HIGHWAYS & STREETSCENE
HIGHWAYS STRUCTURES

Civic Centre 1
High Street
Huddersfield
HD1 2NE

APPROVAL IN PRINCIPLE FOR DESIGN OF

Private Gillcon Lock+Load Retaining Walls in a New Residential Development off Westgate, Cleckheaton

Structure reference:	**K61200C, D**
Date:	**17/06/2026**
Revision:	**P7**
Status:	**Final**
Prepared by:	**D.J. Phillipson**
Checked by:	**D. Rogers**

DOCUMENT CONTROL

Structure title: Private Gillcon Lock+Load Retaining Walls in a New Development off, Westgate, Cleckheaton

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Document issue record

Issue	Status	Prepared	Date	Checked	Date	Approved	Date
-	Appr'l	D.J. Phillipson	20/06/25	D. Rogers	20/06/25	D. Rogers	20/06/25
P1	Appr'l	D.J. Phillipson	09/07/25	D. Rogers	09/07/25	D. Rogers	09/07/25
P2	Draft	D.J. Phillipson	02/09/25	D. Rogers	02/09/25	D. Rogers	02/09/25
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P7	Draft	D.J. Phillipson	17/06/26	D. Rogers	17/06/26	D. Rogers	17/06/26

PROJECT DETAILS

Name of project: Westgate, Cleckheaton

Name of Bridge or Structure: Gillcon Lock+Load Retaining Walls

Structure reference no: K61200C & D

Summary:

AIP is to cover the design of the proposed Lock + Load Retaining Walls adjacent, Plots No's 44 to 52. and adjacent Plot 1 (as shown on drg no QD1776-14-10D).

1. HIGHWAY DETAILS

1.1. Type of highway

1.1.1. Location and OS Map / Grid reference

Location:	Westgate, Cleckheaton
OS Map:	SE184250
Grid Ref (X, Y):	(418400,42500)

1.2. Permitted traffic speed

30 m.p.h.

1.3. Existing restrictions

The walls form the boundary to the Plot garden areas, access is restricted by the plot layout and associated boundaries.

2. SITE DETAILS

2.1. Obstacles crossed

None.

3. PROPOSED STRUCTURE

3.1. Description of structure and design working life

The proposed structure is to be a Lock+Load retaining wall with geogrid-reinforced granular backfill (Class 6I). The system has a 120-year design life as per HAPAS Certificate number 21/H311. The geogrid reinforcement is to be Secugrid 40/40 as per BBA HAPAS Certificate 14/H218.

The Lock+Load alongside Quarry Road is to be 64.2m in length (CH100m – CH164.2m of Wall 03), with a maximum retained height of 3.63m (K61200C).

The Lock+Load alongside Westgate is to be 6.8m in length (CH32.6m – CH36.8m of Wall 01), with a maximum retained height of 1.50m (K61200D).

The reinforced granular backfill is to be compacted Class 6I granular fill, in accordance with the Specification for Highway Works, Series 600.

Construction of the wall is to be in accordance with the manufacturer's installation instructions and HAPAS Certificate number 21/H311.

Design details of the wall are shown on Geoman Ltd. drawing numbers SK24-5558-F1-01, 02, 04E & 05E

3.2. Structural type

Lock + Load Retaining Wall System by Gillcon.

3.3. Foundation type

Wall 01 Lock + Load to be founded on natural clays, bearing pressure from ground investigation report 150kPa, chainage 32.6-36.8m.

Wall 03 Lock+Load to be constructed on a 0.5m deep Load Transfer platform (LTP) over rigid inclusions, chainage 100-164.2 m The ground will be improved to provide the 140kPa required by the retaining wall design, Calculations in appendix C

3.4. Span arrangements

The maximum retained height of Wall 03 alongside Quarry Road is to be 3.63m, see drawing QD1776-14-13 – Section 11-11. The maximum retained height of Wall 01 at Westgate is to be 1.50m, see drawing QD1776-14-13 – Section 12-12.

3.5. Articulation arrangements

As the facing panels are mortarless, no expansion joints are required in the face as a degree of movement can be accommodated due to their mortarless, segmental nature.

3.6. Classes and levels

3.6.1. Consequence class

Consequence class to be CC2 (medium consequence for loss of human life, economic, social or environmental consequences considerable)

3.6.2. Reliability class

Reliability class is to be associated with the consequence class detailed in 3.6.1. Reliability class to be RC2.

Factor for actions to be used KFI = 1,0

3.6.3. Inspection level

Inspection Level 2 – Normal inspection (inspection in accordance with the procedures of the inspecting organisation).

3.7. Road restraint systems requirements

A close boarded 1.8m high timber fence will be constructed behind the retaining wall as the boundary treatment.

The BBA mentions parapet loading from vehicle barriers in Section 4.5, and specific checks are carried out on any vehicle impact loads by the designer. However, in this case it is only a pedestrian barrier (1.8m timber fence) to be considered. Such a fence is shown in Figure 4 of the HAPAS Cert, and this detail is regularly included at the wall crest. The wall design considers the presence of the fence sleeve and associated loading to BS EN 1991-1-4, which will be verified using GEO5 software, considering the effects of the loading on the fence/ sleeve in relation to the upper Lock+Load units. Including the fence sleeves will not therefore compromise the integrity of the wall.

3.8. Proposals for Water Management

Gillcon wall to rear of Plots 44-52 (Wall 03, K61200C) designed with hydrostatic pressure.
A drain to the rear of the wall can not be provided to plots 44-52 due to the wall being at the low point of the site and no available drainage connections are available on site. (The line of perforated pipe along the back of the wall plots 44-48 shown on drg BY00099-STH-B01-XX-DR-S-1007 Rev B, which will take some drainage from the Gillcon wall fill, is not at a level to drain the wall fill.)

For wall adjacent Plot 1, a 150mm diameter perforated longitudinal drain encased in series 500 Type B drainage stone and taken to a suitable outlet see drawing

BV00099-STH-XX-DR-S-1007. Gillcon wall adjacent to Plot 1 (Wall 01, K61200D) designed with no hydrostatic pressure.

3.9. Proposed arrangements for future maintenance and inspection

3.9.1. Traffic management

Any traffic management system requirements will be agreed with Kirklees Council's Highways department prior to the start of works (where applicable)

3.9.2. Arrangements for future maintenance and inspection of structure. Access arrangements to structure.

Inspection will be from the adopted highway

3.10. Environment and sustainability

Constructed from Concrete and Stone backfill, which will be recyclable at end of life.

3.11. Durability. Materials and finishes

Item	Material	Finish / Location
Precast Concrete Facing	Grade RC32/40 XF2	Finish to client requirements, front of wall
Geogrids	Secugrid 40/40 Q6, Extruded Polyester bars	Soil reinforcement to rear of wall
Backfill material	Class 6I in compliance with specification for highway works, (SHW).	Backfill to structure.
Drainage to rear of Wall	150mmØ perforated twin wall drainage pipe laid to positive outlet. Drain to be surrounded with Series 500 Type B drainage stone.	

3.12. Risks and hazards considered for design, execution, maintenance and demolition. Consultation with and/or agreement from Overseeing Organisation

The Risks include

- Maintenance of access for both site operatives and construction traffic
- Live traffic
- Safety of highway users
- Working at height
- Deep Excavation
- Existing utility services
- Manual handling of heavy objects
- Maintenance of close Boarded Fence to prevent Falls.

3.13. Acceptance of recommendations of the structures Options Report (reference date) to be used in the design and reasons for any proposed changes (including estimated cost of proposed structure). If an Options Report has not been prepared, state the reasons for the selected solution and reasons for rejecting alternatives (including comparative whole life costs with dates of estimates).

Originally proposed concrete wall discounted, to allow an off site manufactured proprietary system to be used.

Costs T.B.C.

3.14. Proposed arrangements for construction

3.14.1. **Construction of structure**

Outline Method Statement included in Appendix C

3.14.2. **Traffic management**

Main construction to be from within site boundary, should there be a requirement to carry out works from the adjacent highway, all traffic management will be agreed with Kirklees Highways Streetworks section prior to start on site (where applicable).

3.14.3. **Service diversions**

No existing services are known to be present. However, utilities plans will be obtained and the presence of private services (if any) will be confirmed prior to the commencement of works.

3.14.4. **Interface with existing structures**

N/A

3.15. Deliberate damage and security

Reinforced earth retaining wall with Lock+Load precast concrete panel facing, are a robust material to resist vandalism.

4. DESIGN CRITERIA

4.1. Actions

4.1.1. Permanent actions

All permanent actions as outlined in BS EN 1991-1-1 and the national annex.

Backfill density to be 19kN/m³
Concrete density to be 25kN/m³
Surfacing density to be 22kN/m³

4.1.2. Snow, Wind and Thermal actions

Wind actions as outlined in BS EN 1991-1-3 and the National Annex..
Thermal actions to Concrete Segments, joints as manufacturers recommendations.

4.1.3. Actions relating to normal traffic under AW regulations and C&U regulations

N/A.

4.1.4. Actions relating to General Order traffic under STGO regulations

N/A

4.1.5. Footway or footbridge variable actions

10kN/m^2 has been allowed for the surcharge load in accordance with BS8002:2015 (Table 7).

4.1.6. Actions relating to Special Order traffic, provision for exceptional abnormal indivisible loads including location of vehicle track on deck cross-section

N/A

4.1.7. Accidental actions

Accidental actions to be in accordance with 4.7.3.1 of BS EN 1991-2 and NA to BS EN 1991-2., The Lock+Load design considered a surcharge of 10kPa on the retained side of the wall in the permanent condition and to represent general construction traffic.

4.1.8. **Action during construction**

The retaining wall is to be backfilled in accordance with the MCHW and surcharge loadings are to be derived based on the requirements of PD 6694-1:2011. Therefore, compaction pressures imposed on the wall during construction do not need to be considered. (PD 6694-1:2011 CL 7.3.3)

4.1.9. **Any special action not covered above**

None of the walls included in this approval will attract loading from the houses.

Vehicle access cannot be gained to land retained by either of the walls to which this approval applies.

4.2. Heavy or high load route requirements and arrangements being made to preserve the route, including any provision for future heavier loads or future widening

N/A

4.3. Proposed minimum headroom provided

N/A

4.4. Set out measures that will be incorporated into design to minimise maintenance

Low-maintenance materials used.

4.5. Authorities consulted and any special conditions required

Kirklees Council, Highways - conditions as per this AIP.

4.6. Standards and documents listed in the Technical Approval Schedule

TAS dated May 2025 - See appendix A.

Additional relevant DoT standards published since the above edition of the TAS including amendments, are listed as follows:

'None'.

4.7. Proposed departures from standards listed in 4.6

The proposed retaining walls will be private structures and as such their maintenance responsibility will solely rest with the adjoining properties title holder/s. This will be shown on the land registry title deeds and plans for the relevant properties (i.e. the maintenance responsibility for the retaining walls is shown using an inverted "T" symbol). The developer will send a copy of the land registry deed plan to the Council's Highway Structures section for record purposes.

4.8. Proposed departures from standards concerning methods for dealing with aspects not covered by standards listed in 4.6

Lock+Load Retaining Wall System, HAPAS Certificate 21/H311, with reference to BS 8006-1:2010+A1:2016, and clarification on standards from BBA Civils and Standards.

4.9. Proposed safety critical fixings

N/A

5. STRUCTURAL ANALYSIS

5.1. Methods of analysis proposed for superstructure, substructure and foundations

Fine GEO5 MSE WALL and SLOPE software will be used for wall analyses to BS8006-1:2010 and BS EN 1997-1:2004 Eurocode 7 (Design Approach 1)

The retaining wall components shall be designed in accordance with BS EN 1997-1 Geotechnical Design, General Rules.

The wall shall be analysed based on a metre strip method for Design Approach 1, Combinations 1 & 2 in accordance with BS EN 1997-1.
Each element shall be designed for the worst combination of loads with those stated in Section 4.1.

Ultimate limit state checks shall include, but are not limited to:

- Bearing capacity failure
- Overturning
- Sliding
- Global Instability

5.2. Description and diagram of idealised structure to be used for analysis

The most onerous cross-section from CH100m – CH167m, as shown on Section 9-9 on Geoman Ltd. drawing SK24-5558-F1-05E, will be analysed using the design software. . Section 9-9 considers retained heights of up to 4.10m, and therefore covers the maximum retained height from CH100m – CH164.2m of Wall 03 (3.63m).

5.3. Assumptions intended for calculation of structural element stiffness

Flexible structure.

5.4. Proposed range of soil parameters to be used in the design of earth retaining elements

Retained: MADE GROUND (ashy gravelly SAND [ASH & CLINKER]) & compacted Class 1/2 upfill. These materials were assumed to have the following minimum properties:

MADE GROUND $\phi' = 28°$, $\gamma = 18kN/m^3$ and $c' = 0$ kPa.

CLASS 1/2 FILL $\phi' = 28°$, $\gamma = 19kN/m^3$ and $c' = 0$ kPa.

Foundation: Granular LTP on rigid inclusions

6. GEOTECHNICAL CONDITIONS

6.1. Acceptance of recommendations of the ground investigation report (references/dates) to be used in the design and reasons for any proposed changes

Ground Investigation shows large amounts of fill material under the retaining walls with an unknown bearing capacity and recommends ground improvement. This is to be done in the form of Rigid inclusions to achieve a minimum bearing pressure of 140kPa with a load transfer platform up to formation level of the Lock+Load. See Appendix C.

6.2. Differential settlement to be allowed for in the design of the structure

Differential settlement within each length of retaining wall is anticipated to be negligible (less than 25mm) as the loads in adjacent positions along each wall, and the ground conditions beneath each wall, are similar, foundations are to be placed on rigid inclusions and LTP.

6.3. If the ground investigation report is not yet available, state when the results are expected and list the sources of information used to justify the preliminary choice of foundations

N/A, previously submitted.

7. CHECK

7.1. Proposed Category and Design Supervision Level

Wall is Category 1 for CG300 CL 3.8 (3).

DSL2, (refer to CD 350 Table 7.2).

7.2. If Category 3, name of proposed Independent Checker

N/A

7.3. Erection proposals or temporary works for which Types S and P Proposals will be required, listing structural parts of the permanent structure affected with reasons

The design and installation of all temporary works to facilitate the construction will be the responsibility of the Principal Contractor.
There are no Type S or Type P temporary works required as part of the proposal.

8. DRAWINGS AND DOCUMENTS

8.1. List of drawings (including numbers) and documents accompanying the submission

8.1.1. Drawings (See appendix B)

Reference	Title
BY00099-STH-B01-XX-DR-S-1003, Rev-D	Retaining Wall Heights from Formation
BY00099-STH-B01-XX-DR-S-1007 – Rev B	AIP Walls Land Drain
QD1776-14-10 – Rev D	Mass Concrete and Gillcon Retaining Walls Location Plans
QD1776-14-13 – Rev D	Gillcon Retaining Wall Sections (Sheet 2 of 4)
SK24-5558-F1-01-0	Lock+Load Wall 01 Elevation
SK24-5558-F1-04-E	Lock+Load Wall 03 Elevation
SK24-5558-F1-03-0	Lock+Load Cross - Sections
SK24-5558-F1-05-E	Lock+Load Wall 03 Cross - Sections

8.1.2. Documents (See appendix C)

Reference	Title
HAPAS Certificate 21/H311	Lock and Load Retaining Wall System
HAPAS Certificate 14/H218	Secugrid Geogrids
20251918 email BBA	Email: Gillcon Concrete Products – Lock + Load 21/H311
Gillcon Method Statement	Lock+Load Methodology of Works
Van Elle Method Statement Rev3	Rigid Inclusions Method Statement
3992-A2S-XX-XX-CA-Y-0001-03 Rigid Inclusions Calculations Report	Rigid Inclusions Calculations Report

9. THE ABOVE IS SUBMITTED FOR ACCEPTANCE

Design Team Leader

Name	D.J. Phillipson
Engineering Qualifications	BEng(Hons), CEng, M.IStructE
Name of Organisation	Queensberry Design Ltd.
Date	17/06/2026

Check Team Leader

Name	D. Rogers
Engineering Qualifications	BSc(Hons), MSc
Name of Organisation	Queensberry Design Ltd.
Date	17/06/2026

10. THE ABOVE IS REJECTED/AGREED SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW

Name	Claire Richardson
Position held	Principal Engineer (Bridges & Structures)
Engineering Qualifications	Beng CEng MICE
TAA	Kirklees Council
Date	03-07-2026

For and on behalf of Kirklees Council

APPENDIX A

LIST OF RELEVANT DESIGN DOCUMENTS

Scheme title: Residential Development off Westgate, Cleckheaton Struc Ref: K61200C, D
Structure title: Private Gillcon Lock+Load Retaining Walls Rev P7 17/06/2026

TECHNICAL APPROVAL SCHEDULE (TAS)

Schedule of Documents Relating to Design of Highway Bridges and Structures

(All documents are taken to include revisions current as of May 2026)

Additional standards needed for a particular design should be added to the section at the bottom of the TAS.

The Designer is responsible for ensuring that the standards and references given in the schedule are correct and up to date. Tick all the documents used (✓)

Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	Eurocode 0	**Basis of structural design**		
✓	BS EN 1990:2002 +A1:2005	Eurocode 0: Basis of structural design	+A1:2005 Incorporating corrigenda December 2008 and April 2010	See CD 350 section 7 for additional guidance. This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1990:2023+A1:2026
✓	NA to BS EN 1990:2002 + A1:2005	UK National Annex to Eurocode 0 Basis of structural design	National Amendment No.1	See CD 350 section 7 for additional guidance.
	Eurocode 1	**Actions on structures**		
✓	**BS EN 1991-1-1:2002**	**Eurocode 1: Actions on structures. General Actions. Densities, self-weight, imposed load for buildings**	**Corrigenda December 2004 and March 2009**	**This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1991-1-1:2025**
✓	NA to BS EN 1991-1-1:2002	UK National Annex to Eurocode 1: Actions on structures. General Actions. Densities, self-weight, imposed load for buildings	Corrigenda July 2019	
	BS EN 1991-1-3:2003 +A1:2015	**Eurocode 1: Actions on structures. General Actions. Snow loads**	**+A1:2015 Incorporating corrigenda December 2004 and March 2009**	**This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1991-1-3:2025**

Scheme title: Residential Development off Westgate, Cleckheaton Struc Ref: K61200C, D
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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
✓	NA + A2:18 to BS EN 1991-1-3:2003+A1:2015	UK National Annex to Eurocode 1: Actions on structures. General Actions. Snow loads	+A2:2018 Incorporating corrigenda June 2007, December 2015 and October 2018	
✓	BS EN 1991-1-4:2005 +A1:2010	Eurocode 1: Actions on structures. General Actions. Wind actions	+A1:2010 Corrigenda July 2009 and January 2010	
✓	NA to BS EN 1991-1-4:2005 + A1:2010	UK National Annex to Eurocode 1: Actions on structures. General Actions. Wind actions	National Amendment No.1	
✓	**BS EN 1991-1-5:2003**	**Eurocode 1: Actions on structures. General Actions. Thermal actions**	**Corrigenda December 2004 and March 2009**	**This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1991-1-5:2025**
✓	NA to BS EN 1991-1-5:2003	UK National Annex to Eurocode 1: Actions on structures. General Actions. Thermal actions	-	
✓	BS EN 1991-1-6:2005	Eurocode 1: Actions on structures. General Actions. Actions during execution	Corrigenda July 2008, November 2012 and February 2013	
✓	NA to BS EN 1991-1-6:2005	UK National Annex to Eurocode 1: Actions on structures. General Actions. Actions during execution	-	
✓	BS EN 1991-1-7:2006 +A1:2014	Eurocode 1: Actions on structures. General Actions. Accidental actions	+A1: 2014 Corrigendum February 2010	
✓	NA+A1 to BS EN 1991-1-7:2006+A1:2014	UK National Annex to Eurocode 1: Actions on structures. Part 1-7 : Accidental actions	+A1:2014 Incorporating corrigenda August 2014 and November 2015	See CD 350 for additional guidance.

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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	BS EN 1991-2:2003	Eurocode 1: Actions on structures. Traffic loads on bridges	Corrigenda December 2004 and February 2010	See CD 350 section 7 for additional guidance. This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1991-2:2023
	NA +A1:2020 to BS EN 1991-2:2003	UK National Annex to Eurocode 1: Actions on structures. Traffic loads on bridges	Corrigendum No.1 Amendment June 2020	See CD 350 section 7 for additional guidance.
	Eurocode 2	**Design of concrete structures**		
	BS EN 1992-1-1:2004 + A1:2014	Eurocode 2: Design of concrete structures– Part 1-1: General rules and rules for buildings	Incorporating corrigendum January 2008, November 2010 and January 2014	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1992-1-1:2023
	NA + A2:2014 to BS EN 1992-1-1:2004 + A1:2014	UK National Annex to Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings		This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1992-1-1:2023
	BS EN 1992-2:2005	Eurocode 2: Design of concrete structures – Part 2: Concrete bridges – Design and detailing rules	Corrigendum July 2008	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1992-1-1:2023
	NA to BS EN 1992-2:2005	UK National Annex to Eurocode 2: Design of concrete structure – Part 2: Concrete bridges – Design and detailing rules	-	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1992-1-1:2023
	BS EN 1992-3:2006	Eurocode 2: Design of concrete structures – Part 3: Liquid retaining and containment structures		This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1992-1-1:2023

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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	NA to BS EN 1992-3:2006	UK National Annex to Eurocode 2: Design of concrete structures – Part 3: Liquid retaining and containment structures	-	
	BS EN 1992-4:2018	Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for use in concrete		
	NA to BS EN 1992-4:2018	UK National Annex to Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for use in concrete		
	Eurocode 3	**Design of steel structures**		
	BS EN 1993-1-1:2005 + A1:2014	Eurocode 3: Design of steel structures – Part 1-1 General rules and rules for buildings	Corrigenda February 2006 and April 2009	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1993-1-1:2022
	NA + A1:2014 to BS EN 1993-1-1:2005 + A1:2014	UK National Annex to Eurocode 3: Design of steel structures – Part 1-1 General rules and rules for buildings	-	
	BS EN 1993-1-3:2006	Eurocode 3: Design of steel structures – Part 1-3 General rules – Supplementary rules for cold-formed members and sheeting	Corrigendum November 2009	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1993-1-3:2024
	NA to BS EN 1993-1-3:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 1-3 Supplementary rules for cold-formed members and sheeting	-	

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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	BS EN 1993-1-4:2006 + A2:2020	Eurocode 3: Design of steel structures – Part 1-4 General rules – Supplementary rules for stainless steels	+ A1:2015 Amendment No. 1 + A2:2020 Amendment No. 2	Supersedes BS EN 1993-1-4:2006 + A1:2015
	NA+A1:15 to BS EN 1993-1-4:2006+A1:2015	UK National Annex to Eurocode 3: Design of steel structures – Part 1-4 Supplementary rules for stainless steels	+ A1:2015 Amendment No. 1	
	BS EN 1993-1-5:2006+A2:2019	Eurocode 3: Design of steel structures – Part 1-5 Plated structural elements	Corrigendum April 2009, +A1:2017 Amendment No. 2, +A2:2019	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1993-1-5:2024
	NA+A1:2016 to BS EN 1993-1-5:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 1-5 Plated structural elements	+ A1:2016 Amendment No. 1	
	BS EN 1993-1-6:2007+ A1:2017	Eurocode 3: Design of steel structures – Part 1-6 Strength and stability of shell structures	+ A1:2017 Amendment No. 1	
	BS EN 1993-1-7:2007	**Eurocode 3: Design of steel structures – Part 1-7 Plated structures subject to out of plane loading**	**Corrigendum April 2009**	**This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1993-1-7:2025**
	BS EN 1993-1-8:2005	Eurocode 3: Design of steel structures – Part 1-8 Design of joints	Corrigenda December 2005, September 2006, July 2009 and August 2010	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1993-1-8:2024
	NA to BS EN 1993-1-8:2005	UK National Annex to Eurocode 3: Design of steel structures – Part 1-8 Design of joints	-	

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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	BS EN 1993-1-9:2005	Eurocode 3: Design of steel structures – Part 1-9 Fatigue	Corrigenda December 2005, September 2006 and April 2009	
	NA to BS EN 1993-1-9:2005	UK National Annex to Eurocode 3: Design of steel structures – Part 1-9 Fatigue	-	
	BS EN 1993-1-10:2005	Eurocode 3: Design of steel structures – Part 1-10 Material toughness and through-thickness properties	Corrigenda December 2005, September 2006 and March 2009	
	NA to BS EN 1993-1-10:2005	UK National Annex to Eurocode 3: Design of steel structures – Part 1-10 Material toughness and through thickness properties	-	
	BS EN 1993-1-11:2006	Eurocode 3: Design of steel structures – Part 1-11 Design of structures with tension components	Corrigendum April 2009	
	NA to BS EN 1993-1-11:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 1-11 Design of structures with tension components	-	
	BS EN 1993-1-12:2007	Eurocode 3: Design of steel structures – Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700	Corrigendum April 2009	
	NA to BS EN 1993-1-12:2007	UK National Annex to Eurocode 3: Design of steel structures – Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700	-	

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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	BS EN 1993-2:2006	Eurocode 3: Design of steel structures – Part 2 Steel bridges	Corrigendum July 2009	This document is to be used until 30 March 2028. After which it will be superseded by NA to BS EN 1993-2:2026
	NA + A1:2012 to BS EN 1993-2:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 2 Steel bridges	+ A1:2012	
	BS EN 1993-5:2007	Eurocode 3: Design of steel structures – Part 5 Piling	Corrigendum May 2009	
	NA + A1:2012 to BS EN 1993-5:2007	UK National Annex to Eurocode 3: Design of steel structures – Part 5 Piling	+ A1:2012	
	Eurocode 4	**Design of composite steel and concrete structures**		
	BS EN 1994-1-1:2004	Eurocode 4: Design of composite steel and concrete structures – Part 1-1 General rules and rules for buildings	Corrigendum April 2009	
	NA to BS EN 1994-1-1:2004	UK National Annex to Eurocode 4: Design of composite steel and concrete structures – Part 1-1 General rules and rules for buildings	-	
	BS EN 1994-2:2005	Eurocode 4: Design of composite steel and concrete structures – Part 2 General rules and rules for bridges	Corrigendum July 2008	This document is to be used until 30 March 2028. After which it will be superseded by NA to BS EN 1994-2:2026
	NA to BS EN 1994-2:2005	UK National Annex to Eurocode 4: Design of composite steel and concrete structures – Part 2 General rules and rules for bridges	-	

Scheme title: Residential Development off Westgate, Cleckheaton Struc Ref: K61200C, D
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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	Eurocode 5	**Design of timber structures**		
	BS EN 1995-1-1:2004 + A2:2014	Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings	+ A2:2014 Incorporating corrigendum June 2006	
	NA to BS EN 1995-1-1:2004 + A2:2014	UK National Annex to Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings	+ A2:2014	
	BS EN 1995-2:2004	Eurocode 5: Design of timber structures – Part 2 Bridges	-	
	NA to BS EN 1995-2:2004	UK National Annex to Eurocode 5: Design of timber structures – Part 2 Bridges	-	
	Eurocode 6	**Design of masonry structures**		
	BS EN 1996-1-1:2005+A1:2012	Eurocode 6: Design of masonry structures – Part 1-1 General rules for reinforced and unreinforced masonry structures	+A1:2012 Corrigenda February 2006 and July 2009	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1996-1-1:2022
	NA to BS EN 1996-1-1:2005 +A1:2012	UK National Annex to Eurocode 6: Design of masonry structures – Part 1-1 General rules for reinforced and unreinforced masonry structures	+A1:2012	This document is to be used until 30 March 2028. After which it will be superseded by NA to BS EN 1996-1-1:2022
	BS EN 1996-2:2006	Eurocode 6: Design of masonry structures – Part 2 Design considerations, selection of materials and execution of masonry	Corrigendum September 2009	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1996-2:2024

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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	NA to BS EN 1996-2:2006	UK National Annex to Eurocode 6: Design of masonry structures – Part 2 Design considerations, selection of materials and execution of masonry	Corrigendum No.1	
	BS EN 1996-3:2006	Eurocode 6: Design of masonry structures – Part 3 Simplified calculation methods for unreinforced masonry structures	Corrigendum October 2009	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1996-3:2023
	NA +A1:2014 to BS EN 1996-3:2006	UK National Annex to Eurocode 6: Design of masonry structures – Part 3 Simplified calculation methods for unreinforced masonry structures	+A1:2014	
	Eurocode 7	**Geotechnical design**		
✓	BS EN 1997-1:2004+A1:2013	Eurocode 7: Geotechnical design – Part 1 General rules	+A1:2013 Corrigendum February 2009	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1990:2023, BS EN 1997-1:2024, BS EN 1997-3:2025
✓	NA+A2:2022 to BS EN 1997-1:2004+A1:2013	UK National Annex to Eurocode 7: Geotechnical design – Part 1 General rules	+A1:2013 Incorporating Corrigendum No.1, Amendment 1 – July 2014 and Amendment 2 - 2022	Supersedes NA+A1:2014 to BS EN 1997-1:2004+A1:2013
	BS EN 1997-2:2007	Eurocode 7: Geotechnical design – Part 2 Ground investigation and testing	Corrigendum June 2010	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1997-3:2025, BS EN 1997-2:2024

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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	NA to BS EN 1997-2:2007	UK National Annex to Eurocode 7: Geotechnical design – Part 2 Ground investigation and testing	-	This document is to be used until 30 March 2028. After which it will be superseded by NA to BS EN 1997-2:2024
	Eurocode 8	**Design of structures for earthquake resistance**		
	BS EN 1998-1:2004 + A1:2013	Eurocode 8: Design of structures for earthquake resistance – Part 1 General rules, seismic actions and rules for buildings	Corrigendum June 2009, January 2011 and March 2013	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1998-1-1:2024
	NA to BS EN 1998-1:2004	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 1 General rules, seismic actions and rules for buildings	-	
	BS EN 1998-2:2005+A2:2011	**Eurocode 8: Design of structures for earthquake resistance – Part 2 Bridges**	**Corrigenda February 2010 and February 2012**	**This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1998-2:2025**
	NA to BS EN 1998-2:2005	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 2 Bridges	-	
	BS EN 1998-5:2004	Eurocode 8: Design of structures for earthquake resistance – Part 5 Foundations, retaining structures and geotechnical aspects	-	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1998-5:2024

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Used (✓)	Eurocodes and associated UK National Annexes			
	Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
	NA to BS EN 1998-5:2004	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 5 Foundations, retaining structures and geotechnical aspects	-	
	Eurocode 9	**Design of aluminium structures**		
	BS EN 1999-1-1:2007 + A2:2013	Eurocode 9: Design of aluminium structures– Part 1-1 General structural rules	+ A2:2013 Incorporating corrigendum March 2014	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1999-1-1:2023
	NA to BS EN 1999-1-1:2007 + A1:2009	UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-1 General structural rules	National Amendment No.1 Corrigendum No.1	
	BS EN 1999-1-3:2007 + A1:2011	Eurocode 9: Design of aluminium structures – Part 1-3 Structures susceptible to fatigue	+ A1:2011	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1999-1-3:2023
	NA to BS EN 1999-1-3:2007 + A1:2011	UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-3 Structures susceptible to fatigue	+ A1:2011	
	BS EN 1999-1-4:2007 +A1:2011	Eurocode 9: Design of aluminium structures – Part 1-4 Cold formed structural sheeting	+ A1:2011 Corrigendum November 2009	This document is to be used until 30 March 2028. After which it will be superseded by BS EN 1999-1-4:2023
	NA to BS EN 1999-1-4:2007	UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-4 Cold formed structural sheeting	-	

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Used (✓)	Bsi Published Documents *For guidance only unless clauses are otherwise specified in CD 350 Appendix A.*		
	Published Document reference	**Title**	**Notes**
✓	PD 6687-1:2020	Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3	Supersedes PD 6687-1:2010 See CD 350 clauses 3.6, 4.1, 4.2 and Appendix A for additional guidance. Clause 3.6 in CD 350 refers to clause 2.5 in PD 6687-1, this is now clause 4.5 in PD 6687-1 Clause 4.2 in CD 350 refers to clause 2.22 in PD 6687-1, this is now clause 4.21.4 in PD 6687-1
✓	PD 6687-2:2008	Recommendations for the design of structures to BS EN 1992-2:2005	See CD 350 clauses 4.1, 4.2 and Appendix A for additional guidance.
✓	PD 6688-1-1:2011	Recommendations for the design of structures to BS EN 1991-1-1	See CD 350 Appendix A for additional guidance.
✓	PD 6688-1-4:2015	Background paper to the UK National Annex to BS EN 1991-1-4	See CD 350 Appendix A for additional guidance.
✓	PD 6688-1-7:2009 +A1:2014	Recommendations for the design of structures to BS EN 1991-1-7	See CD350 clause 3.7 and Appendix B for additional guidance.
✓	PD 6688-2:2011	Recommendations for the design of structures to BS EN 1991-2	See CD 350 Appendix A for additional guidance.
	PD 6694-1:2011 + A1:2020	Recommendations for the design of structures subject to traffic loading to BS EN 1997-1	Incorporating Corrigendum 1 Jan 2022 & Corrigendum 2 Jul 2023 See CD 350 Appendix A for additional guidance.
	PD 6695-1-9:2008	Recommendations for the design of structures to BS EN 1993-1-9	See CD 350 Appendix A for additional guidance.
	PD 6695-1-10:2009	Recommendations for the design of structures to BS EN 1993-1-10	See CD 350 Appendix A for additional guidance.
	PD 6695-2:2008 + A1:2012 Incorporating Corrigendum No.1	Recommendation for the design of bridges to BS EN 1993	See CD 350 Appendix A for additional guidance.
	PD 6696-2:2007 + A1:2012	Background paper to BS EN 1994-2 and the UK National Annex to BS EN 1994-2	See CD 350 Appendix A for additional guidance.

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Used (✓)	Bsi Published Documents *For guidance only unless clauses are otherwise specified in CD 350 Appendix A.*		
	Published Document reference	**Title**	**Notes**
	PD 6698:2009	**Recommendations for the design of structures for earthquake resistance to BS EN 1998**	**See CD 350 section 7 for additional guidance.**
	PD 6702-1:2009+A1:2019	Structural use of aluminium. Recommendations for the design of aluminium structures to BS EN 1999	Amended 31 May 2019
	PD 6703:2009	Structural bearings – Guidance on the use of structural bearings	
	PD 6705-2:2020	Structural use of steel and aluminium. Execution of steel bridges conforming to BS EN 1090-2. Guide	Replaces PD 6705-2:2010 + A1:2013
	PD 6705-3:2009	Recommendations on the execution of aluminium structures to BS EN 1090-3	

Used (✓)	Execution Standards referenced in British Standards or Eurocodes		
	Execution Standard reference	**Title**	**Notes**
	BS EN 1090-1:2009+A1:2011	Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components	
	BS EN 1090-2:2018+A1:2024	Execution of steel structures and aluminium structures. Technical requirements for the execution of steel structures	Supersedes BS EN 1090-2:2018
	BS EN 1090-3:2019	Execution of steel structures and aluminium structures – Part 3: Technical requirements for aluminium structures	Supersedes BS EN 1090-3:2008
	BS EN 13670:2009 Incorporating corrigenda October 2015 and November 2015	Execution of concrete structures	

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Used (✓)	Product Standards referenced in British Standards or Eurocodes		
	Product Standard reference	**Title**	**Notes**
	BS EN 206:2013+A2:2021	Concrete – Specification, performance, production and conformity	Supersedes BS EN 206:2013+A1:2016
	BS EN 1317-1:2010	Road Restraint Systems – Part 1 – Terminology and general criteria for test methods	
	BS EN 1317-2:2010	Road Restraint Systems – Part 2 – Performance classes, impact test acceptance criteria and test methods for safety barriers.	
	BS EN 1317-3:2010	Road Restraint Systems – Part 3 – Performance classes, impact test acceptance criteria and test methods for crash cushions.	
	DD ENV 1317-4:2002	Road Restraint Systems – Part 4 – Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers.	*Draft BS EN 1317-4 for public comment published in June 2012*
	BS EN 1317-5:2007+A2:2012	Road Restraint Systems – Part 5 - Product requirements and evaluation of conformity for vehicle restraint systems	Incorporating corrigendum August 2012 *Draft prEN 1317-5 for public comment published in December 2013*
	PD CEN/TR 16949:2016	Road Restraint System – Pedestrian restraint system - Pedestrian parapets	*Bsi Published Document / CEN Technical Report published in July 2016* *(This document should not be used. The requirements of BS 7818:1995 apply.)*
	PD CEN/TS 1317 7:2023	Road restraint systems - Part 7: Performance characterisation and test methods for terminals of safety barriers	*Replaces Draft prEN 1317-7* *(All terminals should be in accordance with this document or ENV1317-4.)*

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Used (✓)	Product Standards referenced in British Standards or Eurocodes		
	Product Standard reference	**Title**	**Notes**
	PD CEN/TS 17342:2019	Road restraint systems - Motorcycle road restraint systems which reduce the impact severity of motorcyclist collisions with safety barriers	*Replaces* PD CEN/TS 1317-8:2012 *(This document should not be used.)*
	PD CEN/TR 17081:2018	Design of fastenings for use in concrete – Plastic design of fastenings with headed and post-installed fasteners	
	BS EN 1337-1:2000	Structural bearings – Part 1: General Design Rules	
	BS EN 1337-2:2004	Structural bearings – Part 2: Sliding elements	
	BS EN 1337-3:2005	Structural bearings – Part 3: Elastomeric bearings	
	BS EN 1337-4:2004	Structural bearings – Part 4: Roller bearings	Corrigendum No.1 March 2007
	BS EN 1337-5:2005	Structural bearings – Part 5: Pot bearings	
	BS EN 1337-6:2004	Structural bearings – Part 6: Rocker bearings	
	BS EN 1337-7:2004	Structural bearings – Part 7: Spherical and cylindrical PTFE bearings	
	BS EN 1337-8:2007	Structural bearings – Part 8: Guide bearings and restraint bearings	
	BS EN 1337-9:1998	Structural bearings – Part 9: Protection	
	BS EN 1337-10:2003	Structural bearings – Part 10: Inspection and maintenance	Corrigendum No.1 November 2003
	BS EN 1337-11:1998	Structural bearings – Part 11: Transport, Storage and Installation.	
	BS EN 10025-1:2004	Hot rolled products of structural steels Part 1: General technical delivery conditions.	
	BS EN 10025-2:2019	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels.	Supersedes BS EN 10025-1:2004
	BS EN 10025-3:2019	Hot rolled products of structural steels Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels.	Supersedes BS EN 10025-3:2004

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Used (✓)	Product Standards referenced in British Standards or Eurocodes		
	Product Standard reference	**Title**	**Notes**
	BS EN 10025-4:2019+A1:2022	Hot rolled products of structural steels Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels.	Supersedes BS EN 10025-4:2019
	BS EN 10025-5:2019	Hot rolled products of structural steels – Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance	Supersedes BS EN 10025-5:2004
	BS EN 10025-6:2019+A1:2022	Hot rolled products of structural steels – Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition.	Supersedes BS EN 10025-6:2019
	BS EN 10080:2005	Steel for the reinforcement of concrete – Weldable reinforcing steel - General	
	BS EN 10210-1:2006	Hot finished structural hollow sections of non-alloy and fine grain steels – Part 1: Technical delivery conditions	
	BS EN 10210-2:2019	Hot finished structural hollow sections – Part 2: Tolerances, dimensions and sectional properties	Supersedes BS EN 10210-2:2006
	BS EN 10248-1:2023	Hot rolled sheet piling of non alloy steels. Technical delivery conditions	Supersedes BS EN 10248-1:1996
	BS EN 10248-2:2024	Hot rolled sheet piling of non alloy steels. Tolerances on shape and dimensions	Supersedes BS EN 10248-2:1996
	BS EN 12063:2024	Execution of special geotechnical work. Sheet pile walls.	Supersedes BS EN 12063:1999
	BS EN 13369:2023	Common rules for precast concrete products	Supersedes BS EN 13369:2018
	BS EN 14388:2005	Road traffic noise reducing devices	There is a 2015 version, however the 2015 version is not harmonised.
	BS EN 15050:2007 + A1:2012	Precast concrete products – Bridge elements	See CD 350 clause 3.8.1 for additional guidance.
	BS EN 15258:2008	Precast concrete products - Retaining wall elements	

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Used (✓)	British Standards		
	British Standard reference	**Title**	**Notes**
	BS 4449:2005+A3:2016	Steel for the reinforcement of concrete	No longer covers plain round bar. (See BS4482 up to 12mm dia, see BS EN 10025-1 for larger sizes and dowels. See BS EN 13877-3 for dowel bars in concrete pavements.)
	BS 5896:2012	Specification for high tensile steel wire and strand for the prestressing of concrete	
	BS 7818:1995	Specification for pedestrian restraint systems in metal	Incorporating Corrigendum No.1 May 2004 and Corrigendum No.2 September 2006 Currently the requirements of BS 7818:1995 are to be used instead of PD CEN/TR 16949:2016
✓	BS 8002:2015	Code of practice for earth retaining structures	
✓	BS 8004:2015 +A1 2020	Code of practice for foundations	Amendment +A1:2020
✓	BS 8006-1:2010+A1:2016	Code of practice for strengthened/reinforced soils and other fills	
	BS 8500-1:2023	Concrete – Complementary British Standard to BS EN 206: Method of specifying and guidance for the specifier.	Supersedes BS 8500-1:2015+A2:2019
	BS 8500-2:2023	Concrete – Complementary British Standard to BS EN 206: Specification for constituent materials and concrete.	Supersedes BS 8500-2:2015+A2:2019
	BS 8666:2020	Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete	Supersedes BS 8666:2005

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Used (✓)	The Manual Contract Document for Highway Works (MCHW)		
	MCHW reference	**Title**	**Notes**
✓	MCHW Volume 1: October 2022	Specification for Highway Works	*Specification compliant with the execution standards must be used. A Departure is necessary for the parts where a compliant revision has not been published.* *Amendments October 2022* *Supersedes April 2022 version*
✓	MCHW Volume 2: October 2022	Notes for guidance on the Specification for Highway Works	*Notes for guidance compliant with the execution standards must be used. A Departure is necessary for the parts where a compliant revision has not been published.* *Amendments October 2022* *Supersedes November 2021 version*
✓	MCHW Volume 3: February 2017	Highway Construction Details	

Used (✓)	The Design Manual for Roads and Bridges (DMRB)		
	DMRB reference	**Title**	**Notes**
	GG 101 Revision 0.1.0	Introduction to the Design Manual for Roads and Bridges	Replaces GG 101 Revision 0
	GG 102 Revision 0	Quality Management Systems for Highway Design	Replaces GD 02/16
	GG 103 Revision 0	Introduction and general requirements for sustainable development and design	
	GG 104 Revision 0.1.0	Requirements for Safety Risk Assessment	Replaces GG 104 Revision 0
✓	GG 184 Revision 0	Specification for the use of Computer Aided Design	Replaces IAN 184/16
✓	CG 300 Revision 0.2.2	Technical approval of highway structures	Supersedes CG 300 Revision 0.2.1
	CG 302 Revision 0	As-built, operational and maintenance records for highway structures	Supersedes BD 62/07
	CG 303 Revision 0	Quality assurance scheme for paints and similar protective coatings	Supersedes BD 35/14
	CG 305 Revision 0	Identification marking of highway structures	Supersedes BD 45/93
	CG 501 Revision 2	Design of highway drainage systems	Supersedes HD 33/16, TA 80/99
	CD 127 Revision 1.0.1	Cross-sections and headrooms	Replaces TD 27/05 and TD 70/08
✓	CD 350 Revision 0	The design of highway structures	Supersedes BD 100/16, BA 57/01, BD 57/01 and IAN 124/11
	CD 351 Revision 0	The design and appearance of highway structures	Supersedes BA 41/98
	CD 352 Revision 0.0.1	Design of road tunnels	Supersedes CD 352 Revision 0

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Used (✓)	The Design Manual for Roads and Bridges (DMRB)		
	DMRB reference	**Title**	**Notes**
	CD 353 Revision 0	Design criteria for footbridges	Supersedes BD 29/17
	CD 354 Revision 1.1.0	Design of minor structures	Supersedes CD 354 Revision 1
	CD 355 Revision 0	Application of whole-life costs for design and maintenance of highway structures	Replaces BD 36/92 and BA 28/92
	CD 356 Revision 1	Design of highway structures for hydraulic action	Supersedes BA 59/94
	CD 357 Revision 1	Bridge expansion joints	Replaces BD 33/94, BA 26/94, IAN 168/12 and IAN 169/12
	CD 358 Revision 2.4.0	Waterproofing and surfacing of concrete bridge decks	Supersedes CD 358 Revision 2.3.0
	CD 359 Revision 0	Design requirements for permanent soffit formwork	Supersedes BA 36/90 and IAN 131/11
	CD 360 Revision 2	Use of compressive membrane action in bridge decks	Supersedes BD 81/02
	CD 361 Revision 0	Weathering steel for highway structures	Supersedes BD 7/01
	CD 362 Revision 1	Enclosure of bridges	Replaces BD 67/96 and BA 67/96
	CD 363 Revision 0	Design rules for aerodynamic effects on bridges	Replaces BD 49/01
	CD 364 Revision 0	Formation of continuity joints in bridge decks	Replaces BA 82/00
	CD 365 Revision 1	Portal and cantilever signs/signals gantries	Replaces BD 51/14, IAN 193/16, BE 7/04
	CD 366 Revision 0	Design criteria for collision protection beams	Replaces BD 65/14
	CD 367 Revision 0	Treatment of existing structures on highways widening schemes	Replaces BD 95/07
	CD 368 Revision 0	Design of fibre reinforced polymer bridges and highway structures	Replaces BD 90/05
	CD 369 Revision 0	Surface protection for concrete highway structures	Replaces BA 85/04
	CD 371 Revision 0	Strengthening highway structures using fibre-reinforced polymers and externally bonded steel plates	Replaces BD 85/08, BD 84/02
	CD 372 Revision 0	Design of post-installed anchors and reinforcing bar connections in concrete	Supersedes IAN 104/15
	CD 373 Revision 0	Impregnation of reinforced and prestressed concrete highway structures using hydrophobic pore-lining impregnants	Supersedes BD 43/03
	CD 374 Revision 0	The use of recycled aggregates in structural concrete	Supersedes BA 92/07
	CD 375 Revision 1	Design of corrugated steel buried structures	Supersedes BD 12/01
	CD 376 Revision 0	Unreinforced masonry arch bridges	Replaces BD 91/04
	CD 377 Revision 4	Requirements for road restraint systems	Supersedes TD 19/06

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Used (✓)	The Design Manual for Roads and Bridges (DMRB)		
	DMRB reference	**Title**	**Notes**
	CD 622 Revision 1	Managing geotechnical risk	Replaces HD 22/08, BD 10/97 and HA 120/08
	CS 461 Revision 0.2.0	Assessment and upgrading of in-service parapets	Supersedes CS 461 Revision 0.1.0
	CS 462 Revision 0.1.0	Repair and management of deteriorated concrete highway structures	Supersedes CS 462 Revision 0
	GD 304 Revision 2	Designing health and safety into maintenance	Replaces IAN 69/15
	LA 104 Revision 1	Environmental assessment and monitoring	Supersedes HA 205/08, HD 48/08, IAN 125/15, and IAN 133/10
	LA 106 Revision 1	Cultural heritage assessment	Supersedes HA 208/07, HA 60/92, HA 75/01
	LA 110 Revision 0	Material assets and waste	Supersedes IAN 153/11
	LA 113 Revision 1	Road drainage and the water environment	Supersedes HD 45/09
	LD 119 Revision 0	Roadside environmental mitigation and enhancement	Formerly LA 119, which superseded HA 65/94 and HA 66/95

	Interim Advice Notes		
	IAN reference	**Title**	**Notes**
	~~IAN 105/08~~	~~Implementation of construction (design and management) 2007 and the withdrawal of SD 10 and SD 11~~	This document has been withdrawn without replacement.

