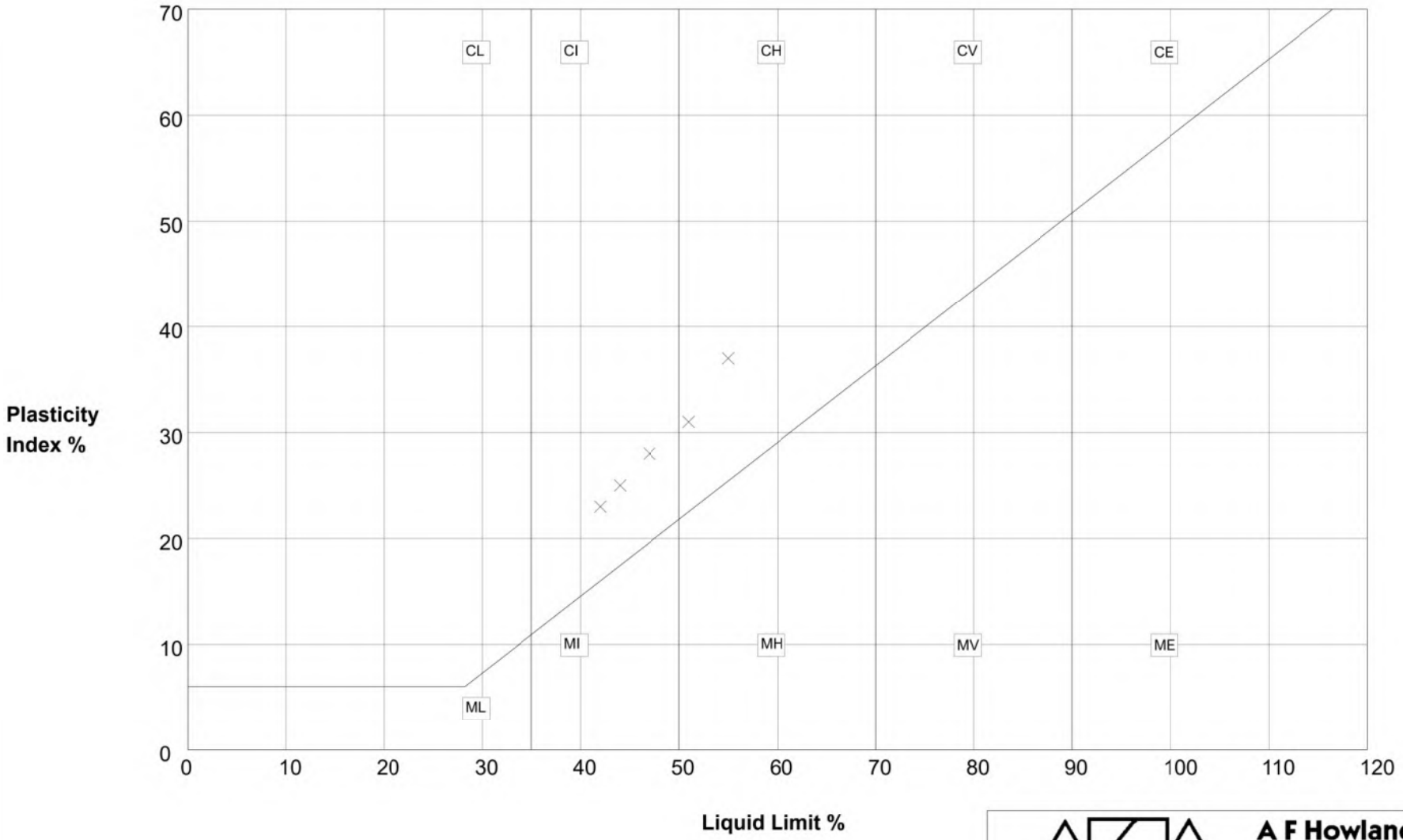

A F Howland Associates
Geotechnical Engineers

Site 6A Grange Road, London N6 4AP			
Title A-Line Plot			
Drawn GNB	**Checked**	**Approved**	**Job No.** 16.185
Date 05/07/2016	**Date**	**Date**	**Figure No.** 16.185/4

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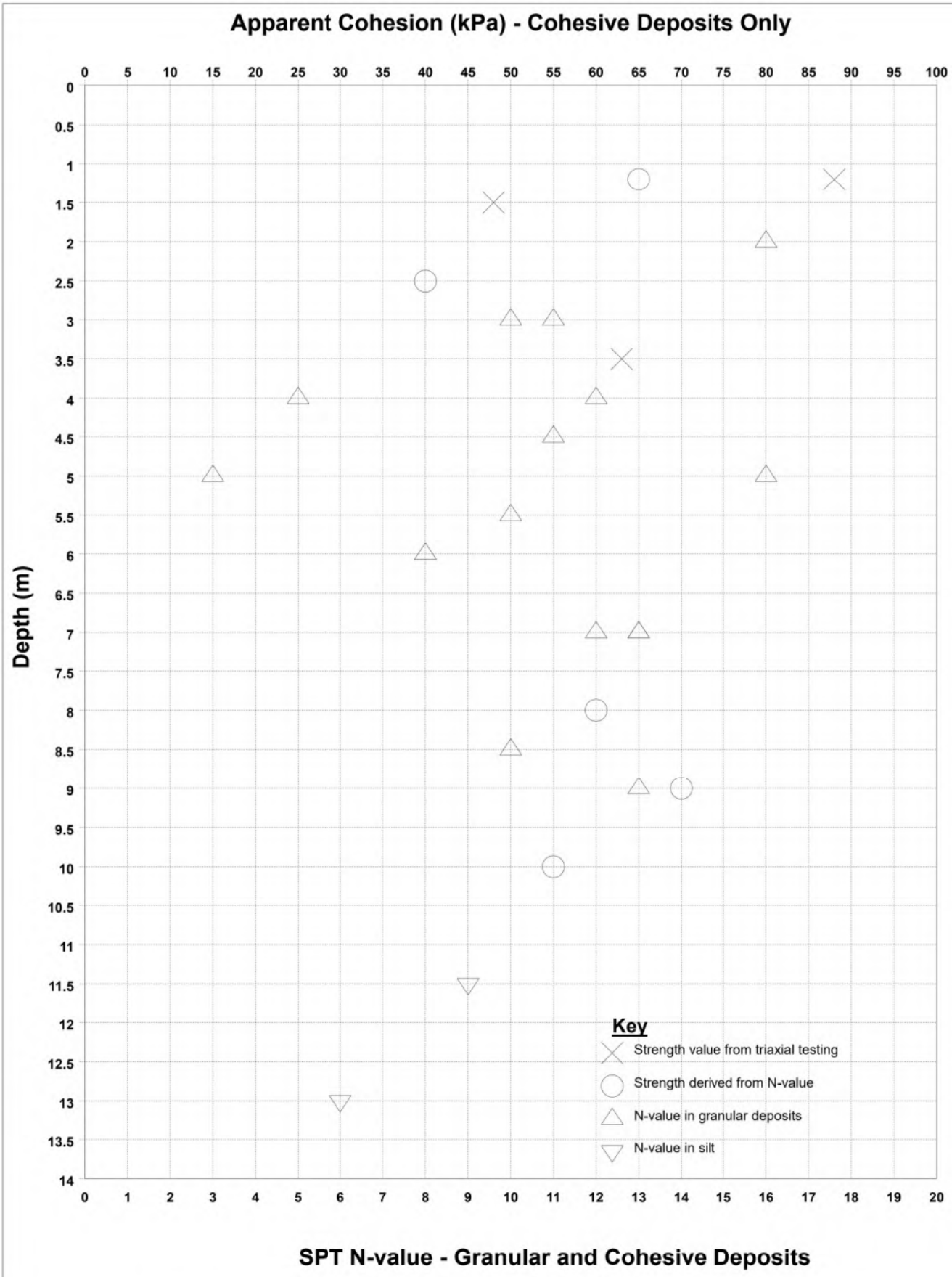

A F Howland Associates Geotechnical Engineers	**Title** N-value and Cohesion Plot			
Site 6A Grange Road, London N6 4AP	**Date Drawn** 06/07/2016	**Date Checked**	**Sheet**	**Job Number** 16.185
Client Lawrence Bent	**Drawn By**	**Checked By**	**Scale**	**Figure No.** 16.185/5a

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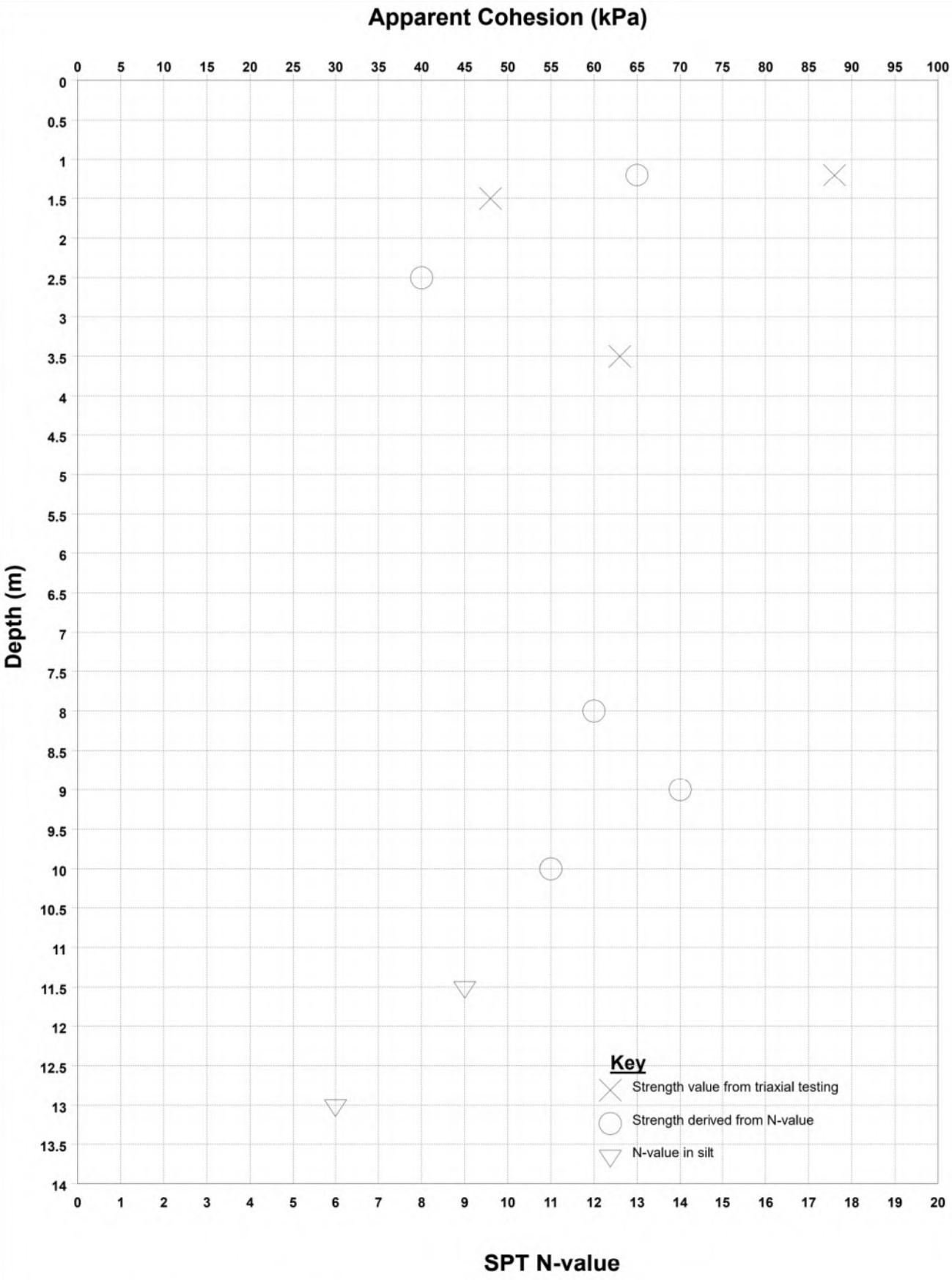

A F Howland Associates Geotechnical Engineers	**Title** Undrained Shear Strength Plot			
Site 6A Grange Road, London N6 4AP	**Date Drawn** 06/07/2016	**Date Checked**	**Sheet**	**Job Number** 16.185
Client Lawrence Bent	**Drawn By**	**Checked By**	**Scale**	**Figure No.** 16.185/5b

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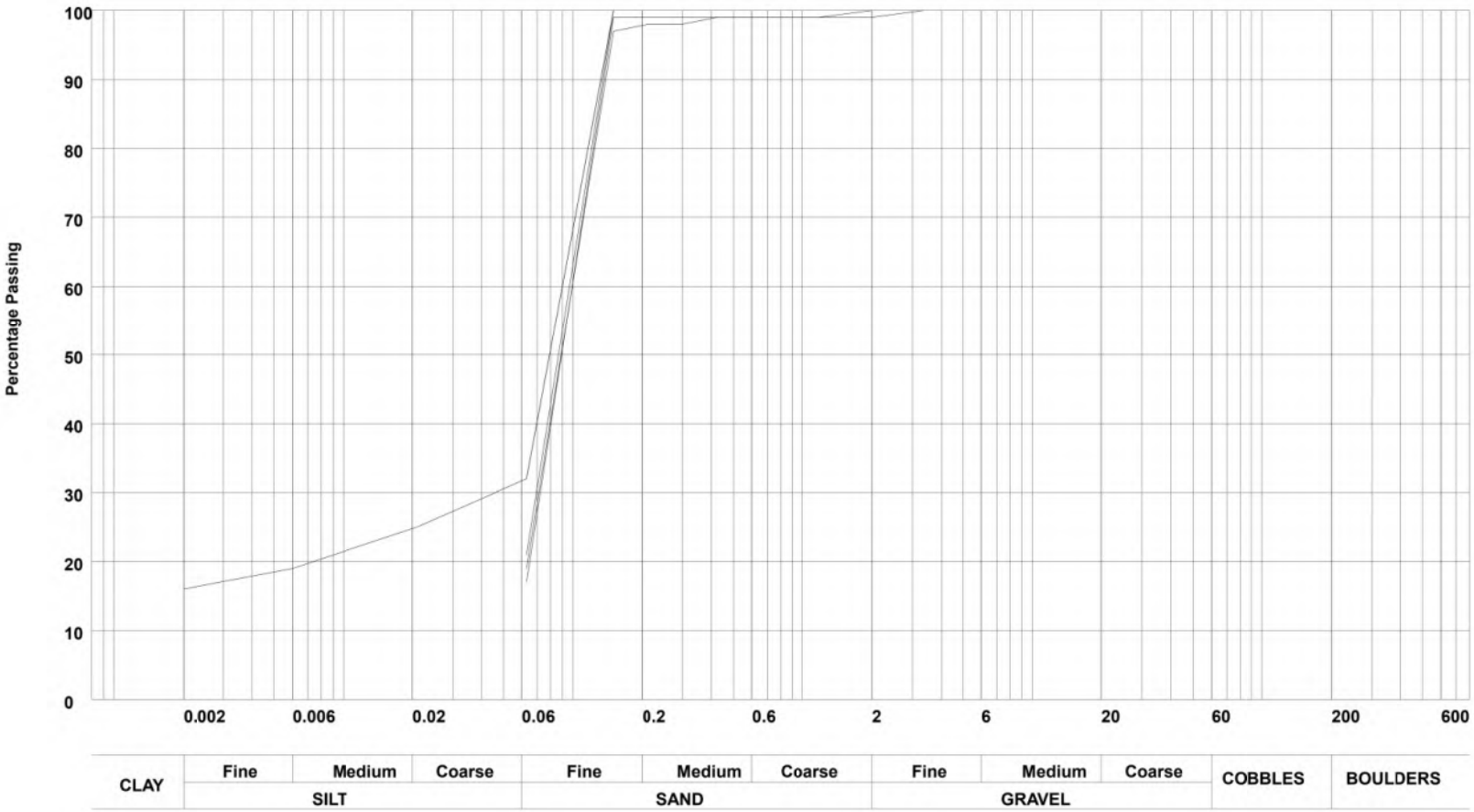

A F Howland Associates
Geotechnical Engineers

Site 6A Grange Road, London N6 4AP			
Title Particle Size Distribution			
Drawn GNB	**Checked**	**Approved**	**Job No.** 16.185
Date 05/07/2016	**Date**	**Date**	**Figure No.** 16.185/6

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A F Howland Associates
The Old Exchange
Newmarket Road
Cringleford
Norwich
NR4 6UF

Tel: 01603 250754
Fax: 01603 250749
Email: admin@howland.co.uk
www: http://www.howland.co.uk

APPENDIX H3

Groundwater Investigation Technical Note

TECHNICAL NOTE

Date: January 2024

File Ref: CB/VL/P22-2546/03TN

Subject: 6a Grange Road, Highgate, N6 4AP – Groundwater Investigation

1.0 INTRODUCTION

1.1 Create Consulting Engineers (CCE) were commissioned by Ilyas Amlani (the 'Client') to undertake a site investigation to determine the standing groundwater levels across the proposed development Site at 6a Grange Road, Highgate, N4 4AP.

Site Location

1.2 The Site is located approximately 570m west of Highgate underground station. The Site can be centred on National Grid Reference 528010, 188063 and the nearest postcode is N6 4AP.

1.3 The Site location is shown on Figure 1.2 below:

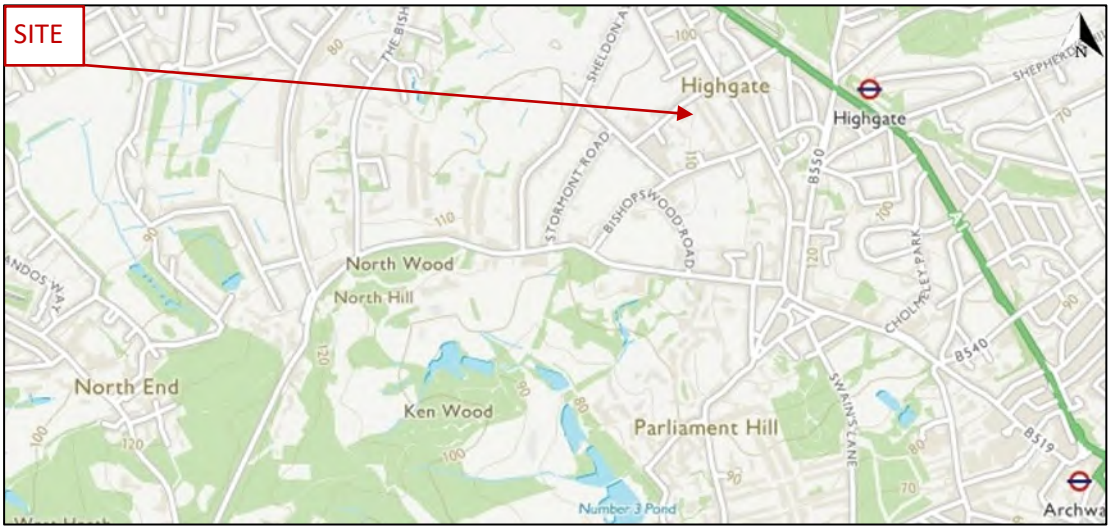


Figure 1.2: Site Location Plan (Ordnance Survey)

Ground Investigation

1.4 In order to establish groundwater standing water levels across the proposed development Site, 3No. boreholes (WS101 to WS103) were drilled and groundwater monitoring well standpipes were installed within each borehole. The Site was then visited on 2No. separate occasions over the winter months to measure groundwater standing levels beneath the Site.

1.5 An Exploratory Hole Location Plan is presented within Appendix A and borehole logs are presented within Appendix B (Exploratory Hole Logs).

2.0 GEOLOGICAL SETTING

2.1 Reference has been made to the BGS 1:50,000 Solid and Drift map of the area, Sheet 256 (North London), dated 2006. The geological plans indicate the Site is underlain by solid strata of the 'Claygate Member'. The BGS map records detail these deposits as predominantly comprising clay, silt and sand. There are no superficial deposit indicated at the Site.

3.0 GROUND CONDITIONS

3.1 Ground conditions are based on the windowless sample boreholes (WS101 to WS103), as detailed in the exploratory hole logs (Appendix B) and summarised below.

Topsoil

3.2 Topsoil was recorded within each of the exploratory holes to depths of between 0 to 0.10 metres below ground level (m BGL) and was generally described as '*medium brown slightly clayey medium sand*'.

Claygate member

3.3 The Made Ground was underlain by soils considered to represent the Claygate Member and was found to comprise interbedded sequences of both cohesive and granular horizons.

3.4 The cohesive top horizon was encountered between 0.05m and 1.9m BGL and generally described as: '*soft to firm orange brown mottled grey sandy CLAY*'.

The underlying granular horizons were encountered between 0.85 and 6.0m BGL and generally described as: '

Groundwater

3.5 During exploratory hole formation, groundwater strikes were recorded between 2.9 and 3.2m BGL in the newly installed boreholes.

3.6 Subsequent monitoring of groundwater standing water levels in each of the newly installed boreholes (WS101 to WS103) and an existing previously installed borehole (BH01A) was then conducted on two separate occasions (December 2023 and January 2024) and these are summarised in Table 3.1 below:

Borehole	Well Top (m AOD)	Standing Water Levels (m BGL)		Standing Water Levels (m AOD)	
		21/12/23	18/01/24	21/12/23	18/01/24
WS101	48	1.29	NR*	46.71	NR*
WS102	48.34	1.40	1.48	46.94	46.86
WS103	48.57	1.77	1.84	46.80	46.73
BH01	c. 48	1.32	1.28	46.68	46.72

* Borehole was waterlogged / covered by a ponding water and frozen over

Table 3.1: Groundwater monitoring results summary

3.7 The standing groundwater levels were observed to be broadly similar in all boreholes across the Site and on both monitoring occasions. The levels ranged between 46.73m and 46.80m AOD at the front on the Site (WS103), 48.86m and 46.94m AOD in the centre of the Site (WS102) and between 46.68m and 46.72m AOD at the rear of the Site (WS101 & BH01). A measurement from borehole WS101 was not possible during the second site monitoring visit due to ponded and iced over water present across the rear of the Site as a result of the heavy rain during the storm in the previous week and present over the top of this well installation.

Note By: Andrew Warren BSc (Hons), MSc, FGS

Approved By: Colin Buchanan BSc (Hons), FGS

Appendices

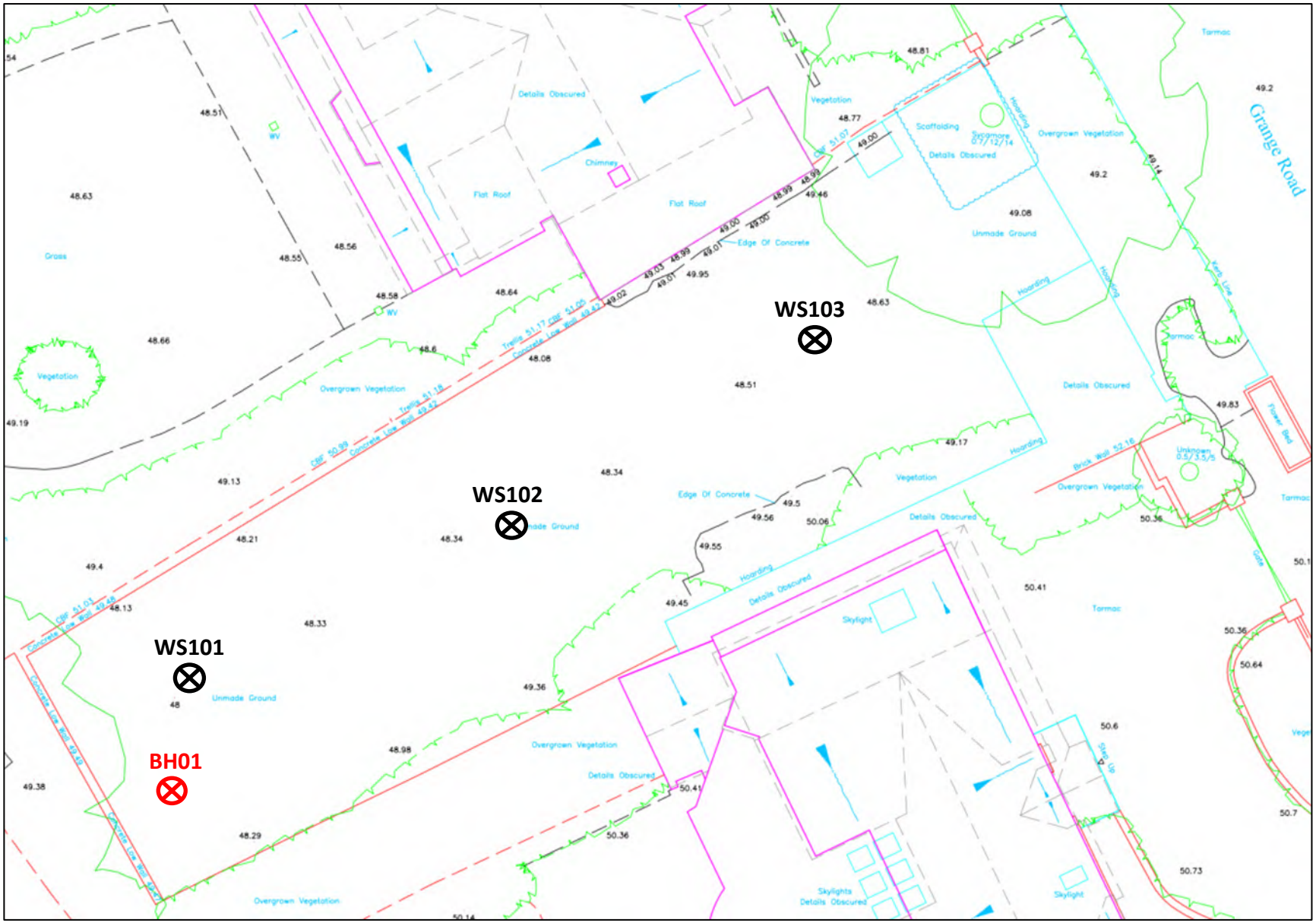
A Exploratory Hole Location Plan

B Exploratory Hole Logs

APPENDICES

APPENDIX A

Exploratory Hole Location Plan


WS103
WS102
WS101
BH01
Grange Road
Flat Roof
Flat Roof
Chimney
Details Obscured
Vegetation
Scaffolding
Sycamore
07/12/14
Overgrown Vegetation
Unmade Ground
Edge Of Concrete
Hoarding
Grass
Tarmac
Skylight
Skylights
Flower Bed
Brick Wall 52.16
Trellis 51.17
Concrete Low Wall 49.42
CBF 50.99
CBF 51.07
CBF 51.05
CBF 51.01
Step Up
Gate

APPENDIX B

Exploratory Hole Logs

Borehole Log

Borehole No. **WS101**

Sheet 1 of 1

Project: 6a Grange Road	Project No: P22-2546	Co-ords:	Hole Type WS
Location: London, N6 4AP		Level: 48.00m aOD	Scale 1:40
Client: Ilyas Amlani		Date: 19/12/2023	Logged CB

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.10	47.90		Grass covered medium brown clayey medium sand. TOPSOIL.
								Soft to firm orange brown mottled grey slightly gravelly sandy CLAY. Gravel is fine to medium subangular flint. CLAYGATE MEMBER.
					1.90	46.10		Loose to medium dense light brown slightly silty medium SAND. CLAYGATE MEMBER.
					4.05	43.95		Dense band of fine SAND stained orange. CLAYGATE MEMBER.
					4.10	43.90		Loose to medium dense yellow brown very clayey medium SAND. CLAYGATE MEMBER.
					6.00	42.00		End of Borehole at 6.00m

Borehole Diameter		Casing Diameter		Chiselling		
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration

Remarks

1. WS01 halted at 6.00m, target depth
2. No groundwater encountered
3. Hole collapse to 3.00m bgl

Borehole Log

Borehole No. **WS102**

Sheet 1 of 1

Project: 6a Grange Road	Project No: P22-2546	Co-ords:	Hole Type WS
Location: London, N6 4AP		Level: 48.34m aOD	Scale 1:40
Client: Ilyas Amlani		Date: 19/12/2023	Logged CB

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.05	48.29		Grass covered medium brown slightly clayey medium sand. TOPSOIL.
								Soft to firm brown mottled grey sandy CLAY. CLAYGATE MEMBER.
					1.20	47.14		Loose to medium dense light brown slightly silty medium SAND. CLAYGATE MEMBER.
					3.10	45.24		Soft light brown sandy CLAY. CLAYGATE MEMBER.
					3.60	44.74		Loose to medium dense yellow brown fine SAND. CLAYGATE MEMBER.
					5.00	43.34		End of Borehole at 5.00m

Borehole Diameter		Casing Diameter		Chiselling		
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration

Remarks

1. WS01 halted at 5.00m, target depth
2. No groundwater encountered
3. Hole collapse to 3.00m bgl

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Borehole Log

Borehole No. **WS103**

Sheet 1 of 1

Project: 6a Grange Road	Project No: P22-2546	Co-ords:	Hole Type WS
Location: London, N6 4AP		Level: 48.57m aOD	Scale 1:40
Client: Ilyas Amlani		Date: 19/12/2023	Logged CB

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.05	48.52		Grass covered medium brown slightly clayey medium sand. TOPSOIL.
								Soft to firm light brown mottled grey sandy CLAY. CLAYGATE MEMBER.
					0.85	47.72		Loose to medium dense light brown slightly silty medium SAND. CLAYGATE MEMBER.
					4.00	44.57		End of Borehole at 4.00m

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8

Borehole Diameter		Casing Diameter		Chiselling		
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration

Remarks

1. WS01 halted at 4.00m, target depth
2. No groundwater encountered
3. Hole collapse to 3.60m bgl

AGS

APPENDIX H4

Retaining Wall Investigation

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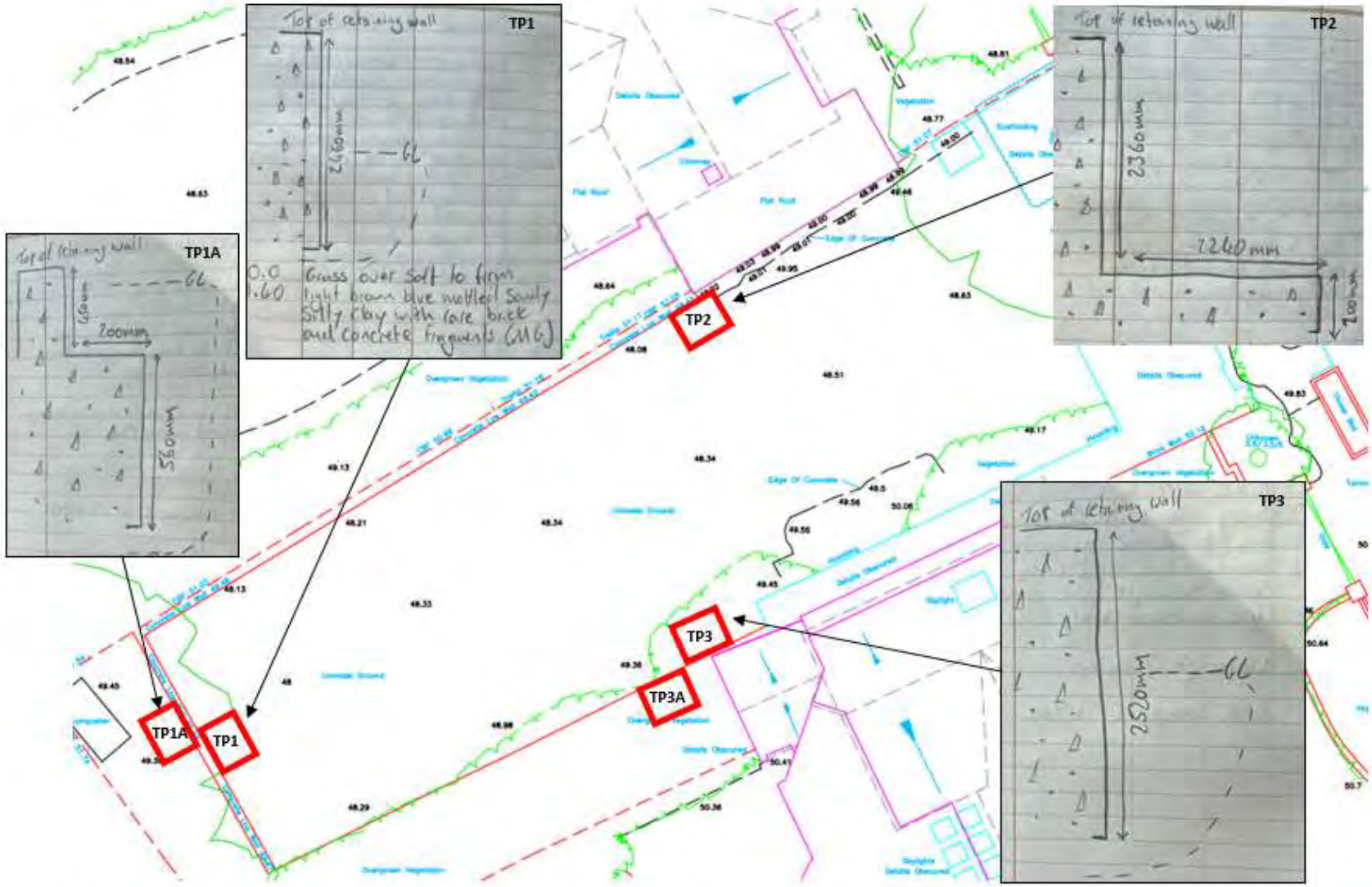

Norfolk Partnership Laboratory
Part of Norse Group

County Hall, Martineau Lane
NORWICH, Norfolk NR1 2SG
Tel: 01603 578389
Email: civil.laboratory@norsegroup.co.uk

Create Consulting Engineers Ltd
FAO Tom Bennett
15 Princes Street
NORWICH
NR3 1AF

Our Project No	105907
Our Report and sample No	NNPL2024091824-654
Your Sample Ref	**1**
Your Order No	5578
Date Report Issued	04 Oct 2024

Tom.Bennett@createconsultingengineers.co.uk

Determination of Falling Head Permeability (in rigid wall permeameter) to In-House Method, Based on Manual of Soil and Laboratory Testing (K H Head) : Vol 2 : Section 10.7

Scheme	6A Grange Road		
Location	TP03	**Depth**	1.7m
Date sampled	06 Sep 2024	**Date received**	09 Sep 2024
Sampled by	Client		
Sample type	Bulk	**Date tested**	24 Sep 2024

If a sample certificate was provided, it is available for inspection. The accuracy of any information provided by third parties cannot be guaranteed. These results only relate to the sample tested. Samples submitted by clients are tested 'as received'

Material	Soil		
Description	Soft mottled brown very silty fine to coarse SAND with rare fine and medium flint gravel.		
Supplier	Not applicable	**Source**	Ex site
Test Specimen			
Location	Not applicable	Orientation	Not applicable
Preparation details			
Method of division	Quartering		
Retained on 37.5mm	0 %	Retained 20mm	2 %
Compaction method	11.3 (BS 1377-2)		
No. of layers	3 layers	Blows per layer	27 blows
Results			
Initial Water content (From trimmings)	30 %	Oven dried @ 105-110 °C	
Initial Bulk Density	1.89 Mg/m³	Initial Dry Density	1.46 Mg/m³
Average Permeability	3.2E-09 m/sec		
Average Test temperature	19.9 °C	Permeant water source	Tap water
Temperature Corrtd Average Permeability	3.2E-09 m/sec		

Remarks

Water content determined in accordance with BS EN ISO 17892-1 : 2014

Test Code = 654

Jim Elliott (Lab Services Manager) _____

APPENDIX H5

Geotechnical Plots

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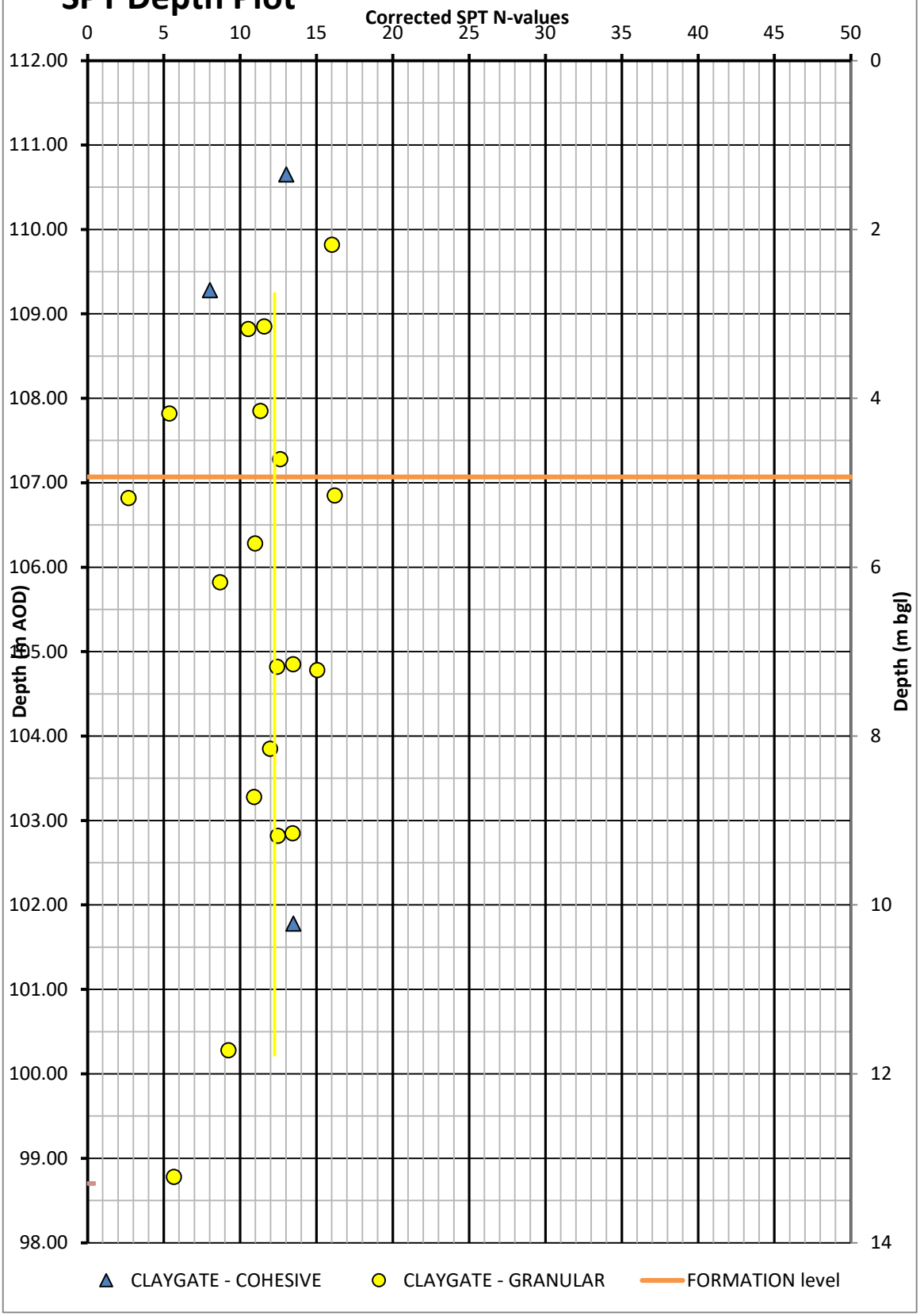
6A Grange Road, SPT Depth Plot



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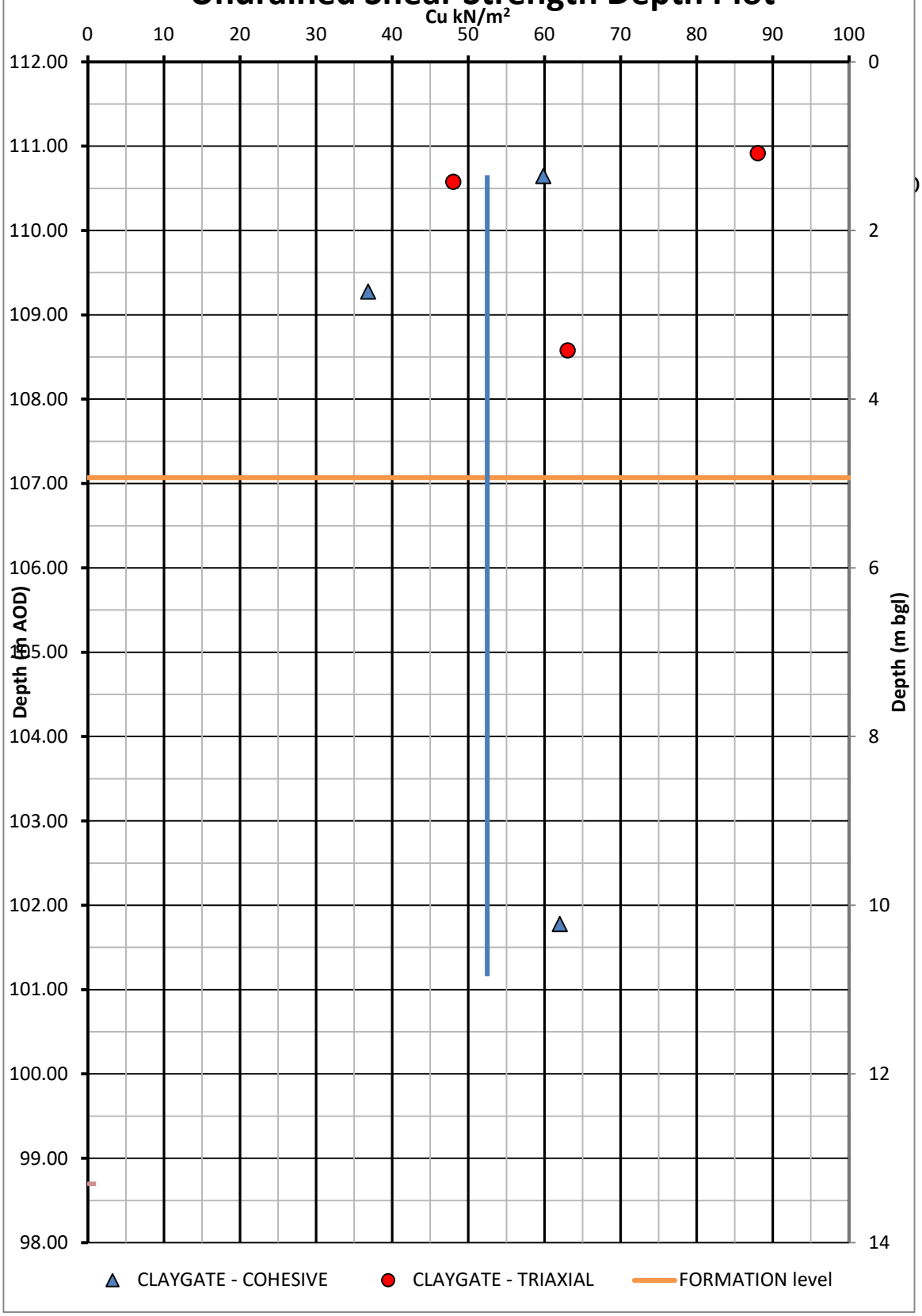
6A Grange Road
Undrained Shear Strength Depth Plot



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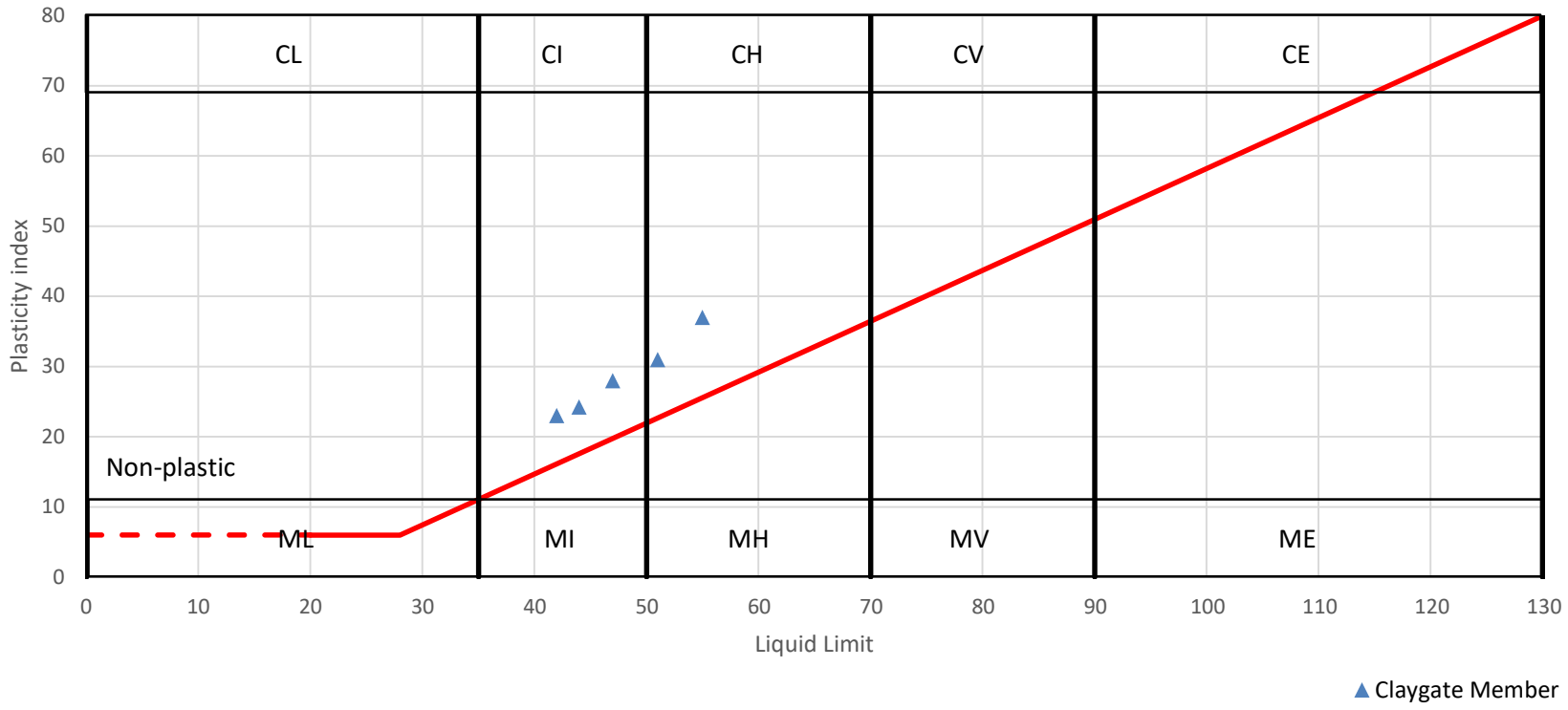
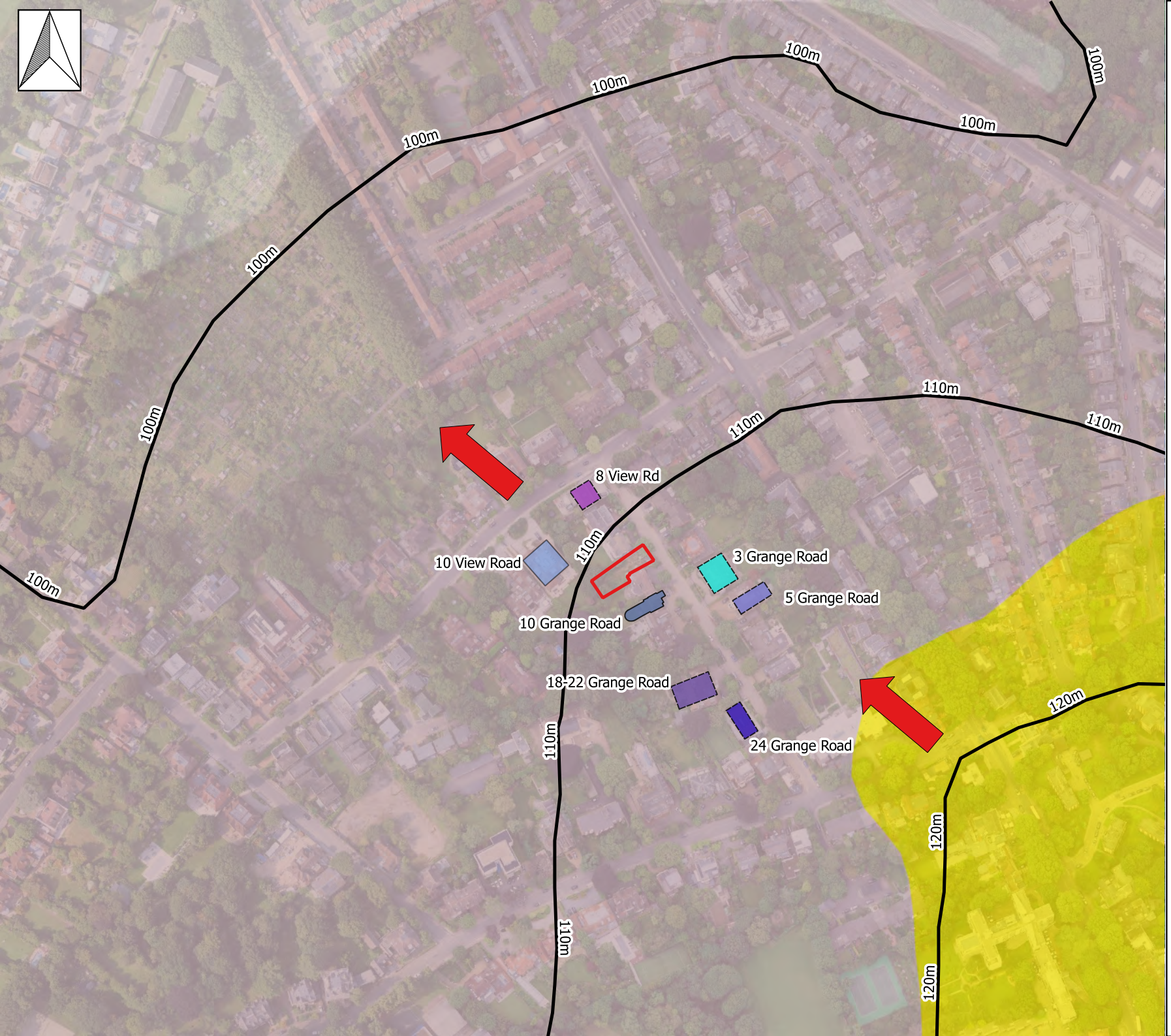
Plasticity Chart



APPENDIX I

Local Groundwater Flow



create

Legend

- Site Boundary
- Indicated Basements
- Groundwater Flow

Geology

- Bagshot Formation
- Claygate Member
- London Clay Formation
- OS contour (m aOD)

Project:	6a Grange Road
Drawing Title:	Groundwater Flow
Drawing No.:	P22-2546-12
Date:	23/10/2024

0 25 50 75 100 125 m

APPENDIX J

Groundwater Rise Scoping Appraisal

Project: 6A Grange Road, London N6
Title: Scoping Appraisal of Potential Groundwater Rise

Location	Easting	Northing	Elevation
WS101	527999.3	188057.4	110.59
WS102	528008.7	188062.6	110.87
WS103	528016.2	188068.4	111.11
BH01	527997	188054	112.08

Applying D'Arcys Law

Q = AiK
where;

Q	groundwater flow	m^3/d
A	cross-section flow area	m^2
i	hydraulic gradient	n/a
K	hydraulic conductivity	m/d

	Low K & i	High K & i	
Q =	1.43	30.80	m^3/d

Hydraulic Gradient (i)

Based on complete data sets from 21/12/23 & 10/06/24 estimated (i) of c. 0.05 0.07 which is relatively high

A - Cross section Area

Taking the silty fine SAND as the confined aquifer unit it varies in thickness between approxiamtely 4.0m and 7.0m
The groundwater flow direction is interpreted to be approximately north westerly and perpendicula to the proposed basement structure
The length of site perpendicular to gw flow is approximately 40m - therefore A is approximately 220 m^2
The length of the basement perpendicular to gw flow is approximately 20m - therefore A is approx. 110 m^2

Hydraulic Conductivity (K)

Based on a site speific falling head test a K of 1.47E-06 m/s has been derived.
It is acknowledged that this is likley to be averaged over the screened section and thus may be underestimated.

