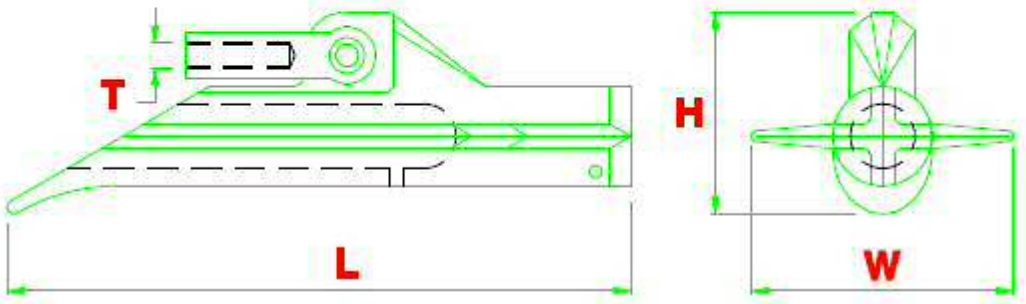
Anchor Systems (Europe) Ltd, Unit 45 Rowfant Business Centre, Rowfant, West Sussex, RH10 4NQ

DUCKBILL SHEET PILING & CONTIGIOUS PILING

Registered Office: North House 198 High Street, Tonbridge, Kent, TN9 1BE
Company Registration No. 04023935, VAT Registered No. 656490607

DUCKBILL ANCHOR SIZES



GROUND ANCHOR	Load Range kN	L mm	W mm	H mm	Surface Area mm^2	Bar Dia/Wire Dia. mm	Manufactured Material	Driven Depth Ave/week Ground (m)	Driving Equipment
AS-300	100-300	500	300	176	110,341	24 & 25	SG Iron/SS 316	9-12+	m/c DR
AS-200	90-200	500	172	150	73,200	24 & 25	SG Iron/SS 316	9-12	m/c DR
AS-140	60-140	500	258	140	96,111	16 & 20	SG Iron/SS 316	6	m/c DR
AS-120	70-140	500	300	134	110,456	20 & 25	SG Iron/SS 316	6-9	m/c DR
AS-100	50-100	422	180	139	57,384	16 & 20	SG Iron/SS 316	6-9	HH m/c
AS-50	30-50	375	98	110	32,525	16 & 20	SG Iron/SS 316	3-6	HH m/c
AS-30	15-30	293	88	107	24,579	12 & 16	SG Iron/SS 316	3	HH m/c
MR1	50-90	375	176	109	52,733	16 & 20	SG Iron/SS 316	6-9	HH m/c
MR2	30-50	375	98	110	32,525	16 & 20	SG Iron/SS 316	3-6	HH m/c
MR3	15-30	293	88	107	24,579	12 & 16	SG Iron/SS 316	3	HH m/c
MR4	10-20	200	88	95	10,625	12 & 16	SG Iron/SS 316	2-3	HH m/c
MR88	5-12	159	48	65	6,047	Wire/Paracore 4-6	SG Iron/SS 316	1.2-1.5	HDR
MR68	1-5	121	32	48	3,219	Wire/Paracore 4	SG Iron/ SS 316	1.2-1.5	HDR
DB88	5-10	159	48	65	6,047	Wire/Paracore 4-6	LM25	1.2-1.5	HDR
DB68	1-5	121	32	48	3,219	Wire/Paracore 4	Aluminium LM25	1.2-1.5	HDR

m/c DR - Machine Driven anchors (i.e. Using montebert 125SX Breaker or similar)
HH m/c - Hand Held Driving Equipment from Anchor Systems (Europe) Ltd
HDR - Hand Drive Rods to be used with a standard hand held hammer

Note: All Dimensions are in millimetres
All load values shown are SLS or Safe Working load recommended for the anchor
Anchor range available in Spheroidal Graphite, Grade 316 Stainless Steel or LM25 Aluminium

Duckbill Ground Anchor Holding Capacities (kN)

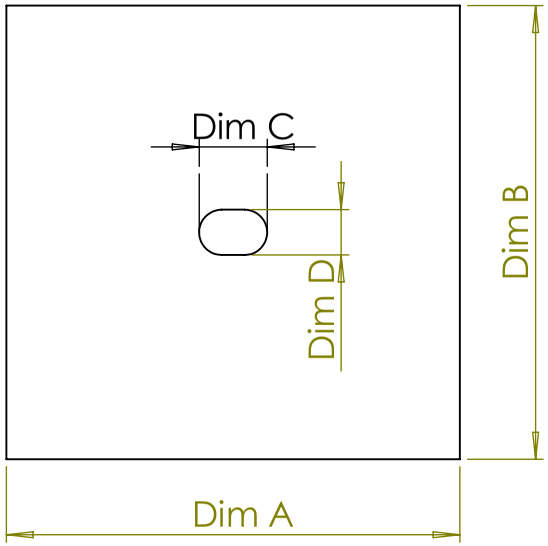
Anchor Systems (Europe) Ltd, Unit 45 Rowfant Business Centre, Rowfant, West Sussex, RH10 4NQ - **www.anchorsystems.co.uk**

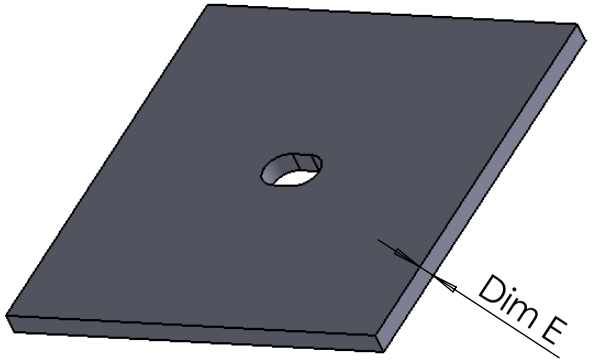
Common Soil Type Description	Geological Soil Classification	Blow Count or "SPT"	AS10	AS20	AS100	AS140	AS200	AS300
Very Dense and/or Cemented Sands; Course Gravel & Cobbles	Caliche, Nitrate Bearing Gravel	60 - 100+	10	20	100	140	200	300
Dense Fine Sand; Very Hard Silts & Clays	Basal Till; Boulder Clay Caliche;	45 - 60	10	20	90	140	200	285
Dense Clays, Sands & Gravel; Very Stiff to Hard Silts & Clays	Glacial Till; Weathered Shale's; Schist Gneiss Siltstone	35 - 50	10	20	90	140	200	270
Medium Dense Sandy Gravel; Very Stiff to Hard Silts & Clays	Glacial Till; Hardpan	25 - 40	8	18	70	110	150	220
Medium Dense Course Sand & Sandy Gravel; Stiff to Very Stiff Silts & clays	Saprolites Residual Soils	14 - 25	8	16	70	110	150	210
Loose to Medium Dense Fine to Course Sand; Firm to Stiff Clays & Silts	Dense Hydraulic Fill; Compacted Fill; Residual Soils	7 - 14	7	16	60	70	110	190
Loose Fine Sand; Alluvium;Soft-Firm Clays; Varied Clays; Fill	Flood Plain Soils; Lake Clays; Abode; Gumbo Fill	4 - 8	7	14	50	60	80	150
Peat, Organic Silts; Inundates Silts Fly Ash	Miscellaneous Fill; Swamp Marsh	0 - 5	5	12	40	50	20 - 50	20 - 80

N.B: For Guidance Purposes Only – True Capacity must be tested with an Anchor Systems Load Locker within the area of soil to be stabilized

In weak soil conditions tests have conclusively shown that grouted anchors can enhance loading capacity

Note: All underground work requires proper safety and location procedures. Do not install anchors without understanding below ground conditions. It is imperative that in all cases, ground anchors are fully locked before being put into service.