Used (✓)	Miscellaneous		
	Standard reference	**Title**	**Notes**
	CIRIA C543	Bridge Detailing Guide	

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Used (✓)	Miscellaneous		
	Standard reference	**Title**	**Notes**
	CIRIA C686	Safe Access for Maintenance and Repair	
	CIRIA C760	Guidance on embedded retaining wall design	
	CIRIA C766	Control of cracking caused by restrained deformation in concrete	Supersedes C660
	CIRIA C777	General fixings – guidance on selection and whole-life management	
	Department for Transport - Design & Maintenance Guidance for Local Authority Roads	Provision of Road Restraint Systems on Local Authority Road	Published October 2011
	Department for Transport	Guidance on the Design, Assessment and Strengthening of Masonry Parapets on Highway Structures	Published 2012

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Additional Standards **Additional standards needed for a particular design should be listed here.**		
Reference	**Title**	**Notes**
BS1722-5:2006+A1:2018	Fences:Specification for close boarded fences and wooden palisade fences	

APPENDIX B

DRAWINGS

Westgate, Cleckheaton | Retaining Wall Heights from Formation

This drawing must be read in conjunction with all other relevant drawings and information. The drawing or information must not be used for construction unless expressly issued for construction. Use displayed dimensions & verify dimensions on site before commencing any work with any discrepancies reported to **Strata** immediately.

DO NOT SCALE OFF DRAWINGS.

Rev	Date	Description	By	Checked
A	29/10/2025	RW height to formation adjacent Plot 180 amended to suit drawing QD1776-14-11. Boundary line to rear of Plot 30 amended to suit site fence line	NE	TECH
B	26/11/2025	Reference to 'CASCADE' removed	NE	TECH
C	06/01/2026	Retained height of Gillcon walls adjacent to Roberts Street and very southern of Quarry Road amended	NE	TECH
D	04/06/2026	Gillcon wall to rear of Plots 44-52 moved 1m into site	NE	TECH

DRAWING KEY :

- Existing adopted highway extent
- Proposed adoptable highway extent (through Section 38 Agreement)
- Proposed Masonry Retaining Wall (with fence) adjacent to the existing / proposed adoptable highway. See drawing QD1776-14-11 & 12 referenced
- Proposed Masonry Retaining Wall adjacent to the existing / proposed adoptable highway. See drawing QD1776-14-11 & 12 referenced
- Proposed Gillcon Retaining Wall adjacent to the existing / proposed adoptable highway - refer to Lock+Load drawings referenced
- Proposed Retaining Wall NOT adjacent to the existing / proposed adoptable highway
- Proposed Gillcon Retaining Wall NOT adjacent to the existing / proposed adoptable highway - refer to Lock+Load drawings referenced
- X.XXm — Proposed Retained Height (measured from formation level). Please note this only applies where the wall is adjacent to highway. Where not adjacent to highway, heights noted as per Queensberry Design's External Works referenced

Drawing References:

- Site Layout by Strata Homes dated 18.02.2025, ref: BY00099-STH-B01-XX-DR-A-SL001 Rev X
- External Works Sheet 1 by Queensberry Design dated 17.02.2022, ref: QD1776-04-01 Rev N
- External Works Sheet 2 by Queensberry Design dated 17.02.2022, ref: QD1776-04-02 Rev N
- Lock+Load Elevations 01 & 02 by Geoman dated 11.09.2024, ref SK24-5558-F1-01 Rev 0.
- Lock+Load Elevations 01 & 02 by Geoman dated 11.09.2024, ref SK24-5558-F1-02 Rev 0.
- Lock+Load Cross-Sections by Geoman dated 11.09.2024, ref SK24-5558-F1-03 Rev 0.
- Lock+Load Wall 03 Elevation by Geoman dated 27.09.2024, ref SK24-5558-F1-04 Rev E.
- Lock+Load Wall 03 Cross-Sections by Geoman dated 27.09.2024, ref SK24-5558-F1-05 Rev E.
- Section 38 Layout by Queensberry Design, ref: QD1776-16-01 Rev H
- Masonry & Gillcon Retaining Wall Location Plans by Queensberry Design, ref: QD1776-14-10 Rev C
- Mass Concrete Retaining Wall Sections by Queensberry Design, ref: QD1776-14-11 Rev C & 12 Rev A

NOTE: There are no proposed or existing burr walls across the development site, i.e. no walls are subject to existing or proposed highway loading

scale: 1:500 @ A1 drawn by: NE date: 26/03/2025

Project: Westgate, Cleckheaton

Drawing name: Retaining Wall Heights from Formation Revision: D

Drawing number: BY00099-STH-B01-XX-DR-S-1003

Planning ref: -

Drawing status: For Approval

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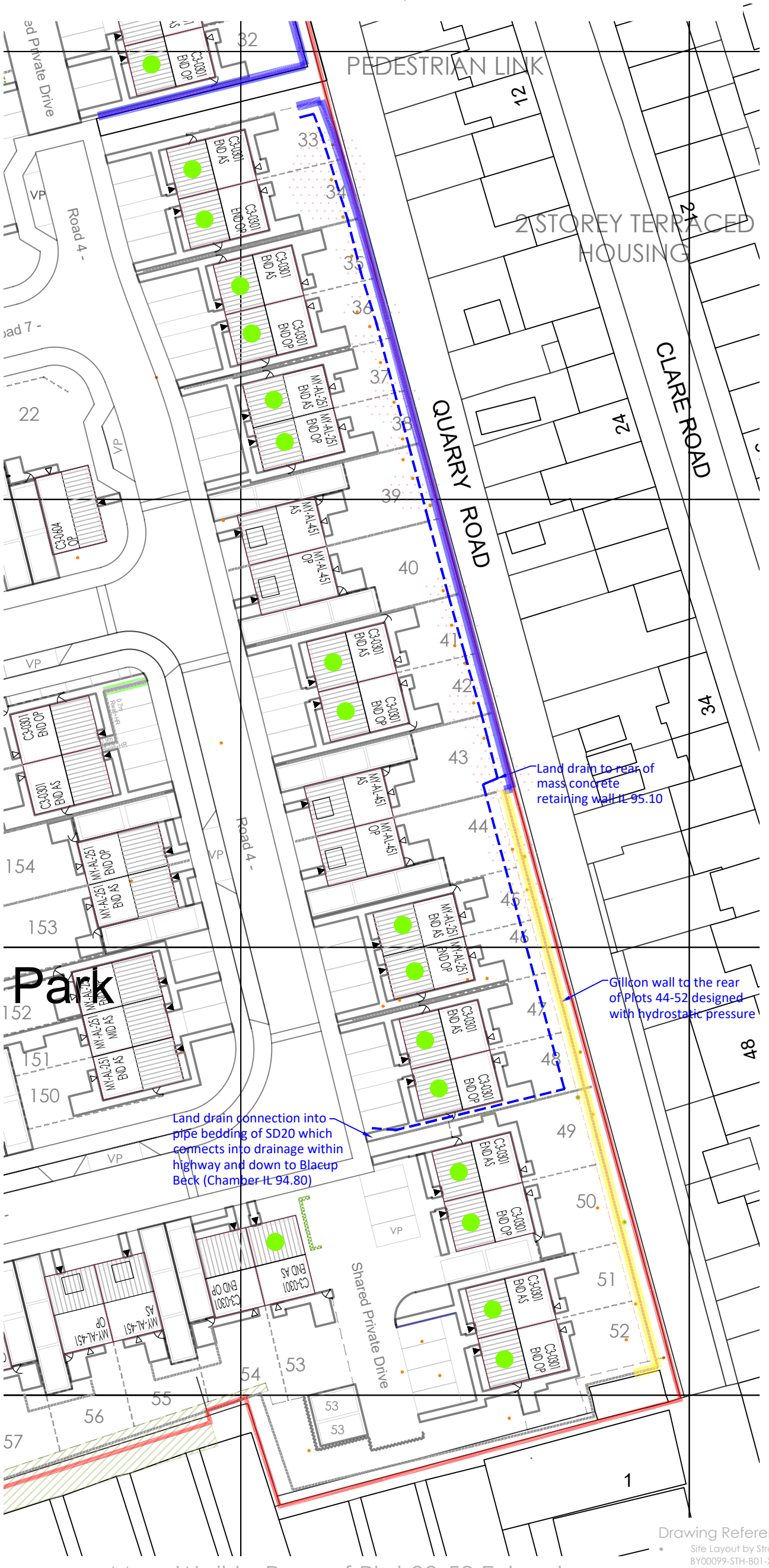
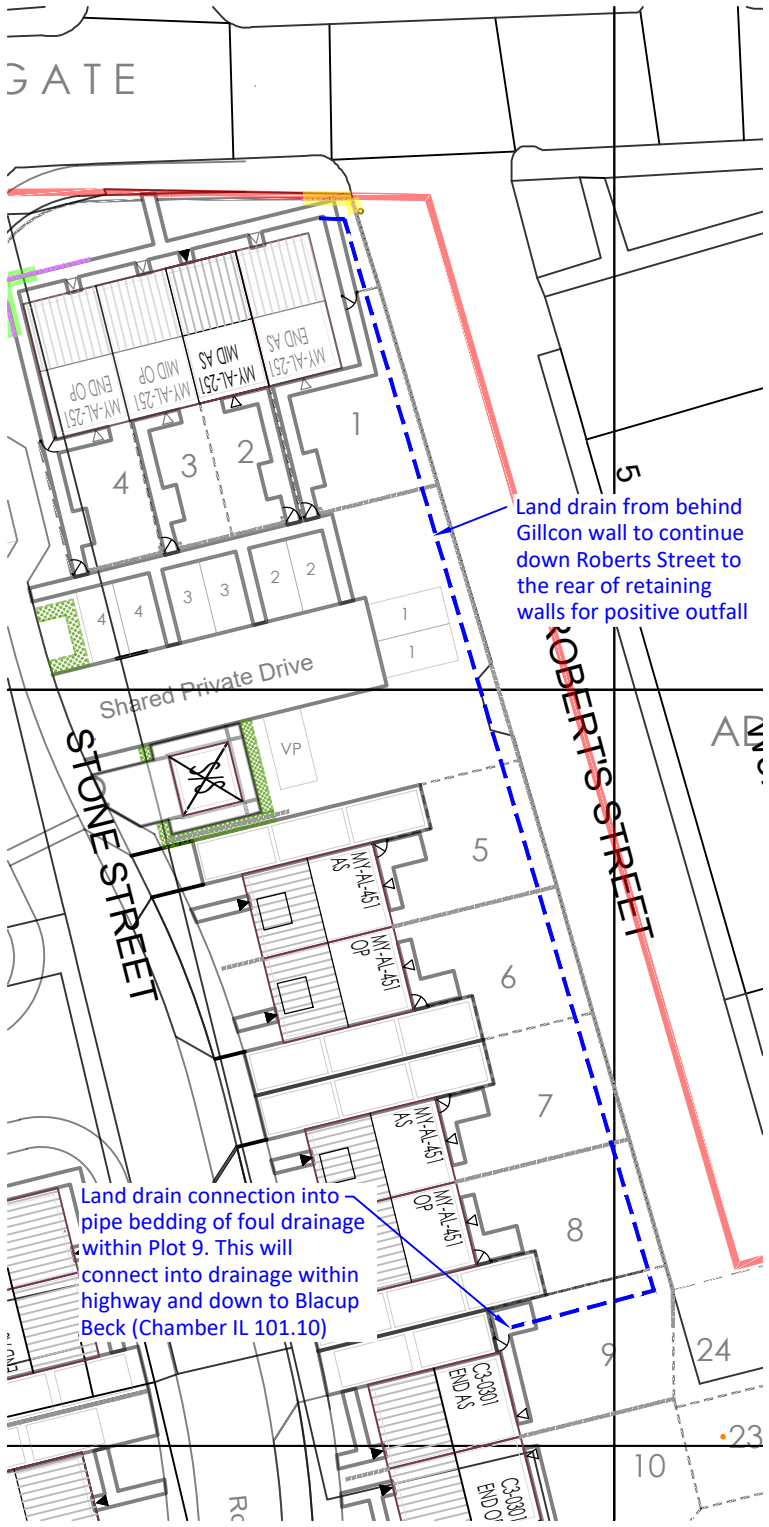
Westgate, Cleckheaton | AIP Walls Land Drain



Mass Wall to Rear of Plot 33-52 Extract

Scale 1:500



Gillcon Wall Adjacent Plot 1 Extract

Scale 1:500

Rev	Date	Description	By	Checked
A	09/12/2025	Outfall from SD20 referenced. Note added to Gillcon wall stating designed with hydrostatic pressure. Layout for rear of Gillcon wall adj. Plot 1 added	TECH	TECH
B	04/06/2026	Drain within Plot 44-48 amended to suit Gillcon wall moved 1m into site from Quarry Road	TECH	TECH

DRAWING KEY :

- Existing adopted highway extent
- Proposed adoptable highway extent (through Section 38 Agreement)
- Proposed Masonry Retaining Wall (with fence) adjacent to the existing / proposed adoptable highway. See drawing QD1776-14-11 & 12 referenced
- Proposed Gillcon Retaining Wall adjacent to the existing / proposed adoptable highway - refer to Lock+Load drawings referenced
- Proposed 150mm perforated pipe to rear of retaining walls

Drawing References:

- Site Layout by Strata Homes dated 18.02.2025, ref: BY00099-STH-B01-XX-DR-A-SL001 Rev X
- External Works Sheet 1 by Queensberry Design dated 17.02.2022, ref: QD1776-04-01 Rev N
- External Works Sheet 2 by Queensberry Design dated 17.02.2022, ref: QD1776-04-02 Rev N
- Lock+Load Wall 03 Elevation by Geoman dated 27.09.2024, ref SK24-5558-F1-04 Rev E.
- Lock+Load Wall 03 Cross-Sections by Geoman dated 27.09.2024, ref SK24-5558-F1-05 Rev E.
- Section 38 Layout by Queensberry Design, ref: QD1776-16-01 Rev H
- Masonry & Gillcon Retaining Wall Location Plans by Queensberry Design, ref: QD1776-14-10 Rev B
- Mass Concrete Retaining Wall Sections by Queensberry Design, ref: QD1776-14-11 Rev B & 12 Rev A

1:500

10m 0 10m 20m 30m 40m 50m

strata

scale: 1:500 @ A3 drawn by: TECH date: 29/10/2025

Project: Westgate, Cleckheaton

Drawing name: AIP Walls Land Drain Revision: B

Drawing number: BY00099-STH-B01-DR-S-1007

Planning ref: -

Drawing status: For Approval

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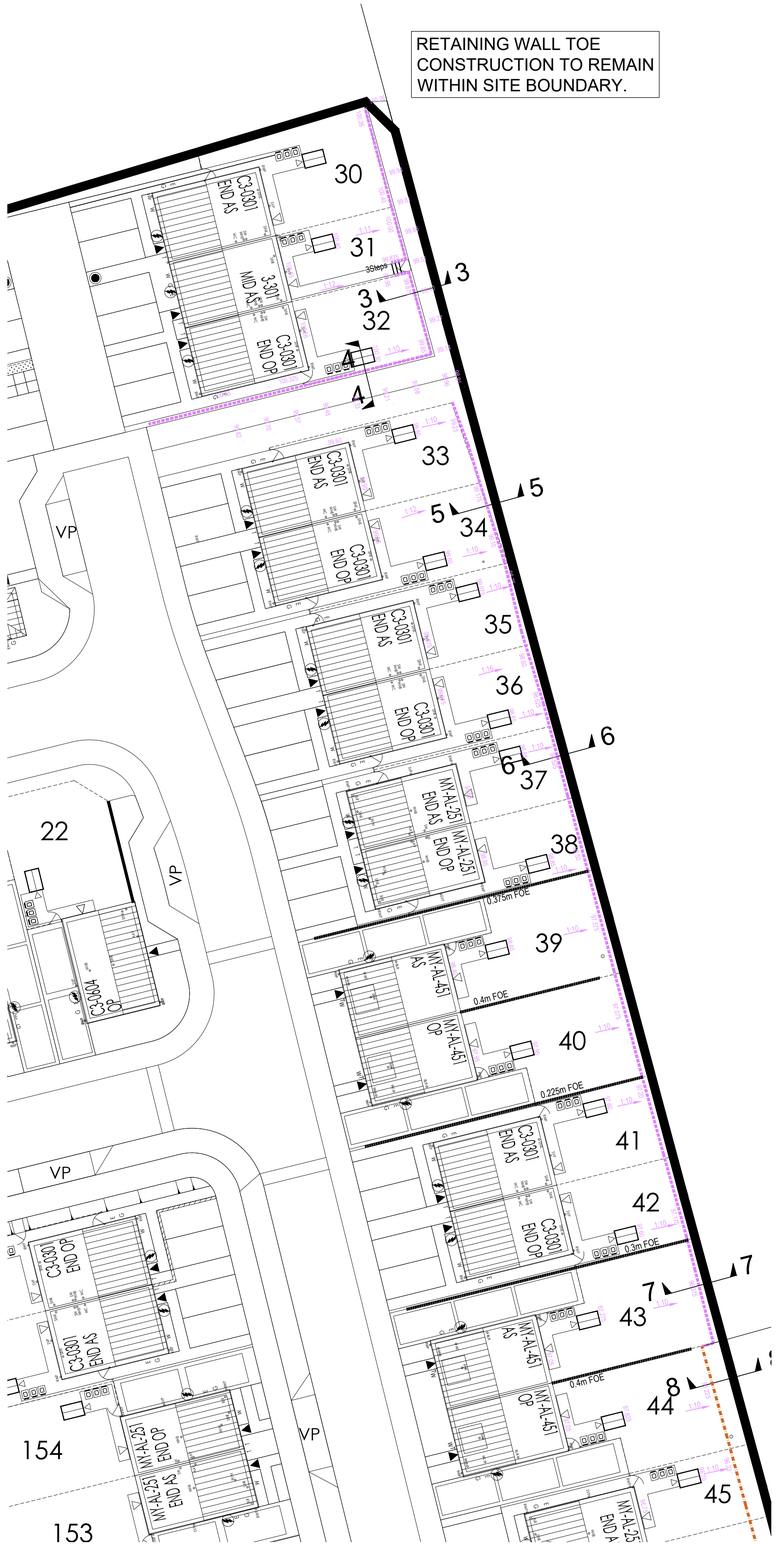
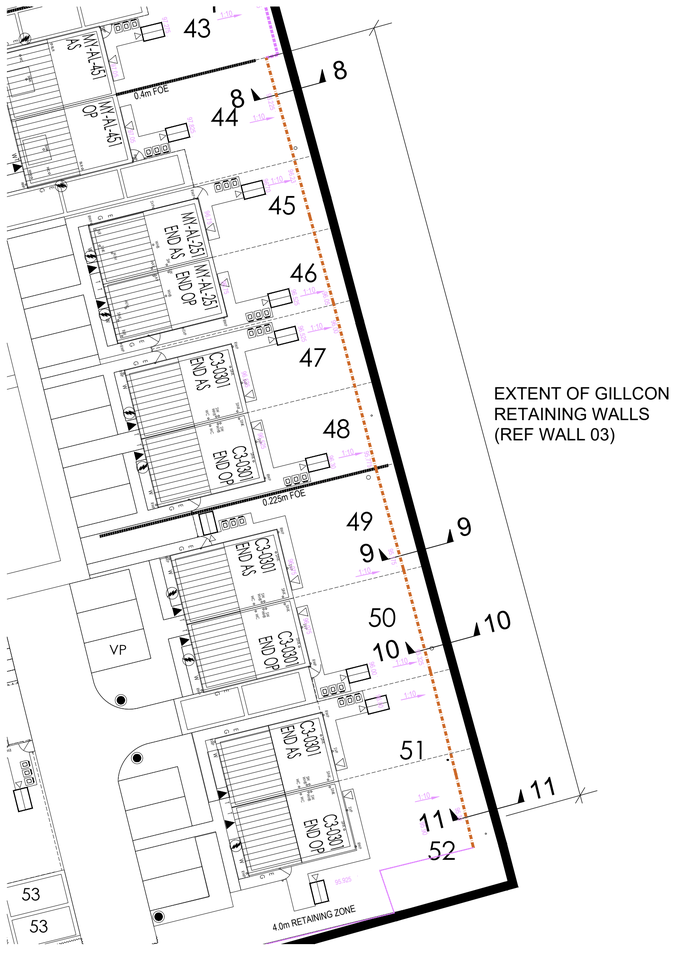
RETAINING WALL TOE CONSTRUCTION TO REMAIN WITHIN SITE BOUNDARY.



ZONE 3 - PLAN VIEW

SCALE - 1:50

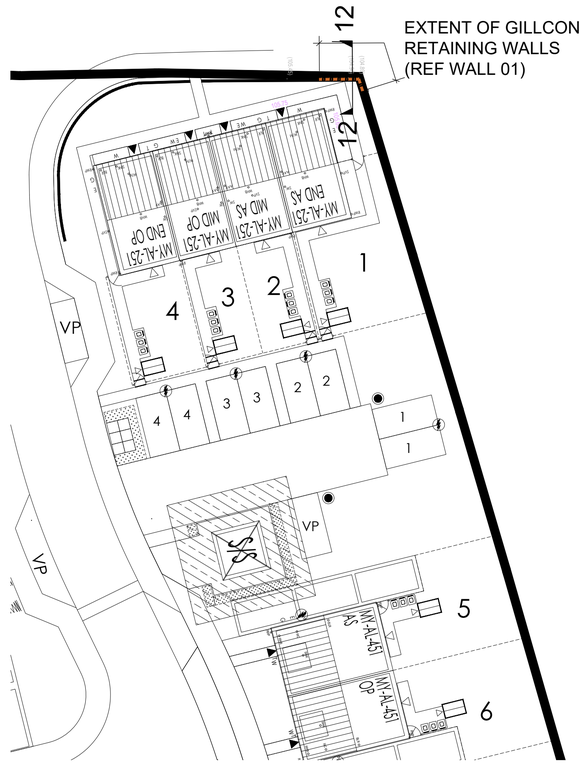
OVERALL ZONAL PLAN



EXTENT OF GILLCON RETAINING WALLS (REF WALL 03)

ZONE 4 - PLAN VIEW

SCALE - 1:50



EXTENT OF GILLCON RETAINING WALLS (REF WALL 01)

ZONE 5 - PLAN VIEW

SCALE - 1:50

Notes:–

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ARCHITECTS ENGINEERS, MECHANICAL AND ELECTRICAL ENGINEERS DRAWINGS TOGETHER WITH THE SPECIFICATIONS.
2. DIMENSIONS TAKEN FROM PROPOSED LAYOUT.

----- MASONRY RETAINING WALLS.

----- GILCON RETAINING WALLS.

Rev	Date	Revision Details	Drawn	Checked
D	12.06.26	WALL LOCATION REVISED AS CLIENT REQUEST	D.J.P.	d.p.
C	23.11.25	RETAINED HEIGHTS REMOVED	DZ	DJP
B	29.10.25	ZONES 1 & 2 OMITTED, ZONE 5 ADDED	DZ	DJP
A	26.08.25	DRAWINGS UPDATED	DZ	DJP
-	12.06.25	INITIAL ISSUE	DZ	DJP

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Client: STRATA

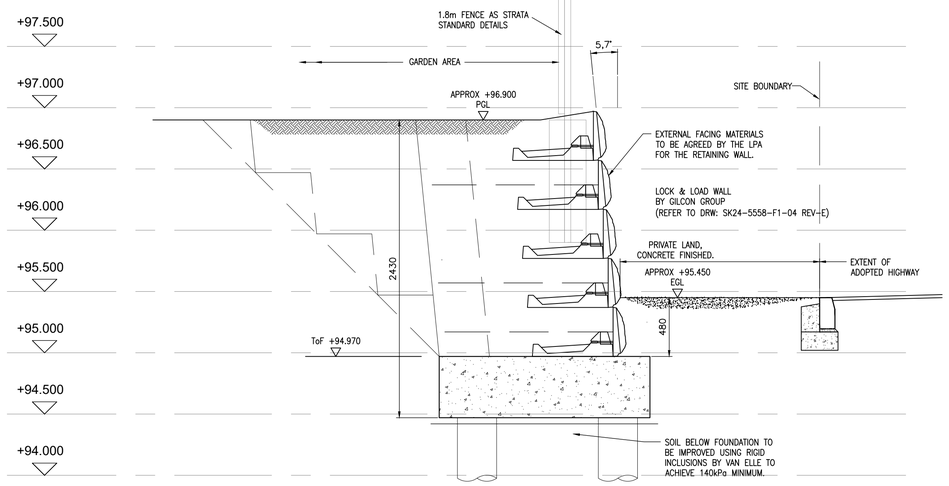
Project: WESTGATE CLECKHEATON

Title: MASONRY & GILLCON RETAINING WALL LOCATION PLANS

Drawn	Checked	Date
DR	DJP	12/06/2025

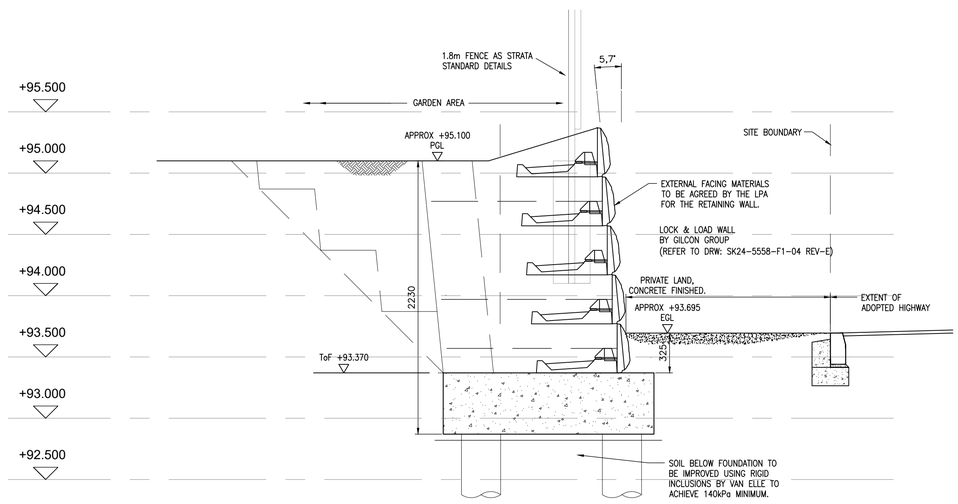
Drawing Number: QD1776-14-10

Drawing Status	Scale	Rev
INITIAL ISSUE	1:500 - A1	D



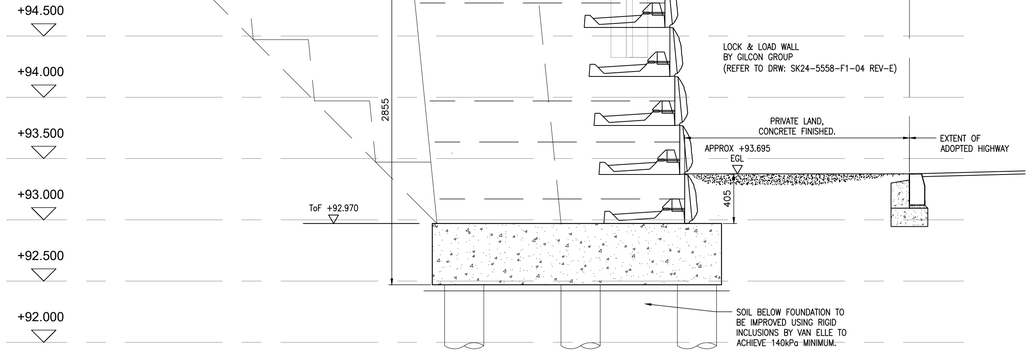
SECTION 8-8

Scale @ 1:25 (WALL 03)



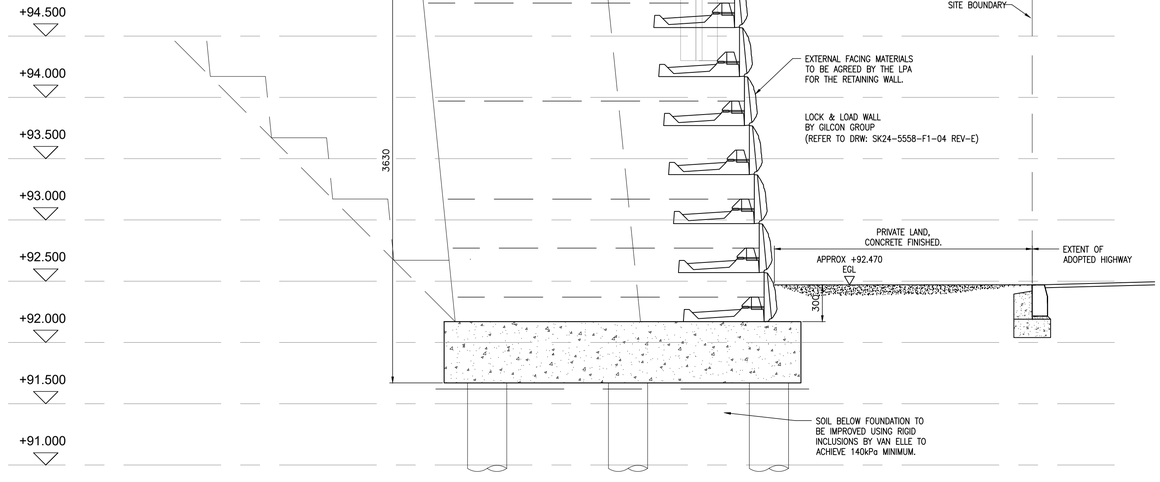
SECTION 9-9

Scale @ 1:25 (WALL 03)



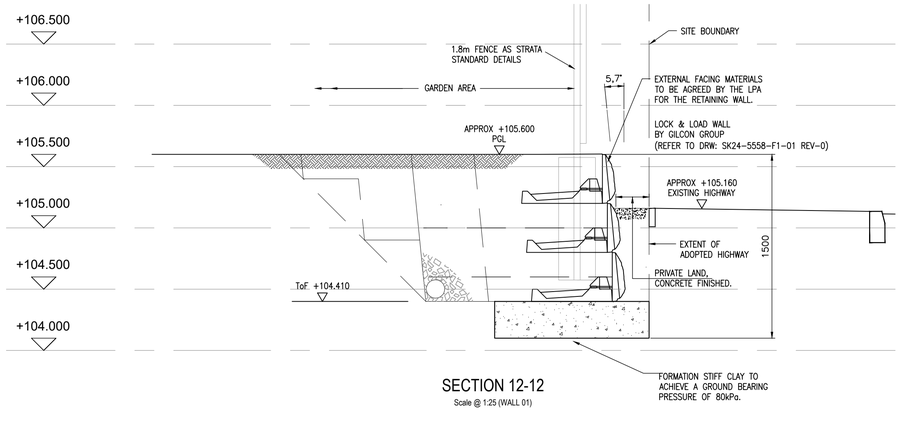
SECTION 10-10

Scale @ 1:25 (WALL 03)



SECTION 11-11

Scale @ 1:25 (WALL 03)



SECTION 12-12

Scale @ 1:25 (WALL 01)

Notes:–

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH GEOMAN DRAWINGS:
   - SK24–5558–F1–03
   - SK24–5558–F1–04E
   - SK24–5558–F1–05E
2. SECTIONS 8–8 TO 12–12 FOR WHICH AIP IS SOUGHT ARE BASED ON DRGS SK24–5558–F01 TO F04, WHICH SHOW THE CRITICAL DESIGN CASES FOR THE WHOLE SITE.

Rev.	Date	Revision Details	Drawn	Checked
D	12.06.26	WALL LOCATION REVISED AS CLIENT REQUEST	D.J.P.	d.p.
C	03.02.26	NOTE 2 ADDED	DZ	DJP
B	03.12.25	SECTION 12-12 ADDED	DZ	DJP
A	26.08.25	DRAWINGS UPDATED	DZ	DJP
-	12.06.25	INITIAL ISSUE	DZ	DJP

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Client: STRATA

Project: WESTGATE CLECKHEATON

Title: GILLCON RETAINING WALL SECTIONS (SHEET 3 of 4)

Drawn	Checked	Date
DR	DJP	12/06/2025

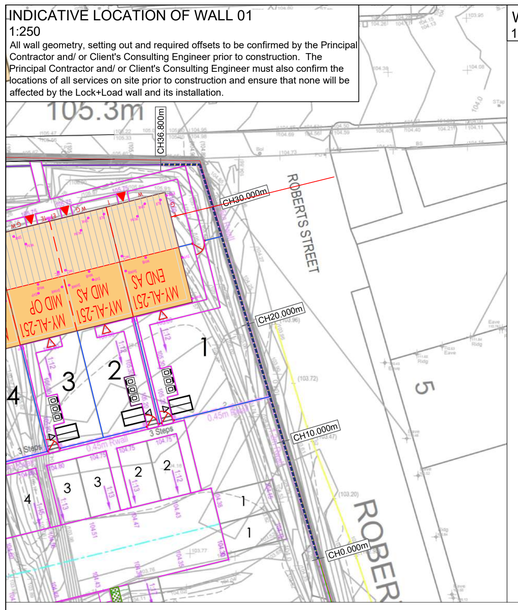
Drawing Number: QD1776-14-13

Drawing Status	Scale	Rev.
INITIAL ISSUE	1:500 - A1	D

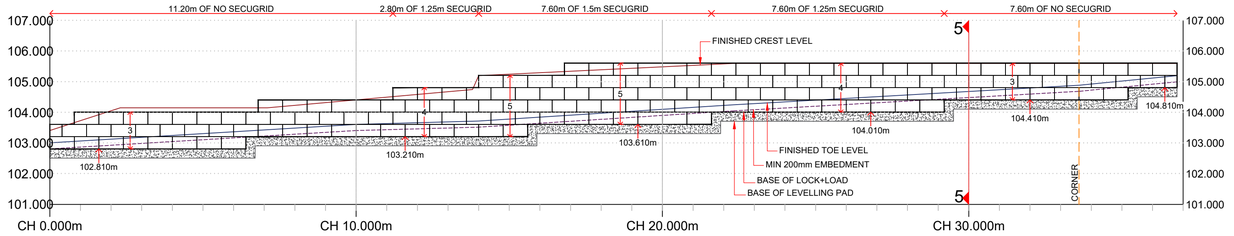
A1

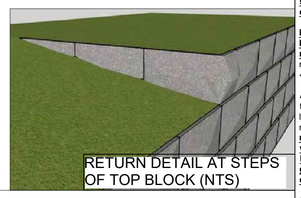
INDICATIVE LOCATION OF WALL 01
1:250

All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction. The Principal Contractor and/ or Client's Consulting Engineer must also confirm the locations of all services on site prior to construction and ensure that none will be affected by the Lock+Load wall and its installation.



WALL 01 ELEVATION
1:100





NOTES:

1) All dimensions in mms unless otherwise specified.

2) BLOCKS: LOCK+LOAD
GEOGRID: SECUGRID 40/40

3) INSTALLATION: Please refer to standard Manufacturer's installation guidelines.

4) REINFORCED BACKFILL:
Class 6I granular fill, in accordance with MCHW SHW Series 600. Granular fill to be benched into in-situ soils and compacted in layers in accordance with the Specification for Highway Works, Series 600, Table 6/4. Class 6I fill to be restricted to '30mm down' for first 1m behind face.

Compliance testing must be undertaken on the Class 6I granular fill, both prior to commencement and throughout the works. This must include particle size testing and shear box of representative samples. Class 6I must have a maximum fines (63µm) content of 15% and comply with the limits in Table 6/3 of Series 600.

This material is assumed to have the following characteristics: Phi' = 35 degrees, Gamma = 19 kN/m³ and c' = 0 kPa, compacted to in accordance with SRW Series 600, Table 6/4. The Contractor is responsible for the selection of this material to ensure compliance with the geotechnical characteristics as shown on the relevant drawings and in the design documents/ calculations.

5) FOUNDATION FOR WALLS 01, 02, 02A, 05 & 05A:
C20/25 concrete levelling pad on a competent bearing stratum to provide a safe bearing resistance of 80kPa. Significant depths of variable MADE GROUND are present at and below formation level of the wall. **The Client's Consulting Engineer & Principal Contractor must ensure that the material at and below formation level will provide a minimum safe bearing resistance of 80kPa and possess a minimum effective friction angle of 28°. These parameters must be confirmed through plate bearing tests and laboratory shear box testing of representative samples of the MADE GROUND prior to construction to allow confirmation of the Lock+Load design.**

If made ground is to be left in place at or below formation level, it must be proof-rolled to check for any soft/ loose areas and confirmed to be medium-dense. Any cohesive material present at or below formation level must be confirmed to possess a minimum undrained shear strength (c_u) of 40kPa.

Any soft/ low strength (c_u<40kPa), loose or unsuitable material (such as topsoil, soft/ loose made ground or alluvium) present at or below formation level of the walls must be excavated down to medium-dense material and replaced with compacted Class 6F2/6F5 granular fill. **If any soft, loose or unsuitable material (c_u<40kPa, SBR<80kPa) is left in place at or below wall formation level, instability and/ or excessive settlement of the Lock+Load walls may occur. If these parameters cannot be achieved, ground improvement (such as dynamic compaction, etc.) should be considered by the Principal Contractor.**

6) SITE / IN-SITU SOILS :
Retained: MADE GROUND (ashy gravelly SAND [ASH & CLINKER]) & compacted Class 1/2 upfill. These materials are assumed to have the following minimum properties:
MADE GROUND* ϕ' = 28°, γ = 18kN/m³ and c' = 0 kPa.
CLASS 1/2 FILL ϕ' = 28°, γ = 19kN/m³ and c' = 0 kPa.

Foundation: Proof-rolled granular MADE GROUND (medium-dense ashy gravelly SAND [ASH & CLINKER]). This material is assumed to have the following minimum properties:
PROOF-ROLLED MADE GROUND* ϕ' = 28°, γ = 18kN/m³ and c' = 0kPa.

*Laboratory shear box testing of representative samples of the MADE GROUND must be undertaken prior to construction. The Contractor & Client's Consulting Engineer are responsible for ensuring the in-situ soils comply with the geotechnical characteristics as shown on the relevant drawings and in the design calculations.

7) DRAINAGE:
A minimum 150mmØ perforated drain pipe should be placed along the full length of the walls. This should be roddable and connected to an appropriate site drainage outlet with consent to discharge. Intermediate rodding points will be required to allow the full length of drain to be maintained (to be determined by scheme drainage designer). Rodding points should be installed at maximum 20m spacings at the top of the walls.

8) FACE ANGLE = 5.7°.

9) TEMPORARY EXCAVATIONS/ SETTING OUT
This solution is for the permanent works only, and is issued on the basis that a safe system of works is provided for construction. Temporary excavations have the potential to fail rapidly and without warning, particularly in granular material. The Principal Contractor/ Wall installer must produce a method statement and risk assessment for the works to be approved by the Client's Consulting Engineer. Temporary stability and design of any temporary works are outside our scope and should be confirmed by others.

All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction.

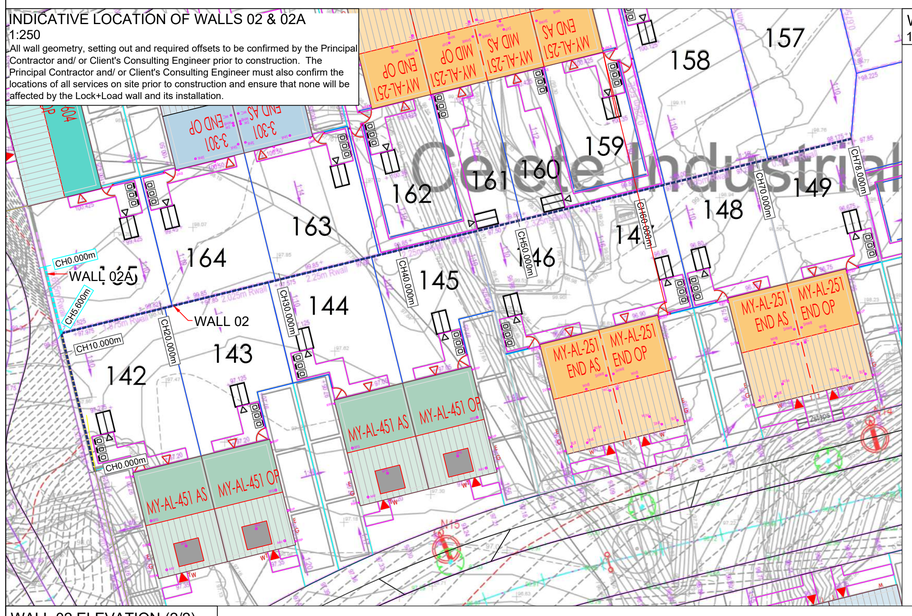
10) BUILDING FOUNDATIONS
It is assumed that any building foundations in the vicinity of the walls will be taken to such a level that no loads will be transferred to the Lock+Load walls and reinforced backfill. Building foundations must not rely on the flexible Lock+Load walls and reinforced backfill for support (including lateral support), and are outside the scope of this design. Please advise us if a piling/ vibro rig and/ or large plant is to be used on the retained side of the Lock+Load walls, as well as their required minimum offsets and maximum operational surcharges, as the design will need to be checked for the rig loads.

11) NOTES ON CALCULATIONS/DRAWINGS:
These plans and the accompanying design documentation should be thoroughly checked by the Client's Consulting Engineer. Any apparent errors, omissions or variations should be reported immediately to Geoman Ltd. Construction of this wall shall not commence unless and until the Client/ Client's Consulting Engineer has considered the Geoman Design Submission Document (QP06 Ref 24-5558) to ensure that there are no errors, omissions or conflict with the scheme design.

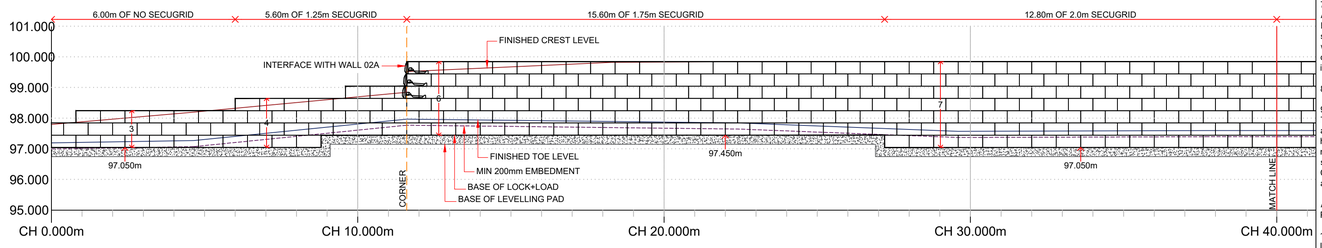
Geoman Ltd. will not be liable for any loss or damage resulting from or arising out of the use of this drawing where it has been used other than in accordance with Geoman's advice and specifications. Unless advice is specifically requested in respect of parts of the site not within the area where the works are undertaken, Geoman shall not be liable for any loss or damage resulting from or arising out of any weakness or other problem in the ground outside the area where the works are undertaken.

INDICATIVE LOCATION OF WALLS 02 & 02A
1:250

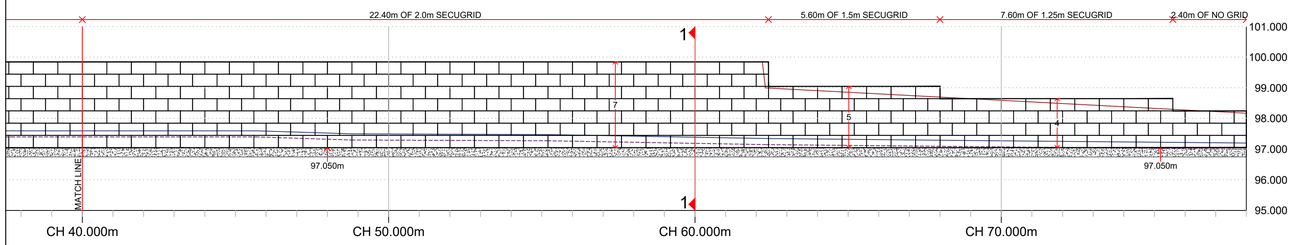
All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction. The Principal Contractor and/ or Client's Consulting Engineer must also confirm the locations of all services on site prior to construction and ensure that none will be affected by the Lock+Load wall and its installation.



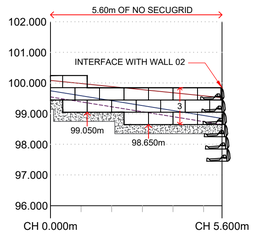
WALL 02 ELEVATION (1/2)
1:100



WALL 02 ELEVATION (2/2)
1:100



WALL 02A ELEVATION
1:100



CONCEPT ONLY
NOT FOR CONSTRUCTION

Rev.	Issue / Revision:	Drawn:	Date:
0		WM	11.09.24

GEOMAN
44 Elmwood Avenue, Belfast, BT9 6AZ 02890 664941 geoman@geoman.co.uk

Project Title:
WESTGATE, CLECKHEATON

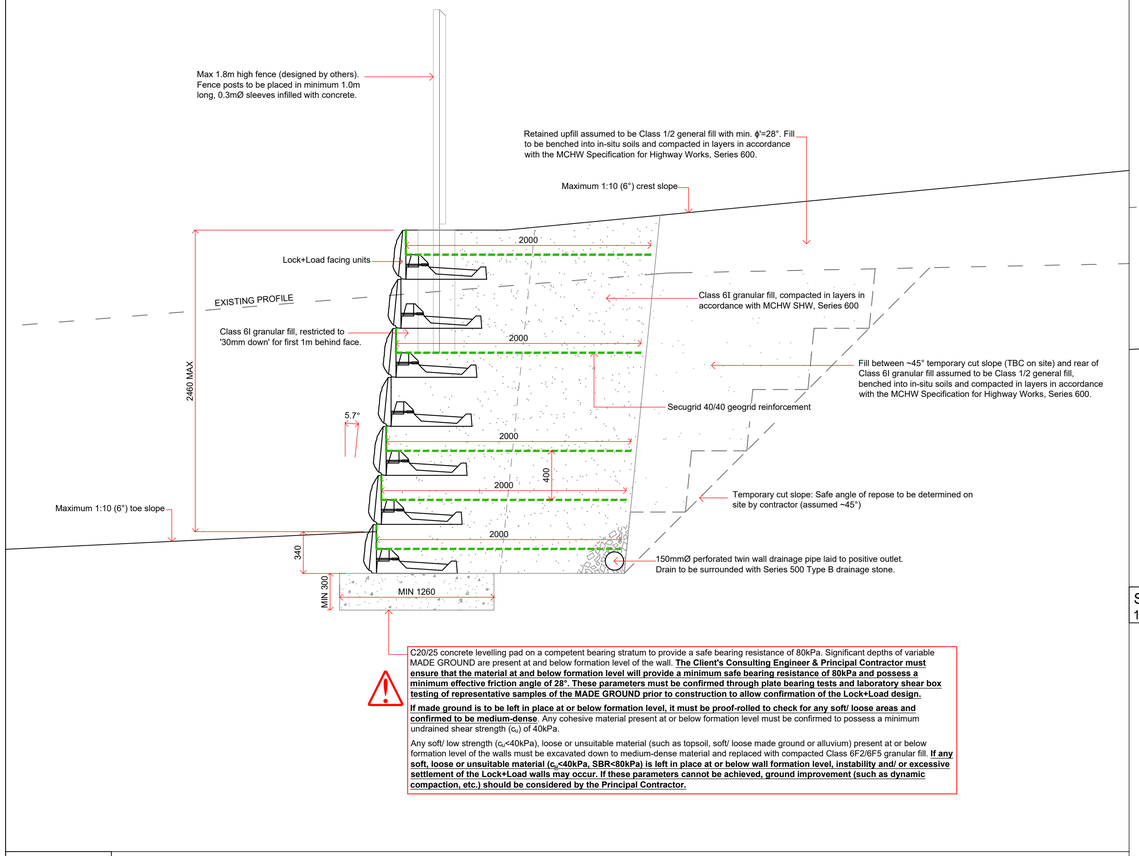
Client:
GILLCON GROUP

Drawing Title:
LOCK+LOAD ELEVATIONS 01 & 02

Designed:		Date:		Project No:	24-5558
Drawn:	WM	Date:	11.09.24	Scale:	AS INDICATED AT A1
Checked:		Date:			

Drawing No: SK24-5558-F1-01 Revision: 0

SECTION 1-1
1:25

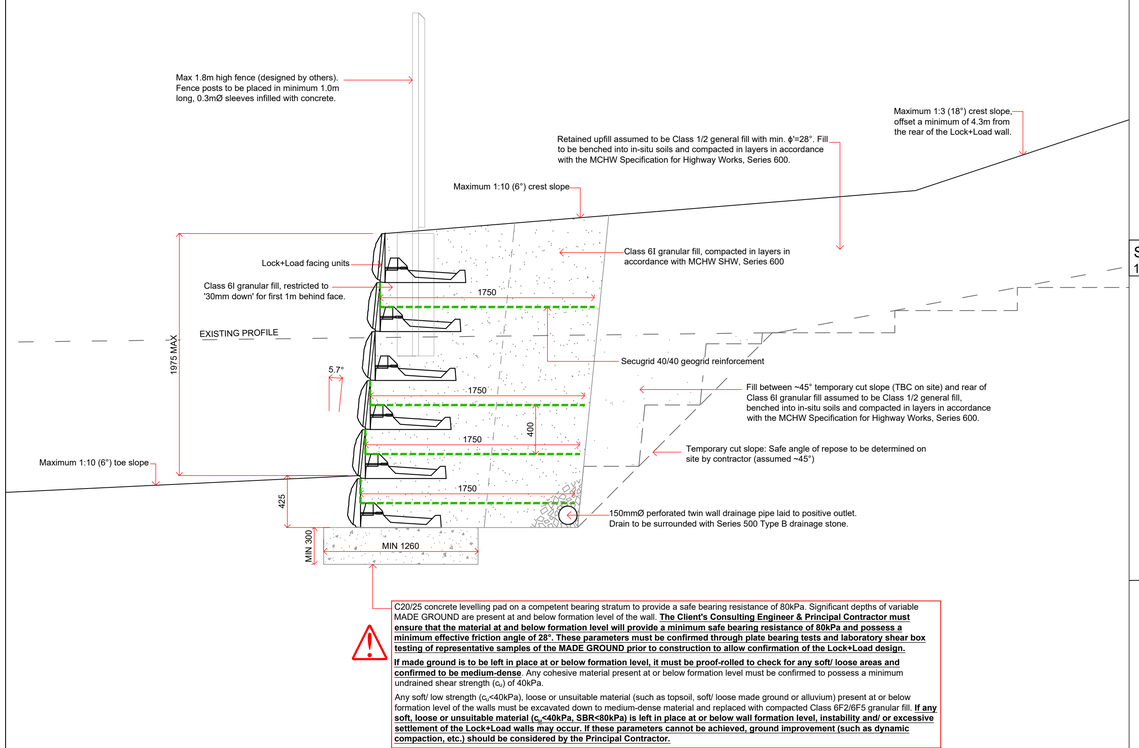


C20/25 concrete levelling pad on a competent bearing stratum to provide a safe bearing resistance of 80kPa. Significant depths of variable MADE GROUND are present at and below formation level of the wall. **The Client's Consulting Engineer & Principal Contractor must ensure that the material at and below formation level will provide a minimum safe bearing resistance of 80kPa and possess a minimum effective friction angle of 28°. These parameters must be confirmed through plate bearing tests and laboratory shear box testing of representative samples of the MADE GROUND prior to construction to allow confirmation of the Lock+Load design.**

If made ground is to be left in place at or below formation level, it must be proof-rolled to check for any soft/ loose areas and confirmed to be medium-dense. Any cohesive material present at or below formation level must be confirmed to possess a minimum undrained shear strength (c_u) of 40kPa.