1.47E-06	m/s
1.27E-01	m/d

Within the scoping appraisal a range of 0.13 2 m/d has been applied

Reduction of Cross-Section Area

The basement construction will reduce the cross-section area for groundwater flow causing localised increase in groundwater elevation up-hydraulic gradient
It is reasonable to assess the potential increase in groundwater elevation by applying the reduced cross-section area and deriving the resultant hydraulic gradient

A (pre construction) = 220 m^2
A (post construction) = 110 m^2

Resultant Hydraulic Gradient (iR) = Q/((A*K) Initial Hydraulic Gradient (i) = 0.05 0.07

Qlow	Qhigh
0.100	0.14

As i = dh/dl
dl = 5 m (based on groundwater monitoring data 21/12/23 & 10/06/24).
dh = 0.50 0.70 0.25 0.35

1. Conservative Estimated Increase in Groundwater Level 0.25 0.35 m
250 350 mm

2. Estimated Increase in Groundwater Level (100m length)

It is more realistic to consider a greater length and cross sectional area for groundwater flow.

A (pre construction) = 550 m^2
A (post construction) = 440 m^2

	Low K & i	High K & i	
Q =	3.58	77.00	m^3/d

Resultant Hydraulic Gradient (iR) = Q/((A*K) Initial Hydraulic Gradient (i) = 0.05 0.07

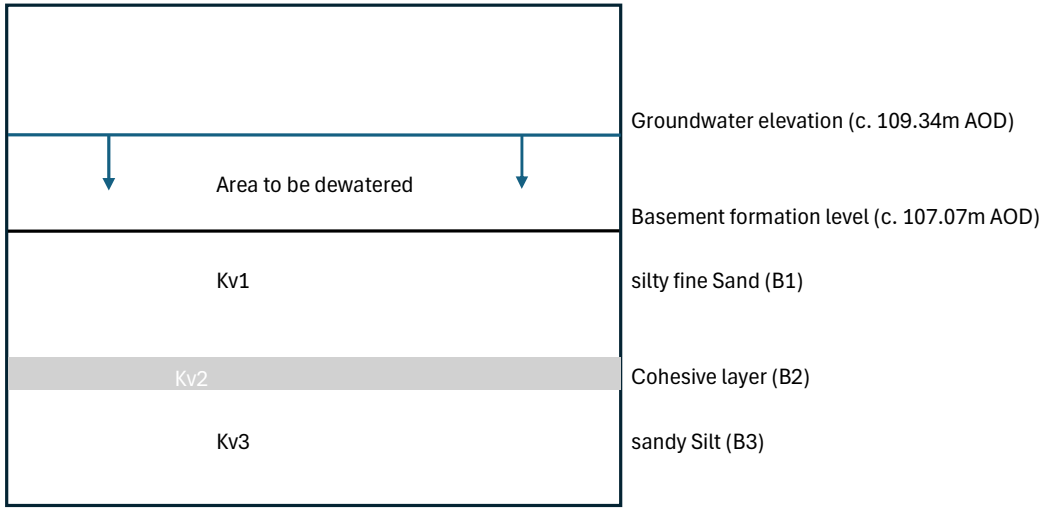
Qlow	Qhigh
0.063	0.0875

As i = dh/dl
dl = 5 m (based on groundwater monitoring data 21/12/23 & 10/06/24).
dh = 0.31 0.44 0.25 0.35

0.06 0.09 m
63 88 mm

Project: 6A Grange Road, London N6
Title: Scoping Appraisal of Potential Hydraulic Resistance

Basic Concept



Hydraulic resistance (R, days) = B/Kv

where; B= thickness of layer
Kv = vertical hydraulic conductivity

Kv1 conservatively estimated =	1	m/d	B1 (below basement formation) =	2.4	m
Kv2 conservatively estimated =	0.01	m/d	B2 =	1	m
Kv3 conservatively estimated =	0.5	m/d	B3 (assumes water bearing sand unit within) =	0.5	m

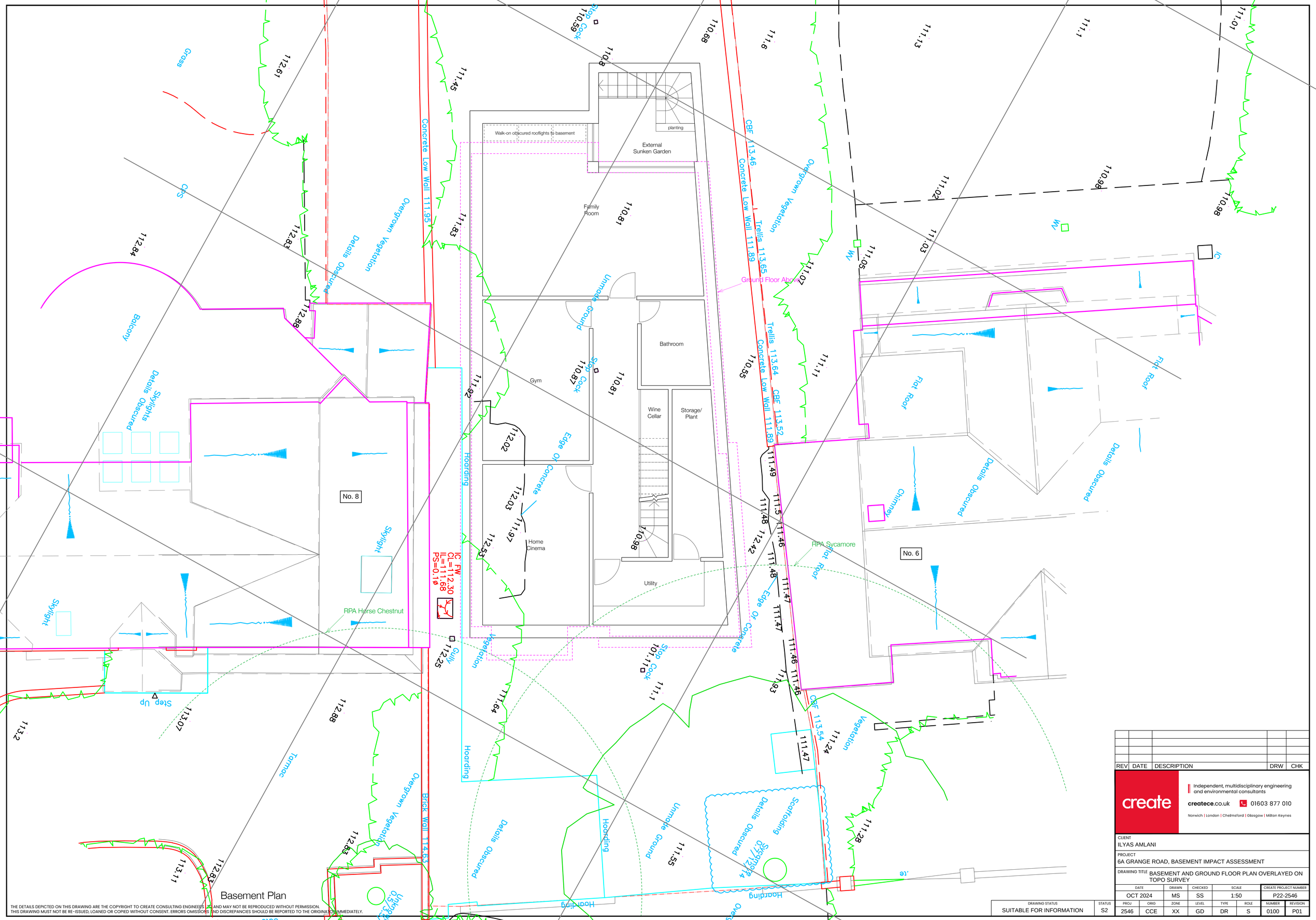
R1 =	2.4	days
R2 =	100	days
R3 =	1	days

Total hydraulic resistance = 103.4 days

Assuming a conservative head difference between groundwater in B1 and B3 of 10m, then
Vertical Leakage across layer B2 = 0.096712 m/d

APPENDIX K

Engineering Drawings



REV	DATE	DESCRIPTION	DRW	CHK

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PROJECT
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DRAWING TITLE
BASEMENT AND GROUND FLOOR PLAN OVERLAYED ON TOPO SURVEY

DATE	DRAWN	CHECKED	SCALE	CREATE PROJECT NUMBER
OCT 2024	MS	SS	1:50	P22-2546

DRAWING STATUS	STATUS	PROJ	ORIG	ZONE	LEVEL	TYPE	ROLE	NUMBER	REVISION
SUITABLE FOR INFORMATION	S2	2546	CCE	XX	GD	DR	S	0100	P01

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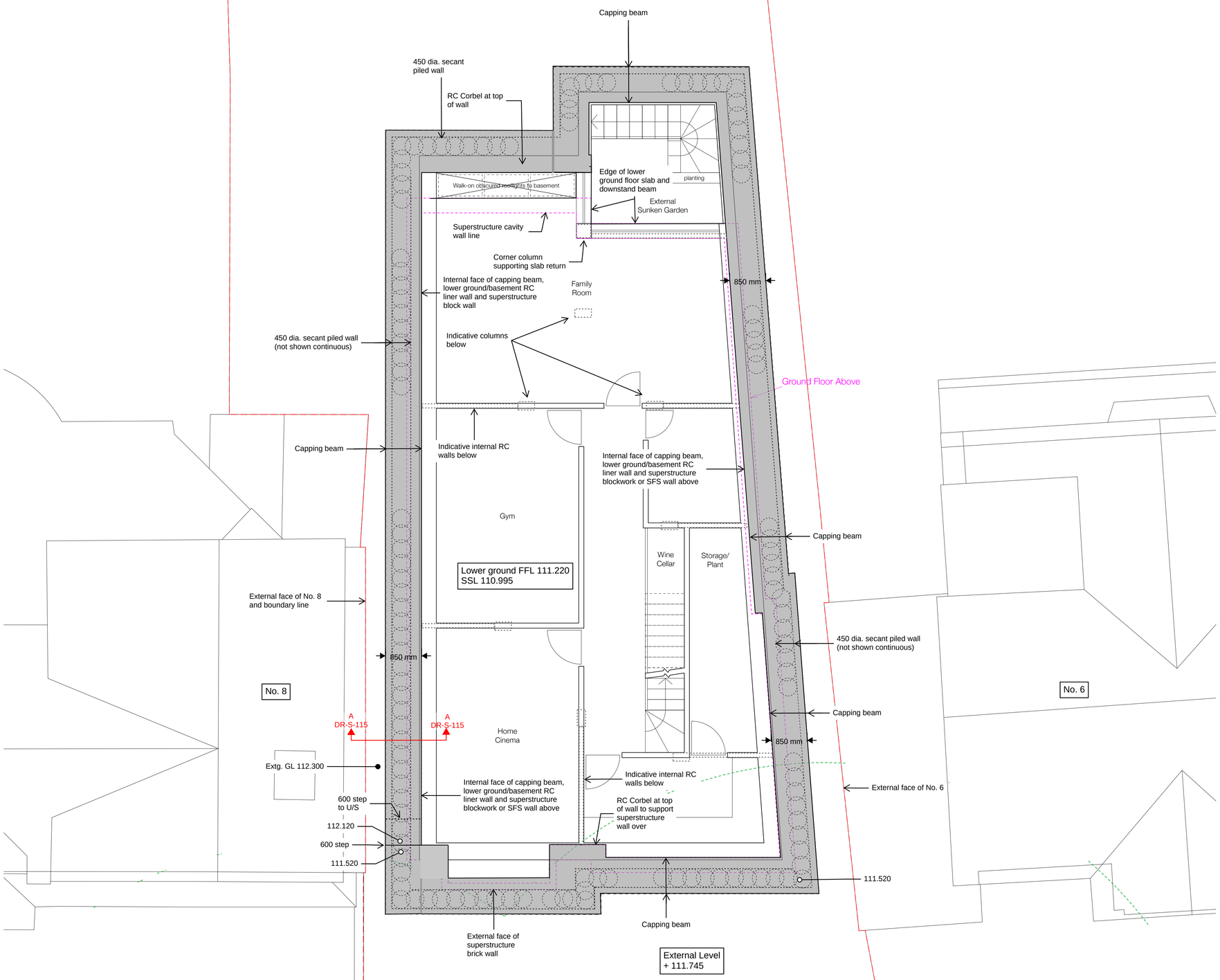

REV	DATE	DESCRIPTION	DRW	CHK
P02	05/25	FFL and SSL updated	MS	MS

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DRAWING TITLE
LOWER GROUND FLOOR / CAPPING BEAM

DATE	DRAWN	CHECKED	SCALE	CREATE PROJECT NUMBER
OCT. 2024	MS	SS	1:20	P22-2546

DRAWING STATUS	STATUS	PROJ	ORIG	ZONE	LEVEL	TYPE	ROLE	NUMBER	REVISION
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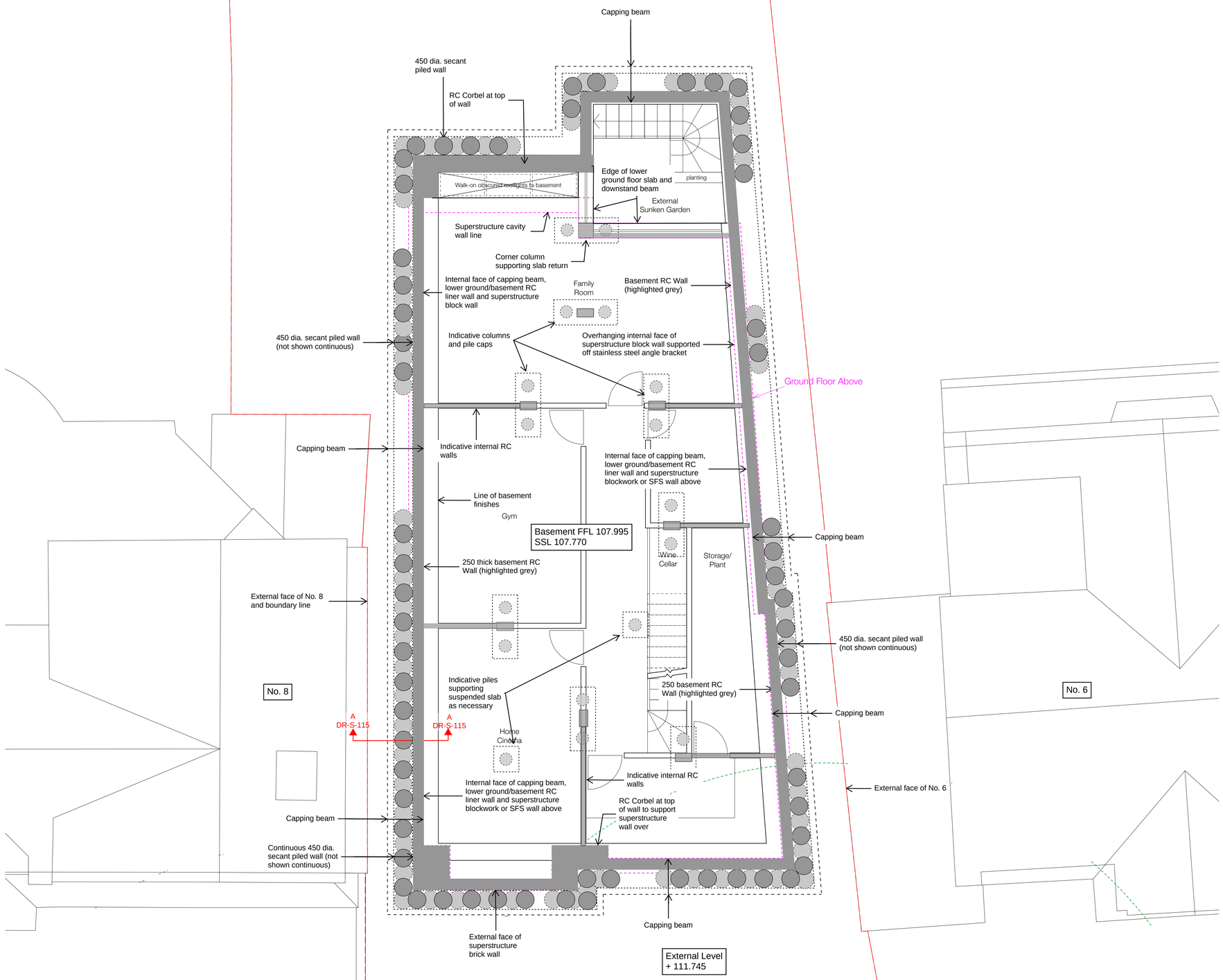

REV	DATE	DESCRIPTION	DRW	CHK
P02	05/25	FFL and SSL updated	MS	MS

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DRAWING TITLE
BASEMENT LAYOUT

DATE	DRAWN	CHECKED	SCALE	CREATE PROJECT NUMBER
OCT. 2024	MS	SS	1:20	P22-2546

DRAWING STATUS	STATUS	PROJ	ORIG	ZONE	LEVEL	TYPE	ROLE	NUMBER	REVISION
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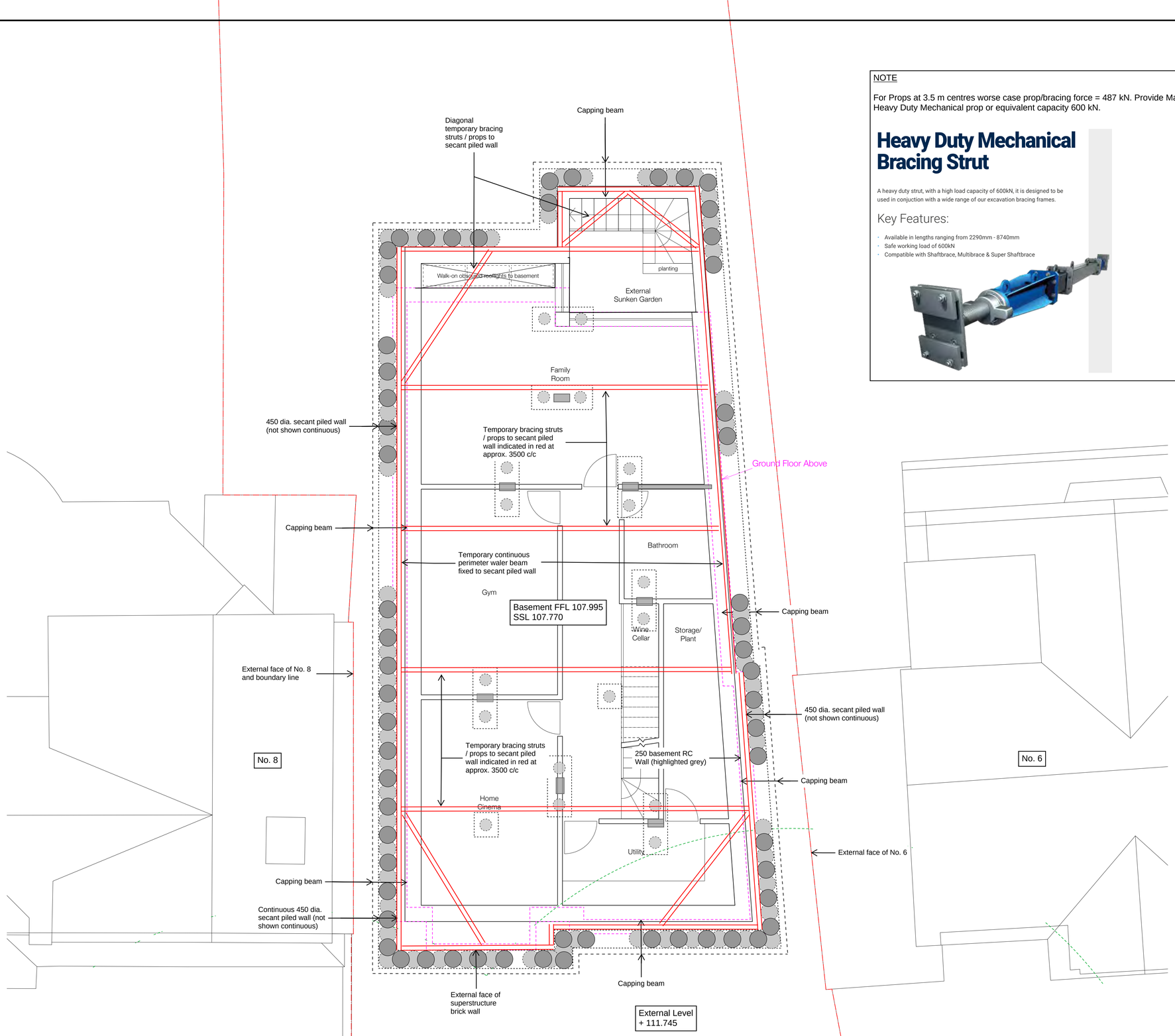

NOTE

For Props at 3.5 m centres worse case prop/bracing force = 487 kN. Provide Maybe Heavy Duty Mechanical prop or equivalent capacity 600 kN.

Heavy Duty Mechanical Bracing Strut

A heavy duty strut, with a high load capacity of 600kN, it is designed to be used in conjuction with a wide range of our excavation bracing frames.

Key Features:

- Available in lengths ranging from 2290mm - 8740mm
- Safe working load of 600kN
- Compatible with Shaftbrace, Multibrace & Super Shaftbrace

PRELIMINARY INDICATIVE TEMPORARY PROPPING / BRACING ARRANGEMENT AT 109.145 m AOD (SHOWN IN RED)

DETAIL DESIGN BY CONTRACTOR

REV	DATE	DESCRIPTION	DRW	CHK
P02	05/25	FFL, SSL and bracing arrangement updated	MS	MS

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DRAWING TITLE
BASEMENT LAYOUT - TEMPORARY WORKS / BRACING ARRANGEMENT

DATE	DRAWN	CHECKED	SCALE	CREATE PROJECT NUMBER
OCT. 2024	MS	SS	1:20	P22-2546

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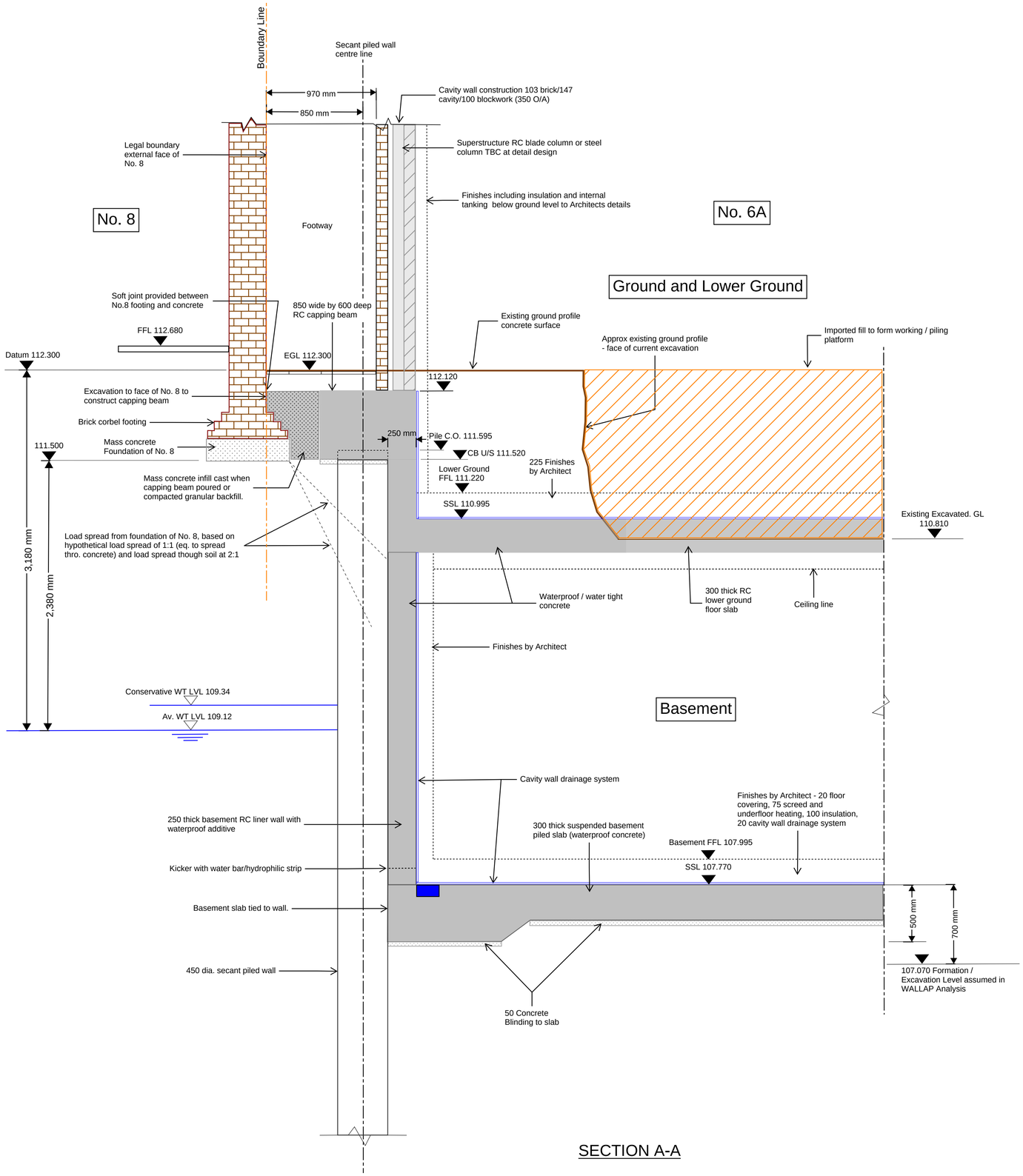

SECTION A-A

(2546-CCE-XX-B1-DR-S-011)

P02	05/25	Basement FFL & LGF amended, drainage channel removed	MS	MS

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DRAWING TITLE
BASEMENT SECTIONS - SECTION A-A

DATE	DRAWN	CHECKED	SCALE	CREATE PROJECT NUMBER
OCT. 2024	MS	SS	1:20	P22-2546

DRAWING STATUS	STATUS	PROJ	ORIG	ZONE	LEVEL	TYPE	ROLE	NUMBER	REVISION
SUITABLE FOR INFORMATION	S2	2546	CCE	XX	B1	DR	S	0115	P02

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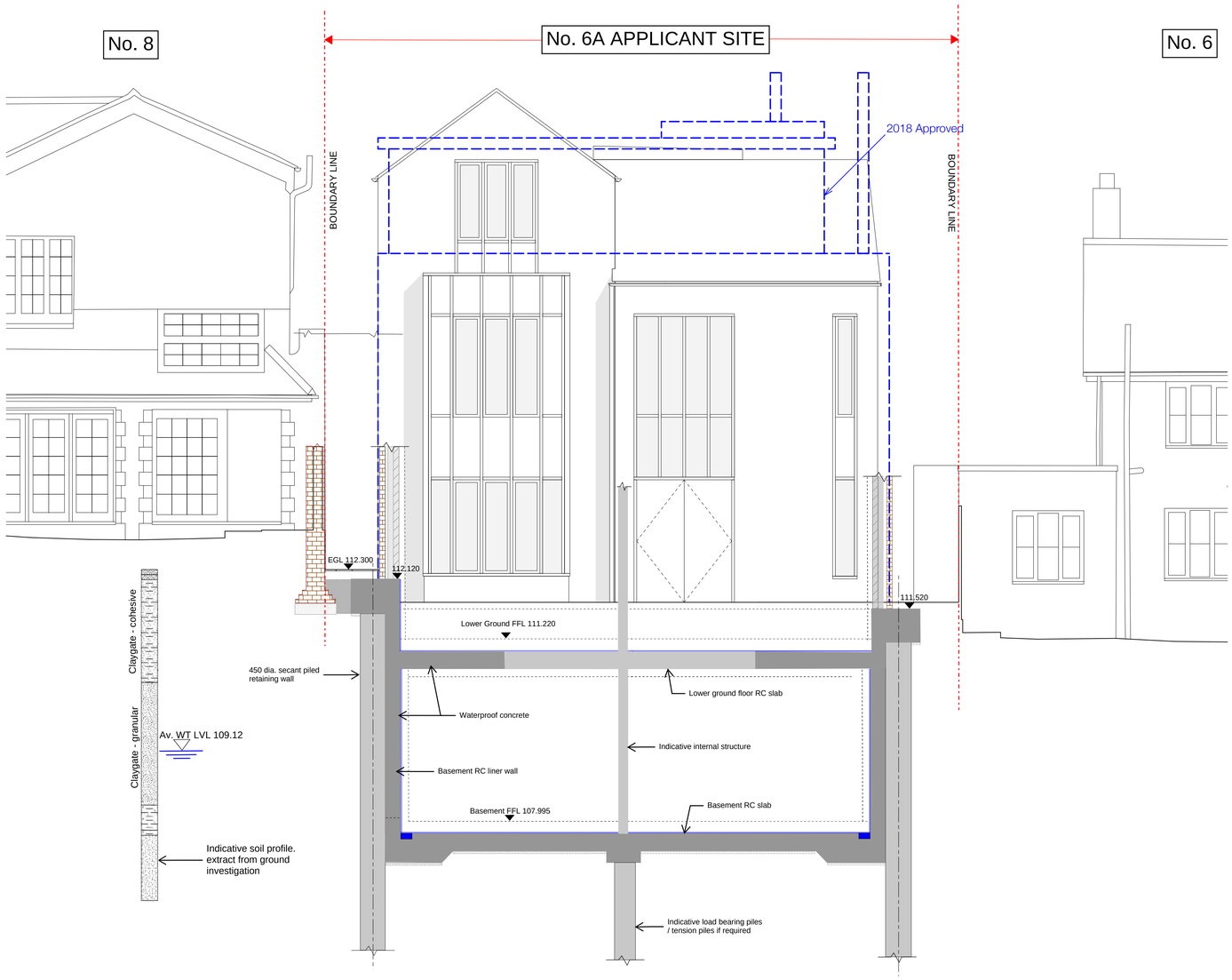

REV	DATE	DESCRIPTION	DRW	CHK
P02	05/25	Basement and LGF FFL amended	MS	MS

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6A GRANGE ROAD, BASEMENT IMPACT ASSESSMENT

DRAWING TITLE
NORTH EAST SECTIONAL ELEVATION

DATE	DRAWN	CHECKED	SCALE	CREATE PROJECT NUMBER
NOV 2024	MS	MS	NTS	P22-2546

DRAWING STATUS	STATUS	PROJ	ORIG	ZONE	LEVEL	TYPE	ROLE	NUMBER	REVISION
SUITABLE FOR INFORMATION	S2	2546	CCE	XX	XX	DR	S	0120	P02

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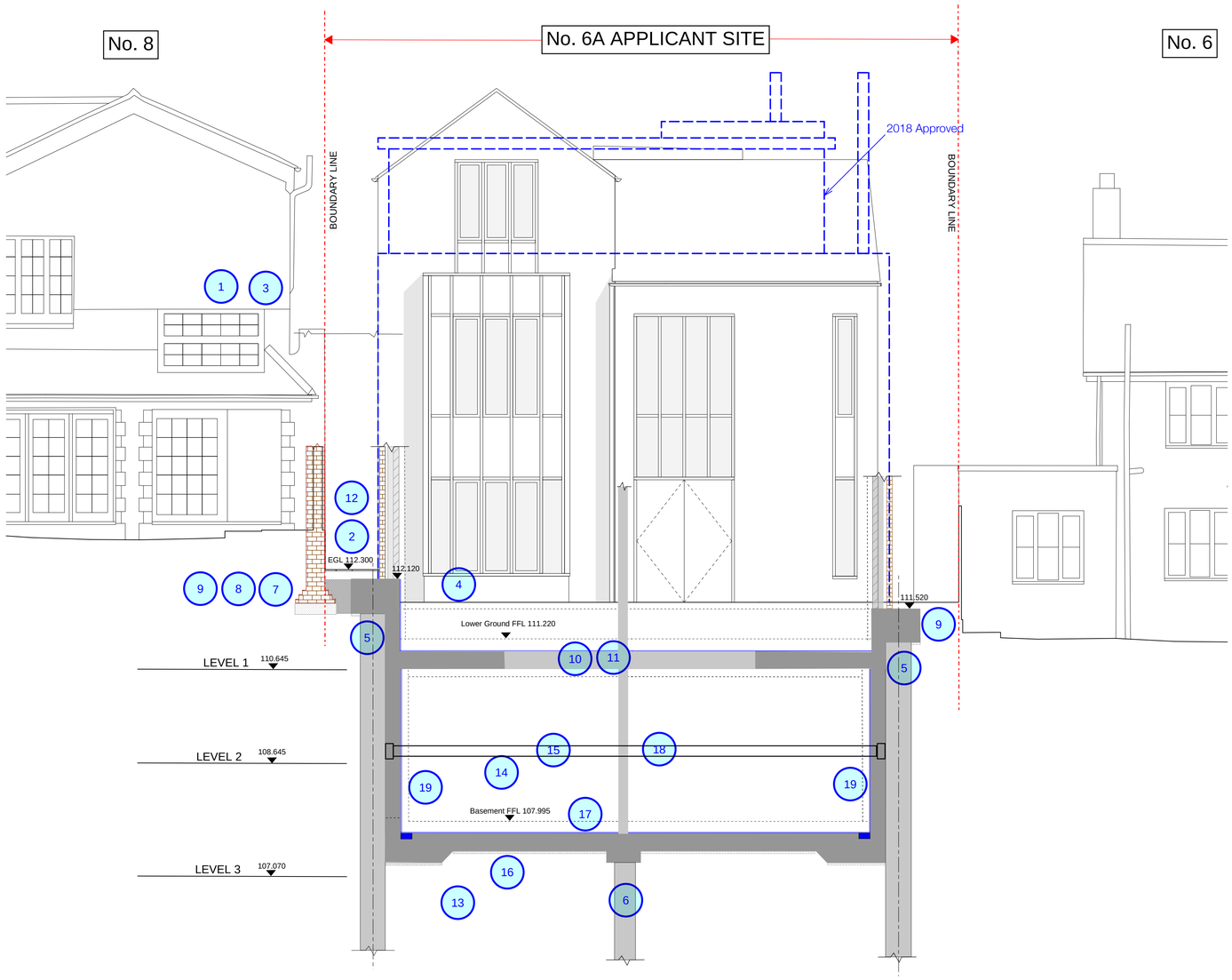

PRELIMINARY CONSTRUCTION METHODOLOGY / SEQUENCE TO BE DEVELOPED BY MAIN CONTRACTOR

1. PARTY WALL SURVEYOR(S) APPOINTED AND CONDITION SURVEY COMPLETED OF EXISTING NEIGHBOURING PROPERTIES NO. 6 AND NO. 8

2. ENABLING WORKS AND TEMPORARY CLOSURE OF PATHWAY ADJACENT NO. 8 (ALTERNATIVE SAFE ACCESS ROUTE THROUGH NO. 6A TEMPORARILY PROVIDED IF NECESSARY)

3. INSTALL MONITORING EQUIPMENT TO NEIGHBOURING PROPERTIES NO. 6 AND NO. 8 (PRECISE LEVELLING AND VIBRATION MONITORING). RECORD BASE READINGS AND AGREE TRIGGER LEVELS WITH PARTY WALL SURVEYOR(S)

4. IMPORT BULK FILL FOR WORKING PLATFORM (PILING MAT)

5. CONSTRUCT FORM/GUID AND INSTALL SECANT PILED WALL TO PERIMETER

6. CONSTRUCT LOAD BEARING PILES AND PLUNGE COLUMNS FOR INTERNAL BASEMENT STRUCTURE

7. EXCAVATE GROUND ON ACTIVE LEFT HAND SIDE BETWEEN SECANT PILED WALL AND THE WALL OF NO. 8 TO UNDERSIDE OF CAPPING BEAM AND BLINDING LEVEL. DITTO ADJACENT NO. 6

8. EXCAVATE GROUND ON PASSIVE RIGHT HAND SIDE TO UNDERSIDE OF CAPPING BEAM AND BLINDING

9. CAST CAPPING BEAM

10. EXCAVATE TO LEVEL 1

11. CAST BLINDING AND LOWER GROUND REINFORCED CONCRETE SLAB WITH OPENING IN SLAB FOR TOP DOWN CONSTRUCTION. SLAB TIED TO SECANT PILED WALL

12. INSTALL DRAINAGE TO REPLACE CUT DRAINAGE TO NO.8 ALONG FOOTPATH BETWEEN THE PROPERTIES

13. PUMP-OUT GROUND WATER FROM WITHIN 'BOX' STRUCTURE AS EXCAVATION AND WORKS PROCEED. GROUND WATER LEVEL IN BOX LOWERED TO BELOW FORMATION LEVEL.

14. EXCAVATE TO LEVEL 2

15. INSTALL TEMPORARY WALER AND PROPPING

16. EXCAVATE TO LEVEL 3

17. CONSTRUCT BLINDING AND BASEMENT SLAB (SLAB SHALL BE TIED TO PILED WALL)

18. ALLOW FOR 28 DAY STRENGTH BEFORE REMOVING LOWER WALING AND PROPPING

19. CONSTRUCT WATERPROOF REINFORCED CONCRETE (RC) LINER WALLS TO PERIMETER AGAINST PILED WALL

REV	DATE	DESCRIPTION	DRW	CHK
P02	05/25	Basement & LGF FFL amended, construction sequence updated	MS	MS

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6A GRANGE ROAD, BASEMENT IMPACT ASSESSMENT

DRAWING TITLE
PRELIMINARY CONSTRUCTION SEQUENCE / METHODOLOGY

DATE	DRAWN	CHECKED	SCALE	CREATE PROJECT NUMBER
NOV 2024	MS	MS	NTS	P22-2546

DRAWING STATUS	STATUS	PROJ	ORIG	ZONE	LEVEL	TYPE	ROLE	NUMBER	REVISION
SUITABLE FOR INFORMATION	S2	2546	CCE	XX	XX	DR	S	0125	P02

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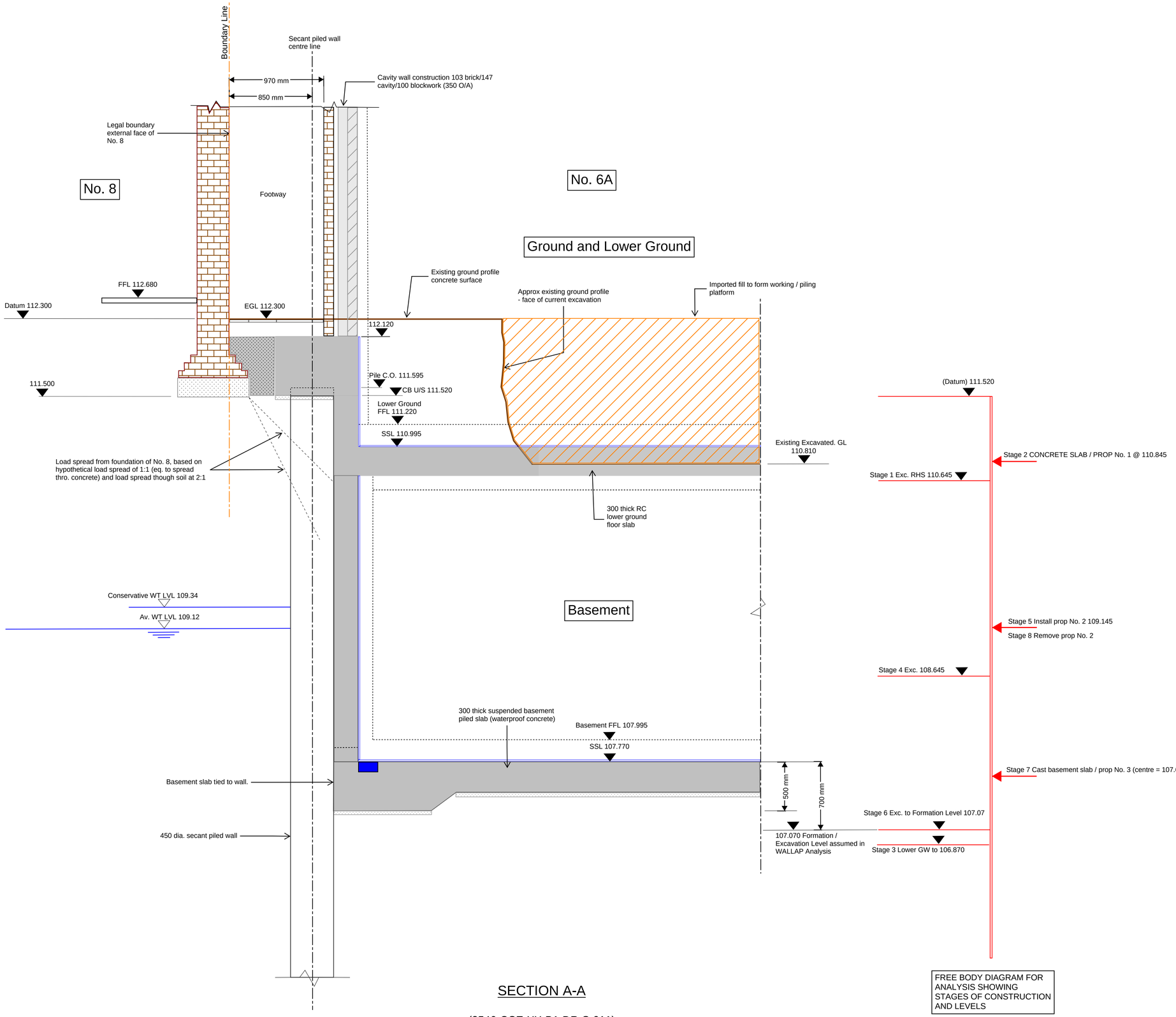

SECTION A-A

(2546-CCE-XX-B1-DR-S-011)

FREE BODY DIAGRAM FOR ANALYSIS SHOWING STAGES OF CONSTRUCTION AND LEVELS

P02	05/25	Basement FFL & LGF amended, drainage channel removed	MS	MS

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PROJECT
6A GRANGE ROAD, BASEMENT IMPACT ASSESSMENT

DRAWING TITLE
BASEMENT SECTIONS - FREE BODY DIAGRAM FOR WALLAP ANALYSIS

DATE	DRAWN	CHECKED	SCALE	CREATE PROJECT NUMBER
OCT. 2024	MS	SS	1:20	P22-2546

DRAWING STATUS	STATUS	PROJ	ORIG	ZONE	LEVEL	TYPE	ROLE	NUMBER	REVISION
SUITABLE FOR INFORMATION	S2	2546	CCE	XX	B1	DR	S	0126	P02

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APPENDIX L

Ground Movement Calculation Sheets

Project: 6A Grange Rd, London N6 4BB	Job No: P22-2546	Sheet No: 1	Rev. I
Subject: Ground Movement Assessment	AW	Checked by: MS	
	Date: 30.04.2025	Date: 01/05/2025	

Ground movement calculations for proposed basement
At 6A Grange Road, London N6 4BB

To accommodate the proposed lower ground floor living space, it is proposed to form a basement at the property.