Anchor Systems Pattress Plate

REF	Dim A	Dim B	Dim C	Dim D	Dim E
Plate 75x75x8	75mm	75mm	45mm	22mm	8mm
Plate 150x150x8	150mm	150mm	45mm	22mm	8mm
Plate 200x200x8	200mm	200mm	45mm	22mm	8mm
Plate 350x350x8	350mm	350mm	45mm	30mm	8mm
Plate 200x200x10	200mm	200mm	45mm	22mm	10mm
Plate 250x250x10	250mm	250mm	45mm	22mm	10mm
Plate 300x300x15	300mm	300mm	45mm	30mm	15mm

Material SG Iron

Finish Galvanised

Revision

ANCHOR SYSTEMS (EUROPE) LTD

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www.anchorsystems.co.uk

Description Anchor Systems Pattress Plate

Drawing No. AS-PP-SG

Rev. 0

Drawn By	G Selvadurai	**Drawn Date**	21/10/2014
Approved By		**Approved Date**	

Tolerance - All Dimensions in mm
Whole Numbers: ±1
One Place Decimals: ±0.5
Angles : ±1°

THIRD ANGLE PROJECTION
DO NOT SCALE
IF IN DOUBT, ASK

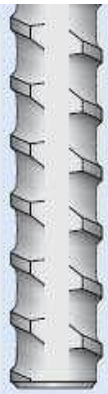
A4

Anchor Systems (Europe) Ltd, Unit 45 Rowfant Business Centre, Rowfant, West Sussex, RH10 4NQ

Galvanised Bar Sizes and Specifications

Standard Bar

Nominal Diameter mm	Steel Grade N/mm²	Ultimate Strength kN	Yield Strength kN	70% Ultimate Strength kN	Cross Sectional Area mm²	Diameter Over Threads mm	Thread Pitch mm	Weight Kg/m
16	500 / 600	121	101	85	201	18	8	1.58
20		188	157	132	314	23	10	2.47
25		295	246	206	491	28	12.5	3.85
28		370	308	259	616	32	14	4.83
32		482	402	337	804	36	16	6.31
40		754	629	528	1257	45	20	9.86
50		1178	982	825	1963	56	26	15.41
63.5	555 / 700	2217	1758	1552	3167	69	21	24.86

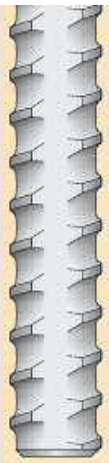


Key features of *GEWI*® Standard:

- Steel Grade: 500 / 600 N/mm² (except 63.5mm, 555 / 700 N/mm²)
- Coarse Pitch Threadform, d / 2 (except 63.5mm, d / 3)
- Left Hand Thread
- Standard Load Range

Standard Bar Plus

Nominal Diameter mm	Steel Grade N/mm²	Ultimate Strength kN	Yield Strength kN	70% Ultimate Strength kN	Cross Sectional Area mm²	Diameter Over Threads mm	Thread Pitch mm	Weight Kg/m
18	670 / 800	203	170	142	254	21	8	2.00
22		304	255	213	380	25	8	2.98
25		393	329	275	491	28	10	3.85
28		493	413	345	616	32	11	4.83
30		566	474	396	707	34	11	5.55
35		770	645	539	962	40	14	7.55
43		1162	973	813	1452	48	17	11.40
57.5		2078	1740	1455	2597	63	20	20.38
63.5		2534	2122	1774	3167	69	21	24.86
75		3534	2960	2474	4418	82	24	34.68



Key features of *GEWI*® *Plus*:

- Steel Grade: 670 / 800 N/mm²
- Reduced Pitch Threadform (d / 3)
- Right Hand Thread
- Increased Load Range Capacity

Technical Details:

Modulus of Elasticity: E = 205,000 N/mm2
Stock Length: 12m, Cutting Tolerance: +/–100mm
Standard Bar: Manufactured in accordance with German Approval Certificate
Standard Plus Bar: Manufactured in accordance with European CUAP

Corrosion Protection:

Sacrificial Corrosion Allowance: TRL 380 and CIRIA Soil Nailing Guide
Hot Dip Galvanising: BE EN ISO 1461 (zinc coating thickness of 85µm, bars remain fully threadable over entire length)

AS-300-SG-S- SG -BA-25- SG

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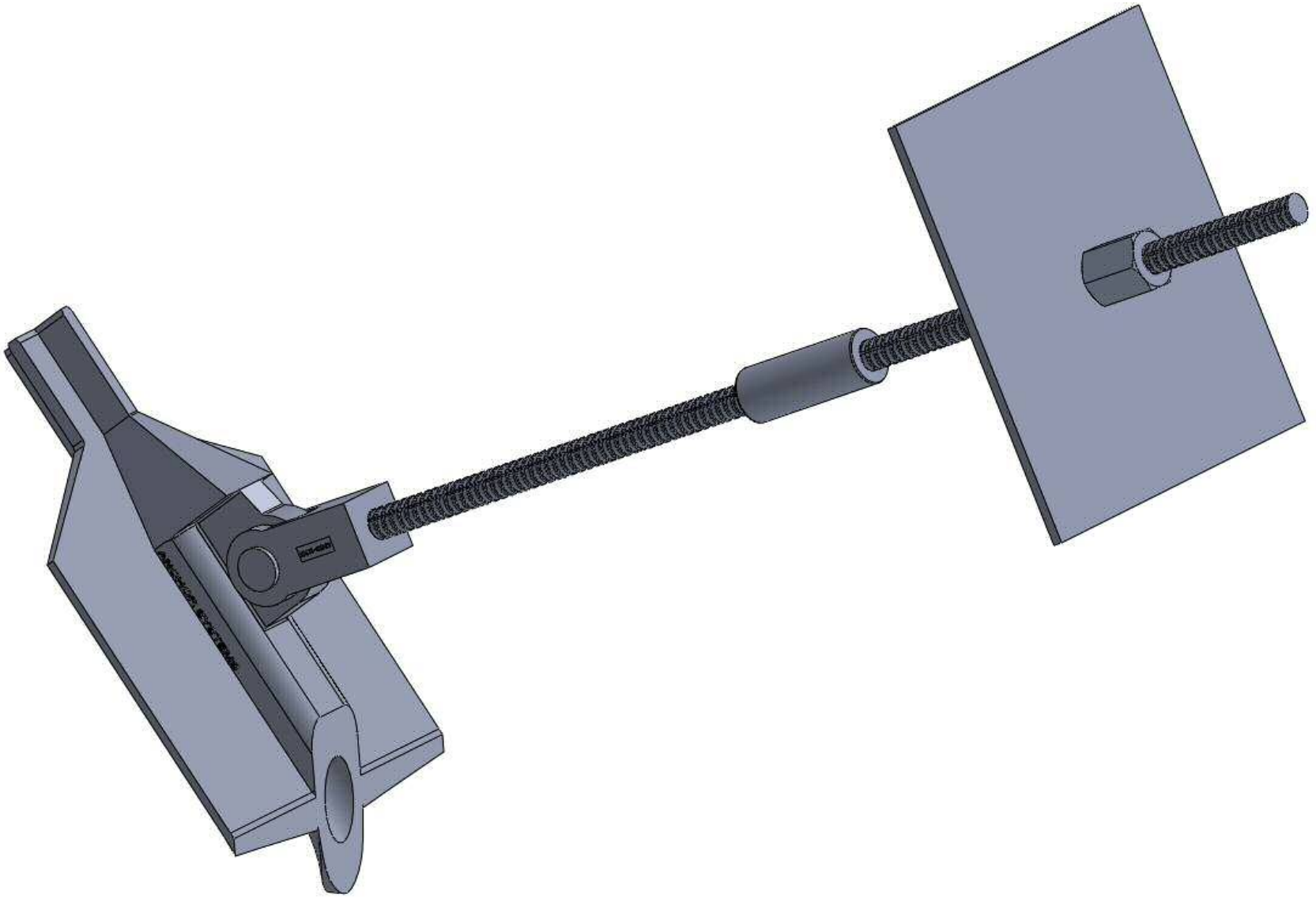