Any soft/ low strength (c_u<40kPa), loose or unsuitable material (such as topsoil, soft/ loose made ground or alluvium) present at or below formation level of the walls must be excavated down to medium-dense material and replaced with compacted Class 6F2/6F5 granular fill. **If any soft, loose or unsuitable material (c_u<40kPa, SBR<80kPa) is left in place at or below wall formation level, instability and/ or excessive settlement of the Lock+Load walls may occur. If these parameters cannot be achieved, ground improvement (such as dynamic compaction, etc.) should be considered by the Principal Contractor.**

SECTION 2-2
1:25



C20/25 concrete levelling pad on a competent bearing stratum to provide a safe bearing resistance of 80kPa. Significant depths of variable MADE GROUND are present at and below formation level of the wall. **The Client's Consulting Engineer & Principal Contractor must ensure that the material at and below formation level will provide a minimum safe bearing resistance of 80kPa and possess a minimum effective friction angle of 28°. These parameters must be confirmed through plate bearing tests and laboratory shear box testing of representative samples of the MADE GROUND prior to construction to allow confirmation of the Lock+Load design.**

If made ground is to be left in place at or below formation level, it must be proof-rolled to check for any soft/ loose areas and confirmed to be medium-dense. Any cohesive material present at or below formation level must be confirmed to possess a minimum undrained shear strength (c_u) of 40kPa.

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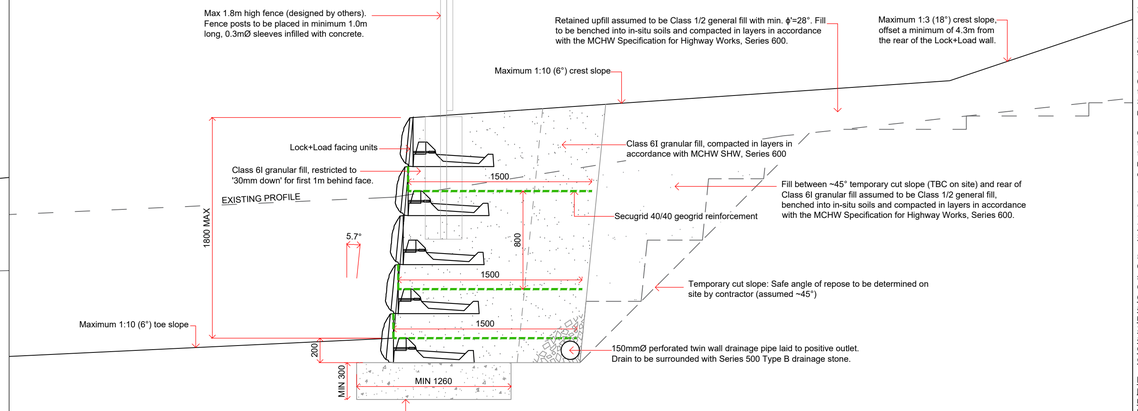
SECTION 3-3
1:25

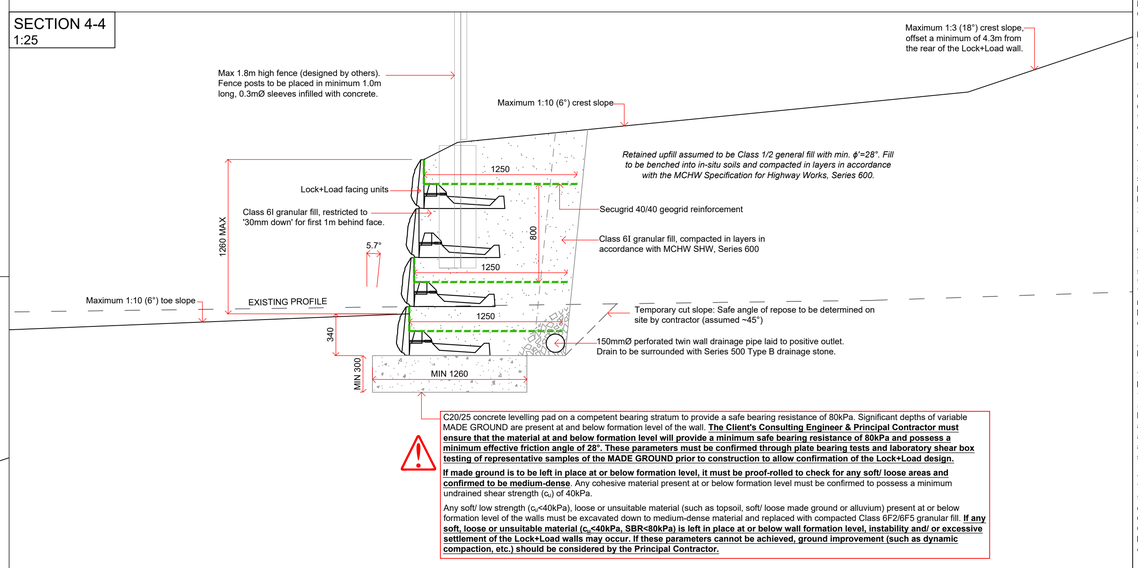


C20/25 concrete levelling pad on a competent bearing stratum to provide a safe bearing resistance of 80kPa. Significant depths of variable MADE GROUND are present at and below formation level of the wall. **The Client's Consulting Engineer & Principal Contractor must ensure that the material at and below formation level will provide a minimum safe bearing resistance of 80kPa and possess a minimum effective friction angle of 28°. These parameters must be confirmed through plate bearing tests and laboratory shear box testing of representative samples of the MADE GROUND prior to construction to allow confirmation of the Lock+Load design.**

If made ground is to be left in place at or below formation level, it must be proof-rolled to check for any soft/ loose areas and confirmed to be medium-dense. Any cohesive material present at or below formation level must be confirmed to possess a minimum undrained shear strength (c_u) of 40kPa.

Any soft/ low strength (c_u<40kPa), loose or unsuitable material (such as topsoil, soft/ loose made ground or alluvium) present at or below formation level of the walls must be excavated down to medium-dense material and replaced with compacted Class 6F2/6F5 granular fill. **If any soft, loose or unsuitable material (c_u<40kPa, SBR<80kPa) is left in place at or below wall formation level, instability and/ or excessive settlement of the Lock+Load walls may occur. If these parameters cannot be achieved, ground improvement (such as dynamic compaction, etc.) should be considered by the Principal Contractor.**

SECTION 4-4
1:25

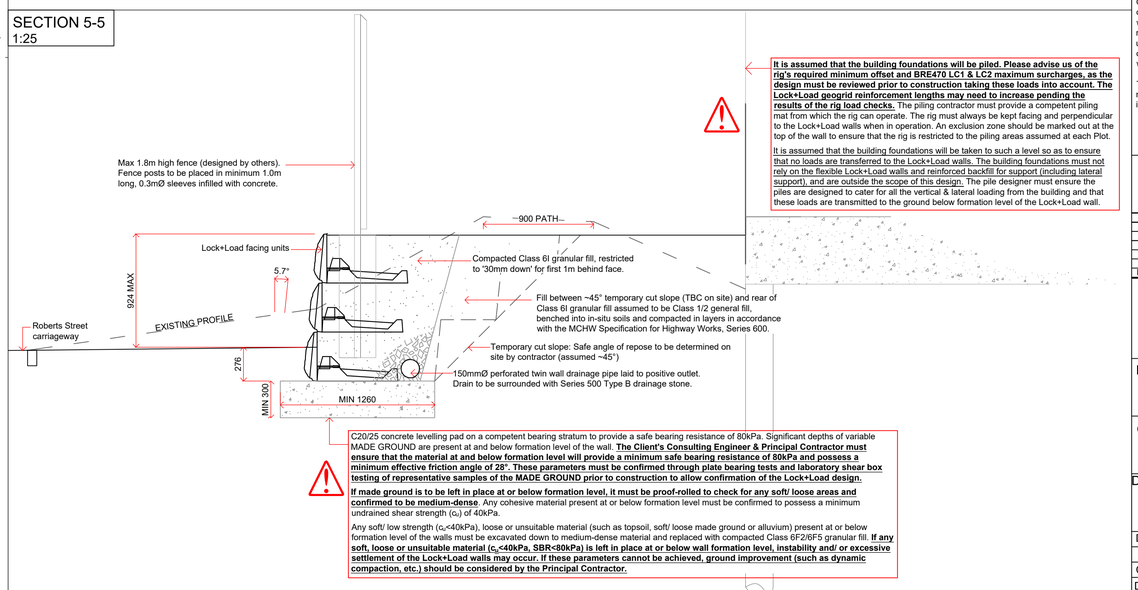


C20/25 concrete levelling pad on a competent bearing stratum to provide a safe bearing resistance of 80kPa. Significant depths of variable MADE GROUND are present at and below formation level of the wall. **The Client's Consulting Engineer & Principal Contractor must ensure that the material at and below formation level will provide a minimum safe bearing resistance of 80kPa and possess a minimum effective friction angle of 28°. These parameters must be confirmed through plate bearing tests and laboratory shear box testing of representative samples of the MADE GROUND prior to construction to allow confirmation of the Lock+Load design.**

If made ground is to be left in place at or below formation level, it must be proof-rolled to check for any soft/ loose areas and confirmed to be medium-dense. Any cohesive material present at or below formation level must be confirmed to possess a minimum undrained shear strength (c_u) of 40kPa.

Any soft/ low strength (c_u<40kPa), loose or unsuitable material (such as topsoil, soft/ loose made ground or alluvium) present at or below formation level of the walls must be excavated down to medium-dense material and replaced with compacted Class 6F2/6F5 granular fill. **If any soft, loose or unsuitable material (c_u<40kPa, SBR<80kPa) is left in place at or below wall formation level, instability and/ or excessive settlement of the Lock+Load walls may occur. If these parameters cannot be achieved, ground improvement (such as dynamic compaction, etc.) should be considered by the Principal Contractor.**

SECTION 5-5
1:25



It is assumed that the building foundations will be piled. Please advise us of the rig's required minimum offset and BRE470 LC1 & LC2 maximum surcharges, as the design must be reviewed prior to construction taking these loads into account. The Lock+Load geogrid reinforcement lengths may need to increase pending the results of the rig load checks. The piling contractor must provide a competent piling mat from which the rig can operate. The rig must always be kept facing and perpendicular to the Lock+Load walls when in operation. An exclusion zone should be marked out at the top of the wall to ensure that the rig is restricted to the piling areas assumed at each Plot.

It is assumed that the building foundations will be taken to such a level so as to ensure that no loads are transferred to the Lock+Load walls. The building foundations must not rely on the flexible Lock+Load walls and reinforced backfill for support (including lateral support), and are outside the scope of this design. The pile designer must ensure the piles are designed to cater for all the vertical & lateral loading from the building and that these loads are transmitted to the ground below formation level of the Lock+Load wall.

C20/25 concrete levelling pad on a competent bearing stratum to provide a safe bearing resistance of 80kPa. Significant depths of variable MADE GROUND are present at and below formation level of the wall. **The Client's Consulting Engineer & Principal Contractor must ensure that the material at and below formation level will provide a minimum safe bearing resistance of 80kPa and possess a minimum effective friction angle of 28°. These parameters must be confirmed through plate bearing tests and laboratory shear box testing of representative samples of the MADE GROUND prior to construction to allow confirmation of the Lock+Load design.**

If made ground is to be left in place at or below formation level, it must be proof-rolled to check for any soft/ loose areas and confirmed to be medium-dense. Any cohesive material present at or below formation level must be confirmed to possess a minimum undrained shear strength (c_u) of 40kPa.

Any soft/ low strength (c_u<40kPa), loose or unsuitable material (such as topsoil, soft/ loose made ground or alluvium) present at or below formation level of the walls must be excavated down to medium-dense material and replaced with compacted Class 6F2/6F5 granular fill. **If any soft, loose or unsuitable material (c_u<40kPa, SBR<80kPa) is left in place at or below wall formation level, instability and/ or excessive settlement of the Lock+Load walls may occur. If these parameters cannot be achieved, ground improvement (such as dynamic compaction, etc.) should be considered by the Principal Contractor.**

A1

NOTES:

1) All dimensions in mms unless otherwise specified.

2) BLOCKS: LOCK+LOAD
GEOGRID: SECUGRID 40/40

3) INSTALLATION: Please refer to standard Manufacturer's installation guidelines.

4) REINFORCED BACKFILL:
Class 6I granular fill, in accordance with MCHW SHW Series 600. Granular fill to be benched into in-situ soils and compacted in layers in accordance with the Specification for Highway Works, Series 600, Table 6/4. Class 6I fill to be restricted to '30mm down' for first 1m behind face.

Compliance testing must be undertaken on the Class 6I granular fill, both prior to commencement and throughout the works. This must include particle size testing and shear box of representative samples. Class 6I must have a maximum fines (63µm) content of 15% and comply with the limits in Table 6/3 of Series 600.

This material is assumed to have the following characteristics: Phi' = 35 degrees, Gamma = 19 kN/m³ and c' = 0 kPa, compacted to in accordance with SRW Series 600, Table 6/4. The Contractor is responsible for the selection of this material to ensure compliance with the geotechnical characteristics as shown on the relevant drawings and in the design documents/ calculations.

5) FOUNDATION FOR WALLS 01, 02, 02A, 05 & 05A:
C20/25 concrete levelling pad on a competent bearing stratum to provide a safe bearing resistance of 80kPa. Significant depths of variable MADE GROUND are present at and below formation level of the wall. **The Client's Consulting Engineer & Principal Contractor must ensure that the material at and below formation level will provide a minimum safe bearing resistance of 80kPa and possess a minimum effective friction angle of 28°. These parameters must be confirmed through plate bearing tests and laboratory shear box testing of representative samples of the MADE GROUND prior to construction to allow confirmation of the Lock+Load design.**

If made ground is to be left in place at or below formation level, it must be proof-rolled to check for any soft/ loose areas and confirmed to be medium-dense. Any cohesive material present at or below formation level must be confirmed to possess a minimum undrained shear strength (c_u) of 40kPa.

Any soft/ low strength (c_u<40kPa), loose or unsuitable material (such as topsoil, soft/ loose made ground or alluvium) present at or below formation level of the walls must be excavated down to medium-dense material and replaced with compacted Class 6F2/6F5 granular fill. **If any soft, loose or unsuitable material (c_u<40kPa, SBR<80kPa) is left in place at or below wall formation level, instability and/ or excessive settlement of the Lock+Load walls may occur. If these parameters cannot be achieved, ground improvement (such as dynamic compaction, etc.) should be considered by the Principal Contractor.**

6) SITE / IN-SITU SOILS :
Retained: MADE GROUND (ashy gravelly SAND [ASH & CLINKER]) & compacted Class 1/2 upfill. These materials are assumed to have the following minimum properties:
MADE GROUND* ϕ' = 28°, γ = 18kN/m³ and c' = 0 kPa.
CLASS 1/2 FILL ϕ' = 28°, γ = 19kN/m³ and c' = 0 kPa.

Foundation: Proof-rolled granular MADE GROUND (medium-dense ashy gravelly SAND [ASH & CLINKER]). This material is assumed to have the following minimum properties:
PROOF-ROLLED MADE GROUND* ϕ' = 28°, γ = 18kN/m³ and c' = 0kPa.

*Laboratory shear box testing of representative samples of the MADE GROUND must be undertaken prior to construction. The Contractor & Client's Consulting Engineer are responsible for ensuring the in-situ soils comply with the geotechnical characteristics as shown on the relevant drawings and in the design calculations.

7) DRAINAGE:
A minimum 150mmØ perforated drain pipe should be placed along the full length of the walls. This should be roddable and connected to an appropriate site drainage outlet with consent to discharge. Intermediate rodding points will be required to allow the full length of drain to be maintained (to be determined by scheme drainage designer). Rodding points should be installed at maximum 20m spacings at the top of the walls.

8) FACE ANGLE = 5.7°.

9) TEMPORARY EXCAVATIONS/ SETTING OUT
This solution is for the permanent works only, and is issued on the basis that a safe system of works is provided for construction. Temporary excavations have the potential to fail rapidly and without warning, particularly in granular material. The Principal Contractor/ Wall installer must produce a method statement and risk assessment for the works to be approved by the Client's Consulting Engineer. Temporary stability and design of any temporary works are outside our scope and should be confirmed by others.

All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction.

10) BUILDING FOUNDATIONS
It is assumed that any building foundations in the vicinity of the walls will be taken to such a level that no loads will be transferred to the Lock+Load walls and reinforced backfill. Building foundations must not rely on the flexible Lock+Load walls and reinforced backfill for support (including lateral support), and are outside the scope of this design. Please advise us if a piling/ vibro rig and/ or large plant is to be used on the retained side of the Lock+Load walls, as well as their required minimum offsets and maximum operational surcharges, as the design will need to be checked for the rig loads.

11) NOTES ON CALCULATIONS/DRAWINGS:
These plans and the accompanying design documentation should be thoroughly checked by the Client's Consulting Engineer. Any apparent errors, omissions or variations should be reported immediately to Geoman Ltd. Construction of this wall shall not commence unless and until the Client/ Client's Consulting Engineer has considered the Geoman Design Submission Document (QP06 Ref 24-5558) to ensure that there are no errors, omissions or conflict with the scheme design.

Geoman Ltd. will not be liable for any loss or damage resulting from or arising out of the use of this drawing where it has been used other than in accordance with Geoman's advice and specifications. Unless advice is specifically requested in respect of parts of the site not within the area where the works are undertaken, Geoman shall not be liable for any loss or damage resulting from or arising out of any weakness or other problem in the ground outside the area where the works are undertaken.

CONCEPT ONLY
NOT FOR CONSTRUCTION

Rev.	Issue / Revision:	Drawn:	Date:
0		WM	11.09.24

GEOMAN
44 Elmwood Avenue, Belfast, BT9 6AZ 02890 664941 geoman@geoman.co.uk

Project Title:
WESTGATE, CLECKHEATON

Client:
GILLCON GROUP

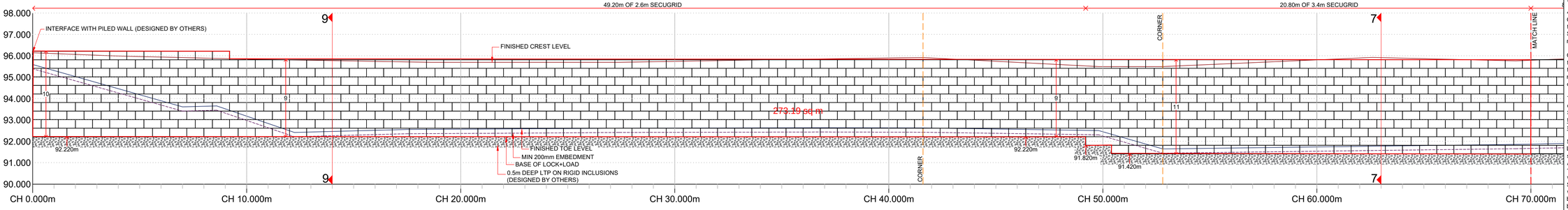
Drawing Title:
LOCK+LOAD CROSS-SECTIONS

Designed:		Date:		Project No:	24-5558
Drawn:	WM	Date:	11.09.24	Scale:	AS INDICATED AT A1
Checked:		Date:			

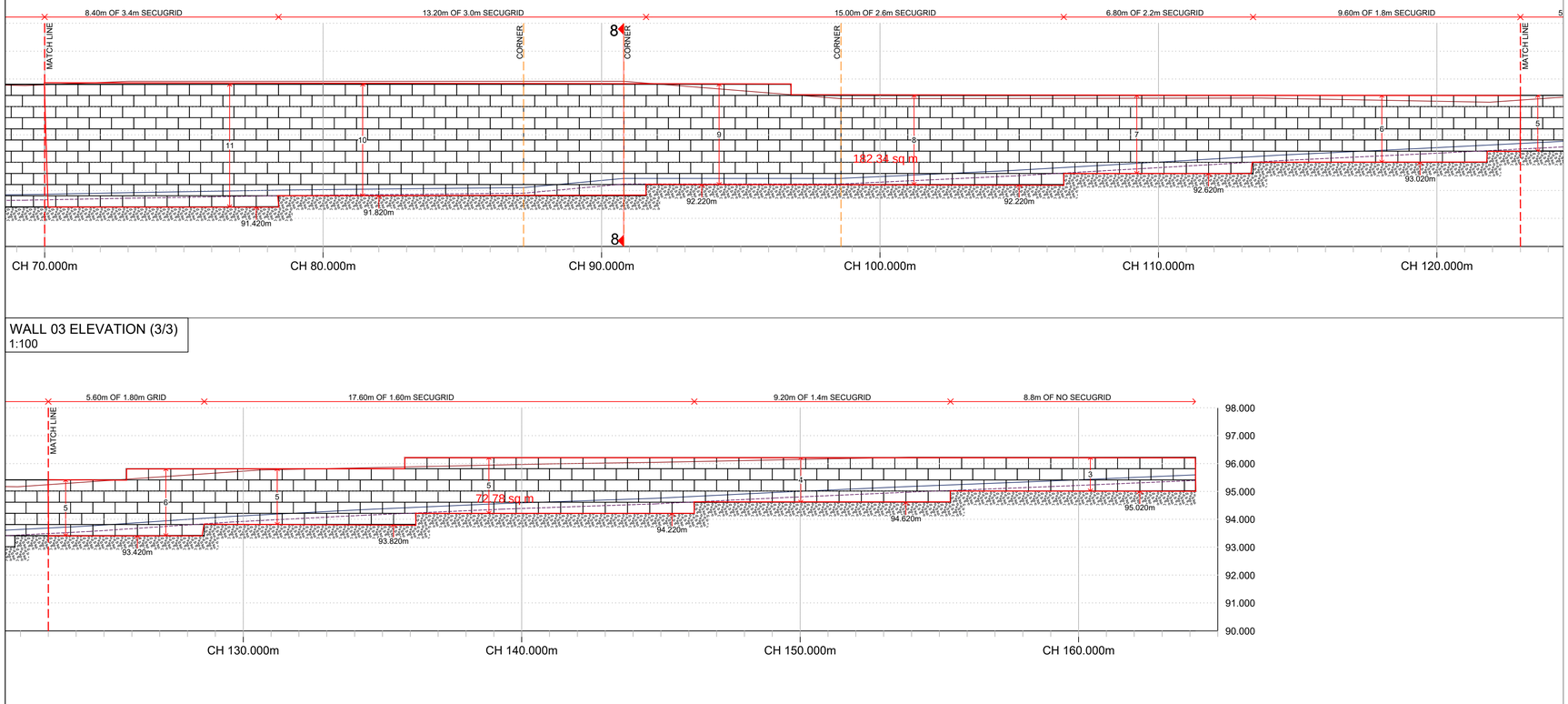
Drawing No: SK24-5558-F1-03 Revision: 0

A1

WALL 03 ELEVATION (1/3)
1:100

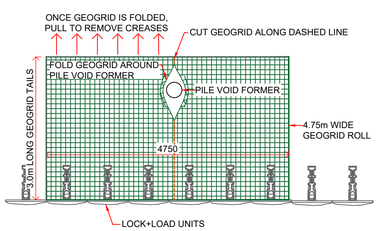


WALL 03 ELEVATION (2/3)
1:100



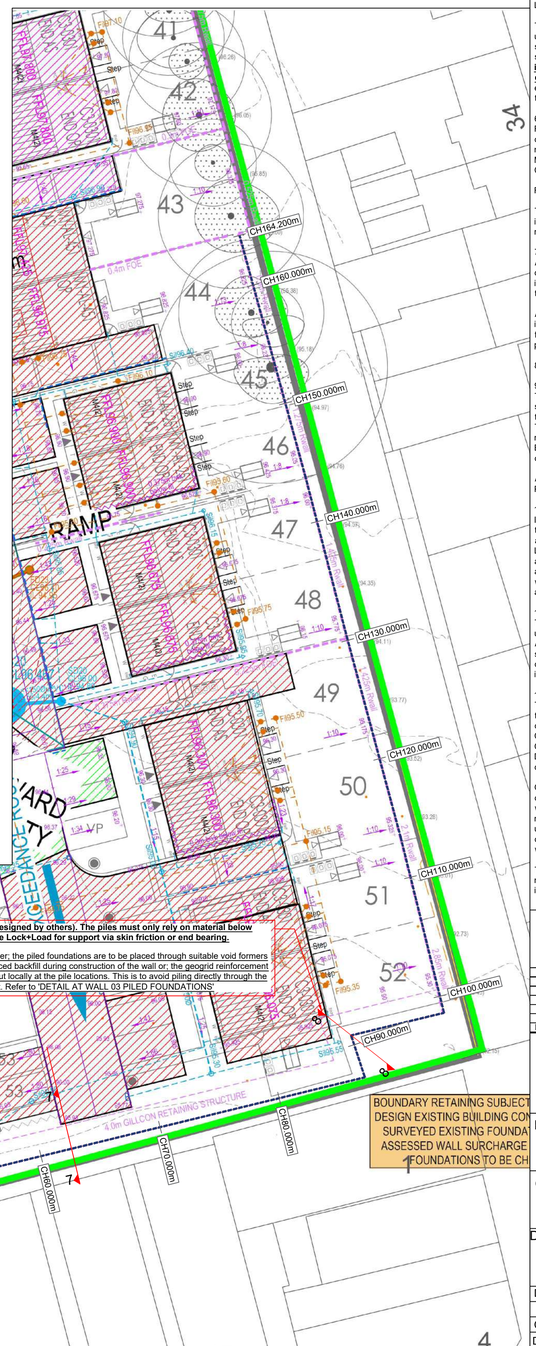
WALL 03 ELEVATION (3/3)
1:100

DETAIL AT WALL 03 PILED FOUNDATIONS - TBC (NTS)



INDICATIVE LOCATION OF WALL 03
1:250

All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction. The Principal Contractor and/ or Client's Consulting Engineer must also confirm the locations of all services on site prior to construction and ensure that none will be affected by the Lock+Load wall and its installation.



NOTES:

1) All dimensions in mms unless otherwise specified.

2) BLOCKS: LOCK+LOAD GEOGRID: SECUGRID 40/40

3) INSTALLATION: Refer to standard Manufacturer's installation guidelines.

4) REINFORCED BACKFILL:
Class 6I granular fill, in accordance with MCHW SHW Series 600. Granular fill to be benched into in-situ soils and compacted in layers in accordance with the Specification for Highway Works, Series 600, Table 6/4. Class 6I fill to be restricted to '30mm down' for first 1m behind face.

Compliance testing must be undertaken on the Class 6I granular fill, both prior to commencement and throughout the works. This must include particle size testing and shear box of representative samples. Class 6I must have a maximum fines (63µm) content of 15% and comply with the limits in Table 6/3 of Series 600.

This material is assumed to have the following characteristics: Phi' = 35 degrees, Gamma = 19 kN/m³ and c' = 0 kPa, compacted to in accordance with SRW Series 600, Table 6/4. The Contractor is responsible for the selection of this material to ensure compliance with the geotechnical characteristics as shown on the relevant drawings and in the design documents/ calculations.

5) FOUNDATION FOR WALL 03:
Logs in Sirius Geotechnical Report C9907/AMG/1039 suggest the presence of significant depths of very loose MADE GROUND & very low strength ALLUVIUM at the location of Wall 03. An undrained shear strength (c_u) of 18kPa was recorded in WS604 at a depth of 2.75m, and SPT 'N' values of 0 were recorded at depths of 3m and 5m in BH601 and BH602 respectively. Such material would not be a suitable foundation material for the Lock+Load wall, and remedial action must therefore be undertaken to provide a competent base from which to construct Lock+Load Wall 03. The maximum applied bearing pressure at the base of Lock+Load Wall 03 will be 140kPa.

We understand that rigid inclusions and a 0.5m deep Load Transfer platform (LTP) are to be installed (both designed by others). It is assumed that the LTP will include high-strength geogrid layer(s) in both the longitudinal and transverse directions, with the geogrid wrapped up the face at both ends of the LTP and anchored sufficiently.

This Lock + Load element design only considers the design of the wall from the upper surface of the LTP. The Lock+Load analyses include checks on external stability (wall sliding & overturning) and internal stability (geogrid tensile strength, pullout, etc.). **Global stability, bearing capacity of the LTP & rigid inclusions, and settlement are outside the scope of the Lock+Load element design.** Any issues relating to the LTP and rigid inclusions (for example, differential settlement of the geogrid-reinforced fill spanning between the rigid inclusions, etc.) are also outside the scope of this design.

6) SITE / IN-SITU SOILS :
Retained: MADE GROUND (ashy gravelly SAND [ASH & CLINKER]) & compacted Class 1/2 upfill. These materials are assumed to have the following minimum properties;
MADE GROUND ϕ' = 28°, γ = 18kN/m³ and c' = 0 kPa.
CLASS 1/2 FILL ϕ' = 28°, γ = 19kN/m³ and c' = 0 kPa.

Foundation solution for Wall 03: LTP on rigid inclusions (designed by others)

The Contractor & Client's Consulting Engineer are responsible for ensuring the in-situ soils comply with the geotechnical characteristics as shown on the relevant drawings and in the design calculations.

7) DRAINAGE:
Adequate permanent, maintained surface water drainage must be included to collect any water from hardstanding areas, parking bays and the access road in the crest area of the wall. This should be connected to an outlet away from the wall (site drainage is outside the scope of the wall design).

Any water entering the retained ground must therefore be limited to rainfall infiltrating into the Plot 44 - 58 gardens. As the heel drain has been omitted from the wall as requested, some seepage through the mortarless facing panels may occur, particularly following heavy rainfall.

8) FACE ANGLE = 5.7°.

9) TEMPORARY EXCAVATIONS/ SETTING OUT
This solution is for the permanent works only, and is issued on the basis that a safe system of works is provided for construction. Temporary excavations have the potential to fail rapidly and without warning, particularly in granular material. The Principal Contractor/ Wall installer must produce a method statement and risk assessment for the works to be approved by the Client's Consulting Engineer. Temporary stability and design of any temporary works are outside our scope and should be confirmed by others.

All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction.

10) BUILDING FOUNDATIONS
It is assumed that any building foundations in the vicinity of the wall will be taken to such a level that no loads will be transferred to the Lock+Load wall and reinforced backfill. Building foundations must not rely on the flexible Lock+Load wall and reinforced backfill for support (including lateral support), and are outside the scope of this design. Please advise us if a piling/ vibro rig and/ or large plant is to be used on the retained side of the Lock+Load wall, as well as their required minimum offsets and maximum operational surcharges, as the design will need to be checked for the rig loads.

11) SETTLEMENT
The Client's Consulting Engineer must assess the risk of settlement of ~4m of upfill over significant depths of very loose MADE GROUND & very low strength ALLUVIUM to the rear of the wall. Ground improvement (designed by others) such as deep soil mixing, vibro stone columns, etc. may be required to limit differential and total settlement (to be confirmed by specialist ground improvement contractor).

12) NOTES ON CALCULATIONS/DRAWINGS:
These plans and the accompanying design documentation should be thoroughly checked by the Client's Consulting Engineer. Any apparent errors, omissions or variations should be reported immediately to Geoman Ltd. Construction of this wall shall not commence unless and until the Client/ Client's Consulting Engineer has considered the Geoman Design Submission Document (QP06 Ref 24-5558) to ensure that there are no errors, omissions or conflict with the scheme design.

Geoman Ltd. will not be liable for any loss or damage resulting from or arising out of the use of this drawing where it has been used other than in accordance with Geoman's advice and specifications. Unless advice is specifically requested in respect of parts of the site not within the area where the works are undertaken, Geoman shall not be liable for any loss or damage resulting from or arising out of any weakness or other problem in the ground outside the area where the works are undertaken.

FOR APPROVAL

Rev.	Issue / Revision:	Drawn	Date:
E	REVISED AS PER DRAWING 'QD1776 ENG '	WM	22.01.26
D		WM	24.09.25
C		WM	17.09.25
B		WM	25.03.25
A		WM	04.03.25
0		WM	27.09.24

GEOMAN
44 Elmwood Avenue, Belfast, BT9 6AZ 02890 664941 geoman@geoman.co.uk

Project Title:
WESTGATE, CLECKHEATON

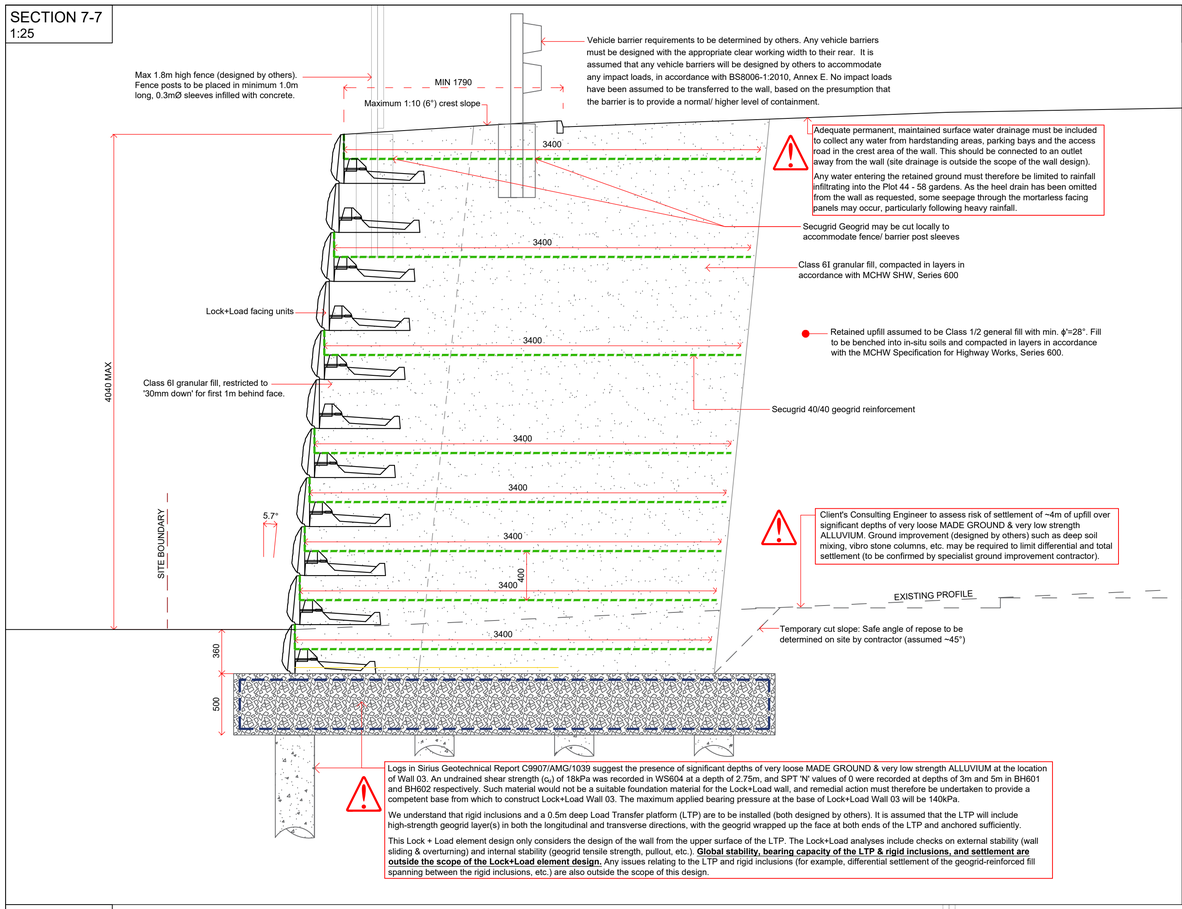
Client:
GILLCON GROUP

Drawing Title:
LOCK+LOAD WALL 03 ELEVATION

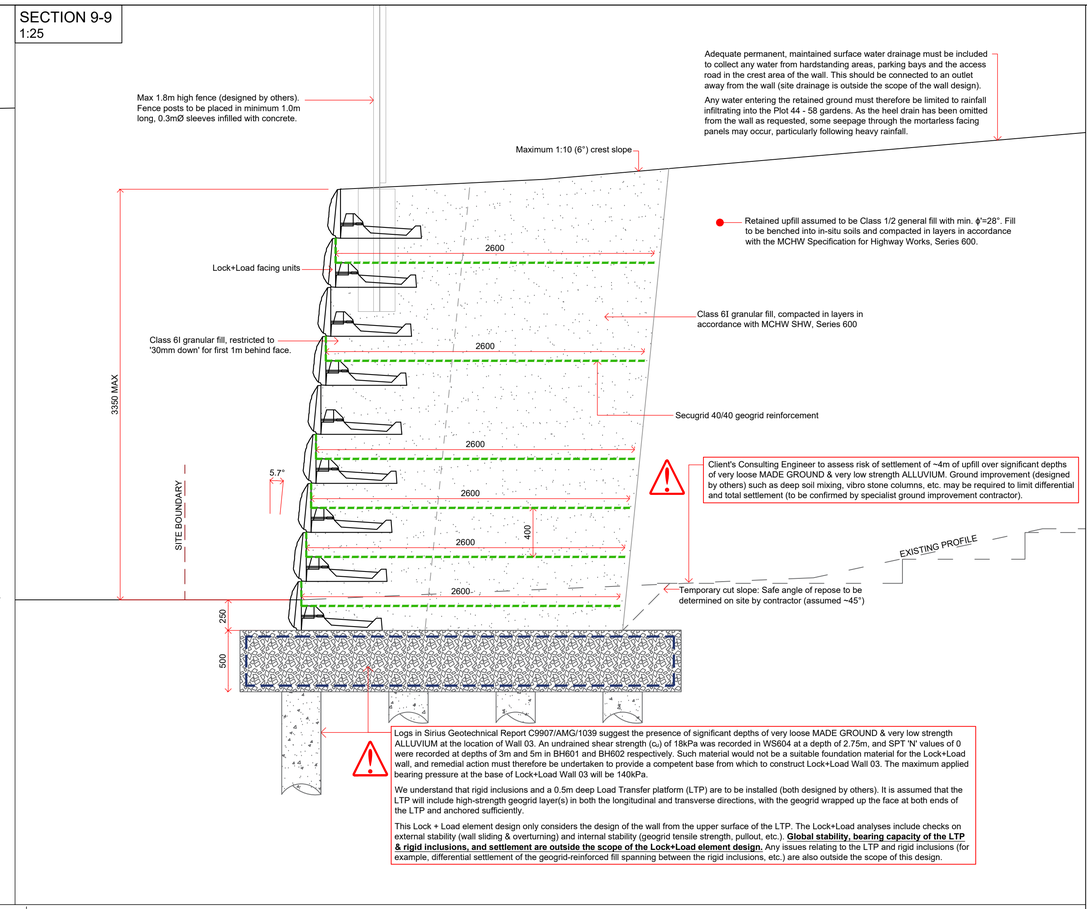
Designed:		Date:		Project No:	24-5558
Drawn:	WM	Date:	22.01.26	Scale:	AS INDICATED AT A1
Checked:		Date:			

Drawing No: SK24-5558-F1-04 Revision: E

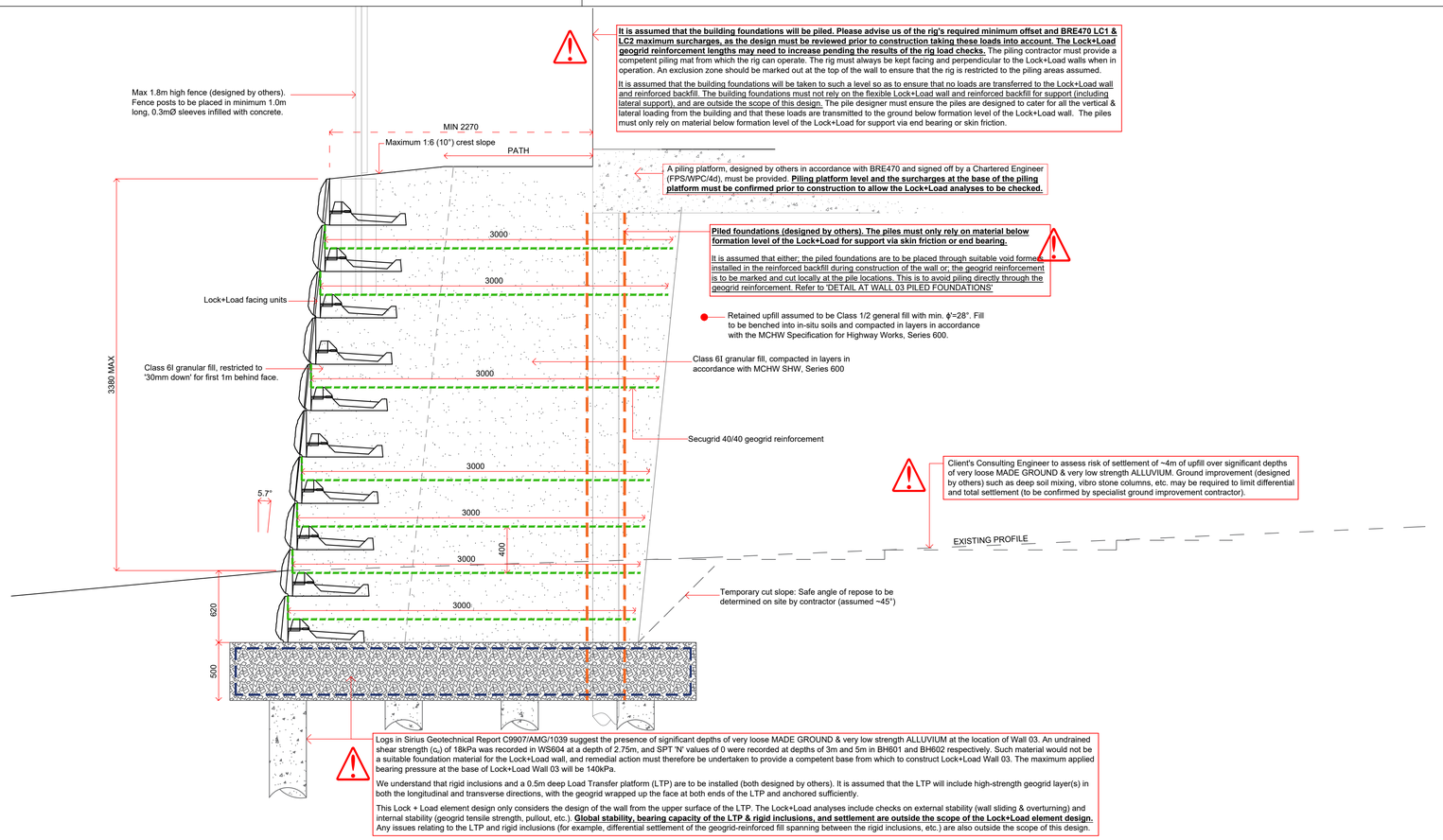
SECTION 7-7
1:25



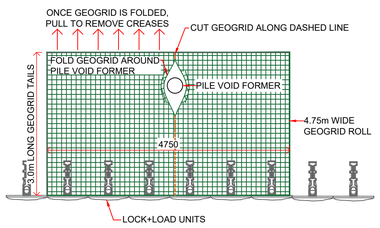
SECTION 9-9
1:25



SECTION 8-8
1:25



DETAIL AT WALL 03 PILED FOUNDATIONS - TBC (NTS)



A1

NOTES:

1) All dimensions in mms unless otherwise specified.

2) BLOCKS: LOCK+LOAD GEOGRID: SECUGRID 40/40

3) INSTALLATION: Refer to standard Manufacturer's installation guidelines.

4) REINFORCED BACKFILL:
Class 6I granular fill, in accordance with MCHW SHW Series 600. Granular fill to be benched into in-situ soils and compacted in layers in accordance with the Specification for Highway Works, Series 600, Table 6/4. Class 6I fill to be restricted to '30mm down' for first 1m behind face.

Compliance testing must be undertaken on the Class 6I granular fill, both prior to commencement and throughout the works. This must include particle size testing and shear box of representative samples. Class 6I must have a maximum fines (63µm) content of 15% and comply with the limits in Table 6/3 of Series 600.

This material is assumed to have the following characteristics: Phi' = 35 degrees, Gamma = 19 kN/m³ and c' = 0 kPa, compacted to in accordance with SRW Series 600, Table 6/4. The Contractor is responsible for the selection of this material to ensure compliance with the geotechnical characteristics as shown on the relevant drawings and in the design documents/ calculations.

5) FOUNDATION FOR WALL 03:
Logs in Sirius Geotechnical Report C9907/AMG/1039 suggest the presence of significant depths of very loose MADE GROUND & very low strength ALLUVIUM at the location of Wall 03. An undrained shear strength (c_u) of 18kPa was recorded in WS604 at a depth of 2.75m, and SPT 'N' values of 0 were recorded at depths of 3m and 5m in BH601 and BH602 respectively. Such material would not be a suitable foundation material for the Lock+Load wall, and remedial action must therefore be undertaken to provide a competent base from which to construct Lock+Load Wall 03. The maximum applied bearing pressure at the base of Lock+Load Wall 03 will be 140kPa.

We understand that rigid inclusions and a 0.5m deep Load Transfer platform (LTP) are to be installed (both designed by others). It is assumed that the LTP will include high-strength geogrid layer(s) in both the longitudinal and transverse directions, with the geogrid wrapped up the face at both ends of the LTP and anchored sufficiently.

This Lock + Load element design only considers the design of the wall from the upper surface of the LTP. The Lock+Load analyses include checks on external stability (wall sliding & overturning) and internal stability (geogrid tensile strength, pullout, etc.). **Global stability, bearing capacity of the LTP & rigid inclusions, and settlement are outside the scope of the Lock+Load element design.** Any issues relating to the LTP and rigid inclusions (for example, differential settlement of the geogrid-reinforced fill spanning between the rigid inclusions, etc.) are also outside the scope of this design.