Ground movement estimates from basement excavation have been made using software (WALLAP) and, following the methodology of CIRIA C760: Embedded Retaining Walls Guidance for Economic Design, Gaba et al., CIRIA, 2017. Some tables and graphs are reproduced in the calculations.

Figure 1 Layout Plan

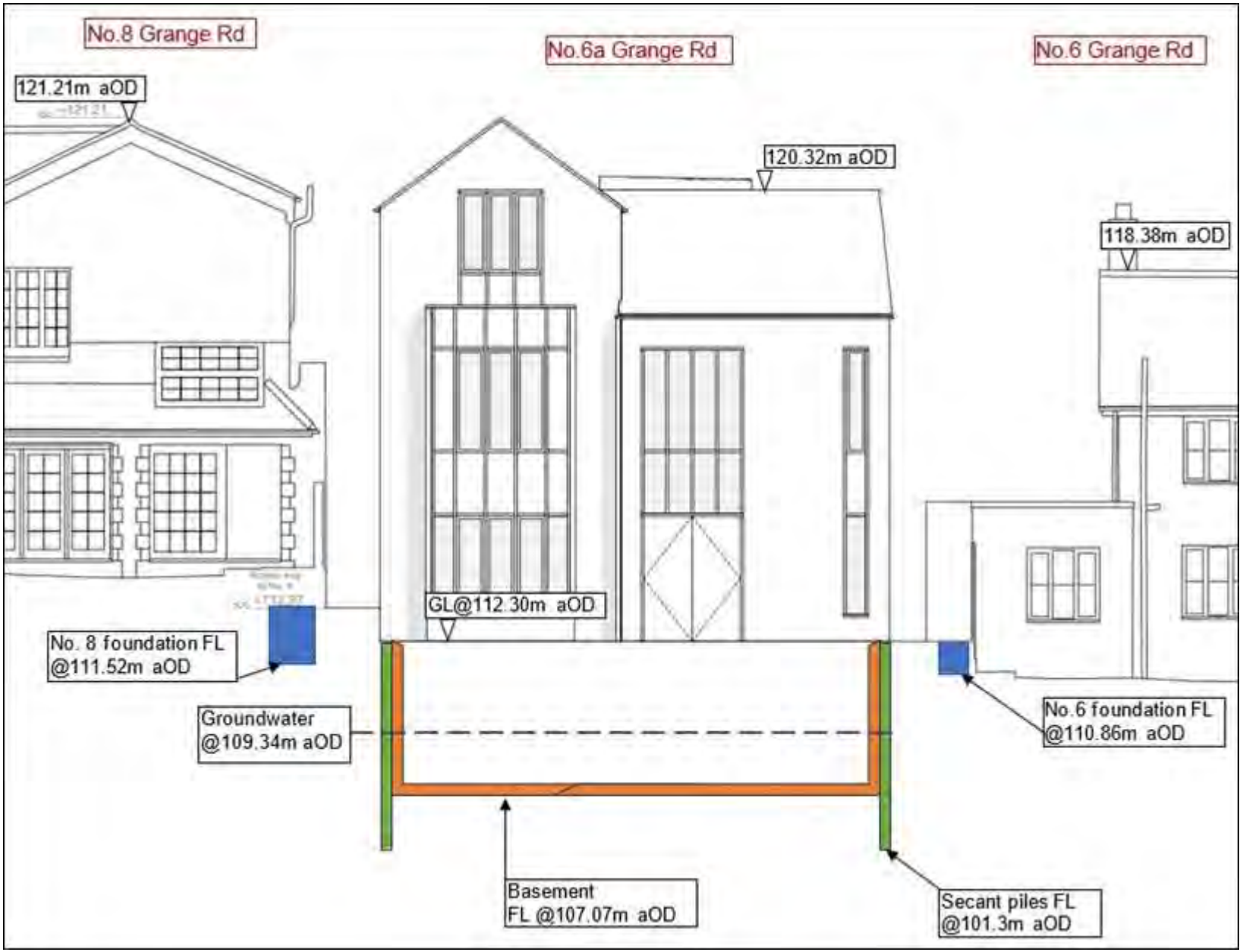

Figure 2 Front Elevation

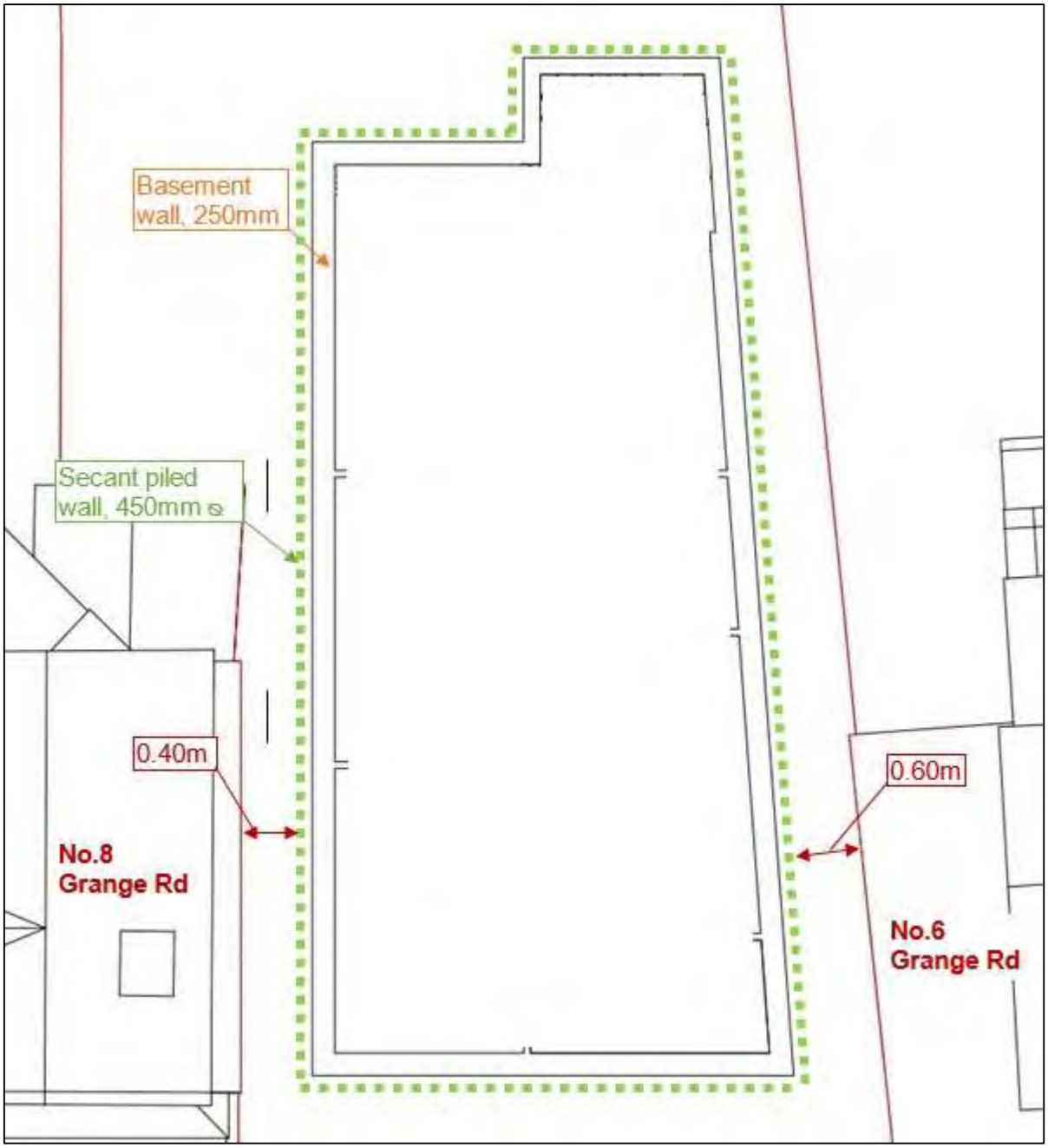

Figure 3: Basement Layout

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CALCULATION SHEET

Project: **6A Grange Rd, London N6 4BB**	Job No: P22-2546	Sheet No: 5	Rev. I
Subject: **Ground Movement Assessment**	AW	Checked by: MS	
	Date: 30.04.2025	Date: 01/05/2025	

Ground Model

The ground investigation report for the Site (reproduced in Appendix C of the BIA) recorded granular conditions below formation level.
Monitoring of installed standpipes recorded groundwater at depths of between 109.5m and 108.79m aOD, with a conservative level of 109.34m aOD used for design.

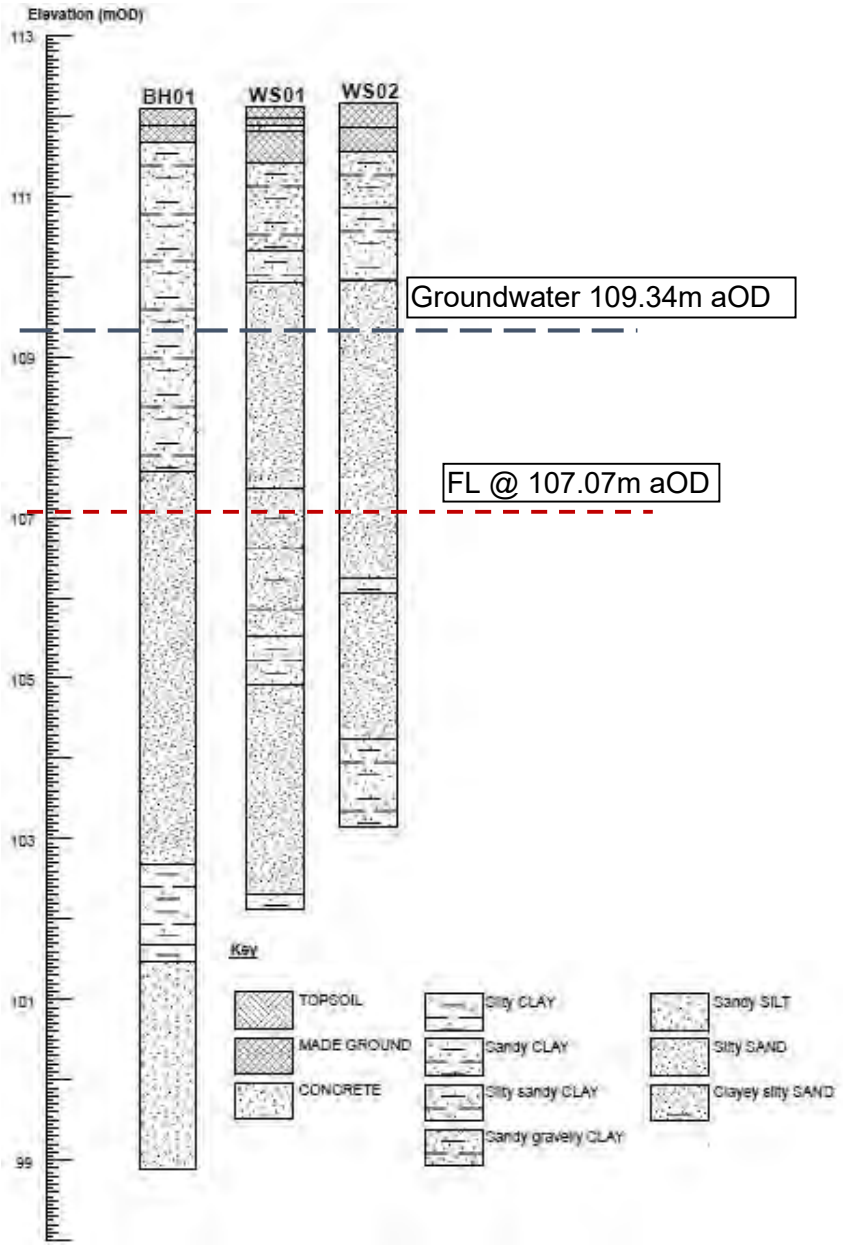

Figure 4: Ground conditions

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Project: **6A Grange Rd, London N6 4BB**	Job No: P22-2546	Sheet No: 6	Rev. I
Subject: **Ground Movement Assessment**	AW	Checked by: MS	
	Date: 30.04.2025	Date: 01/05/2025	

CIRIA C760

Ref. Puller (2003), page 162 C760

Ground Surface Movement Due To Wall Construction – CIRIA C760

CIRIA C760 indicates ground surface movement as a result of diaphragm wall construction

To enable basement construction and groundwater flow around the basement, initially, a secant piled wall will be formed. Table 6.1, indicates ground movement as a result of secant pile insertion.

Table 6.1 Ground surface movements due to bored pile and diaphragm wall installation in stiff clay

Wall type	Horizontal movements		Vertical movements	
	Surface movement at wall (per cent of wall depth)	*Distance behind wall to negligible movement (multiple of wall depth)*	*Surface movement at wall (per cent of wall depth)*	*Distance behind wall to negligible movement (multiple of wall depth)*
Bored piles				
Contiguous	0.04	1.5	0.04	2
Secant	0.08	1.5	0.05	2
Diaphragm walls				
Planar	0.05	1.5	0.05	1.5
Counterfort	0.1	1.5	0.05	1.5

Notes

1 Maximum surface movement occurs close to the wall and is calculated as a percentage of the pile depth/diaphragm wall trench depth, as appropriate.

2 Extent of movement is calculated non-dimensionally by dividing by the pile depth/diaphragm wall trench depth, as appropriate.

Table 6.2 Support stiffness categories (after Carder, 1995)

Support stiffness	Description/examples
High	Top-down construction, temporary props installed before permanent props at high level.
Moderate	Temporary props of high stiffness installed before permanent props at low level.
Low	Cantilever walls, temporary props of low stiffness or temporary props installed at low level.

Table 6.3 Ground surface movements due to excavation in front of bored pile, diaphragm wall and sheet pile walls wholly embedded in competent ground (stiff clays)

Movement type	High support stiffness (high propped wall, top-down construction)		Low support stiffness (cantilever or low-stiffness temporary props or temporary props installed at low level)	
	Surface movement at wall (per cent of max excavation depth)	*Distance behind wall to negligible movement (multiple of max excavation depth)*	*Surface movement at wall (per cent of max excavation depth)*	*Distance behind wall to negligible movement (multiple of max excavation depth)*
Horizontal	0.15	4	0.4	4
Vertical	0.1	3.5	0.35	3.5

Notes

1 Maximum surface movement occurs close to the wall and is expressed as a percentage of maximum excavation depth in front of the wall.

2 Extent of movement is calculated non-dimensionally by dividing by maximum excavation depth.

3 Movements exclude those arising from wall installation effects.

4 Movements are for good workmanship and walls wholly embedded in stiff clays, retaining stiff clays or other competent soils.

5 Movements will be greater where soft soils are encountered at formation level (see Figure 6.14 and Appendix A6).

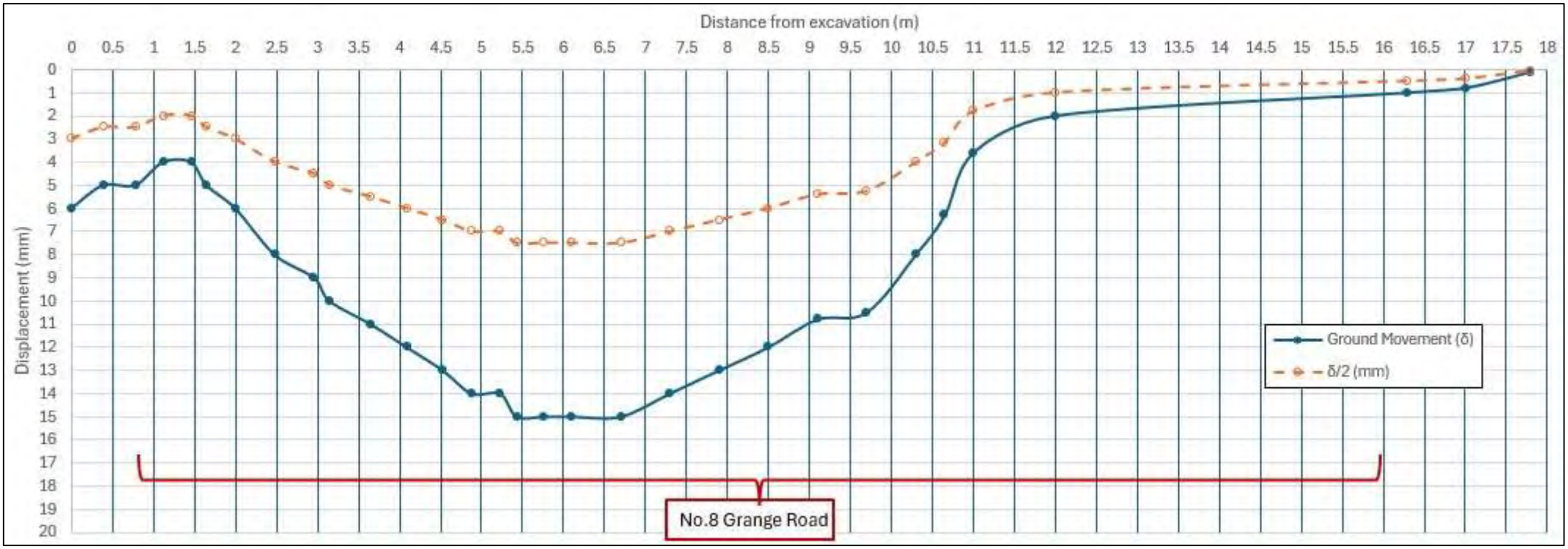

Figure 5: Reproduced C760Figure 6.17 with data from WALLAP output – Vertical Surface Movement Due to Excavation – No.8 Grange Road

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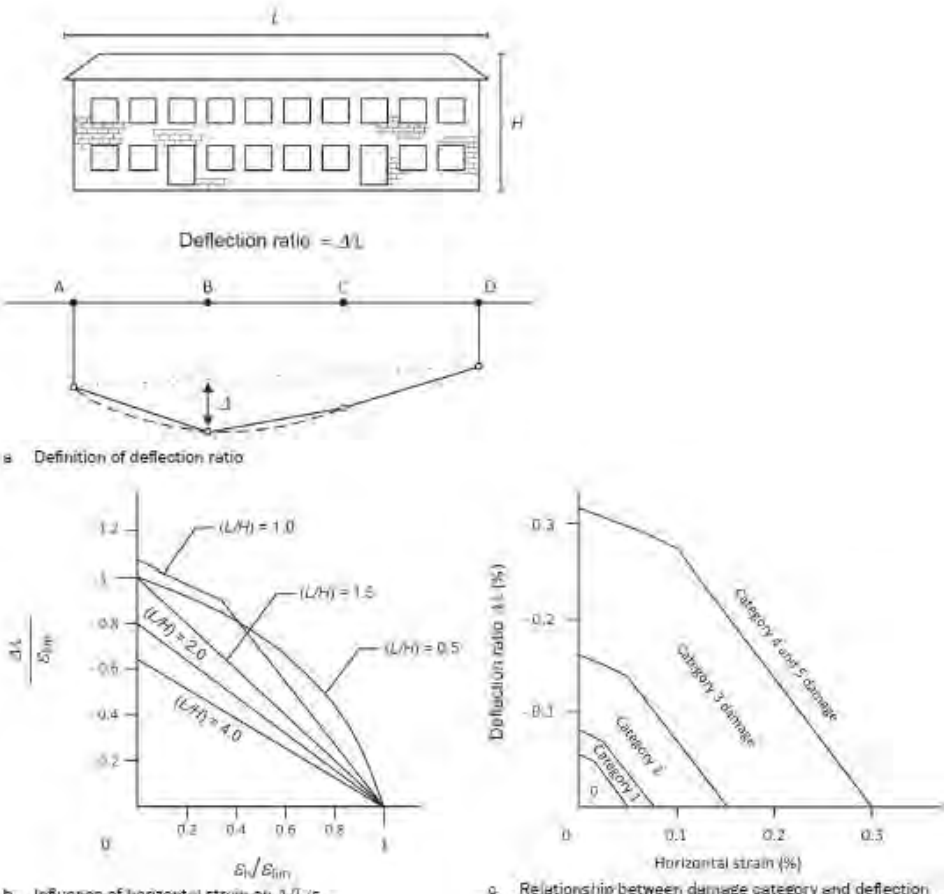
CALCULATION SHEET

Project: **6A Grange Rd, London N6 4BB**	Job No: P22-2546	Sheet No: 8	Rev. I
Subject: **Ground Movement Assessment**	AW	Checked by: MS	
	Date: 30.04.2025	Date: 01/05/2025	

CIRIA C760

Basement formation should be by means of top-down technique.



a Definition of deflection ratio

b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

c Relationship between damage category and deflection ratio and horizontal tensile strain for hogging for (L/H) = 1.0

Note

By adopting values of ε_{lim} associated with various damage categories given in Table 6.4, figure (b) can be developed into an interaction diagram showing the relationship between Δ/L and ε_h for a particular value of L/H figure (c) shows such a diagram for (L/H) = 1.0.

Figure 6.27 Relationship between damage category, deflection ratio and horizontal tensile strain (after Burland, 2001)

Box 6.3 Procedure for Stage 2 damage category assessment

The following steps should be undertaken in making a Stage 2 assessment of the damage to a structure:

1. Establish L and H for the structure (see Figure 6.27a for definitions of L and H).
2. Determine (L/H).
3. Determine relationship between (Δ/L) and ε_h for the required (L/H) from Figure 6.27b for ε_{lim} values from Table 6.4.
4. Estimate vertical and horizontal ground surface movements in the vicinity of the structure.
5. Determine (Δ/L) and ε_h (= δ_h/L) where δ_h is the horizontal movement.
6. Estimate damage category from the relationship between (Δ/L) and ε_h established from Step 3.

If the estimated damage category is higher than that specified, a Stage 3 assessment should be carried out.

Extract from CIRIA C760, Table 6.4

Table 6.4 Classification of visible damage to walls (after Burland et al, 1977, Boscardin and Cording, 1989, and Burland, 2001)

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain, ε_{lim} (%)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	<0.1	0.0 to 0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection	<1	0.05 to 0.075
2 Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.	<5	0.075 to 0.15
3 Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5 to 15 or a number of cracks >3	0.15 to 0.3
4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Services pipes disrupted.	15 to 25, but also depends on number of cracks	>0.3
5 Very severe	This requires a major repair, involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	Usually >25, but depends on numbers of cracks	

Notes

1 In assessing the degree of damage, account must be taken of its location in the building or structure.

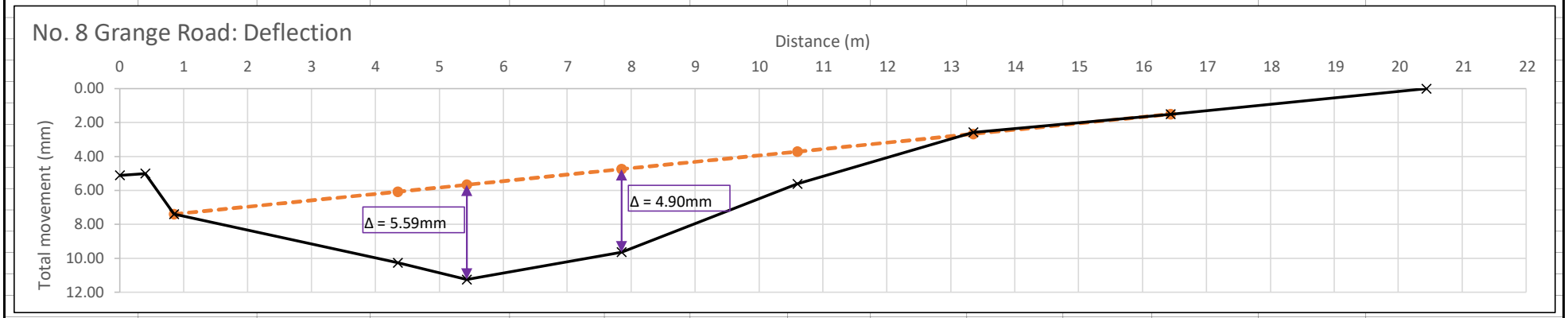
2 Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.

	Vertical Settlements along Building							Horizontal Settlements along Building					
Foundations at No.8 GR	Piled wall toe (m aOD)	Excavation FL (m aOD)	Wall Depth* (m)	Excavation Depth* (m)	Building Length (m)								
111.52	101.3	107.07	10.22	4.45	14000								
Distance (m)	Wall install movement (mm)	Distance/ excavation depth	WALLAP output: movement due to excavation (mm)	Total movement (mm)	Straight line along Elevation	Δv (mm)	Δv/L	Wall install movement (mm)	movement due to excavation (mm)	Total (mm)	Difference (mm)	Horizontal Strain ε_h	Notes
0	5.11			5.11				8.176	0	8.176			
0.4	5.01			5.01	5.01	0.00	0.000%	7.96	0.00	7.96	0.21	0.053%	Dist. of piles to 8GR
0.85	4.90	0.19	2.5	7.40	7.40	0.00	0.000%	7.72	2.50	10.22	2.26	-0.502%	Dist. of excv. to 8GR
4.35	4.02	0.98	6.25	10.27	6.07	4.20	0.030%	5.86	6.25	12.11	1.88	-0.054%	8GR intermediate point
5.43	3.75	1.22	7.5	11.25	5.66	5.59	0.040%	5.28	7.50	12.78	0.67	-0.062%	8GR intermediate point
7.85	3.15	1.76	6.5	9.65	4.75	4.90	0.035%	3.99	6.50	10.49	1.62	0.046%	8GR intermediate point
10.6	2.46	2.38	3.15	5.61	3.71	1.90	0.014%	2.52	3.15	5.67	4.82	0.175%	8GR intermediate point
13.35	1.77	3.00	0.8	2.57	2.67	-0.10	0.001%	1.06	0.80	1.86	3.82	0.157%	8GR intermediate point
16.44	1.00	3.69	0.5	1.50	1.50	0.00	0.000%	0.00	0.50	0.50	1.36	0.089%	
20.44	0.00	4.59	0	0.00		0.00	0.000%	0.00	0.00	0.00	1.86	0.026%	Dist. to 8GR end

* relative to adjacent foundations

Table 6.1		
1.5	15.33	Dist to neg horizontal movement from wall construction (m)
2	20.44	Dist to neg vertical movement from wall construction (m)

Table 6.3		
4	17.8	Dist to neg horizontal movement from excavation (m)
3.5	15.575	Dist to neg vertical movement from excavation (m)



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CALCULATION SHEET

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Project: 6A Grange Rd, London N6 4BB	Job No: P22-2546	Sheet No: 11	Rev. I
Subject: Ground Movement Assessment	AW	Checked by: MS	
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CIRIA C760

Ground Movements @ 8 Grange Road

Fig. 6.27a

$$\frac{L}{H} = \frac{16.0}{9.0} = \boxed{1.78}$$

Fig 6.27b
Sheet 10

Horizontal Strains

$$\varepsilon_h = \frac{\Delta}{l} = \frac{(4.82)}{16{,}000} = 3.01 \times 10^{-4} = \boxed{0.03\%}$$

very slight category $\frac{\varepsilon_h}{\varepsilon_{lim}} = \frac{0.03}{0.075} = \boxed{0.4}$

very slight category $\frac{\varepsilon_h}{\varepsilon_{lim}} = \frac{0.03}{0.05} = \boxed{0.6}$

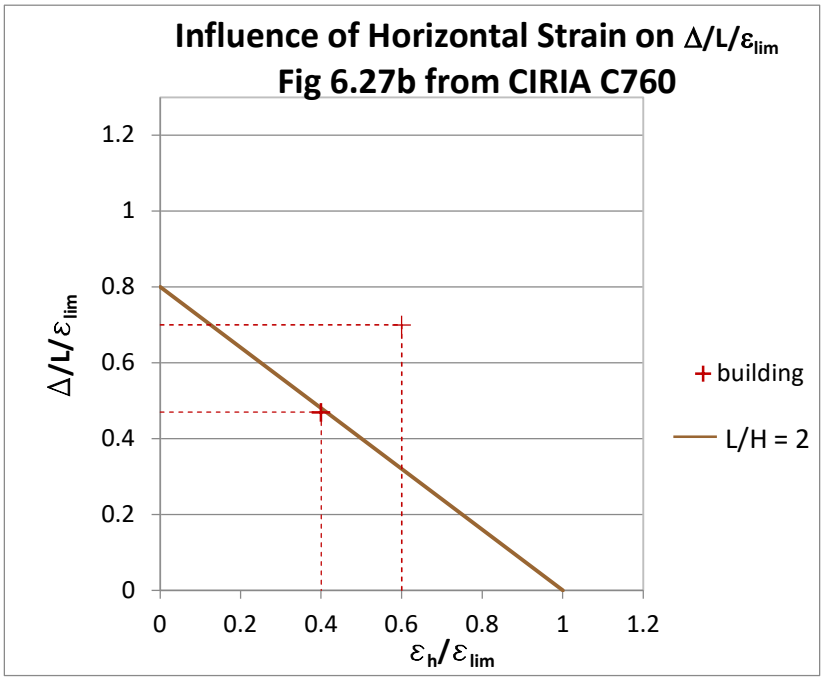
Fig. 6.27a
Sheet 10

Vertical Strains

$$\frac{\Delta}{l} = \frac{(5.59)}{16{,}000} = 3.49 \times 10^{-4} = \boxed{0.035\%}$$

very slight category $\frac{\Delta/l}{\varepsilon_{lim}} = \frac{0.035}{0.075} = \boxed{0.47}$

very slight category $\frac{\Delta/l}{\varepsilon_{lim}} = \frac{0.035}{0.05} = \boxed{0.7}$



The influence of horizontal strain indicates the basement works will result in a damage Category of between very slight to slight (Cat.1 to Cat.2) at No.8 Grange Road.

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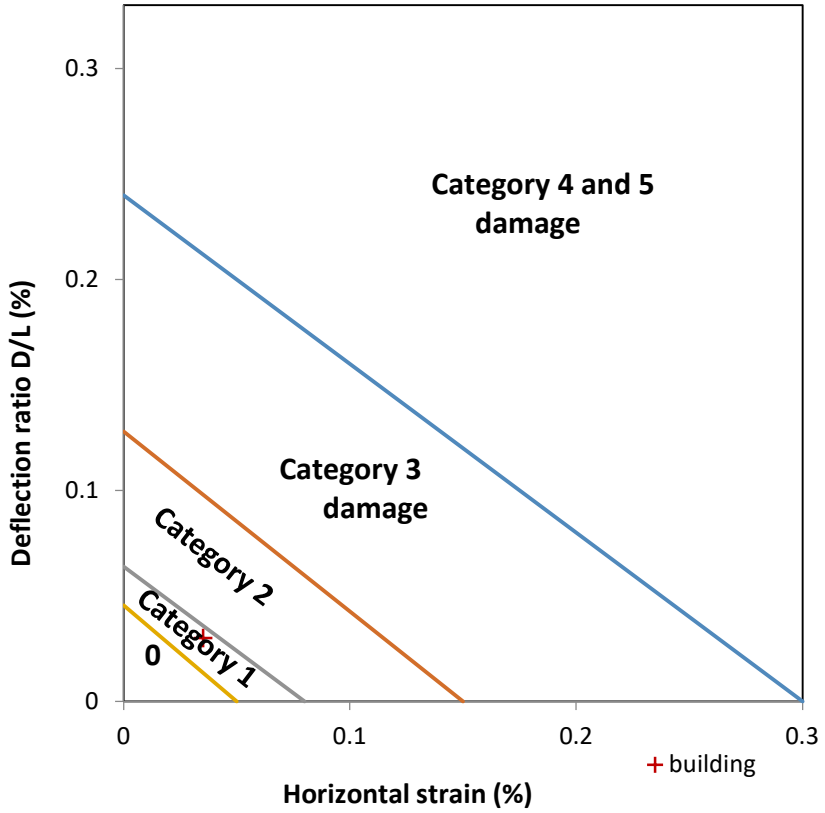
Project: 6A Grange Rd, London N6 4BB	Job No: P22-2546	Sheet No: 12	Rev. I
Subject: Ground Movement Assessment	AW	Checked by: MS	
	Date: 30.04.2025	Date: 01/05/2025	

Fig 6.27c Relationship between damage category and deflection ratio and horizontal tensile strain (L/H) = 1.5



Plotting the influence of horizontal strain against the deflection ratio indicates No.8 Grange Road will be subject to Category 1 damage: '*Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection*' is indicated.

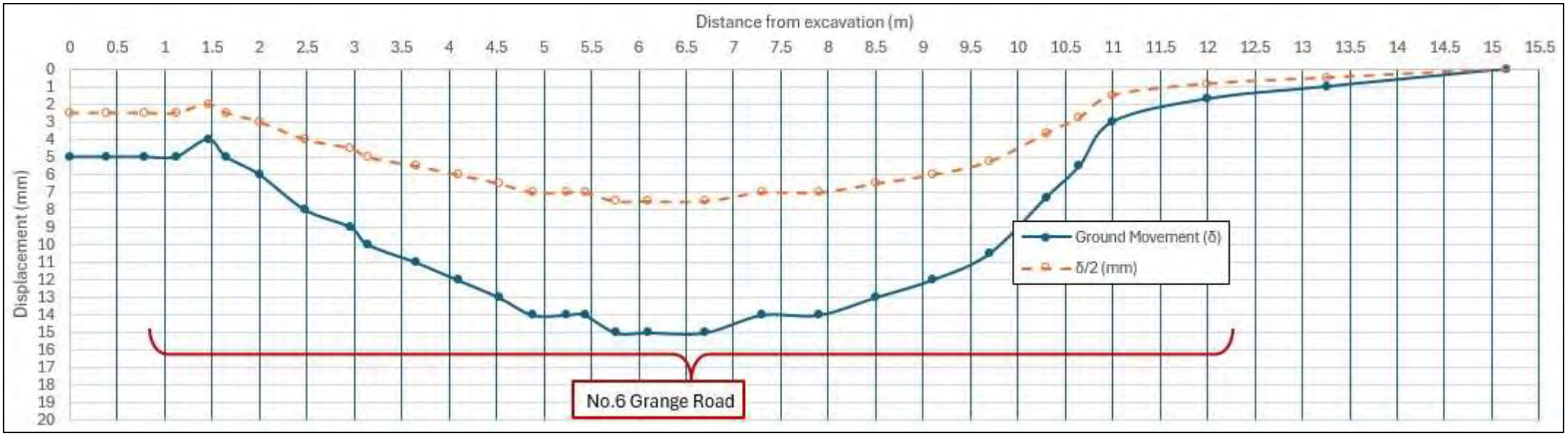


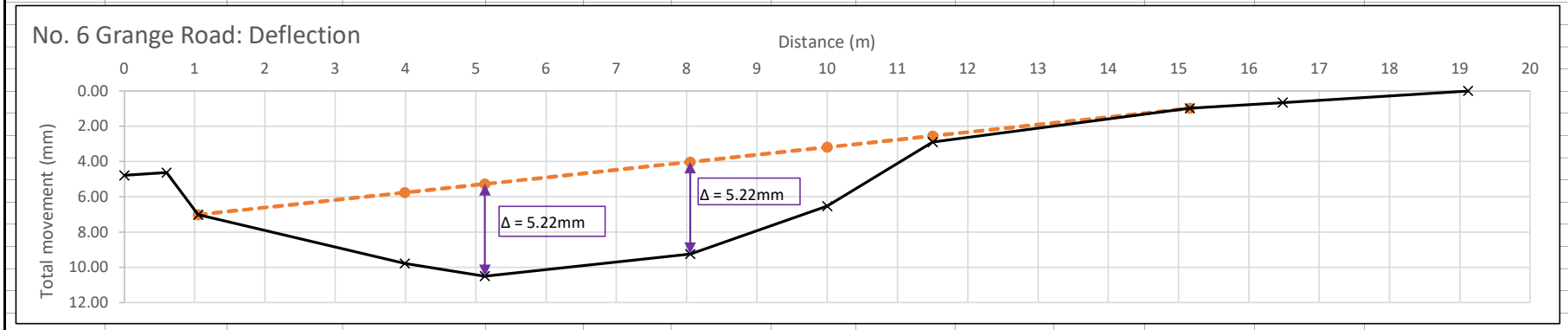
Figure 6: Reproduced C760Figure 6.17 with data from WALLAP output – Vertical Surface Movement Due to Excavation – No.6 Grange Road

	Vertical Settlements along Building							Horizontal Settlements along Building					
Foundations at No.6 GR	Piled wall toe (m aOD)	Excavation FL (m aOD)	Wall Depth* (m)	Excavation Depth* (m)	Building Length (m)								
110.86	101.3	107.07	9.56	3.79	14000								
Distance (m)	Wall install movement (mm)	Distance/ excavation depth	WALLAP output: movement due to excavation (mm)	Total movement (mm)	Straight line along Elevation	Δv (mm)	Δv/L	Wall install movement (mm)	movement due to excavation (mm)	Total (mm)	Difference (mm)	Horizontal Strain ε_h	Notes
0	4.78			4.78				7.648	0	7.648			
0.6	4.63			4.63	4.63	0.00	0.000%	7.33	0.00	7.33	0.32	0.053%	Dist. of piles to 6GR
1.05	4.52	0.28	2.50	7.02	7.02	0.00	0.000%	7.09	2.50	9.59	2.26	-0.502%	Dist of exc. to 6GR
3.99	3.78	1.05	6.00	9.78	5.76	4.02	0.029%	5.52	6.00	11.52	1.93	-0.066%	Dist. of exc. to 6GR side ext.
5.13	3.50	1.35	7.00	10.50	5.27	5.22	0.037%	4.91	7.00	11.91	0.39	-0.034%	Dist. of exc. to 6GR intermediate point
8.05	2.77	2.12	6.48	9.25	4.03	5.22	0.037%	3.35	6.48	9.83	2.08	0.071%	Dist. of exc. to 6GR intermediate point
10	2.28	2.64	4.25	6.53	3.19	3.34	0.024%	2.31	4.25	6.56	3.27	0.168%	Dist. of exc. to 6GR intermediate point
11.5	1.91	3.03	1.00	2.91	2.55	0.35	0.003%	1.51	1.00	2.51	4.05	0.212%	Dist. of exc. to 6GR intermediate point
15.16	0.99	4.00	0.00	0.99	0.99	0.00	0.000%	0.00	0.00	0.00	2.51	0.069%	Dist. of exc. to 6GR end.
16.48	0.66	4.35	0.00	0.66		0.66	0.005%		0.00	0.00	0.00	0.000%	
19.12	0.00	5.04	0	0.00		0.00	0.000%		0.00	0.00			

* relative to adjacent foundations

Table 6.1		
1.5	14.34	Dist to neg horizontal movement from wall construction (m)
2	19.12	Dist to neg vertical movement from wall construction (m)

Table 6.3		
4	15.16	Dist to neg horizontal movement from excavation (m)
3.5	13.265	Dist to neg vertical movement from excavation (m)



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Project: 6A Grange Rd, London N6 4BB	Job No: P22-2546	Sheet No: 15	Rev. I
Subject: Ground Movement Assessment	AW	Checked by: MS	
	Date: 30.04.2025	Date: 01/05/2025	

CIRIA C760

Ground Movements @ 6 Grange Road

Fig. 6.27a

$$\frac{L}{H} = \frac{14.0}{7.48} = \boxed{1.87}$$

Fig 6.27b
Sheet 10

Horizontal Strains

$$\varepsilon_h = \frac{\Delta}{l} = \frac{(4.05)}{14{,}000} = 2.89 \times 10^{-4} = \boxed{0.029\%}$$

very slight category $\frac{\varepsilon_h}{\varepsilon_{lim}} = \frac{0.029}{0.075} = \boxed{0.39}$

very slight category $\frac{\varepsilon_h}{\varepsilon_{lim}} = \frac{0.029}{0.05} = \boxed{0.58}$

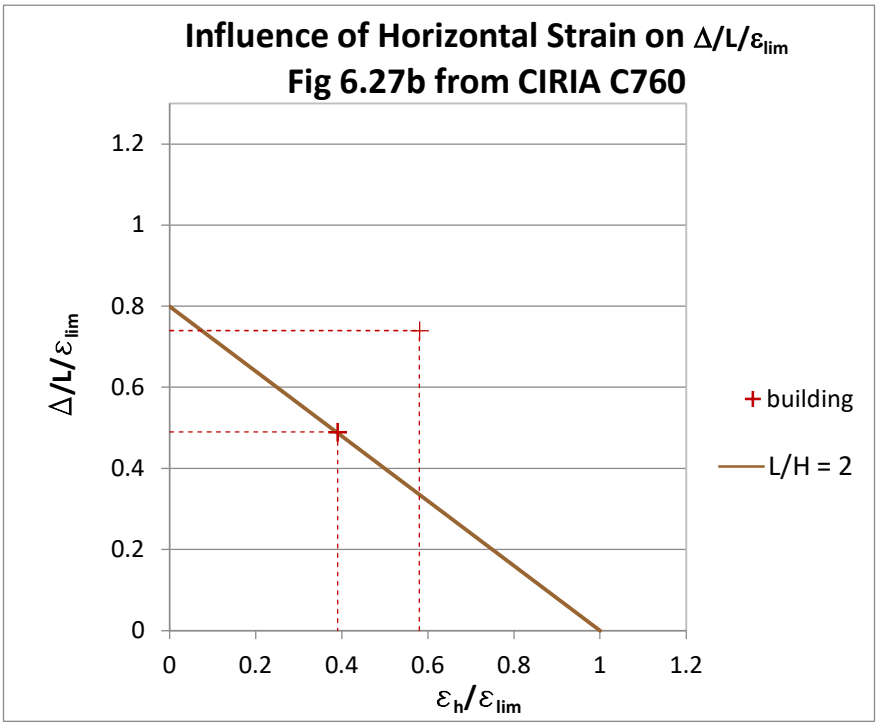
Fig. 6.27a
Sheet 10

Vertical Strains

$$\frac{\Delta}{l} = \frac{(5.22)}{14{,}000} = 3.7 \times 10^{-4} = \boxed{0.037\%}$$

very slight category $\frac{\Delta/l}{\varepsilon_{lim}} = \frac{0.037}{0.075} = \boxed{0.49}$

very slight category $\frac{\Delta/l}{\varepsilon_{lim}} = \frac{0.037}{0.05} = \boxed{0.74}$



The influence of horizontal strain indicates the basement works will result in a damage Category of very slight to slight (Cat.1 to Cat.2) No.6 Grange Road.