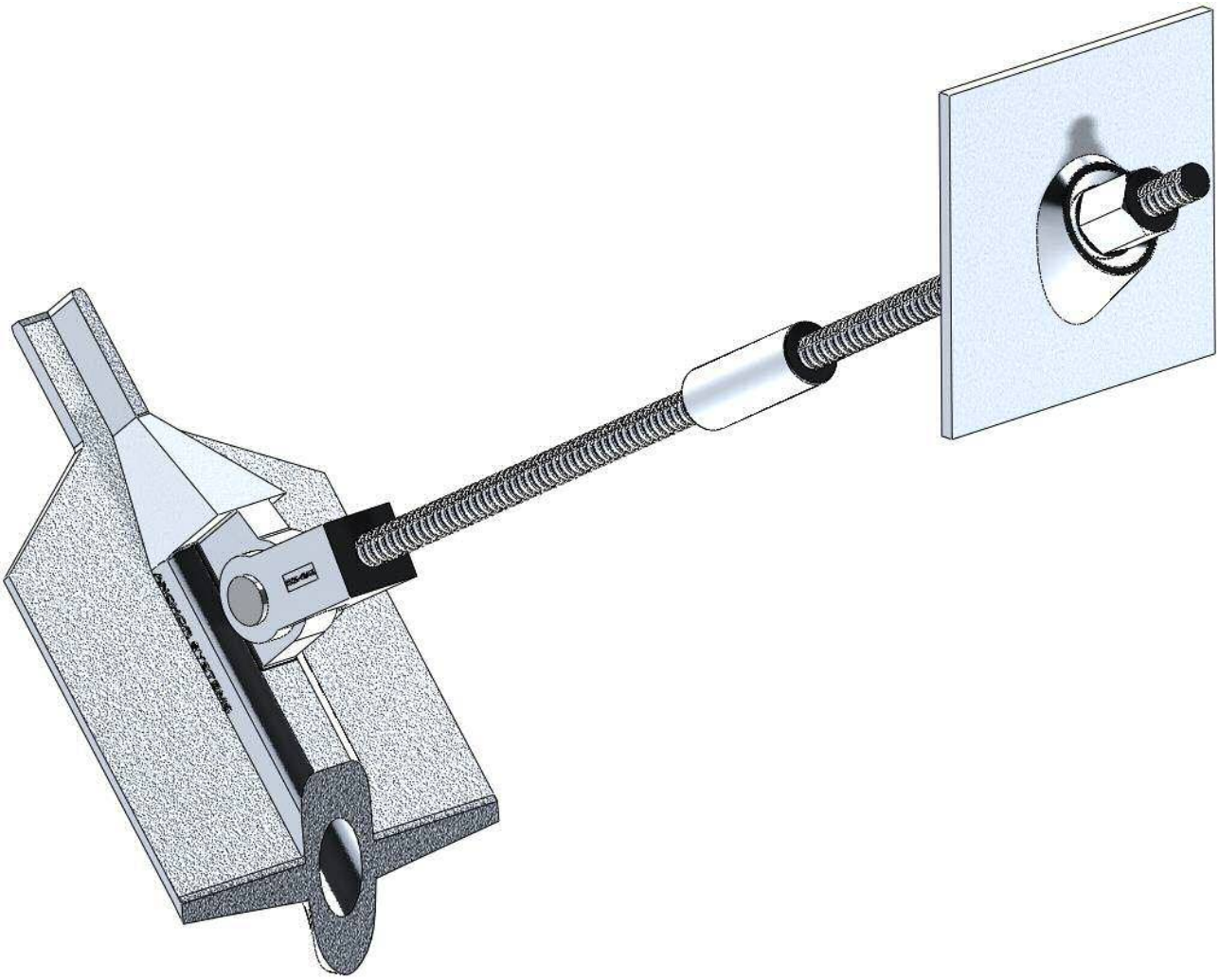
Registered Office: North House 198 High Street, Tonbridge, Kent, TN9 1BE
Company Registration No. 04023935, VAT Registered No.656490607

AS-300-SG-S-SG-BA-25-SG with Wedge Boss

Anchor Systems (Europe) Ltd, Unit 45 Rowfant Business Centre, Rowfant, West Sussex, RH10 4NQ