6) SITE / IN-SITU SOILS :
Retained: MADE GROUND (ashy gravelly SAND [ASH & CLINKER]) & compacted Class 1/2 upfill. These materials are assumed to have the following minimum properties:
MADE GROUND ϕ' = 28°, γ = 18kN/m³ and c' = 0 kPa.
CLASS 1/2 FILL ϕ' = 28°, γ = 19kN/m³ and c' = 0 kPa.

Foundation solution for Wall 03: LTP on rigid inclusions (designed by others)

The Contractor & Client's Consulting Engineer are responsible for ensuring the in-situ soils comply with the geotechnical characteristics as shown on the relevant drawings and in the design calculations.

7) DRAINAGE:
Adequate permanent, maintained surface water drainage must be included to collect any water from hardstanding areas, parking bays and the access road in the crest area of the wall. This should be connected to an outlet away from the wall (site drainage is outside the scope of the wall design).

Any water entering the retained ground must therefore be limited to rainfall infiltrating into the Plot 44 - 58 gardens. As the heel drain has been omitted from the wall as requested, some seepage through the mortarless facing panels may occur, particularly following heavy rainfall.

8) FACE ANGLE = 5.7°.

9) TEMPORARY EXCAVATIONS/ SETTING OUT
This solution is for the permanent works only, and is issued on the basis that a safe system of works is provided for construction. Temporary excavations have the potential to fail rapidly and without warning, particularly in granular material. The Principal Contractor/ Wall installer must produce a method statement and risk assessment for the works to be approved by the Client's Consulting Engineer. Temporary stability and design of any temporary works are outside our scope and should be confirmed by others.

All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction.

10) BUILDING FOUNDATIONS
It is assumed that any building foundations in the vicinity of the wall will be taken to such a level that no loads will be transferred to the Lock+Load wall and reinforced backfill. Building foundations must not rely on the flexible Lock+Load wall and reinforced backfill for support (including lateral support), and are outside the scope of this design. Please advise us if a piling/ vibro rig and/ or large plant is to be used on the retained side of the Lock+Load wall, as well as their required minimum offsets and maximum operational surcharges, as the design will need to be checked for the rig loads.

11) SETTLEMENT
The Client's Consulting Engineer must assess the risk of settlement of ~4m of upfill over significant depths of very loose MADE GROUND & very low strength ALLUVIUM to the rear of the wall. Ground improvement (designed by others) such as deep soil mixing, vibro stone columns, etc. may be required to limit differential and total settlement (to be confirmed by specialist ground improvement contractor).

12) NOTES ON CALCULATIONS/DRAWINGS:
These plans and the accompanying design documentation should be thoroughly checked by the Client's Consulting Engineer. Any apparent errors, omissions or variations should be reported immediately to Geoman Ltd. Construction of this wall shall not commence unless and until the Client/ Client's Consulting Engineer has considered the Geoman Design Submission Document (QP06 Ref 24-5558) to ensure that there are no errors, omissions or conflict with the scheme design.

Geoman Ltd. will not be liable for any loss or damage resulting from or arising out of the use of this drawing where it has been used other than in accordance with Geoman's advice and specifications. Unless advice is specifically requested in respect of parts of the site not within the area where the works are undertaken, Geoman shall not be liable for any loss or damage resulting from or arising out of any weakness or other problem in the ground outside the area where the works are undertaken.

FOR APPROVAL

Rev.	Issue / Revision:	Drawn:	Date:
E	REVISED AS PER DRAWING 'QD1776 ENG '	WM	22.01.26
D		WM	24.09.25
C		WM	17.09.25
B		WM	25.03.25
A		WM	04.03.25
0		WM	27.09.24

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Project Title:
WESTGATE, CLECKHEATON

Client:
GILLCON GROUP

Drawing Title:
LOCK+LOAD WALL 03 CROSS-SECTIONS

Designed:		Date:		Project No:	24-5558
Drawn:	WM	Date:	22.01.26	Scale:	AS INDICATED AT A1
Checked:		Date:			

Drawing No: SK24-5558-F1-05 Revision: E

APPENDIX C

ADDITIONAL INFORMATION

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HAPAS Certificate
21/H311
Product Sheet 1

LOCK+LOAD RETAINING WALL SYSTEM

LOCK+LOAD WALL SYSTEM FOR REINFORCED SOIL-RETAINING WALLS AND BRIDGE ABUTMENTS

This HAPAS Certificate Product Sheet(1) is issued by the British Board of Agrément (BBA), supported by Highways England (HE) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Government and the Department for Infrastructure, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers Group and industry bodies. HAPAS Certificates are normally each subject to a review every three years.
(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to the Lock+Load Wall System for reinforced soil-retaining walls and bridge abutments. The system comprises concrete block facing units with connected concrete block counterforts, in conjunction with Secugrid geogrids and compacted fill.

CERTIFICATION INCLUDES:

- factors relating to compliance with HAPAS requirements
- factors relating to compliance with Regulations where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design consideration
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Mechanical properties — the concrete block units and the geogrids are not physically connected, and transfer no force between them. The forces for which the geogrid is designed are predetermined. The facing system has been designed for pull out forces and shear between segmental units (see section 7).

Durability — when designed and installed in accordance with the provisions of this Certificate, the system will have adequate durability for its intended use as a retaining wall or bridge abutment over 120 year design life (see section 9).

The BBA has awarded this Certificate to the company named above for the system described herein. This system has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 1 October 2021

Hardy Giesler
Chief Executive Officer

The BBA is a UKAS accredited certification body – Number 113.
The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at w ww.bbacerts.co.uk
Readers MUST check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA directly.
Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

Requirements

In the opinion of the BBA, the LOCK+LOAD Wall System for reinforced soil-retaining walls and bridge abutments, when designed and installed in accordance with the provisions of this Certificate, will contribute to meeting the requirements of Highways England and local Highway Authorities for the design and construction of reinforced soil-retaining walls and bridge abutments.

Regulations

Construction (Design and Management) Regulations 2015
Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See sections: 1 *Description* (1.2), 3 *Delivery and site handling* (3.1, 3.3, 3.5 and 3.6), 11 *General* (11.6) and the *Installation* part of this Certificate.

Additional Information

CE marking

The Certificate holder has taken the responsibility of CE marking the blocks in accordance with harmonised European Standard BS EN 771-3 : 2011.

The manufacturer has taken the responsibility of CE marking the geogrids in accordance with harmonised European Standard BS EN 13251 : 2001.

Technical Specification

1 Description

1.1 The LOCK+LOAD Wall System for reinforced soil-retaining walls and bridge abutments comprise:

- L+L Typical, L+L Half Panel, L+L Left Outside Corner and L+L Right Outside Corner concrete facing units
- L+L Counterfort
- Secugrid geogrids(1)
- Compacted fill material.

(1) Covered by BBA Certificate 14/H218.

Concrete facing units

1.2 The facing units are manufactured from concrete conforming to the following minimum specification, satisfying Highways England requirements for durability of class XF2 exposure to BS 8500-1 : 2006 (see Table 1 of this Certificate).

Table 1 Concrete characteristics

Property	Value
Minimum concrete cube strength at 28 days ($N \cdot mm^{-2}$)	40
Minimum cement content ($Kg \cdot m^{-3}$)	340
Maximum water/cement ratio	0.55

1.3 The concrete block facing units covered by this Certificate are shown in Table 2 and Figures 1a and 1b.

Table 2 Concrete block facing units

Unit type	Height (mm)	Depth (mm)	Width (mm)	Weight (kg)
L+L Facing Panel	405	95	810	40
L+L Counterfort	195	685	152.5	19

Figure 1a L+L facing units

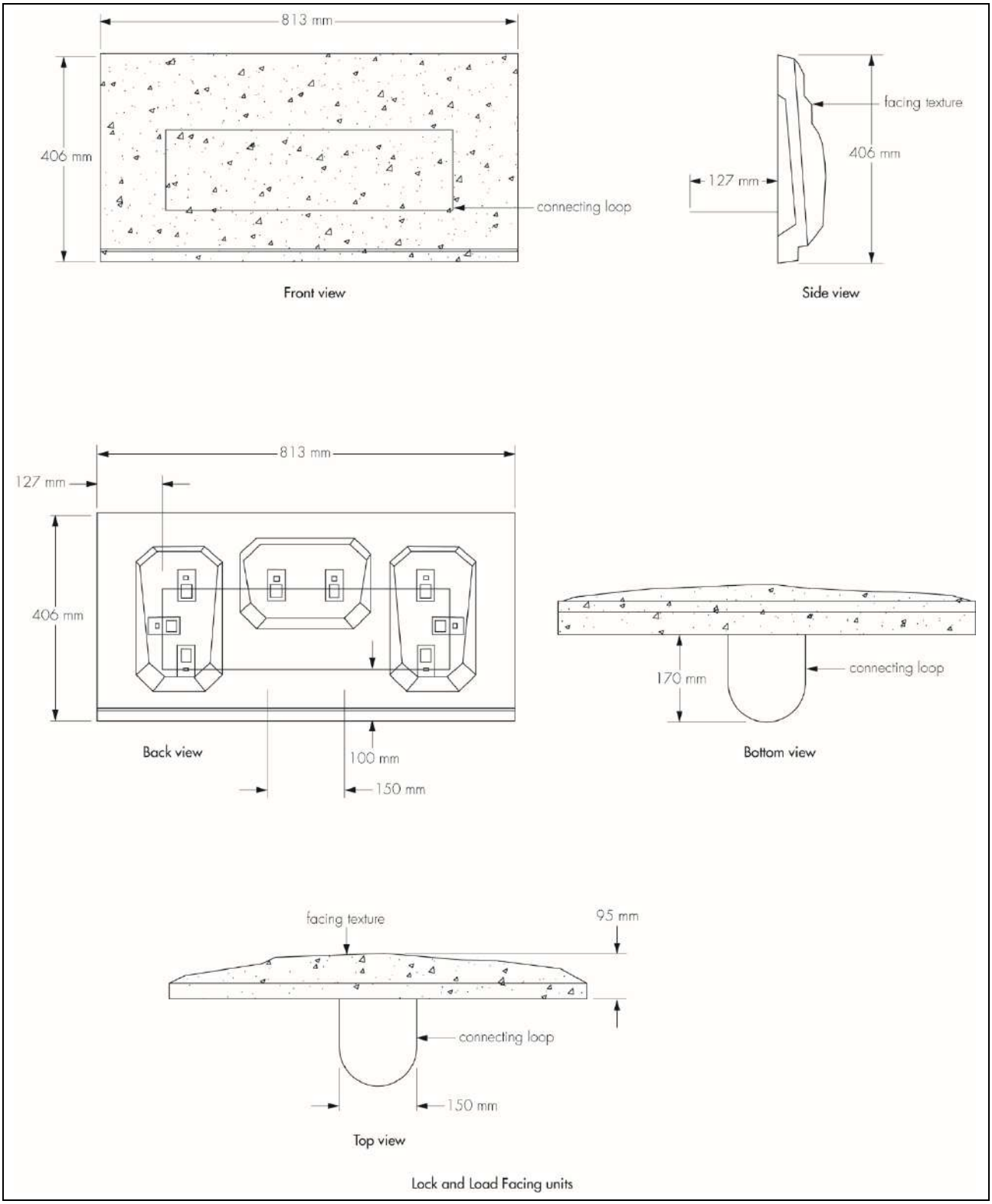
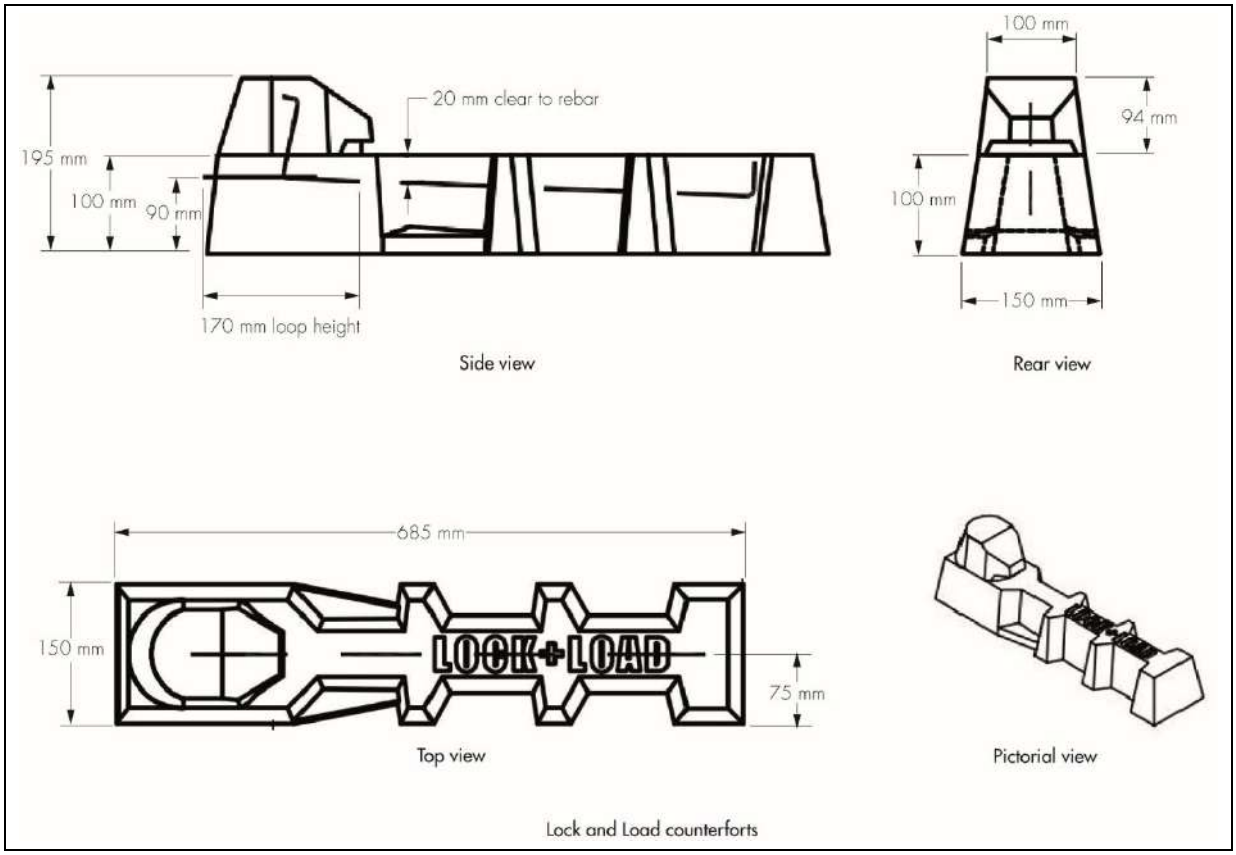


Figure 1b L+L facing units



1.4 The concrete block facing units conform to BS EN 771-3 : 2011. The performance characteristics given in Table 3 have been declared by the manufacturer in accordance with this Standard.

Table 3 Performance values in accordance with BS EN 771-3

Property	Test method	Manufacturer's declared values
Dimensional tolerances		Category D2
Compressive strength (mean) ($N \cdot mm^{-2}$)		>40
Density ($kg \cdot m^{-3}$)		2350
Maximum water absorption (%)	BS EN 1338 : 2003 Annex E	6

1.5 The concrete block facing units are available in a range of colours including Sandstone and Black. All pigments used for the coloration of the concrete units comply with BS EN 12878 : 2014.

Geogrids

1.6 Secugrid PET geogrids are planar structures consisting of a regular open network of woven or knitted integrally connected tensile elements of extruded polyester bars welded together to form grids. The grades(1) covered by this Certificate are:

- Secugrid 30/30 Q6
- Secugrid 40/40 Q6
- Secugrid 60/60 Q6
- Secugrid 40/20 R6
- Secugrid 60/20 R6
- Secugrid 80/20 R6
- Secugrid 120/40 R6
- Secugrid 150/40 R6
- Secugrid 200/40 R6
- Secugrid 400/40 R6

(1) Full product details are given in BBA Certificate 14/H218.

Fill material

1.7 Fill material must comply with the requirements set out in BS 8006-1 : 2010 and the *Manual of Contract Documents for Highway Works* (MCHW), Volume 1 *Specification for Highway Works* (SHW).

2 Manufacture

2.1 The concrete block facing units are manufactured to an agreed specification by the Certificate holder. Ingredients for the concrete are weighed by a computer-controlled weigh-batcher system, and the blocks cast in block machines.

2.2 The geogrids are manufactured from extruded high tenacity polyester (PET) bars of various section sizes, which are welded together at the appropriate centres to form the grids.

2.3 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control being operated by the manufacturer are being maintained.

2.4 The manufacturer's management system for the concrete block facing units has been assessed by the BBA

2.5 The management system of the geogrid manufacturer has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 by TüV Nord Cert GmBH (Certificate 44 100 940655).

3 Delivery and site handling

3.1 The concrete block facing units and counterforts are tied together with steel loops and delivered to site on shrink-wrapped pallets. The pallets carry a manufacturer's label bearing the product type and batch code. Pallets should not be stacked more than two high.

3.2 To avoid damage, care should be taken in transit and handling. Damaged materials must not be used. During prolonged periods of storage on site, the blocks should remain covered on pallets.

3.3 The geogrids are delivered to site in 4.75 m wide rolls, either 50 or 100 m in length. Each roll is wrapped for transit and site protection, in stretch foil.

3.4 Rolls are labelled with the geogrid grade and identification. The grade of geogrid is ink-jet printed on the cross machine direction bars approximately every metre, to aid in identification on site in accordance with BS EN ISO 10320 : 2019.

3.5 The geogrids should be stored in clean, dry conditions and protected from mechanical or chemical damage, exposure to direct sunlight (to protect against UV degradation) and extreme temperatures. When laid horizontally, the rolls may be stacked up to seven high. No other loads should be stored on top of the stack. The packaging should not be removed until immediately prior to installation.

3.6 Toxic fumes are given off if the geogrids catch fire and, therefore, the necessary precautions should be taken, following the instructions of the material safety data sheet for the product.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the LOCK+LOAD Wall System for reinforced soil-retaining walls and bridge abutments.

Design Considerations

4 General

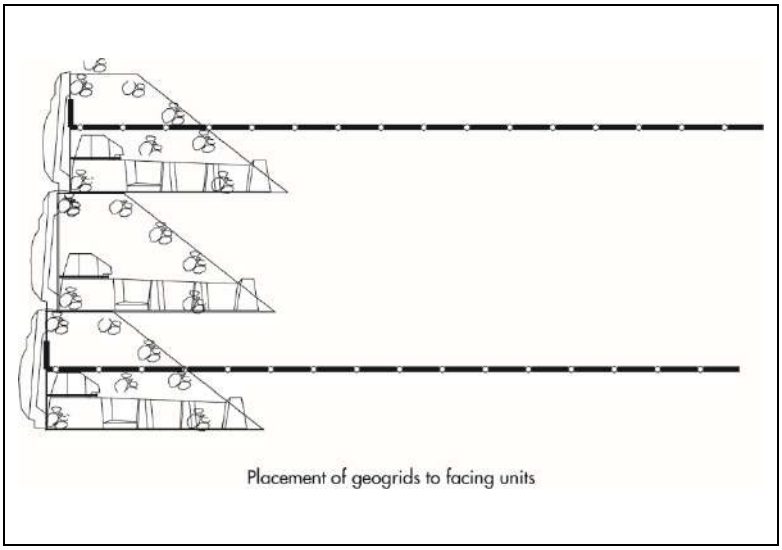
4.1 When designed and installed in accordance with this Certificate, the system is satisfactory for the construction of reinforced soil-retaining walls and bridge abutments.

4.2 Structural stability of the system is achieved through:

- interface shear capacity between face and counterfort
- the tensile strength of the geogrids
- the embedment and resistance to sliding and pull out of the geogrids from the fill material
- the embedment and resistance to sliding and pull out of the counterfort from the fill material.

4.3 The connection between the facing unit and the counterfort is provided by the steel loop, and the force generated by the counterfort restrains the facing unit. No attachment is made between the concrete units and the geogrid so force is not shared or transferred between them. The geogrid is laid up to and against facing material, however. It is critical the construction of the connection is carried out carefully and is closely supervised (see the *Installation* part of this Certificate).

Figure 2 Placement of geogrids to facing units



4.4 Prior to the commencement of work, the designer must satisfy the design approval and certification procedures of the relevant Highway Authority.

4.5 The BBA has not assessed the structures for supporting parapet loading caused by vehicle collision at the top of the concrete block facing units.

4.6 Reinforced soil structures constructed using the system should be protected with suitable barriers, to protect the structure against potential damage from vehicle impact and vehicle fires.

4.7 In addition to those factors covered in section 6, attention must also be paid in design to:

- site preparation
- fill material properties
- the specification for placing and compaction of the fill material
- drainage behind the wall
- protection of the geogrid against damage during installation.

4.8 It is considered that with correct design and workmanship, and by following the recommendations of this Certificate, normally accepted tolerances of line and level for the construction of retaining walls as defined in BS 8006-1 : 2010, Table 18, can be achieved. However, where the alignment of the vertical face is critical, consideration may be given to providing a brickwork skin, or similar, to the wall units.

4.9. Particular attention should be paid to changes in direction of walls where overlapping of the geogrids may occur. Detailed guidance is given in the Certificate holder's technical literature. BS 8006-1 : 2010 also gives guidance on typical layout plans for the geogrids (reinforcing elements) in bridge abutments.

5 Practicability of installation

The system is designed to be installed by trained contractors in accordance with the specifications and construction drawings (see the *Installation* part of this Certificate). Close supervision is required to ensure the integrity of the connection between the geogrids and concrete block facing units.

6 Design

Design methodology

6.1 Reinforced soil-retaining walls and bridge abutments constructed using the system must be designed in accordance with BS 8006-1 : 2010 and the Manual of Contract Document for Highway Works Volume 1, *Specification for Highway Works*.

6.2 In accordance with BS 8006-1 : 2010, Annex B, the required design life for permanent walls and bridge abutments is 120 years.

6.3 To evaluate the overall stability of the wall system, it is necessary to consider:

- the design strength and length of embedment of the geogrid
- the design strength of concrete facing units
- the interface shear capacity of the blocks between layers of geogrid reinforcement.

Design strength of geogrids (ultimate limit state)

6.4 The design methodology for determination of the ultimate limit state (ULS) design strength of the geogrids is given in BS 8006-1 : 2010 and in the design sections of BBA HAPAS Certificate 14/H218 (see also section 7.1 of this Certificate).

6.5 The ULS design strength of the geogrid ($T_{D\,(ULS)}$), should be taken as:

$T_{CR}/f_{m,}$

where:

T_{CR} is the long-term tensile creep strength of the geogrid, at the appropriate design life and design temperature
f_m is the partial material factor.

6.6 For the ULS, the design load (T_j) at each level that the geogrid must resist, is calculated using prescribed load factors in accordance with BS 8006-1 : 2010. In all cases, T_j must be < $T_{D\,(ULS).}$

Design strength of geogrids (serviceability limit state)

6.7 The serviceability limit state (SLS) design strength of the geogrid ($T_{D\,(SLS)}$), should be taken as:

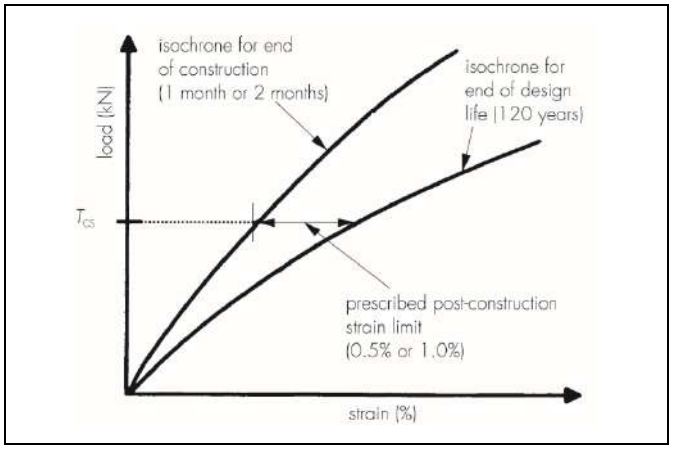
T_{CS}/f_m,

where:

T_{CS} is the tensile load in the reinforcement which induces the prescribed limit value of post-construction strain in the geogrid
f_m is the partial material factor.

6.8 The strain in the geogrid must be limited to 0.5% over the service life for installations subject to permanent structural loading, such as bridge abutments, and limited to 1.0% post-construction for structures not subject to permanent structural loading (eg retaining walls). The definitions of prescribed post-construction strain limit and T_{CS}, the tensile load that would create the prescribed post-construction strain, are explained in Figure 3.

Figure 3 Definition of T_{CS}



6.9 The prescribed maximum allowable post-construction creep strains allowed by BS 8006-1 : 2010 for the SLS of reinforced soil-retaining walls and bridge abutments are shown in Table 4 of this Certificate.

Table 4 Serviceability limits on post-construction internal strains for bridge abutments and retaining walls

Structure	Strain (%)	Design period for the purposes of determining limiting strain
Bridge abutments and retaining walls with permanent structural loading	0.5	2 months – 120 years
Retaining walls, with no applied structural loading, ie transient live loadings only	1.0	1 month – 120 years

6.10 Post-construction strain can be related to the average load in the reinforcement. The average SLS design loads (T_{avj}) that the geogrid must resist is to be calculated in accordance with BS 8006-1 : 2010. The average load in the *j*th level (T_{avj}), is related to the maximum load in the reinforcement (T_j) by a factor *k* such that $T_{avj} = T_j/k$. The factor *k* has a minimum value of unity and generally falls in the range of 1.0 to 2.0. Where the distribution of tensile load along the loaded length of the reinforcement is not proven by field measurements, the factor *k* should be taken as unity. In all cases, $T_{avj} < T_{D(SLS)}$.

6.11 Design values for T_{cs} and reduction factors for determination of $T_{D(SLS)}$ are given in sections 7.2 to 7.3.

Design of geogrids (determination of resistance to direct sliding and pull out)

6.12 The design methodology for determination of resistance to pull out and direct sliding and, therefore, the required length of embedment of the geogrids, is given in BS 8006-1 : 2010 and in the design sections of BBA HAPAS Certificate 14/H218, Product Sheet 1.

Design strength of concrete facing units

6.13 The design resistance to pull-out between the concrete block units and soil is determined by testing in accordance with ASTM Designation Number D 6706-01 and is considered acceptable for the intended use specified in this Certificate.

Interface shear capacity between concrete facing units and counterforts

6.14 The interface shear capacity between the concrete block facing units should be checked at the ULS and checks should be made to ensure that it is not exceeded by the design load (*T*j) at each level (see section 7.7).

Specification of fill material

6.15 The designer should specify the relevant properties of the fill material for the reinforced soil structure deemed acceptable for the purposes of the design. Acceptable materials should satisfy the requirements of BS 8006-1 : 2010 and the MCHW, Volume 1, Series 600.

6.16 Where concrete wall units are to be embedded in potentially aggressive soils, the guidance given in BRE Special Digest 1 : 2005 should be followed.

6.17 Fill materials classified as 6I, 6J, 7B, 7C and 7D should comply with the limits of the MCHW, Volume 1, 600 series, Table 6/3, regarding maximum water soluble sulfate content and maximum oxidisable sulfides content.

7 Mechanical properties

ULS design strength of geogrids ($T_{D(ULS)}$)

7.1 The characteristic short-term tensile strength (T_{char}) and the associated reduction factors for creep (RF_{CR}), installation damage (RF_{ID}), weathering (RF_{W}), environmental degradation (RF_{CH}) and extrapolation of data (f_s) required for determination of the ULS design strength of the geogrids ($T_{D(ULS)}$) are given in BBA HAPAS Certificate 14/H218, Product Sheet 1.

SLS design strength of geogrids (T_{CS})

7.2 Secugrid geogrids design values for T_{CS} are given in Table 5. To limit strain to less than 0.5% over design life, limit loading to 30% of T_{Char}.

Table 5 Maximum tensile load inducing prescribed post-construction strain limits for Secugrid geogrids

Grade	Machine Direction (MD)				Cross Machine Direction (CMD)			
	Short Term Tensile Strength(1) (kN per m width)			Mean Strain at Maximum Tensile Load(1) (%)	Short Term Tensile Strength(1) (kN per m width)			Mean Strain at Maximum Tensile Load(1) (%)
	Mean Value	Tolerance	T_{char}[2		Mean Value	Tolerance	T_{char}[2	
Secugrid 30/30 Q6	30.0	0.0	30.0	6.0 (+2.0/-2.0)	30.0	0.0	30.0	6.0 (+2.0/-2.0)
Secugrid 40/40 Q6	40.0	0.0	40.0	6.0 (+2.0/-2.0)	40.0	0.0	40.0	6.0 (+2.0/-2.0)
Secugrid 60/60 Q6	60.0	0.0	60.0	6.0 (+2.0/-2.0)	60.0	0.0	60.0	6.0 (+2.0/-2.0)
Secugrid 80/80 Q6	80.0	0.0	80.0	6.0 (+2.0/-2.0)	80.0	0.0	80.0	6.0 (+2.0/-2.0)
Secugrid 40/20 R6	40.0	0.0	40.0	6.5 (+2.0/-2.0)	20.0	0.0	20.0	6.5 (+2.0/-2.0)
Secugrid 60/20 R6	60.0	0.0	60.0	6.5 (+2.0/-2.0)	20.0	0.0	20.0	6.5 (+2.0/-2.0)
Secugrid 80/20 R6	80.0	0.0	80.0	6.5 (+2.0/-2.0)	20.0	0.0	20.0	6.5 (+2.0/-2.0)
Secugrid 120/40 R6	120.0	0.0	120.0	6.5 (+2.0/-2.0)	40.0	0.0	40.0	6.5 (+2.0/-2.0)
Secugrid 150/40 R6	150.0	0.0	150.0	6.5 (+2.0/-2.0)	40.0	0.0	40.0	6.5 (+2.0/-2.0)
Secugrid 200/40 R6	200.0	0.0	200.0	6.5 (+2.0/-2.0)	40.0	0.0	40.0	6.5 (+2.0/-2.0)
Secugrid 400/40 R6	400.0	0.0	400.0	6.5 (+2.0/-2.0)	40.0	0.0	40.0	6.5 (+2.0/-2.0)

(1) Values derived from short-term tests in accordance with BS EN ISO 10319 : 2015.
(2) The characteristic short-term tensile strength (Tchar) values are the mean short-term tensile strength minus 1 x the tolerance value, in accordance with BS EN 13251 : 2016.

7.3 Reduction factors for installation damage, weathering and environmental degradation (RF_{ID}, RF_{W} and RF_{CH}) and factors of safety for the extrapolation of data (f_s) required for determination of the serviceability design strength of the geogrids ($T_{D(SLS)}$) are given in BBA HAPAS Certificate 14/H218, Product Sheet 1.

Counterfort capacity

7.4 The counterforts are tested for resistance to pull out forces by soil interaction. Long term capacities have been determined by testing in accordance with ASTM D6706-01.

Interface capacity between concrete facing units and counterforts

7.5 Interface capacity between the concrete block facing units and the counterfort is provided by the steel loop connection. Steel loop connection complies with BS EN 14475 : 2006 and contributes to compliance with BS 8006-1 : 2010 + A1 : 2016 (steel coating exceeds 70µm). For the system, the interface shear capacity of the blocks is higher than the corresponding connection strength values. Therefore, the connection strength values govern the design.

8 Maintenance

The exposed faces of the concrete block facing units may require periodic maintenance, to remove dirt build up, mould and moss growth. All other components of the system are confined within the wall and do not require maintenance.

9 Durability

9.1 When designed and installed in accordance with this Certificate, the system will have adequate durability for the required 120 year design life of a retaining wall and bridge abutment in conditions encountered in the UK.

9.2 Where the blocks are to be embedded in potentially aggressive soils, the guidance given in BS 8006-1 : 2010 and BRE Special Digest 1 : 2005 should be followed.

10 Reuse and recyclability

The concrete facing units can be crushed and re-used as aggregate. The fill material can also be re-used.

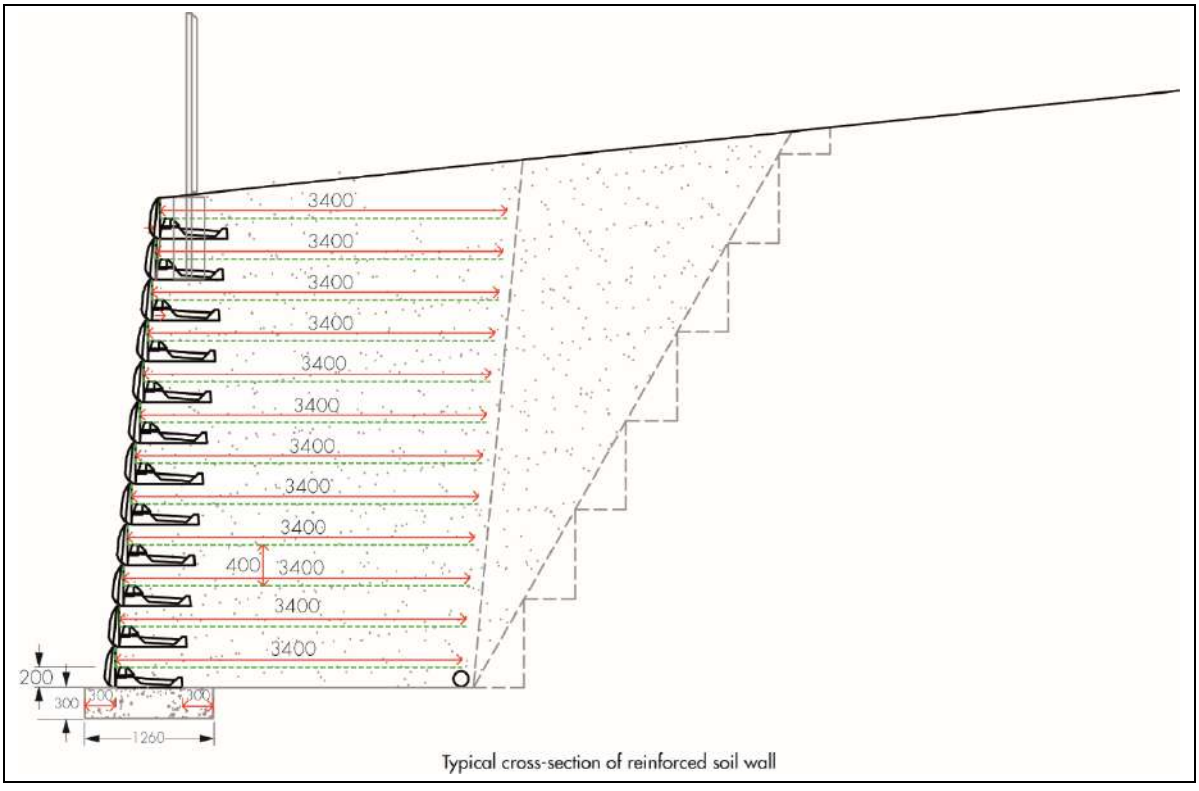
Installation

11 General

11.1 Detailed information on installation of the LOCK+LOAD Wall System for reinforced soil-retaining walls and bridge abutments can be found in the Certificate holder's Installation Guide.

11.2 A typical cross-section of a reinforced soil-retaining wall constructed using the system is shown in Figure 4.

Figure 4 Typical cross-section of reinforced soil wall



11.3 Installation should also comply with the requirements of BS 8006-1 : 2010 and BS EN 14475 : 2006.

11.4 Close supervision is required, particularly during placement of the geogrids and initial compaction of the backfill material.

11.5 Detailed guidance on forming curves and corners, including the placement of geogrids, can be found in the Certificate holder's Installation Guide.

11.6 Where accurate cutting of concrete block facing units is required on site, disc-cutting techniques may be used, for which appropriate precautions must be taken to mitigate against hazards associated with dust.

11.7 During construction it is particularly important to ensure that:

- fill is properly compacted, especially close to concrete block facing units
- at each construction stage, the level of the compacted fill coincides with the level of the concrete block facing unit connection to prevent the risk of voids occurring below the geogrid
- the geogrid is tensioned at right angles to the plane of the facing, within a tolerance of ± 50 mm in a five-metre length, and the geogrid is pulled tight to ensure that all slack is removed
- regular checks are made to confirm the alignment of the face and to ensure that any disturbance from the compaction process is promptly corrected.

12 Procedure

12.1 The first row of concrete block facing units is laid on a levelling pad comprising either well-graded, good compactable material ranging in diameter from 6 to 38 mm, or a suitable concrete foundation laid to the correct level. It is important that the first course of concrete block facing units is laid accurately to the correct line and level, to avoid compounding errors in alignment as the wall is built. If steps occur in the base level, refer to the Certificate holder's Installation Guide.

12.2 The drain pipe and drainage stone are placed at the back of the counterfort, or as specified on plans.

12.3 The backfill is placed over the tail of the counterfort first, with a minimum of 610 mm of select 4/20 mm material kept behind the wall face for the foundation of the next row. Beyond this, the specified back fill material is used. For rows that will contain soil reinforcement, the grid is placed after the first lift of fill is compacted (305 mm).

12.4 The compaction requirements for the main fill material depend on the fill type selected and can be found in the MCHW, Volume 1, Clause 612. Heavy plant exceeding one tonne should not be allowed within 610 mm of the wall (Note: This differs from typical modular block wall systems). A large vibrating plate compactor must be used to carry out compaction within this zone, and must compact right up to the rear of the wall.

12.5 Geogrids are placed at the levels shown on the project construction drawings. A suitable length of geogrid is cut from the roll and laid with a minimum of 50 mm of the cut edge rolled up against the back edge of the raised front lip of the concrete block facing units. The geogrid is placed with the machine direction perpendicular to the wall face and pulled back over the compacted area. Steps 12.3 to 12.4 are repeated until the backfill is level with the top of concrete facing unit.

12.6 The next course of concrete blocks facing units is laid, ensuring that the vertical faces are offset by at least 20 mm. The filling and compaction process is repeated as detailed in sections 12.3 to 12.5.

12.7 The general construction procedure described is repeated until the required coping is reached.

Technical Investigations

13 Investigations

13.1 The manufacturing process for the concrete block facing units was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

13.2 An examination was made of test data relating to:

- strength of concrete block facing units
- durability
- the connection strength between the geogrids and concrete block facing units.

13.3 An assessment was made of the method of installation to assess the practicability and ease of construction of the system.

13.4 Research papers and test reports regarding the performance of the system during seismic activity were examined.

13.5 Case studies relating to use of the system in projects around the world were examined.

13.6 Dimensional check tests were carried out on the concrete block facing panels and the counterfort units.

Bibliography

BRE Special Digest 1 : 2005 *Concrete in aggressive ground*

BS 8006-1 : 2010 + A1 : 2016 *Code of practice for strengthened/reinforced soils and other fills*

BS 8500-1 : 2006 + A1 : 2012 *Concrete — Complementary British Standard to BS EN 206-1 — Method of specifying and guidance for the specifier*

BS EN 1338:2003 *Concrete paving blocks — Requirements and test methods*

BS EN 771-3 : 2011 + A1 : 2015 *Specification for masonry units — Aggregate concrete masonry units (Dense and lightweight aggregates)*

BS EN 12878 : 2014 *Pigments for the colouring of building materials based on cement and/or lime — Specifications and methods of test*

BS EN 13251 : 2001 *Geotextiles and geotextile-related products — Characteristic required for use in earthworks, foundations and retaining structures*

BS EN 14475 : 2006 *Execution of special geotechnical works — Reinforced fill*

BS EN ISO 9001 : 2015 *Quality management systems — Requirements*

BS EN ISO 10320 : 2019 *Geotextiles and geotextile-related products — Identification on site*

BS EN ISO 10319 : 2015 *Geosynthetics. Wide-width tensile test*

ASTM D6706-01 *Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil*

Manual of Contract Documents For Highway Works, Volume 1 *Specification for Highway Works*, amendment November 2008

14 Conditions

14.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

14.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

14.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

14.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

14.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

14.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

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HAPAS Certificate
14/H218
Product Sheet 1 Issue 3

SECUGRID GEOGRIDS

SECUGRID PET GEOGRIDS FOR REINFORCED SOIL EMBANKMENTS

This Product Sheet[1] is issued by the British Board of Agrément (BBA). The Highways Authorities Product Approval Scheme (HAPAS) is supported by National Highways (NH) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Government; and the Department for Infrastructure, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers Group and industry bodies.

(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to Secugrid PET Geogrids for reinforced soil embankments, a range of uniaxial and biaxial extruded and welded high tenacity polyester (PET) geogrids, for use as reinforcement in embankments with slope angles up to 70°, in accordance with the *Manual of Contract Documents for Highway Works* (MCHW), Volume 1 *Specification for Highway Works* (SHW), Series 600, and designated Standards BS EN 13251 : 2016, BS 8006-1 : 2010, PD/ISO TR 20432 : 2007, CIRIA SP123 : 1996 and BS EN 14475 : 2006.

The BBA has awarded this Certificate to the company named above for the products described herein. These products have been assessed as complying with the requirements of the BBA HAPAS Certification Scheme according to the assessments set out in this Certificate.

On behalf of the British Board of Agrément

Date of Third issue: 23 August 2024
Originally certified on 23 June 2014

Hardy Giesler
Chief Executive Officer

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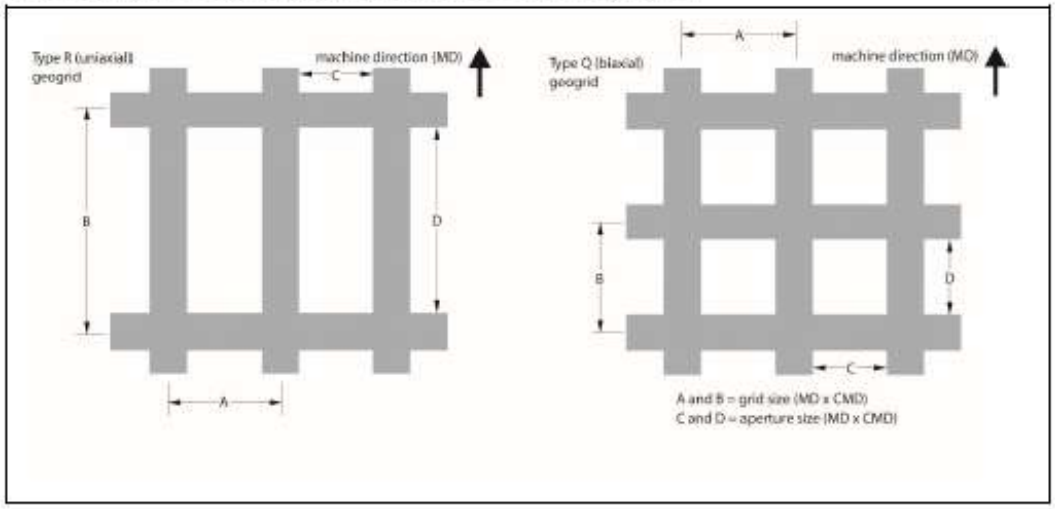
1 Product Description

1.1 The Certificate holder specifies the products under assessment, Secugrid PET Geogrids for reinforced soil embankments, as a range of uniaxial and biaxial extruded and welded high tenacity polyester (PET) geogrids, for use as reinforcement in embankments with slope angles up to 70° in accordance with the MCHW, Volume 1 (SHW), and designated Standards BS EN 13251 : 2016, BS 8006-1 : 2010, PD/ISO TR 20432 : 2007, CIRIA SP123 : 1996 and BS EN 14475 : 2006.

1.2 The geogrids are manufactured in one standard grade of various strengths and mesh sizes. Typical uniaxial and biaxial geogrids are illustrated in Figure 1.

Figure 1 Secugrid PET Geogrids for reinforced soil embankments – configuration



1.3 Secugrid PET Geogrids for reinforced soil embankments have the characteristics given in Table 1.

Table 1 General specifications for Secugrid PET Geogrids for reinforced soil embankments

Grade	Nominal mass[1] ($g \cdot m^{-2}$)	Grid size[2] warp/weft A x B (mm)	Aperture size[2] warp/weft C x D (mm)	Nominal roll width (m)	Nominal roll length (m)
30/30 Q6	320	40 x 40	34 x 34	4.75	100
40/40 Q6	360	40 x 40	34 x 34		100
60/60 Q6	620	40 x 40	32 x 32		100
80/80 Q6	675	40 x 40	30 x 30		100
40/20 R6	285	40 x 80	33 x 73		100
60/20 R6	420	40 x 80	31 x 73		100
80/20 R6	380	40 x 80	30 x 73		100
120/40 R6	580	40 x 80	28 x 71		100
150/40 R6	680	40 x 80	27 x 71		100
200/40 R6	810	40 x 80	25 x 71		100
400/40 R6	1420	40 x 80	14 x 70		50

(1) Mass/unit area measured in accordance with BS EN ISO 9864 : 2005.

(2) Mean measured dimensions (see Figure 1 for reference).

2 Requirements

Requirements for the products are outlined in the BBA HAPAS Certification Scheme and Technical Specifications Documents, and have been established from the following specification documents:

- the MCHW(1), Volume 1 (SHW), Series 600
- BS EN 13251 : 2016
- BS 8006-1 : 2010
- PD/ISO TR 20432 : 2007
- CIRIA SP123 : 1996
- BS EN 14475 : 2006.

(1) The MCHW is operated by National Highways (NH) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Government; and the Department for Infrastructure, Northern Ireland).

3 Summary of Product Assessment

The products were assessed on the basis of the following characteristics in accordance with HAPAS requirements.

3.1 Short-term tensile strength

3.1.1 Secugrid PET Geogrids for reinforced soil embankments have the tensile strength and elongation characteristics shown in Tables 2 to 5 and Figure 2.