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CALCULATION SHEET

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Project: 6A Grange Rd, London N6 4BB	Job No: P22-2546	Sheet No: 16	Rev. I
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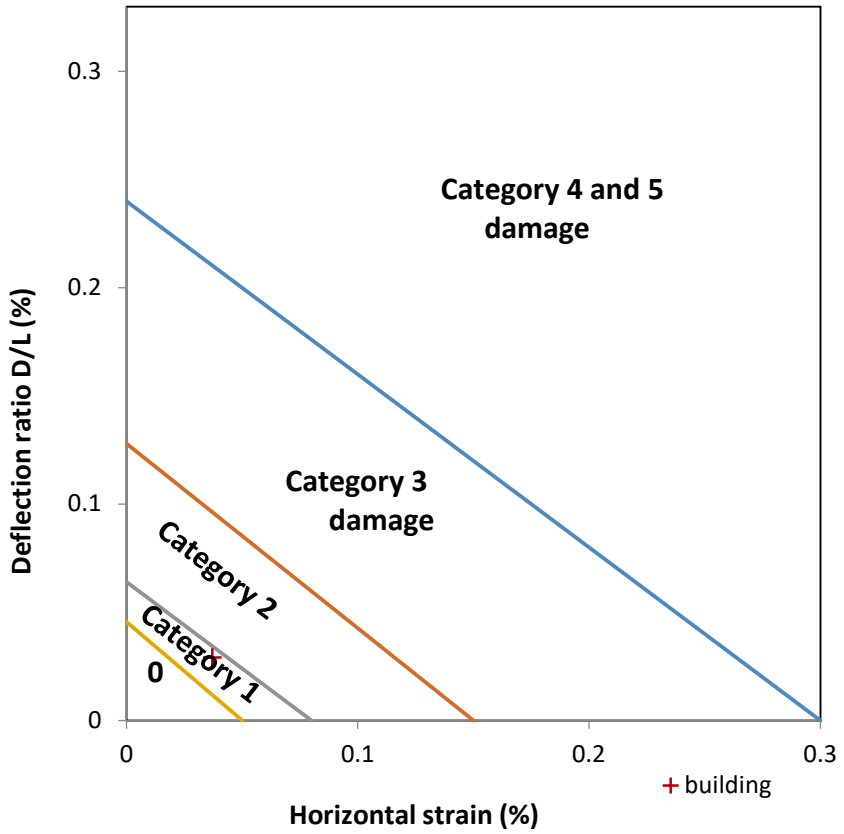
	Date: 30.04.2025	Date: 01/05/2025	

Fig 6.27c Relationship between damage category and deflection ratio and horizontal tensile strain (L/H) = 1.5



Plotting the influence of horizontal strain against the deflection ratio indicates No.6 Grange Road will be subject to Category 1 damage: '*Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection.*' is indicated.

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CALCULATION SHEET

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Project: **6A Grange Rd, London N6 4BB**	Job No: P22-2546	Sheet No: 17	Rev. I
Subject: **Ground Movement Assessment**	AW	Checked by: MS	
	Date: 30.04.2025	Date: 01/05/2025	

<u>Check on services within Grange Road</u>

Distance to road = 7.0m

At seven metres, any services within Grange Road will be subject to <5mm of movement, which is well within tolerance for services. Therefore, services within the road will not be impacted by basement construction at No.6a Grange Road.

WALLAP output No.8 Grange Road

```
CREATE CONSULTING ENGINEERS LTD                              | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60          | Job No.    2546
                              Licensed from GEOSOLVE         | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605          |
6a Grange Road Secant Wall                                   | Date: 8-06-2025
No.8 Grange Road Side                                        | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
```

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types: Left side	Soil types: Right side
1	112.30	1 Made Ground	1 Made Ground
2	111.52	2 Claygate - cohesive	2 Claygate - cohesive
3	110.30	3 Claygate - granular	3 Claygate - granular

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Made Ground	18.00	10000	0.530	NC	0.309	5.499	0.0d
					(0.490)	(1.279)	(6.937)	
2	Claygate ..	19.00	17500	0.590	OC	1.000	1.000	35.00u
	(111.52)		(100.0)		(0.490)	(2.000)	(2.571)	(1.000)
3	Claygate ..	18.00a	22000	0.500	OC	0.333	3.000	
	(110.30)	20.00b	(100.0)		(0.300)	(0.000)	(0.000)	

Note: (a) and (b) are Bulk Densities above and below the water table

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Made Ground	28.39	0.570	0.00	32.96	0.570	0.00
2	Claygate - cohesive	0.00	0.000	0.00	0.00	1.000	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. 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	109.34	109.34	0.0	1	106.87	106.87	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 = 3.0000E+07 kN/m2
          Moment of inertia of wall I = 3.3500E-03 m4/m run
                                  E.I = 100500 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	110.84	1.00	0.300000	3.000E+07	4.00	0.00	0	Strut	No	R
2	109.15	1.00	1.000000	50000	1.00	0.00	0	Strut	No	R
3	107.77	1.00	0.300000	3.000E+07	4.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surcharge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge(kN/m2) Near edge	Far edge	Surcharge Cat.	Soil type	Part fact.	Short Q reduc. fact.
1	111.52	0.40(L)	10.00	1.00	107.00	=	--	--	1.00U	--

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 111.52
2	Change EI of wall to 70350 kN.m2/m run Allow wall to relax with new modulus value
3	Excavate to elevation 111.52 on LEFT side
4	Change EI of wall to 70350 kN.m2/m run Reset wall displacements to zero at this stage
5	Excavate to elevation 110.65 on RIGHT side
6	Install strut or anchor no.1 at elevation 110.84
7	Apply water pressure profile no.1 (Mod. Conserv.)
8	Excavate to elevation 108.65 on RIGHT side
9	Install strut or anchor no.2 at elevation 109.15
10	Excavate to elevation 107.07 on RIGHT side
11	Install strut or anchor no.3 at elevation 107.77
12	Remove strut or anchor no.2 at elevation 109.15
13	Change EI of wall to 50250 kN.m2/m run Allow wall to relax with new modulus value

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) = 0 m

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

Width of excavation/fill on Left side of wall = 20.00 m
Width of excavation/fill 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	Apply surcharge no.1 at elev. 111.52	Yes	Yes	Yes
2	Change EI of wall to 70350kN.m2/m run	Yes	Yes	Yes
3	Excav. to elev. 111.52 on LEFT side	Yes	Yes	Yes
4	Change EI of wall to 70350kN.m2/m run	Yes	Yes	Yes
5	Excav. to elev. 110.65 on RIGHT side	Yes	Yes	Yes
6	Install prop no.1 at elev. 110.84	Yes	Yes	Yes
7	Apply water pressure profile no.1	Yes	Yes	Yes
8	Excav. to elev. 108.65 on RIGHT side	Yes	Yes	Yes
9	Install prop no.2 at elev. 109.15	Yes	Yes	Yes
10	Excav. to elev. 107.07 on RIGHT side	Yes	Yes	Yes
11	Install prop no.3 at elev. 107.77	Yes	Yes	Yes
12	Remove prop no.2 at elev. 109.15	Yes	Yes	Yes
13	Change EI of wall to 50250kN.m2/m run	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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CREATE CONSULTING ENGINEERS LTD | Sheet No.
Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 8-06-2025
No.8 Grange Road Side | Checked :

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 111.52

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	112.30	112.30	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 20.00m 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.

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	112.30	0.00	0.004	2.24E-04	0.0	0.0		100500
2	111.91	-8.41	0.004	2.24E-04	-1.6	-0.0		100500
3	111.52	-9.80	0.004	2.26E-04	-5.2	-1.4		100500
		-16.10	0.004	2.26E-04	-5.2	-1.4		
4	111.18	-9.74	0.004	2.35E-04	-9.6	-3.7		100500
5	110.84	13.03	0.003	2.53E-04	-9.0	-7.1		100500
6	110.65	20.63	0.003	2.69E-04	-5.7	-8.6		100500
7	110.30	26.49	0.003	2.99E-04	2.4	-9.2		100500
		1.59	0.003	2.99E-04	2.4	-9.2		
8	109.82	2.07	0.003	3.40E-04	3.3	-7.9		100500
9	109.34	1.21	0.003	3.74E-04	4.1	-6.2		100500
10	109.15	0.80	0.003	3.84E-04	4.2	-5.4		100500
11	108.65	-0.20	0.003	4.06E-04	4.4	-3.2		100500
12	108.21	-0.86	0.003	4.16E-04	4.2	-1.4		100500
13	107.77	-1.30	0.002	4.19E-04	3.7	0.3		100500
14	107.42	-1.52	0.002	4.15E-04	3.2	1.5		100500
15	107.07	-1.64	0.002	4.08E-04	2.6	2.5		100500
16	106.87	-1.67	0.002	4.03E-04	2.3	3.0		100500
17	106.54	-1.67	0.002	3.92E-04	1.8	3.7		100500
18	106.20	-1.61	0.002	3.79E-04	1.2	4.1		100500
19	105.60	-1.42	0.002	3.53E-04	0.3	4.5		100500
20	105.00	-1.13	0.001	3.27E-04	-0.5	4.4		100500
21	104.40	-0.79	0.001	3.02E-04	-1.0	3.8		100500
22	103.80	-0.40	0.001	2.82E-04	-1.4	3.0		100500
23	103.20	0.02	0.001	2.67E-04	-1.5	2.1		100500
24	102.60	0.48	0.001	2.57E-04	-1.4	1.1		100500
25	102.00	1.00	0.000	2.52E-04	-0.9	0.4		100500
26	101.65	1.32	0.000	2.52E-04	-0.5	0.1		100500
27	101.30	1.66	0.000	2.51E-04	-0.0	0.0		---

(continued)

Stage No.1 Apply surcharge no.1 at elevation 111.52

LEFT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	1842
2	111.91	0.00	7.02	2.17	38.60	2.17	2.17a	1842
3	111.52	0.00	14.04	4.34	77.20	4.34	4.34a	1842
		Total>	14.04	3.90m	104.03	3.90	3.90a	3223
4	111.18	Total>	34.26	5.60m	125.12	13.84	13.84	3230
5	110.84	Total>	63.92	7.30m	155.65	40.18	40.18	3236
6	110.65	Total>	75.21	8.28m	167.45	49.81	49.81	3239
7	110.30	Total>	87.26	14.82	180.38	59.24	59.24	3246
		0.00	87.26	29.06	261.77	30.13	30.13	2987
8	109.82	0.00	94.97	31.62	284.91	34.49	34.49	2993
9	109.34	0.00	99.30	33.07	297.91	37.46	37.46	3000
10	109.15	1.90	99.27	33.06	297.80	37.79	39.69	3002
11	108.65	6.95	99.27	33.06	297.80	38.73	45.68	3009
12	108.21	11.32	99.65	33.18	298.95	39.73	51.06	3015
13	107.77	15.70	100.48	33.46	301.43	40.94	56.64	3021
14	107.42	19.20	101.45	33.78	304.36	42.04	61.24	3026
15	107.07	22.70	102.68	34.19	308.04	43.24	65.94	3031
16	106.87	24.70	103.48	34.46	310.45	43.97	68.67	3033
17	106.54	28.05	104.99	34.96	314.97	45.25	73.30	3038
18	106.20	31.40	106.67	35.52	320.01	46.59	77.99	3042
19	105.60	37.40	110.06	36.65	330.19	49.13	86.53	3051
20	105.00	43.40	113.87	37.92	341.61	51.81	95.21	3059
21	104.40	49.40	118.02	39.30	354.05	54.58	103.98	3067
22	103.80	55.40	122.44	40.77	367.33	57.44	112.84	3075
23	103.20	61.40	127.10	42.32	381.30	60.36	121.76	3083
24	102.60	67.40	131.95	43.94	395.84	63.34	130.74	3091
25	102.00	73.40	136.95	45.61	410.86	66.39	139.79	3100
26	101.65	76.90	139.94	46.60	419.81	68.19	145.09	3104
27	101.30	80.40	142.96	47.61	428.88	70.01	150.41	3109

RIGHT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	1842
2	111.91	0.00	7.02	2.17	38.60	10.58	10.58	1842
3	111.52	0.00	14.04	4.34	77.20	14.14	14.14	1842
		Total>	14.04	3.90m	104.03	20.00	20.00	3223
4	111.18	Total>	20.50	5.60m	111.36	23.58	23.58	3230
5	110.84	Total>	26.96	7.30m	118.69	27.15	27.15	3236
6	110.65	Total>	30.67	8.28m	122.90	29.18	29.18	3239
7	110.30	Total>	37.22	10.00m	130.34	32.75	32.75	3246
		0.00	37.22	12.39	111.66	28.54	28.54	2987
8	109.82	0.00	45.86	15.27	137.58	32.42	32.42	2993
9	109.34	0.00	54.50	18.15	163.50	36.25	36.25	3000
10	109.15	1.90	56.40	18.78	169.20	36.99	38.89	3002
11	108.65	6.95	61.45	20.46	184.35	38.93	45.88	3009
12	108.21	11.32	65.83	21.92	197.48	40.59	51.91	3015
13	107.77	15.70	70.20	23.38	210.60	42.24	57.94	3021
14	107.42	19.20	73.70	24.54	221.10	43.56	62.76	3026
15	107.07	22.70	77.20	25.71	231.60	44.88	67.58	3031
16	106.87	24.70	79.20	26.37	237.60	45.64	70.34	3033
17	106.54	28.05	82.55	27.49	247.65	46.92	74.97	3038

(continued)

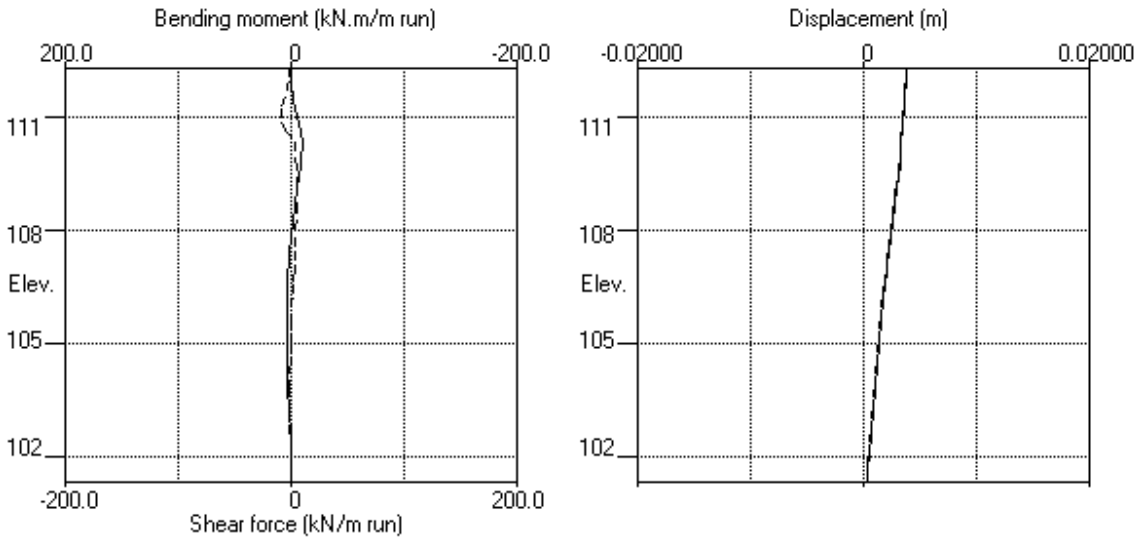
Stage No.1 Apply surcharge no.1 at elevation 111.52

		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
18	106.20	31.40	85.90	28.60	257.70	48.21	79.61	3042
19	105.60	37.40	91.90	30.60	275.70	50.55	87.95	3051
20	105.00	43.40	97.90	32.60	293.70	52.94	96.34	3059
21	104.40	49.40	103.90	34.60	311.70	55.37	104.77	3067
22	103.80	55.40	109.90	36.60	329.70	57.84	113.24	3075
23	103.20	61.40	115.90	38.59	347.70	60.34	121.74	3083
24	102.60	67.40	121.90	40.59	365.70	62.86	130.26	3091
25	102.00	73.40	127.90	42.59	383.70	65.39	138.79	3100
26	101.65	76.90	131.40	43.76	394.20	66.87	143.77	3104
27	101.30	80.40	134.90	44.92	404.70	68.35	148.75	3109