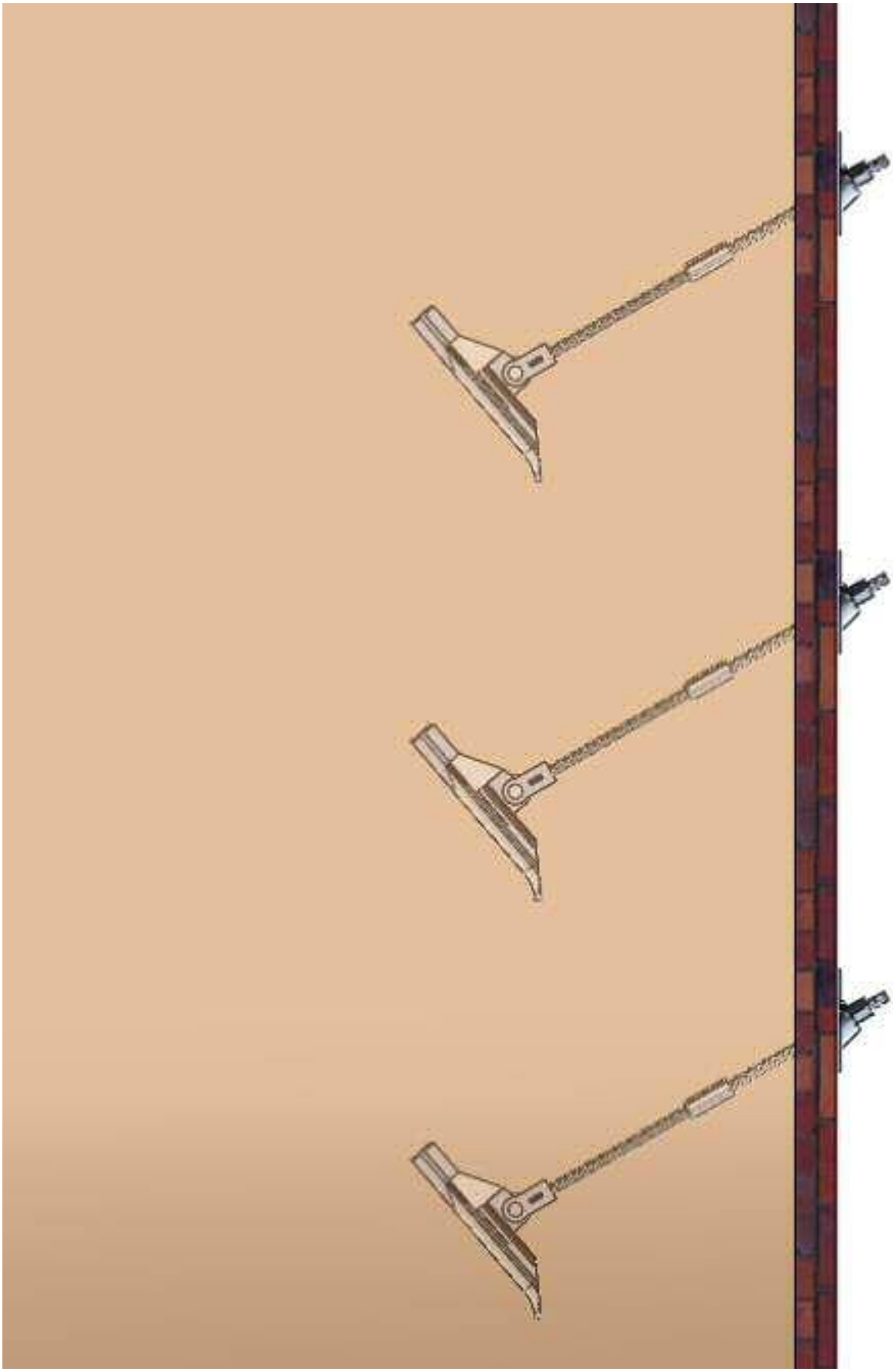
AS-300-SG-S-SG-BA-25-SG with Wedge Boss

Anchor Systems (Europe) Ltd, Unit 45 Rowfant Business Centre, Rowfant, West Sussex, RH10 4NQ



AS-300-SG-S-SG-BA-25-SG with Wedge Boss

Anchor Systems (Europe) Ltd, Unit 45 Rowfant Business Centre, Rowfant, West Sussex, RH10 4NQ



DUCKBILL®
Ground Anchor Systems

Project Report

ANCHOR SYSTEMS (EUROPE) LTD

North Wharf Gardens Piling Works

Client: **Amwaj Property Limited**
Contractor: **Taylor/Wimpey JV**
Installer: **Miller Piling Ltd**
Design: **J Reddington Limited**
Supply: **350No. AS-300 galvanised anchors at 9m depth**

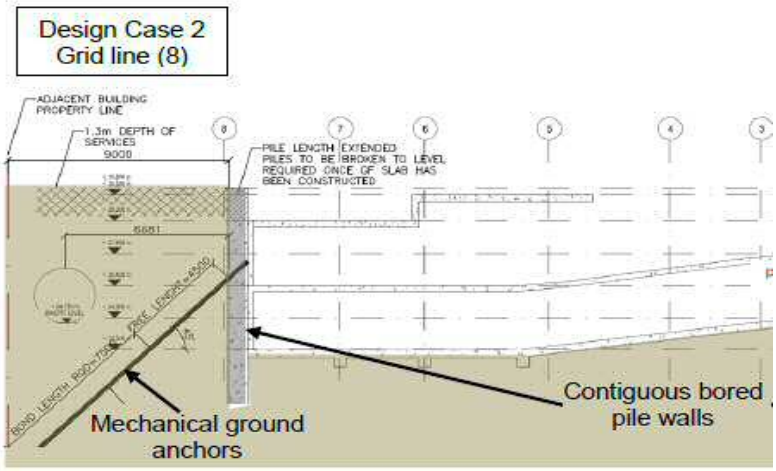
Requirements

Anchor Systems (Europe) Ltd (ASEL) were contacted by J-Reddington Group to design a mechanical anchoring system for North wharf gardens. The contiguous piling design was part of the Five star hotel groundwork's solution which is part of the wider mixed use scheme including 335 homes, affordable business, retail and social and community spaces, including a new primary school, serviced apartments and a gym.

ASEL in recommending the retaining system to counteract the bearing pressure on the walls, had to consider the existing Thames water services that are running adjacent to build area. ASEL also had to prove that the ground anchor system did not have a detrimental impact on the service pipes as a result of installing and loading the system.

Solution

ASEL were engaged by Miller Piling to work with J Reddington to provide a design for the ground anchor solution. We also provided calculations to support the fact that there would be no detrimental impact to local services. In the development of the ground anchor design an innovative whaler beam solution was used to distribute the anchor loads across the contiguous piled wall. This innovation created the understanding that a designed capping beam (est. £150k) was no longer required.



ASEL performed a site test to determine the localised soil mechanics failure condition. The AS-300 Ground Anchor was tensile tested to 224kN Ultimate Resistance based on the design and a lock off load (working load) of 157kN. The AS-300 ground anchors were installed to depths of 7-12m and average installation time was between 20-30 minutes using a 20 ton excavator. During the construction phase ASEL intermittently provided a site supervisory service to ensure that the construction of the grounds anchors were being completed to the design statement and installation methodology. Our involvement in this process ensured an unimpeded installation and subsequent working relationship with all parties.

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Anchor Systems (Europe) Ltd, Unit 45 Rowfant Business Centre, Rowfant, West Sussex, RH10 4NQ

DUCKBILL®
Ground Anchor Systems

PROJECT REPORT

M1 Junction 12

Client: **Highways Agency**
Engineers: **Costain Limited**
Contractor: **Piletec Geotechnical Ltd**

Requirements

The M1 Junction 12 North Bound on-ramp needed refurbishment as part of the M1 improvements. This involved the temporary anchoring of a sheet pile wall while allow the traffic to continue using the on ramp. The anchors were to be installed in 5 levels as the excavation was carried out.

The load requirement was up to 85 kN plus a F.O.S of 1.25, with the anchors ranging in depth from 9m to 6m.

Solution

The anchor of choice was the AS-200, this anchor is rated at 200 kN and came complete with a 25mm bar and load plate. Three anchors were tested by Anchor Systems (Europe) Ltd with the results being verified by the Costain Ltd Engineer

A total of 165 anchors were used over 5 levels, all of which tested to beyond the design requirement.

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DUCKBILL®
Ground Anchor Systems

PROJECT REPORT

SECURING HIGH LOAD SHEET PILING DURING UPGRADING OF THE A1(M)

Client & Main Contractor: **RMG Construction Joint Venture**
Installer: **WT Specialist Contracts Ltd**

Requirements

During the upgrading of the A1(M) to three and four lane motorway standard, extensive excavations for a new bridge abutment were required at Alconbury in Cambridgeshire where the A1 crossed a local road.

Deep sheet piling, with significant highway loadings above, was needed to retain the earthworks and provide a large margin for safety. Duckbill mechanical ground anchors from Anchor Systems (Europe) were specified by main contractor RMG Construction Joint Venture, comprising Alfred McAlpine, AMEC, Dragados and Brown & Root.