Table 2 Characteristic machine direction tensile strength of Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
30/30 Q6	Short-term tensile test to EN ISO 10319 : 2015	≥ 30 kN·m^{-1}	Pass
40/40 Q6		≥ 40 kN·m^{-1}	Pass
60/60 Q6		≥ 60 kN·m^{-1}	Pass
80/80 Q6		≥ 80 kN·m^{-1}	Pass
40/20 R6		≥ 40 kN·m^{-1}	Pass
60/20 R6		≥ 60 kN·m^{-1}	Pass
80/20 R6		≥ 80 kN·m^{-1}	Pass
120/40 R6		≥ 120 kN·m^{-1}	Pass
150/40 R6		≥ 150 kN·m^{-1}	Pass
200/40 R6		≥ 200 kN·m^{-1}	Pass
400/40 R6		≥ 400 kN·m^{-1}	Pass

Table 3 Characteristic machine direction elongation at minimum tensile strength of Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
30/30 Q6	Short-term tensile test to EN ISO 10319 : 2015	6.0 % (± 2.0 %)	Pass
40/40 Q6		6.0 % (± 2.0 %)	Pass
60/60 Q6		6.0 % (± 2.0 %)	Pass
80/80 Q6		6.0 % (± 2.0 %)	Pass
40/20 R6		6.5 % (± 2.0 %)	Pass
60/20 R6		6.5 % (± 2.0 %)	Pass
80/20 R6		6.5 % (± 2.0 %)	Pass
120/40 R6		6.5 % (± 2.0 %)	Pass
150/40 R6		6.5 % (± 2.0 %)	Pass
200/40 R6		6.5 % (± 2.0 %)	Pass
400/40 R6		6.5 % (± 2.0 %)	Pass

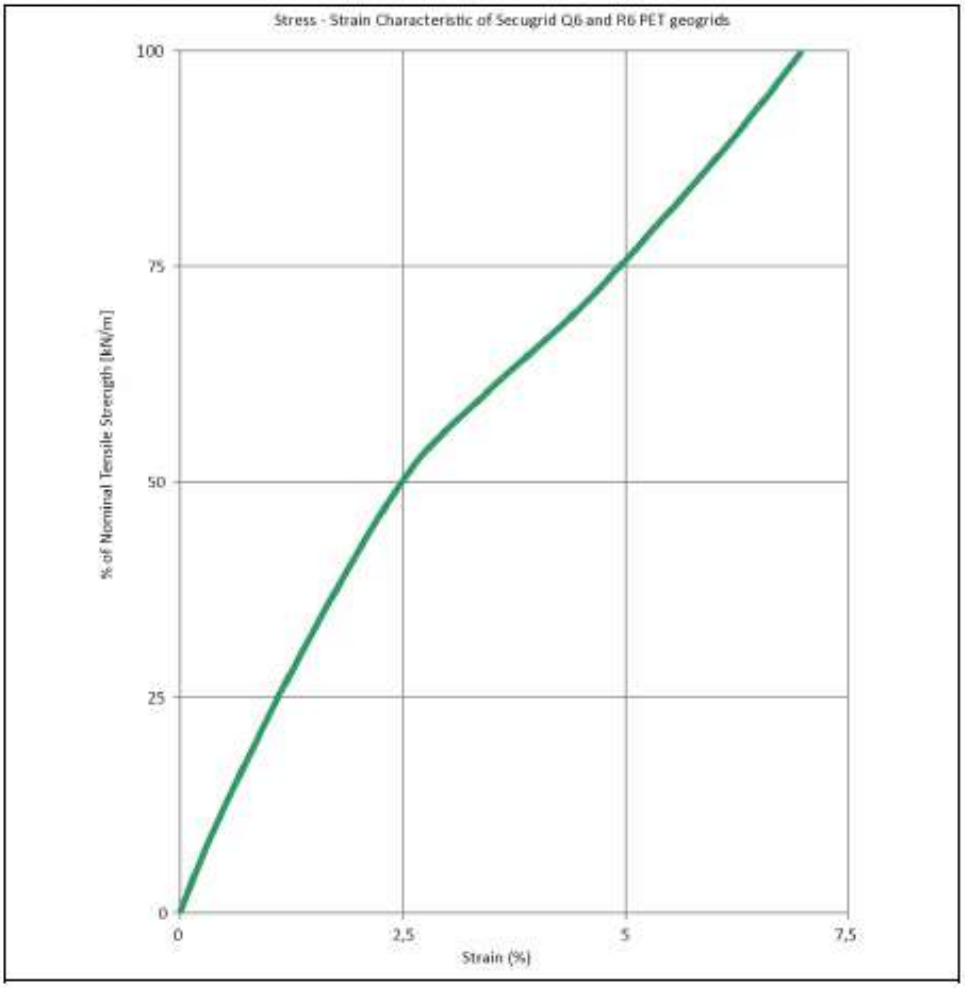
Table 4 Characteristic cross machine direction tensile strength of Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
30/30 Q6	Short-term tensile test to	≥ 30 kN·m^{-1}	Pass
40/40 Q6	EN ISO 10319 : 2015	≥ 40 kN·m^{-1}	Pass
60/60 Q6		≥ 60 kN·m^{-1}	Pass
80/80 Q6		≥ 80 kN·m^{-1}	Pass
40/20 R6		≥ 20 kN·m^{-1}	Pass
60/20 R6		≥ 20 kN·m^{-1}	Pass
80/20 R6		≥ 20 kN·m^{-1}	Pass
120/40 R6		≥ 40 kN·m^{-1}	Pass
150/40 R6		≥ 40 kN·m^{-1}	Pass
200/40 R6		≥ 40 kN·m^{-1}	Pass
400/40 R6		≥ 40 kN·m^{-1}	Pass

Table 5 Characteristic cross machine direction elongation at minimum tensile strength of Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
30/30 Q6	Short-term tensile test to	6.0 % (± 2.0 %)	Pass
40/40 Q6	EN ISO 10319 : 2015	6.0 % (± 2.0 %)	Pass
60/60 Q6		6.0 % (± 2.0 %)	Pass
80/80 Q6		6.0 % (± 2.0 %)	Pass
40/20 R6		6.5 % (± 2.0 %)	Pass
60/20 R6		6.5 % (± 2.0 %)	Pass
80/20 R6		6.5 % (± 2.0 %)	Pass
120/40 R6		6.5 % (± 2.0 %)	Pass
150/40 R6		6.5 % (± 2.0 %)	Pass
200/40 R6		6.5 % (± 2.0 %)	Pass
400/40 R6		6.5 % (± 2.0 %)	Pass

Figure 2 Typical stress-strain characteristics of Secugrid PET Geogrids for reinforced soil embankments

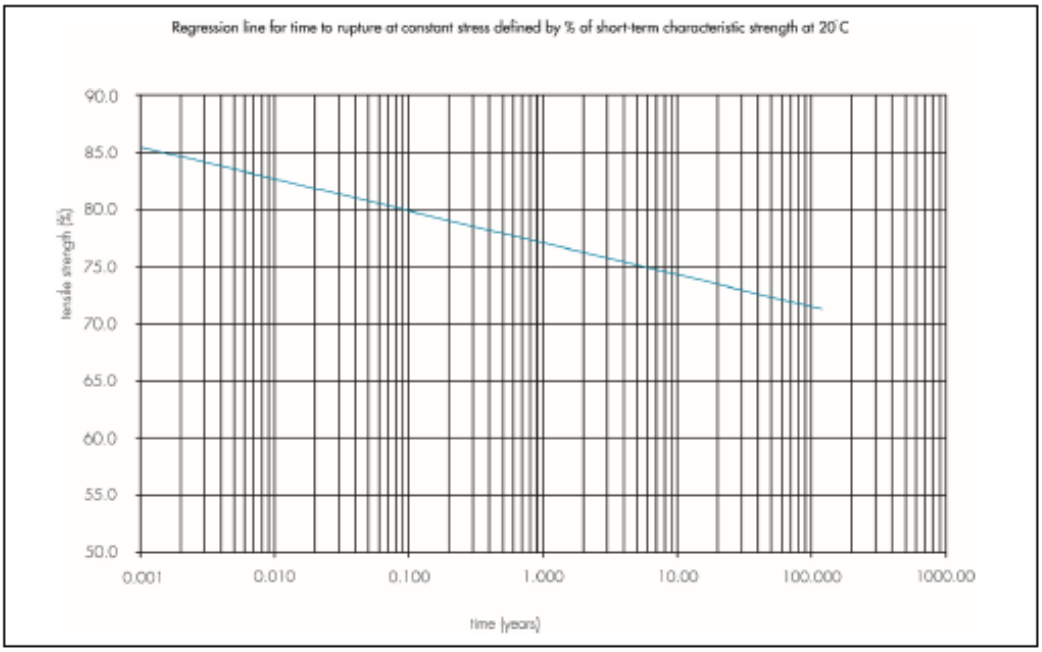


3.1.2 The assessment showed that the products comply with HAPAS requirements for short-term tensile strength.

3.2 Long-term tensile strength

3.2.1 The long-term creep performance of the products has been determined in accordance with the principles of PD/ISO TR 20432 : 2007 using conventional test data and stepped isothermal method (SIM) creep rupture test. The resultant creep rupture diagram is shown in Figure 3 of this Certificate.

Figure 3 Regression line for life expectancy at constant stress defined by percentage of characteristic short-term tensile strength at 20 °C



3.2.2 Long-term tensile strength (T_{CR}) values for the products can be derived using the formula given in BS 8006-1 : 2010, with the long-term creep reduction factors (RF_{CR}) and R_1 to be determined using the method stated in PD/ISO TR 20432 shown in Tables 6 and 7 of this Certificate.

Table 6 Long term creep reduction factors (RF_{CR}) for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
Secugrid PET Geogrids for reinforced soil embankments	Long term creep rupture to PD/ISO TR 20432 : 2007 using conventional test data to EN ISO 13431 : 1999-08 and SIM test data to ASTM D6992 : 2016	60 years design life Design soil temperature 20 °C	1.39
		120 years design life Design soil temperature 20 °C	1.40

Table 7 Long term creep R_1 for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
Secugrid PET Geogrids for reinforced soil embankments	Long term creep rupture to PD ISO/TR 20432 : 2007 using conventional test data to EN ISO 13431 : 1999-08 and SIM test data to ASTM D6992 : 2016	60 years design life Design soil temperature 20 °C	1.00
		120 years design life Design soil temperature 20 °C	1.00

3.2.3 The assessment showed that the products comply with HAPAS requirements for long-term tensile strength.

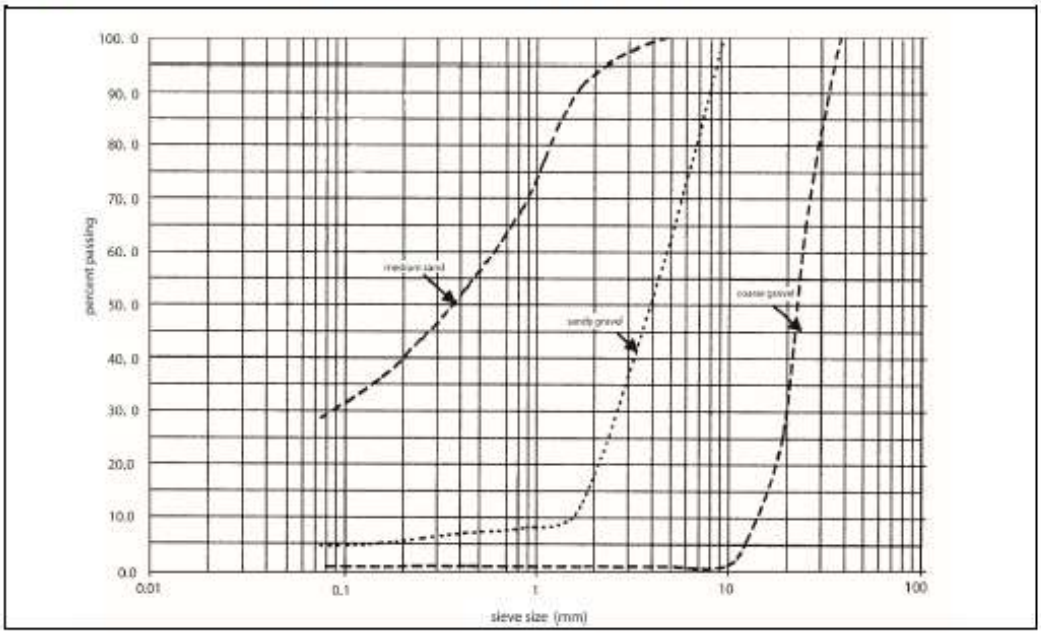
3.3 Installation damage

3.3.1 To allow for loss of strength due to mechanical damage sustained during installation, the appropriate reduction factor (RF_{ID}) should be selected from Table 8. These reduction factors have been established from full-scale installation damage tests using a range of materials whose gradings can be seen in Figure 4, with a minimum compacted depth of 200 mm. For soils not covered by Table 8, appropriate values of RF_{ID} may be determined from site-specific trials, or the engineer responsible for the design of the project may exercise engineering judgment to interpolate between the values given.

Table 8 Reduction factors for installation damage (RF_{id}) for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement / Result		
		Sand 0/2 mm (coarse sand) $d_{90} \leq 1.17$ (mm)	Crushed sand-split mixture 0/8 mm (sandy gravel) $d_{90} \leq 7.18$ (mm)	Split 0/32 mm (coarse gravel) $d_{90} \leq 26.06$ (mm)
30/30 Q6 40/40 Q6 40/20 R6	Installation damage to BS 8006-1 : 2010, Annex D	1.06	1.08	1.09
60/60 Q6 60/20 R6		1.02	1.05	1.08
80/80 Q6 80/20 R6		1.01	1.03	1.05
120/40 R6 150/40 R6 200/40 R6 400/40 R6		1.00	1.02	

Figure 4 Particle size distributions of soils used in installation damage testing



3.3.2 The assessment showed that the products comply with HAPAS requirements for installation damage.

3.4 Pull-out resistance

3.4.1 The BBA recommends that site-specific pull-out tests are carried out to confirm the value of bond coefficient (f_b) used in the final design.

3.5 Weathering (including exposure to UV light)

3.5.1 In accordance with PD/ISO TR 20432 : 2007, Section 9.3, if Secugrid PET Geogrids for reinforced soil embankments are exposed for a maximum of 12 hours, no reduction factor needs to be applied. If the exposure time is longer, then the reduction factor RF_W in Table 9 of this Certificate must be used for the maximum exposure of 1 month.

Table 9 Reduction factors for Weathering (RF_W) for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
Secugrid PET Geogrids for reinforced soil embankments	Weathering to EN 12224 : 2000 and PD/ISO TR 20432 : 2007	Periods of exposure are limited to a maximum of 1 month	1.00

3.5.2 The assessment showed that the products comply with HAPAS requirements for weathering.

3.6 Hydrolysis

Table 10 Reduction factors for hydrolysis (RF_{CH}) for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
Secugrid PET Geogrids for reinforced soil embankments	Hydrolysis from PD/ISO TR 20432 : 2007, Table 2 Index tests to EN 12224 : 2000, EN 12447 : 2001, and EN 14030 : 2001 Test and control specimens were prepared to EN 12226 : 2012.	pH range of 2 to 4 for 60 years design lifetime at 20 °C service temperature	RF_{CH} = 1.07 and R_2 = 1.03
		pH range of 4.1 to 9 for 60 years design lifetime at 20 °C service temperature	RF_{CH} = 1.00 and R_2 = 1.03
		pH range of 9.1 to 10 for 60 years design lifetime at 20 °C service temperature	RF_{CH} = 1.01 and R_2 = 1.03
		pH range of 10.1 to 11 for 60 years design lifetime at 20 °C service temperature	RF_{CH} = 1.03 and R_2 = 1.03
		pH range of 11.1 to 12.5 for 60 years design lifetime at 20 °C service temperature	RF_{CH} = 1.11 and R_2 = 1.03
		pH range of 2 to 4 for 120 years design lifetime at 20 °C service temperature	RF_{CH} = 1.10 and R_2 = 1.05
		pH range of 4.1 to 9 for 120 years design lifetime at 20 °C service temperature	RF_{CH} = 1.01 and R_2 = 1.05
		pH range of 9.1 to 10 for 120 years design lifetime at 20 °C service temperature	RF_{CH} = 1.02 and R_2 = 1.05
		pH range of 10.1 to 11 for 120 years design lifetime at 20 °C service temperature	RF_{CH} = 1.06 and R_2 = 1.05
		pH range of 11.1 to 12.5 for 120 years design lifetime at 20 °C service temperature	RF_{CH} = 1.21 and R_2 = 1.05

3.6.1 The assessment showed that the products comply with HAPAS requirements for hydrolysis.

3.7 Microbiological degradation

Table 11 Microbiological degradation for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
Secugrid PET Geogrids for reinforced soil embankments	Microbiological degradation to EN 12225 : 2000	No considerable loss of retained tensile strength	Pass

3.7.1 The assessment showed that the products comply with HAPAS requirements for microbiological degradation.

3.8 CEG and molecular weight

Table 12 CEG and molecular weight for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
Secugrid PET Geogrids for reinforced soil embankments	Carboxyl end group (CEG) count to ASTM D7409	< 30 mmol·kg^{-1}	Pass
	Molecular weight (M_n) by viscosity to ASTM D4603	≥ 25000 g·mol^{-1}	Pass

3.8.1 The assessment showed that the products comply with HAPAS requirements for CEG and molecular weight.

3.9 Screening test for resistance to acid and alkaline liquids

Table 13 Screening test for resistance to acid and alkaline liquids for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
Secugrid PET Geogrids for reinforced soil embankments	Screening test method for determining the resistance to acid and alkaline liquids to EN 14030 : 2001. Test and control specimens were prepared to EN 12226 : 2012	No considerable loss of retained tensile strength	Pass

3.9.1 The assessment showed that the products comply with HAPAS requirements for resistance to acid and alkaline liquids.

3.10 Factor of safety for the extrapolation of data (fs)

Table 14 Factor of safety for the extrapolation of data (f_s) for Secugrid PET Geogrids for reinforced soil embankments

Product assessed	Assessment method	Requirement	Result
Secugrid PET Geogrids for reinforced soil embankments	The values calculated in accordance with PD ISO/TR 20432 : 2007, using the R_1 and R_2 values given in Tables 7 and 12 of this Certificate.	60 years design life Design soil temperature 20 °C	1.03
		120 years design life Design soil temperature 20 °C	1.05

3.10.1 The assessment showed that the products comply with HAPAS requirements for factor of safety for the extrapolation of data (f_s).

3.11 Durability

3.11.1 When designed and installed in accordance with the requirements of BS 8006-1 : 2010, BS EN 14475 : 2006 and PD ISO/TR 20432 : 2007 and this Certificate, Secugrid PET Geogrids for reinforced soil embankments will have a service life of up to 120 years, exceeding the typical service life required for reinforced soil embankments.

4 Summary of Process Assessment

Manufacturing process and quality control	Complies with HAPAS requirements
Delivery and site handling	Complies with HAPAS requirements
Installation	Complies with HAPAS requirements

4.1 Manufacture

4.1.1 The BBA has undertaken the following tasks for the assessment of product manufacture and has established that the manufacture complies with BBA HAPAS Certification Scheme requirements:

- the BBA has recorded and evaluated the manufacturer's documentation of the methods adopted for quality control procedures and product testing against HAPAS requirements
- the BBA has assessed the quality control operated over batches of incoming materials and formulations against HAPAS Requirements
- the BBA has evaluated the process for management of non-conforming work
- the BBA has audited the production process and verified that it is in accordance with the documented process

- the BBA has checked that equipment has been properly tested and calibrated.

4.1.2 The BBA has undertaken to review the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

† 4.1.3 The management system of the manufacturer has been assessed and registered as meeting the requirements of ISO/IEC 9001 : 2015 by TÜV Nord Cert GmBH (Certificate 44 100 940655).

4.2 Delivery and site handling

† 4.2.1 Secugrid PET Geogrids for reinforced soil embankments are delivered to site in rolls with the nominal widths, lengths and weights shown in Table 1. Each roll is wrapped for transit and site protection in stretch foil and is labelled with the geogrid grade and identification. The packaging must not be removed until immediately prior to installation. The grade of geogrid is ink-jet printed on the cross-machine direction bars approximately every metre.

Figure 5 Label

4.2.2 To achieve the performance described in this Certificate, delivery and site handing must be performed in accordance with the Certificate holder's instructions and this Certificate, including:

- rolls must be stored in clean, dry conditions and protected from mechanical or chemical damage, exposure to direct sunlight and extreme temperatures. When laid horizontally, the rolls may be stacked up to seven high. No other loads should be stored on top of the stack. It must be ensured that the rolls cannot move at any time once stacked and stored
- toxic fumes are given off if the geogrids catch fire and therefore the necessary precautions must be taken following the instructions given in the material safety data sheet for the products.

4.3 Design

4.3.1 Reinforced soil embankments constructed using Secugrid PET Geogrids must be designed in accordance with BS 8006-1 : 2010 and the MCHW, Volume 1 (SHW), Series 600.

4.3.2 The design tensile strength of reinforcement (T_D), the long-term tensile creep rupture strength (T_{CR}), extrapolated tensile load based on creep strain at the end of the design life (T_{CS}) and the material safety factor (f_m) must be calculated in accordance with the methodology set out in BS 8006-1 : 2010.

4.3.3 Recommended values for RF_{CR}, RF_{ID}, RF_W, RF_{CH} and f_s are given in section 3. Conditions of use outside the scope for which the reduction factors are defined are not covered by this Certificate and advice should be sought from the Certificate holder.

4.3.4 CIRIA SP123 : 1996, Sections 4.5 and 4.6, describes the methods for determining resistance to direct sliding and maximum available bond, to which the appropriate partial factors should be applied in accordance with BS 8006-1 : 2010. For detailed design, the resistance to direct sliding should be determined from soil and Secugrid PET Geogrid specific shear box testing.

4.3.5 The designer should specify the relevant properties of fill and the thickness and compaction of the fill material deemed acceptable for the purpose of the design. Acceptable materials should satisfy the requirements of BS 8006-1 : 2010 and the MCHW, Volume 1 (SHW), Series 600 and be in line with those conditions used to determine the installation damage partial safety factors in the design.

4.4 Installation

4.4.1 The Certificate holder's instructions for installation of the products were confirmed as meeting the BBA HAPAS Certification Scheme requirements.

4.4.2 To achieve the performance described in this Certificate, the products must be installed by competent ground engineering contractors familiar with these types of products, in accordance with the specifications and construction drawings.

4.4.3 To achieve the performance described in this Certificate, installation of reinforced soil embankments incorporating Secugrid PET Geogrids must be in accordance with the Certificate's holder's installation instructions, BS 8006-1 : 2010, BS EN 14475 : 2006 and the MCHW, Volume 1 (SHW), Series 600 and HAPAS requirements.

† 4.4.4 The Certificate holder's instructions advise that care should be taken to ensure that the products are laid with the warp (longitudinal) direction parallel to the direction of principal stress. Design drawings should indicate orientation of the products.

4.4.5 Installation procedure

† 4.4.5.1 The products are laid by unrolling manually or mechanically to the length required. Grades up to 40 $kN \cdot m^{-1}$ can be cut with a sharp knife, but for grades exceeding this, an angle grinder with a smooth diamond grinding wheel and a cutting depth of at least 300 mm is recommended. Due to the mechanical stresses during the cutting process, individual, small damages of the geogrid bars can occur in the direct area of influence. For installation, therefore, the first 100 mm away from the cutting edge must not be considered for overlaps required by the design. As a result, in overlapping areas, a larger overlapping length in the transverse direction of 100 mm should be considered in comparison to the recommended value stated in the design.

4.4.5.2 Lengths of the geogrids are laid flat without folds, parallel with widths in contact and overlapping by a minimum of 300 mm. Each reinforcing layer must be continuous in the direction of loading. If wrinkles occur, these are to be worked out to the free ends of the products. Recommendations for overlaps and soil type can be provided by the manufacturer. Pre-tensioning of the geogrids is usually not required since they are produced without any construction-related strain. If pre-stressing is required, it must be carried out according to the project specification or after consultation with the Certificate holder.

† 4.4.5.3 Particular care should be taken to ensure that the geogrids are adequately covered before compaction or trafficking. Construction traffic will damage unprotected geogrids.

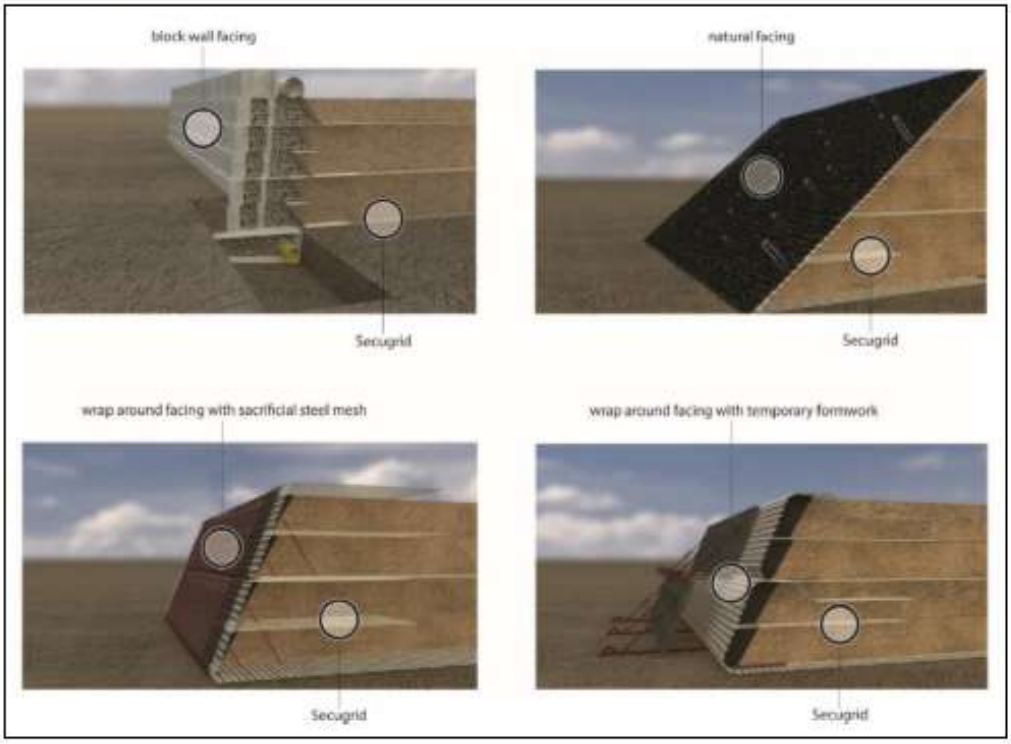
4.4.5.4 Fill material is placed to a minimum compacted depth of 200 mm. During the installation of the fill material, the geogrids must not develop folds and wrinkles.

4.4.5.5 All coarse and mixed-granular soils or base course materials according to the project specification or requirements outlined in the national Building Regulations [eg the MCHW, Volume 1 (SHW), Series 600 or BS 8006-1 : 2010] can be used. In subbase and base courses for road construction, preferably crushed stone-sand mixtures and/or gravel-sand mixtures of grading specifications 0/32, 0/45 or 0/56, are used. The respective soil-mechanical parameters must be observed during the planning phase. The bulk material should be selected according to the specifications of the detailed design. The use of recycled aggregates might be appropriate for some applications. Consideration should be given to the use of such materials, and guidance can be found in the national Building Regulations. An optimal mode of operation is achieved by a well-graded crushed granular mixture, without considerable fines. If coarse-granular material > 63 mm maximum particle size must be used, the suitability must be discussed with the Certificate holder.

4.4.5.6 The products must be covered with fill within the time specified in the design to prevent degradation caused by UV light.

† 4.4.5.7 Facings are positioned as detailed on the engineer's design drawing and, where the products are used for this purpose, they must be wrapped around and anchored back into the fill. Formwork is used to assist in maintaining the shape of the facing but, whether prefabricated or otherwise, such facings are outside the scope of this Certificate. A typical example is shown in Figure 6.

Figure 6 Facings



4.4.6 Visits were made to installations in progress to assess the practicability and ease of construction of the products.

4.5 Maintenance

As the products are confined within the soil and have suitable durability, maintenance is not required.

5 Fulfilment of Requirements

5.1 The conclusion of this BBA assessment is that Secugrid PET Geogrids for reinforced soil embankments, when used in accordance with the provisions of this Certificate, comply with the BBA HAPAS Certification Scheme requirements.

5.2 In order for the products to continue to meet Scheme requirements, they must be installed, used and maintained as per the manufacturer's instructions and as detailed in the Certificate.

6 Validity of Certificate

Continuing validity of this Certificate is dependent on the following factors:

- continuing compliance with product or process requirements, as described in the HAPAS Scheme document, and the specification documents referred to therein

- ongoing BBA surveillance of factory production control, to verify that the specifications and quality control being operated by the manufacturer are being maintained
- acceptable results from long-term exposure monitoring
- acceptable data to confirm durability
- formal triennial Review of the Certificate, and Reissue for required technical or non-technical updates
- compliance with ongoing Certificate obligations by the Certificate holder and manufacturer(s).

† 7 Additional Regulations

Construction (Design and Management) Regulations 2015
Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

CE marking

The Certificate holder has taken the responsibility of CE marking the products in accordance with Designated Standard EN 13251 : 2016.

Annex A

When Secugrid PET Geogrids for reinforced soil embankments are used as part of retaining wall systems, both serviceability limit state and ultimate limit state design in the form of isochronous curves are required. Serviceability limit state and ultimate limit state design in the form of isochronous curves must be declared by the Certificate holder, as per BS 8006-1 : 2010, and approved by the BBA.

8 Bibliography

ASTM D4603 *Average Molecular weight*

ASTM D6992 : 2016 *Accelerated creep rupture based on Time Temperature Superposition using Stepped Isothermal Method (SIM)*

ASTM D7409 *Carboxyl end group (CEG) count*

BS 8006-1 : 2010 + A1 : 2016 *Code of practice for strengthened/reinforced soils and other fills*

BS EN 13251 : 2016 *Geotextiles and geotextile-related products — Characteristics required for use in earthworks, foundations and retaining structures*

BS EN 14475 : 2006 *Execution of special geotechnical works — Reinforced fill*

BS EN ISO 9864 : 2005 *Geosynthetics — Test method for the determination of mass per unit area of geotextiles and geotextile-related products*

CIRIA SP123 : 1996 *Soil Reinforcement with Geotextiles, Jewell R.A*

EN 12224 : 2000 *Geotextiles and geotextile-related products — Determination of the resistance to weathering*

EN 12225 : 2000 *Geosynthetics — Method for determining the microbiological resistance by a soil burial test*

EN 12226 : 2012 *Test and control specimens' preparation*

EN 12447 : 2001 *Geotextiles and geotextile-related products — Screening test method for determining the resistance to hydrolysis in water*

EN 14030 : 2001 *Geotextiles and geotextile-related products — Screening test method for determining the resistance to acid and alkaline liquids*

EN ISO 10319 : 2015 *Geosynthetics — Wide-width tensile test*

EN ISO 13431 : 1999-08 *Determination of tensile creep behaviour*

ISO/IEC 9001 : 2015 *Quality management systems — Requirements*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works*

PD/ISO TR 20432 : 2007 *Guidelines for the determination of the long-term strength of geosynthetics for soil reinforcement*

9 Conditions of Certification

9.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

9.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

9.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

9.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

9.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to UKCA marking and CE marking.

9.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

Claire Richardson

From: Paul Green <
Sent: 18 September 2025 10:20
To: Nathan Eastwood
Subject: Gillcon Concrete Products - Lock+Load 21/H311

External email

Hi Nathan,

Direct response from the BBA below, outlining out certificate is in date and meets the current standards.

regards,

Paul Green – Associate Director

Gillcon Group Retaining Walls

Gillcon Group Ltd
Registered in England no. NI646684

From: BBA Civils & Highways
Sent: Thursday, September 18, 2025 9:07 AM
To:
Cc:
Subject: RE: Gillcon Concrete Products - Lock+Load 21/H311

Hello Paul,

I have checked your Certificate and the reference in the bibliography is to the current standard of BS 8006-1:2010+A1:2016. All references to BS 8006 in the certificate are to the current standard.

Thanks,
Adam

Adam Vaughan
Operations Manager

a: 4 St Pauls Square, Liverpool, L3 9SJ

Lock+Load – Methodology of Works

Carry out reduce level dig as per site specific designs, in preparation for levelling pad and backfill installation.

A 300mm levelling Pad will be placed and compacted using a suitable compaction device in line with the design specification.

Base Level

Lock and load panels will be lifted by the Teleporter and placed as close to the work as possible to minimise the likelihood of musculoskeletal disorders. Two number operatives will then manually lift the lock & load panels into position.

Set one panel at each end of the wall section to be constructed. Check panel with survey markers for correct position from survey hub. Place level on back of panel and plumb by adding or subtracting grading material under counterfort until panel is vertical. Place level on top of panel and level horizontally in the same manner. Check top elevation of both panels on each end of wall segment being constructed with laser level to ensure run will be level.

Secure a pin (non-conductive pins) at each set and levelled panel (15m – 25m apart) and run a string line the entire distance of wall segment to be constructed.

Additional non-conductive pins may be added to eliminate sag in the string line.

Double check alignment with laser or survey instrument. Now set the intervening panels along the string line.

At this point, the top rear of panels will vary slightly off the string line.

Adjust panel alignment and height by adding or subtracting gravel from underneath each counterfort until all panels align with string. If adding material under counterfort, make sure to tamp material tight.

Slight variations of panels exceeding string line height, can be adjusted by tapping the top of the panel with a sledge hammer using a piece of timber to prevent chipping of the concrete.

Low panels can be adjusted up by tipping them forward and adding gravel under base of panel to raise its elevation.

Operatives must ensure the alignment of the bottom row as it helps assure straight level and aligned wall.

Place drainpipe and drainage stone (aggregate) as detailed within the design drawings. Drainage stone is lifted into position using machines and spread into correct position by operatives using rakes.

On short non-engineered walls, the drainpipe will be located at the rear of the counterfort and on the levelling pad (lowest elevation).

On walls specifying geo-grid it must be placed in line with the design detail.

Commence backfill operation by placing backfill material over the tail of the counterfort first.

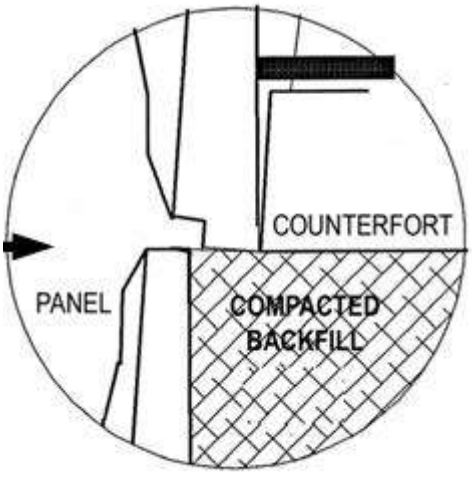
Keep a minimum of 0.6m of backfill material (stone) behind wall face to form the foundation of the next row.

Beyond this use the specified backfill material.

Panel rows should be back filled and compacted in two lifts of 200mm with the second lift rising to approximately 50mm above panels top edge so that the material will compact to top of panel. Make minor adjustments as necessary. Backfill material is lifted into position by machine and spread into correct locations by operatives using rakes. Operatives then proceed to compact backfill using specified compaction machinery.

Once selected fill material is placed over the counterforts the specified backfill can be placed, leveled and compacted in 200mm lifts. Take care not to displace the wall alignment or damage soil reinforcement.

Subsequent Rows



ASSEMBLY DETAIL

Using a flat point shovel scrape along the first 125mm of wall face using the top of the previous coarse as a guide until level.

The back needs to be level with the top of previous panel and compacted. The 25mm gap at the base of the next panel is to allow for mass consolidation in taller walls.

Placing of Geogrid

Rolls of Geogrid will be delivered to site as requested and brought to the work area by GWS Durham. The rolls of Geogrid will be offloaded by either Gillcon's skid steer or excavator with forks attachment. Rolls of Geogrid will be off loaded one at a time.

In order to roll out the Geogrid rolls, Gillcon skid steer / excavator driver with forks attachment will lift one roll of Geogrid and a Gillcon operative will place a steel tube up the centre of the Geogrid roll. Before Gillcon operatives approach the Geogrid roll with the steel tube, the machine driver needs to isolate the machine to prevent accidental movement of the machine when operatives are within the slew zone of the machine. The steel tube with Geogrid Roll on it will then be placed onto tripods (one tripod end of steel tube). The steel tube will then be secured into position on the tripods with a latch.

Gillcon operatives will then roll out the required amount of Geogrid and cut to size using consaw. Lengths of Geogrid will be placed as below by two number operatives. This process will be repeated until the roll of Geogrid has been used.

In order to replace the Geogrid rolls, the skid steer / excavator driver with forks attachment will lift the empty roll with steel tube through it and lift it off the tripod. When off the tripod, Gillcon operative will remove the steel tube from empty plastic roll of Geogrid. At no time does a Gillcon operative manually lift the empty roll from the tripod.

When installing the geo-grid as per design, backfill only approximately ½ the way up panel back making sure that the fill is evenly distributed and about level over the whole grid area.

Compact this lift of fill being careful over the counterforts. Roller compactors may not be used to compact on the first lift over the barely covered counterforts as damage may be caused.

Once compacted and levelled place geogrids with grid directional strength, perpendicular to the wall face.

Geogrid must be placed in line with the design to ensure that the geo-grid is the proper strength and length for its position in the retaining wall structure. Place the geogrid so that a minimum of 75mm remains vertical and in contact with the panel back.

This Process is repeated in layers for the entirety of construction.

METHOD STATEMENT

Contract / Enquiry Name	Cleckheaton
Contract / Enquiry No.	241261-01
Method Statement for	Rigid Inclusions

Method Statement No.	Revision No	Revision Description
1	01	Revised following site visit
1	02	Revised to show new platform location / 14.08.25
1	03	Revised following comments from Kirklees Council

Initial	Name	Position	Date
Prepared by	Phil Hall	Operations Manager	11.07.25
Reviewed by	Claire Garrett	Ground Improvement Director	11.07.25
Client Acknowledgement by			

Distribution	
Copy No	Title
1	Strata
2	VE Supervisor
3	
4	
5	
6	

By signing this method statement, I confirm that I have been briefed on its contents and understand my personal responsibilities to work in accordance with the Method Statement/Risk Assessments

Print Name	Signature	Title

Method Statement Contents

1. Scope of Works

Approximately 296no, 320mm diameter Rigid Inclusions are to be installed beneath the proposed 167m retaining wall (see location below). C16/20 Concrete will be used for all Rigid inclusion positions. A Full working procedure on the installation of the rigid inclusions can be found in Appendix C of this Document.

The plant and equipment to be used will arrive on a low loader, hiab and flatbed trailer. Lift plans will be in place prior to mobilizing to site. The Van Elle site team will agree on and establish a laydown area prior to works commencing.

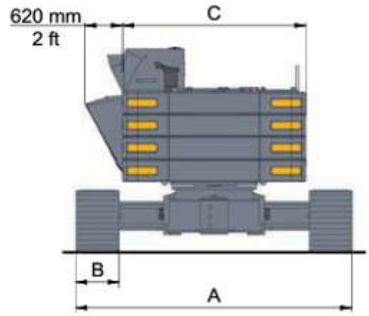
A tracked pump will be used to enable the unhindered pumping of concrete to the piling rig. Access for concrete wagons must be available from the site entrance to the working area / working platform.

The compressor, storage container and jet wash bowser will be placed accordingly to allow easy access. A supply of water to the laydown area must be provided by Strata (or groundworker). This can be either by a direct feed or IBC's.

Before works commence; an attendant excavator will be needed to set up the augers of the piling rig. A site-specific lift plan will be in place for the rigging and de-rigging of the augers using the attendant excavator. The attendant driver of the excavator must sign onto the RAMS and complete the excavator driver checklist.

At the end of every shift, the piling rig and equipment will track at least 15m away from the treatment area to allow the groundworkers safe access to complete the follow on works.
The top 1.0m of platform will be removed by the groundworker and a further 0.5m will then be excavated and re-installed locally above the rigid inclusion positions. The 500mm between the top of inclusion and underside of slab will be the load transfer mattress. Prior to works re-commencing, the groundworker must ensure that the platform is re-installed/extended at least 2m past the furthest Rigid Inclusion position in the piling sequence, and that the slope is battered at 45°.

The working platform must extend a minimum of 10m from the site boundary. The width of the rigid inclusion treatment area from the two most external positions is 2.16m.
The rig width must also be considered for changes of direction of the platform, corners, etc., most notably the dog leg in the south east corner of the site. A sketch of the anticipated platform can be found in Appendix D of this document.
In operational mode, the rig width is 4.5m (see dimensions below). Any access/egress ramps must be the width of the rig, plus 2m ether side.



A	Breite Unterwagen Crawler width	3,00 – 4,50 m	9.8 – 14.7 ft
B	Kettenbreite Width of track shoes	700 mm	2.3 ft
C	Oberwagenbreite Width of uppercarriage	3,00 m	9.8 ft

Figure 1 – rig track dimensions in operational mode.

Van Elle note the presence of existing structures in close proximity to the proposed retaining wall/VE rigid inclusion treatment area. Strata are responsible to have in place a procedure and protection for piling works adjacent to party walls, adjacent structures, and site boundaries. An instruction from Strata must be issued to Van Elle before the installation of Rigid Inclusions within 10m of any existing structures is carried out. Debris netting should be installed by Strata when working in close proximity to neighbouring properties.

4no plate load test is to be carried out across a selection of the rigid inclusion positions.
1 set of 4no concrete cubes will be taken per working day and tested at 7, 28, 28 and 56 days.
Setting out of the rigid inclusion positions will be carried out by The Main Contractor, the setting out may be carried out in passes which will identified on sequence drawings/position layout drawings.

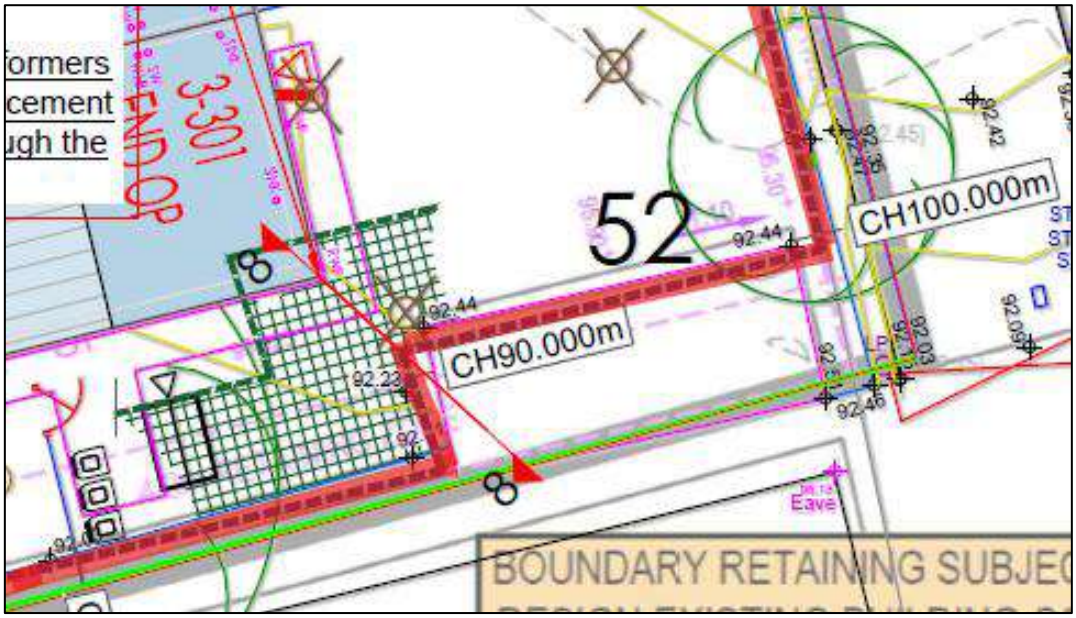


Figure 2 – Rigid Inclusion Treatment to the proposed dog leg highlighted in red.

The project will be carried out in 1 visit, start date is currently awaiting confirmation. The full duration of the project will be approximately 2 weeks. Site hours will be 0730 – 1730.

2. Site Location, Access, and Boundaries

Site boundaries are to be maintained by the Main Contractor with suitable fencing to prevent unauthorised access / egress.

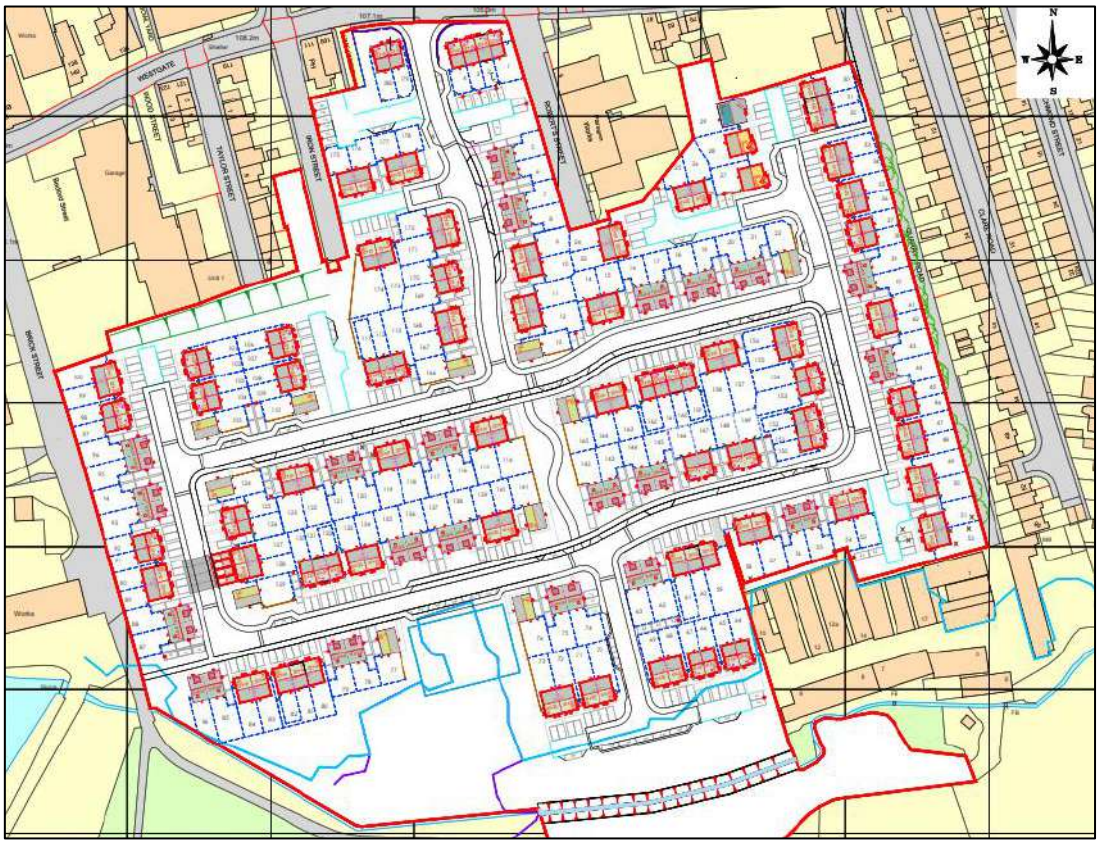


Figure 3 - Site Location Plan

The rig will access the site via the designated site entrance off Westgate, A643. The rig is to be offloaded on the piling platform or an agreed area with suitable hardstand.

All operatives will access site through the main gate and the Main Contractor induction will be held in the site office. The rig, pump and all other auxiliary plant will access the site through the site entrance and be offloaded in accordance with the relevant procedure (found in Appendix C of this Document).

3. Pre-commencement Requirements

3.1 Existing Services

The proposed piling area must be CAT scanned by Main Contractor/Others prior to works commencing, to ensure it is free of services.
Any services that are within a 5m proximity of the nearest column position must be exposed/sprayed/ clearly marked out.

3.2 Working Platform Requirements

The Main Contractor will provide the VE crew with a firm and level hard standing and free draining working platform as specified, based upon the BRE load cases provided by VEL for the rig to be used.
As stated within the FPS Working Platform Certificate (WPC4D) guidance, attention needs to be given to the edges of working platforms: determine how near the edge of the platform plant can be permitted while avoiding instability.

Sites where there have been cut and fill operations, or where plant is required to operate near slopes or batters will need to be checked for slope stability with the additional loading of the plant in place. Sloping sites present particular problems for stability, which should be addressed in the design. – In general terms the rig will be able to access level changes based on the following gradients: -

- Rig in transported mode – Mast down 1 in 6
- Rig in all operational modes - Mast Up – 1 in 10

If the rig is operational (installing Rigid Inclusions) the working platform gradient will be specific to machine type and manufacture guidance.
The working platform will be maintained throughout the duration of the piling works. If obstructions are removed the mat must be properly reinstated in accordance with the original piling mat design.
The working platform, including ramps and accesses, is to be used only by plant for which it has been designed.
The Main contractor must provide visual demarcation to advise of the extent of the Certified Working Platform. This must also be accompanied by a copy of the Rigid Inclusion layout drawing denoting the certified area of platform. This is to be appended to the current signed Working Platform Certificate.
The working platform certificate must be signed before the commencement of any works on site. The Working Platform inspection register must be completed on a weekly basis and following any change or maintenance to the platform.
Any parts of the piling mat deemed unacceptable by the VE Foreman or Site Manager must be rectified straight away.

- The working platform level must be provided before any piling commences.
- The working Platform Certificate must be signed and issued by the Main contactor prior to raising the mast of the rig.

3.3 Setting Out of Rigid Inclusion Positions

The Main contractor will undertake the setting out using the most up to date construction issue drawings of the rigid inclusion layout detail. This is to be provided by the Main Contractor. A pin and mushroom cap must be used for specific rigid inclusion positions.

4. Resources

4.1 Materials

Item	Quantity
Concrete	As Required
Diesel	As Required

4.2 Plant

The following equipment items are envisaged to be used for piling operations: -

Item	Quantity
Piling Rig	1
Compressor	1
Excavator and Driver (Client attendant)	1
MEWP	1
Tracked Concrete Pump	1
Jet wash bowser	1
Fuel Bowser	1
Concrete Wagons	As required
Plant and Equipment delivery vehicles	As required

All plant and equipment will be certified and maintained to PUWER 98 and where applicable, LOLER 98
All lifting equipment will be certified and maintained to LOLER 98.

4.3 Labour and Staff Contacts: -

The following manpower is envisaged to be used for piling operations:

Site Personnel	Competence
VEL Works Superintendent (Visiting)	SMSTS
Supervisor	SMSTS / SSSTS
Rig Operator	CPCS/NPORS rig operator bored Above 20tonnes
Frontman	CPCS / NPORS Slinger / Signaller CPCS / NPORS Rig Attendant.
Pumpman	CPCS / NPORS Concrete Pump.

The following Staff contacts are available for all other enquiries:

Office Contacts	Name	Contact Phone Number
Contracts Manager	Mustafa Elgalal	07864 606835
Operations Manager	Phil Hall	07704 311517
Safety Manager	Jim Davies	07834 800550

5. Methodology

All tasks involved with the Rigid Inclusion installation process will be carried out in accordance with VE working procedures.