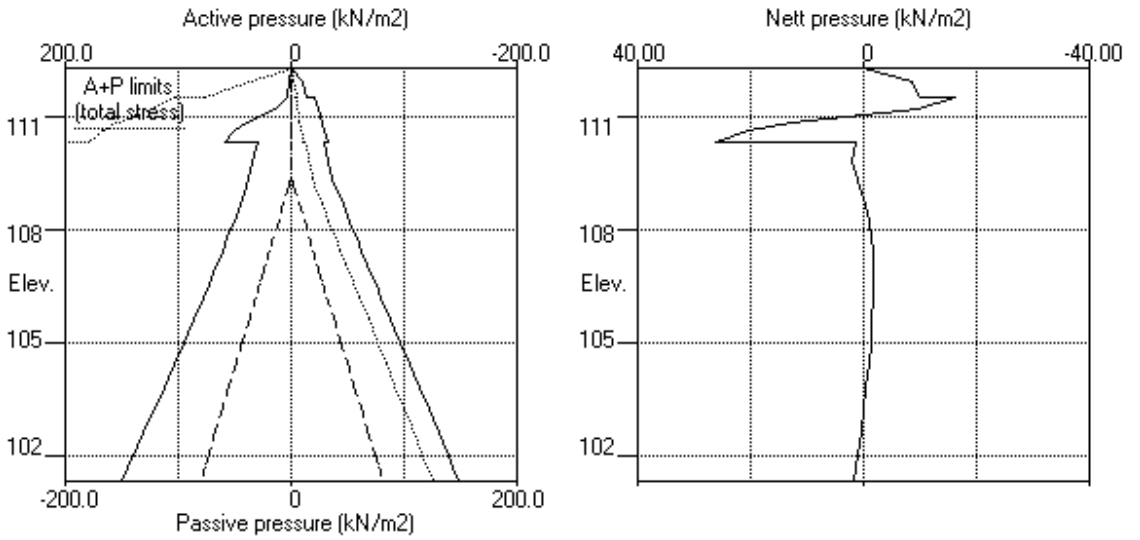
Note: 3.90 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
```

Stage No.1 Apply surcharge no.1 at elev. 111.52



Stage No.1 Apply surcharge no.1 at elev. 111.52



CREATE CONSULTING ENGINEERS LTD | Sheet No.
Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 8-06-2025
No.8 Grange Road Side | Checked :

Units: kN,m

Stage No. 2 Change EI of wall to 70350 kN.m2/m run
Allow wall to relax with new modulus value

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
2	112.30	112.30	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 20.00m 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.

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	112.30	0.00	0.004	1.79E-04	0.0	0.0		70350
2	111.91	-7.86	0.004	1.79E-04	-1.5	-0.0		70350
3	111.52	-9.55	0.004	1.83E-04	-4.9	-1.3		70350
		-15.66	0.004	1.83E-04	-4.9	-1.3		
4	111.18	-9.75	0.004	1.95E-04	-9.2	-3.6		70350
5	110.84	12.89	0.003	2.20E-04	-8.7	-6.9		70350
6	110.65	20.43	0.003	2.40E-04	-5.5	-8.3		70350
7	110.30	26.21	0.003	2.82E-04	2.6	-8.9		70350
		1.31	0.003	2.82E-04	2.6	-8.9		
8	109.82	1.74	0.003	3.37E-04	3.3	-7.5		70350
9	109.34	0.90	0.003	3.82E-04	3.9	-5.8		70350
10	109.15	0.51	0.003	3.96E-04	4.1	-5.0		70350
11	108.65	-0.42	0.003	4.24E-04	4.1	-3.0		70350
12	108.21	-0.98	0.003	4.36E-04	3.8	-1.2		70350
13	107.77	-1.33	0.002	4.39E-04	3.3	0.3		70350
14	107.42	-1.49	0.002	4.35E-04	2.8	1.4		70350
15	107.07	-1.56	0.002	4.25E-04	2.3	2.3		70350
16	106.87	-1.56	0.002	4.18E-04	2.0	2.8		70350
17	106.54	-1.52	0.002	4.04E-04	1.4	3.3		70350
18	106.20	-1.44	0.002	3.88E-04	0.9	3.7		70350
19	105.60	-1.21	0.001	3.56E-04	0.1	4.0		70350
20	105.00	-0.92	0.001	3.24E-04	-0.5	3.8		70350
21	104.40	-0.61	0.001	2.95E-04	-1.0	3.3		70350
22	103.80	-0.26	0.001	2.71E-04	-1.2	2.6		70350
23	103.20	0.10	0.001	2.54E-04	-1.3	1.7		70350
24	102.60	0.51	0.001	2.43E-04	-1.1	0.9		70350
25	102.00	0.80	0.000	2.38E-04	-0.7	0.3		70350
26	101.65	0.98	0.000	2.38E-04	-0.4	0.1		70350
27	101.30	1.18	0.000	2.37E-04	-0.0	0.0		---

(continued)

Stage No.2 Change EI of wall to 70350 kN.m2/m run
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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	8699
2	111.91	0.00	7.02	2.17	38.60	2.44	2.44	8699
3	111.52	0.00	14.04	4.34	77.20	4.46	4.46	8699
		Total>	14.04	3.90m	104.03	4.12	4.12	15224
4	111.18	Total>	34.26	5.60m	125.12	13.83	13.83	15253
5	110.84	Total>	63.92	7.30m	155.65	40.11	40.11	5392
6	110.65	Total>	75.21	8.28m	167.45	49.71	49.71	5398
7	110.30	Total>	87.26	14.82	180.38	59.10	59.10	5408
		0.00	87.26	29.06	261.77	29.99	29.99	5158
8	109.82	0.00	94.97	31.62	284.91	34.32	34.32	5169
9	109.34	0.00	99.30	33.07	297.91	37.30	37.30	5180
10	109.15	1.90	99.27	33.06	297.80	37.64	39.54	5185
11	108.65	6.95	99.27	33.06	297.80	38.62	45.57	5197
12	108.21	11.32	99.65	33.18	298.95	39.67	50.99	5207
13	107.77	15.70	100.48	33.46	301.43	40.92	56.62	5217
14	107.42	19.20	101.45	33.78	304.36	42.05	61.25	4081
15	107.07	22.70	102.68	34.19	308.04	43.28	65.98	4088
16	106.87	24.70	103.48	34.46	310.45	44.02	68.72	4092
17	106.54	28.05	104.99	34.96	314.97	45.32	73.37	4098
18	106.20	31.40	106.67	35.52	320.01	46.68	78.08	4104
19	105.60	37.40	110.06	36.65	330.19	49.24	86.64	4115
20	105.00	43.40	113.87	37.92	341.61	51.91	95.31	4126
21	104.40	49.40	118.02	39.30	354.05	54.67	104.07	4137
22	103.80	55.40	122.44	40.77	367.33	57.51	112.91	4148
23	103.20	61.40	127.10	42.32	381.30	60.40	121.80	4159
24	102.60	67.40	131.95	43.94	395.84	63.36	130.76	6862
25	102.00	73.40	136.95	45.61	410.86	66.29	139.69	14525
26	101.65	76.90	139.94	46.60	419.81	68.02	144.92	14548
27	101.30	80.40	142.96	47.61	428.88	69.77	150.17	14570

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	8699
2	111.91	0.00	7.02	2.17	38.60	10.30	10.30	8699
3	111.52	0.00	14.04	4.34	77.20	14.01	14.01	8699
		Total>	14.04	3.90m	104.03	19.78	19.78	15224
4	111.18	Total>	20.50	5.60m	111.36	23.58	23.58	15253
5	110.84	Total>	26.96	7.30m	118.69	27.21	27.21	5392
6	110.65	Total>	30.67	8.28m	122.90	29.28	29.28	5398
7	110.30	Total>	37.22	10.00m	130.34	32.89	32.89	5408
		0.00	37.22	12.39	111.66	28.68	28.68	5158
8	109.82	0.00	45.86	15.27	137.58	32.58	32.58	5169
9	109.34	0.00	54.50	18.15	163.50	36.40	36.40	5180
10	109.15	1.90	56.40	18.78	169.20	37.13	39.03	5185
11	108.65	6.95	61.45	20.46	184.35	39.04	45.99	5197
12	108.21	11.32	65.83	21.92	197.48	40.65	51.98	5207
13	107.77	15.70	70.20	23.38	210.60	42.26	57.96	5217
14	107.42	19.20	73.70	24.54	221.10	43.54	62.74	4081
15	107.07	22.70	77.20	25.71	231.60	44.84	67.54	4088
16	106.87	24.70	79.20	26.37	237.60	45.58	70.28	4092

(continued)

Stage No.2 Change EI of wall to 70350 kN.m2/m run
Allow wall to relax with new modulus value

		RIGHT 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
17	106.54	28.05	82.55	27.49	247.65	46.84	74.89	4098
18	106.20	31.40	85.90	28.60	257.70	48.12	79.52	4104
19	105.60	37.40	91.90	30.60	275.70	50.45	87.85	4115
20	105.00	43.40	97.90	32.60	293.70	52.83	96.23	4126
21	104.40	49.40	103.90	34.60	311.70	55.28	104.68	4137
22	103.80	55.40	109.90	36.60	329.70	57.77	113.17	4148
23	103.20	61.40	115.90	38.59	347.70	60.30	121.70	4159
24	102.60	67.40	121.90	40.59	365.70	62.85	130.25	6862
25	102.00	73.40	127.90	42.59	383.70	65.49	138.89	14525
26	101.65	76.90	131.40	43.76	394.20	67.04	143.94	14548
27	101.30	80.40	134.90	44.92	404.70	68.59	148.99	14570

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
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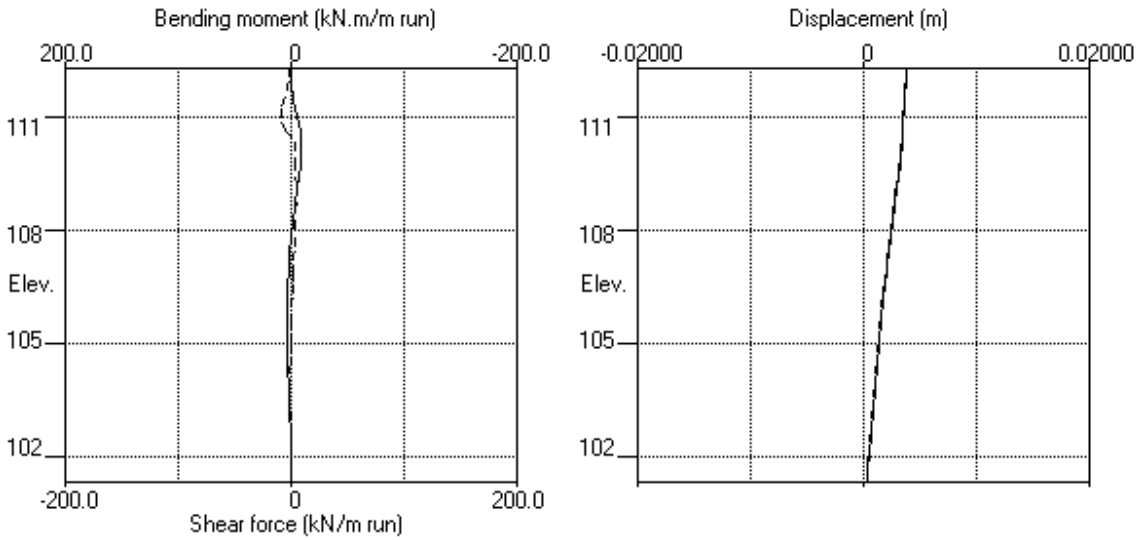
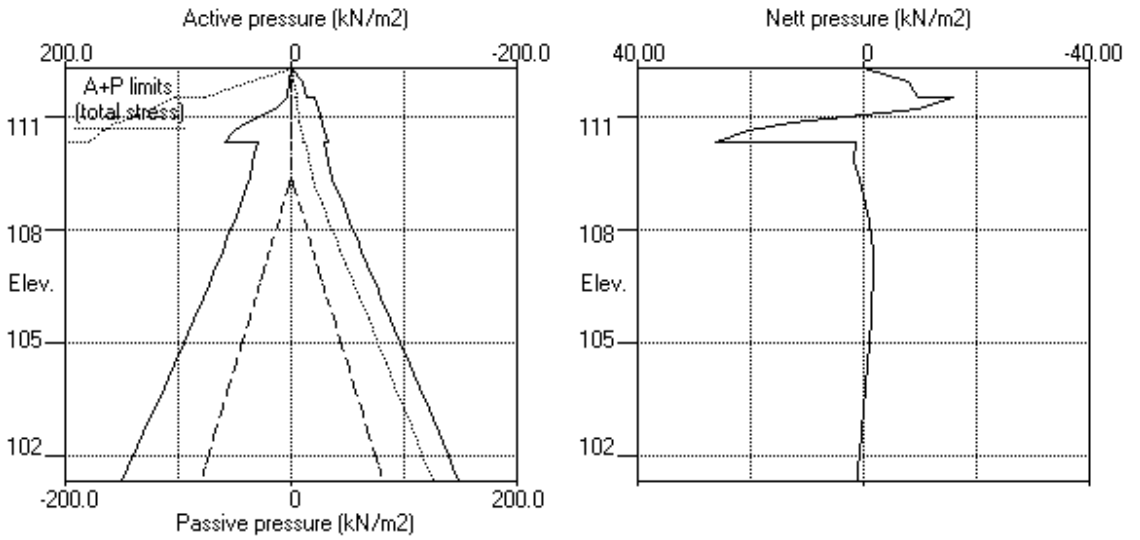
Stage No.2 Change EI of wall to 70350kN.m2/m run



Stage No.2 Change EI of wall to 70350kN.m2/m run



CREATE CONSULTING ENGINEERS LTD | Sheet No.
Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 8-06-2025
No.8 Grange Road Side | Checked :

Units: kN,m

Stage No. 3 Excavate to elevation 111.52 on LEFT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
3	111.52	112.30	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 20.00m 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.

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	112.30	0.00	0.001	-2.15E-05	0.0	0.0		70350
2	111.91	-7.23	0.001	-2.13E-05	-1.4	-0.1		70350
3	111.52	-11.05	0.001	-1.74E-05	-5.0	-1.3		70350
		-9.28	0.001	-1.74E-05	-5.0	-1.3		
4	111.18	-13.06	0.002	-6.20E-06	-8.8	-3.4		70350
5	110.84	9.26	0.001	1.80E-05	-9.4	-6.7		70350
6	110.65	16.61	0.001	3.87E-05	-6.9	-8.4		70350
7	110.30	22.06	0.001	8.25E-05	-0.2	-9.7		70350
		3.50	0.001	8.25E-05	-0.2	-9.7		
8	109.82	3.53	0.001	1.46E-04	1.5	-9.4		70350
9	109.34	2.32	0.001	2.06E-04	2.9	-8.4		70350
10	109.15	1.80	0.001	2.28E-04	3.3	-7.8		70350
11	108.65	0.54	0.001	2.76E-04	3.9	-6.0		70350
12	108.21	-0.28	0.001	3.08E-04	3.9	-4.2		70350
13	107.77	-0.84	0.001	3.29E-04	3.7	-2.6		70350
14	107.42	-1.14	0.001	3.38E-04	3.3	-1.3		70350
15	107.07	-1.33	0.001	3.42E-04	2.9	-0.2		70350
16	106.87	-1.39	0.001	3.42E-04	2.6	0.3		70350
17	106.54	-1.44	0.000	3.39E-04	2.1	1.1		70350
18	106.20	-1.43	0.000	3.33E-04	1.7	1.8		70350
19	105.60	-1.30	0.000	3.16E-04	0.8	2.5		70350
20	105.00	-1.07	-0.000	2.95E-04	0.1	2.7		70350
21	104.40	-0.78	-0.000	2.74E-04	-0.4	2.5		70350
22	103.80	-0.45	-0.000	2.55E-04	-0.8	2.1		70350
23	103.20	-0.08	-0.000	2.41E-04	-1.0	1.5		70350
24	102.60	0.34	-0.001	2.32E-04	-0.9	0.8		70350
25	102.00	0.65	-0.001	2.28E-04	-0.6	0.3		70350
26	101.65	0.84	-0.001	2.27E-04	-0.3	0.1		70350
27	101.30	1.05	-0.001	2.27E-04	-0.0	0.0		---

(continued)

Stage No.3 Excavate to elevation 111.52 on LEFT side

LEFT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	5.31	5.31	2500
4	111.18	Total>	20.22	1.70m	111.08	5.49	5.49	2505
5	110.84	Total>	49.88	3.40m	141.61	31.61	31.61	2510
6	110.65	Total>	61.18	4.38m	153.41	41.11	41.11	2513
7	110.30	Total>	73.22	6.10m	166.34	50.34	50.34	2518
		0.00	73.22	24.38	219.65	28.14	28.14	2217
8	109.82	0.00	80.93	26.95	242.80	32.27	32.27	2222
9	109.34	0.00	85.27	28.40	255.81	35.06	35.06	2227
10	109.15	1.90	85.24	28.38	255.71	35.33	37.23	2229
11	108.65	6.95	85.24	28.39	255.73	36.15	43.10	2234
12	108.21	11.32	85.64	28.52	256.91	37.07	48.40	2238
13	107.77	15.70	86.48	28.80	259.43	38.22	53.92	2242
14	107.42	19.20	87.46	29.12	262.38	39.28	58.48	2246
15	107.07	22.70	88.70	29.54	266.10	40.45	63.15	2250
16	106.87	24.70	89.52	29.81	268.55	41.16	65.86	2252
17	106.54	28.05	91.03	30.31	273.10	42.42	70.47	2255
18	106.20	31.40	92.73	30.88	278.20	43.74	75.14	2258
19	105.60	37.40	96.16	32.02	288.49	46.26	83.66	2264
20	105.00	43.40	100.01	33.30	300.04	48.91	92.31	2270
21	104.40	49.40	104.21	34.70	312.63	51.67	101.07	2276
22	103.80	55.40	108.69	36.19	326.08	54.51	109.91	2282
23	103.20	61.40	113.41	37.77	340.24	57.42	118.82	2289
24	102.60	67.40	118.33	39.40	355.00	60.40	127.80	2295
25	102.00	73.40	123.42	41.10	370.25	63.36	136.76	2301
26	101.65	76.90	126.45	42.11	379.34	65.10	142.00	2304
27	101.30	80.40	129.52	43.13	388.56	66.87	147.27	2308

RIGHT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	1395
2	111.91	0.00	7.02	2.17	38.60	7.23	7.23	1395
3	111.52	0.00	14.04	4.34	77.20	11.05	11.05	1395
		Total>	14.04	3.90m	104.03	14.59	14.59	2441
4	111.18	Total>	20.50	5.60m	111.36	18.55	18.55	2446
5	110.84	Total>	26.96	7.30m	118.69	22.34	22.34	2451
6	110.65	Total>	30.67	8.28m	122.90	24.50	24.50	2454
7	110.30	Total>	37.22	10.00m	130.34	28.28	28.28	2459
		0.00	37.22	12.39	111.66	24.64	24.64	2149
8	109.82	0.00	45.86	15.27	137.58	28.74	28.74	2154
9	109.34	0.00	54.50	18.15	163.50	32.74	32.74	2158
10	109.15	1.90	56.40	18.78	169.20	33.54	35.44	2160
11	108.65	6.95	61.45	20.46	184.35	35.61	42.56	2165
12	108.21	11.32	65.83	21.92	197.48	37.35	48.67	2169
13	107.77	15.70	70.20	23.38	210.60	39.06	54.76	2174
14	107.42	19.20	73.70	24.54	221.10	40.42	59.62	2177
15	107.07	22.70	77.20	25.71	231.60	41.78	64.48	2181
16	106.87	24.70	79.20	26.37	237.60	42.56	67.26	2183
17	106.54	28.05	82.55	27.49	247.65	43.86	71.91	2186

(continued)

Stage No.3 Excavate to elevation 111.52 on LEFT side

		RIGHT 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
18	106.20	31.40	85.90	28.60	257.70	45.18	76.58	2189
19	105.60	37.40	91.90	30.60	275.70	47.56	84.96	2195
20	105.00	43.40	97.90	32.60	293.70	49.98	93.38	2201
21	104.40	49.40	103.90	34.60	311.70	52.45	101.85	2207
22	103.80	55.40	109.90	36.60	329.70	54.96	110.36	2213
23	103.20	61.40	115.90	38.59	347.70	57.50	118.90	2218
24	102.60	67.40	121.90	40.59	365.70	60.06	127.46	2224
25	102.00	73.40	127.90	42.59	383.70	62.71	136.11	2230
26	101.65	76.90	131.40	43.76	394.20	64.26	141.16	2234
27	101.30	80.40	134.90	44.92	404.70	65.82	146.22	2237

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CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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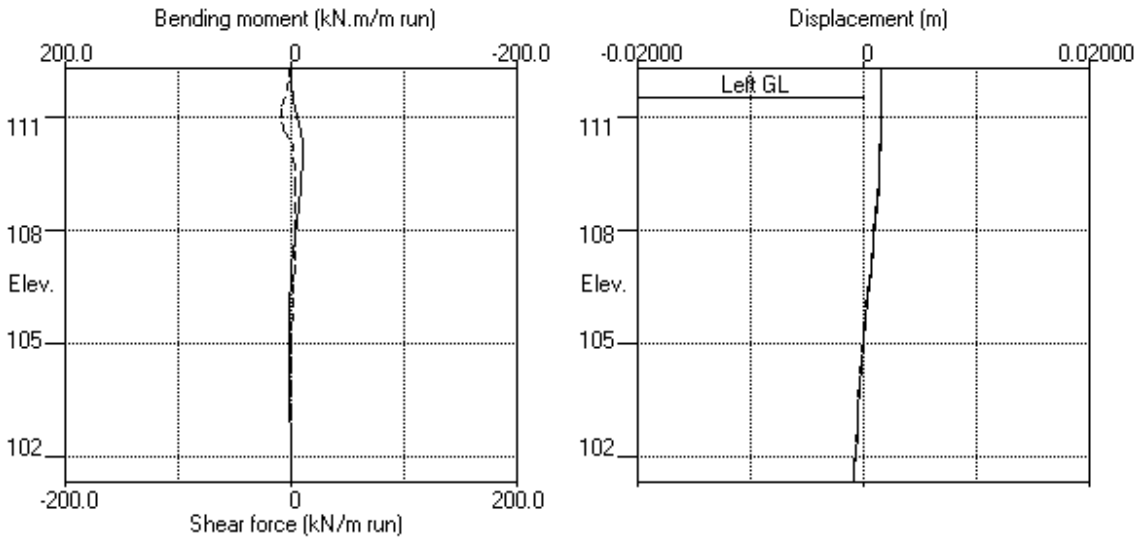
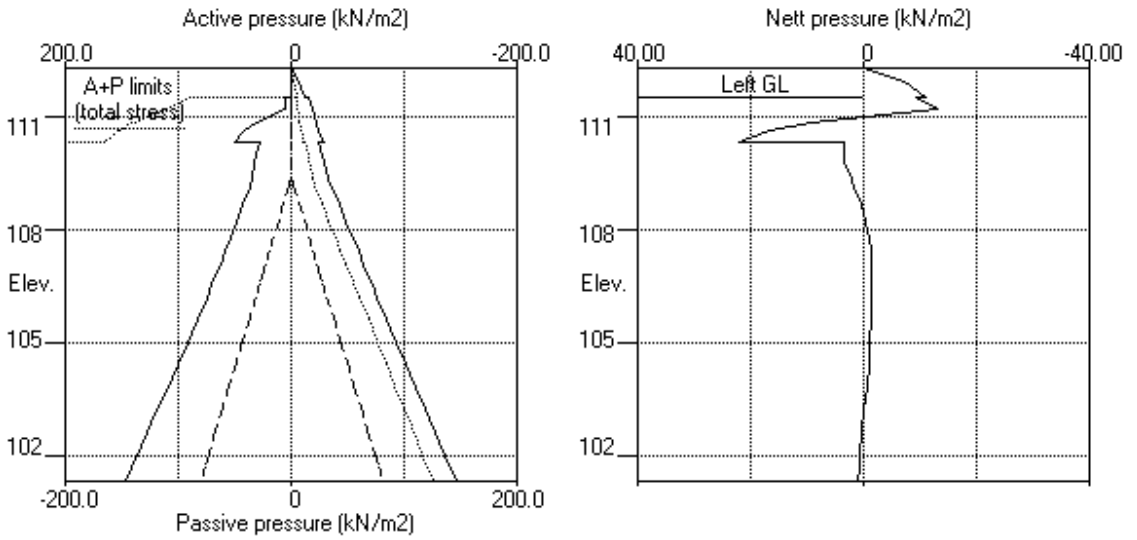
Stage No.3 Excav. to elev. 111.52 on LEFT side



Stage No.3 Excav. to elev. 111.52 on LEFT side



CREATE CONSULTING ENGINEERS LTD | Sheet No.
Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 8-06-2025
No.8 Grange Road Side | Checked :

Units: kN,m

Stage No. 5 Excavate to elevation 110.65 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
5	111.52	110.65	Cant.	2.686	102.44	110.59	0.05	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 20.00m 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 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	112.30	0.00	0.006	1.17E-03	0.0	-0.0		70350
2	111.91	0.00	0.005	1.17E-03	0.0	0.1		70350
3	111.52	0.00	0.005	1.16E-03	0.0	0.1		70350
4	111.18	1.70	0.004	1.15E-03	0.3	0.3		70350
5	110.84	10.22	0.004	1.12E-03	2.3	1.1		70350
6	110.65	20.92	0.004	1.10E-03	5.4	1.7		70350
		-0.27	0.004	1.10E-03	5.4	1.7		
7	110.30	13.15	0.003	1.04E-03	7.6	3.7		70350
		4.72	0.003	1.04E-03	7.6	3.7		
8	109.82	-4.21	0.003	9.38E-04	7.7	8.1		70350
9	109.34	-4.41	0.002	8.12E-04	5.6	11.2		70350
10	109.15	-4.39	0.002	7.58E-04	4.8	12.2		70350
11	108.65	-4.51	0.002	6.15E-04	2.5	14.0		70350
12	108.21	-4.76	0.002	4.94E-04	0.5	14.6		70350
13	107.77	-3.28	0.001	3.82E-04	-1.2	14.6		70350
14	107.42	-2.27	0.001	3.01E-04	-2.2	14.0		70350
15	107.07	-1.46	0.001	2.30E-04	-2.9	13.1		70350
16	106.87	-1.06	0.001	1.93E-04	-3.1	12.5		70350
17	106.54	-0.52	0.001	1.40E-04	-3.4	11.4		70350
18	106.20	-0.09	0.001	9.57E-05	-3.5	10.3		70350
19	105.60	0.41	0.001	3.54E-05	-3.4	8.1		70350
20	105.00	0.68	0.001	-3.09E-06	-3.1	6.1		70350
21	104.40	0.80	0.001	-2.53E-05	-2.6	4.4		70350
22	103.80	0.84	0.001	-3.64E-05	-2.1	2.9		70350
23	103.20	0.86	0.001	-4.06E-05	-1.6	1.7		70350
24	102.60	0.91	0.001	-4.15E-05	-1.1	0.8		70350
25	102.00	0.84	0.001	-4.13E-05	-0.6	0.2		70350
26	101.65	0.81	0.001	-4.12E-05	-0.3	0.1		70350
27	101.30	0.79	0.001	-4.12E-05	-0.0	0.0		---

(continued)

Stage No.5 Excavate to elevation 110.65 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	0.00	0.00a	5592
4	111.18	Total>	20.22	1.70m	111.08	1.70	1.70a	5603
5	110.84	Total>	49.88	3.40m	141.61	10.22	10.22	5614
6	110.65	Total>	61.18	4.38m	153.41	20.92	20.92	5620
7	110.30	Total>	73.22	6.10m	166.34	32.20	32.20	5631
		0.00	73.22	24.38	219.65	24.38	24.38a	5380
8	109.82	0.00	80.93	26.95	242.80	26.95	26.95a	5391
9	109.34	0.00	85.27	28.40	255.81	28.40	28.40a	5403
10	109.15	1.90	85.24	28.38	255.71	28.38	30.28a	5408
11	108.65	6.95	85.24	28.39	255.73	28.39	35.34a	5420
12	108.21	11.32	85.64	28.52	256.91	28.52	39.84a	5431
13	107.77	15.70	86.48	28.80	259.43	30.63	46.33	5441
14	107.42	19.20	87.46	29.12	262.38	32.33	51.53	5450
15	107.07	22.70	88.70	29.54	266.10	34.00	56.70	5459
16	106.87	24.70	89.52	29.81	268.55	34.93	59.63	5463
17	106.54	28.05	91.03	30.31	273.10	36.49	64.54	5472
18	106.20	31.40	92.73	30.88	278.20	38.02	69.42	5480
19	105.60	37.40	96.16	32.02	288.49	40.73	78.13	5494
20	105.00	43.40	100.01	33.30	300.04	43.42	86.82	5509
21	104.40	49.40	104.21	34.70	312.63	46.11	95.51	5524
22	103.80	55.40	108.69	36.19	326.08	48.83	104.23	5539
23	103.20	61.40	113.41	37.77	340.24	51.59	112.99	5553
24	102.60	67.40	118.33	39.40	355.00	54.42	121.82	5568
25	102.00	73.40	123.42	41.10	370.25	57.22	130.62	5583
26	101.65	76.90	126.45	42.11	379.34	58.88	135.78	5591
27	101.30	80.40	129.52	43.13	388.56	60.55	140.95	5600

RIGHT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	92.23	21.19	21.19	5899
7	110.30	Total>	6.56	1.72m	99.68	19.04	19.04	5910
		0.00	6.56	2.18	19.67	19.67	19.67p	5658
8	109.82	0.00	15.20	5.06	45.59	31.16	31.16	5671
9	109.34	0.00	23.84	7.94	71.52	32.81	32.81	5683
10	109.15	1.90	25.74	8.57	77.22	32.77	34.67	5688
11	108.65	6.95	30.80	10.26	92.39	32.89	39.84	5701
12	108.21	11.32	35.18	11.72	105.55	33.27	44.60	5712
13	107.77	15.70	39.57	13.18	118.72	33.91	49.61	5723
14	107.42	19.20	43.09	14.35	129.26	34.61	53.81	5732
15	107.07	22.70	46.61	15.52	139.82	35.45	58.15	5741
16	106.87	24.70	48.62	16.19	145.86	36.00	60.70	5746
17	106.54	28.05	51.99	17.31	155.98	37.00	65.05	5755

(continued)

Stage No.5 Excavate to elevation 110.65 on RIGHT side

		RIGHT 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
18	106.20	31.40	55.37	18.44	166.11	38.11	69.51	5764
19	105.60	37.40	61.43	20.46	184.29	40.32	77.72	5779
20	105.00	43.40	67.50	22.48	202.51	42.74	86.14	5794
21	104.40	49.40	73.59	24.51	220.77	45.31	94.71	5810
22	103.80	55.40	79.69	26.54	239.07	47.99	103.39	5825
23	103.20	61.40	85.81	28.57	257.43	50.74	112.14	5841
24	102.60	67.40	91.94	30.62	275.83	53.51	120.91	5856
25	102.00	73.40	98.09	32.66	294.27	56.38	129.78	5872
26	101.65	76.90	101.68	33.86	305.05	58.07	134.97	5881
27	101.30	80.40	105.28	35.06	315.84	59.76	140.16	5890

Note: 39.84 a Soil pressure at active limit
19.67 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
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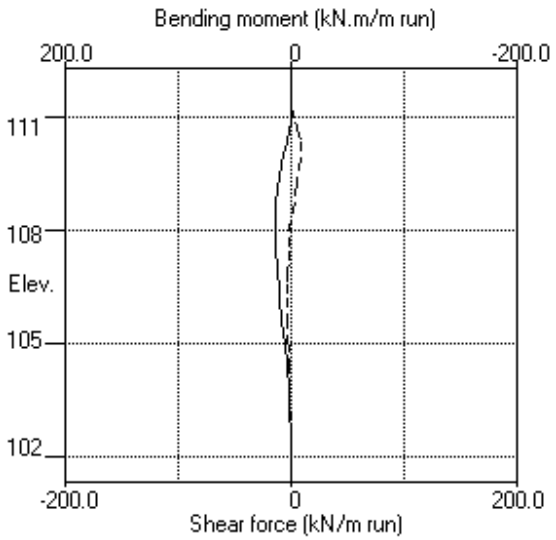
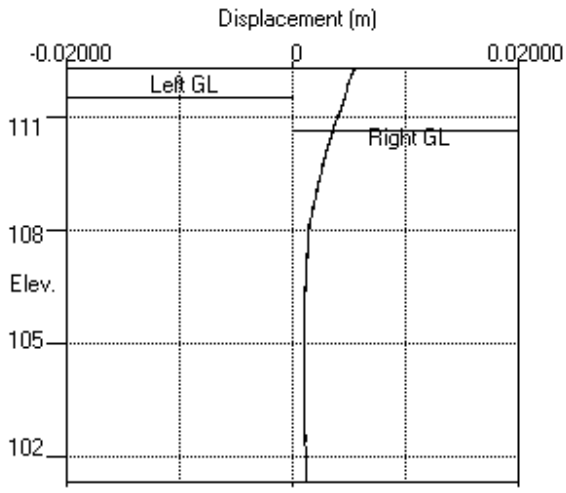
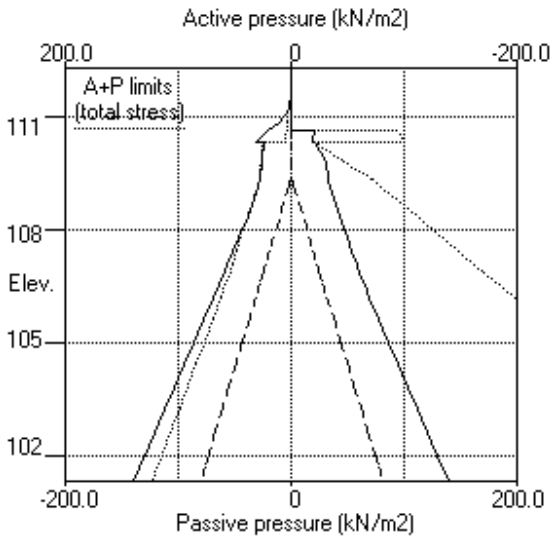
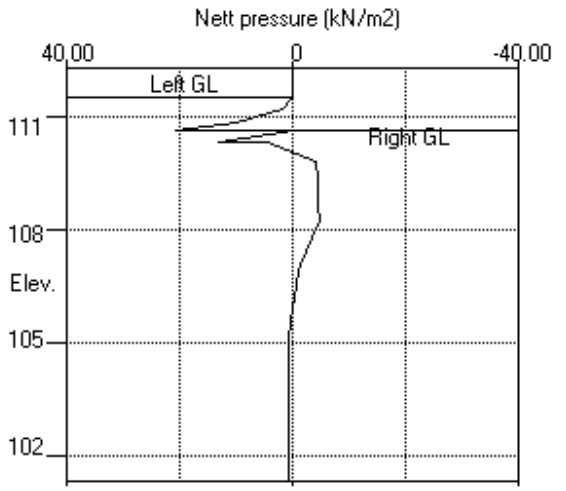
Stage No.5 Excav. to elev. 110.65 on RIGHT side





Stage No.5 Excav. to elev. 110.65 on RIGHT side





Units: kN,m

Stage No. 7 Apply water pressure profile no.1 (Mod. Conserv.)

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
7	111.52	110.65	110.84	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 20.00m 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 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	112.30	0.00	0.005	6.34E-04	0.0	0.0		70350
2	111.91	0.00	0.004	6.34E-04	0.0	0.1		70350
3	111.52	0.00	0.004	6.30E-04	0.0	0.1		70350
		8.11	0.004	6.30E-04	0.0	0.1		
4	111.18	5.74	0.004	6.16E-04	2.4	0.8		70350
5	110.84	10.21	0.004	5.84E-04	5.1	2.5	-5.9	70350
		10.21	0.004	5.84E-04	-0.8	2.5		
6	110.65	20.61	0.004	5.56E-04	2.2	2.5		70350
		-0.89	0.004	5.56E-04	2.2	2.5		
7	110.30	11.45	0.004	4.97E-04	4.0	3.4		70350
		4.72	0.004	4.97E-04	4.0	3.4		
8	109.82	-5.66	0.003	4.00E-04	3.8	6.1		70350
9	109.34	-6.52	0.003	2.94E-04	0.8	7.1		70350
10	109.15	-5.73	0.003	2.53E-04	-0.3	7.2		70350
11	108.65	-3.79	0.003	1.55E-04	-2.7	6.3		70350
12	108.21	-2.20	0.003	8.98E-05	-4.0	4.8		70350
13	107.77	-0.64	0.003	4.43E-05	-4.7	3.1		70350
14	107.42	0.58	0.003	2.35E-05	-4.7	1.4		70350
15	107.07	2.17	0.003	1.63E-05	-4.2	-0.1		70350
16	106.87	3.46	0.003	1.77E-05	-3.6	-0.8		70350
17	106.54	3.04	0.003	2.77E-05	-2.5	-1.9		70350
18	106.20	2.61	0.003	4.52E-05	-1.6	-2.5		70350
19	105.60	1.86	0.003	8.77E-05	-0.2	-3.1		70350
20	105.00	1.16	0.003	1.36E-04	0.7	-3.1		70350
21	104.40	0.57	0.003	1.82E-04	1.2	-2.6		70350
22	103.80	0.09	0.003	2.22E-04	1.4	-1.9		70350
23	103.20	-0.27	0.002	2.50E-04	1.3	-1.2		70350
24	102.60	-0.51	0.002	2.68E-04	1.1	-0.6		70350
25	102.00	-0.83	0.002	2.76E-04	0.7	-0.2		70350

(continued)

Stage No.7 Apply water pressure profile no.1 (Mod. Conserv.)

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
26	101.65	-0.99	0.002	2.77E-04	0.4	-0.0		70350
27	101.30	-1.14	0.002	2.77E-04	-0.0	0.0		---

At elev. 110.84 Prop force = 5.9 kN/m run

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	8.11	8.11	22306
4	111.18	Total>	20.22	1.70m	111.08	5.74	5.74	22349
5	110.84	Total>	49.88	3.40m	141.61	10.21	10.21	2853
6	110.65	Total>	61.18	4.38m	153.41	20.61	20.61	2856
7	110.30	Total>	73.22	6.10m	166.34	31.35	31.35	2861
		0.00	73.22	24.38	219.65	24.38	24.38a	2589
8	109.82	0.00	80.93	26.95	242.80	26.95	26.95a	2595
9	109.34	0.00	85.27	28.40	255.81	28.40	28.40a	2600
10	109.15	1.56	85.58	28.50	256.75	28.50	30.05a	2603
11	108.65	5.69	86.50	28.81	259.51	28.81	34.49a	2609
12	108.21	9.27	87.69	29.20	263.07	29.20	38.47a	2614
13	107.77	12.85	89.32	29.75	267.97	29.75	42.60a	2619
14	107.42	15.72	90.95	30.28	272.84	30.28	46.00a	2623
15	107.07	18.58	92.82	30.91	278.46	31.29	49.88	2627
16	106.87	20.22	94.00	31.30	281.99	32.28	52.50	2629
17	106.54	22.96	96.13	32.01	288.38	33.96	56.92	2633
18	106.20	25.70	98.43	32.78	295.29	35.68	61.38	2637
19	105.60	30.61	102.95	34.28	308.85	38.84	69.45	2644
20	105.00	35.52	107.89	35.93	323.67	42.14	77.66	2651
21	104.40	40.43	113.18	37.69	339.53	45.56	86.00	2659
22	103.80	45.35	118.75	39.54	356.24	49.11	94.46	2666
23	103.20	50.26	124.56	41.48	373.67	52.78	103.04	2673
24	102.60	55.17	130.56	43.48	391.69	56.55	111.71	2680
25	102.00	60.08	136.74	45.53	410.21	60.32	120.40	2687
26	101.65	62.94	140.40	46.75	421.21	62.54	125.48	2691
27	101.30	65.81	144.11	47.99	432.33	64.78	130.59	2695

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	92.23	21.50	21.50	2856
7	110.30	Total>	6.56	1.72m	99.68	19.90	19.90	2861
		0.00	6.56	2.18	19.67	19.67	19.67p	2589
8	109.82	0.00	15.20	5.06	45.59	32.61	32.61	2595
9	109.34	0.00	23.84	7.94	71.52	34.92	34.92	2600
10	109.15	0.00	27.26	9.08	81.78	35.79	35.79	2603

(continued)

Stage No.7 Apply water pressure profile no.1 (Mod. Conserv.)

		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
11	108.65	0.00	36.36	12.11	109.07	38.28	38.28	2609
12	108.21	0.00	44.24	14.73	132.73	40.67	40.67	2614
13	107.77	0.00	52.13	17.36	156.40	43.24	43.24	2619
14	107.42	0.00	58.45	19.46	175.34	45.42	45.42	2623
15	107.07	0.00	64.77	21.57	194.30	47.70	47.70	2627
16	106.87	0.00	68.38	22.77	205.14	49.04	49.04	2629
17	106.54	3.96	71.14	23.69	213.43	49.92	53.88	2633
18	106.20	7.92	73.91	24.61	221.74	50.85	58.76	2637
19	105.60	15.00	78.88	26.27	236.65	52.59	67.60	2644
20	105.00	22.09	83.87	27.93	251.60	54.41	76.50	2651
21	104.40	29.18	88.87	29.59	266.60	56.25	85.43	2659
22	103.80	36.27	93.88	31.26	281.64	58.10	94.37	2666
23	103.20	43.36	98.91	32.94	296.73	59.94	103.30	2673
24	102.60	50.45	103.95	34.62	311.86	61.77	112.22	2680
25	102.00	57.54	109.01	36.30	327.03	63.68	121.22	2687
26	101.65	61.67	111.97	37.29	335.91	64.80	126.48	2691
27	101.30	65.81	114.93	38.27	344.80	65.92	131.73	2695

Note: 46.00 a Soil pressure at active limit
19.67 p Soil pressure at passive limit

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Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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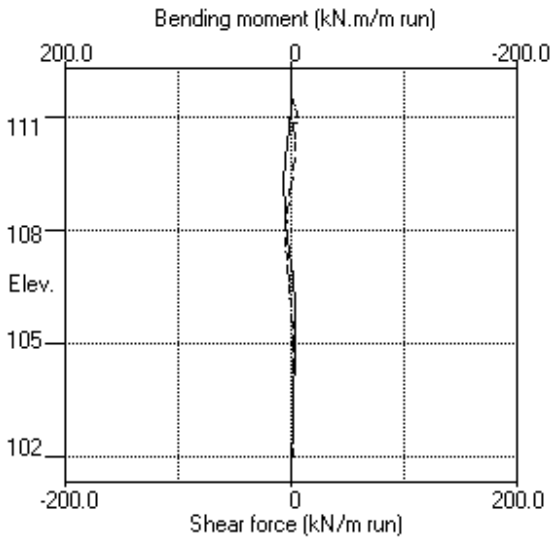
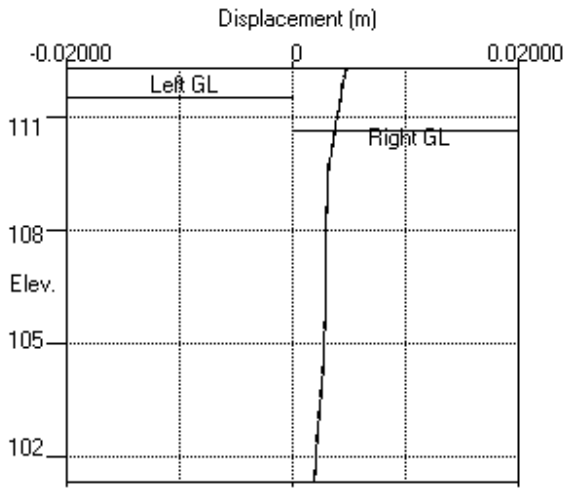
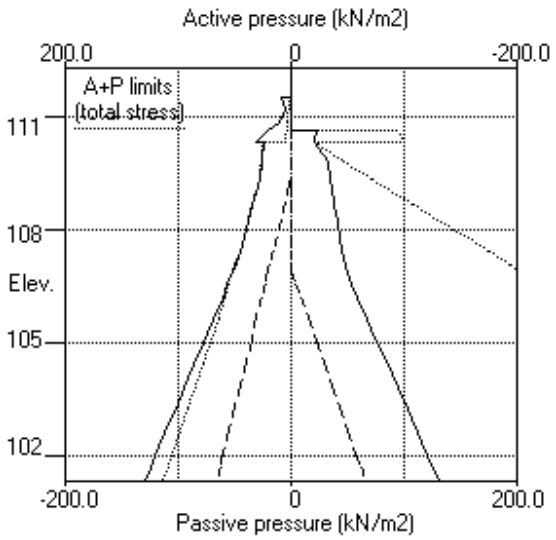
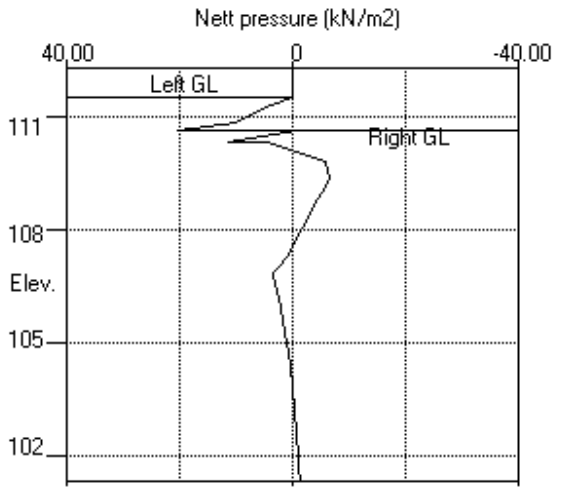
Stage No.7 Apply water pressure profile no.1 (Mod. Conserv.)





Stage No.7 Apply water pressure profile no.1 (Mod. Conserv.)





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Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 8-06-2025
No.8 Grange Road Side | Checked :

Units: kN,m

Stage No. 8 Excavate to elevation 108.65 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
8	111.52	108.65	110.84	2.431	n/a	106.78	1.87	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 20.00m 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 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	112.30	0.00	0.001	-1.95E-03	0.0	0.0		70350
2	111.91	0.00	0.002	-1.95E-03	0.0	0.1		70350
3	111.52	0.00	0.002	-1.96E-03	0.0	0.1		70350
		47.16	0.002	-1.96E-03	0.0	0.1		
4	111.18	25.00	0.003	-1.97E-03	12.3	3.0		70350
5	110.84	10.12	0.004	-2.03E-03	18.2	9.2	-76.6	70350
		10.12	0.004	-2.03E-03	-58.4	9.2		
6	110.65	19.07	0.004	-2.06E-03	-55.5	-1.9		70350
7	110.30	27.27	0.005	-2.05E-03	-47.5	-19.8		70350
		24.38	0.005	-2.05E-03	-47.5	-19.8		
8	109.82	26.95	0.006	-1.91E-03	-35.2	-39.1		70350
9	109.34	28.40	0.007	-1.66E-03	-21.9	-52.9		70350
10	109.15	30.05	0.007	-1.53E-03	-16.4	-56.6		70350
11	108.65	34.49	0.008	-1.16E-03	-0.1	-60.9		70350
12	108.21	14.84	0.008	-8.28E-04	10.7	-58.2		70350
13	107.77	-0.74	0.008	-5.07E-04	13.8	-51.9		70350
14	107.42	0.05	0.009	-2.71E-04	13.7	-47.1		70350
15	107.07	1.06	0.009	-5.31E-05	13.9	-42.2		70350
16	106.87	1.73	0.009	6.29E-05	14.2	-39.4		70350
17	106.54	0.45	0.009	2.42E-04	14.5	-34.5		70350
18	106.20	-0.67	0.009	4.02E-04	14.5	-29.7		70350
19	105.60	-2.35	0.008	6.37E-04	13.6	-21.3		70350
20	105.00	-3.68	0.008	8.09E-04	11.8	-13.8		70350
21	104.40	-4.77	0.007	9.22E-04	9.2	-7.6		70350
22	103.80	-5.69	0.007	9.88E-04	6.1	-3.1		70350
23	103.20	-4.95	0.006	1.01E-03	2.9	-0.1		70350
24	102.60	-2.75	0.005	1.02E-03	0.6	0.6		70350
25	102.00	-0.65	0.005	1.02E-03	-0.4	0.4		70350
26	101.65	0.59	0.004	1.02E-03	-0.4	0.1		70350

(continued)

Stage No.8 Excavate to elevation 108.65 on RIGHT side

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
27	101.30	1.85	0.004	1.02E-03	0.0	0.0		---

At elev. 110.84 Prop force = 76.6 kN/m run

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	47.16	47.16	22497
4	111.18	Total>	20.22	1.70m	111.08	25.00	25.00	22540
5	110.84	Total>	49.88	3.40m	141.61	10.12	10.12	2828
6	110.65	Total>	61.18	4.38m	153.41	19.07	19.07	2831
7	110.30	Total>	73.22	6.10m	166.34	27.27	27.27	2837
		0.00	73.22	24.38	219.65	24.38	24.38a	2563
8	109.82	0.00	80.93	26.95	242.80	26.95	26.95a	2569
9	109.34	0.00	85.27	28.40	255.81	28.40	28.40a	2574
10	109.15	1.56	85.58	28.50	256.75	28.50	30.05a	2576
11	108.65	5.69	86.50	28.81	259.51	28.81	34.49a	2582
12	108.21	9.27	87.69	29.20	263.07	29.20	38.47a	2587
13	107.77	12.85	89.32	29.75	267.97	29.75	42.60a	2593
14	107.42	15.72	90.95	30.28	272.84	30.28	46.00a	2597
15	107.07	18.58	92.82	30.91	278.46	30.91	49.49a	2601
16	106.87	20.22	94.00	31.30	281.99	31.30	51.52a	2603
17	106.54	22.96	96.13	32.01	288.38	32.01	54.97a	2607
18	106.20	25.70	98.43	32.78	295.29	32.78	58.48a	2611
19	105.60	30.61	102.95	34.28	308.85	34.28	64.89a	2618
20	105.00	35.52	107.89	35.93	323.67	35.93	71.45a	2625
21	104.40	40.43	113.18	37.69	339.53	37.69	78.12a	2632
22	103.80	45.35	118.75	39.54	356.24	39.54	84.89a	2639
23	103.20	50.26	124.56	41.48	373.67	43.03	93.29	2646
24	102.60	55.17	130.56	43.48	391.69	47.99	103.15	2653
25	102.00	60.08	136.74	45.53	410.21	52.93	113.01	2660
26	101.65	62.94	140.40	46.75	421.21	55.84	118.79	2664
27	101.30	65.81	144.11	47.99	432.33	58.77	124.58	2668

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.82	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	109.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	2791
12	108.21	0.00	7.88	2.62	23.63	23.63	23.63p	2797

(continued)

Stage No.8 Excavate to elevation 108.65 on RIGHT side

		RIGHT 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
13	107.77	0.00	15.75	5.25	47.26	43.33	43.33	2802
14	107.42	0.00	22.06	7.34	66.17	45.95	45.95	2807
15	107.07	0.00	28.36	9.45	85.09	48.43	48.43	2811
16	106.87	0.00	31.97	10.65	95.91	49.79	49.79	2814
17	106.54	3.96	34.73	11.56	104.18	50.56	54.52	2818
18	106.20	7.92	37.49	12.48	112.46	51.24	59.15	2822
19	105.60	15.00	42.44	14.13	127.33	52.24	67.24	2830
20	105.00	22.09	47.43	15.79	142.28	53.04	75.14	2837
21	104.40	29.18	52.43	17.46	157.29	53.71	82.89	2845
22	103.80	36.27	57.46	19.14	172.39	54.31	90.58	2852
23	103.20	43.36	62.53	20.82	187.58	54.88	98.24	2860
24	102.60	50.45	67.62	22.52	202.87	55.46	105.91	2867
25	102.00	57.54	72.75	24.23	218.25	56.12	113.66	2875
26	101.65	61.67	75.76	25.23	227.27	56.52	118.19	2879
27	101.30	65.81	78.78	26.23	236.33	56.92	122.73	2884

Note: 84.89 a Soil pressure at active limit
23.63 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
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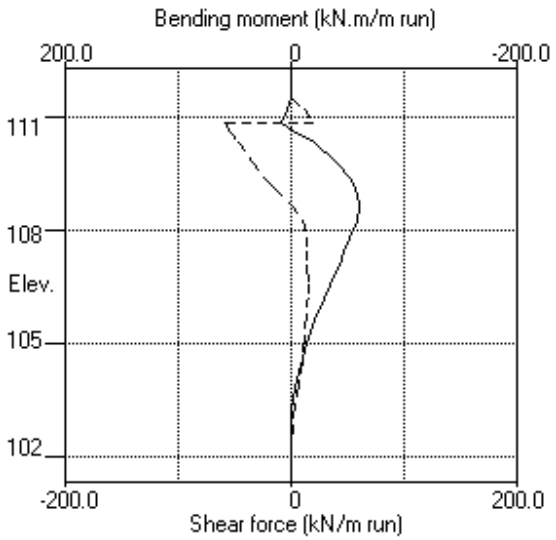
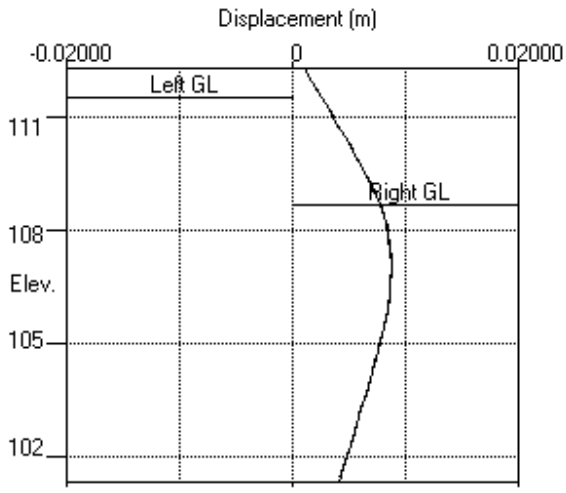
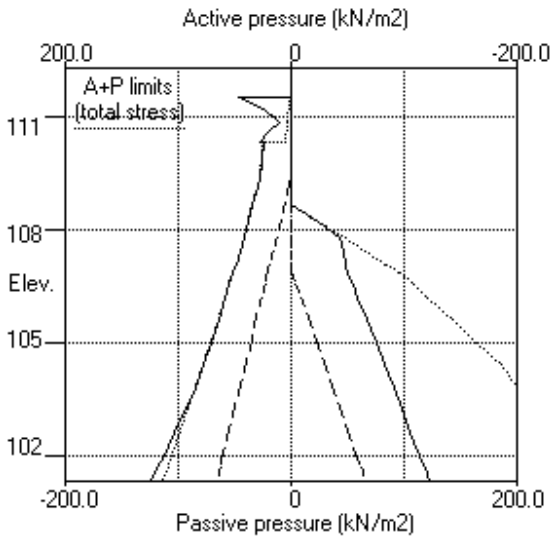
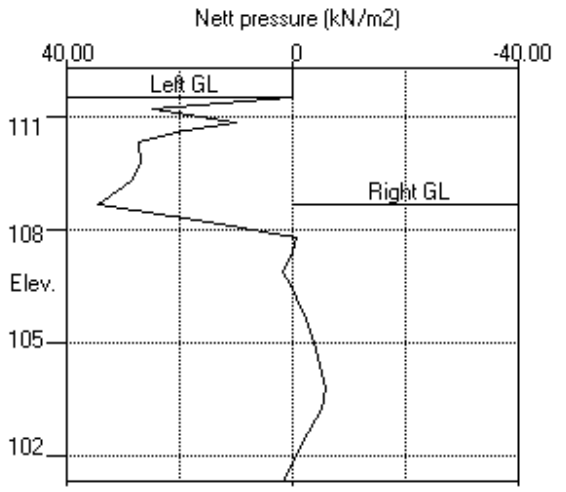
Stage No.8 Excav. to elev. 108.65 on RIGHT side





Stage No.8 Excav. to elev. 108.65 on RIGHT side





CREATE CONSULTING ENGINEERS LTD | Sheet No.
Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 8-06-2025
No.8 Grange Road Side | Checked :

Units: kN,m

Stage No. 10 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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
10	111.52	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 20.00m 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 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	112.30	0.00	-0.000	-2.92E-03	0.0	0.0		70350
2	111.91	0.00	0.001	-2.92E-03	0.0	0.1		70350
3	111.52	0.00	0.002	-2.92E-03	0.0	0.1		70350
		61.88	0.002	-2.92E-03	0.0	0.1		
4	111.18	32.52	0.003	-2.95E-03	16.0	3.9		70350
5	110.84	10.38	0.004	-3.01E-03	23.3	11.8	-50.2	70350
		10.38	0.004	-3.01E-03	-26.9	11.8		
6	110.65	18.54	0.004	-3.05E-03	-24.0	6.8		70350
7	110.30	25.67	0.005	-3.12E-03	-16.4	-0.3		70350
		24.38	0.005	-3.12E-03	-16.4	-0.3		
8	109.82	26.95	0.007	-3.16E-03	-4.1	-4.6		70350
9	109.34	28.40	0.009	-3.20E-03	9.2	-3.5		70350
10	109.15	30.05	0.009	-3.21E-03	14.7	-1.3	-102.7	70350
		30.05	0.009	-3.21E-03	-88.0	-1.3		
11	108.65	34.49	0.011	-3.11E-03	-71.7	-41.7		70350
12	108.21	38.47	0.012	-2.79E-03	-55.7	-69.7		70350
13	107.77	42.60	0.013	-2.32E-03	-38.0	-89.6		70350
14	107.42	46.00	0.014	-1.86E-03	-22.5	-100.2		70350
15	107.07	49.49	0.014	-1.35E-03	-5.8	-105.1		70350
16	106.87	40.72	0.015	-1.05E-03	3.2	-105.3		70350
17	106.54	31.98	0.015	-5.57E-04	15.4	-102.1		70350
18	106.20	23.30	0.015	-8.02E-05	24.7	-95.3		70350
19	105.60	7.85	0.015	6.74E-04	34.0	-77.3		70350
20	105.00	-7.50	0.014	1.26E-03	34.1	-56.6		70350
21	104.40	-12.14	0.013	1.68E-03	28.2	-36.7		70350
22	103.80	-11.42	0.012	1.95E-03	21.2	-22.2		70350
23	103.20	-10.28	0.011	2.11E-03	14.6	-11.2		70350
24	102.60	-8.87	0.010	2.19E-03	8.9	-4.6		70350
25	102.00	-7.39	0.008	2.22E-03	4.0	-1.2		70350

(continued)

Stage No.10 Excavate to elevation 107.07 on RIGHT side

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
26	101.65	-6.46	0.008	2.22E-03	1.6	-0.1		70350
27	101.30	-2.68	0.007	2.22E-03	0.0	-0.0		---

At elev. 110.84 Prop force = 50.2 kN/m run
At elev. 109.15 Prop force = 102.7 kN/m run

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	61.88	61.88	21875
4	111.18	Total>	20.22	1.70m	111.08	32.52	32.52	21917
5	110.84	Total>	49.88	3.40m	141.61	10.38	10.38	21960
6	110.65	Total>	61.18	4.38m	153.41	18.54	18.54	2983
7	110.30	Total>	73.22	6.10m	166.34	25.67	25.67	2989
		0.00	73.22	24.38	219.65	24.38	24.38a	2722
8	109.82	0.00	80.93	26.95	242.80	26.95	26.95a	2728
9	109.34	0.00	85.27	28.40	255.81	28.40	28.40a	2734
10	109.15	1.56	85.58	28.50	256.75	28.50	30.05a	2737
11	108.65	5.69	86.50	28.81	259.51	28.81	34.49a	2743
12	108.21	9.27	87.69	29.20	263.07	29.20	38.47a	2748
13	107.77	12.85	89.32	29.75	267.97	29.75	42.60a	2754
14	107.42	15.72	90.95	30.28	272.84	30.28	46.00a	2758
15	107.07	18.58	92.82	30.91	278.46	30.91	49.49a	2762
16	106.87	20.22	94.00	31.30	281.99	31.30	51.52a	2765
17	106.54	22.96	96.13	32.01	288.38	32.01	54.97a	2769
18	106.20	25.70	98.43	32.78	295.29	32.78	58.48a	2773
19	105.60	30.61	102.95	34.28	308.85	34.28	64.89a	2780
20	105.00	35.52	107.89	35.93	323.67	35.93	71.45a	2788
21	104.40	40.43	113.18	37.69	339.53	37.69	78.12a	2795
22	103.80	45.35	118.75	39.54	356.24	39.54	84.89a	2803
23	103.20	50.26	124.56	41.48	373.67	41.48	91.73a	2810
24	102.60	55.17	130.56	43.48	391.69	43.48	98.65a	2818
25	102.00	60.08	136.74	45.53	410.21	45.53	105.61a	2825
26	101.65	62.94	140.40	46.75	421.21	46.80	109.74	2829
27	101.30	65.81	144.11	47.99	432.33	50.91	116.72	2834

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.82	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	109.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

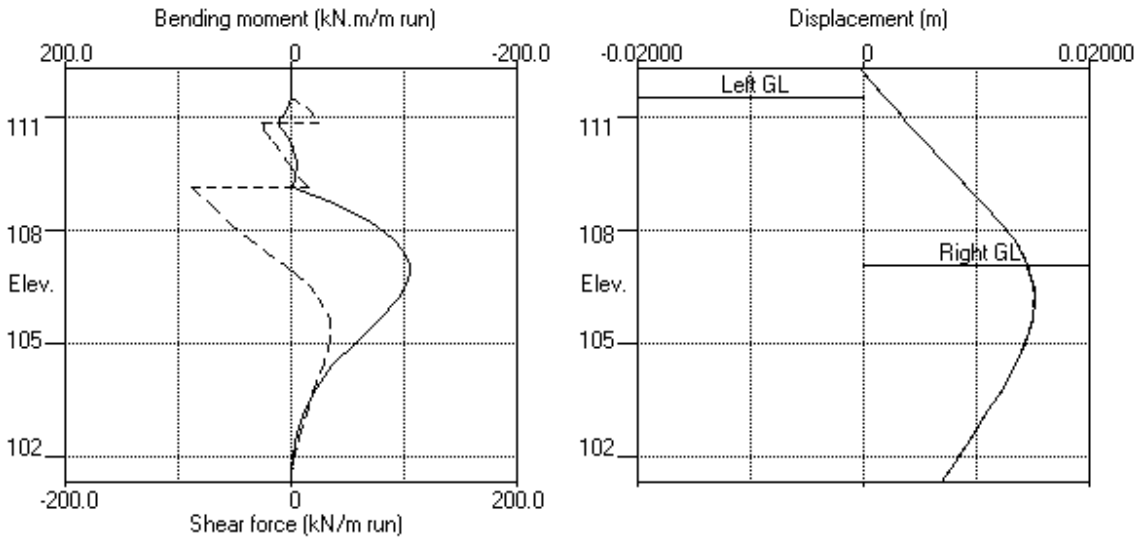
Stage No.10 Excavate to elevation 107.07 on RIGHT side

		RIGHT 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
12	108.21	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	107.77	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	107.42	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	3142
16	106.87	0.00	3.60	1.20	10.80	10.80	10.80p	3145
17	106.54	3.96	6.34	2.11	19.03	19.03	22.99p	3150
18	106.20	7.92	9.09	3.03	27.26	27.26	35.18p	3154
19	105.60	15.00	14.01	4.67	42.04	42.04	57.04p	3163
20	105.00	22.09	18.95	6.31	56.86	56.86	78.95p	3171
21	104.40	29.18	23.92	7.96	71.75	61.08	90.27	3180
22	103.80	36.27	28.91	9.63	86.72	60.04	96.31	3188
23	103.20	43.36	33.93	11.30	101.80	58.65	102.01	3197
24	102.60	50.45	39.00	12.99	116.99	57.06	107.51	3205
25	102.00	57.54	44.10	14.69	132.31	55.47	113.00	3214
26	101.65	61.67	47.10	15.68	141.30	54.53	116.20	3218
27	101.30	65.81	50.12	16.69	150.35	53.58	119.39	3223

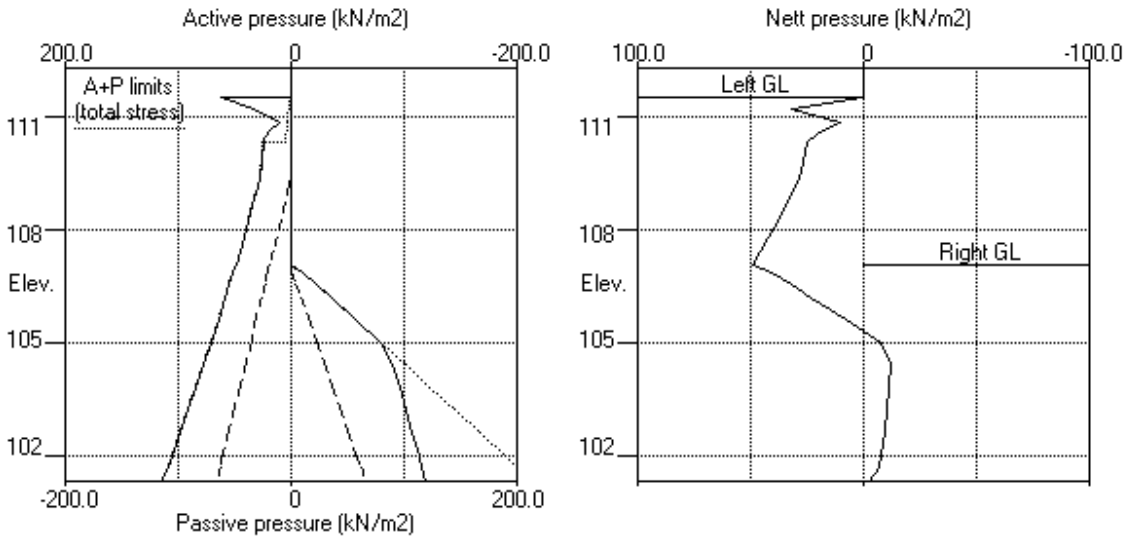
Note: 105.61 a Soil pressure at active limit
78.95 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
```

Stage No.10 Excav. to elev. 107.07 on RIGHT side



Stage No.10 Excav. to elev. 107.07 on RIGHT side



Units: kN,m

Stage No. 12 Remove strut or anchor no.2 at elevation 109.15

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
12	111.52	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 20.00m 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 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	112.30	0.00	-0.001	-3.53E-03	0.0	0.0		70350
2	111.91	0.00	0.000	-3.53E-03	0.0	0.1		70350
3	111.52	0.00	0.001	-3.53E-03	0.0	0.1		70350
		70.96	0.001	-3.53E-03	0.0	0.1		
4	111.18	36.88	0.003	-3.55E-03	18.3	4.4		70350
5	110.84	10.27	0.004	-3.62E-03	26.3	13.3	-90.9	70350
		10.27	0.004	-3.62E-03	-64.5	13.3		
6	110.65	17.71	0.005	-3.66E-03	-61.8	1.0		70350
7	110.30	23.62	0.006	-3.66E-03	-54.7	-19.2		70350
		24.38	0.006	-3.66E-03	-54.7	-19.2		
8	109.82	26.95	0.008	-3.52E-03	-42.3	-41.9		70350
9	109.34	28.40	0.009	-3.23E-03	-29.1	-59.1		70350
10	109.15	30.05	0.010	-3.09E-03	-23.5	-64.1		70350
11	108.65	34.49	0.011	-2.65E-03	-7.2	-72.0		70350
12	108.21	38.47	0.012	-2.23E-03	8.8	-71.8		70350
13	107.77	42.60	0.013	-1.84E-03	26.5	-63.4	-74.5	70350
		42.60	0.013	-1.84E-03	-48.0	-63.4		
14	107.42	46.43	0.014	-1.49E-03	-32.4	-77.5		70350
15	107.07	50.32	0.014	-1.09E-03	-15.5	-85.8		70350
16	106.87	42.74	0.014	-8.50E-04	-6.2	-88.0		70350
17	106.54	34.42	0.015	-4.28E-04	6.8	-87.8		70350
18	106.20	25.99	0.015	-1.29E-05	16.9	-83.7		70350
19	105.60	10.66	0.015	6.60E-04	27.9	-70.0		70350
20	105.00	-4.87	0.014	1.20E-03	29.6	-52.4		70350
21	104.40	-9.86	0.013	1.59E-03	25.2	-34.8		70350
22	103.80	-9.57	0.012	1.85E-03	19.4	-21.7		70350
23	103.20	-8.89	0.011	2.01E-03	13.8	-11.4		70350
24	102.60	-7.94	0.010	2.09E-03	8.8	-5.0		70350
25	102.00	-6.91	0.008	2.12E-03	4.3	-1.5		70350

(continued)

Stage No.12 Remove strut or anchor no.2 at elevation 109.15

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
26	101.65	-6.23	0.008	2.13E-03	2.0	-0.3		70350
27	101.30	-5.38	0.007	2.13E-03	0.0	-0.0		---

At elev. 110.84 Prop force = 90.9 kN/m run
At elev. 107.77 Prop force = 74.5 kN/m run

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	70.96	70.96	22979
4	111.18	Total>	20.22	1.70m	111.08	36.88	36.88	23024
5	110.84	Total>	49.88	3.40m	141.61	10.27	10.27	6043
6	110.65	Total>	61.18	4.38m	153.41	17.71	17.71	6050
7	110.30	Total>	73.22	6.10m	166.34	23.62	23.62	6062
		0.00	73.22	24.38	219.65	24.38	24.38a	5809
8	109.82	0.00	80.93	26.95	242.80	26.95	26.95a	5822
9	109.34	0.00	85.27	28.40	255.81	28.40	28.40a	5834
10	109.15	1.56	85.58	28.50	256.75	28.50	30.05a	5839
11	108.65	5.69	86.50	28.81	259.51	28.81	34.49a	5853
12	108.21	9.27	87.69	29.20	263.07	29.20	38.47a	5864
13	107.77	12.85	89.32	29.75	267.97	29.75	42.60a	5876
14	107.42	15.72	90.95	30.28	272.84	30.71	46.43	3734
15	107.07	18.58	92.82	30.91	278.46	31.74	50.32	3740
16	106.87	20.22	94.00	31.30	281.99	32.30	52.52	3743
17	106.54	22.96	96.13	32.01	288.38	33.22	56.18	3749
18	106.20	25.70	98.43	32.78	295.29	34.11	59.81	3755
19	105.60	30.61	102.95	34.28	308.85	35.67	66.28	3765
20	105.00	35.52	107.89	35.93	323.67	37.23	72.75	3775
21	104.40	40.43	113.18	37.69	339.53	38.82	79.25	3785
22	103.80	45.35	118.75	39.54	356.24	40.46	85.81	3795
23	103.20	50.26	124.56	41.48	373.67	42.17	92.42	3805
24	102.60	55.17	130.56	43.48	391.69	43.94	99.11	3815
25	102.00	60.08	136.74	45.53	410.21	45.77	105.85	3825
26	101.65	62.94	140.40	46.75	421.21	46.91	109.85	3831
27	101.30	65.81	144.11	47.99	432.33	49.56	115.37	320898

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.82	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	109.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.12 Remove strut or anchor no.2 at elevation 109.15

		RIGHT 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
12	108.21	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	107.77	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	107.42	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	3811
16	106.87	0.00	3.60	1.20	10.80	9.78	9.78	3815
17	106.54	3.96	6.34	2.11	19.03	17.80	21.75	3821
18	106.20	7.92	9.09	3.03	27.26	25.90	33.82	3826
19	105.60	15.00	14.01	4.67	42.04	40.62	55.62	3837
20	105.00	22.09	18.95	6.31	56.86	55.53	77.62	3847
21	104.40	29.18	23.92	7.96	71.75	59.93	89.11	3857
22	103.80	36.27	28.91	9.63	86.72	59.11	95.38	3867
23	103.20	43.36	33.93	11.30	101.80	57.95	101.31	3877
24	102.60	50.45	39.00	12.99	116.99	56.59	107.04	3888
25	102.00	57.54	44.10	14.69	132.31	55.22	112.76	3898
26	101.65	61.67	47.10	15.68	141.30	54.41	116.09	3904
27	101.30	65.81	50.12	16.69	150.35	54.94	120.74	320898

Note: 42.60 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

```
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Program: WALLAP  Version 6.09  Revision A59.B77.R60          | Job No.    2546
                              Licensed from GEOSOLVE         | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605          |
6a Grange Road Secant Wall                                   | Date: 8-06-2025
No.8 Grange Road Side                                        | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
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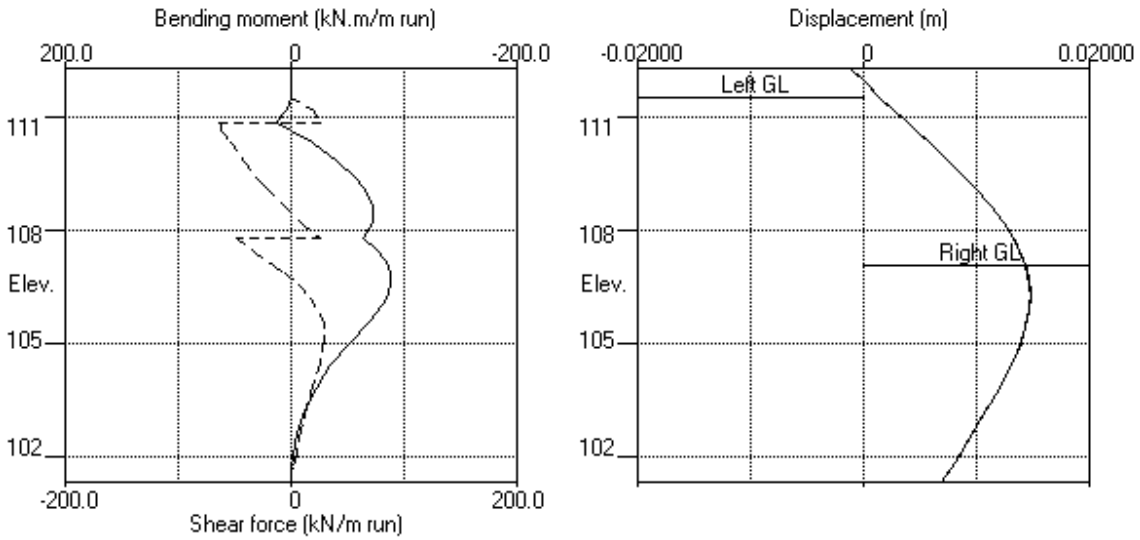
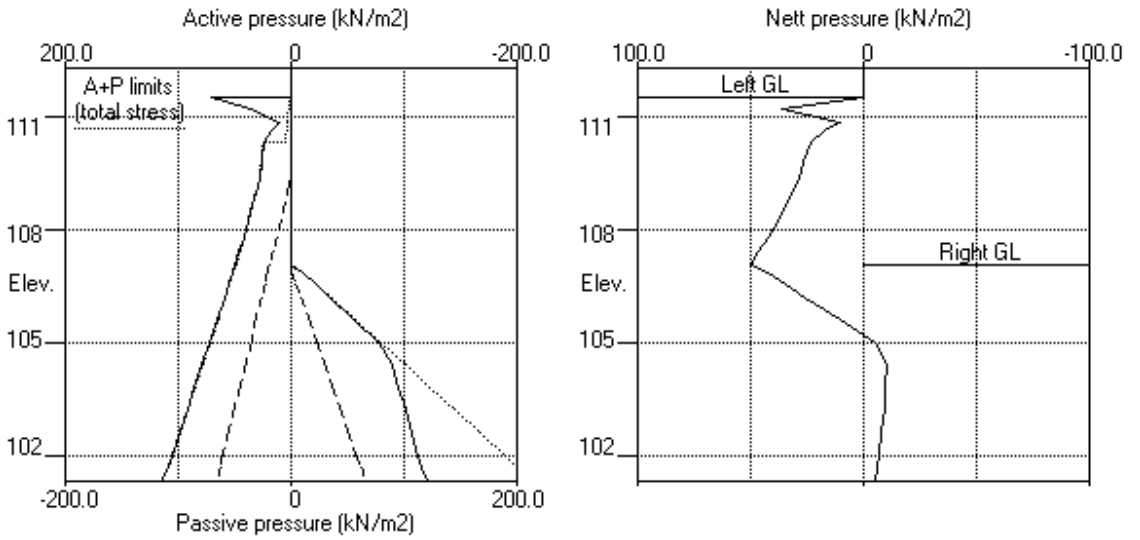
Stage No.12 Remove prop no.2 at elev. 109.15



Stage No.12 Remove prop no.2 at elev. 109.15



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CREATE CONSULTING ENGINEERS LTD                              | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60          | Job No.    2546
                              Licensed from GEOSOLVE         | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605          |
6a Grange Road Secant Wall                                   | Date: 8-06-2025
No.8 Grange Road Side                                        | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
Stage No. 13   Change EI of wall to 50250 kN.m2/m run
              Allow wall to relax with new modulus value
```