Solution

As excavations progressed for the abutment, installation of four rows of Duckbill anchors on the 9m high sheet piles was undertaken by sister company, WT Specialist Contracts.

Using a JCB with Montabert 125 breaker, WT drove the MR1 SG anchors, with 20mm high yield bars, to a depth of 6m into the dense clays and pulverised fuel ash.

For additional safety, due to the A1 traffic loadings, the anchors were grouted and, after 24 hours, tensioned to 130kN proof load. They were then relaxed to a 65kN working load, providing an adequate safety margin, and terminated with 20mm plates and load nuts.

RMG Construction Joint Venture chose the cost-effective Duckbill anchor system for its high capacity loadings capability and because supply, testing and rapid, trouble free deployment could all be undertaken by WT companies under sub contract.

DUCKBILL®
Ground Anchor Systems

PROJECT REPORT

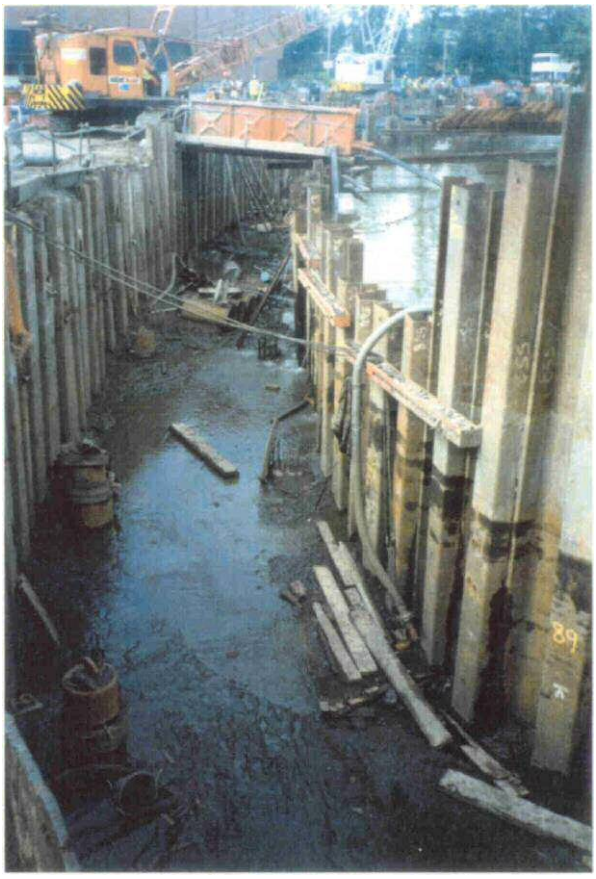
PEASHOLM GREEN BRIDGE JUNCTION IMPROVEMENTS, RIVER FOSS, YORK

Client: **City of York Council**
Main Contractor: **Alfred McAlpine Construction**
Installer: **WT Specialist Contracts**

Requirements

Part of the scheme for junction improvements at Peasholme Green Bridge over the River Foss involved renewing a section of river bank retaining wall and creating a new section of land to support the widened slip road to the new Foss bridge.

To enable this to happen sheet piling had to be secured along the bank, under difficult conditions and Duckbill anchors were selected for their strength, reliability and instant loading capacity and because both supply and installation could be undertaken, at the right price, by WT companies under a single subcontract arrangement.



Installation

Alfred McAlpine Construction first installed a row of sheet piles, some 2m from the existing bank retaining wall, which were tied across the river. A second row of piles was installed behind the wall and the area between the two rows of piles pumped out to allow a 150m section of the wall to be cut away. The landside piling then had to be anchored to allow a new retaining wall to be constructed and the section filled to support the widened slip road.

Operating on the soft silt in the narrow, wet area between the two sets of sheet piling, WT Specialist Contracts had to install the Duckbill ground anchors at 45^0, making sure to avoid a main Victorian trunk sewer, to retain the sheet piling.

With very limited access, WT used specialist equipment to drive the 6m long MR1 Duckbills with high yield bars into the soft clays and sandy gravels. After rapid proof loading to 110kN, each anchor was set at a working load of 50kN and terminated with an angled plate and load nut.

Nearly 150 Duckbill ground anchors were quickly and successfully installed and their ability to accept immediate working loads prevented any delays and ensured the smooth progress of the overall contract.

DUCKBILL®
Ground Anchor Systems

PROJECT REPORT

CENTURY WHARF, CARDIFF
- SECURING SHEET PILES FOR RIVERSIDE WALKWAY

Client: **Westbury Homes**
Engineers: **Veryards Consulting Engineers Ltd**
Main Contractor: **Opco**
Installer: **WT Specialist Contracts Ltd**

Requirements

As part of a new development at Century Walk in Cardiff, a new riverwalk was constructed in conjunction with Westbury Homes. The footpath on a 32m section of riverbank, previously retained with gabion baskets, needed to be widened and raised. New sheet piling, installed in front of the gabions, had to be effectively secured using an anchoring system with a design life of 120years and the new walkway brought up to standard for adoption by Cardiff City Council.

Solution

Project engineers, Veryards, specified our well proven Duckbill mechanical ground anchors because they could be supplied in complete Grade 316 stainless steel assemblies that would meet the required life expectancy in the sulphate contaminated ground. In addition, they were able to be installed in the confined working area and would achieve immediate proof loading.

Operating in restricted space on a narrow strip of land at the water's edge, WT Specialist Contracts used a special drill rig to install a total of 86 Duckbill anchors at three different levels.

The 59 MR1 anchors and 27 MR2 anchors were driven 6m into the gravel and cobble substrate and proof tested to the design load. They were then released to the required working load and secured with a stainless steel load plate and nut to fully secure the sheet piling for long term retention of the river bank.

NORTH WHARF GARDENS,

DUCKBILL® GROUND ANCHORS FOR CONTIGUOUS BORED PILE WALL,

DESIGN CALCULATIONS,

Revision A

October 2014

Tellus Design Limited

SE008, e-Innovation Centre, Telford Campus, Priorslee, Telford, Shropshire, TF2 9FT, UK

Tel: 01952 288331 I Mobile: 07584 079553 I Email: info@tellusdesign.co.uk

1 Introduction

This report contains design calculations for temporary mechanical ground anchors (Duckbill® system) forming part of a bored pile retaining wall. These temporary anchors are required to support the piled wall during excavation for a basement to a residential development. The maximum retained height of the bored pile wall is approximately 8.1m with the ground anchors installed towards the top of the wall (see Figure 1.1).