Rigid Inclusion Installation
Installation of the rigid inclusions will be carried out in accordance with the VE working procedure for installation rigid inclusions.

Leaving site
The work area shall be left in a clean & tidy manner. The Foreman will make sure that the rig is configured for transport in accordance with the manufacturer's instructions, making sure all securing bolts & pins are correctly fitted and that the rig is safe to transport. All excessive spoil must be cleaned off the rig tracks.

Testing
Test will be set up as per Van Elle testing procedure unless otherwise specified in Clients/Main Contractor's specification.

Augers will be added / removed by Mechanical lifting with attendant excavator.
- Augers are lifted with a single leg drop chain secured to the lifting point on the attendant excavator. All excavator movements will be supervised by the Piling Operative.
- The area around the front of the rig shall be clear of all personnel prior to lifting augers.
- Excavators must not move when the operative is in front of the rig or within the danger zone of the excavator.
- Lift plans will be provided for all auger lifts.

MEWP Operations
MEWPs will be operated by a competent operative wearing a work restraint harness. Plant movements will be controlled by the Rig Attendant. The excavator will lift sections of auger & remain stationary. Excavators will not move whilst cherry pickers are adjacent to the rig. An operative will be at ground level to operate the ground controls in the event of an emergency.

Concreting
Refer to VE Work Instruction for concrete pumping.
The concrete plant will be set up on a suitable platform, if a agitator is being used;
- Without a ramp using a drum fitted with change-over valves.

Concrete hoses will be positioned or buried to prevent damage from site vehicles. All sections will be coupled and secured with clamps & split pins. Additionally, whip-checks can be used on hose joints that are off ground.
Hoses will be moved around site using a short leg chain or strop on the excavator lift point. Hoses will not be lifted in excavator buckets.
The concrete wagon will be directed to the concrete plant under supervision of the Rig Attendant or Pump man. A suitable washout area agreed/provided by the main contractor (prior to starting works) will be used by concrete delivery wagons to prevent ground contamination.

Cleaning out hoses & clearing blockages
The cleaning out of hoses & clearing blockages will be carried out in accordance with the Working procedure for Pumping Concrete.

Lifting Operation
Lift plans will be in place prior to any lifts being carried out. These lifts shall be carried by competent and certified persons only. All LOLER certification will be in place and all equipment will be checked and recorded in accordance with procedures. Pre-use checks will be carried out daily and recorded as per procedure on a Van Elle SET09 document.
No persons are to stand under any loads during lifting operations.

Security
Foreman will make sure that adequate measures are taken to prevent the theft or unauthorised use of equipment/materials. This will include locking away all tools in the van or lock up, removing keys from plant & equipment where fitted, when not in use and left unattended & using cab guards if fitted.

Mobilisation to and from site
Mobilisation will be carried out in accordance with the VE mobilisation and set up procedure.

On site fabrication of augers etc

Note: - Client Hot Works Permit must be issued prior to any fabrication works commence.

On site fabrication of augers etc shall be carried out in a separate area free from combustible materials.

The area shall be surrounded by screens to protect others from arc-eye etc.

Gas cylinders shall be stored securely upright to prevent damage/accidentally being knocked over.

The fabricator shall wear the correct PPE: full face shield, long sleeve flame retardant overalls, leather gauntlets, safety boots and respiratory protection when required.

At least 1 no. 2kg extinguisher in proper working order must be kept in the immediate area of the work and used immediately smoke or smouldering or flames are detected.

The work area must be inspected approximately 60 minutes after the completion of work and immediate steps taken to extinguish any smouldering or flames.

6. Piling Restriction Zones

All piling operatives will follow the designated pedestrian footpaths to the perimeter of the piled structures or piling mat.

A Banksman/Traffic Marshall must be in attendance with the rig driver when operating or moving the rig.

Throughout the piling process, a minimum 10m exclusion zone around the rig will be safeguarded by physical barrier or policed by the Banksman to prevent access by other contractors. The piling area shall be dedicated to piling personnel; with other contractors excluded without permission to enter.

Signs will be posted on crowd barriers stated, "**PILING IN PROGRESS – KEEP OUT**".

As concrete is pumped into the pile position all personnel will maintain 5 metres clearance around the front of the rig to prevent injury from falling spoil being cleared by the auger cleaner. The rig driver is responsible for making sure that no spoil that could cause injury rides up the auger beyond the auger cleaner. A 5m exclusion zone for all non-piling related staff should be in place around the full length of the concrete hose. No one should be stood over, or step over a hose during pumping. Daily Plant Inspections for all moving plant to be carried out.

Banksman to maintain clear sight and be responsible of all moving plant within working area. If path of site is broken/obstructed, all works to stop immediately.

UNDER ANY CIRCUMSTANCES ARE UNAUTHORISED PERSSONEL ARE TO ENTER VE WORKING AREA. IF ANY UNAUTHORISED PERSSONEL ENTER, ALL WORKS TO STOP AND DOWN TOOLS IMMEDIATLEY.

The 'Piling Restricted Zone' requirements are detailed in 'Appendix B' of this document.

7. Description of the Works

7.1 General

Rigid Inclusions will be constructed with a diesel-powered track mounted Piling Rig.

- Workmanship will be consistent throughout the duration of the piling works.
- All VE crew and subcontractors will be focused on their work throughout the working day
- It is important that all VE staff take the breaks that they are entitled to throughout the day.
- The quality of work will be to a consistent high standard and this standard will not drop at any time i.e. end of shift / week / last day before holiday period etc.
- All staff will be deemed competent to carry out the task in hand.

7.2 Working Hours

Working hours will be as follows:

Monday to Friday: 0730 – 1730. Weekend working or work outside of these hours to be agreed with Main Contractor

7.3 Lighting

Task lighting as fitted to plant will be provided and maintained by VEL. General/safety lighting for the access and working area will be provided by the Main Contractor if necessary.

7.4 Rigging and De-rigging

The rigging and de-rigging process will take place in a designated area and be carried out by a trained and competent person.

7.5 Rigid Inclusion Installation Sequence

The installation sequence will be generally as per agreed with the Main Contractor during the pre-start phase.

7.6 Party Wall
The Main Contractor is responsible to have in place a procedure and protection piling works adjacent to party walls, adjacent structures, and site boundaries.

7.7 As-Built Drawing
The VE As-Built drawing will be included as part of the site file documentation. The As Built will also be submitted to the Client and the appointed Engineer for review and approval prior to site commencement.

8. Programme
The work will proceed generally in accordance with a programme and sequence agreed between the Main Contractor and VEL programme, as advised in the Tender Summary letter.

9. Health and Safety

9.1 The main risk associated with the piling operations are as follows: -
- Failure of piling rig.
- Items falling from height.
- Failure of piling platform.
- Open bores.
- Collision and crushing by piling equipment.

To overcome these potential risks, the following safety processes will be implemented to ensure a safe method of working.

9.2 Induction
All VEL personnel will attend the main contractor project induction prior to any works commencing.
All hazards and requirements particular to the project, along with details of the project first aider, fire wardens and nearest A&E facility will be briefed to the VEL workforce during this process.

9.3 Equipment Inspections
The nominated Site Supervisor shall complete checklists and working documents, which shall be checked by the Piling Project Manager for their completeness and accuracy. These are: -
- Pre-Use Rig Inspections – recorded daily.
- Pre-Use Plant and Machinery Inspections – recorded daily.
- Pre-Use Lifting Accessory Inspections – recorded weekly.

9.4 PPE
Correct types of PPE for all site personnel shall be worn as required, they include:
- Hard hats, mandatory
- Hi-visibility upper garment, mandatory.
- Hi-visibility trousers, mandatory.
- Safety Footwear with ankle and mid sole protection, mandatory.
- Eye protection appropriate to task, mandatory.
- Gloves, appropriate to task mandatory
- Hearing protection, mandatory/appropriate to task
- Full Flame-retardant overalls, when carrying out hot works.
- Any other PPE deemed applicable to the task.

Additional items of PPE may be required for specific operations. Those items will be identified, and a briefing given as required. All PPE will to be fit for purpose.

9.5 Records
A copy of the full SHES package will be retained on site for inspection and will be briefed to all site personnel, by the VE Project Manager or Site Foreman.
A record of all briefings will be kept on site in the SHES file.

9.6 Fire Extinguishers/First Aid

Fire extinguishers will be located in the piling rig and job box they must be in date and serviced.
First aid kits and Eye wash located in the job box.

9.7 Risk Assessment

Ref:	Title:
RA001	Working at height.
RA002	Lifting Operations.
RA004	Vehicle Movements.
RA005	Loading & Unloading plant.
RA008	Manual Handling.
RA009	MEWP
RA010	Compressor
RA014	Security
RA015	Pressure Washer
RA016	Overhead services.
RA018	Underground Services.
RA019	Working Platform
RA020	Attendant excavator driver
RA024	Rig Operations.
RA025	Hose Burst/Steels/Clamps
RA026	Concrete blockage ground hoses.
RA027	Blowing out concrete.
RA028	Concrete Pumping
RA029	Refuelling Plant and Machinery
RA030	Concrete block pump hopper.
RA032	Concrete block Augers.
RA033	Concrete block Rig Mast Steel Pipes.
RA034	Concrete block Drop hose/Swan Neck.
RA035	Rigging & Derigging.
RA042	Abrasive Wheels.

Please note –
Any amendments and information no matter how basic can be captured in the Point of Work Risk Assessment (POWRA)

The VE supervisor or his representative will complete POWRA prior to works commencing. The POWRA will briefly outline the works taking place, document number and revision of the RAMS being worked to, Permit number and any isolation requirements, along with task PPE requirements and any task and control measures not included with the main project RAMS or Task Briefing Sheets.
These documents will be briefed to and signed by all VEL personnel (inclusive of agency staff) in the work area and also attendant excavator operators, crane operators and engineering staff.

9.8 Security

Project security arrangements will be advised the Main Contractor.

9.9 Welfare Facilities

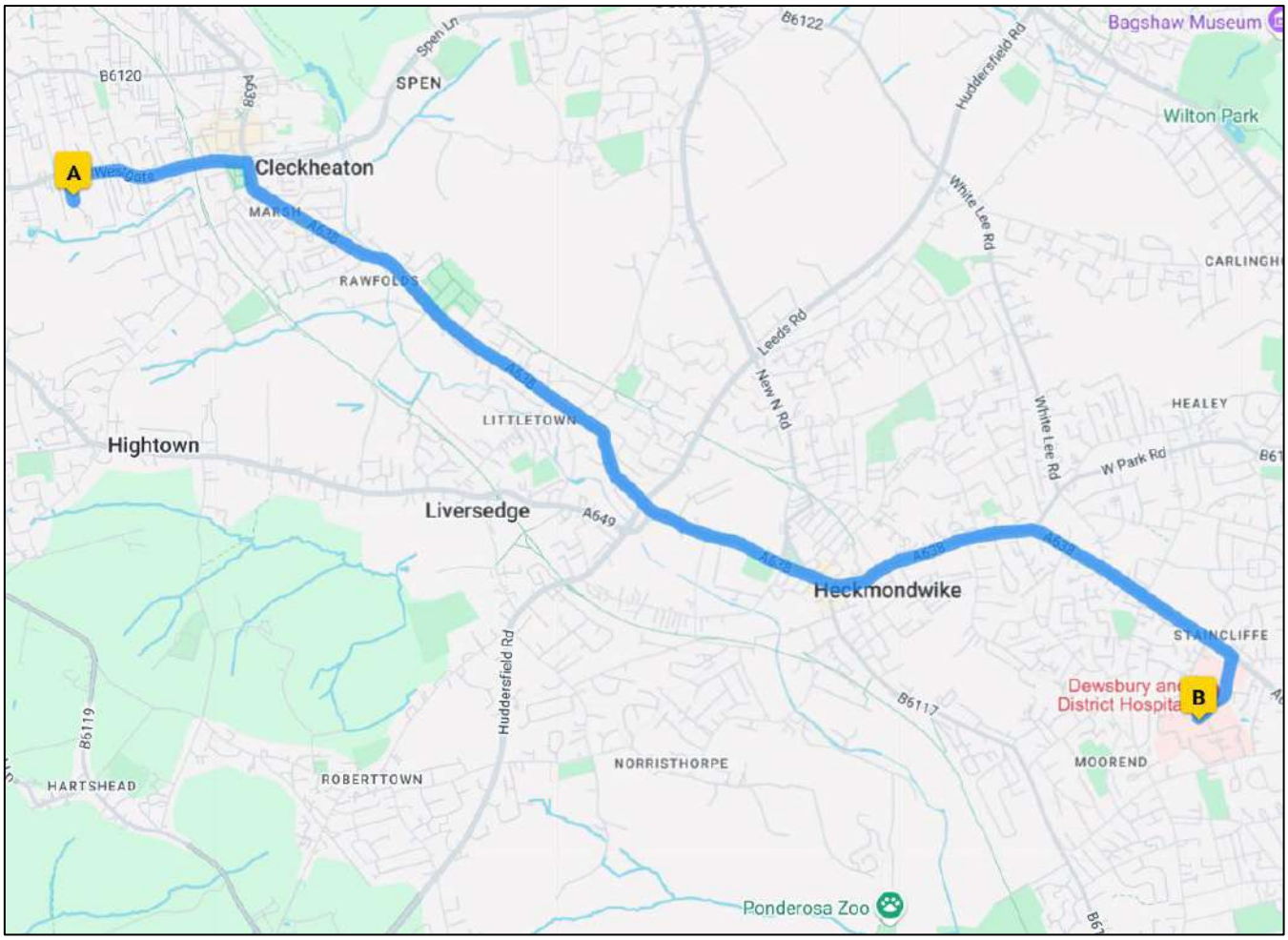
Site welfare facilities will be provided by the Main Contractor and will be fully compliant with CDM Regs 2015.

9.10 Emergency Plan

Communication and emergency plans will be drawn up in line with Main Contractor requirements and advised during the project induction.

In the event of an emergency, the Site Manager will be informed immediately, followed by the SHES Manager.

- First aid arrangements will be provided by the Main Contractor and VEL personnel.
- Emergency Contact for Environment Agency (080:0) 80 70 60
- If talking to the Emergency Services, the site is at: **(formerly stone street) Off Westgate, Cleckheaton, BD19 5DR**
- Nearest Hospital with Casualty Department as follows: **Dewsbury and District Hospital, Halifax Road, Dewsbury, West Yorkshire, WF13 4HS**
- What three words for the works location are **///dice.dirt.votes.**



10. Environment

- The main contactor as responsible for the removal of waste produced by VEL in the course of their works, inclusive of general waste, by a licence waste carrier to an appropriately licence waste facility.
- Concrete washout facilities will be provided by the Main Contractor
- Wheel washing arrangements will be provided and managed by the Main Contractor.
- Water via mains connect or bowsers will be provided by the Main Contractor.
- Piling operations will take place only within the specified working hours unless prior approval is sought and granted by the Main Contractor.
- General waste shall be deposited into designated skips or another appropriate receptacle.
- Vehicle idling is not permitted.
- Engines shall be turned off when not in use.
- Fuel / oil spills shall be prevented.
- Spill containment and emergency spill kits shall be used to catch and clean the spills / leaks.
- Should an environmental incident occur VEL will follow the procedure prescribed within the main contactor induction and also follow guidance from Environmental Handbook.
- VEL supervisor will notify the Main Contactors representative of any incidents.

10.1 Fuel Spillage

VEL will have a minimum of 2 spill kits on site per rig to deal with any fuel or oil spills.
In the event of a spill the area will be segregated off and the spill kits positioned to minimise the risk of the spillage spreading.
Plant nappies/drip trays or Enviro Pad are to be used where possible.
The Main Contractor's representative and the VEL Project Manager will be made aware immediately.

VAN ELLE
TOTAL FOUNDATION SOLUTIONS

Appendix A

CFA/RIGID INCLUSIONS
RESTRICTED ZONE

Red Zone: The Rig Operator must ensure the rig is placed in a safe condition before an Authorised Person enters the Red Zone. The operator must give a 'Thumbs up' to the Authorised Person wanting access confirming it is safe to enter before they enter the Red Zone.

Green Zone: Rig Operators sight line (safe approach), optimum Rig Attendant position.

Note: People entering the Red Zone must be aware of and consider the increased risk of falling objects and plant movements from other plant such as excavators and dumper trucks.

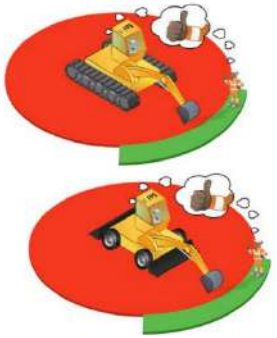
Due to the worksite layout, it might not be possible to maintain a 10m barrier distance behind the counterweight of the rig. In these situations a minimum distance of 2m must be established at all times.

CONCRETE PUMP
RESTRICTED ZONE

Red Zone: Authorised Person only (pump operator) - this zone must include barriers to demarcate the area. 2m controlled zone from the outer edge of the concrete vehicle when reversing.

Green Zone: Always signal 'Thumbs up' to the pump operator and or concrete delivery driver and receive a positive 'Thumbs up' response before entering. Keep in driver's line of site when reversing the truck, always get the 'Thumbs up' before entering Red Zone.

360° EXCAVATOR
(TRACKED OR WHEELED)
RESTRICTED ZONE



Red Zone: To be determined by the boom length and slew radius. No personnel to enter area unless the attachment is on the ground and the machine is placed in a safe condition.

Green Zone: Safe area - Plant Operators line of sight. Always signal 'Thumbs up' to the Plant Operator and receive a positive 'Thumbs up' response before entering Red Zone.

Note: The slew radius of the machine will vary dependant on the machine type and size.

MEWP (BOOM)
RESTRICTED ZONE

Red Zone: Keep out of this area at all times. Except in emergency situations.

Green Zone: Always signal a 'Thumbs up' to the Plant Operator and receive a positive 'Thumbs up' response before entering Red Zone.

Appendix B

Always

- Make sure you are fit for work
- STOP if anything changes
- Ensure exclusion zones are in place around all plant and machinery
- Have a daily briefing and diligently follow the method statement, lifting plan or permit

Never

- Use plant or equipment that is unfit for purpose
- Stand in a position of potential danger
- Walk by and ignore a hazard or unsafe act
- Undertake a task for which you are not trained or competent

Appendix C

Appendix D

A-squared Studio

Westgate, Cleckheaton, West Yorkshire

Rigid Inclusions Design Calculations

June 2026

3992-A2S-XX-XX-CA-Y-0001-03

Project Name	Westgate, Cleckheaton, West Yorkshire
Project Number	3992
Client	Van Elle Limited
Document Name	Rigid Inclusions Design Calculations

A-squared Studio Engineers Ltd
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www.a2-studio.com

Revision	Date	Prepared by	Checked by	Description	Level of Check (1, 2 or 3)	BS 5975 Level of Check
0	30.06.2025	Abubakar Sani	Ana Carvalho	First Issue	2	1
1	14.07.2025	Abubakar Sani	Ana Carvalho	Revised to latest RI layout	2	1
2	14.10.2025	Seth Furney	Ana Carvalho	Revised to latest wall drawings and RI layout	2	1
3	15.06.2026	Seth Furney	Ana Carvalho	Revised to latest RI layout	2	1

Internal Level of Checking

Check Level 1 is a general check by another member of the A-squared design team

Check level 2 is a check of principles and arithmetic by another member of the A-squared design team

Check level 3 is a fully independent design for comparison by another independent team either within A-squared or from another organisation

BS 5975 Level of Checking

Check Level 0 is a general check by another member of the A-squared design team

Check Level 1 is a check of principles and arithmetic by another member of the A-squared design team

Check level 2 is fully independent design for comparison by another independent team within A-squared

Check level 3 is a fully independent design for comparison by another team that is from another organisation

Contents

Appendices

1. Scope

A-squared Studio Engineers Ltd (A-squared) has been commissioned by Van Elle Limited (Van Elle) to undertake the detailed design of a rigid inclusion ground improvement solution for the proposed development at Westgate, Cleckheaton, West Yorkshire.

The project is centered on the construction of housing development at Westgate, Cleckheaton (referred to as “the site” in this document).

The site has been split into 4 areas based on former uses:

- Area A (1.1 ha in north-west) – Former Westgate Chemical works. Ward Fabrication currently occupies the north, with open rough ground to the south.
- Area B (1.7 ha, south) – Former Rolling Iron Mill and Wharfe Textile Mill, with an infilled reservoir in the west corner and Blacup Beck along the southern boundary. Most of the buildings have been demolished, with a small section of Wharfe Mill still occupied.
- Area C (2.0 ha, east) – Former scrap yard, malthouse, brickworks and quarry. Little evidence of former land use remains. The area is very uneven with a level change of approximately 5m between the south and north.
- Area D (1.6 ha, central and north) – Central industrial units occupied by Garnet Wires, in the central warehouse. Evidence of small units in the surrounding area, although all now at slab level. Car park located in the north.

Across Area C, the levels vary significantly by up to 6m, with steep embankments in the south-east where land is 3m to 6m lower than adjacent land to the north and west. Until recently, this area comprised mostly shrubs and trees, which have been cleared since the intrusive site investigation took place. There are remnants of brick and stone walls to former buildings on the southern boundary of the site, as well as the concrete slab to a former building in the east of the site, adjacent to the site boundary with Quarry Road.

As part of the enabling works, an earth bund (earth geogrid-reinforced retaining wall) is proposed to separate Area C from the rest of the site. The south-westernmost extent of the proposed earth geogrid-reinforced retaining wall being located at the eastern end of Area B. The southernmost extent of the proposed wall coincides with the eastern end of the recently demolished Wharfe Mill building and external yard area, which both stand higher than the adjoining land to the east.

The approximate location of the proposed earth geogrid-reinforced retaining wall is shown in Figure 1.1. As a result of the difference in retained heights ranging between 2.5m and 4.6m, the geogrid-reinforced wall has been subdivided into three sections comprising Section A, Section B, and Sections C. See Figure 1.1 for the locations of the sections in plan.

Area-specific ground investigation works carried out by Sirius Geotechnical Limited in 2024 indicated the presence of significant depths of Made Ground, to depths ranging between 0.9m and 9.5m below ground level at the location of the proposed geogrid-reinforced earth retaining wall. The Made Ground is variable, typically comprising interbedded layers of granular and cohesive materials, but presence of soft to firm slightly gravelly sandy clay was recorded in places.

Thus, as part of the foundation for the geogrid-reinforced earth retaining wall, ground improvement foundation solutions (in the form of rigid inclusions) are required.

The rigid inclusions are designed with a diameter of 320mm and are to be constructed using a displacement auger.

A load transfer platform (LTP) will be required to install the rigid inclusions required on this site. It is assumed that the LTP will have a minimum thickness of 500mm. The design of the LTP is by others and is outside the scope of A-squared. The design of the PPL is

to be undertaken by a competent contractor in accordance with a detailed earthworks specification (to be prepared by others and in accordance with the requirements of this design).

The rigid inclusions shall terminate at the underside of the LTP.

It is noted that earthworks will be carried out involving cut and fill across the site. The earthwork exercise is required to regrade or backfill the current/design ground level to tie-up with the top level of the geogrid-reinforced earth retaining wall. The design of the earthworks and the geogrid-reinforced wall is by others.

It is noted that there will be settlement associated with the regrading/filling exercise and the construction of the geogrid-reinforced wall. The settlement expected during construction activities will be built out for the geogrid-reinforced earth retaining wall footprint and immediate area behind the wall, but this report does not include the analysis of full area of filling across the site. It is assumed that there are no other causes of additional ground settlement associated with dewatering, poor compaction of backfill and LTP, or heave caused by the rigid inclusion installation inducing excess pore water pressures.

Note that the ground improvement design is primarily driven by SLS considerations and so all computed settlement predictions are mainly dependent upon adopted ground stiffness parameters, which have some inherent degree of variability. Moderately conservative assumptions have been made selecting these parameters, to mitigate this risk.

This is a contractor designed element of the works.

The design has been classified as being Geotechnical Category 2 in accordance with BS EN 1997-1.

A detailed CDM risk assessment for the proposed rigid inclusions works is provided in Appendix A: . The Client & Designer for this project are subject to certain duties under the CDM Regulations.

Figure 1.1 Layout of the Proposed Earth Geogrid- Reinforced Wall

2. Relevant Documentation

The followings documents and drawings have been used to undertake the settlement analysis of the proposed rigid inclusions:

2.1. Documents

- Lithos Consulting Limited's Geoenvironmental Appraisal doc. ref. 3043/2D (July 2023)
- Sirius Geotechnical Limited's Updated Factual Site Investigation Letter Report doc. ref. C9907A/AMG/10556 (July 2024)

2.2. Drawings

- Geoman Limited's Lock+Load Wall 03 Elevation doc. ref. SK24-5558-F1-04. Rev. D
- Geoman Limited's Lock+Load Wall 03 Cross-Sections doc. ref. SK24-5558-F1-05. Rev. D
- Strata Limited's Site Layout doc. ref. BY00099-STH-B01-XX-DR-A SL001. Rev R
- Sirius Limited's Indicative Extent of Ground Improvement Beneath Retaining Walls doc. ref. SR3975. Rev 0
- Van Elle – Rigid Inclusion Layout ref. 241261-VE-00-FN-DR-X-0001 P4
- Strata – Van Elle Top of Platform Levels rf. BY000-STH-B01-XX-DR-S-1005 Rev. A

3. Rigid Inclusion Design Requirements

Design in accordance with BS EN 1992-1-1 and BS EN 1997-1 and ASIRI guidance document *Recommendations for the Design, Construction and Control of Rigid Inclusion Ground Improvements*.

- Rigid inclusions to be constructed with a 320mm diameter displacement auger.
- C16/20 concrete to be used.
- The thickness of the unreinforced granular LTP is to be 500mm.
- Maximum settlement of the geogrid-reinforced earth retaining wall assumed to be, 25mm total (only loading induced settlements evaluated for the wall footprint).

Rigid inclusions are not piles but are a ground improvement technique using higher vertical stiffness columns constructed through compressible soils to reduce overall settlement and increase bearing capacity. The pile design sections within BS EN 1997-1 and BS 8004:2015 are not applicable to rigid inclusions.

Ground improvement efficiency depends on the stiffness relationship between the ground and the rigid inclusions. Load from the structure is distributed to the soil and rigid inclusions via an LTP. This is thus a soil-structure interaction problem and so the analysis requires the use of complex analytical computations.

If there is ongoing consolidation of the weak soils, either naturally as a recent deposit or due to a change in loading conditions from (e.g.) raising ground level or lowering the groundwater level, then this will introduce additional loadings into the rigid inclusions and induce additional settlements of the LTP. The performance of the rigid inclusions is thus intimately linked to the performance of the overlying platform, along with any change to the existing in-situ conditions.

The design of the geogrid-reinforced earth retaining wall is not in A-squared's scope. It is recommended that the designer of the geogrid-reinforced earth retaining wall considers the allowable total settlement in their design.

4. Adopted Ground Model

Information from the site-specific ground investigations conducted by Sirius Geotechnical Limited and Lithos Consulting Limited have been used to develop the ground model and geotechnical parameters used in this design. The plots of the relevant borehole showing the SPT_{N60} data are shown in Appendix B: .

The proposed ground model is based on the available site investigation information, laboratory testing, technical literature, and previous experience in the local area.

Values for drained Young's Modulus (E') for the Made Ground and weathered Sandstone (recovered as Gravel) is based on the consideration of CIRIA Report C143 as:

$$E' = 2N_{60}$$

Values for drained Young's Modulus (E') for the intact Sandstone is based on the CIRIA Report C181.

The ground model and geotechnical parameters adopted for the purpose of the design are summarised in the table below. If the ground conditions on site are not as expected within this design, then A-squared must be contacted immediately and the design must be revised.

Table 4.1 Geotechnical Parameters for Ground Improvement Design

Stratum	Top of Layer (mOD)	Thickness (m)	Bulk Unit Weight (kN/m^3)	Angle of Shearing Resistance, ϕ' (degrees)	Drained Cohesion, c' (kPa)	Drained Young's Modulus, E' (MPa)
Load Transfer Platform/ Piling platform material	Varies	0.50	20	40	-	60
Made Ground	EGL	Varies	18	27	-	8
extremely weak Sandstone recovered as Gravel	+85.50	2.00	20	40	-	100
very weak - medium strong - strong Sandstone	+83.50	23.5 [1]	20	45[2]	10[2]	215 [3]

[1] The rigid boundary for this model has been taken at +60.00mOD.

[2] Parameters calculated in accordance with Hoek & Brown 2002.

[3] Stiffness in calculated is as per CIRIA Report C181

The design groundwater level adopted for the purpose of this analysis is taken at the conservative level of +92.00mOD.

In addition to the soil parameters presented in Table 4.1, the properties of the fill material behind the wall and the geogrid-reinforced earth retaining wall are also required for the carrying out the assessment on this scheme.

Considering the design of the fill material and the geogrid-reinforced earth wall are not the responsibility of A-squared, an assumption has been made for the properties of these materials and presented in Table 4.2 below. The characteristic parameters for these materials are proposed and that the actual designers of these elements need to ensure that the materials are designed with strength and stiffness properties that is equal or higher than considered in this design.

Table 4.2 Assumed Geotechnical Parameters for the Fill Material and the Geogrid-reinforced Retaining Wall

Stratum	Thickness (m)	Bulk Unit Weight (kN/m^3)	Angle of Shearing Resistance, ϕ' (degrees)	Drained Young's Modulus, E' (MPa)
Fill Material	Varies	19	28	8
Geogrid-reinforced Retaining Wall	Varies	20	-	100

It should be noted that the Geogrid-reinforced earth retaining wall has been modelled as a non-porous linear elastic material.

Also, the thickness of the fill material and the geogrid-reinforced retaining wall varies across the different sections considered in design.

5. Design Philosophy

The SLS performance of the rigid inclusions is investigated using the soil-structure interaction software Plaxis 2D. All analyses are undertaken using drained stiffness parameters for the soils and, as such, represent the long-term settlement that would be expected under the specified loading.

5.1. Plaxis 2D Plane Strain Analysis of Rigid Inclusions

To determine the performance of the rigid inclusions under the geogrid-reinforced earth retaining wall, a Plaxis 2D plane strain analysis is used to represent the foundations. In this scheme the diameter of the inclusions is predefined and hence the analysis is used to determine the centre to centre spacing (c/c) and the optimum length of the rigid inclusions such that the settlement criteria are met. Given that the inclusions would be laid out in a square grid, the plane strain analysis considers structural embedded beam elements to represent the rigid inclusions instead of soil volume cylindrical elements. This is deemed most suitable in order to determine any lateral pressure being applied to the rigid inclusion as a result of the earthworks fill behind the geogrid-reinforced earth retaining wall.

5.1.1. Rigid Inclusions beneath Structures

To determine the performance of the rigid inclusions under the geogrid-reinforced earth retaining wall, a Plaxis 2D plane strain analysis is used. Rigid inclusions are to be constructed using a 320mm diameter displacement auger which displaces soil and hence the relative friction between the rigid inclusion and soil is assumed to be 1.0. Figure 5.1 shows the plane strain model developed in Plaxis 2D for the different wall sections.

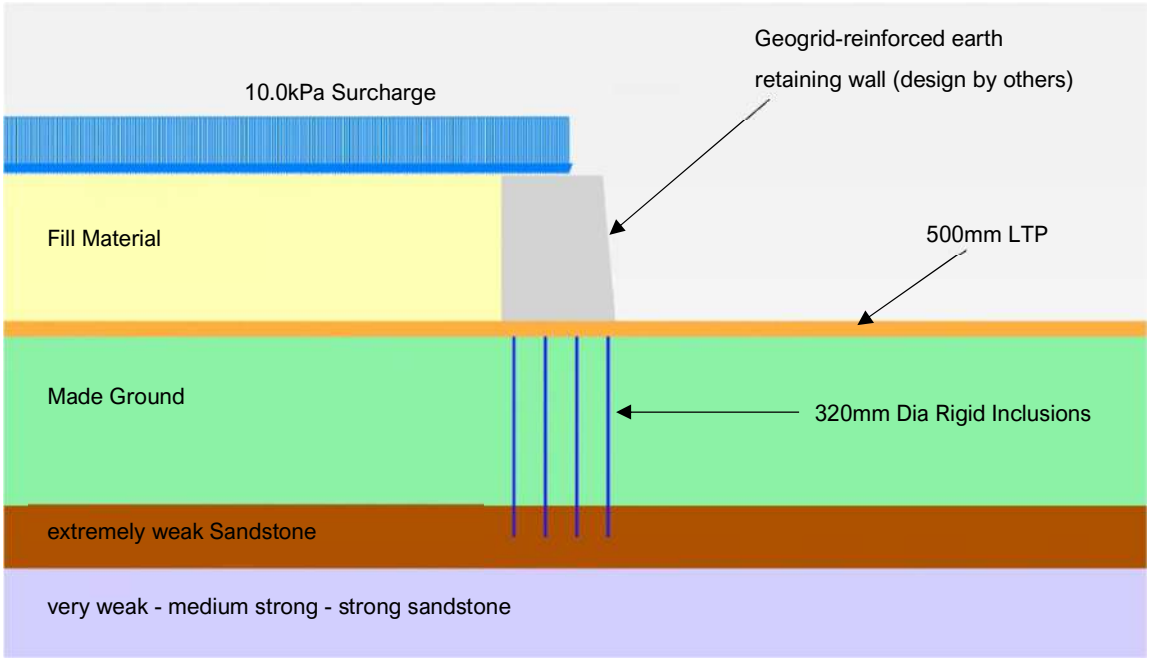

Figure 5.1 Plaxis 2D Plane Strain model of Rigid Inclusion

The rigid inclusions transfer the load from the Load Transfer Platform to stiffer layers below. The calculated c/c spacing and embedment lengths of the inclusions beneath the LTP are detailed in Table 5.1 below.

Table 5.1 Average rigid inclusions spacing and lengths

Area	Assumed Top of Reinforced Wall (mOD)	Assumed Top of LTP (mOD) [1]	Reinforced Wall Height (m)	Surcharge (kPa)	No. rows of inclusions along width of wall (m)	Centre to centre spacing of inclusions along wall linear length (m)	Rigid inclusion length below the base of the LTP (m)
Section A	96.000	91.37 to 91.57	4.63	10	3	1.49	7.00
Section B	96.000	92.170	3.83	10	3	1.53	7.00
Section C	95.470 to 97.00	92.17 to 95.02	3.30	10	2	1.53	7.00

Note: Top of rigid inclusions at 0.5m below top of LTP for all sections

5.1.2. Analysis in accordance with DA-1 (BS EN 1997-1, 2004)

The ULS performance of the rigid inclusions beneath the slab are also investigated by re-analysing the Plaxis 3D model with factored actions and soil resistance, and this geotechnical design resistance calculated in accordance with Design Approach DA-1 as described in BS EN 1997-1 (2004).

Combination 1: A1 “+” M1 “+” R1.

Combination 2: A2 “+” M2 “+” R1.

where “A” is the partial factor for the action, “M” for the material and “R” for the resistance.

Calculations have been undertaken for Combinations 1 & 2 using the partial factors provided in Table 5.2 below.

Table 5.2 EC7 Partial factors

DA-1 (UK National Annex)	Combination 1	Combination 2
Permanent action	1.35	1.0
Variable action	1.5	1.3
Angle of shearing resistance $\tan\phi'$ γ_ϕ (coarse grained soils)	1.0	1.25
Cohesion, c’	1.0	1.25
Undrained shear strength γ_{cu} (fine grained soils)	1.0	1.4
Resistances	1.0	1.0

The ULS GEO performance of the ground improvement is assessed to check the stability of the ground against failure while considering that the rigid inclusions only serve to control the settlements. Hence, a DA-1 Combination 2 analysis is run in Plaxis 2D to ensure that there is no geotechnical instability of the existing/improved ground due to the earthworks exercise.

A bearing capacity calculation has been carried out using an inhouse excel spreadsheet to determine the allowable bearing capacity of the LTP material and Made Ground to support the applied surcharges of the fill material and the geogrid-reinforced wall.

In addition, ULS STR checks are carried out on the rigid inclusions themselves to ensure that they have sufficient compression capacity to support the Combination 1 loadings (Section 7.2).

6. Results

6.1. Plaxis 2D Plane Strain SLS Results

The performance of the geogrid-reinforced earth retaining wall under an applied surcharge of up to 10kPa has been analysed using Plaxis 2D software as a plane strain model. The as-built diameter of the inclusions is expected to be at least 320mm. It is important to note that, as part of the design requirement, the maximum allowable long-term settlement of the geogrid-reinforced earth retaining wall is 25mm.

Thus, only the settlements induced by loading of the existing ground are evaluated (i.e. no consideration of additional settlements from earthworks or within the geogrid-reinforced retaining wall has been accounted for). The results of the predicted settlements are presented in Appendix C: and summarised below in Table 6.1.

Table 6.1 Summary of Plaxis 2D Results

Area	Assumed Top of Reinforced Wall (mOD)	Assumed Top of LTP (mOD) [1]	Design surcharge (kPa)	No. of rows of inclusions along width of wall (m)	Centre to centre spacing of inclusions along wall linear length (m)	Rigid inclusion length below the base of the LTP (m)	Maximum computed settlement (mm)
Section A	96.000	91.370	10	3	1.49	7.00	15.0
Section B	96.000	92.170	10	3	1.53	7.00	7.0
Section C	95.470	92.170	10	2	1.53	7.00	6.0

[1] LTP to be 0.500m thick

[2] Settlement from loading only has been evaluated

6.2. Plaxis 2D Plane Strain ULS Results

In addition to the SLS analyses, Plaxis 2D ULS analyses were carried out to investigate the geotechnical performance of the geogrid-reinforced wall/LTP/rigid inclusion system against failure.

The final design arrangement is also run in Combination 2 according to DA-1 of BS EN 1997-1 (2004). The applied load on the backfill is assumed to be variable. The calculated stresses for the ULS C2 analyses were compared to the allowable bearing capacities of the LTP and the Made Ground. The calculated allowable bearing capacity of the LTP and Made ground were found to be greater than the stresses observed in Plaxis. Thus, are deemed adequate. See the results output of stress distribution with depth for the ULS C2 from Plaxis and the bearing capacity calculations in Appendix C: and Appendix D: respectively.

Furthermore, the analyses also considered a check on Combination 1 design approach in accordance to DA-1 of BS EN 1997-1 (2004). This check was carried out to determine the structural forces and bending moment within the rigid inclusions induced as a result of the earthworks exercise.

It is important to note that this design does not take consideration of additional settlements due to the earthworks fill/cut to be carried out during the construction program.

Results are presented in Appendix C: and the summarised results for C1 structural checks are given in Table 6.2.

The ULS C2 checks demonstrate that the foundation system meets the GEO requirements for stability. Installation of the rigid inclusions to control settlements is demonstrated to be effective (i.e. the criteria are now met) by the SLS checks.

Whilst these predictions satisfy the design requirements, the actual performance will be primarily related to the stiffness of the ground as well as to the length and spacing of the inclusions, and the characteristics of the platform and geogrid-reinforced wall. Also, the loading pattern and arrangement, and whether all areas are fully loaded at the same time will be important and is not within the control of Van Elle.

Table 6.2 Summary of Plaxis 2D ULS C1 Results

Area	Reinforced Wall Height (m)	Axial Load (kN)	Bending Moment (kNm)	Shear Force (kN)
Section A	4.63	101.7	11.5	14
Section B	3.83	86.0	5.0	5
Section C	3.30	52.0	3.9	4

7. Structural Calculations

7.1. Concrete Strength

Once drilled to the required length, the rigid inclusions will be filled with a minimum C16/20 at 28 days concrete (with a maximum aggregate size of 20mm).

7.2. Compression Capacity

In accordance with BS EN 1992-1 the design concrete compression resistance of the proposed inclusions is calculated to be 468kN (Appendix E:).

The maximum load on an individual inclusion is 102kN (from Table 6.2 above). This is less than the calculated design compression resistance, assuming C16/20 concrete is used.

The STR resistance of the inclusions is greater than the maximum DA1-C1 structural loads computed, therefore any inclusion can safely resist the axial structural compressive actions.

7.3. Structural Bending Capacity

The plain concrete section has been checked in accordance with BS EN 1992-1 for the bending moment and axial load in Table 6.2 in Oasys Adsec 10 and considered adequate, as per calculations shown in Appendix E: .

7.4. Aggressivity Assessment

It is noted that several samples were taken to determine the sulphate concentration across the site as reported in the Lithos Ground Investigation Report. However, none of the trial pits where the samples were taken are located near the geogrid-reinforced earth retaining wall. Nonetheless, the Lithos Ground Investigation Report states that the concrete for areas B, C (location of the geogrid-reinforced wall), and D must be designed for a Design Sulphate Class of DS-3 and an ACEC class of AC-5.

8. Design Summary

A-squared Studio Engineers Ltd (A-squared) has been commissioned by Van Elle Limited (Van Elle) to undertake the detailed design of a rigid inclusion ground improvement solution for the proposed development at Westgate, Cleckheaton, West Yorkshire.

The project is centered on the construction of housing development at Westgate, Cleckheaton (referred to as “the site” in this document).

The site has been split into 4 areas based on former uses:

- Area A (1.1 ha in north-west) – Former Westgate Chemical works. Ward Fabrication currently occupies the north, with open rough ground to the south.
- Area B (1.7 ha, south) – Former Rolling Iron Mill and Wharfe Textile Mill, with an infilled reservoir in the west corner and Blacup Beck along the southern boundary. Most of the buildings have been demolished, with a small section of Wharfe Mill still occupied.
- Area C (2.0 ha, east) – Former scrap yard, malthouse, brickworks and quarry. Little evidence of former land use remains. The area is very uneven with a level change of approximately 5m between the south and north.
- Area D (1.6 ha, central and north) – Central industrial units occupied by Garnet Wires, in the central warehouse. Evidence of small units in the surrounding area, although all now at slab level. Car park located in the north.

Across Area C, the levels vary significantly by up to 6m, with steep embankments in the south-east where land is 3m to 6m lower than adjacent land to the north and west. Until recently, this area comprised mostly shrubs and trees, which have been cleared since the intrusive site investigation took place. There are remnants of brick and stone walls to former buildings on the southern boundary of the site, as well as the concrete slab to a former building in the east of the site, adjacent to the site boundary with Quarry Road.

As part of the enabling works, an earth bund (earth geogrid-reinforced retaining wall) is proposed to separate Area C from the rest of the site. The south-westernmost extent of the proposed earth geogrid-reinforced retaining wall being located at the eastern end of Area B. The southernmost extent of the proposed wall coincides with the eastern end of the recently demolished Wharfe Mill building and external yard area, which both stand higher than the adjoining land to the east.

Area-specific ground investigation works carried out by Sirius Geotechnical Limited in 2024 indicated the presence of significant depths of Made Ground, to depths ranging between 0.9m and 9.5m below ground level at the location of the proposed geogrid-reinforced earth retaining wall. The Made Ground is variable, typically comprising interbedded layers of granular and cohesive materials, but presence of soft to firm slightly gravelly sandy clay was recorded in places.

Thus, as part of the foundation for the geogrid-reinforced earth retaining wall, ground improvement foundation solutions (in the form of rigid inclusions) are required.

It is noted that earthworks will be carried out involving cut and fill across the site. The earthwork exercise is required to regrade or backfill the current/design ground level to tie-up with the top level of the geogrid-reinforced earth retaining wall. The design of the earthworks behind the wall and settlement prediction for the full area, and design of geogrid-reinforced wall is by others.

The rigid inclusions are designed with a diameter of 320mm and are to be constructed using a displacement auger. The rigid inclusions shall terminate at the underside of the LTP.

A load transfer platform (LTP) will be required to install the rigid inclusions required on this site. It is assumed that the LTP will have a minimum thickness of 500mm. The design of the LTP is by others and is outside the scope of A-squared. The design of the PPL is

to be undertaken by a competent contractor in accordance with a detailed earthworks specification (to be prepared by others and in accordance with the requirements of this design).

Thus, this design can be summarised as:

- Rigid inclusion diameter is proposed to be 320mm and to be installed using a displacement auger.
- The spacing and lengths of the rigid inclusions are summarised in Table 6.1. and layout presented in Appendix G.
- Maximum predicted settlement of the wall is 16mm.
- Minimum C16/20 concrete, DS-3 AC-5 concrete class recommended as per the Lithos Ground Investigation Report .

Furthermore, the following points should be noted for the granular Load Transfer Platform beneath the geogrid-reinforced wall:

- 500mm minimum thickness.
- A CBR compaction value of no less than 15% for the underlying layer of 500mm or more.
- Design angle of friction of granular platform material at least 40 degrees after compaction.
- Less than 15% fines.
- Free of organic matter.
- Los Angeles abrasion coefficient less than 35.
- Minimum 95% optimum dry density after compaction.
- Particle size distribution to be well graded with a maximum particle size of 75mm.
- A separation layer (Terram 1000 or equivalent geotextile layer) to be placed beneath the granular platform on top of the subgrade.
- Installation operations shall be supervised as appropriate in order to ensure platform distribution and requirements are as per the design intent. An appropriate installation and compaction methodology shall be provided in general accordance with the MCHW.
- Installation, testing of platform material and testing of platform performance shall be undertaken by the Contractor in order to meet the specified stiffness criteria in this document. A method statement covering all of these aspects shall be provided for review prior to commencement of the works.
- The Contractor shall provide and maintain drainage to prevent the build-up of groundwater within the platform over its design life.

Other points to note:

- If needed, trimming of the inclusions shall be undertaken so as not to damage them and to leave a horizontal head over which the LTP can be reinstated.
- Any expansive/ soft/ loose soils within the ground to be removed in entirety and replaced with a competent granular fill material.
- Piling contractor to use adequate rig in order to ensure that rigid inclusions are installed to the designed depth and to a competent stratum.
- Obstructions within the ground to be removed and any excavations backfilled with compacted granular fill – positions to be recorded and made available to all parties.
- Temporary piling platform design is by others or not covered in this report. This may be reused as the permanent load transfer platform provided the load transfer platform can be demonstrated to be of the required strength and stiffness over its full volume after completion of the installation of the rigid inclusions.

- Similarly, the piling platform may be locally removed and then replaced to facilitate the trimming of the head of the inclusions, provided the load transfer platform can be demonstrated to be of the required strength and stiffness over its full volume after completion of the installation of the rigid inclusions.
- Inclusions may be integrity tested by 300mm plate load testing directly on top of an inclusion, prior to construction of the granular platform or reinforced concrete foundation.
- A suitable testing regime should be implemented across the site, to verify the design assumption in relation to LTP and rigid inclusions. This may include the following:
    - Testing of concrete cubes at 1 set per shift/75m^3.
    - 1 No. Plate load test per 100 rigid inclusions.
- No significant raising of ground levels (other than those already accommodated) is permitted without the design of the rigid inclusions being re-evaluated.
- No permanent lowering of groundwater is permitted without the design of the rigid inclusions being re-evaluated.
- It is to be noted that this design does not provide an assessment of any possible impacts of the earthworks and inclusions activities on any buildings, assets or utilities within the vicinity of the site.
- Any departure/deviation from the design assumptions shall be raised with the designer immediately (prior to resuming site work).
- Note that the assessment described in this document assumes uniform loading across a continuous wall surface and does not take into account the actual real life loading patterns, including patch loads and/or point loads. Neither does it take into account the influence of joints along the wall length and edge effects, and similar.
- Total observed settlement of the geogrid-reinforced wall will be the relative geogrid-reinforced wall settlement into the load transfer platform plus the settlement of the rigid inclusion platform.

Appendix A: Designer's Risk Assessment

A-squared Studio

Designers Risk Assessment

Project Name:	Westgate, Cleckheaton, West Yorkshire	**Rev.**	00	**Date:** 14/07/2025
Title	Designers Risk Assessment			
Fatal Risks:	Plant - Person Interface Overturning of Plant Lifting Operations	Third Parties / Public Existing Services Uncontrolled Excavations		
Project No:	3992			
Designer	Abubakar Sani			
Checker	Ana Carvalho			

RISK ASSESSMENT

LIKELIHOOD (L) \ SEVERITY (S)	S5	S4	S3	S2	S1
L5	25	20	15	10	5
L4	20	16	12	8	4
L3	15	12	9	6	3
L2	10	8	6	4	2
L1	5	4	3	2	1

RISK DESCRIPTIONS

RISK INDEX	DEFINITION
17 to 25	Complete re-design required.
10 to 16	The risk is intolerable. Further design alternatives should be assessed
4 to 9	The risk is on the border line of acceptability. Design alternatives must be assessed
3	The risk is just tolerable. Design alternatives need to be investigated.
1 to 2	The risk is tolerable. No further analysis of design alternatives is necessary.