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
13	111.52	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 20.00m 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 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	112.30	0.00	-0.001	-3.47E-03	0.0	0.0		50250
2	111.91	0.00	0.000	-3.47E-03	0.0	0.1		50250
3	111.52	0.00	0.001	-3.47E-03	0.0	0.4		50250
		70.21	0.001	-3.47E-03	0.0	0.4		
4	111.18	36.63	0.003	-3.51E-03	18.2	5.1		50250
5	110.84	10.33	0.004	-3.60E-03	26.1	14.7	-82.4	50250
		10.33	0.004	-3.60E-03	-56.3	14.7		
6	110.65	17.80	0.005	-3.66E-03	-53.5	4.0		50250
7	110.30	23.67	0.006	-3.68E-03	-46.4	-13.6		50250
		24.42	0.006	-3.68E-03	-46.4	-13.6		
8	109.82	26.95	0.008	-3.54E-03	-34.1	-33.3		50250
9	109.34	28.40	0.009	-3.24E-03	-20.8	-47.7		50250
10	109.15	30.05	0.010	-3.09E-03	-15.2	-51.6		50250
11	108.65	34.49	0.011	-2.63E-03	1.1	-56.7		50250
12	108.21	38.47	0.012	-2.22E-03	17.0	-54.0		50250
13	107.77	42.60	0.013	-1.87E-03	34.8	-43.1	-86.1	50250
		42.60	0.013	-1.87E-03	-51.4	-43.1		
14	107.42	46.28	0.014	-1.56E-03	-35.8	-58.5		50250
15	107.07	50.03	0.014	-1.16E-03	-19.0	-68.0		50250
16	106.87	41.99	0.015	-9.13E-04	-9.8	-70.8		50250
17	106.54	33.48	0.015	-4.66E-04	2.9	-71.7		50250
18	106.20	24.95	0.015	-2.02E-05	12.7	-68.9		50250
19	105.60	9.76	0.015	7.05E-04	23.1	-57.4		50250
20	105.00	-5.33	0.014	1.28E-03	24.4	-42.2		50250
21	104.40	-9.70	0.013	1.68E-03	19.9	-27.1		50250
22	103.80	-8.74	0.012	1.94E-03	14.4	-16.3		50250
23	103.20	-7.43	0.011	2.09E-03	9.5	-8.1		50250
24	102.60	-5.94	0.010	2.16E-03	5.5	-3.4		50250

(continued)

Stage No.13 Change EI of wall to 50250 kN.m2/m run
Allow wall to relax with new modulus value

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
25	102.00	-4.43	0.008	2.18E-03	2.4	-1.0		50250
26	101.65	-3.47	0.007	2.19E-03	1.0	-0.2		50250
27	101.30	-2.34	0.007	2.19E-03	0.0	-0.0		---

At elev. 110.84 Prop force = 82.4 kN/m run
At elev. 107.77 Prop force = 86.1 kN/m run

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	70.21	70.21	28314
4	111.18	Total>	20.22	1.70m	111.08	36.63	36.63	28369
5	110.84	Total>	49.88	3.40m	141.61	10.33	10.33	15702
6	110.65	Total>	61.18	4.38m	153.41	17.80	17.80	15720
7	110.30	Total>	73.22	6.10m	166.34	23.67	23.67	15751
		0.00	73.22	24.38	219.65	24.42	24.42	15472
8	109.82	0.00	80.93	26.95	242.80	26.95	26.95a	5682
9	109.34	0.00	85.27	28.40	255.81	28.40	28.40a	5695
10	109.15	1.56	85.58	28.50	256.75	28.50	30.05a	5699
11	108.65	5.69	86.50	28.81	259.51	28.81	34.49a	5712
12	108.21	9.27	87.69	29.20	263.07	29.20	38.47a	5724
13	107.77	12.85	89.32	29.75	267.97	29.75	42.60a	5735
14	107.42	15.72	90.95	30.28	272.84	30.57	46.28	5744
15	107.07	18.58	92.82	30.91	278.46	31.45	50.03	5753
16	106.87	20.22	94.00	31.30	281.99	31.93	52.15	5758
17	106.54	22.96	96.13	32.01	288.38	32.75	55.71	5767
18	106.20	25.70	98.43	32.78	295.29	33.60	59.30	5776
19	105.60	30.61	102.95	34.28	308.85	35.23	65.84	5791
20	105.00	35.52	107.89	35.93	323.67	37.00	72.53	5806
21	104.40	40.43	113.18	37.69	339.53	38.90	79.33	6286
22	103.80	45.35	118.75	39.54	356.24	40.88	86.22	6303
23	103.20	50.26	124.56	41.48	373.67	42.89	93.15	6320
24	102.60	55.17	130.56	43.48	391.69	44.94	100.10	6337
25	102.00	60.08	136.74	45.53	410.21	47.01	107.09	6353
26	101.65	62.94	140.40	46.75	421.21	48.29	111.23	6363
27	101.30	65.81	144.11	47.99	432.33	51.07	116.88	6373

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.82	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

(continued)

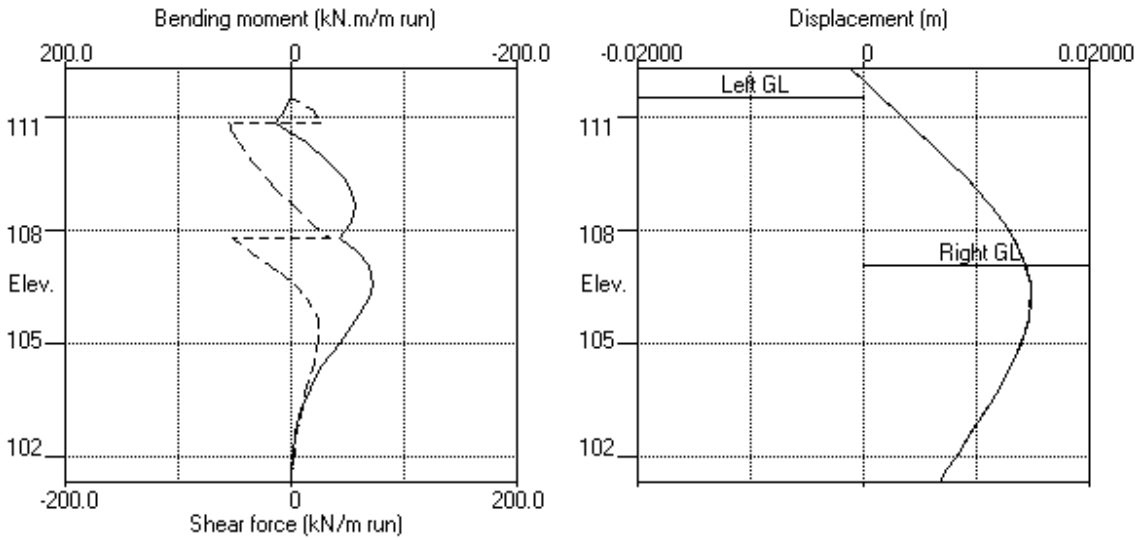
Stage No.13 Change EI of wall to 50250 kN.m2/m run
Allow wall to relax with new modulus value

		RIGHT 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
10	109.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	108.21	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	107.77	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	107.42	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	5911
16	106.87	0.00	3.60	1.20	10.80	10.16	10.16	5916
17	106.54	3.96	6.34	2.11	19.03	18.28	22.23	5925
18	106.20	7.92	9.09	3.03	27.26	26.43	34.35	5934
19	105.60	15.00	14.01	4.67	42.04	41.08	56.08	5949
20	105.00	22.09	18.95	6.31	56.86	55.76	77.86	5965
21	104.40	29.18	23.92	7.96	71.75	59.85	89.03	6286
22	103.80	36.27	28.91	9.63	86.72	58.69	94.96	6303
23	103.20	43.36	33.93	11.30	101.80	57.22	100.58	6320
24	102.60	50.45	39.00	12.99	116.99	55.60	106.04	6337
25	102.00	57.54	44.10	14.69	132.31	53.98	111.52	6353
26	101.65	61.67	47.10	15.68	141.30	53.03	114.71	6363
27	101.30	65.81	50.12	16.69	150.35	53.42	119.23	6373

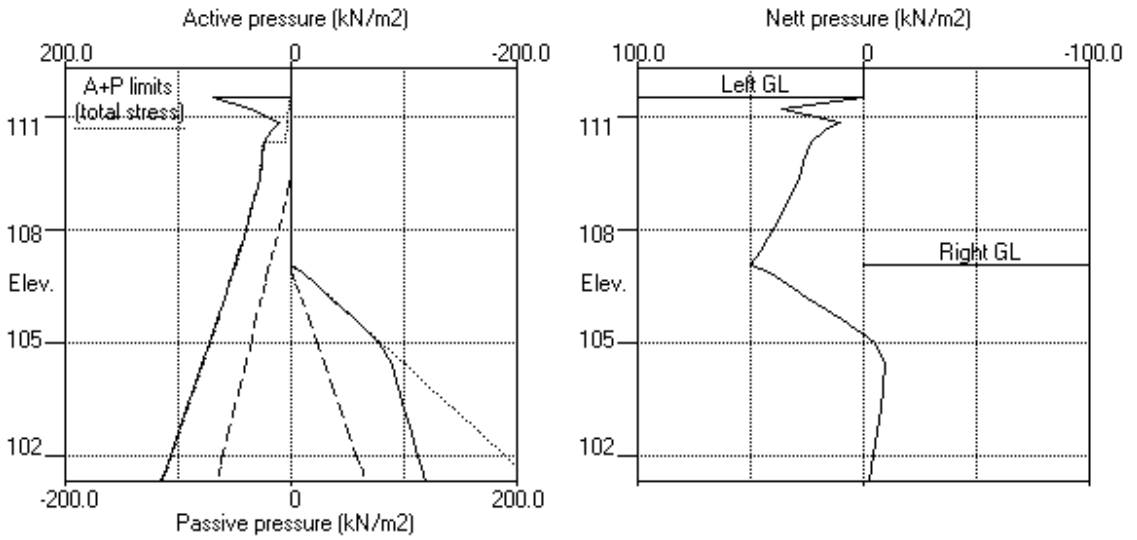
Note: 42.60 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
```

Stage No.13 Change EI of wall to 50250kN.m2/m run



Stage No.13 Change EI of wall to 50250kN.m2/m run



Units: kN,m

Summary of results

LIMIT STATE PARAMETERS

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

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr -ation	Direction of failure
1	112.30	112.30	Cant.	Conditions not suitable for FoS calc.				
2	112.30	112.30	Cant.	Conditions not suitable for FoS calc.				
3	111.52	112.30	Cant.	Conditions not suitable for FoS calc.				
4	111.52	112.30		No analysis at this stage				
5	111.52	110.65	Cant.	2.686	102.44	110.59	0.05	L to R
6	111.52	110.65		No analysis at this stage				
7	111.52	110.65	110.84	Conditions not suitable for FoS calc.				
8	111.52	108.65	110.84	2.431	n/a	106.78	1.87	L to R
9	111.52	108.65		No analysis at this stage				

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

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

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 20.00m 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	kN/m	kN/m
1	112.30	0.006	-0.001	0	-0	0	-0	0	0	0	0
2	111.91	0.005	0.000	0	-0	0	-0	0	-2	0	-2
3	111.52	0.005	0.000	0	-1	0	-2	0	-5	0	-7
4	111.18	0.004	0.000	5	-4	7	-5	18	-10	25	-13
5	110.84	0.004	0.000	15	-7	20	-10	26	-65	36	-87
6	110.65	0.005	0.000	7	-9	9	-12	5	-62	7	-83
7	110.30	0.006	0.000	4	-20	5	-27	8	-55	10	-74
8	109.82	0.008	0.000	8	-42	11	-57	8	-42	10	-57
9	109.34	0.009	0.000	11	-59	15	-80	9	-29	12	-39
10	109.15	0.010	0.000	12	-64	16	-87	15	-88	20	-119
11	108.65	0.011	0.000	14	-72	19	-97	4	-72	6	-97
12	108.21	0.012	0.000	15	-72	20	-97	17	-56	23	-75
13	107.77	0.013	0.000	15	-90	20	-121	35	-51	47	-69
14	107.42	0.014	0.000	14	-100	19	-135	14	-36	18	-48
15	107.07	0.014	0.000	13	-105	18	-142	14	-19	19	-26
16	106.87	0.015	0.000	13	-105	17	-142	14	-10	19	-13
17	106.54	0.015	0.000	11	-102	15	-138	15	-3	21	-5
18	106.20	0.015	0.000	10	-95	14	-129	25	-3	33	-5
19	105.60	0.015	0.000	8	-77	11	-104	34	-3	46	-5
20	105.00	0.014	0.000	6	-57	8	-76	34	-3	46	-4
21	104.40	0.013	0.000	4	-37	6	-50	28	-3	38	-4
22	103.80	0.012	0.000	3	-22	4	-30	21	-2	29	-3
23	103.20	0.011	0.000	2	-11	3	-15	15	-2	20	-2
24	102.60	0.010	0.000	1	-5	2	-7	9	-1	12	-2
25	102.00	0.008	0.000	0	-2	1	-2	4	-1	6	-1
26	101.65	0.008	0.000	0	-0	0	-0	2	-1	3	-1
27	101.30	0.007	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 Calculated max. kN.m/m	elev.	min. kN.m/m	elev.	Bending moment Factored max. kN.m/m	min.	Shear force Calculated max. kN/m	elev.	min. kN/m	elev.	Shear force Factored max. kN/m	min. kN/m
1	5	105.60	-9	110.30	6	-12	4	108.65	-10	111.18	6	-13
2	4	105.60	-9	110.30	5	-12	4	108.65	-9	111.18	6	-12
3	3	105.00	-10	110.30	4	-13	4	108.21	-9	110.84	5	-13
4	No calculation at this stage											
5	15	107.77	-0	112.30	20	-0	8	109.82	-3	106.20	10	-5
6	No calculation at this stage											
7	7	109.15	-3	105.60	10	-4	5	110.84	-5	107.42	7	-6
8	9	110.84	-61	108.65	12	-82	18	110.84	-58	110.84	25	-79
9	No calculation at this stage											
10	12	110.84	-105	106.87	16	-142	34	105.00	-88	109.15	46	-119
11	No calculation at this stage											
12	13	110.84	-88	106.87	18	-119	30	105.00	-65	110.84	40	-87
13	15	110.84	-72	106.54	20	-97	35	107.77	-56	110.84	47	-76

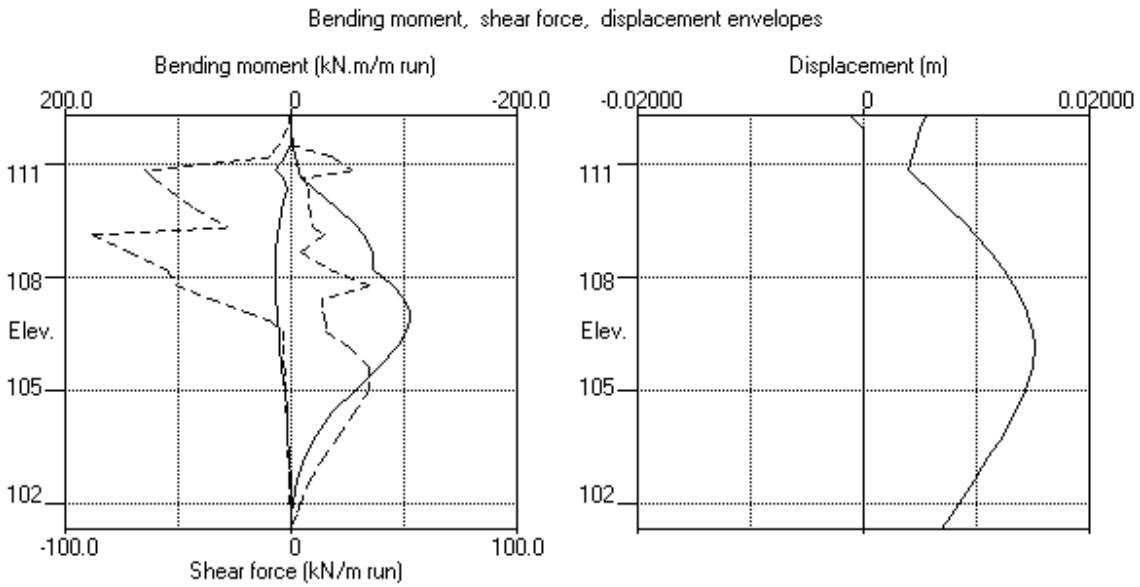
Maximum and minimum displacement at each stage

Stage no.	maximum m	elev.	minimum m	elev.	Stage description
1	0.004	112.30	0.000	112.30	Apply surcharge no.1 at elev. 111.52
2	0.004	112.30	0.000	112.30	Change EI of wall to 70350kN.m2/m run
3	0.002	111.18	-0.001	101.30	Excav. to elev. 111.52 on LEFT side
4	Wall displacements reset to zero				Change EI of wall to 70350kN.m2/m run
5	0.006	112.30	0.000	112.30	Excav. to elev. 110.65 on RIGHT side
6	No calculation at this stage				Install prop no.1 at elev. 110.84
7	0.005	112.30	0.000	112.30	Apply water pressure profile no.1
8	0.009	107.07	0.000	112.30	Excav. to elev. 108.65 on RIGHT side
9	No calculation at this stage				Install prop no.2 at elev. 109.15
10	0.015	106.20	-0.000	112.30	Excav. to elev. 107.07 on RIGHT side
11	No calculation at this stage				Install prop no.3 at elev. 107.77
12	0.015	106.20	-0.001	112.30	Remove prop no.2 at elev. 109.15
13	0.015	106.20	-0.001	112.30	Change EI of wall to 50250kN.m2/m run

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 1 at elev. 110.84 --Calculated-- kN per m run	kN per prop	Factored kN per prop	Prop no. 2 at elev. 109.15 --Calculated-- kN per m run	kN per prop	Factored kN per prop	Prop no. 3 at elev. 107.77 --Calculated-- kN per m run	kN per prop	Factored kN per prop
7	6	6	8	---	---	---	---	---	---
8	77	77	103	---	---	---	---	---	---
10	50	50	68	103	103	139	---	---	---
12	91	91	123	---	---	---	74	74	101
13	82	82	111	---	---	---	86	86	116

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 8GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 8-06-2025
No.8 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                          Units: kN,m
```



WALLAP output No.6 Grange Road

```
CREATE CONSULTING ENGINEERS LTD                              | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60          | Job No.    2546
                              Licensed from GEOSOLVE         | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605          |
6a Grange Road Secant Wall                                   | Date: 5-06-2025
No.6 Grange Road Side                                        | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
```

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types: Left side	Soil types: Right side
1	112.30	1 Made Ground	1 Made Ground
2	111.52	2 Claygate - cohesive	2 Claygate - cohesive
3	110.30	3 Claygate - granular	3 Claygate - granular

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Made Ground	18.00	10000	0.530	NC (0.490)	0.309 (1.279)	5.499 (6.937)	0.0d
2	Claygate .. (111.52)	19.00	17500 (100.0)	0.590	OC (0.490)	1.000 (2.000)	1.000 (2.571)	35.00u (1.000)
3	Claygate .. (110.30)	18.00a 20.00b	22000 (100.0)	0.500	OC (0.300)	0.333 (0.000)	3.000 (0.000)	

Note: (a) and (b) are Bulk Densities above and below the water table

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Made Ground	28.39	0.570	0.00	32.96	0.570	0.00
2	Claygate - cohesive	0.00	0.000	0.00	0.00	1.000	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. 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	109.34	109.34	0.0	1	106.87	106.87	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 = 3.0000E+07 kN/m2
           Moment of inertia of wall I = 3.3500E-03 m4/m run
                                 E.I = 100500 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	110.84	1.00	0.300000	3.000E+07	4.00	0.00	0	Strut	No	R
2	109.15	1.00	1.000000	50000	1.00	0.00	0	Strut	No	R
3	107.77	1.00	0.300000	3.000E+07	4.00	0.00	0	Strut	No	R

SURCHARGE LOADS

Surcharge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge(kN/m2) Near edge	Far edge	Surcharge Cat.	Soil type	Part fact.	Short Q reduc. fact.
1	111.52	0.60(L)	10.00	1.00	40.00	=	--	--	1.00U	--
2	111.52	2.94(L)	10.00	1.00	60.00	=	--	--	1.00F	--

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 111.52
2	Apply surcharge no.2 at elevation 111.52
3	Change EI of wall to 70350 kN.m2/m run Allow wall to relax with new modulus value
4	Excavate to elevation 111.52 on LEFT side
5	Change EI of wall to 70350 kN.m2/m run Reset wall displacements to zero at this stage
6	Excavate to elevation 110.65 on RIGHT side
7	Install strut or anchor no.1 at elevation 110.84
8	Apply water pressure profile no.1 (Mod. Conserv.)
9	Excavate to elevation 108.65 on RIGHT side
10	Install strut or anchor no.2 at elevation 109.15
11	Excavate to elevation 107.07 on RIGHT side
12	Install strut or anchor no.3 at elevation 107.77
13	Remove strut or anchor no.2 at elevation 109.15
14	Change EI of wall to 50250 kN.m2/m run Allow wall to relax with new modulus value

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) = 0 m

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

Width of excavation/fill on Left side of wall = 20.00 m
Width of excavation/fill 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	Apply surcharge no.1 at elev. 111.52	Yes	Yes	Yes
2	Apply surcharge no.2 at elev. 111.52	Yes	Yes	Yes
3	Change EI of wall to 70350kN.m2/m run	Yes	Yes	Yes
4	Excav. to elev. 111.52 on LEFT side	Yes	Yes	Yes
5	Change EI of wall to 70350kN.m2/m run	Yes	Yes	Yes
6	Excav. to elev. 110.65 on RIGHT side	Yes	Yes	Yes
7	Install prop no.1 at elev. 110.84	Yes	Yes	Yes
8	Apply water pressure profile no.1	Yes	Yes	Yes
9	Excav. to elev. 108.65 on RIGHT side	Yes	Yes	Yes
10	Install prop no.2 at elev. 109.15	Yes	Yes	Yes
11	Excav. to elev. 107.07 on RIGHT side	Yes	Yes	Yes
12	Install prop no.3 at elev. 107.77	Yes	Yes	Yes
13	Remove prop no.2 at elev. 109.15	Yes	Yes	Yes
14	Change EI of wall to 50250kN.m2/m run	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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CREATE CONSULTING ENGINEERS LTD | Sheet No.
Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 5-06-2025
No.6 Grange Road Side | Checked :

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 111.52

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	112.30	112.30	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 20.00m 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.

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	112.30	0.00	0.001	-3.00E-05	0.0	0.0		100500
2	111.91	-3.10	0.001	-3.00E-05	-0.6	-0.0		100500
3	111.52	-3.13	0.001	-2.91E-05	-1.8	-0.5		100500
		-5.48	0.001	-2.91E-05	-1.8	-0.5		
4	111.18	-3.58	0.001	-2.60E-05	-3.4	-1.4		100500
5	110.84	1.97	0.001	-1.92E-05	-3.6	-2.6		100500
6	110.65	4.73	0.001	-1.35E-05	-3.0	-3.3		100500
7	110.30	7.72	0.001	-1.21E-06	-0.8	-4.0		100500
		0.88	0.001	-1.21E-06	-0.8	-4.0		
8	109.82	1.43	0.001	1.83E-05	-0.3	-4.2		100500
9	109.34	1.28	0.001	3.84E-05	0.4	-4.2		100500
10	109.15	1.14	0.001	4.63E-05	0.6	-4.1		100500
11	108.65	0.72	0.001	6.58E-05	1.1	-3.7		100500
12	108.21	0.37	0.001	8.08E-05	1.3	-3.2		100500
13	107.77	0.08	0.001	9.32E-05	1.4	-2.6		100500
14	107.42	-0.10	0.001	1.01E-04	1.4	-2.1		100500
15	107.07	-0.25	0.001	1.07E-04	1.3	-1.6		100500
16	106.87	-0.32	0.001	1.10E-04	1.3	-1.3		100500
17	106.54	-0.40	0.001	1.14E-04	1.2	-0.9		100500
18	106.20	-0.46	0.001	1.16E-04	1.0	-0.6		100500
19	105.60	-0.50	0.001	1.18E-04	0.7	-0.1		100500
20	105.00	-0.48	0.001	1.18E-04	0.4	0.3		100500
21	104.40	-0.41	0.001	1.15E-04	0.2	0.4		100500
22	103.80	-0.30	0.000	1.13E-04	-0.0	0.5		100500
23	103.20	-0.17	0.000	1.10E-04	-0.2	0.4		100500
24	102.60	-0.02	0.000	1.08E-04	-0.2	0.2		100500
25	102.00	0.16	0.000	1.07E-04	-0.2	0.1		100500
26	101.65	0.27	0.000	1.07E-04	-0.1	0.0		100500
27	101.30	0.39	0.000	1.07E-04	0.0	0.0		---

(continued)

Stage No.1 Apply surcharge no.1 at elevation 111.52

LEFT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	1573
2	111.91	0.00	7.02	2.17	38.60	2.17	2.17a	1573
3	111.52	0.00	14.04	4.34	77.20	5.87	5.87	1573
		Total>	14.04	3.90m	104.03	5.54	5.54	2752
4	111.18	Total>	22.55	5.60m	113.41	11.29	11.29	2757
5	110.84	Total>	34.84	7.30m	126.57	20.68	20.68	2763
6	110.65	Total>	41.44	8.28m	133.67	25.63	25.63	2766
7	110.30	Total>	51.14	10.00m	144.26	32.51	32.51	2771
		0.00	51.14	17.03	153.42	22.03	22.03	2494
8	109.82	0.00	61.05	20.33	183.15	26.90	26.90	2499
9	109.34	0.00	69.19	23.04	207.58	31.04	31.04	2505
10	109.15	1.90	70.69	23.54	212.06	31.83	33.73	2507
11	108.65	6.95	74.45	24.79	223.35	33.87	40.82	2513
12	108.21	11.32	77.66	25.86	232.98	35.63	46.96	2518
13	107.77	15.70	80.93	26.95	242.78	37.44	53.14	2523
14	107.42	19.20	83.61	27.84	250.83	38.92	58.12	2527
15	107.07	22.70	86.35	28.76	259.06	40.44	63.14	2531
16	106.87	24.70	87.95	29.29	263.85	41.32	66.02	2533
17	106.54	28.05	90.67	30.19	272.01	42.81	70.86	2537
18	106.20	31.40	93.44	31.12	280.33	44.34	75.74	2540
19	105.60	37.40	98.53	32.81	295.59	47.12	84.52	2547
20	105.00	43.40	103.75	34.55	311.25	49.97	93.37	2554
21	104.40	49.40	109.09	36.33	327.26	52.86	102.26	2561
22	103.80	55.40	114.52	38.14	343.56	55.79	111.19	2568
23	103.20	61.40	120.03	39.97	360.10	58.75	120.15	2575
24	102.60	67.40	125.61	41.83	376.84	61.74	129.14	2581
25	102.00	73.40	131.25	43.71	393.75	64.75	138.15	2588
26	101.65	76.90	134.56	44.81	403.68	66.51	143.41	2592
27	101.30	80.40	137.89	45.92	413.66	68.28	148.68	2596

RIGHT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	1573
2	111.91	0.00	7.02	2.17	38.60	5.27	5.27	1573
3	111.52	0.00	14.04	4.34	77.20	9.01	9.01	1573
		Total>	14.04	3.90m	104.03	11.03	11.03	2752
4	111.18	Total>	20.50	5.60m	111.36	14.87	14.87	2757
5	110.84	Total>	26.96	7.30m	118.69	18.71	18.71	2763
6	110.65	Total>	30.67	8.28m	122.90	20.91	20.91	2766
7	110.30	Total>	37.22	10.00m	130.34	24.79	24.79	2771
		0.00	37.22	12.39	111.66	21.15	21.15	2494
8	109.82	0.00	45.86	15.27	137.58	25.47	25.47	2499
9	109.34	0.00	54.50	18.15	163.50	29.76	29.76	2505
10	109.15	1.90	56.40	18.78	169.20	30.69	32.59	2507
11	108.65	6.95	61.45	20.46	184.35	33.15	40.10	2513
12	108.21	11.32	65.83	21.92	197.48	35.26	46.59	2518
13	107.77	15.70	70.20	23.38	210.60	37.36	53.06	2523
14	107.42	19.20	73.70	24.54	221.10	39.03	58.23	2527
15	107.07	22.70	77.20	25.71	231.60	40.69	63.39	2531
16	106.87	24.70	79.20	26.37	237.60	41.63	66.33	2533
17	106.54	28.05	82.55	27.49	247.65	43.21	71.26	2537

(continued)

Stage No.1 Apply surcharge no.1 at elevation 111.52

		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
18	106.20	31.40	85.90	28.60	257.70	44.79	76.19	2540
19	105.60	37.40	91.90	30.60	275.70	47.62	85.02	2547
20	105.00	43.40	97.90	32.60	293.70	50.44	93.84	2554
21	104.40	49.40	103.90	34.60	311.70	53.27	102.67	2561
22	103.80	55.40	109.90	36.60	329.70	56.09	111.49	2568
23	103.20	61.40	115.90	38.59	347.70	58.92	120.32	2575
24	102.60	67.40	121.90	40.59	365.70	61.76	129.16	2581
25	102.00	73.40	127.90	42.59	383.70	64.59	137.99	2588
26	101.65	76.90	131.40	43.76	394.20	66.24	143.14	2592
27	101.30	80.40	134.90	44.92	404.70	67.90	148.30	2596

Note: 2.17 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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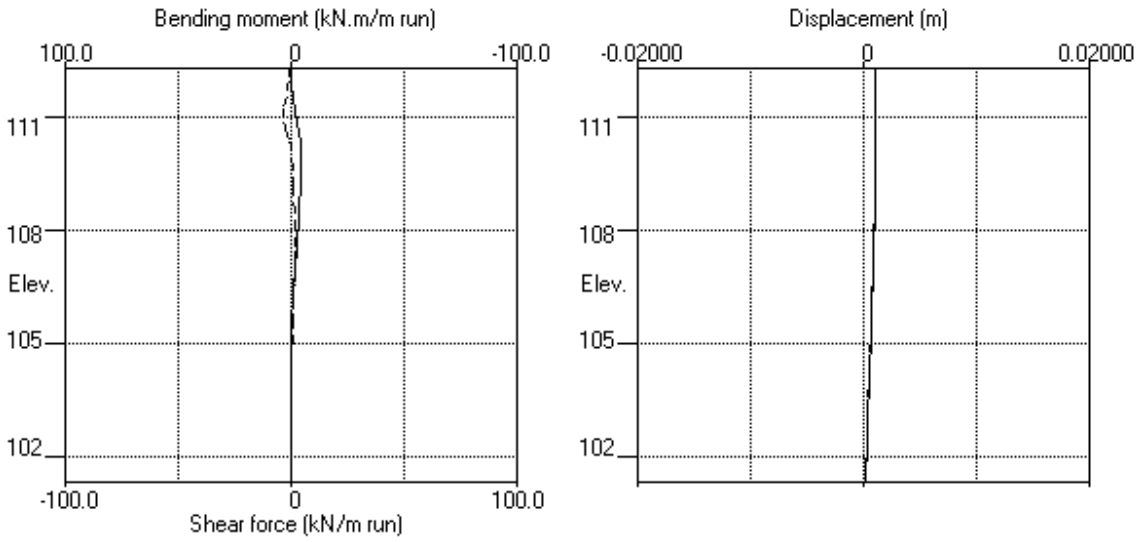
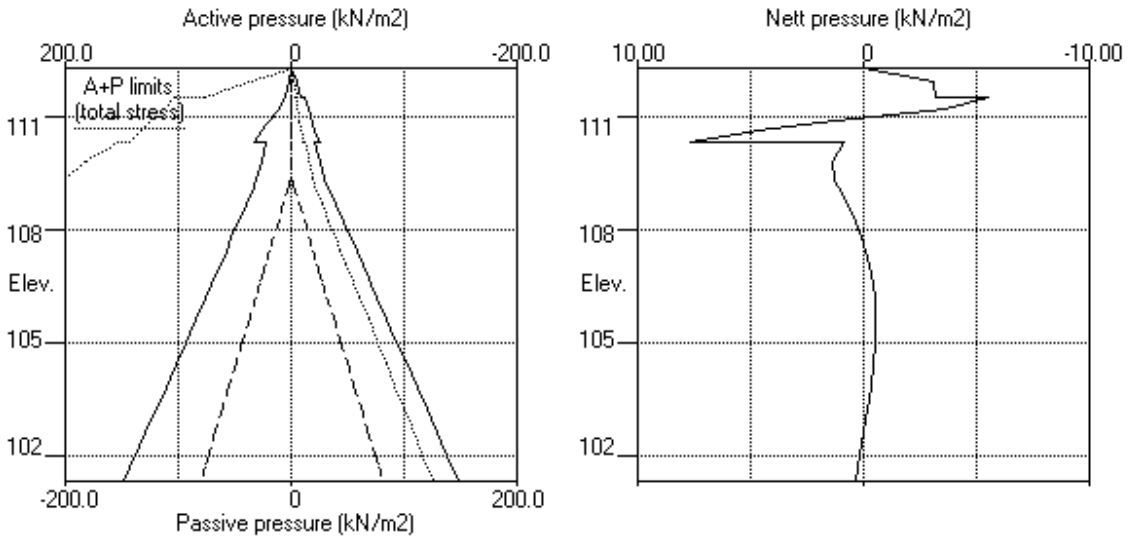
Stage No.1 Apply surcharge no.1 at elev. 111.52



Stage No.1 Apply surcharge no.1 at elev. 111.52



Units: kN,m

Stage No. 2 Apply surcharge no.2 at elevation 111.52

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
2	112.30	112.30	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 20.00m 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.

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	112.30	0.00	0.001	-1.22E-04	0.0	-0.0		100500
2	111.91	-3.14	0.001	-1.22E-04	-0.6	-0.0		100500
3	111.52	-3.32	0.001	-1.21E-04	-1.9	-0.5		100500
		-5.81	0.001	-1.21E-04	-1.9	-0.5		
4	111.18	-4.05	0.001	-1.17E-04	-3.5	-1.4		100500
5	110.84	1.46	0.001	-1.10E-04	-4.0	-2.7		100500
6	110.65	4.28	0.001	-1.04E-04	-3.4	-3.5		100500
7	110.30	7.54	0.001	-9.14E-05	-1.4	-4.3		100500
		0.38	0.001	-9.14E-05	-1.4	-4.3		
8	109.82	1.12	0.001	-6.93E-05	-1.0	-4.9		100500
9	109.34	1.22	0.001	-4.50E-05	-0.5	-5.3		100500
10	109.15	1.18	0.001	-3.49E-05	-0.2	-5.3		100500
11	108.65	0.99	0.001	-8.17E-06	0.3	-5.3		100500
12	108.21	0.79	0.001	1.44E-05	0.7	-5.1		100500
13	107.77	0.57	0.001	3.58E-05	1.0	-4.7		100500
14	107.42	0.40	0.001	5.16E-05	1.2	-4.3		100500
15	107.07	0.24	0.001	6.60E-05	1.3	-3.9		100500
16	106.87	0.15	0.001	7.35E-05	1.3	-3.7		100500
17	106.54	0.02	0.001	8.50E-05	1.3	-3.2		100500
18	106.20	-0.09	0.001	9.49E-05	1.3	-2.8		100500
19	105.60	-0.25	0.001	1.09E-04	1.2	-2.0		100500
20	105.00	-0.35	0.001	1.19E-04	1.0	-1.4		100500
21	104.40	-0.40	0.001	1.25E-04	0.8	-0.8		100500
22	103.80	-0.40	0.001	1.29E-04	0.6	-0.4		100500
23	103.20	-0.35	0.001	1.31E-04	0.4	-0.2		100500
24	102.60	-0.27	0.001	1.31E-04	0.2	-0.0		100500
25	102.00	-0.15	0.001	1.31E-04	0.0	0.0		100500
26	101.65	-0.07	0.001	1.31E-04	0.0	0.0		100500
27	101.30	0.03	0.001	1.31E-04	0.0	-0.0		---

(continued)

Stage No.2 Apply surcharge no.2 at elevation 111.52

LEFT side

Node no.	Y coord	Water press.	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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	53897
2	111.91	0.00	7.02	2.17	38.60	2.17	2.17a	1533
3	111.52	0.00	14.04	4.34	77.20	5.78	5.78	1533
		Total>	14.04	3.90m	104.03	5.38	5.38	2683
4	111.18	Total>	22.57	5.60m	113.43	11.06	11.06	2688
5	110.84	Total>	35.00	7.30m	126.74	20.50	20.50	2693
6	110.65	Total>	41.77	8.28m	134.00	25.57	25.57	2696
7	110.30	Total>	51.92	10.00m	145.05	32.79	32.79	2701
		0.00	51.92	17.29	155.77	21.95	21.95	2419
8	109.82	0.00	62.75	20.90	188.26	27.11	27.11	2424
9	109.34	0.00	71.97	23.96	215.90	31.60	31.60	2430
10	109.15	1.90	73.88	24.60	221.63	32.54	34.44	2432
11	108.65	6.95	78.63	26.19	235.90	34.90	41.85	2437
12	108.21	11.32	82.52	27.48	247.57	36.88	48.21	2442
13	107.77	15.70	86.28	28.73	258.83	38.83	54.53	2447
14	107.42	19.20	89.21	29.71	267.64	40.37	59.57	2451
15	107.07	22.70	92.11	30.67	276.34	41.91	64.61	2455
16	106.87	24.70	93.76	31.22	281.28	42.80	67.50	2457
17	106.54	28.05	96.51	32.14	289.52	44.28	72.33	2461
18	106.20	31.40	99.25	33.05	297.75	45.76	77.16	2464
19	105.60	37.40	104.18	34.69	312.55	48.46	85.86	2471
20	105.00	43.40	109.16	36.35	327.48	51.19	94.59	2477
21	104.40	49.40	114.21	38.03	342.62	53.96	103.36	2484
22	103.80	55.40	119.33	39.74	357.98	56.77	112.17	2491
23	103.20	61.40	124.53	41.47	373.58	59.62	121.02	2497
24	102.60	67.40	129.80	43.22	389.40	62.51	129.91	2504
25	102.00	73.40	135.15	45.00	405.44	65.43	138.83	2510
26	101.65	76.90	138.30	46.05	414.89	67.14	144.04	2514
27	101.30	80.40	141.47	47.11	424.40	68.87	149.27	2518

RIGHT side

Node no.	Y coord	Water press.	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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	53897
2	111.91	0.00	7.02	2.17	38.60	5.31	5.31	1533
3	111.52	0.00	14.04	4.34	77.20	9.10	9.10	1533
		Total>	14.04	3.90m	104.03	11.19	11.19	2683
4	111.18	Total>	20.50	5.60m	111.36	15.12	15.12	2688
5	110.84	Total>	26.96	7.30m	118.69	19.04	19.04	2693
6	110.65	Total>	30.67	8.28m	122.90	21.29	21.29	2696
7	110.30	Total>	37.22	10.00m	130.34	25.25	25.25	2701
		0.00	37.22	12.39	111.66	21.57	21.57	2419
8	109.82	0.00	45.86	15.27	137.58	25.99	25.99	2424
9	109.34	0.00	54.50	18.15	163.50	30.38	30.38	2430
10	109.15	1.90	56.40	18.78	169.20	31.35	33.25	2432
11	108.65	6.95	61.45	20.46	184.35	33.91	40.86	2437
12	108.21	11.32	65.83	21.92	197.48	36.10	47.42	2442
13	107.77	15.70	70.20	23.38	210.60	38.26	53.96	2447
14	107.42	19.20	73.70	24.54	221.10	39.98	59.18	2451
15	107.07	22.70	77.20	25.71	231.60	41.68	64.38	2455
16	106.87	24.70	79.20	26.37	237.60	42.64	67.34	2457
17	106.54	28.05	82.55	27.49	247.65	44.26	72.31	2461

(continued)

Stage No.2 Apply surcharge no.2 at elevation 111.52

		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
18	106.20	31.40	85.90	28.60	257.70	45.86	77.26	2464
19	105.60	37.40	91.90	30.60	275.70	48.71	86.11	2471
20	105.00	43.40	97.90	32.60	293.70	51.54	94.94	2477
21	104.40	49.40	103.90	34.60	311.70	54.36	103.76	2484
22	103.80	55.40	109.90	36.60	329.70	57.17	112.57	2491
23	103.20	61.40	115.90	38.59	347.70	59.97	121.37	2497
24	102.60	67.40	121.90	40.59	365.70	62.78	130.18	2504
25	102.00	73.40	127.90	42.59	383.70	65.58	138.98	2510
26	101.65	76.90	131.40	43.76	394.20	67.21	144.11	2514
27	101.30	80.40	134.90	44.92	404.70	68.84	149.24	2518

Note: 2.17 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

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CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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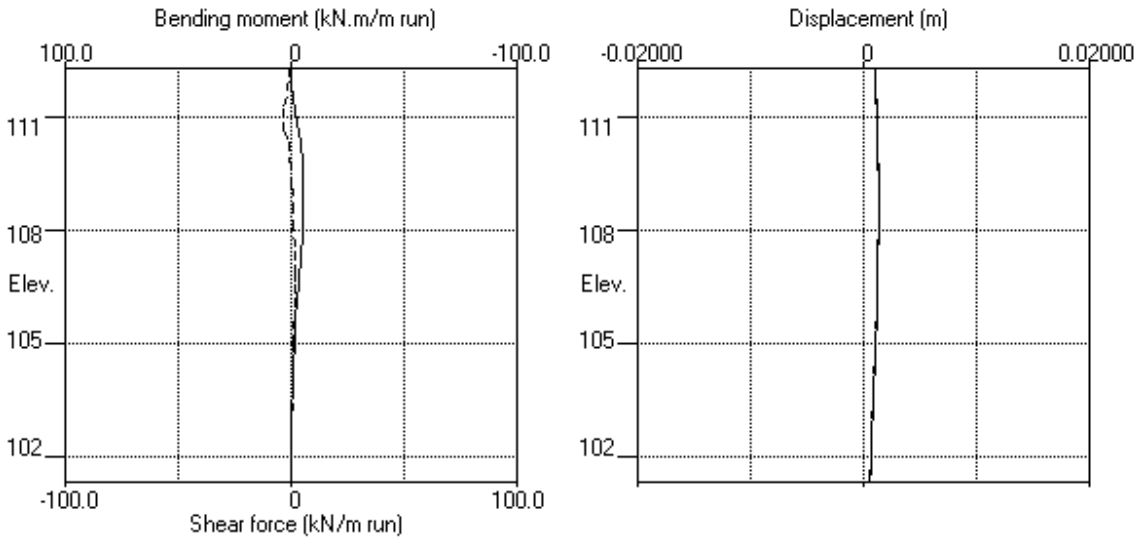
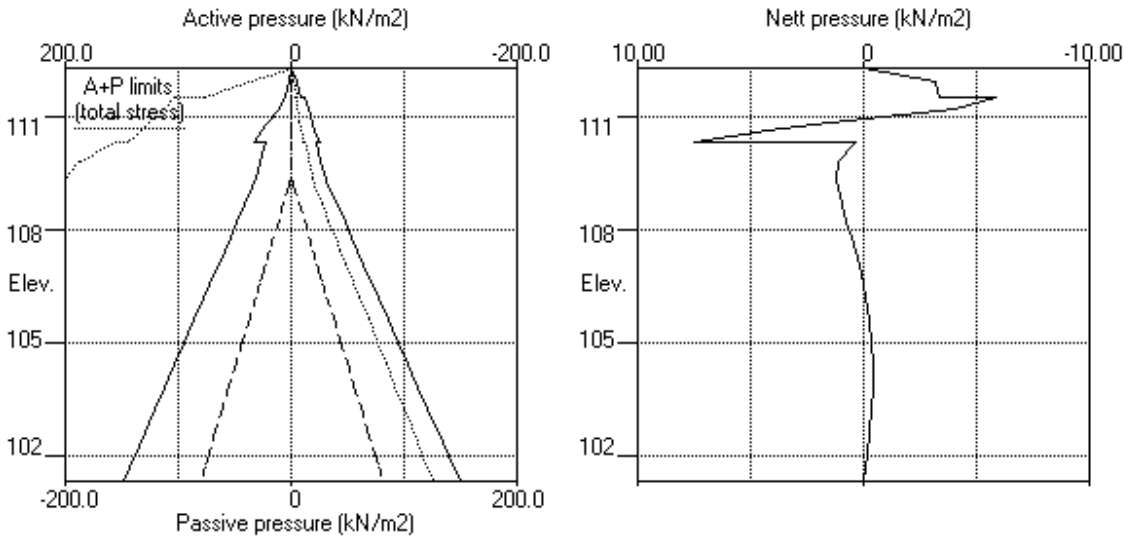
Stage No.2 Apply surcharge no.2 at elev. 111.52



Stage No.2 Apply surcharge no.2 at elev. 111.52



CREATE CONSULTING ENGINEERS LTD | Sheet No.
Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 5-06-2025
No.6 Grange Road Side | Checked :

Units: kN,m

Stage No. 3 Change EI of wall to 70350 kN.m2/m run
Allow wall to relax with new modulus value

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
3	112.30	112.30	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 20.00m 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.