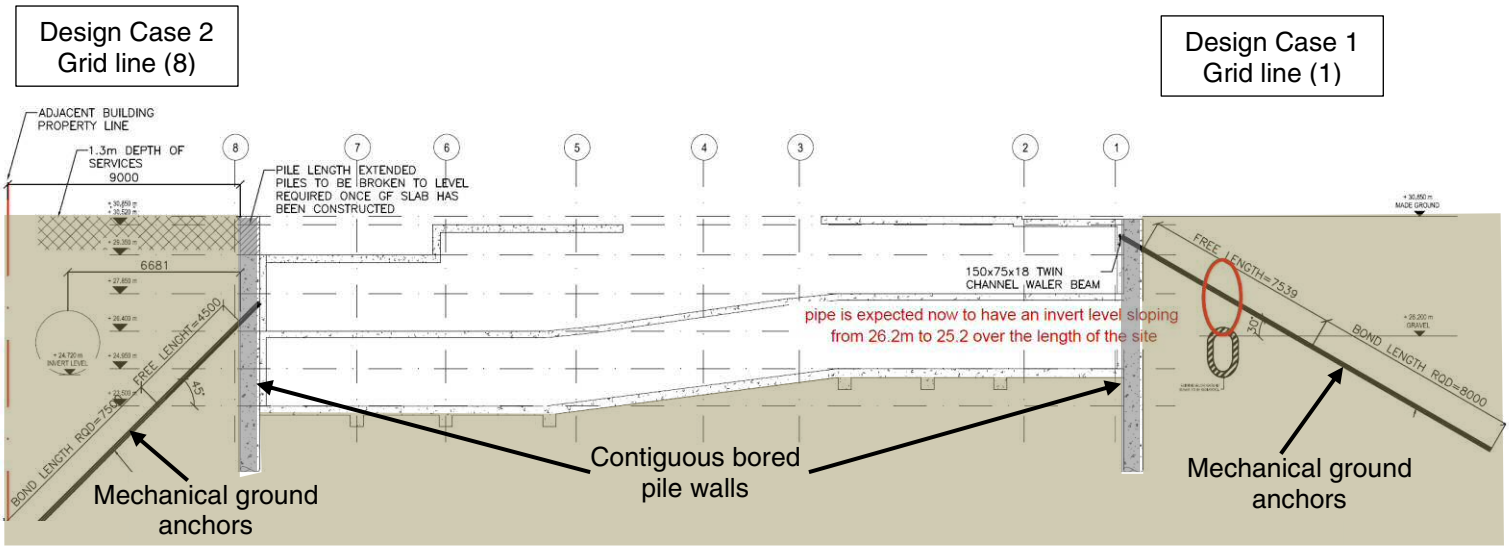


Figure 1.1. Typical cross section through basement

The design of the contiguous bored pile retaining wall has been carried out by Miller Piling Ltd, which included calculations for the required working loads of the anchors to ensure stability (expressed as a characteristic inclined load per anchor). The anchors are to be installed by Miller Piling Ltd. The piles for the scheme are spaced at 750mm centres.

The scope of this design is limited to assessing the capacity of the mechanical ground anchors to resist the specified working loads in accordance for BS EN 1997-1:2004 (i.e. Eurocode 7). The objectives of these calculations are to determine the design capacity of a single ground anchor installed at this site and provide an anchor design layout in terms of anchor type and length for the two design cases for anchors installed along Grid Line 1 and Grid Line 8.

2 Reference Documents

The design has been based upon the following documents provided by Anchor Systems (Europe) Limited.

Ground Investigation Report
- Site test reports for anchors installed and tested 15-07-14 & 18-07-14 – (ASEL), see Appendix 1

Piled Wall Design Data
- Capping Beam Propping/Anchor Tie Rod Design – 29-04-14 – (JRL)

Ground Anchor Technical Data
- Duckbill® Ground Anchor Systems – Products, Applications and Technical Information

Using data from the above documents, the working loads in Table 2.1 below have been used for the design of the anchors. These working loads are unfactored. For the design of the anchors to BS EN1997-1, these working loads will be considered as characteristic values and treated as unfavourable permanent actions.

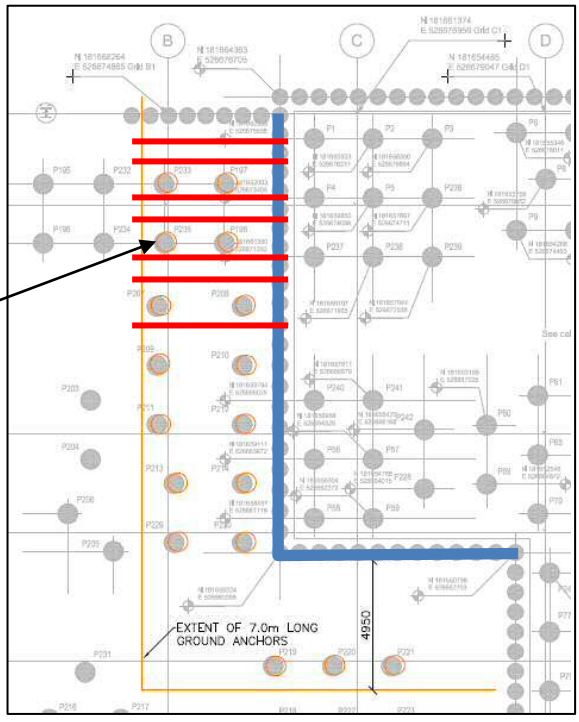
Table 2.1. Anchor working loads

Design Section	*Reduced ground level FPL (m AOD)*	*Anchor head level (m AOD)*	*Anchor inclination α (°)*	*Inclined anchor load (kN)*	*Horizontal spacing (m)*
Design Case 1 Grid Line (1)	30.85	30.00	30	137.0	1.50
Design Case 2 Grid Line (8)	30.85	27.00	45	144.0	0.75
Design Case 3a Grid Line B-C	30.85	27.95	45	156.9(2)	1.125(1)
Design Case 3b Grid Line B-C	30.85	27.95	30	128.1(2)	1.125(1)

Note:

1) Average anchor spacing based upon two anchors provided for every three piles (i.e. 3 × pile spacing / 2 = 3 × 0.75m / 2 = 1.125m)
2) Inclined anchor loads based upon a horizontal SLS prop force of 98.6kN/m (i.e. anchor load = 98.6 × 1.125 /cosα)

Design Case 3 – Exterior bearing piles obstructing anchors



Using the WALLAP retaining wall model from the JRL design report, the ground model shown in Figure 3.2 was developed for the anchor design.