LIKELIHOOD (L)	L5	L4	L3	L2	L1
	HIGHLY LIKELY	PROBABLE	POSSIBLE	UNLIKELY	HIGHLY UNLIKELY

SEVERITY (S)	S5	S4	S3	S2	S1
Structure	Major collapse	Partly collapse	Failure	Distress	Acceptable
Safety	Multiple fatality	Major injury / single fatality	Injury or illness	Minor injury	No injury

Ref.	Stage (Construction, Operational or Maintenance)	Hazard	Possible consequences without mitigation	Risk			Design Action / Control Measures	Residual Risk			Residual Risk	Risk Owner	Comments / Actions
				L	S	Risk		L	S	Risk			
Specific risks related to the design													
1	Maintenance	Significant thickness of Made Ground material being greater than considered in design	Settlement of the geogrid-reinforced wall as a result of deeper Made Ground which may cause the allowable total settlement to be exceeded, thereby causing differential settlement along the wall linear length.	4	3	12	Rigid inclusion designer to be notified if Made Ground is found to be deeper than considered in design so the design can be updated accordingly.	3	3	9	Settlement limit of 25mm being exceeded if the Made Ground is deeper than considered in design.	Principal Contractor	Competent person to monitor rigid inclusions installation process
3	Construction	Ground being weaker than considered in design	Increased settlements of the fill and reinforced wall	4	2	8	Piling Contractor to ensure that a competent person monitors the rigid inclusions installation and that ground is not weaker than considered in design	3	2	6	Increased settlement if ground is weaker.	Piling Contractor	Competent person to monitor the rigid inclusions instalation process and notify the rigid inclusion designer immediately.
2	Construction	Groundwater being shallower or highly mobile than considered in design	Reduced bearing capacity which may also result in cement washout thereby affecting the concrete design strength.	3	2	6	Piling Contractor must ensure that the groundwater level is not higher/hhighly mobile than considered in design.	2	2	4	Reduced bearing capacity and concrete washout if groundwater is not as per considered in design	Piling Contractor	Competent person to monitor the piling process
5	Construction	Rigid inclusions reach design length before practical refusal due to variable ground conditions	Ground improvement fails to meet SLS loads and/or displacement requirements	3	2	6	Inclusions should be installed to practical refusal within the Sandstone formation	2	2	4		Piling Contractor	
6	Construction	Design compatibility inclusions	Specification for the rigid inclusions needs to be compatible with the specification and construction of the load transfer platform.	4	3	12	Specification for the rigid inclusions must be provided to the earthworks specifier and contractor.	3	3	9		Principal Contractor / Principal Designer	
7	Construction	Central reinforcement not installed in the rigid inclusions.	Induced bending moment in the rigid inclusions being higher than the bending resistance of the inclusion, thereby causing failure of the inclusion in bending.	4	3	12	Piling Contractor to ensure that a single B12 (500N/mm2) bar is installed in all inclusions to resist the induced lateral surchage from the fill material. The bar diameter can be increased for ease of plung in a concreted inclusion bore.	3	3	9	Failure of rigid inclusion as a result of the bending resistance being exceeded.	Principal Contractor / Principal Designer	Competent person to monitor and ensure rigid inclusions are installed with the required reinforcement.

A-squared Studio

Designers Risk Assessment

Project Name:	Westgate, Cleckheaton, West Yorkshire	**Rev.**	00	**Date:** 14/07/2025
Title	Designers Risk Assessment			
Fatal Risks:	Plant - Person Interface Overturning of Plant Lifting Operations	Third Parties / Public Existing Services Uncontrolled Excavations		
Project No:	3992			
Designer	Abubakar Sani			
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RISK ASSESSMENT

LIKELIHOOD (L) \ SEVERITY (S)	S5	S4	S3	S2	S1
L5	25	20	15	10	5
L4	20	16	12	8	4
L3	15	12	9	6	3
L2	10	8	6	4	2
L1	5	4	3	2	1

RISK DESCRIPTIONS

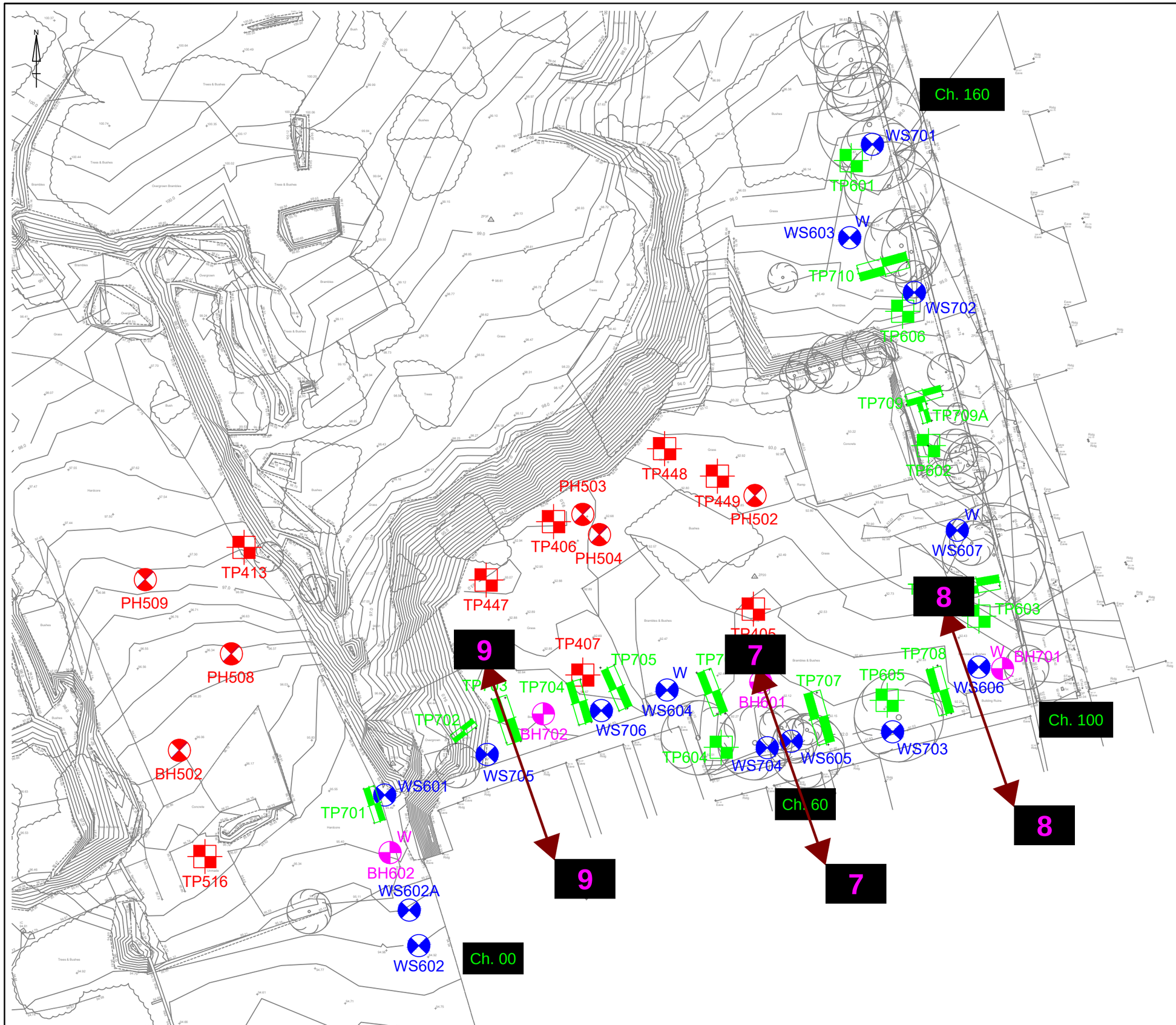
RISK INDEX	DEFINITION
17 to 25	Complete re-design required.
10 to 16	The risk is intolerable. Further design alternatives should be assessed
4 to 9	The risk is on the border line of acceptability. Design alternatives must be assessed
3	The risk is just tolerable. Design alternatives need to be investigated.
1 to 2	The risk is tolerable. No further analysis of design alternatives is necessary.

LIKELIHOOD (L)	L5	L4	L3	L2	L1
	HIGHLY LIKELY	PROBABLE	POSSIBLE	UNLIKELY	HIGHLY UNLIKELY

SEVERITY (S)	S5	S4	S3	S2	S1
Structure	Major collapse	Partly collapse	Failure	Distress	Acceptable
Safety	Multiple fatality	Major injury / single fatality	Injury or illness	Minor injury	No injury

Ref.	Stage	Hazard	Possible consequences	Risk			Design Action	Residual Risk			Residual Risk	Risk Owner	Comments / Actions
General construction risks related to the design													
4	Construction	Piling rig used in the platform design	Piling rig overturning	3	4	12	Piling Contractor to ensure piling rig type does not change.	2	4	8	Piling contractor still changes the piling rig without informing the platform designer	Principal Contractor	If piling rig changes the designer of the piling platform must be informed
5	Construction	Strength of subgrade affecting the stability of the piling platform	Piling rig overturning	3	4	12	Subgrade to be inspected. Excavation to be deepened if design strength not encountered.	2	4	8	Subgrade not inspected properly.	Principal Contractor	Competent persons to inspect the subgrade
6	Construction	Piling rig instability	Piling rig overturning	3	4	12	Adequate piling platform to be designed, constructed, tested and maintained.	2	4	8	Design not adequate. Construction, testing, maintenance not in accordance with best practice.	Principal Contractor	Competent person to design the platform. Competent contractor to construct, test and maintain the platform.
7	Construction	Use of piling rigs, plant or equipment	Damage of constructed piles	2	1	2	Piling rig etc to be used as planned and not to undertake any uncontrolled activities.	1	1	1	Affect the integrity of the piles.	Principal Contractor	Competent contractor to be used with trained operatives.
8	Construction	Services below ground level	Injury to persons or damage to plant	3	3	9	No works to commence until a permit to dig has been provided.	2	3	6	Unchartered services are encountered	Principal Contractor	Best practice to be followed.
9	Construction	Ensure no uncontrolled excavations for pile cap construction or for trimming of inclusions	Instability of temporary slopes	3	3	9	Contractor to ensure safe battered excavations within the piling platform material. Sides need to slope at a safe angle.	2	3	6	Excavation design not adequate.	Principal Contractor	Competent contractor to design and provide the safe excavation.
10	Construction	Breaking down inclusions	Injury to persons	3	3	9	Operatives to use methods, plant or equipment that does not put them at risk within an excavation.	2	3	6	Safe methods not followed.	Principal Contractor	Competent contractor to be used with trained operatives.
11	Construction	Manual work within excavations	Injury to persons	3	3	9	Manual work within excavations to be minimised as much as possible.	2	3	6	Safe methods not followed.	Principal Contractor	Competent contractor to be used with trained operatives.
12	Construction	Excavation access and egress	Injury to persons	3	3	9	Safe access and egress to the excavations to be detailed in a site specific plan.	2	3	6	Safe access / egress not used.	Principal Contractor	Competent contractor to be used with trained operatives.
13	Construction	Safe access to the inclusion for testing	Injury	3	3	9	Testing to be suitably programmed by the Principal Contractor prior to placing cap reinforcement. Contractor RAMS to incorporate.	2	3	6	Safe access / egress not provided or is concurrent with steel fixing activities.	Principal Contractor	To be planned properly.

Appendix B: Ground Investigation Data



KEY

Sirius 2023/4 Retaining Wall Investigation

- Trial Pit
- Windowless Sampler Borehole
- W Windowless Sampler Borehole with Groundwater Monitoring Well
- W Cable Percussion Borehole with Groundwater Monitoring Well

Previous Lithos Investigations

- TP Trial Pit
- PH Rotary Probehole
- BH Cable Percussion Borehole with Rotary Core Follow-on

Notes

1. This drawing should not be viewed in isolation from the accompanying report.
2. Lithos exploratory hole locations are approximate; see exploratory hole logs for co-ordinates.
3. Base topographical survey plan is Professional Surveying Drawing No. 50067_PSL_001_1, dated May 2020. Some site clearance has been undertaken since date of survey.

REVISION		BY	DATE
0	For Information	MF	05/12/23
A	Selected Lithos Borehole and Trial Pits Added	AMG	08/12/23
B	June 2024 Boreholes and Trial Pits Added	AMG	01/07/24
C	>>	>>	>>
D	>>	>>	>>

SIRIUS
GEOTECHNICAL LTD
4245 Park Approach,
Thorpe Park,
Leeds
LS15 8GB
www.thesiriusgroup.com
TEL: 0113 264 9960
FAX: 0113 264 9962

CLIENT

Strata Homes

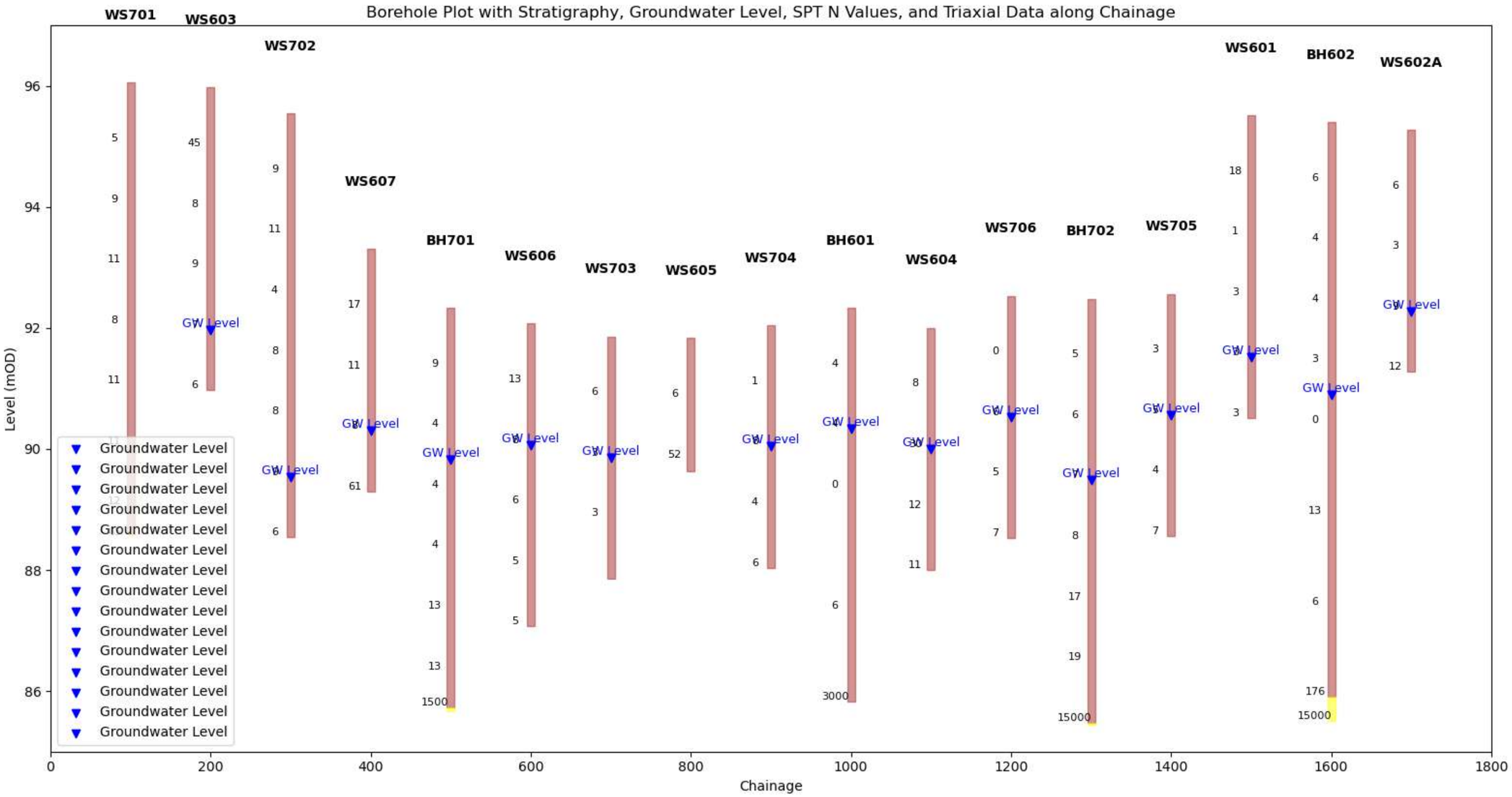
SITE

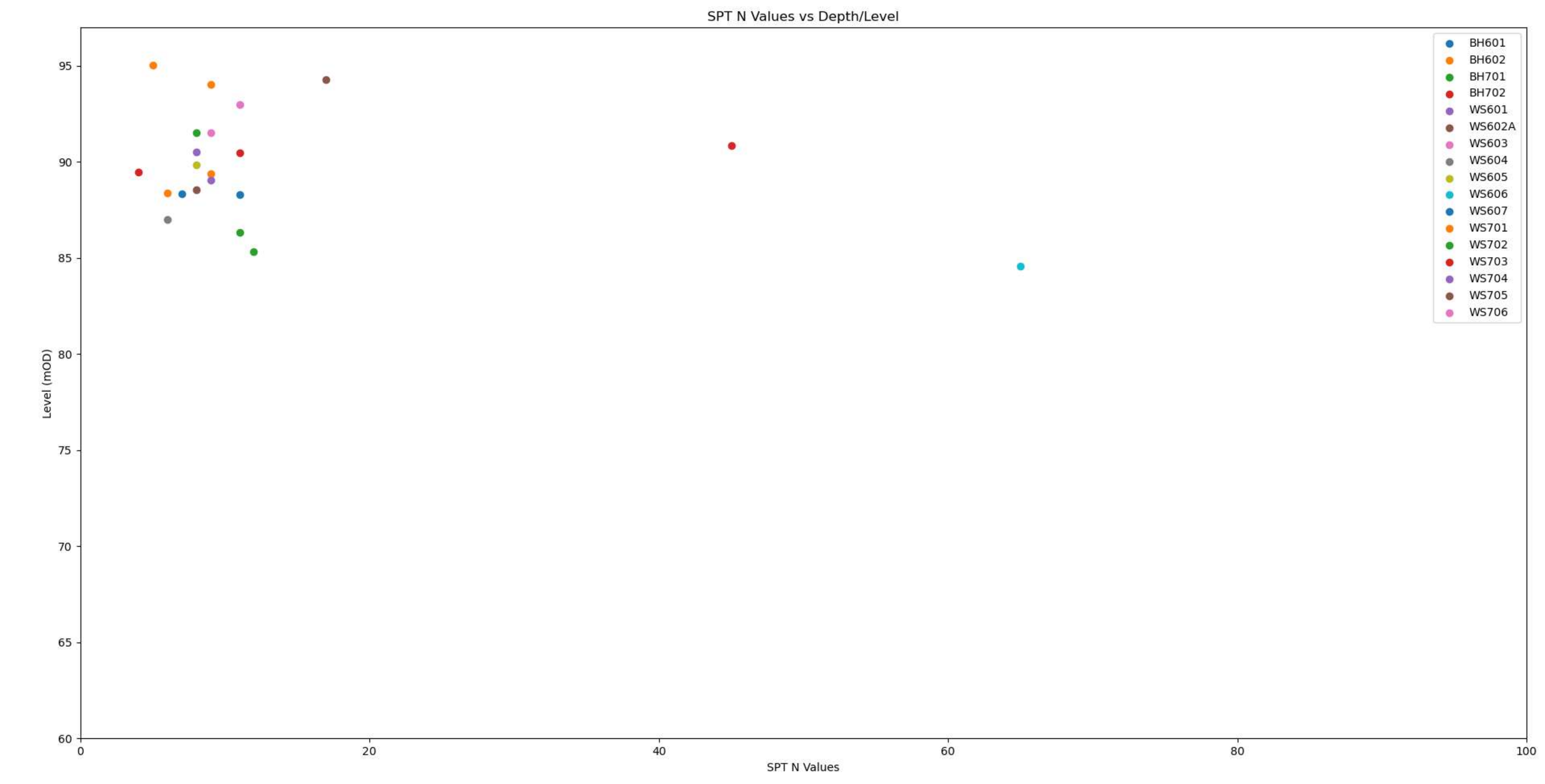
Land off Westgate, Cleckheaton

DRAWING TITLE

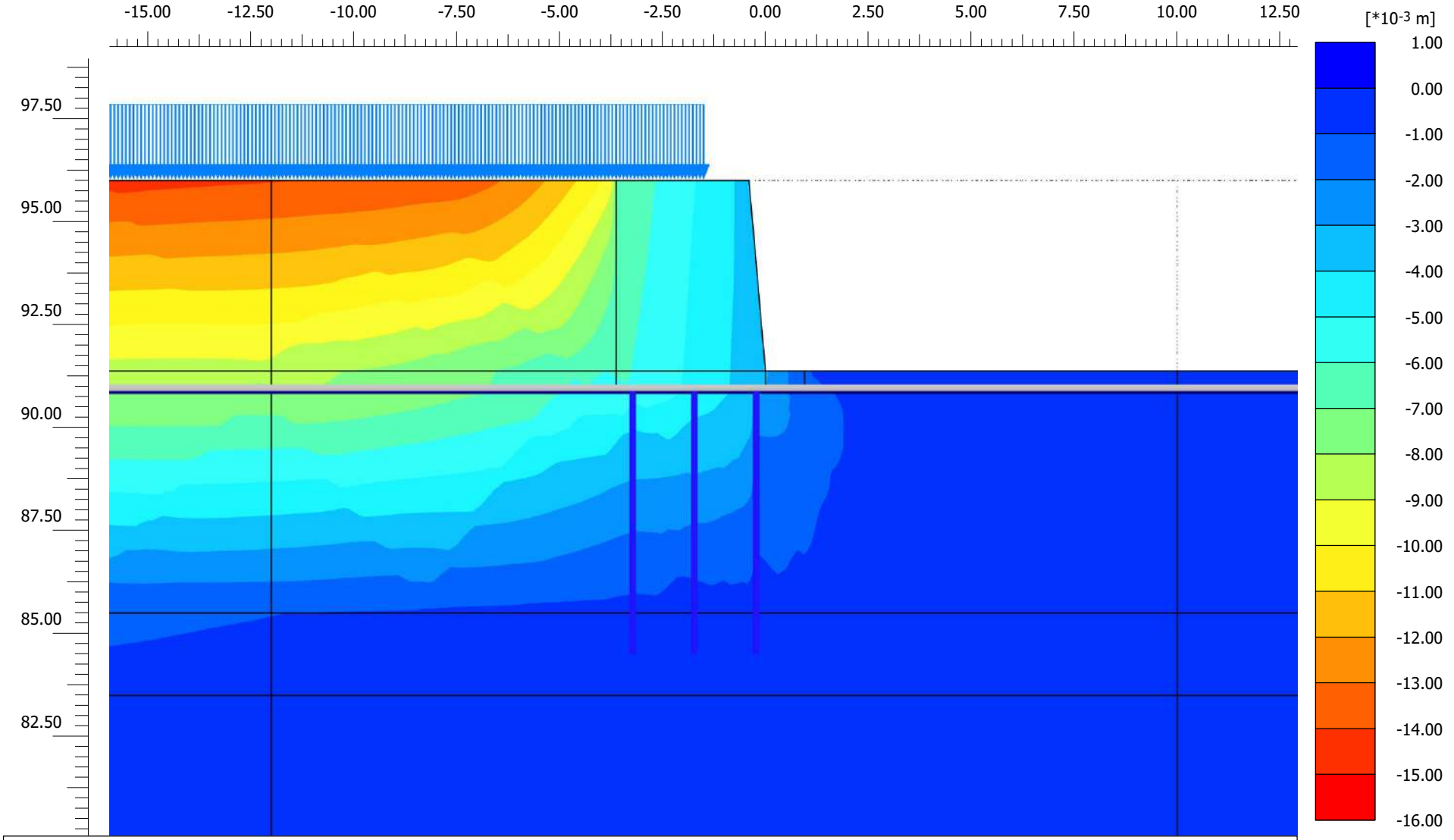
Exploratory Hole Location Plan

DRAWING NO.	REVISION NO.
C9907/02	B
DRAWN BY: MF	APPROVED BY: AMG
DATE: December 2023	SCALE: 1:500
PAPER SIZE: A3	


Borehole Plot with Stratigraphy, Groundwater Level, SPT N Values, and Triaxial Data along Chainage
WS701
WS603
WS702
WS607
BH701
WS606
WS703
WS605
WS704
BH601
WS604
WS706
BH702
WS705
WS601
BH602
WS602A
GW Level
Groundwater Level
Level (mOD)
Chainage
0
200
400
600
800
1000
1200
1400
1600
1800
86
88
90
92
94
96


SPT N Values vs Depth/Level
Level (mOD)
SPT N Values
95
90
85
80
75
70
65
60
0
20
40
60
80
100
BH601
BH602
BH701
BH702
WS601
WS602A
WS603
WS604
WS605
WS606
WS607
WS701
WS702
WS703
WS704
WS705
WS706

Appendix C: Plaxis 2D Output



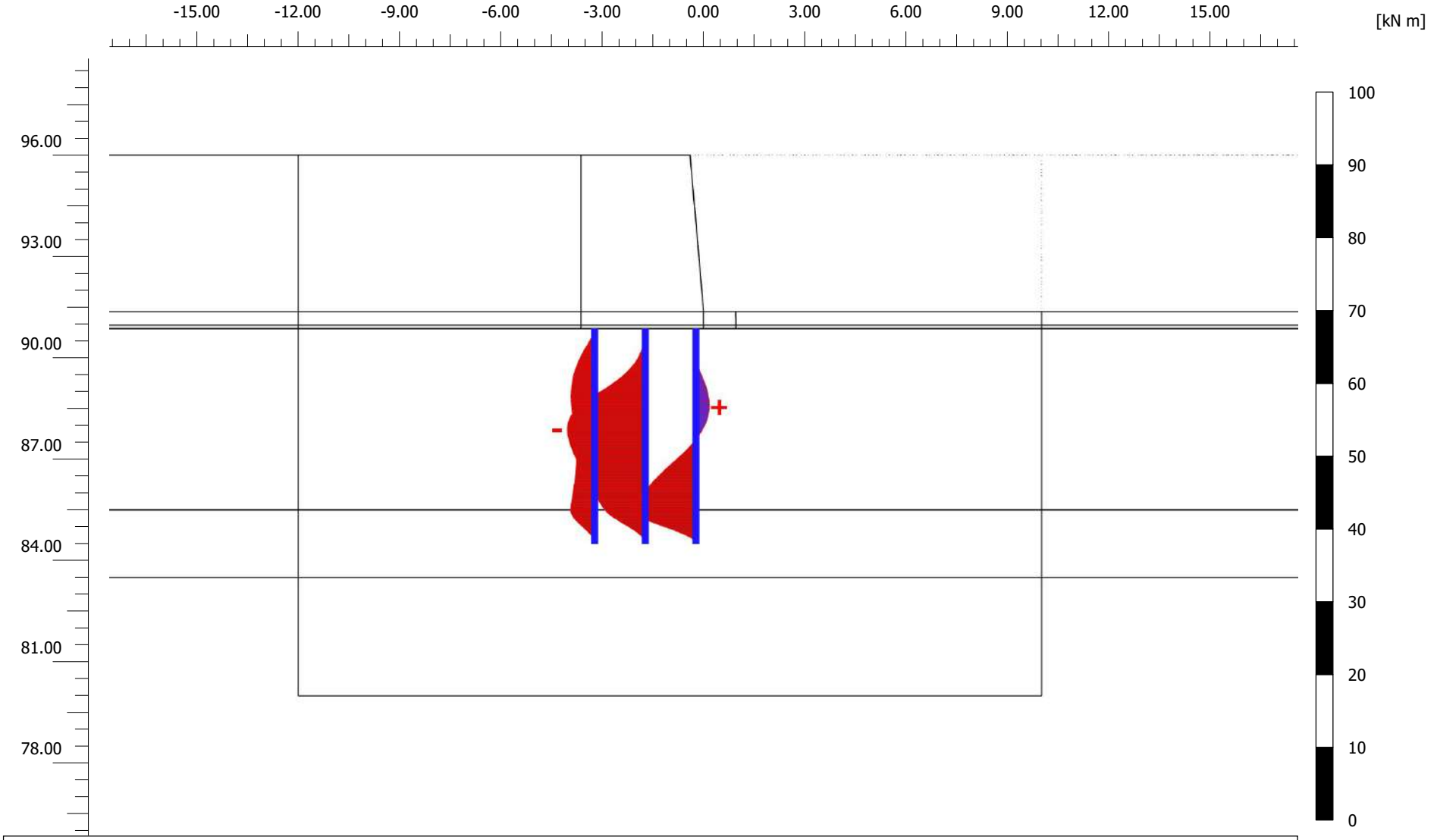
Total displacements u_y (scaled up 100 times)

Maximum value = 0.000 m (Element 11876 at Node 41123)

Minimum value = -0.01509 m (Element 758 at Node 289)

PLAXIS® 2D CONNECT Edition

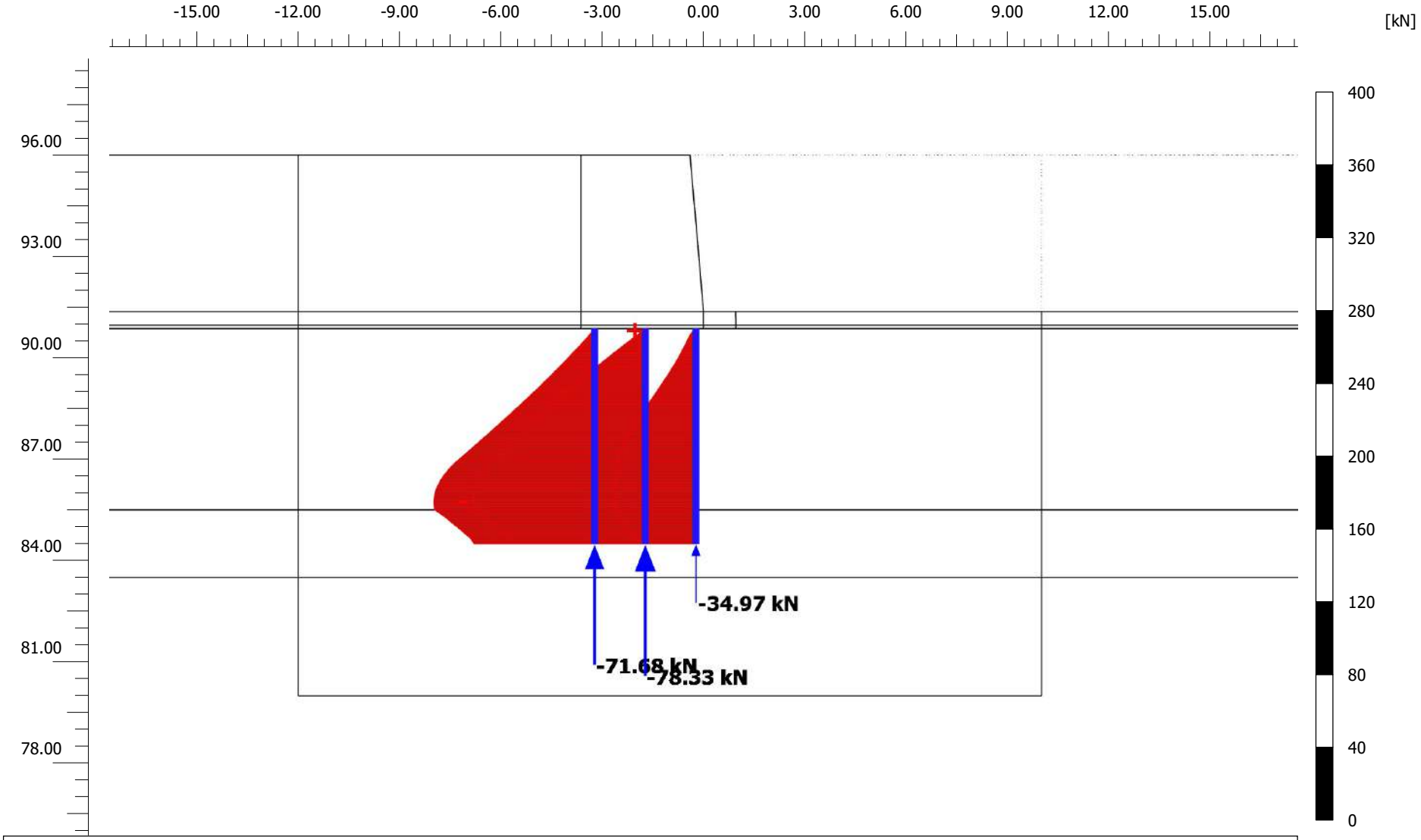
Project description Westgate, Cleckheaton (VE)			*Date* 16/10/2025
Project filename Section A_02	*Step* 7	*Company* A-Squared Studio Consulting Engineers	



Bending moments M (scaled up 0.200 times) per structural element

Maximum value = 1.966 kN m (Element 57 at Node 105701)

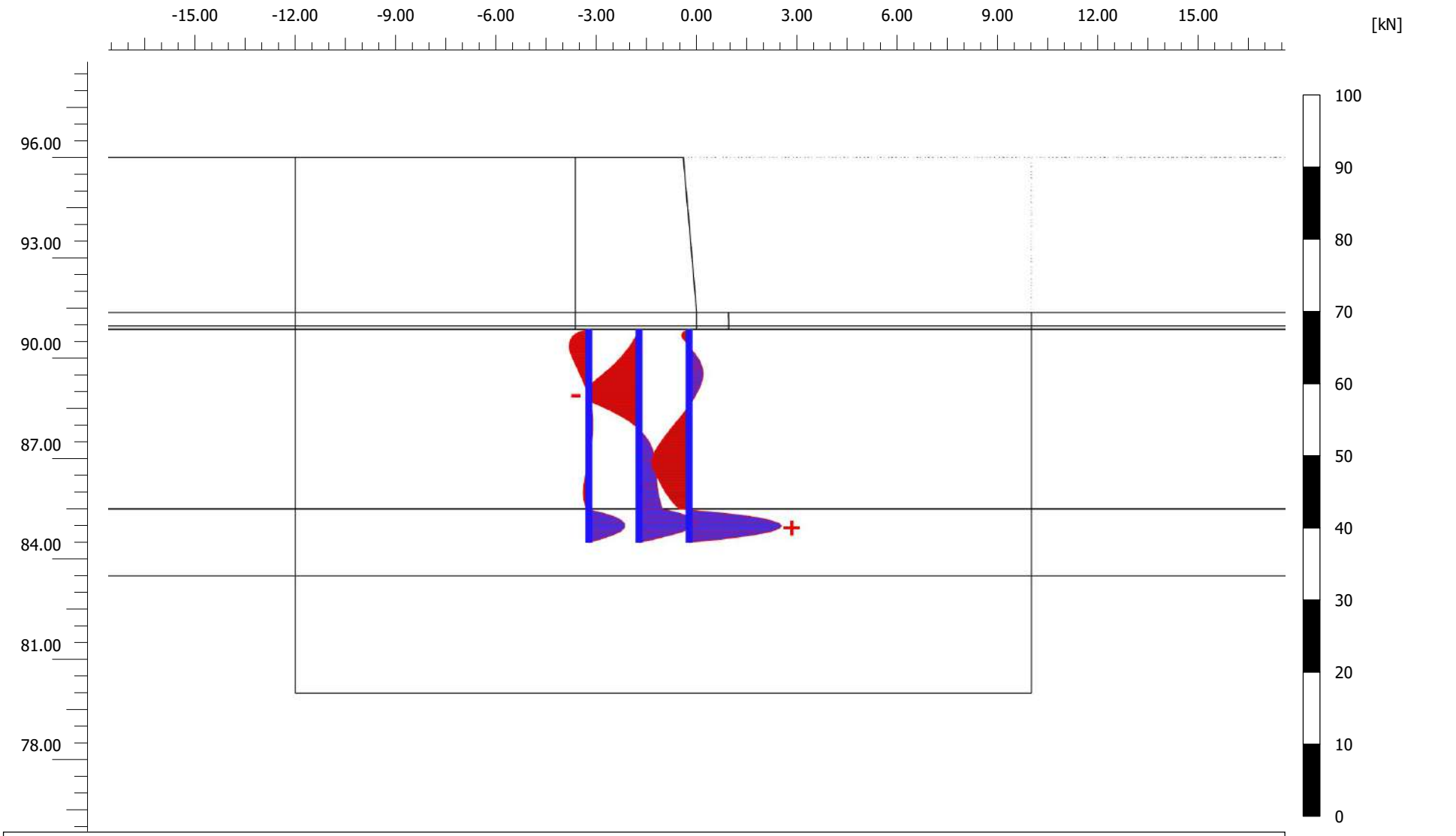
Minimum value = -11.53 kN m (Element 36 at Node 105618)



Axial forces N (scaled up 0.0500 times) per structural element

Maximum value = $-6.558*10^{-3}$ kN (Element 24 at Node 105567)

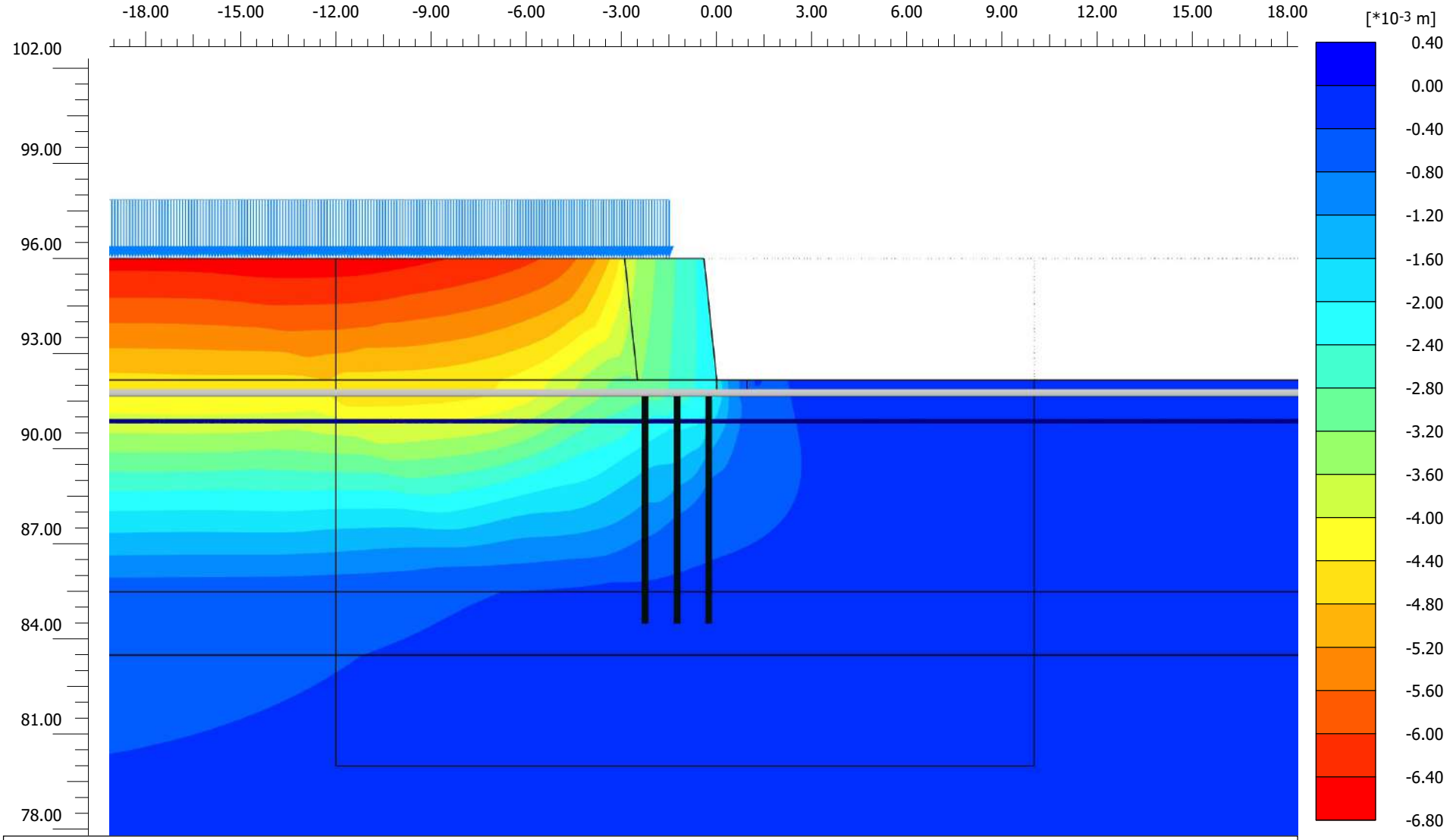
Minimum value = -101.7 kN (Element 43 at Node 105644)



Shear forces Q (scaled up 0.200 times) per structural element

Maximum value = 13.82 kN (Element 68 at Node 105746)

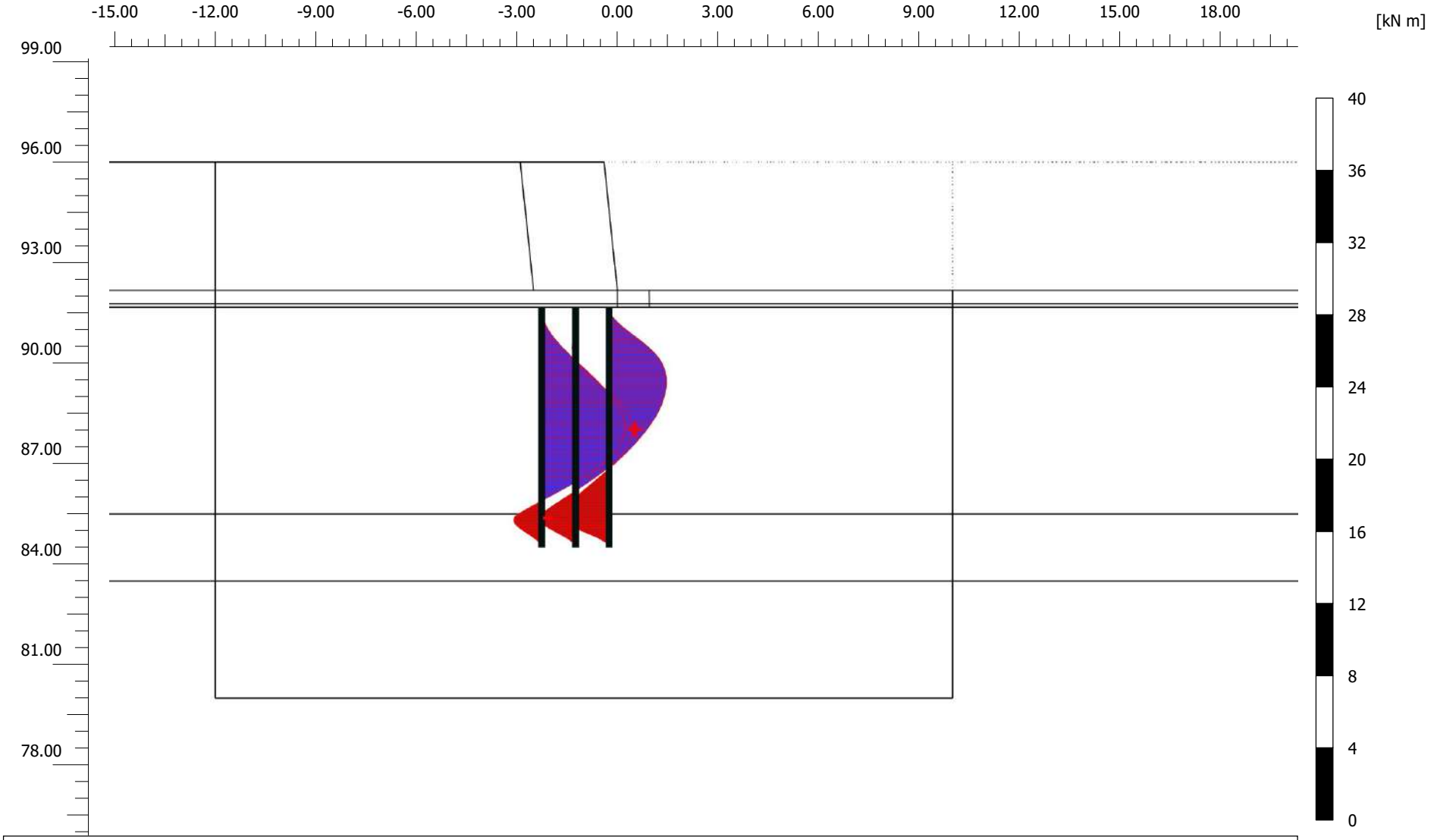
Minimum value = -7.936 kN (Element 32 at Node 105603)



Total displacements u_y (scaled up 200 times)

Maximum value = 0.000 m (Element 12066 at Node 40733)

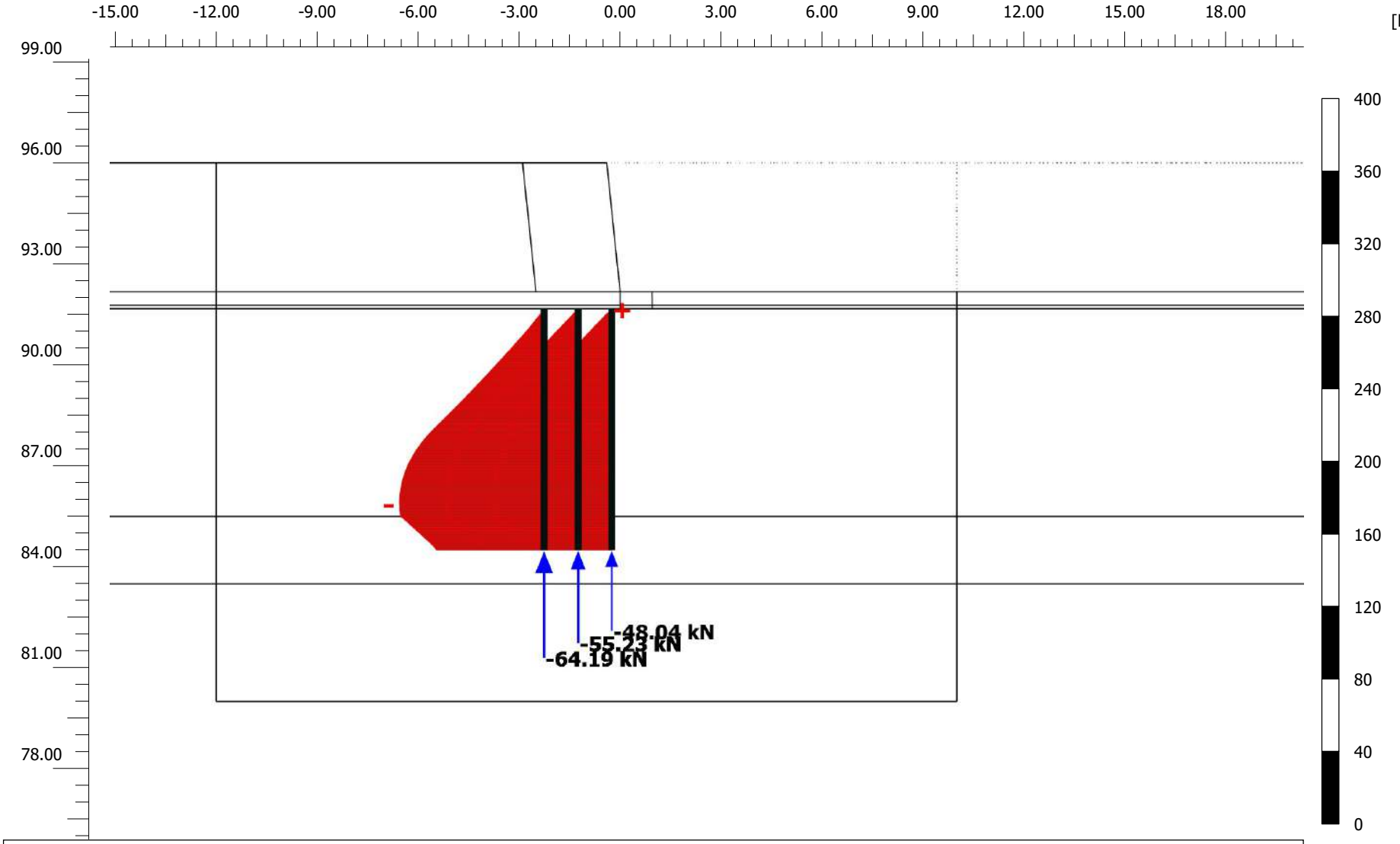
Minimum value = -6.676*10^{-3} m (Element 816 at Node 14725)