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	112.30	0.00	0.001	-1.48E-04	0.0	-0.0		70350
2	111.91	-2.73	0.001	-1.48E-04	-0.5	-0.0		70350
3	111.52	-3.05	0.001	-1.47E-04	-1.7	-0.4		70350
		-5.34	0.001	-1.47E-04	-1.7	-0.4		
4	111.18	-3.78	0.001	-1.43E-04	-3.2	-1.3		70350
5	110.84	1.53	0.001	-1.34E-04	-3.6	-2.5		70350
6	110.65	4.27	0.001	-1.26E-04	-3.0	-3.2		70350
7	110.30	7.47	0.001	-1.09E-04	-1.0	-3.9		70350
		0.32	0.001	-1.09E-04	-1.0	-3.9		
8	109.82	1.00	0.001	-8.22E-05	-0.7	-4.4		70350
9	109.34	1.06	0.001	-5.26E-05	-0.2	-4.6		70350
10	109.15	1.01	0.001	-4.06E-05	0.0	-4.7		70350
11	108.65	0.81	0.001	-9.10E-06	0.5	-4.6		70350
12	108.21	0.60	0.001	1.69E-05	0.8	-4.3		70350
13	107.77	0.40	0.001	4.10E-05	1.0	-3.9		70350
14	107.42	0.24	0.001	5.83E-05	1.1	-3.5		70350
15	107.07	0.10	0.001	7.38E-05	1.2	-3.1		70350
16	106.87	0.03	0.001	8.17E-05	1.2	-2.9		70350
17	106.54	-0.08	0.001	9.35E-05	1.2	-2.5		70350
18	106.20	-0.17	0.001	1.03E-04	1.1	-2.1		70350
19	105.60	-0.29	0.001	1.17E-04	1.0	-1.5		70350
20	105.00	-0.36	0.001	1.25E-04	0.8	-0.9		70350
21	104.40	-0.37	0.001	1.30E-04	0.6	-0.5		70350
22	103.80	-0.34	0.001	1.33E-04	0.4	-0.2		70350
23	103.20	-0.27	0.001	1.33E-04	0.2	-0.0		70350
24	102.60	-0.18	0.001	1.33E-04	0.0	0.0		70350
25	102.00	-0.05	0.001	1.33E-04	-0.0	0.0		70350
26	101.65	0.04	0.001	1.33E-04	-0.0	0.0		70350
27	101.30	0.13	0.001	1.33E-04	0.0	-0.0		---

(continued)

Stage No.3 Change EI of wall to 70350 kN.m2/m run
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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	6680
2	111.91	0.00	7.02	2.17	38.60	2.37	2.37	6680
3	111.52	0.00	14.04	4.34	77.20	5.92	5.92	6680
		Total>	14.04	3.90m	104.03	5.61	5.61	11690
4	111.18	Total>	22.57	5.60m	113.43	11.20	11.20	11713
5	110.84	Total>	35.00	7.30m	126.74	20.54	20.54	11736
6	110.65	Total>	41.77	8.28m	134.00	25.56	25.56	5700
7	110.30	Total>	51.92	10.00m	145.05	32.76	32.76	4158
		0.00	51.92	17.29	155.77	21.92	21.92	3908
8	109.82	0.00	62.75	20.90	188.26	27.05	27.05	3917
9	109.34	0.00	71.97	23.96	215.90	31.52	31.52	3925
10	109.15	1.90	73.88	24.60	221.63	32.45	34.35	3929
11	108.65	6.95	78.63	26.19	235.90	34.81	41.76	3938
12	108.21	11.32	82.52	27.48	247.57	36.79	48.12	3945
13	107.77	15.70	86.28	28.73	258.83	38.74	54.44	3953
14	107.42	19.20	89.21	29.71	267.64	40.30	59.50	3959
15	107.07	22.70	92.11	30.67	276.34	41.85	64.55	3966
16	106.87	24.70	93.76	31.22	281.28	42.73	67.43	3969
17	106.54	28.05	96.51	32.14	289.52	44.23	72.28	3975
18	106.20	31.40	99.25	33.05	297.75	45.73	77.13	3981
19	105.60	37.40	104.18	34.69	312.55	48.44	85.84	3992
20	105.00	43.40	109.16	36.35	327.48	51.19	94.59	4002
21	104.40	49.40	114.21	38.03	342.62	53.97	103.37	4910
22	103.80	55.40	119.33	39.74	357.98	56.80	112.20	4923
23	103.20	61.40	124.53	41.47	373.58	59.66	121.06	4936
24	102.60	67.40	129.80	43.22	389.40	62.55	129.95	4949
25	102.00	73.40	135.15	45.00	405.44	65.48	138.88	4962
26	101.65	76.90	138.30	46.05	414.89	67.20	144.10	4970
27	101.30	80.40	141.47	47.11	424.40	68.92	149.32	4977

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	6680
2	111.91	0.00	7.02	2.17	38.60	5.10	5.10	6680
3	111.52	0.00	14.04	4.34	77.20	8.97	8.97	6680
		Total>	14.04	3.90m	104.03	10.95	10.95	11690
4	111.18	Total>	20.50	5.60m	111.36	14.98	14.98	11713
5	110.84	Total>	26.96	7.30m	118.69	19.00	19.00	11736
6	110.65	Total>	30.67	8.28m	122.90	21.29	21.29	5700
7	110.30	Total>	37.22	10.00m	130.34	25.29	25.29	4158
		0.00	37.22	12.39	111.66	21.60	21.60	3908
8	109.82	0.00	45.86	15.27	137.58	26.05	26.05	3917
9	109.34	0.00	54.50	18.15	163.50	30.46	30.46	3925
10	109.15	1.90	56.40	18.78	169.20	31.44	33.34	3929
11	108.65	6.95	61.45	20.46	184.35	34.00	40.95	3938
12	108.21	11.32	65.83	21.92	197.48	36.19	47.51	3945
13	107.77	15.70	70.20	23.38	210.60	38.35	54.05	3953
14	107.42	19.20	73.70	24.54	221.10	40.05	59.25	3959
15	107.07	22.70	77.20	25.71	231.60	41.74	64.44	3966
16	106.87	24.70	79.20	26.37	237.60	42.71	67.41	3969

(continued)

Stage No.3 Change EI of wall to 70350 kN.m2/m run
Allow wall to relax with new modulus value

		RIGHT 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
17	106.54	28.05	82.55	27.49	247.65	44.31	72.36	3975
18	106.20	31.40	85.90	28.60	257.70	45.90	77.30	3981
19	105.60	37.40	91.90	30.60	275.70	48.73	86.13	3992
20	105.00	43.40	97.90	32.60	293.70	51.54	94.94	4002
21	104.40	49.40	103.90	34.60	311.70	54.34	103.74	4910
22	103.80	55.40	109.90	36.60	329.70	57.14	112.54	4923
23	103.20	61.40	115.90	38.59	347.70	59.94	121.34	4936
24	102.60	67.40	121.90	40.59	365.70	62.73	130.13	4949
25	102.00	73.40	127.90	42.59	383.70	65.53	138.93	4962
26	101.65	76.90	131.40	43.76	394.20	67.16	144.06	4970
27	101.30	80.40	134.90	44.92	404.70	68.79	149.19	4977

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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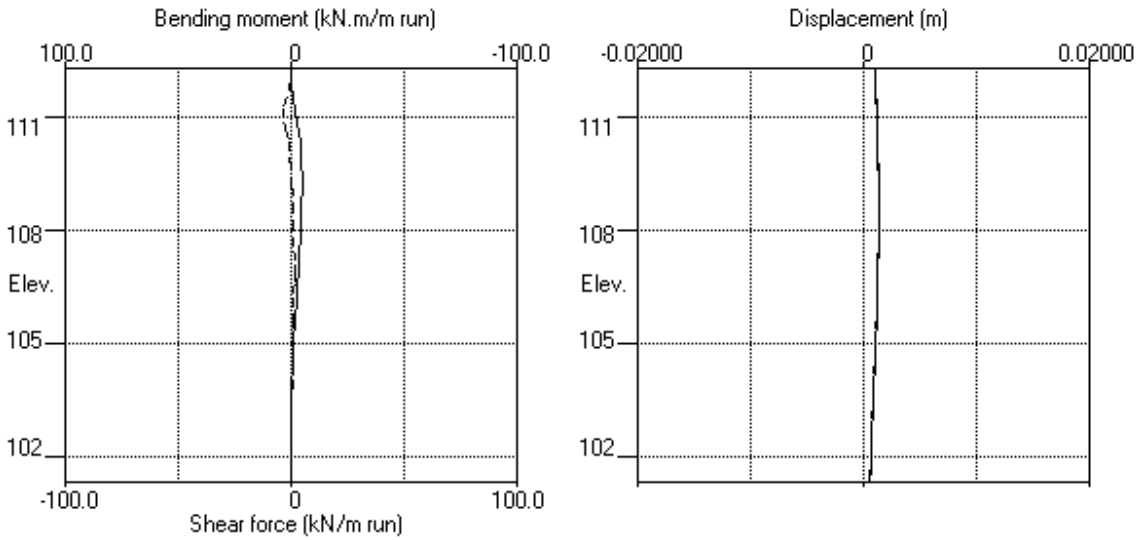
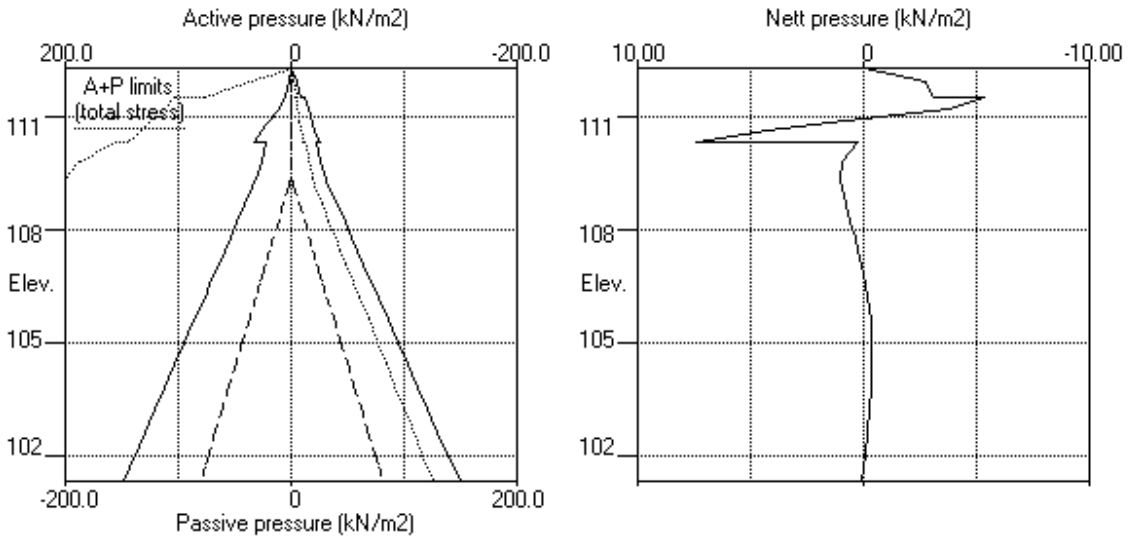
Stage No.3 Change EI of wall to 70350kN.m2/m run



Stage No.3 Change EI of wall to 70350kN.m2/m run



Units: kN,m

Stage No. 4 Excavate to elevation 111.52 on LEFT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
4	112.30	111.52	Cant.	74.813	101.44	111.48	0.04	R to L

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 20.00m 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.

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	112.30	0.00	-0.001	-3.48E-04	0.0	-0.0		70350
2	111.91	-2.17	-0.001	-3.48E-04	-0.4	0.0		70350
3	111.52	-6.03	-0.001	-3.47E-04	-2.0	-0.5		70350
		-0.54	-0.001	-3.47E-04	-2.0	-0.5		
4	111.18	-4.88	-0.001	-3.43E-04	-2.9	-1.3		70350
5	110.84	-2.17	-0.001	-3.34E-04	-4.1	-2.6		70350
6	110.65	0.38	-0.001	-3.26E-04	-4.3	-3.4		70350
7	110.30	3.26	-0.001	-3.06E-04	-3.7	-4.8		70350
		2.44	-0.001	-3.06E-04	-3.7	-4.8		
8	109.82	2.73	-0.001	-2.69E-04	-2.4	-6.3		70350
9	109.34	2.44	-0.000	-2.24E-04	-1.2	-7.2		70350
10	109.15	2.26	-0.000	-2.05E-04	-0.8	-7.4		70350
11	108.65	1.73	-0.000	-1.53E-04	0.2	-7.5		70350
12	108.21	1.28	-0.000	-1.08E-04	0.9	-7.3		70350
13	107.77	0.87	-0.000	-6.63E-05	1.4	-6.8		70350
14	107.42	0.58	-0.000	-3.51E-05	1.6	-6.2		70350
15	107.07	0.32	-0.000	-6.81E-06	1.8	-5.6		70350
16	106.87	0.18	-0.000	8.01E-06	1.8	-5.3		70350
17	106.54	-0.01	-0.000	3.05E-05	1.9	-4.6		70350
18	106.20	-0.17	-0.000	5.00E-05	1.8	-4.0		70350
19	105.60	-0.38	-0.000	7.80E-05	1.7	-2.9		70350
20	105.00	-0.50	-0.000	9.76E-05	1.4	-2.0		70350
21	104.40	-0.54	-0.000	1.10E-04	1.1	-1.2		70350
22	103.80	-0.52	-0.000	1.17E-04	0.8	-0.7		70350
23	103.20	-0.45	-0.000	1.21E-04	0.5	-0.3		70350
24	102.60	-0.34	-0.001	1.22E-04	0.2	-0.1		70350
25	102.00	-0.20	-0.001	1.23E-04	0.1	-0.0		70350
26	101.65	-0.10	-0.001	1.23E-04	0.0	0.0		70350
27	101.30	0.01	-0.001	1.23E-04	0.0	0.0		---

(continued)

Stage No.4 Excavate to elevation 111.52 on LEFT side

LEFT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	5.27	5.27	2500
4	111.18	Total>	8.53	1.70m	99.39	5.11	5.11	2505
5	110.84	Total>	20.96	3.40m	112.70	12.00	12.00	2510
6	110.65	Total>	27.73	4.38m	119.96	16.93	16.93	2513
7	110.30	Total>	37.88	6.10m	131.01	23.97	23.97	2518
		0.00	37.88	12.62	113.65	20.04	20.04	2217
8	109.82	0.00	48.72	16.22	146.15	24.97	24.97	2222
9	109.34	0.00	57.93	19.29	173.80	29.26	29.26	2227
10	109.15	1.90	59.85	19.93	179.54	30.12	32.02	2229
11	108.65	6.95	64.61	21.52	193.83	32.32	39.27	2234
12	108.21	11.32	68.51	22.81	205.53	34.18	45.51	2238
13	107.77	15.70	72.27	24.07	216.82	36.03	51.73	2242
14	107.42	19.20	75.22	25.05	225.67	37.51	56.71	2246
15	107.07	22.70	78.14	26.02	234.41	39.01	61.71	2250
16	106.87	24.70	79.79	26.57	239.37	39.87	64.57	2252
17	106.54	28.05	82.55	27.49	247.66	41.32	69.37	2255
18	106.20	31.40	85.31	28.41	255.94	42.78	74.18	2258
19	105.60	37.40	90.28	30.06	270.84	45.46	82.86	2264
20	105.00	43.40	95.30	31.74	285.91	48.19	91.59	2270
21	104.40	49.40	100.40	33.43	301.20	50.97	100.37	2276
22	103.80	55.40	105.58	35.16	316.73	53.81	109.21	2282
23	103.20	61.40	110.84	36.91	332.52	56.68	118.08	2289
24	102.60	67.40	116.19	38.69	348.56	59.60	127.00	2295
25	102.00	73.40	121.61	40.50	364.83	62.55	135.95	2301
26	101.65	76.90	124.81	41.56	374.42	64.28	141.18	2304
27	101.30	80.40	128.03	42.63	384.08	66.03	146.43	2308

RIGHT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	1395
2	111.91	0.00	7.02	2.17	38.60	2.17	2.17a	1395
3	111.52	0.00	14.04	4.34	77.20	6.03	6.03	1395
		Total>	14.04	3.90m	104.03	5.81	5.81	2441
4	111.18	Total>	20.50	5.60m	111.36	9.99	9.99	2446
5	110.84	Total>	26.96	7.30m	118.69	14.17	14.17	2451
6	110.65	Total>	30.67	8.28m	122.90	16.55	16.55	2454
7	110.30	Total>	37.22	10.00m	130.34	20.70	20.70	2459
		0.00	37.22	12.39	111.66	17.60	17.60	2149
8	109.82	0.00	45.86	15.27	137.58	22.24	22.24	2154
9	109.34	0.00	54.50	18.15	163.50	26.83	26.83	2158
10	109.15	1.90	56.40	18.78	169.20	27.87	29.77	2160
11	108.65	6.95	61.45	20.46	184.35	30.59	37.54	2165
12	108.21	11.32	65.83	21.92	197.48	32.90	44.22	2169
13	107.77	15.70	70.20	23.38	210.60	35.16	50.86	2174
14	107.42	19.20	73.70	24.54	221.10	36.94	56.14	2177
15	107.07	22.70	77.20	25.71	231.60	38.69	61.39	2181
16	106.87	24.70	79.20	26.37	237.60	39.68	64.38	2183
17	106.54	28.05	82.55	27.49	247.65	41.33	69.38	2186

(continued)

Stage No.4 Excavate to elevation 111.52 on LEFT side

		RIGHT 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
18	106.20	31.40	85.90	28.60	257.70	42.96	74.36	2189
19	105.60	37.40	91.90	30.60	275.70	45.84	83.24	2195
20	105.00	43.40	97.90	32.60	293.70	48.69	92.09	2201
21	104.40	49.40	103.90	34.60	311.70	51.52	100.92	2207
22	103.80	55.40	109.90	36.60	329.70	54.33	109.73	2213
23	103.20	61.40	115.90	38.59	347.70	57.14	118.54	2218
24	102.60	67.40	121.90	40.59	365.70	59.94	127.34	2224
25	102.00	73.40	127.90	42.59	383.70	62.74	136.14	2230
26	101.65	76.90	131.40	43.76	394.20	64.38	141.28	2234
27	101.30	80.40	134.90	44.92	404.70	66.01	146.41	2237

Note: 2.17 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

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Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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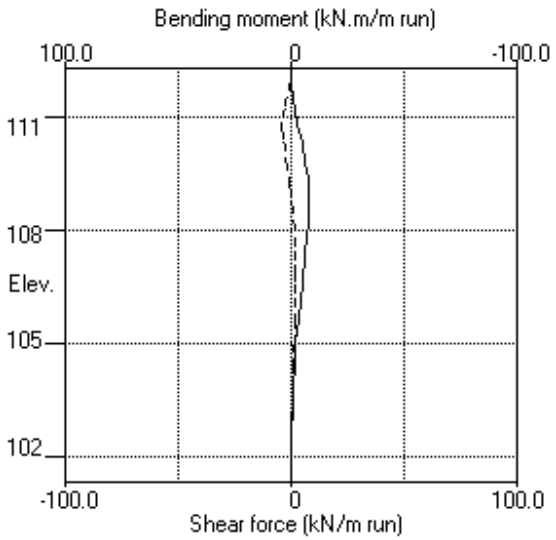
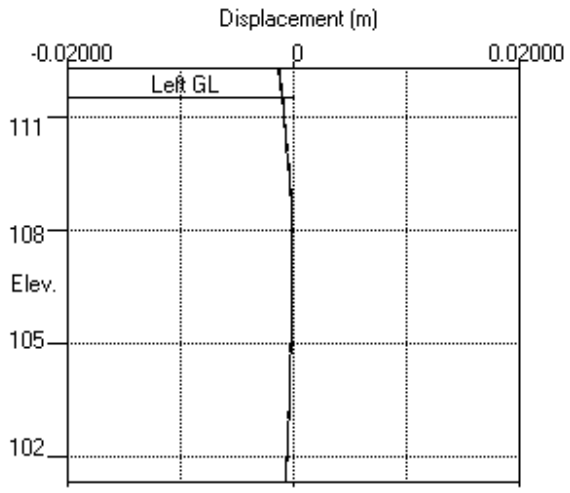
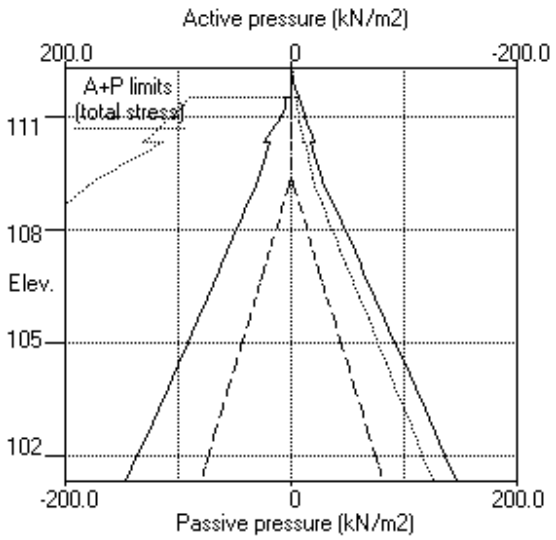
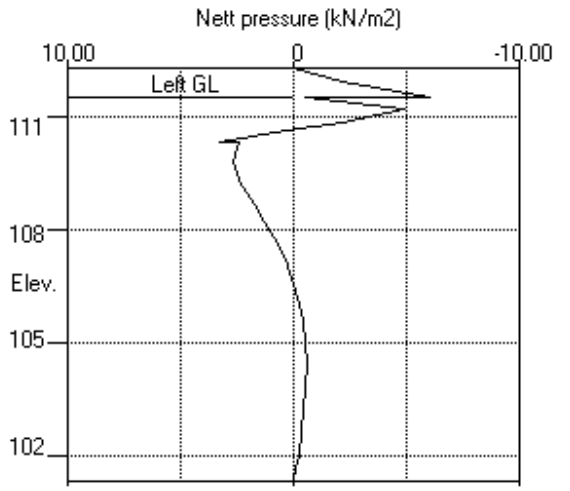
Stage No.4 Excav. to elev. 111.52 on LEFT side





Stage No.4 Excav. to elev. 111.52 on LEFT side





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Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 5-06-2025
No.6 Grange Road Side | Checked :

Units: kN,m

Stage No. 6 Excavate to elevation 110.65 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
6	111.52	110.65	Cant.	4.051	102.16	110.59	0.06	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 20.00m 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 5

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	112.30	0.00	0.005	6.30E-04	0.0	-0.0		70350
2	111.91	0.00	0.005	6.30E-04	0.0	0.1		70350
3	111.52	0.00	0.005	6.29E-04	0.0	-0.0		70350
4	111.18	1.70	0.005	6.24E-04	0.3	0.0		70350
5	110.84	3.40	0.004	6.14E-04	1.2	0.2		70350
6	110.65	5.97	0.004	6.05E-04	2.1	0.6		70350
		-5.33	0.004	6.05E-04	2.1	0.6		
7	110.30	2.72	0.004	5.81E-04	1.6	1.1		70350
		-1.42	0.004	5.81E-04	1.6	1.1		
8	109.82	-1.74	0.004	5.32E-04	0.9	2.0		70350
9	109.34	-0.98	0.004	4.72E-04	0.2	2.2		70350
10	109.15	-0.78	0.004	4.46E-04	0.0	2.2		70350
11	108.65	-0.40	0.003	3.77E-04	-0.3	2.1		70350
12	108.21	-0.18	0.003	3.18E-04	-0.4	1.9		70350
13	107.77	-0.05	0.003	2.63E-04	-0.4	1.7		70350
14	107.42	0.02	0.003	2.23E-04	-0.4	1.6		70350
15	107.07	0.06	0.003	1.86E-04	-0.4	1.4		70350
16	106.87	0.07	0.003	1.67E-04	-0.4	1.3		70350
17	106.54	0.08	0.003	1.37E-04	-0.4	1.2		70350
18	106.20	0.08	0.003	1.11E-04	-0.4	1.1		70350
19	105.60	0.06	0.003	7.34E-05	-0.3	0.9		70350
20	105.00	0.04	0.003	4.56E-05	-0.3	0.7		70350
21	104.40	0.03	0.003	2.64E-05	-0.3	0.6		70350
22	103.80	0.03	0.003	1.41E-05	-0.2	0.4		70350
23	103.20	0.04	0.003	7.06E-06	-0.2	0.3		70350
24	102.60	0.08	0.003	3.57E-06	-0.2	0.2		70350
25	102.00	0.14	0.003	2.27E-06	-0.1	0.0		70350
26	101.65	0.18	0.003	2.08E-06	-0.1	0.0		70350
27	101.30	0.24	0.003	2.04E-06	0.0	0.0		---

(continued)

Stage No.6 Excavate to elevation 110.65 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	0.00	0.00a	2500
4	111.18	Total>	8.53	1.70m	99.39	1.70	1.70a	2505
5	110.84	Total>	20.96	3.40m	112.70	3.40	3.40a	2510
6	110.65	Total>	27.73	4.38m	119.96	5.97	5.97	2513
7	110.30	Total>	37.88	6.10m	131.01	13.51	13.51	2518
		0.00	37.88	12.62	113.65	12.62	12.62a	2217
8	109.82	0.00	48.72	16.22	146.15	16.34	16.34	2222
9	109.34	0.00	57.93	19.29	173.80	21.15	21.15	2227
10	109.15	1.90	59.85	19.93	179.54	22.20	24.10	2229
11	108.65	6.95	64.61	21.52	193.83	24.84	31.79	2234
12	108.21	11.32	68.51	22.81	205.53	27.03	38.35	2238
13	107.77	15.70	72.27	24.07	216.82	29.15	44.85	2242
14	107.42	19.20	75.22	25.05	225.67	30.81	50.01	2246
15	107.07	22.70	78.14	26.02	234.41	32.46	55.16	2250
16	106.87	24.70	79.79	26.57	239.37	33.39	58.09	2252
17	106.54	28.05	82.55	27.49	247.66	34.94	62.99	2255
18	106.20	31.40	85.31	28.41	255.94	36.50	67.90	2258
19	105.60	37.40	90.28	30.06	270.84	39.28	76.68	2264
20	105.00	43.40	95.30	31.74	285.91	42.07	85.47	2270
21	104.40	49.40	100.40	33.43	301.20	44.89	94.29	2276
22	103.80	55.40	105.58	35.16	316.73	47.73	103.13	2282
23	103.20	61.40	110.84	36.91	332.52	50.61	112.01	2289
24	102.60	67.40	116.19	38.69	348.56	53.51	120.91	2295
25	102.00	73.40	121.61	40.50	364.83	56.45	129.85	2301
26	101.65	76.90	124.81	41.56	374.42	58.18	135.08	2304
27	101.30	80.40	128.03	42.63	384.08	59.92	140.32	2308

RIGHT side

Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
			Effective stresses					
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	92.23	11.30	11.30	2593
7	110.30	Total>	6.56	1.72m	99.68	10.79	10.79	2598
		0.00	6.56	2.18	19.67	14.04	14.04	2307
8	109.82	0.00	15.20	5.06	45.59	18.08	18.08	2312
9	109.34	0.00	23.84	7.94	71.52	22.13	22.13	2317
10	109.15	1.90	25.74	8.57	77.22	22.98	24.88	2319
11	108.65	6.95	30.80	10.26	92.39	25.24	32.19	2324
12	108.21	11.32	35.18	11.72	105.55	27.21	38.54	2329
13	107.77	15.70	39.57	13.18	118.72	29.20	44.90	2334
14	107.42	19.20	43.09	14.35	129.26	30.79	49.99	2337
15	107.07	22.70	46.61	15.52	139.82	32.40	55.10	2341
16	106.87	24.70	48.62	16.19	145.86	33.32	58.02	2343
17	106.54	28.05	51.99	17.31	155.98	34.86	62.91	2346

(continued)

Stage No.6 Excavate to elevation 110.65 on RIGHT side

		RIGHT 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
18	106.20	31.40	55.37	18.44	166.11	36.42	67.82	2350
19	105.60	37.40	61.43	20.46	184.29	39.21	76.61	2356
20	105.00	43.40	67.50	22.48	202.51	42.03	85.43	2363
21	104.40	49.40	73.59	24.51	220.77	44.86	94.26	2369
22	103.80	55.40	79.69	26.54	239.07	47.70	103.10	2375
23	103.20	61.40	85.81	28.57	257.43	50.56	111.96	2381
24	102.60	67.40	91.94	30.62	275.83	53.43	120.83	2388
25	102.00	73.40	98.09	32.66	294.27	56.31	129.71	2394
26	101.65	76.90	101.68	33.86	305.05	58.00	134.90	2398
27	101.30	80.40	105.28	35.06	315.84	59.68	140.08	2401

Note: 12.62 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

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CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
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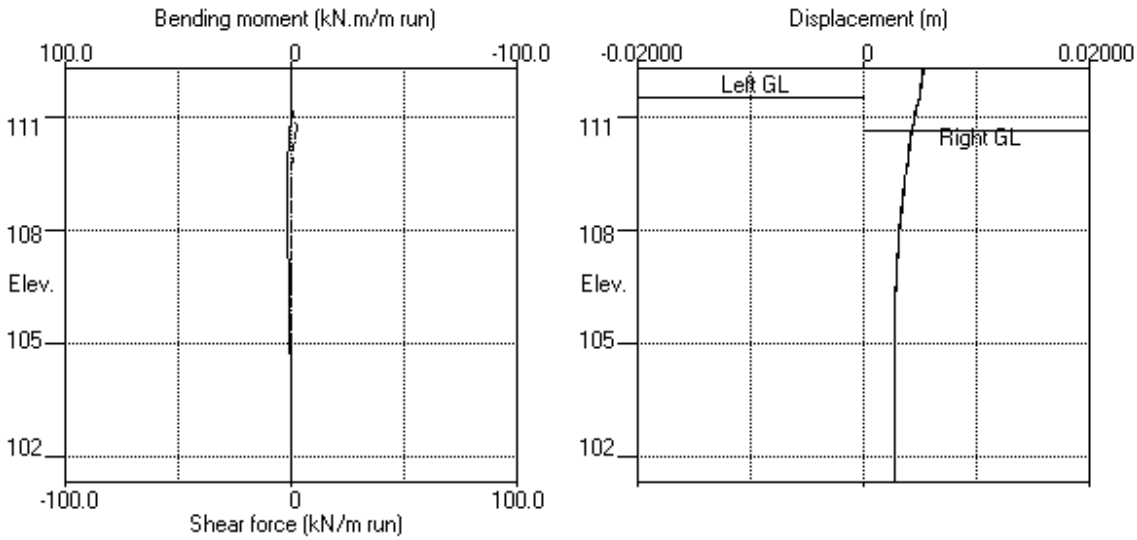
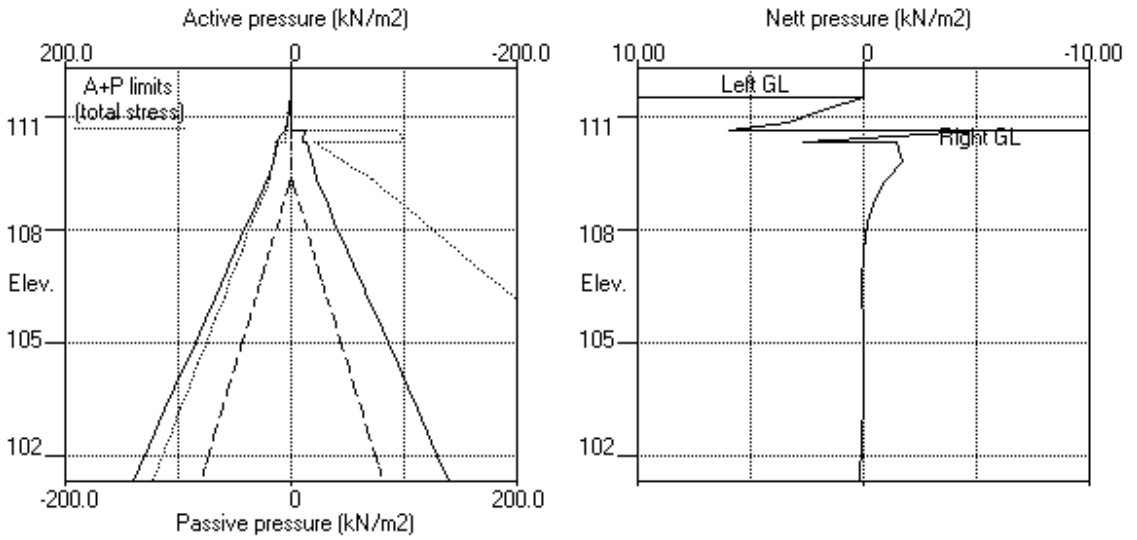
Stage No.6 Excav. to elev. 110.65 on RIGHT side



Stage No.6 Excav. to elev. 110.65 on RIGHT side



Units: kN,m

Stage No. 8 Apply water pressure profile no.1 (Mod. Conserv.)

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
8	111.52	110.65	110.84	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 20.00m 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 5

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	112.30	0.00	0.005	1.76E-04	0.0	-0.0		70350
2	111.91	0.00	0.005	1.76E-04	0.0	0.1		70350
3	111.52	0.00	0.005	1.74E-04	0.0	-0.0		70350
		6.87	0.005	1.74E-04	0.0	-0.0		
4	111.18	5.13	0.005	1.69E-04	2.0	0.4		70350
5	110.84	3.40	0.004	1.55E-04	3.5	1.4	-3.6	70350
		3.40	0.004	1.55E-04	-0.1	1.4		
6	110.65	5.71	0.004	1.43E-04	0.8	1.5		70350
		-5.85	0.004	1.43E-04	0.8	1.5		
7	110.30	1.29	0.004	1.15E-04	-0.0	1.6		70350
		-2.07	0.004	1.15E-04	-0.0	1.6		
8	109.82	-3.08	0.004	6.66E-05	-1.2	1.6		70350
9	109.34	-4.59	0.004	1.28E-05	-3.1	0.6		70350
10	109.15	-3.79	0.004	-7.63E-06	-3.9	-0.1		70350
11	108.65	-1.78	0.004	-5.24E-05	-5.3	-2.4		70350
12	108.21	-0.10	0.004	-7.59E-05	-5.7	-4.8		70350
13	107.77	1.60	0.004	-8.20E-05	-5.4	-7.3		70350
14	107.42	3.01	0.004	-7.38E-05	-4.6	-9.0		70350
15	107.07	4.48	0.004	-5.51E-05	-3.3	-10.4		70350
16	106.87	5.36	0.004	-4.03E-05	-2.3	-10.9		70350
17	106.54	4.35	0.004	-1.07E-05	-0.6	-11.4		70350
18	106.20	3.43	0.004	2.29E-05	0.7	-11.4		70350
19	105.60	2.03	0.004	8.64E-05	2.3	-10.4		70350
20	105.00	0.92	0.004	1.47E-04	3.2	-8.8		70350
21	104.40	0.08	0.004	1.99E-04	3.5	-6.7		70350
22	103.80	-0.54	0.004	2.40E-04	3.3	-4.7		70350
23	103.20	-1.01	0.004	2.68E-04	2.9	-2.9		70350
24	102.60	-1.37	0.004	2.85E-04	2.2	-1.4		70350
25	102.00	-1.65	0.004	2.92E-04	1.3	-0.4		70350

(continued)

Stage No.8 Apply water pressure profile no.1 (Mod. Conserv.)

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
26	101.65	-1.80	0.004	2.93E-04	0.7	-0.1		70350
27	101.30	-1.93	0.003	2.94E-04	0.0	0.0		---

At elev. 110.84 Prop force = 3.6 kN/m run

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	6.87	6.87	22271
4	111.18	Total>	8.53	1.70m	99.39	5.13	5.13	22314
5	110.84	Total>	20.96	3.40m	112.70	3.40	3.40a	2837
6	110.65	Total>	27.73	4.38m	119.96	5.71	5.71	2840
7	110.30	Total>	37.88	6.10m	131.01	12.79	12.79	2846
		0.00	37.88	12.62	113.65	12.62	12.62a	2573
8	109.82	0.00	48.72	16.22	146.15	16.22	16.22a	2579
9	109.34	0.00	57.93	19.29	173.80	19.34	19.34	2584
10	109.15	1.56	60.19	20.04	180.57	20.31	21.87	2587
11	108.65	5.69	65.87	21.94	197.62	22.77	28.46	2592
12	108.21	9.27	70.56	23.50	211.69	24.82	34.09	2598
13	107.77	12.85	75.12	25.02	225.37	26.85	39.70	2603
14	107.42	15.72	78.71	26.21	236.12	28.49	44.20	2607
15	107.07	18.58	82.26	27.39	246.77	30.15	48.73	2611
16	106.87	20.22	84.27	28.06	252.82	31.12	51.33	2613
17	106.54	22.96	87.64	29.19	262.93	32.77	55.73	2617
18	106.20	25.70	91.01	30.31	273.04	34.47	60.18	2621
19	105.60	30.61	97.07	32.32	291.21	37.65	68.26	2628
20	105.00	35.52	103.18	34.36	309.54	40.99	76.51	2635
21	104.40	40.43	109.36	36.42	328.09	44.48	84.92	2642
22	103.80	45.35	115.63	38.51	346.89	48.10	93.45	2649
23	103.20	50.26	121.98	40.62	365.95	51.83	102.08	2656
24	102.60	55.17	128.42	42.76	385.25	55.63	110.79	2663
25	102.00	60.08	134.93	44.93	404.79	59.48	119.56	2670
26	101.65	62.94	138.76	46.21	416.29	61.75	124.69	2674
27	101.30	65.81	142.62	47.49	427.85	64.03	129.84	2678

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	92.23	11.56	11.56	2840
7	110.30	Total>	6.56	1.72m	99.68	11.51	11.51	2846
		0.00	6.56	2.18	19.67	14.68	14.68	2573
8	109.82	0.00	15.20	5.06	45.59	19.30	19.30	2579
9	109.34	0.00	23.84	7.94	71.52	23.93	23.93	2584
10	109.15	0.00	27.26	9.08	81.78	25.66	25.66	2587

(continued)

Stage No.8 Apply water pressure profile no.1 (Mod. Conserv.)

		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
11	108.65	0.00	36.36	12.11	109.07	30.24	30.24	2592
12	108.21	0.00	44.24	14.73	132.73	34.18	34.18	2598
13	107.77	0.00	52.13	17.36	156.40	38.10	38.10	2603
14	107.42	0.00	58.45	19.46	175.34	41.19	41.19	2607
15	107.07	0.00	64.77	21.57	194.30	44.25	44.25	2611
16	106.87	0.00	68.38	22.77	205.14	45.98	45.98	2613
17	106.54	3.96	71.14	23.69	213.43	47.43	51.38	2617
18	106.20	7.92	73.91	24.61	221.74	48.83	56.74	2621
19	105.60	15.00	78.88	26.27	236.65	51.23	66.23	2628
20	105.00	22.09	83.87	27.93	251.60	53.50	75.59	2635
21	104.40	29.18	88.87	29.59	266.60	55.65	84.83	2642
22	103.80	36.27	93.88	31.26	281.64	57.72	93.99	2649
23	103.20	43.36	98.91	32.94	296.73	59.73	103.09	2656
24	102.60	50.45	103.95	34.62	311.86	61.71	112.16	2663
25	102.00	57.54	109.01	36.30	327.03	63.67	121.21	2670
26	101.65	61.67	111.97	37.29	335.91	64.81	126.49	2674
27	101.30	65.81	114.93	38.27	344.80	65.96	131.77	2678

Note: 16.22 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

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Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
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Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
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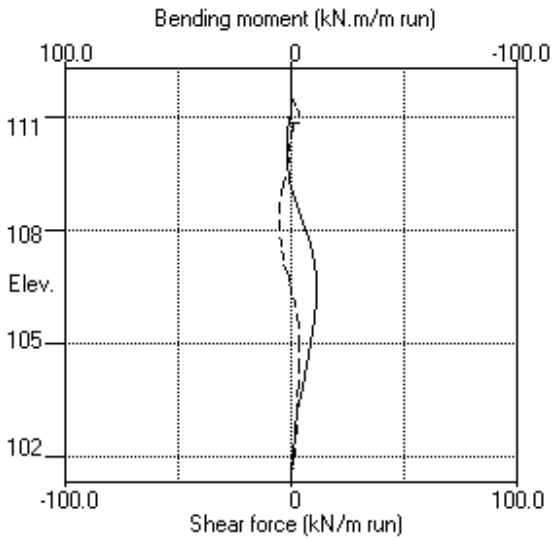
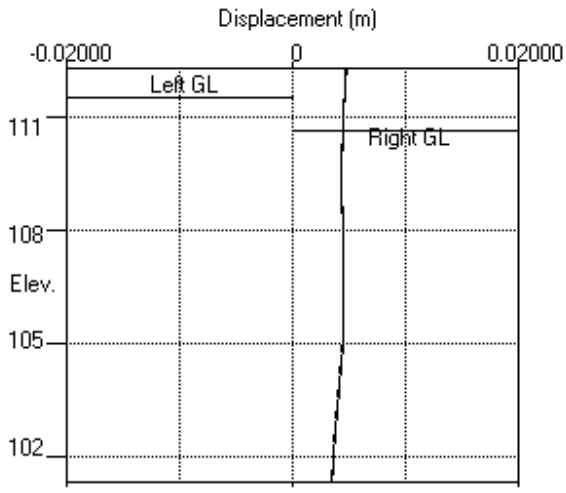
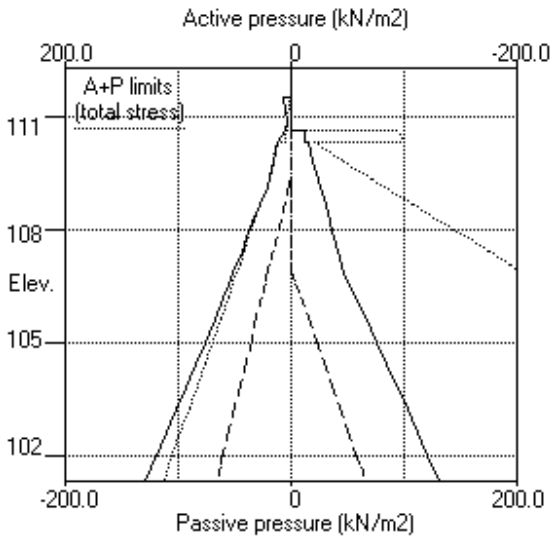
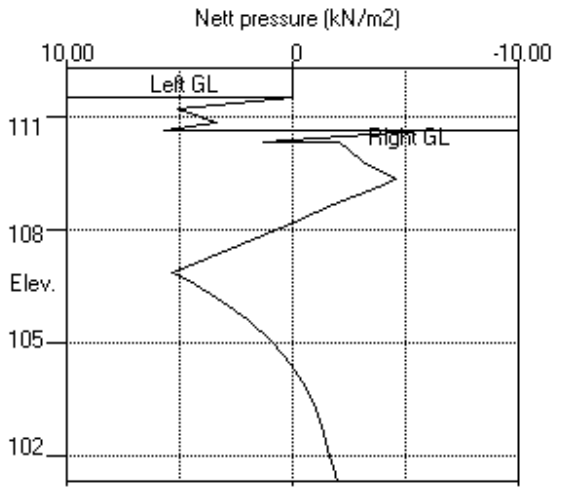
Stage No.8 Apply water pressure profile no.1 (Mod. Conserv.)





Stage No.8 Apply water pressure profile no.1 (Mod. Conserv.)