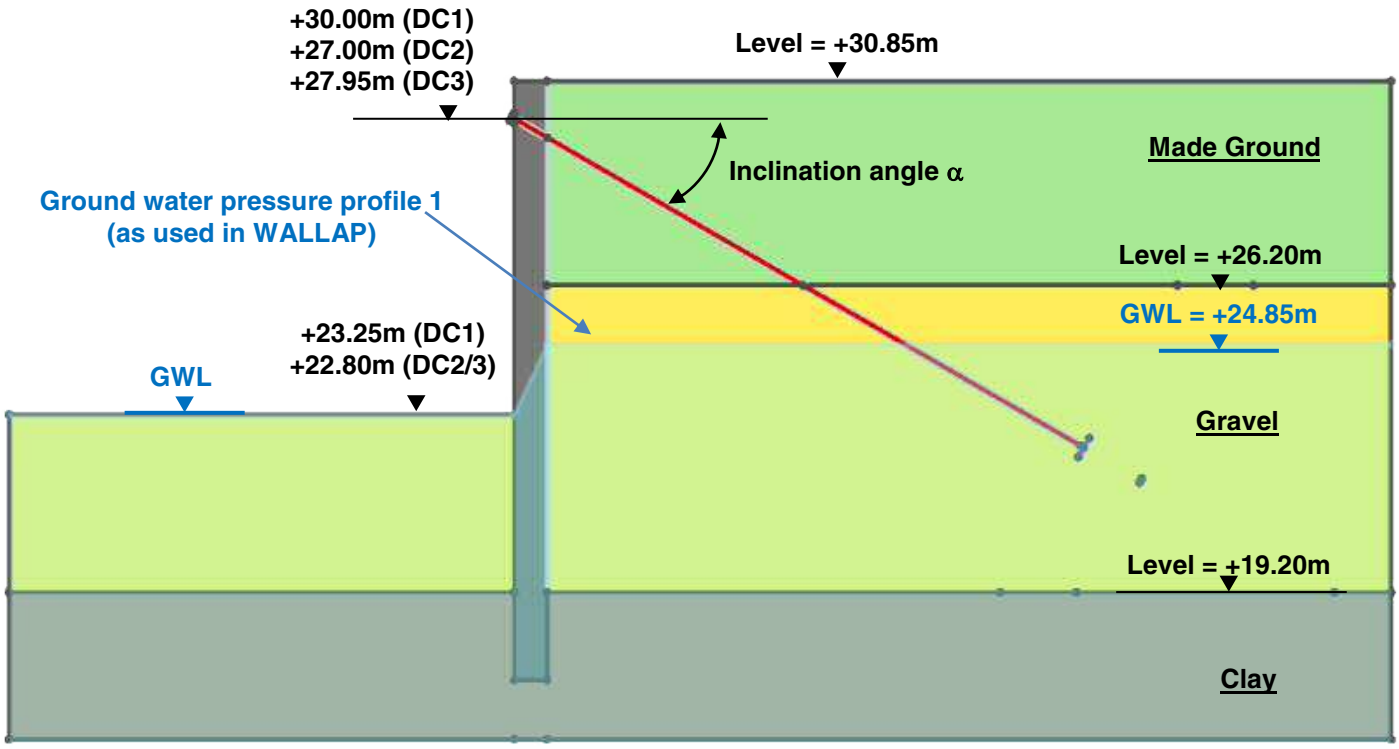


Figure 3.2. Ground model for design

Based on the ground model above and the test anchor results, the anchors will need to be driven into the Gravel to a level of at least 25.0m AOD. The pull-out capacity of the anchors will be based upon an effective stress analysis using effective shear strength parameters for the coarse grained Gravel deposits.

The pull-out capacity of the mechanical anchor has been estimated using the following four approaches:

(1) Historical data

With this approach, the ULTIMATE holding capacities are taken from ASEL's data table for anchors installed within common soil types. The data table is based upon SPT 'N' blow counts and descriptions of the soil types.

(2) Theoretical published design methods

A method for calculating the ultimate holding capacities for plate anchors in coarse grained soils is included in BS8006-1:2010 in the section concerning the design of anchored earth structures. The method relies upon the passive resistance of the soil in front of the anchor plate.

(3) Site suitability test results

The results of the site anchor tests are used to determine the characteristic value of pull-out resistance, $R_{a.k}$ using correlation factors to account for the number of tests performed.

4 Anchor Pull-Out Capacity Calculations

4.1 Historical Data

EC7 DA1-1

Partial load factor on unfavourable permanent actions $\gamma_G = 1.35$

Partial factor on prestressed anchorage resistance $\gamma_a = 1.10$

Maximum characteristic anchor force = 144kN (Design Case 2)

Maximum design anchor force $P_d = 1.35 \times 144 = 194.4$kN

Applying partial factor on anchorage resistance, $R_{a,k} = 194.4 \times 1.10 = 213.8$kN

Therefore, required characteristic anchor resistance, $R_{a,k} \geq 214$kN.

Assuming the anchor is driven into GRAVEL with an SPT 'N' value of 25, the ultimate holding capacity for a type AS300 anchor is between 210kN and 220kN. Hence, adequate resistance to satisfy DA1-1.

Note: Type AS120 anchor has surface area equivalent to the 97.6% of the AS300 anchor and would therefore be expected to achieve a proportionately lower ultimate holding capacity in the range 205kN to 215kN.

Common Soil Type Description	Geological Soil Classification	Blow Count or "SPT"	AS10	AS20	AS100	AS140	AS200	AS300
Very Dense and/or Cemented Sands; Course Gravel & Cobbles	Caliche, Nitrate Bearing Gravel	60 - 100+	10	20	100	140	200	300
Dense Fine Sand; Very Hard Silts & Clays	Basal Till; Boulder Clay Caliche;	45 - 60	10	20	90	140	200	285
Dense Clays, Sands & Gravel; Very Stiff to Hard Silts & Clays	Glacial Till; Weathered Shale's; Schist Gneiss Siltstone	35 - 50	10	20	90	140	200	270
Medium Dense Sandy Gravel; Very Stiff to Hard Silts & Clays	Glacial Till; Hardpan	25 - 40	8	18	70	110	150	220
Medium Dense Course Sand & Sandy Gravel; Stiff to Very Stiff Silts & clays	Saprolites Residual Soils	14 - 25	8	16	70	110	150	210
Loose to Medium Dense Fine to Course Sand; Firm to Stiff Clays & Silts	Dense Hydraulic Fill; Compacted Fill; Residual Soils	7 - 14	7	16	60	70	110	190
Loose Fine Sand; Alluvium;Soft-Firm Clays; Varied Clays; Fill	Flood Plain Soils; Lake Clays; Abode; Gumbo Fill	4 - 8	7	14	50	60	80	150
Peat, Organic Silts; Inundates Silts Fly Ash	Miscellaneous Fill; Swamp Marsh	0 - 5	5	12	40	50	20 - 50	20 - 80

4.3 Site suitability tests

The design value of the anchorage resistance, $R_{a,d}$, is derived from the characteristic value of pull-out resistance $R_{a,k}$ based on suitability tests. The design value, $R_{a,d}$, is obtained from the characteristic value by applying a partial factor, γ_a. In EN1997-1, the recommended value for the partial factor γ_a. is 1.1. A correlation factor ξ_a that accounts for the number of tests and variability of results is applied to the test results.

Two site tests were performed on a Type AS120 anchor (see results in Appendix 1). The measured holding capacities were as follows:

$R_{a.measured.min}$ = 224kN (at 8.85m depth)
$R_{a.measured.min}$ = 224kN (at 11.02m depth)

Allowing for a correlation factor of ξ_{a2} =1.20 based upon the results of less than three on-site tests, the characteristic values are:

$R_{a,k} = R_{a.measured.min} / \xi_{a2}$ =224/1.20 = 186.7kN per anchor (at 8.85m depth)
$R_{a,k} = R_{a.measured.min} / \xi_{a2}$ =224/1.20 = 186.7kN per anchor (at 11.02m depth)

Hence, the design resistance of the anchor types are:

$R_{a.d} = R_{a.k} / \gamma_a$.