Bending moments M (scaled up 0.500 times) per structural element

Maximum value = 4.963 kN m (Element 16 at Node 107055)

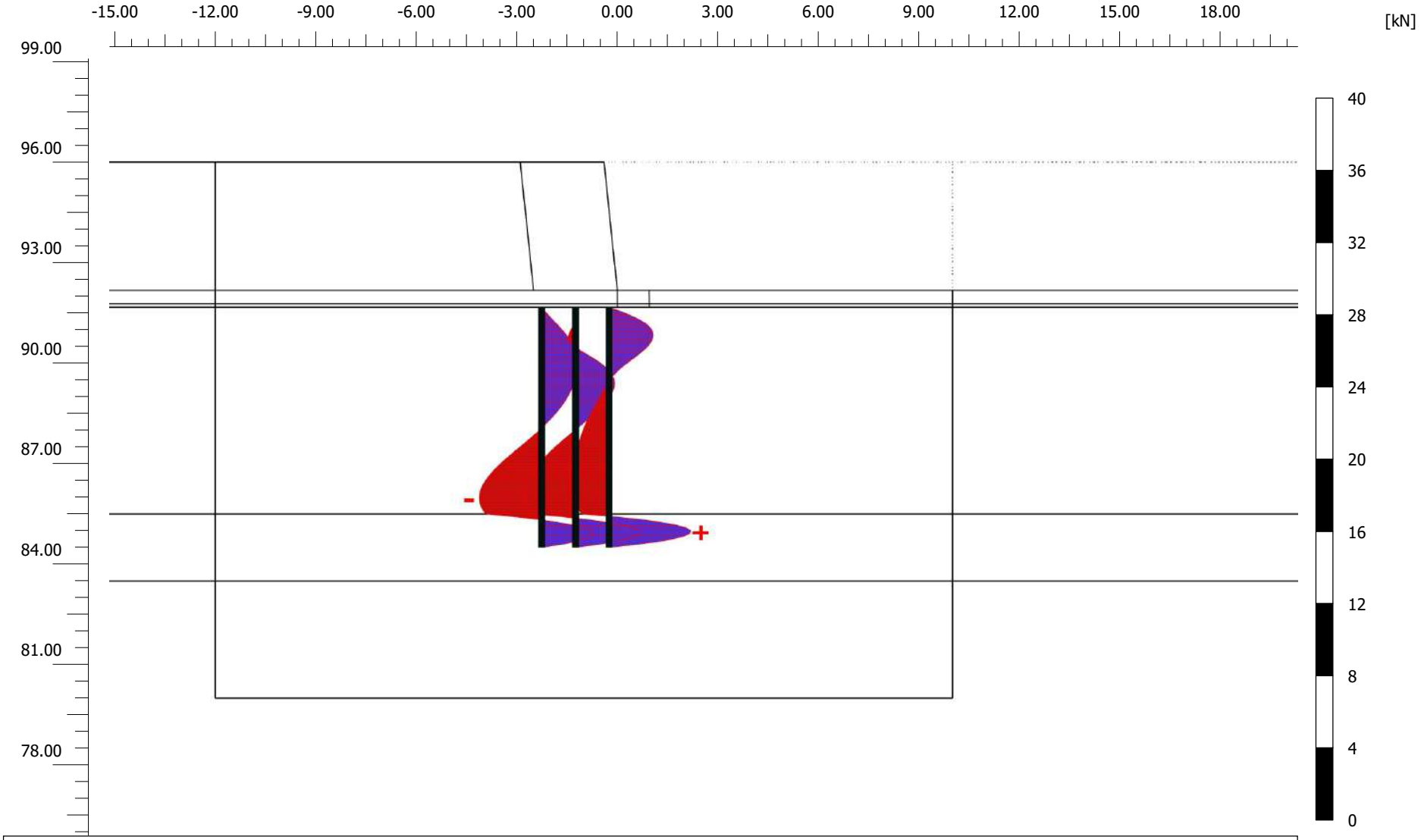
Minimum value = -3.039 kN m (Element 76 at Node 107297)



Axial forces N (scaled up 0.0500 times) per structural element

Maximum value = $1.399*10^{-3}$ kN (Element 53 at Node 107204)

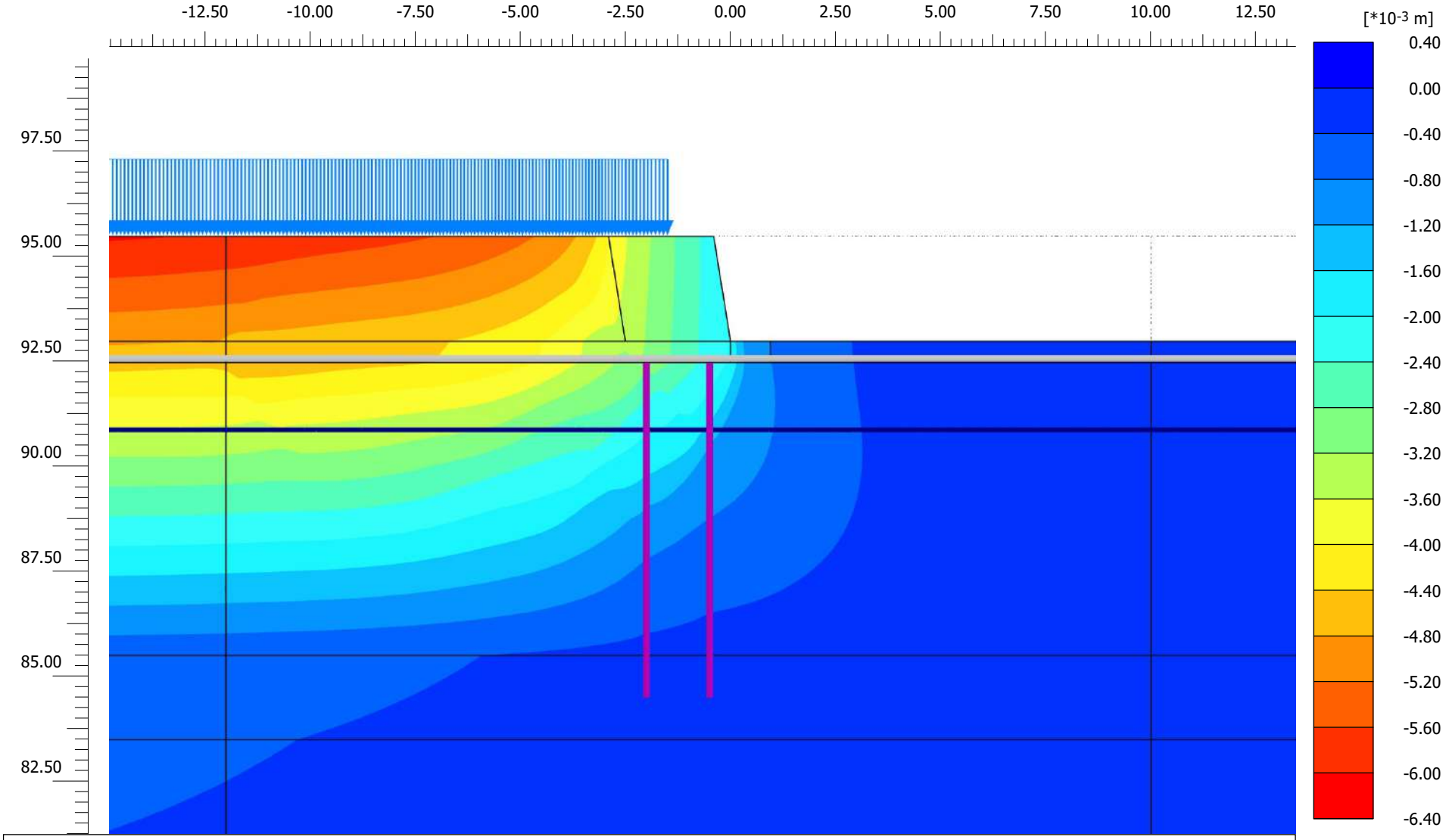
Minimum value = -85.91 kN (Element 23 at Node 107082)



Shear forces Q (scaled up 0.500 times) per structural element

Maximum value = 4.875 kN (Element 77 at Node 107302)

Minimum value = -3.722 kN (Element 22 at Node 107081)



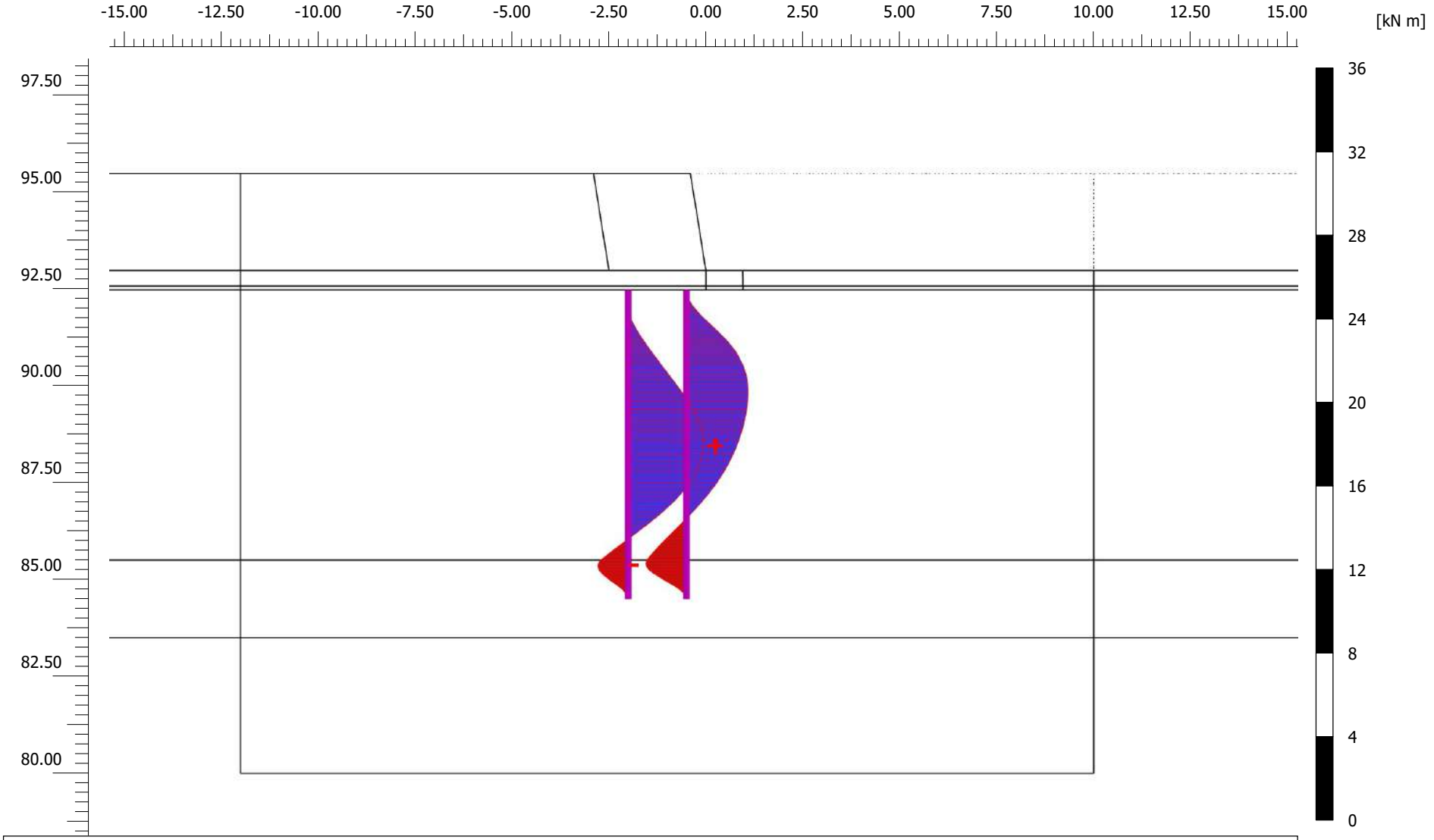
Total displacements u_y (scaled up 200 times)

Maximum value = 0.000 m (Element 12381 at Node 47547)

Minimum value = $-6.123*10^{-3}$ m (Element 857 at Node 51)

PLAXIS® 2D CONNECT Edition

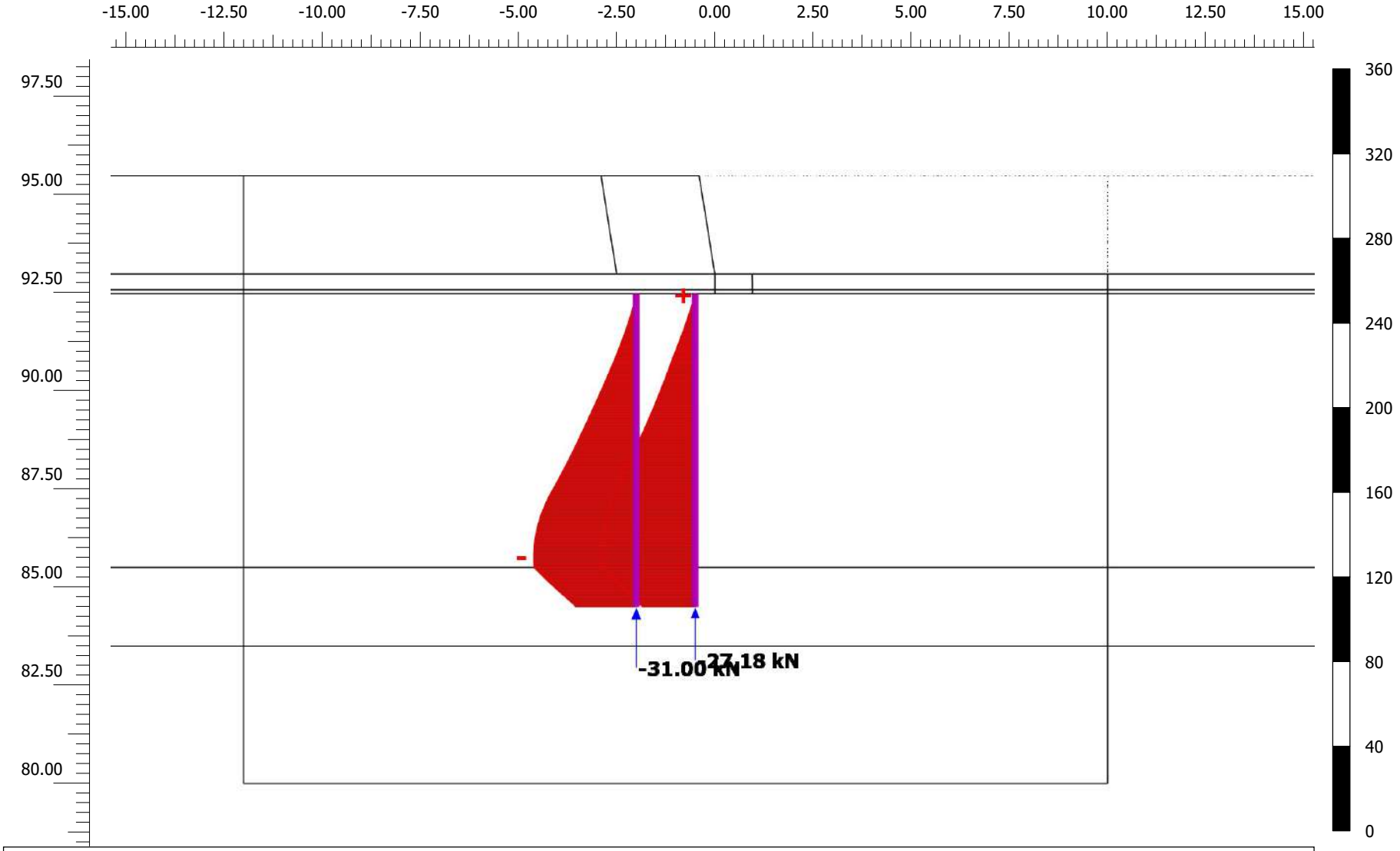
Project description Westgate, Cleckheaton (VE)			*Date* 16/10/2025
Project filename Section C_02	*Step* 3	*Company* A-Squared Studio Consulting Engineers	



Bending moments M (scaled up 0.500 times) per structural element

Maximum value = 3.863 kN m (Element 18 at Node 109588)

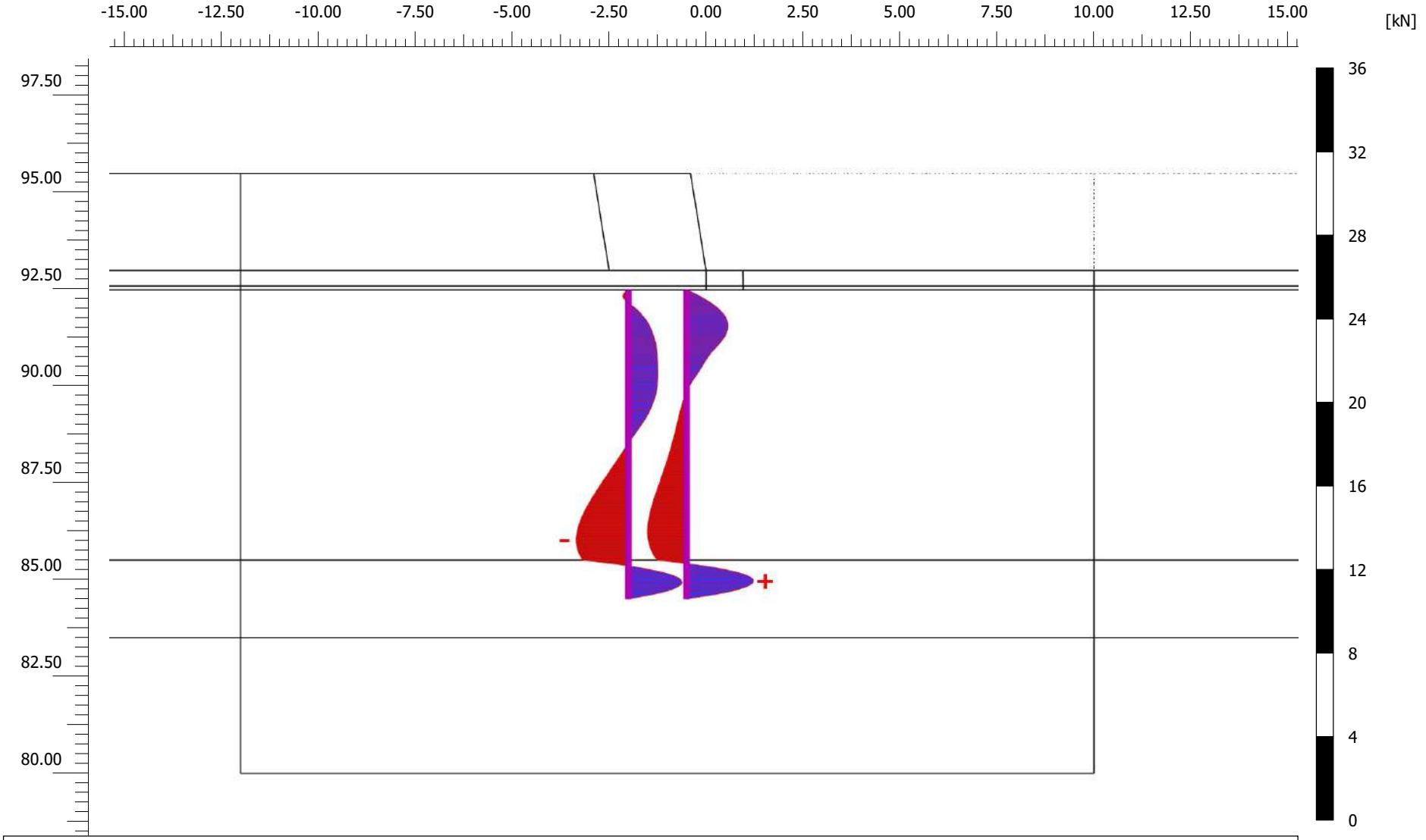
Minimum value = -2.115 kN m (Element 56 at Node 109742)



Axial forces N (scaled up 0.0500 times) per structural element

Maximum value = $-1.035*10^{-3}$ kN (Element 30 at Node 109637)

Minimum value = -52.42 kN (Element 26 at Node 109621)



Shear forces Q (scaled up 0.500 times) per structural element

Maximum value = 3.442 kN (Element 57 at Node 109747)

Minimum value = -2.698 kN (Element 25 at Node 109618)

Appendix D: A2 Bearing Capacity Calculations

A-squared Studio

Bearing Capacity Calculation Sheet					
Project	Westgate, Cleckheaton, West Yorkshire - LTP			**Project No.**	3992
Prepared by	Abu Sani	**Checked by**	Ana Carvalho	**Date**	26.06.2025

Calculation Type	**Soil Conditions**
Permissible Stress	Drained

Additional Factors		
Depth	**Ground Inclination**	**Rigidity**
No	No	No

Bearing Capacity:

$$\frac{R}{A'} = \frac{c'N_c b_c s_c i_c d_c g_c r_c + q'N_q b_q s_q i_q d_q g_q r_q + 0.5\gamma' B' N_\gamma b_\gamma s_\gamma i_\gamma d_\gamma g_\gamma r_\gamma}{FoS}$$

Ground Conditions	
Angle of Friction f_k' (º)	40.0
Cohesion c_k' (kPa)	0.0
Young's Modulus E' (MPa)	60.0
Soil Unit Weight g (kN/m^3)	20.0
Water Unit Weight g_w (kN/m^3)	10
Groundwater Depth (m)	2.0
Ground Inclination w (º)	
g' (kN/m^3)	10.0

Foundation Geometry	
Width B (m)	3.25
Length L (m)	10.00
Depth D (m)	0.10
e_B (mm)	
e_L (mm)	
a (º)	
F_v (kN)	
F_B (kN)	
F_L (kN)	

f_d' (º)	40.0
c_d' (kPa)	0.0
G (MPa)	25.0
B' (m)	3.25
L' (m)	10.00
q (kPa)	2.0
u (kPa)	0.0
q' (kPa)	2.0
q (º)	0.0
FoS	3.00

Bearing Factors		**Base Factors**	
N_c	75.31	b_c	1.00
N_q	64.20	b_q	1.00
N_γ	106.05	b_γ	1.00

Shape Factors		**Inclination Factors**			
s_c	1.21	i_c	1.00	m_B	1.75
s_q	1.21	i_q	1.00	m_L	1.25
s_γ	0.90	i_γ	1.00	m_q	1.25

Calculated Ultimate Bearing Capacity (kPa)	1711

Calculated Allowable Bearing Capacity (kPa)	570
Working Unfactored Vertical Action (kN)	18531

Notes

1. Bearing capacity spreadsheet developed based on guidance from BS EN 1997-1, BS 8004, and Poulos et al., 2001.
2. Cells highlighted in red represent parameters that must be input for accurate bearing capacity results.
3. Cells highlighted in yellow represent non-essential input cells. These should be filled if information is available.
4. This spreadsheet allows both *limit state* and *permissible stress* capacity calculations.
5. *Limit state* bearing capacity calculations are in accordance with BS EN 1997-1, and accounts for the dead/live load split.

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Bearing Capacity Calculation Sheet					
Project	Westgate, Cleckheaton, West Yorkshire - Subgrade			**Project No.**	3992
Prepared by	Abu Sani	**Checked by**	Ana Carvalho	**Date**	26.06.25

Calculation Type	**Soil Conditions**
Permissible Stress	Drained

Additional Factors		
Depth	**Ground Inclination**	**Rigidity**
No	No	No

Bearing Capacity:

$$\frac{R}{A'} = \frac{c'N_c b_c s_c i_c d_c g_c r_c + q'N_q b_q s_q i_q d_q g_q r_q + 0.5\gamma' B' N_\gamma b_\gamma s_\gamma i_\gamma d_\gamma g_\gamma r_\gamma}{FoS}$$

Ground Conditions	
Angle of Friction f_k' (º)	27.0
Cohesion c_k' (kPa)	0.0
Young's Modulus E' (MPa)	8.0
Soil Unit Weight g (kN/m^3)	18.0
Water Unit Weight g_w (kN/m^3)	10
Groundwater Depth (m)	2.0
Ground Inclination w (º)	
g' (kN/m^3)	8.0

Foundation Geometry	
Width B (m)	4.25
Length L (m)	11.00
Depth D (m)	0.60
e_B (mm)	
e_L (mm)	
a (º)	
F_v (kN)	
F_B (kN)	
F_L (kN)	

f_d' (º)	27.0
c_d' (kPa)	0.0
G (MPa)	3.3
B' (m)	4.25
L' (m)	11.00
q (kPa)	10.8
u (kPa)	0.0
q' (kPa)	10.8
q (º)	0.0
FoS	3.00

Bearing Factors		**Base Factors**	
N_c	23.94	b_c	1.00
N_q	13.20	b_q	1.00
N_γ	12.43	b_γ	1.00

Shape Factors		**Inclination Factors**			
s_c	1.19	i_c	1.00	m_B	1.72
s_q	1.18	i_q	1.00	m_L	1.28
s_γ	0.88	i_γ	1.00	m_q	1.28

Calculated Ultimate Bearing Capacity (kPa)	354

Calculated Allowable Bearing Capacity (kPa)	118
Working Unfactored Vertical Action (kN)	5523

Notes

1. Bearing capacity spreadsheet developed based on guidance from BS EN 1997-1, BS 8004, and Poulos et al., 2001.
2. Cells highlighted in red represent parameters that must be input for accurate bearing capacity results.
3. Cells highlighted in yellow represent non-essential input cells. These should be filled if information is available.
4. This spreadsheet allows both *limit state* and *permissible stress* capacity calculations.
5. *Limit state* bearing capacity calculations are in accordance with BS EN 1997-1, and accounts for the dead/live load split.

Appendix E: Structural Calculations

A-squared Studio

Standard Form
EC2 Concrete Pile Load Capacity Check

PROJECT	Westgate, Cleckheaton, West Yorkshire						
TITLE	EC2 structural Capacity Check	Orig.	Date	Verif.	Date	Ref. No./rev.	Sheet
		ASK	26/06/2025	AC	26/06/2025	3922	1
Section						Date 26/06/2025	

Based on EC2 Design
Maximum Structural Capacity for 320 mm diameter pile

Do piles conform to BS EN 1536 or BS EN 14199? Yes — BS 8004 Table 14 determines design pile diameter d_d may be different to BS EN 1992-1-1 2.3.4.3

The Value of design compressive strength of concrete is defined as:

$f_{cd} = (a_{cc} * f_{ck}) / (y_c * k_f)$ ***Clauses 2.4.2.5(2) & 3.1.6***

Therefore for C 16/20 Concrete, characteristic cylinder strength = 16 N/mm^2

Where:

a_{cc} =	0.6		Unreinforced
f_{ck} =	16	N/mm^2	
y_C =	1.50		
k_f =	1.10		

(2) The partial factor for concrete γ_c given in 2.4.2.4 (1) should be multiplied by a factor, k_f, for calculation of design resistance of cast in place piles without permanent casing.

Note: The value of k_f for use in a Country may be found in its National Annex. The recommended value is 1,1.

Therefore

f_{cd} =	5.82	N/mm^2

Design Axial Resistance of 320 mm diameter pile

$N_{rd} = A_c * f_{cd} + A_s * f_{yd}$

Where:

d_d	320	mm^2	BS EN 1992-1-1 2.3.4.1
A_c =	80425	mm^2	
f_{cd} =	5.82	N/mm^2	
A_s	Ignore		
f_{yd}	Ignore		

2.3.4 Geometric data

2.3.4.1 General

(1) The rules for geometric data are given in EN 1990 Section 4.

2.3.4.2 Supplementary requirements for cast in place piles

(1)P Uncertainties related to the cross-section of cast in place piles and concreting procedures shall be allowed for in design.

(2) In the absence of other provisions the diameter used in design calculations, of cast in place piles without permanent casing should be taken as:
- if $d_{nom} < 400$ mm: $d = d_{nom} - 20$ mm
- if $400 \le d_{nom} \le 1000$ mm: $d = 0{,}95 . d_{nom}$
- if $d_{nom} > 1000$ mm: $d = d_{nom} - 50$ mm

Where d_{nom} is the nominal diameter of the pile.

Basing Design on Compressive Strength of Concrete Area alone

$N_{rd} = A_c * f_{cd}$

For a	320	mm	diameter pile
A_c =	80425	mm^2	for structural design

Therefore

N_{rd} =	**468**	kN

Job number	3992
Job title	Westgate, Cleckheaton, West Yorkshire
Calculation heading	Rigid Inclusions
By	ASK
Checked by	AC

1 Units

The following units are used throughout this calculation.

Force	kN	*Area*	mm^2
Length	m	*Second moment of area*	mm^4
Section dimensions	mm	*Section modulus*	mm^3
Stress	N/mm^2	*Area per unit length*	mm^2/m
Strain	‰	*Angle*	°
Moment	kNm	*Axial stiffness*	kN
Curvature	‰/m	*Bending stiffness*	kNm^2
Density	t/m^3		

2 Design code

The following design code is used: Eurocode 2 (part 1), National Annex: UK

3 Materials

The following materials are used in these calculations.

3.1 Concrete

- C28/35
  - *Strength, f_{ck}:* 28 N/mm^2
  - *Elastic modulus, E:* 32308 N/mm^2
  - *Density, ρ:* 2.4 t/m^3
- C32/40_Revised
  - *Strength, f_{ck}:* 32 N/mm^2
  - *Elastic modulus, E:* 33346 N/mm^2
  - *Density, ρ:* 2.4 t/m^3
- C20/25 - modified
  - *Strength, f_{ck}:* 20 N/mm^2

Elastic modulus, E: 29962 N/mm²

Density, ρ: 2.4 t/m^3

- C16/20 - modified

Strength, f_{ck}: 16 N/mm²

Elastic modulus, E: 28608 N/mm²

Density, ρ: 2.4 t/m^3

3.2 Reinforcement

- 500B

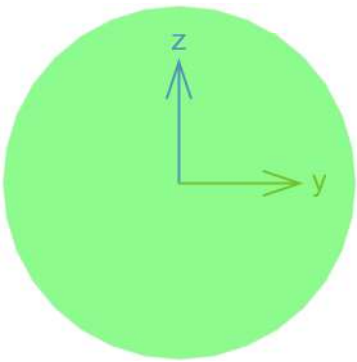
Strength, f_{yk}: 500 N/mm²

Elastic modulus, E: 200e3 N/mm²

Density, ρ: 7.85 t/m^3

4 Sections

4.1 Section 1 (320mm Plain Section)



Definition		*Reinforcement*		
Material	Concrete	*Type*	*Description*	*Position(s)*
Grade	C16/20 - modified	*POINT*	B0.00001	0,0
Profile	STD C 320			

4.1.1 Analysis

4.1.1.1 ULS Results Summary

Case	*F_x (kN)*	*M_{yy} (kNm)*	*M_{zz} (kNm)*	*Utilisation*	*Status*
1	-101.7	11.5	0	87%	✓
2	-101.7	0	11.5	87%	✓
3	-86	5	0	24%	✓

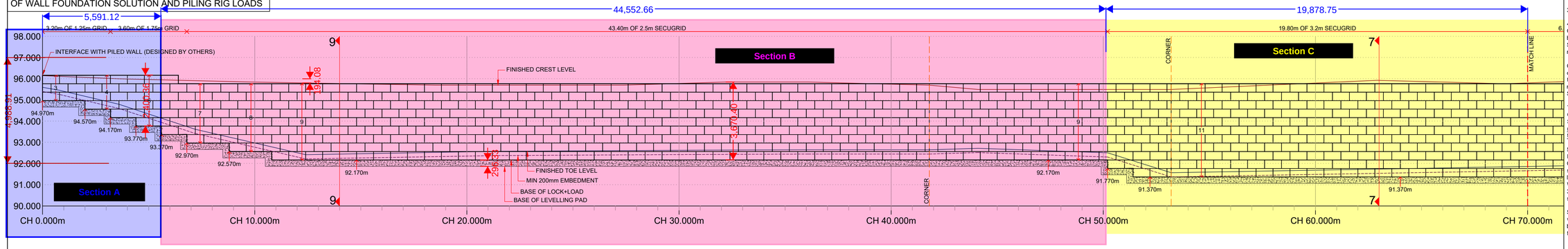
Case	F_x (kN)	M_{yy} (kNm)	M_{zz} (kNm)	Utilisation	Status
4	-86	0	5	24%	✓
5	-52	3.9	0	18%	✓
6	-52	0	3.9	18%	✓

4.1.1.2 SLS Results Summary

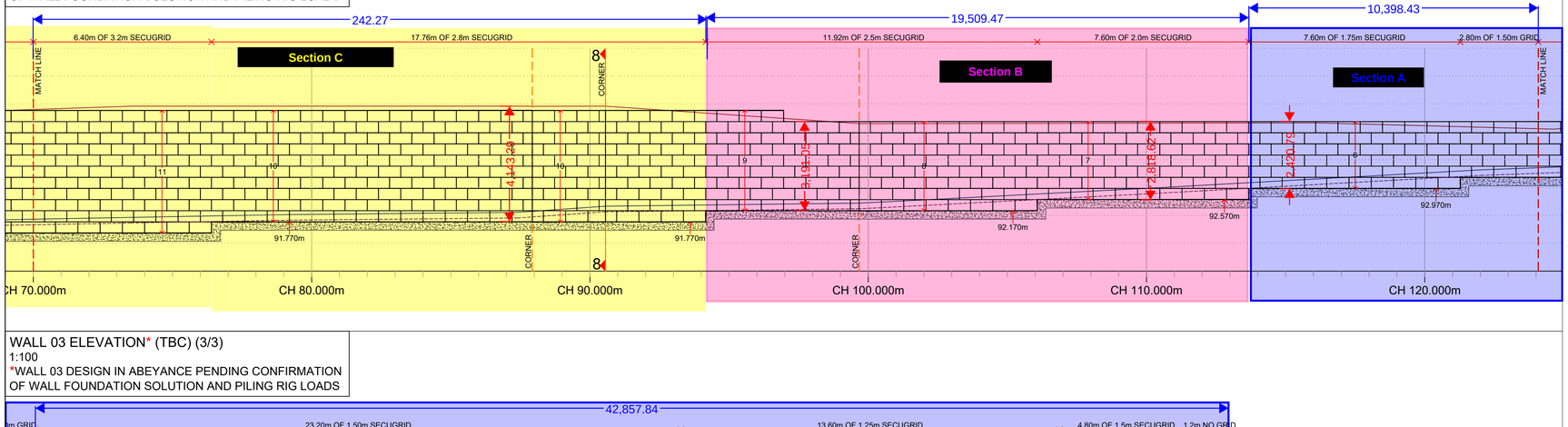
Case	F_x (kN)	M_{yy} (kNm)	M_{zz} (kNm)	Cracked?	Crack width (mm)	EA (kN)	EI_{yy} (kNm^2)	EI_{zz} (kNm^2)
1	-101.7	11.5	0	**CRACKED**	49718.6638	-1.016e6	4560.922	0
2	-101.7	0	11.5	**CRACKED**	58038.0412	-868.9e3	0	4265.397
3	-86	5	0	**UNCRACKED**	0	2.328e6	14779.13	0
4	-86	0	5	**UNCRACKED**	0	2.328e6	0	14779.13
5	-52	3.9	0	**UNCRACKED**	0	2.344e6	14898.8	0
6	-52	0	3.9	**UNCRACKED**	0	2.344e6	0	14898.8

Appendix F: Geogrid-Reinforced Wall Sections

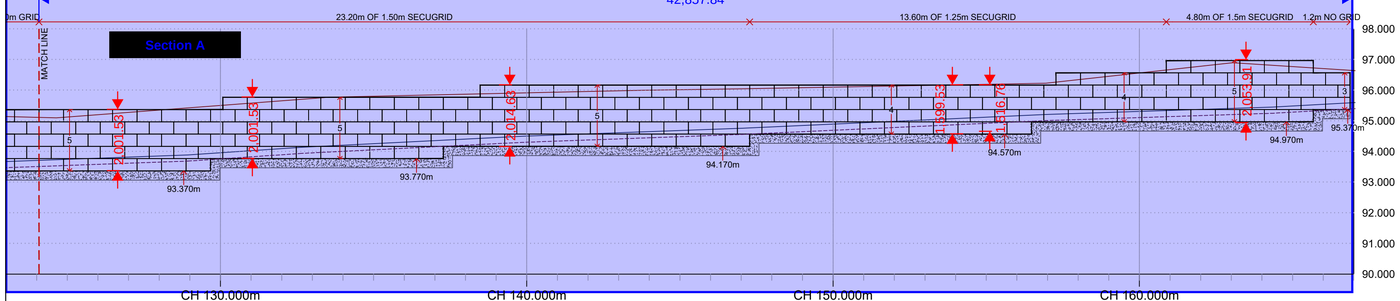
WALL 03 ELEVATION* (TBC) (1/3)
1:100
*WALL 03 DESIGN IN ABEYANCE PENDING CONFIRMATION OF WALL FOUNDATION SOLUTION AND PILING RIG LOADS



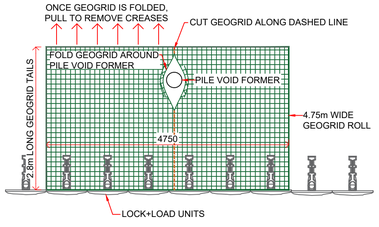
WALL 03 ELEVATION* (TBC) (2/3)
1:100
*WALL 03 DESIGN IN ABEYANCE PENDING CONFIRMATION OF WALL FOUNDATION SOLUTION AND PILING RIG LOADS



WALL 03 ELEVATION* (TBC) (3/3)
1:100
*WALL 03 DESIGN IN ABEYANCE PENDING CONFIRMATION OF WALL FOUNDATION SOLUTION AND PILING RIG LOADS

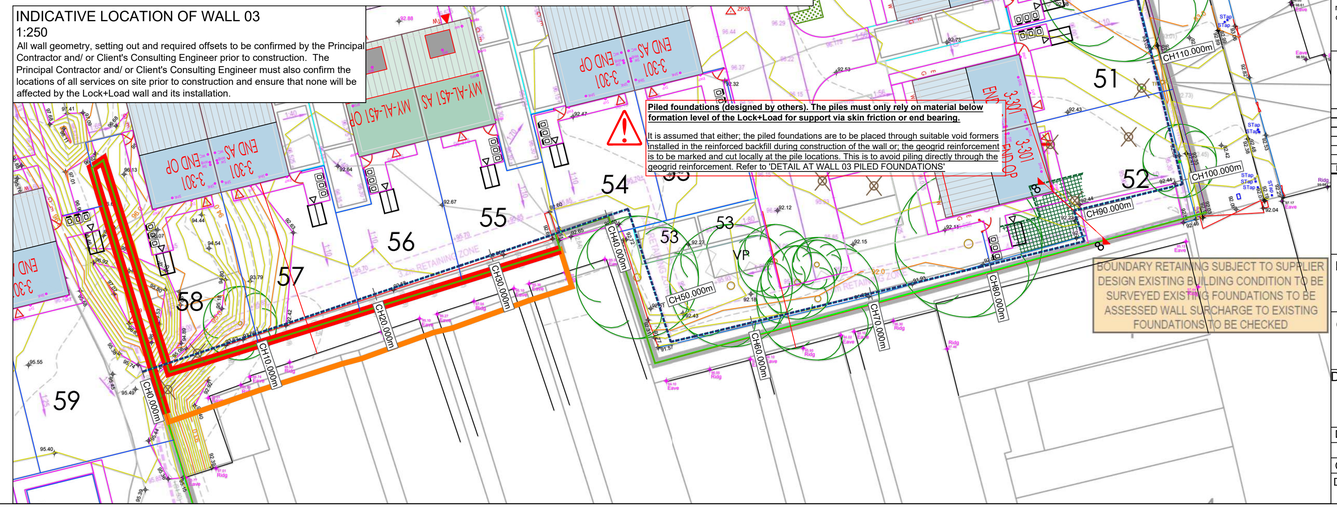


DETAIL AT WALL 03 PILED FOUNDATIONS - TBC (NTS)




RETURN DETAIL AT STEPS OF TOP BLOCK (NTS)

INDICATIVE LOCATION OF WALL 03
1:250
All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction. The Principal Contractor and/ or Client's Consulting Engineer must also confirm the locations of all services on site prior to construction and ensure that none will be affected by the Lock+Load wall and its installation.



A1

NOTES:

1) All dimensions in mms unless otherwise specified.

2) BLOCKS: LOCK+LOAD GEOGRID: SECUGRID 40/40

3) INSTALLATION: Refer to standard Manufacturer's installation guidelines.

4) REINFORCED BACKFILL:
Class 6I granular fill, in accordance with MCHW SHW Series 600. Granular fill to be benched into in-situ soils and compacted in layers in accordance with the Specification for Highway Works, Series 600, Table 6/4. Class 6I fill to be restricted to '30mm down' for first 1m behind face.

Compliance testing must be undertaken on the Class 6I granular fill, both prior to commencement and throughout the works. This must include particle size testing and shear box of representative samples. Class 6I must have a maximum fines (63µm) content of 15% and comply with the limits in Table 6/3 of Series 600.

This material is assumed to have the following characteristics: Phi' = 35 degrees, Gamma = 19 kN/m³ and c' = 0 kPa, compacted to in accordance with SRW Series 600, Table 6/4. The Contractor is responsible for the selection of this material to ensure compliance with the geotechnical characteristics as shown on the relevant drawings and in the design documents/ calculations.

5) FOUNDATION FOR WALL 03:
Logs in Sirius 'Updated Factual Site Investigation Letter Report' C9907A/AMG/10556 suggest the presence of significant depths of soft (low strength) and very loose MADE GROUND & very low strength ALLUVIUM at the location of Wall 03. An undrained shear strength (c_u) of 18kPa was recorded in WS604 at a depth of 2.75m, and SPT 'N' values of 0 were recorded at depths of 3m and 5m in BH601 and BH602 respectively. WS703 encountered soft low strength made ground at a depth of 3m.

Such material would not be a suitable foundation material for the Lock+Load wall, and remedial action must therefore be undertaken to provide a competent base from which to construct Lock+Load Wall 03. We would suggest the following three broad options are considered:

1. Excavation of all soft/ soft-firm (c_u<70kPa) and loose material (including all alluvial deposits and cohesive made ground) down to SANDSTONE/ MUDSTONE bedrock. Compacted Class 6F2/ 6F5 granular fill to be used to replace excavated material back up to wall formation level. The depth of excavation and replacement required (5m+) may make this option unfeasible, particularly in such close proximity to the site boundary.
2. Some form of ground improvement (designed by others) to ensure a minimum safe bearing resistance of 140kPa at wall formation level and that global stability and settlement magnitudes satisfy design standards. The may take the form of deep soil mixing, vibro stone columns, etc. (to be confirmed by specialist ground improvement contractor).
3. A piled based (designed by others) for the Lock+Load wall.

If any soft/ soft-firm, loose or unsuitable material (c_u<70kPa, SBR<140kPa) is left in place at or below wall formation level, instability and/ or excessive settlement of the Lock+Load wall may occur.

6) SITE / IN-SITU SOILS :
Retained: MADE GROUND (ashy gravelly SAND [ASH & CLINKER]) & compacted Class 1/2 upfill. These materials are assumed to have the following minimum properties:
MADE GROUND ϕ' = 28°, γ = 18kN/m³ and c' = 0 kPa.
CLASS 1/2 FILL ϕ' = 28°, γ = 19kN/m³ and c' = 0 kPa.

Foundation solution for Wall 03 - **TBC**.

The Contractor & Client's Consulting Engineer are responsible for ensuring the in-situ soils comply with the geotechnical characteristics as shown on the relevant drawings and in the design calculations.

7) DRAINAGE:
A minimum 150mmØ perforated drain pipe should be placed along the full length of the wall. This should be roddable and connected to an appropriate site drainage outlet with consent to discharge. Intermediate rodding points will be required to allow the full length of drain to be maintained (to be determined by scheme drainage designer). Rodding points should be installed at maximum 20m spacings at the top of the walls. Intermediate outlets may be required at any low points in the wall formation (e.g. at CH53m) - to be determined by scheme drainage designer.

8) FACE ANGLE = 5.7°.

9) TEMPORARY EXCAVATIONS/ SETTING OUT
This solution is for the permanent works only, and is issued on the basis that a safe system of works is provided for construction. Temporary excavations have the potential to fail rapidly and without warning, particularly in granular material. The Principal Contractor/ Wall installer must produce a method statement and risk assessment for the works to be approved by the Client's Consulting Engineer. Temporary stability and design of any temporary works are outside our scope and should be confirmed by others.

All wall geometry, setting out and required offsets to be confirmed by the Principal Contractor and/ or Client's Consulting Engineer prior to construction.

10) BUILDING FOUNDATIONS
It is assumed that any building foundations in the vicinity of the wall will be taken to such a level that no loads will be transferred to the Lock+Load wall and reinforced backfill. Building foundations must not rely on the flexible Lock+Load wall and reinforced backfill for support (including lateral support), and are outside the scope of this design. Please advise us if a piling/ vibro rig and/ or large plant is to be used on the retained side of the Lock+Load wall, as well as their required minimum offsets and maximum operational surcharges, as the design will need to be checked for the rig loads.

11) SETTLEMENT
The Client's Consulting Engineer must assess the risk of settlement of ~4m of upfill over significant depths of very loose MADE GROUND & very low strength ALLUVIUM to the rear of the wall. Ground improvement (designed by others) such as deep soil mixing, vibro stone columns, etc. may be required to limit differential and total settlement (to be confirmed by specialist ground improvement contractor).

12) NOTES ON CALCULATIONS/DRAWINGS:
These plans and the accompanying design documentation should be thoroughly checked by the Client's Consulting Engineer. Any apparent errors, omissions or variations should be reported immediately to Geoman Ltd. Construction of this wall shall not commence unless and until the Client/ Client's Consulting Engineer has considered the Geoman Design Submission Document (QP06 Ref 24-5558) to ensure that there are no errors, omissions or conflict with the scheme design.

CONCEPT ONLY
NOT FOR CONSTRUCTION

Rev.	Issue / Revision:	Drawn:	Date:
B		WM	25.03.25
A		WM	04.03.25
0		WM	27.09.24

GEOMAN
44 Elmwood Avenue, Belfast, BT9 6AZ 02890 664941 geoman@geoman.co.uk

Project Title:
WESTGATE, CLECKHEATON

Client:
GILLCON GROUP

Drawing Title:
LOCK+LOAD WALL 03 ELEVATION

Designed:		Date:		Project No:	24-5558
Drawn:	WM	Date:	25.03.25	Scale:	AS INDICATED AT A1
Checked:		Date:			
Drawing No:	SK24-5558-F1-04			Revision:	B

Appendix G: Rigid Inclusions Layout

WORKING PLATFORM LEVEL= .....mOD

NOTES:

1. ALL DIMENSION ARE IN mm UNLESS STATED OTHERWISE.
2. THIS DRAWING IS BASED ON THE FOLLOWING DRAWINGS RECEIVED FROM:
   -

RIGID INCLUSION SIZE IS NOT TO SCALE

RIGID INCLUSION INSTALLATION DATE:

	/ /		/ /
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	/ /		/ /
	/ /		/ /

REV	DATE	DESCRIPTION	BY	CHECK
P4	11.05.26	Revised Design Information	L.B	C.G
P3	01.10.25	Re-design	L.B	C.G
P2	01.10.25	Revised Design Information	L.B	C.G
P1	07.07.25	FIRST ISSUE	L.B	C.G

BEARING PRESSURES kN/m²		No. of POINTS
MAIN FOUNDATIONS	SLAB	
140	NA	295

DRAWING STATUS

FOR APPROVAL

CLIENT

Strata Homes

PROJECT

Cleckheaton

TITLE

Rigis Inclusion Layout

VAN ELLE
TOTAL FOUNDATION SOLUTIONS
The Genesis Centre, Garrett Field, Birchwood, Warrington, WA3 7BH
01925 394968 | www.van-elle.co.uk

DRAWN	DATE	SCALE
L.B	07.07.25	1:100 @ A0
CHECKED	DATE	PROJECT CODE
C.G	07.07.25	241261

DRAWING NUMBER	REV
241261-VE-00-FN-DR-X-0001	P4

A-squared Studio

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