CREATE CONSULTING ENGINEERS LTD | Sheet No.
Program: WALLAP Version 6.09 Revision A59.B77.R60 | Job No. 2546
Licensed from GEOSOLVE | Made by : AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605 |
6a Grange Road Secant Wall | Date: 5-06-2025
No.6 Grange Road Side | Checked :

Units: kN,m

Stage No. 9 Excavate to elevation 108.65 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
9	111.52	108.65	110.84	2.574	n/a	107.03	1.62	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 20.00m 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 5

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	112.30	0.00	0.002	-1.84E-03	0.0	0.0		70350
2	111.91	0.00	0.003	-1.84E-03	0.0	0.1		70350
3	111.52	0.00	0.003	-1.85E-03	0.0	-0.0		70350
		37.40	0.003	-1.85E-03	0.0	-0.0		
4	111.18	20.22	0.004	-1.85E-03	9.8	2.2		70350
5	110.84	3.40	0.005	-1.89E-03	13.8	6.7	-53.5	70350
		3.40	0.005	-1.89E-03	-39.7	6.7		
6	110.65	4.57	0.005	-1.90E-03	-38.9	-0.9		70350
7	110.30	9.74	0.006	-1.89E-03	-36.4	-13.9		70350
		12.62	0.006	-1.89E-03	-36.4	-13.9		
8	109.82	16.22	0.006	-1.78E-03	-29.5	-29.5		70350
9	109.34	19.29	0.007	-1.58E-03	-21.0	-41.7		70350
10	109.15	21.60	0.008	-1.48E-03	-17.1	-45.3		70350
11	108.65	27.62	0.008	-1.19E-03	-4.7	-50.9		70350
12	108.21	9.14	0.009	-9.23E-04	3.4	-50.9		70350
13	107.77	3.35	0.009	-6.57E-04	6.1	-48.4		70350
14	107.42	3.86	0.009	-4.55E-04	7.3	-46.0		70350
15	107.07	4.56	0.009	-2.63E-04	8.8	-43.2		70350
16	106.87	5.05	0.009	-1.58E-04	9.8	-41.3		70350
17	106.54	3.45	0.009	6.28E-06	11.2	-37.8		70350
18	106.20	2.00	0.009	1.56E-04	12.1	-33.8		70350
19	105.60	-0.24	0.009	3.83E-04	12.7	-26.3		70350
20	105.00	-2.11	0.009	5.55E-04	11.9	-18.9		70350
21	104.40	-3.71	0.009	6.75E-04	10.2	-12.3		70350
22	103.80	-5.12	0.008	7.49E-04	7.6	-7.0		70350
23	103.20	-4.41	0.008	7.87E-04	4.7	-2.9		70350
24	102.60	-3.22	0.007	8.02E-04	2.4	-1.0		70350
25	102.00	-1.96	0.007	8.06E-04	0.9	-0.2		70350
26	101.65	-1.21	0.006	8.07E-04	0.3	-0.0		70350

(continued)

Stage No.9 Excavate to elevation 108.65 on RIGHT side

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
27	101.30	-0.45	0.006	8.07E-04	0.0	-0.0		---

At elev. 110.84 Prop force = 53.5 kN/m run

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	37.40	37.40	22465
4	111.18	Total>	8.53	1.70m	99.39	20.22	20.22	22509
5	110.84	Total>	20.96	3.40m	112.70	3.40	3.40a	2713
6	110.65	Total>	27.73	4.38m	119.96	4.57	4.57	2716
7	110.30	Total>	37.88	6.10m	131.01	9.74	9.74	2721
		0.00	37.88	12.62	113.65	12.62	12.62a	2441
8	109.82	0.00	48.72	16.22	146.15	16.22	16.22a	2446
9	109.34	0.00	57.93	19.29	173.80	19.29	19.29a	2451
10	109.15	1.56	60.19	20.04	180.57	20.04	21.60a	2454
11	108.65	5.69	65.87	21.94	197.62	21.94	27.62a	2459
12	108.21	9.27	70.56	23.50	211.69	23.50	32.77a	2464
13	107.77	12.85	75.12	25.02	225.37	25.02	37.87a	2469
14	107.42	15.72	78.71	26.21	236.12	26.21	41.93a	2473
15	107.07	18.58	82.26	27.39	246.77	27.39	45.97a	2477
16	106.87	20.22	84.27	28.06	252.82	28.06	48.28a	2479
17	106.54	22.96	87.64	29.19	262.93	29.19	52.14a	2483
18	106.20	25.70	91.01	30.31	273.04	30.31	56.01a	2486
19	105.60	30.61	97.07	32.32	291.21	32.32	62.94a	2493
20	105.00	35.52	103.18	34.36	309.54	34.36	69.88a	2500
21	104.40	40.43	109.36	36.42	328.09	36.42	76.85a	2506
22	103.80	45.35	115.63	38.51	346.89	38.51	83.85a	2513
23	103.20	50.26	121.98	40.62	365.95	42.62	92.87	2520
24	102.60	55.17	128.42	42.76	385.25	47.18	102.35	2526
25	102.00	60.08	134.93	44.93	404.79	51.79	111.87	2533
26	101.65	62.94	138.76	46.21	416.29	54.51	117.45	2537
27	101.30	65.81	142.62	47.49	427.85	57.23	123.04	2541

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.82	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	109.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	2612
12	108.21	0.00	7.88	2.62	23.63	23.63	23.63p	2617

(continued)

Stage No.9 Excavate to elevation 108.65 on RIGHT side

		RIGHT 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
13	107.77	0.00	15.75	5.25	47.26	34.52	34.52	2622
14	107.42	0.00	22.06	7.34	66.17	38.07	38.07	2627
15	107.07	0.00	28.36	9.45	85.09	41.41	41.41	2631
16	106.87	0.00	31.97	10.65	95.91	43.23	43.23	2633
17	106.54	3.96	34.73	11.56	104.18	44.74	48.70	2637
18	106.20	7.92	37.49	12.48	112.46	46.09	54.00	2641
19	105.60	15.00	42.44	14.13	127.33	48.17	63.17	2648
20	105.00	22.09	47.43	15.79	142.28	49.90	71.99	2655
21	104.40	29.18	52.43	17.46	157.29	51.38	80.56	2662
22	103.80	36.27	57.46	19.14	172.39	52.70	88.97	2669
23	103.20	43.36	62.53	20.82	187.58	53.92	97.28	2676
24	102.60	50.45	67.62	22.52	202.87	55.11	105.56	2683
25	102.00	57.54	72.75	24.23	218.25	56.30	113.84	2690
26	101.65	61.67	75.76	25.23	227.27	56.99	118.66	2695
27	101.30	65.81	78.78	26.23	236.33	57.68	123.49	2699

Note: 83.85 a Soil pressure at active limit
23.63 p Soil pressure at passive limit

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CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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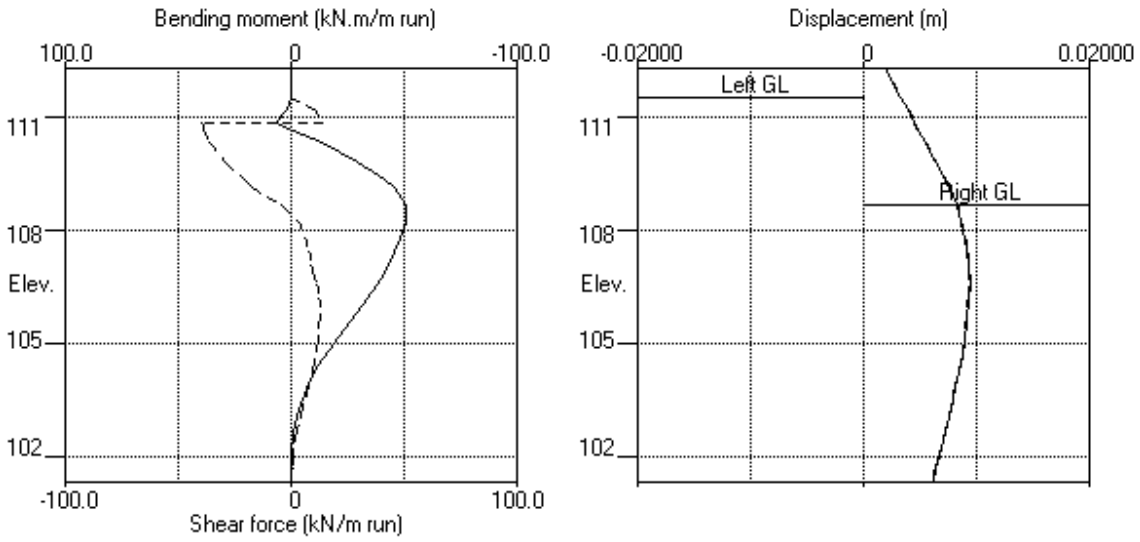
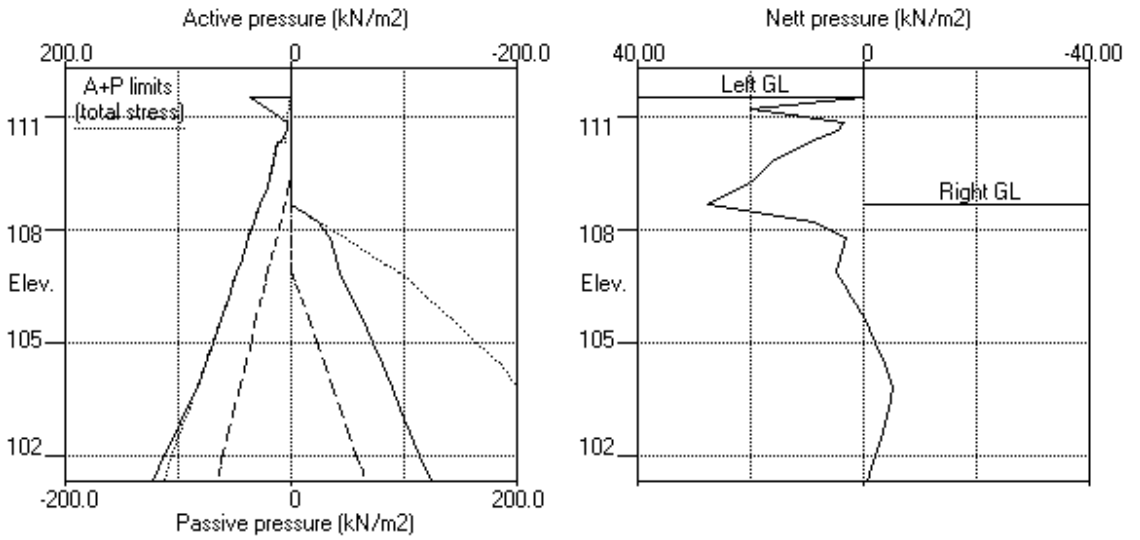
Stage No.9 Excav. to elev. 108.65 on RIGHT side



Stage No.9 Excav. to elev. 108.65 on RIGHT side



Units: kN,m

Stage No. 11 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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
11	111.52	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 20.00m 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 5

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	112.30	0.00	0.001	-2.66E-03	0.0	0.0		70350
2	111.91	0.00	0.002	-2.66E-03	0.0	0.1		70350
3	111.52	0.00	0.003	-2.66E-03	0.0	-0.0		70350
		49.78	0.003	-2.66E-03	0.0	-0.0		
4	111.18	26.54	0.004	-2.67E-03	13.0	2.9		70350
5	110.84	3.62	0.004	-2.71E-03	18.1	8.9	-31.1	70350
		3.62	0.004	-2.71E-03	-13.0	8.9		
6	110.65	4.38	0.005	-2.74E-03	-12.2	6.5		70350
7	110.30	8.43	0.006	-2.78E-03	-10.0	2.6		70350
		12.62	0.006	-2.78E-03	-10.0	2.6		
8	109.82	16.22	0.007	-2.83E-03	-3.1	-0.3		70350
9	109.34	19.29	0.009	-2.87E-03	5.4	0.3		70350
10	109.15	21.60	0.009	-2.90E-03	9.3	1.6	-86.5	70350
		21.60	0.009	-2.90E-03	-77.2	1.6		
11	108.65	27.62	0.011	-2.83E-03	-64.8	-34.3		70350
12	108.21	32.77	0.012	-2.58E-03	-51.6	-59.9		70350
13	107.77	37.87	0.013	-2.20E-03	-36.1	-78.7		70350
14	107.42	41.93	0.014	-1.81E-03	-22.2	-89.0		70350
15	107.07	45.97	0.014	-1.39E-03	-6.8	-94.0		70350
16	106.87	37.48	0.014	-1.13E-03	1.6	-94.5		70350
17	106.54	29.16	0.015	-7.19E-04	12.7	-92.0		70350
18	106.20	20.83	0.015	-3.15E-04	21.1	-86.3		70350
19	105.60	5.90	0.015	3.25E-04	29.1	-70.8		70350
20	105.00	-7.08	0.015	8.27E-04	28.8	-52.0		70350
21	104.40	-7.97	0.014	1.18E-03	24.3	-36.2		70350
22	103.80	-8.30	0.013	1.43E-03	19.4	-23.2		70350
23	103.20	-8.26	0.012	1.58E-03	14.4	-12.7		70350
24	102.60	-7.98	0.011	1.66E-03	9.5	-5.7		70350
25	102.00	-7.59	0.010	1.69E-03	4.9	-1.7		70350

(continued)

Stage No.11 Excavate to elevation 107.07 on RIGHT side

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
26	101.65	-7.34	0.010	1.69E-03	2.3	-0.5		70350
27	101.30	-5.51	0.009	1.69E-03	0.0	-0.0		---

At elev. 110.84 Prop force = 31.1 kN/m run
At elev. 109.15 Prop force = 86.5 kN/m run

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	49.78	49.78	21872
4	111.18	Total>	8.53	1.70m	99.39	26.54	26.54	21914
5	110.84	Total>	20.96	3.40m	112.70	3.62	3.62	21957
6	110.65	Total>	27.73	4.38m	119.96	4.38	4.38a	2898
7	110.30	Total>	37.88	6.10m	131.01	8.43	8.43	2903
		0.00	37.88	12.62	113.65	12.62	12.62a	2633
8	109.82	0.00	48.72	16.22	146.15	16.22	16.22a	2639
9	109.34	0.00	57.93	19.29	173.80	19.29	19.29a	2645
10	109.15	1.56	60.19	20.04	180.57	20.04	21.60a	2647
11	108.65	5.69	65.87	21.94	197.62	21.94	27.62a	2653
12	108.21	9.27	70.56	23.50	211.69	23.50	32.77a	2658
13	107.77	12.85	75.12	25.02	225.37	25.02	37.87a	2663
14	107.42	15.72	78.71	26.21	236.12	26.21	41.93a	2668
15	107.07	18.58	82.26	27.39	246.77	27.39	45.97a	2672
16	106.87	20.22	84.27	28.06	252.82	28.06	48.28a	2674
17	106.54	22.96	87.64	29.19	262.93	29.19	52.14a	2678
18	106.20	25.70	91.01	30.31	273.04	30.31	56.01a	2682
19	105.60	30.61	97.07	32.32	291.21	32.32	62.94a	2689
20	105.00	35.52	103.18	34.36	309.54	34.36	69.88a	2697
21	104.40	40.43	109.36	36.42	328.09	36.42	76.85a	2704
22	103.80	45.35	115.63	38.51	346.89	38.51	83.85a	2711
23	103.20	50.26	121.98	40.62	365.95	40.62	90.88a	2718
24	102.60	55.17	128.42	42.76	385.25	42.76	97.93a	2725
25	102.00	60.08	134.93	44.93	404.79	44.93	105.01a	2732
26	101.65	62.94	138.76	46.21	416.29	46.21	109.15a	2737
27	101.30	65.81	142.62	47.49	427.85	49.05	114.86	2741

RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.82	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	109.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.11 Excavate to elevation 107.07 on RIGHT side

		RIGHT 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
12	108.21	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	107.77	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	107.42	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	2994
16	106.87	0.00	3.60	1.20	10.80	10.80	10.80p	2997
17	106.54	3.96	6.34	2.11	19.03	19.03	22.99p	3001
18	106.20	7.92	9.09	3.03	27.26	27.26	35.18p	3006
19	105.60	15.00	14.01	4.67	42.04	42.04	57.04p	3014
20	105.00	22.09	18.95	6.31	56.86	54.86	76.96	3022
21	104.40	29.18	23.92	7.96	71.75	55.64	84.83	3030
22	103.80	36.27	28.91	9.63	86.72	55.88	92.15	3038
23	103.20	43.36	33.93	11.30	101.80	55.77	99.13	3046
24	102.60	50.45	39.00	12.99	116.99	55.46	105.91	3054
25	102.00	57.54	44.10	14.69	132.31	55.06	112.60	3062
26	101.65	61.67	47.10	15.68	141.30	54.82	116.49	3067
27	101.30	65.81	50.12	16.69	150.35	54.56	120.37	3071

Note: 109.15 a Soil pressure at active limit
57.04 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
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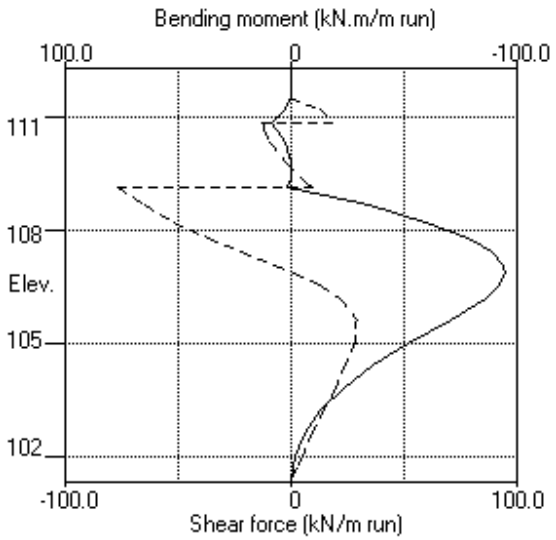
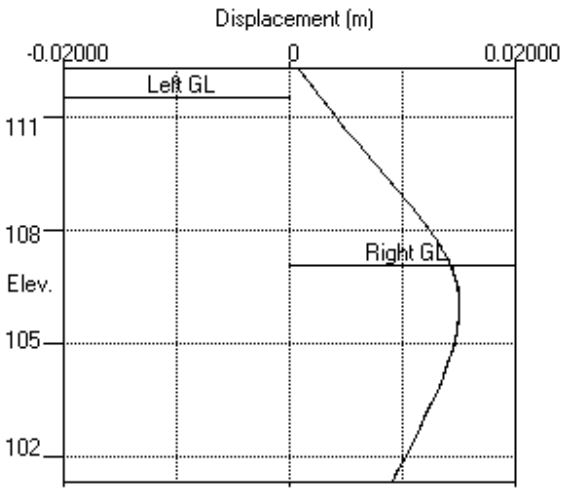
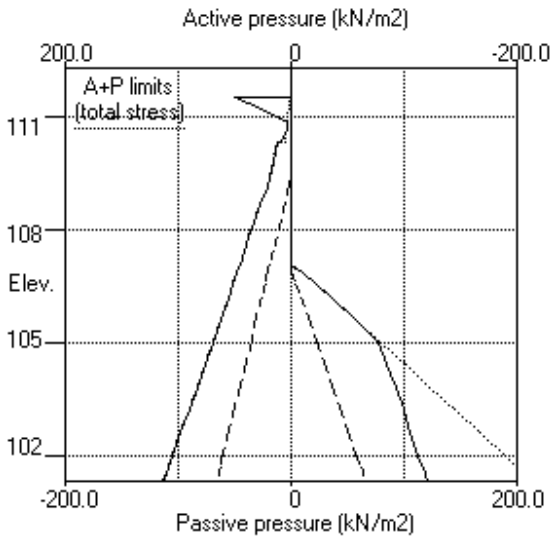
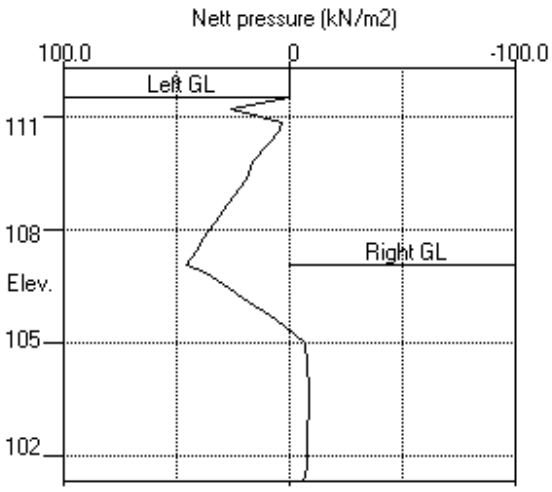
Stage No.11 Excav. to elev. 107.07 on RIGHT side





Stage No.11 Excav. to elev. 107.07 on RIGHT side





Units: kN,m

Stage No. 13 Remove strut or anchor no.2 at elevation 109.15

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
13	111.52	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 20.00m 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 5

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	112.30	0.00	-0.000	-3.17E-03	0.0	0.0		70350
2	111.91	0.00	0.001	-3.17E-03	0.0	0.1		70350
3	111.52	0.00	0.002	-3.17E-03	0.0	-0.0		70350
		57.43	0.002	-3.17E-03	0.0	-0.0		
4	111.18	30.21	0.003	-3.18E-03	14.9	3.3		70350
5	110.84	3.53	0.005	-3.23E-03	20.6	10.2	-65.5	70350
		3.53	0.005	-3.23E-03	-44.9	10.2		
6	110.65	4.38	0.005	-3.25E-03	-44.1	1.5		70350
7	110.30	6.71	0.006	-3.24E-03	-42.2	-13.3		70350
		12.62	0.006	-3.24E-03	-42.2	-13.3		
8	109.82	16.22	0.008	-3.13E-03	-35.3	-31.6		70350
9	109.34	19.29	0.009	-2.91E-03	-26.8	-46.6		70350
10	109.15	21.60	0.010	-2.79E-03	-22.9	-51.3		70350
11	108.65	27.62	0.011	-2.45E-03	-10.5	-59.8		70350
12	108.21	32.77	0.012	-2.12E-03	2.8	-61.6		70350
13	107.77	37.87	0.013	-1.79E-03	18.2	-56.7	-62.7	70350
		37.87	0.013	-1.79E-03	-44.5	-56.7		
14	107.42	42.28	0.014	-1.51E-03	-30.5	-69.9		70350
15	107.07	46.67	0.014	-1.17E-03	-14.9	-77.8		70350
16	106.87	39.18	0.014	-9.67E-04	-6.3	-79.9		70350
17	106.54	31.21	0.015	-6.10E-04	5.5	-80.0		70350
18	106.20	23.10	0.015	-2.58E-04	14.6	-76.5		70350
19	105.60	8.26	0.015	3.13E-04	24.0	-64.6		70350
20	105.00	-4.86	0.014	7.74E-04	25.0	-48.5		70350
21	104.40	-6.05	0.014	1.11E-03	21.7	-34.5		70350
22	103.80	-6.74	0.013	1.35E-03	17.9	-22.7		70350
23	103.20	-7.08	0.012	1.49E-03	13.7	-12.8		70350
24	102.60	-7.20	0.011	1.57E-03	9.4	-6.1		70350
25	102.00	-7.19	0.010	1.61E-03	5.1	-1.9		70350

(continued)

Stage No.13 Remove strut or anchor no.2 at elevation 109.15

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
26	101.65	-7.15	0.010	1.61E-03	2.6	-0.6		70350
27	101.30	-7.79	0.009	1.61E-03	0.0	-0.0		---

At elev. 110.84 Prop force = 65.5 kN/m run
At elev. 107.77 Prop force = 62.7 kN/m run

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	57.43	57.43	22983
4	111.18	Total>	8.53	1.70m	99.39	30.21	30.21	23028
5	110.84	Total>	20.96	3.40m	112.70	3.53	3.53	6043
6	110.65	Total>	27.73	4.38m	119.96	4.38	4.38a	6050
7	110.30	Total>	37.88	6.10m	131.01	6.71	6.71	6061
		0.00	37.88	12.62	113.65	12.62	12.62a	5809
8	109.82	0.00	48.72	16.22	146.15	16.22	16.22a	5821
9	109.34	0.00	57.93	19.29	173.80	19.29	19.29a	5834
10	109.15	1.56	60.19	20.04	180.57	20.04	21.60a	5839
11	108.65	5.69	65.87	21.94	197.62	21.94	27.62a	5852
12	108.21	9.27	70.56	23.50	211.69	23.50	32.77a	5864
13	107.77	12.85	75.12	25.02	225.37	25.02	37.87a	5875
14	107.42	15.72	78.71	26.21	236.12	26.57	42.28	3734
15	107.07	18.58	82.26	27.39	246.77	28.09	46.67	3740
16	106.87	20.22	84.27	28.06	252.82	28.90	49.12	3743
17	106.54	22.96	87.64	29.19	262.93	30.20	53.16	3749
18	106.20	25.70	91.01	30.31	273.04	31.43	57.13	3755
19	105.60	30.61	97.07	32.32	291.21	33.49	64.11	3765
20	105.00	35.52	103.18	34.36	309.54	35.46	70.98	3775
21	104.40	40.43	109.36	36.42	328.09	37.37	77.81	3785
22	103.80	45.35	115.63	38.51	346.89	39.28	84.62	3795
23	103.20	50.26	121.98	40.62	365.95	41.20	91.46	3805
24	102.60	55.17	128.42	42.76	385.25	43.15	98.32	3815
25	102.00	60.08	134.93	44.93	404.79	45.13	105.21	3825
26	101.65	62.94	138.76	46.21	416.29	46.30	109.24	3831
27	101.30	65.81	142.62	47.49	427.85	47.91	113.72	320890

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	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.82	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	109.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.13 Remove strut or anchor no.2 at elevation 109.15

		RIGHT 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
12	108.21	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	107.77	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	107.42	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	3811
16	106.87	0.00	3.60	1.20	10.80	9.94	9.94	3815
17	106.54	3.96	6.34	2.11	19.03	17.99	21.95	3821
18	106.20	7.92	9.09	3.03	27.26	26.12	34.03	3826
19	105.60	15.00	14.01	4.67	42.04	40.84	55.85	3837
20	105.00	22.09	18.95	6.31	56.86	53.75	75.84	3847
21	104.40	29.18	23.92	7.96	71.75	54.67	83.86	3857
22	103.80	36.27	28.91	9.63	86.72	55.10	91.37	3867
23	103.20	43.36	33.93	11.30	101.80	55.18	98.54	3878
24	102.60	50.45	39.00	12.99	116.99	55.07	105.52	3888
25	102.00	57.54	44.10	14.69	132.31	54.86	112.40	3898
26	101.65	61.67	47.10	15.68	141.30	54.72	116.39	3904
27	101.30	65.81	50.12	16.69	150.35	55.70	121.51	320890

Note: 37.87 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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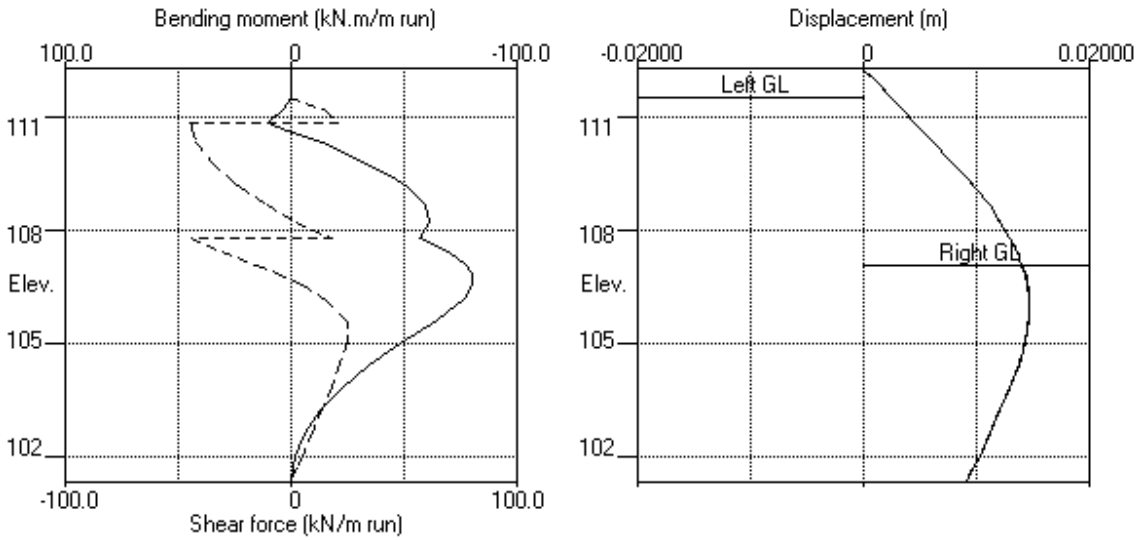
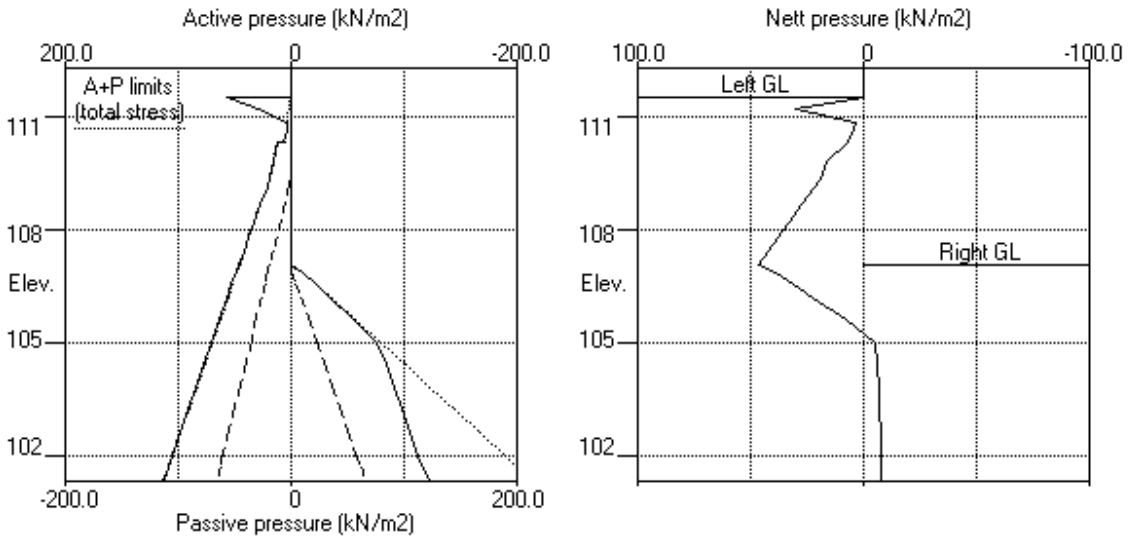
Stage No.13 Remove prop no.2 at elev. 109.15



Stage No.13 Remove prop no.2 at elev. 109.15



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CREATE CONSULTING ENGINEERS LTD                              | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60          | Job No.    2546
                              Licensed from GEOSOLVE         | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605          |
6a Grange Road Secant Wall                                   | Date: 5-06-2025
No.6 Grange Road Side                                        | Checked :
-------------------------------------------------------------------------------
                                                        Units: kN,m
Stage No. 14   Change EI of wall to 50250 kN.m2/m run
              Allow wall to relax with new modulus value
```

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
14	111.52	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 20.00m 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 5

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	112.30	0.00	-0.000	-3.13E-03	0.0	0.0		50250
2	111.91	0.00	0.001	-3.13E-03	0.0	0.1		50250
3	111.52	0.00	0.002	-3.13E-03	0.0	0.1		50250
		56.89	0.002	-3.13E-03	0.0	0.1		
4	111.18	30.03	0.003	-3.15E-03	14.8	3.6		50250
5	110.84	3.56	0.005	-3.21E-03	20.5	10.7	-58.6	50250
		3.56	0.005	-3.21E-03	-38.1	10.7		
6	110.65	4.44	0.005	-3.24E-03	-37.4	3.3		50250
7	110.30	6.77	0.006	-3.25E-03	-35.4	-9.4		50250
		12.67	0.006	-3.25E-03	-35.4	-9.4		
8	109.82	16.23	0.008	-3.14E-03	-28.5	-24.9		50250
9	109.34	19.29	0.009	-2.91E-03	-20.0	-37.1		50250
10	109.15	21.60	0.010	-2.79E-03	-16.1	-40.8		50250
11	108.65	27.64	0.011	-2.44E-03	-3.6	-46.6		50250
12	108.21	32.83	0.012	-2.12E-03	9.6	-46.1		50250
13	107.77	37.87	0.013	-1.83E-03	25.0	-39.0	-72.1	50250
		37.87	0.013	-1.83E-03	-47.0	-39.0		
14	107.42	42.15	0.014	-1.58E-03	-33.0	-53.0		50250
15	107.07	46.40	0.014	-1.24E-03	-17.5	-61.8		50250
16	106.87	38.50	0.014	-1.02E-03	-9.0	-64.4		50250
17	106.54	30.35	0.015	-6.47E-04	2.5	-65.3		50250
18	106.20	22.14	0.015	-2.67E-04	11.3	-62.8		50250
19	105.60	7.40	0.015	3.49E-04	20.1	-52.8		50250
20	105.00	-5.38	0.014	8.38E-04	20.7	-38.8		50250
21	104.40	-6.10	0.014	1.18E-03	17.3	-27.0		50250
22	103.80	-6.19	0.013	1.42E-03	13.6	-17.4		50250
23	103.20	-5.94	0.012	1.56E-03	10.0	-9.5		50250
24	102.60	-5.52	0.011	1.64E-03	6.5	-4.4		50250

(continued)

Stage No.14 Change EI of wall to 50250 kN.m2/m run
Allow wall to relax with new modulus value

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
25	102.00	-4.99	0.010	1.67E-03	3.4	-1.4		50250
26	101.65	-4.66	0.009	1.67E-03	1.7	-0.5		50250
27	101.30	-5.00	0.009	1.67E-03	0.0	-0.0		---

At elev. 110.84 Prop force = 58.6 kN/m run
At elev. 107.77 Prop force = 72.1 kN/m run

LEFT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	89.98	56.89	56.89	27886
4	111.18	Total>	8.53	1.70m	99.39	30.03	30.03	27940
5	110.84	Total>	20.96	3.40m	112.70	3.56	3.56	11188
6	110.65	Total>	27.73	4.38m	119.96	4.44	4.44	11200
7	110.30	Total>	37.88	6.10m	131.01	6.77	6.77	11222
		0.00	37.88	12.62	113.65	12.67	12.67	10951
8	109.82	0.00	48.72	16.22	146.15	16.23	16.23	10975
9	109.34	0.00	57.93	19.29	173.80	19.29	19.29a	15479
10	109.15	1.56	60.19	20.04	180.57	20.04	21.60a	15492
11	108.65	5.69	65.87	21.94	197.62	21.95	27.64	19744
12	108.21	9.27	70.56	23.50	211.69	23.56	32.83	19783
13	107.77	12.85	75.12	25.02	225.37	25.02	37.87a	5479
14	107.42	15.72	78.71	26.21	236.12	26.44	42.15	5488
15	107.07	18.58	82.26	27.39	246.77	27.82	46.40	5497
16	106.87	20.22	84.27	28.06	252.82	28.57	48.78	5502
17	106.54	22.96	87.64	29.19	262.93	29.78	52.73	5510
18	106.20	25.70	91.01	30.31	273.04	30.96	56.66	5518
19	105.60	30.61	97.07	32.32	291.21	33.07	63.68	5533
20	105.00	35.52	103.18	34.36	309.54	35.20	70.72	5548
21	104.40	40.43	109.36	36.42	328.09	37.35	77.78	5562
22	103.80	45.35	115.63	38.51	346.89	39.55	84.90	6868
23	103.20	50.26	121.98	40.62	365.95	41.77	92.03	6886
24	102.60	55.17	128.42	42.76	385.25	43.99	99.16	6904
25	102.00	60.08	134.93	44.93	404.79	46.23	106.31	6923
26	101.65	62.94	138.76	46.21	416.29	47.55	110.49	6933
27	101.30	65.81	142.62	47.49	427.85	49.31	115.12	6944

RIGHT side

Node no.	Y coord	Water press. kN/m2	Effective stresses: Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	112.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	111.91	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	111.52	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	111.18	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	110.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	110.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	109.82	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

(continued)

Stage No.14 Change EI of wall to 50250 kN.m2/m run
Allow wall to relax with new modulus value

		RIGHT 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
10	109.15	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	108.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	108.21	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	107.77	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	107.42	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	5643
16	106.87	0.00	3.60	1.20	10.80	10.29	10.29	5648
17	106.54	3.96	6.34	2.11	19.03	18.43	22.39	5657
18	106.20	7.92	9.09	3.03	27.26	26.60	34.52	5665
19	105.60	15.00	14.01	4.67	42.04	41.28	56.28	5680
20	105.00	22.09	18.95	6.31	56.86	54.01	76.10	5696
21	104.40	29.18	23.92	7.96	71.75	54.70	83.88	5711
22	103.80	36.27	28.91	9.63	86.72	54.82	91.09	6868
23	103.20	43.36	33.93	11.30	101.80	54.61	97.97	6886
24	102.60	50.45	39.00	12.99	116.99	54.23	104.68	6904
25	102.00	57.54	44.10	14.69	132.31	53.76	111.30	6923
26	101.65	61.67	47.10	15.68	141.30	53.48	115.15	6933
27	101.30	65.81	50.12	16.69	150.35	54.31	120.12	6944

Note: 37.87 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

```
CREATE CONSULTING ENGINEERS LTD                                | Sheet No.
Program: WALLAP  Version 6.09  Revision A59.B77.R60            | Job No.    2546
                              Licensed from GEOSOLVE           | Made by :    AW
Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
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                                                        Units: kN,m
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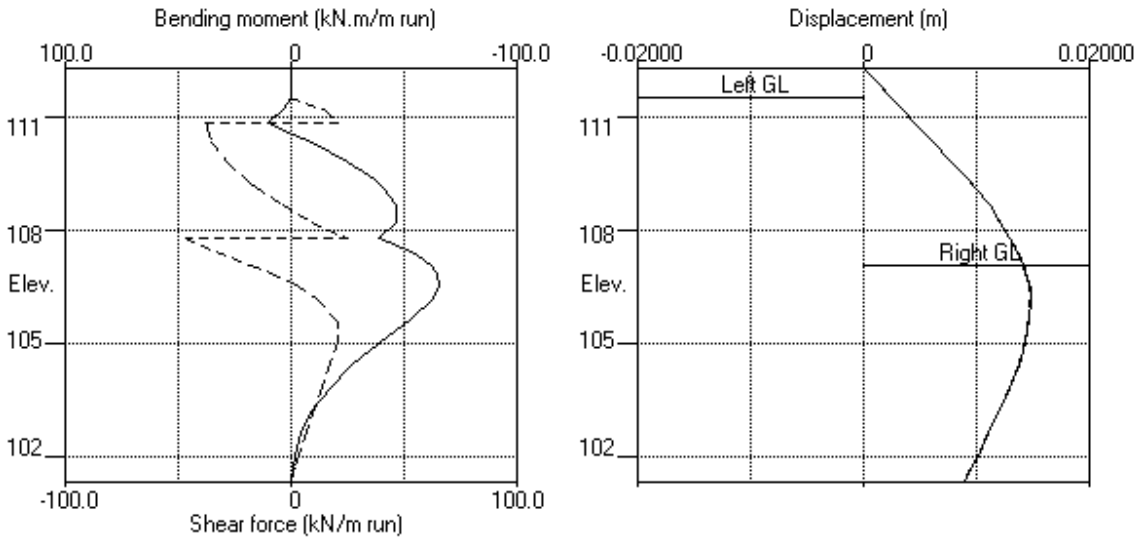
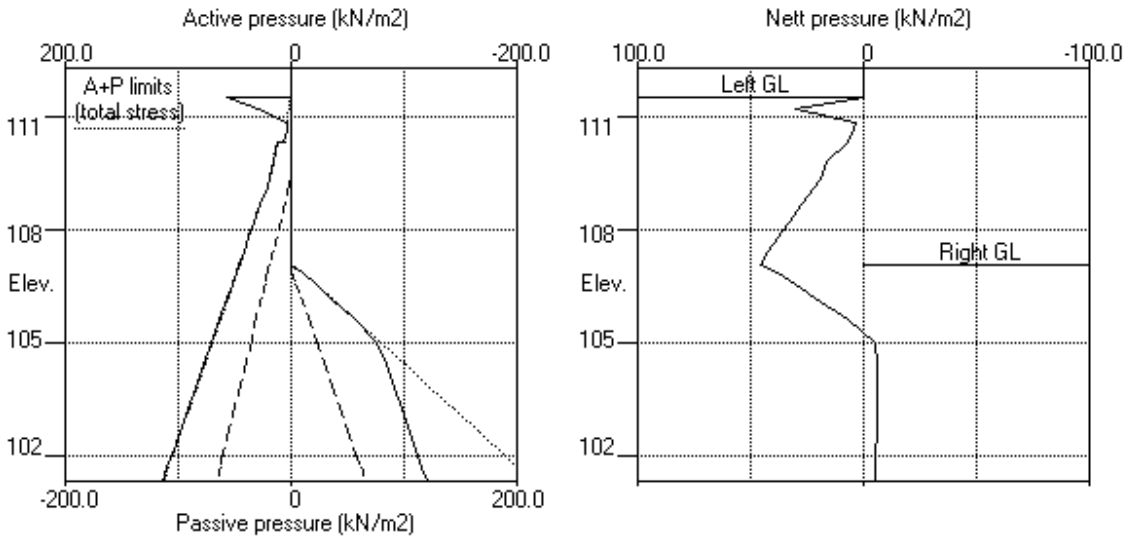
Stage No.14 Change EI of wall to 50250kN.m2/m run



Stage No.14 Change EI of wall to 50250kN.m2/m run



Units: kN,m

Summary of results

LIMIT STATE PARAMETERS

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

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 101.30 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	112.30	112.30	Cant.	Conditions not suitable for FoS calc.				
2	112.30	112.30	Cant.	Conditions not suitable for FoS calc.				
3	112.30	112.30	Cant.	Conditions not suitable for FoS calc.				
4	112.30	111.52	Cant.	74.813	101.44	111.48	0.04	R to L
5	111.52	112.30		No analysis at this stage				
6	111.52	110.65	Cant.	4.051	102.16	110.59	0.06	L to R
7	111.52	110.65		No analysis at this stage				
8	111.52	110.65	110.84	Conditions not suitable for FoS calc.				
9	111.52	108.65	110.84	2.574	n/a	107.03	1.62	L to R
10	111.52	108.65		No analysis at this stage				

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

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

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 20.00m 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	kN/m	kN/m
1	112.30	0.005	-0.000	0	-0	0	-0	0	0	0	0
2	111.91	0.005	0.000	0	-0	0	-0	0	-1	0	-1
3	111.52	0.005	0.000	0	-0	0	-1	0	-2	0	-3
4	111.18	0.005	0.000	4	-1	5	-2	15	-4	20	-5
5	110.84	0.005	0.000	11	-3	14	-4	21	-45	28	-61
6	110.65	0.005	0.000	6	-3	9	-5	2	-44	3	-60
7	110.30	0.006	0.000	3	-14	4	-19	2	-42	2	-57
8	109.82	0.008	0.000	2	-32	3	-43	1	-35	1	-48
9	109.34	0.009	0.000	2	-47	3	-63	5	-27	7	-36
10	109.15	0.010	0.000	2	-51	3	-69	9	-77	13	-104
11	108.65	0.011	0.000	2	-60	3	-81	1	-65	1	-87
12	108.21	0.012	0.000	2	-62	3	-83	10	-52	13	-70
13	107.77	0.013	0.000	2	-79	2	-106	25	-47	34	-63
14	107.42	0.014	0.000	2	-89	2	-120	7	-33	10	-45
15	107.07	0.014	0.000	1	-94	2	-127	9	-18	12	-24
16	106.87	0.014	0.000	1	-95	2	-128	10	-9	13	-12
17	106.54	0.015	0.000	1	-92	2	-124	13	-1	17	-1
18	106.20	0.015	0.000	1	-86	1	-116	21	-0	28	-0
19	105.60	0.015	0.000	1	-71	1	-96	29	-0	39	-0
20	105.00	0.015	0.000	1	-52	1	-70	29	-0	39	-0
21	104.40	0.014	0.000	1	-36	1	-49	24	-0	33	-0
22	103.80	0.013	0.000	0	-23	1	-31	19	-0	26	-0
23	103.20	0.012	0.000	0	-13	1	-17	14	-0	19	-0
24	102.60	0.011	0.000	0	-6	0	-8	10	-0	13	-0
25	102.00	0.010	0.000	0	-2	0	-3	5	-0	7	-0
26	101.65	0.010	0.000	0	-1	0	-1	3	-0	4	-0
27	101.30	0.009	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.

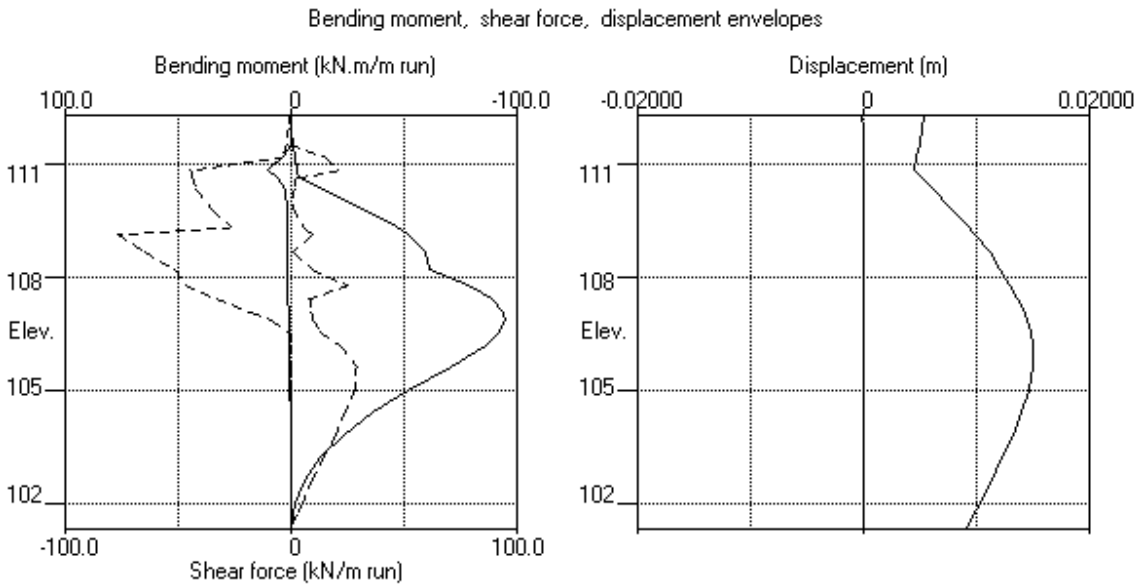
Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment Calculated max. kN.m/m	elev.	min. kN.m/m	elev.	Bending moment Factored max. kN.m/m	min.	Shear force Calculated max. kN/m	elev.	min. kN/m	elev.	Shear force Factored max. kN/m	min. kN/m
1	0	103.80	-4	109.82	1	-6	1	107.77	-4	110.84	2	-5
2	0	101.65	-5	109.15	0	-7	1	106.54	-4	110.84	2	-5
3	0	102.60	-5	109.15	0	-6	1	106.87	-4	110.84	2	-5
4	0	111.91	-8	108.65	0	-10	2	106.54	-4	110.65	3	-6
5	No calculation at this stage											
6	2	109.15	-0	111.52	3	-0	2	110.65	-0	107.42	3	-1
7	No calculation at this stage											
8	2	109.82	-11	106.54	2	-15	3	110.84	-6	108.21	5	-8
9	7	110.84	-51	108.65	9	-69	14	110.84	-40	110.84	19	-54
10	No calculation at this stage											
11	9	110.84	-95	106.87	12	-128	29	105.60	-77	109.15	39	-104
12	No calculation at this stage											
13	10	110.84	-80	106.54	14	-108	25	105.00	-45	110.84	34	-61
14	11	110.84	-65	106.54	14	-88	25	107.77	-47	107.77	34	-63

Maximum and minimum displacement at each stage

Stage no.	maximum m	elev.	minimum m	elev.	Stage description
1	0.001	110.30	0.000	112.30	Apply surcharge no.1 at elev. 111.52
2	0.001	108.65	0.000	112.30	Apply surcharge no.2 at elev. 111.52
3	0.001	108.65	0.000	112.30	Change EI of wall to 70350kN.m2/m run
4	0.000	112.30	-0.001	112.30	Excav. to elev. 111.52 on LEFT side
5	Wall displacements reset to zero				Change EI of wall to 70350kN.m2/m run
6	0.005	112.30	0.000	112.30	Excav. to elev. 110.65 on RIGHT side
7	No calculation at this stage				Install prop no.1 at elev. 110.84
8	0.005	112.30	0.000	112.30	Apply water pressure profile no.1
9	0.009	106.54	0.000	112.30	Excav. to elev. 108.65 on RIGHT side
10	No calculation at this stage				Install prop no.2 at elev. 109.15
11	0.015	106.20	0.000	112.30	Excav. to elev. 107.07 on RIGHT side
12	No calculation at this stage				Install prop no.3 at elev. 107.77
13	0.015	106.20	-0.000	112.30	Remove prop no.2 at elev. 109.15
14	0.015	106.20	-0.000	112.30	Change EI of wall to 50250kN.m2/m run

Prop forces at each stage (horizontal components)

Stage no.	Prop no. 1 at elev. 110.84 Calculated kN per m run	Prop no. 1 Factored kN per prop	Prop no. 1 Factored kN per prop	Prop no. 2 at elev. 109.15 Calculated kN per m run	Prop no. 2 Factored kN per prop	Prop no. 2 Factored kN per prop	Prop no. 3 at elev. 107.77 Calculated kN per m run	Prop no. 3 Factored kN per prop	Prop no. 3 Factored kN per prop
8	4	4	5	---	---	---	---	---	---
9	53	53	72	---	---	---	---	---	---
11	31	31	42	87	87	117	---	---	---
13	66	66	88	---	---	---	63	63	85
14	59	59	79	---	---	---	72	72	97

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Data filename/Run ID: 6GR_2546_secant_wall_20250605            |
6a Grange Road Secant Wall                                     | Date: 5-06-2025
No.6 Grange Road Side                                          | Checked :
-------------------------------------------------------------------------------
                                                          Units: kN,m
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