$R_{a.d}$ = 186.7/ 1.10 = 169.7kN (at 8.85m depth)
$R_{a.d}$ = 186.7/ 1.10 = 169.7kN (at 11.02m depth)

EC7 DA1-1

Partial load factor on unfavourable permanent actions γ_G = 1.35

Maximum characteristic anchor force = 144kN (Design Case 2)

Maximum design anchor force P_d = 1.35 × 144 = 194.4kN

Design anchor resistance $R_{a,d}$ < Design anchor force P_d, therefore does not satisfy DA1-1

EC7 DA1-2

Partial load factor on unfavourable permanent actions γ_G = 1.00

Maximum characteristic anchor force = 144kN (Design Case 2)

Maximum design anchor force P_d = 1.0 × 144 = 144kN

Design anchor resistance $R_{a,d}$ > Design anchor force P_d, therefore does satisfy DA1-2

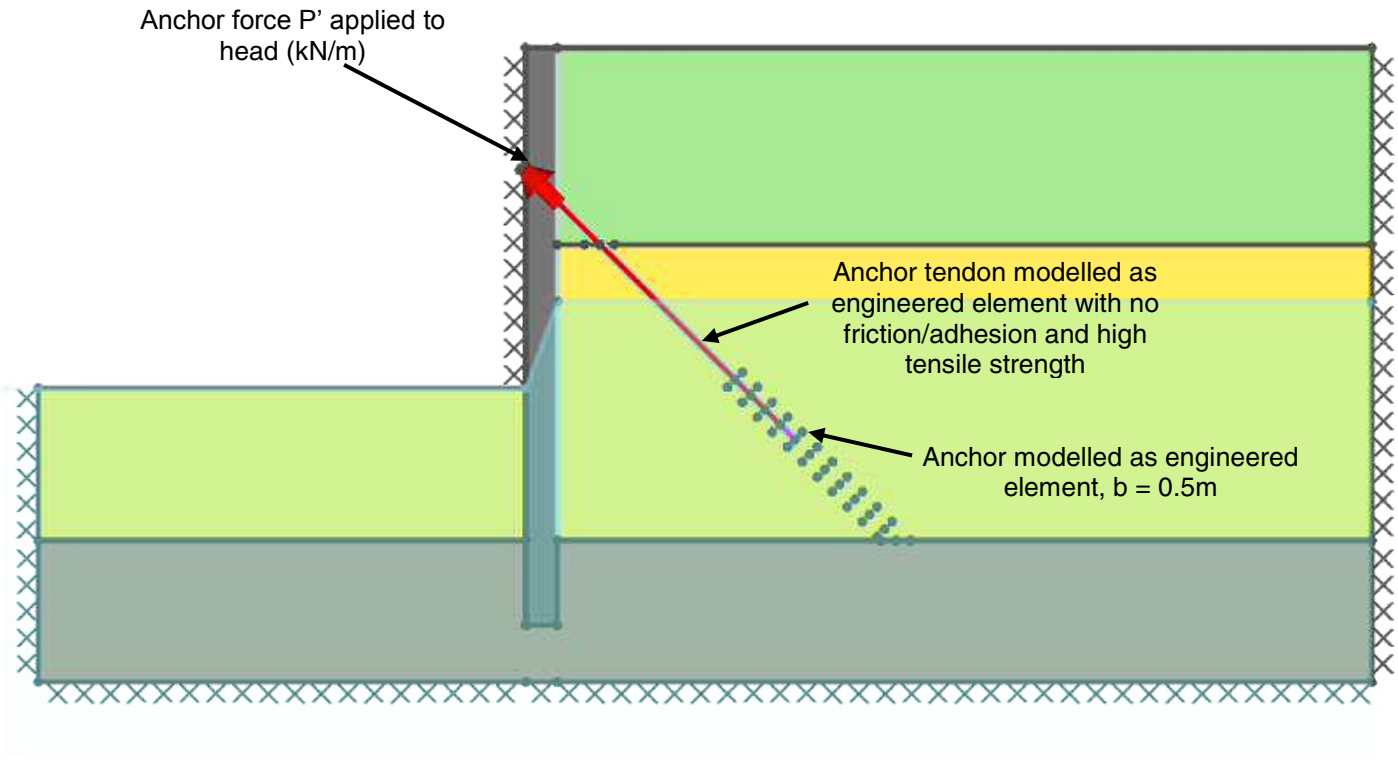


Figure 4.4.7. DC3a LimitState GEO model for inclined anchor pull-out capacity

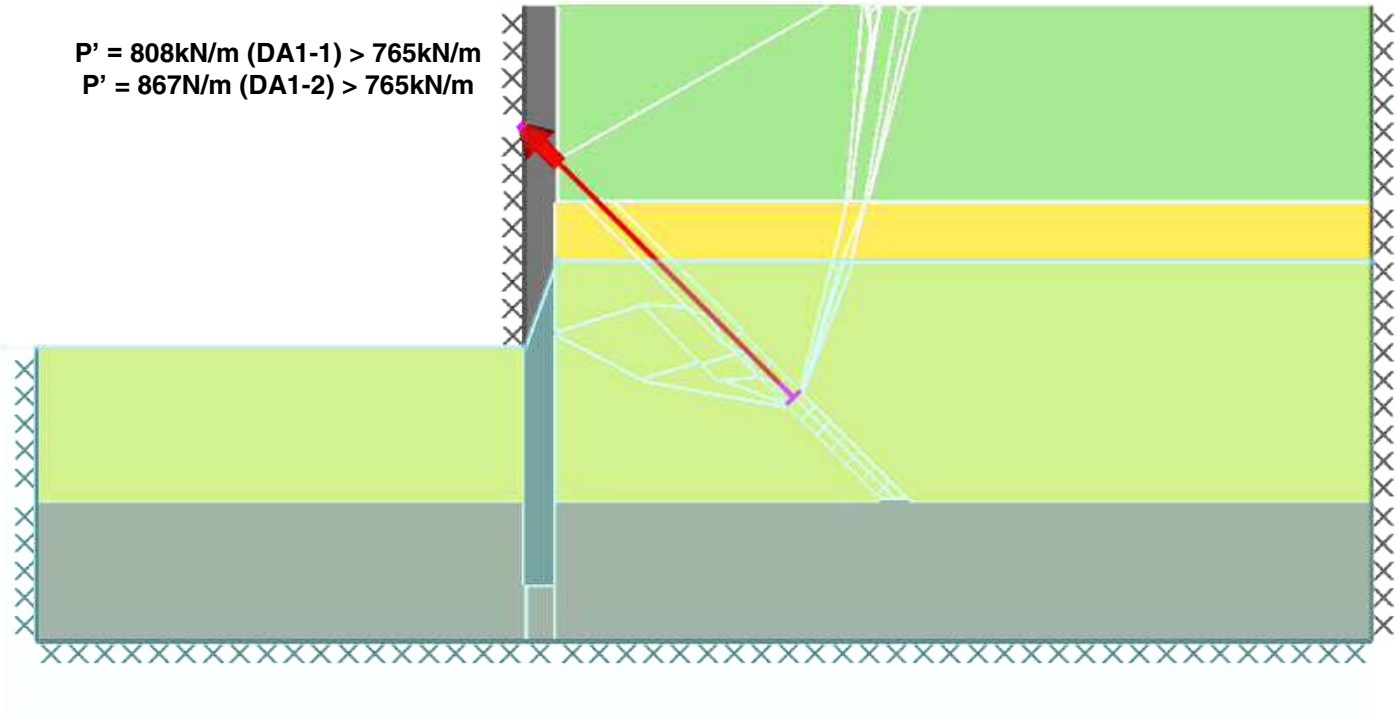


Figure 4.4.8. DC3a Pull-out failure - Inclined anchor pull-out capacity for 9m length

6 Conclusions

These calculations have demonstrated that the Type AS120 anchors have adequate pull-out capacity to resist the imposed loads from the contiguous bored pile wall for the temporary works phase. This assessment is based upon the anchors being installed within the Gravel layer.

The structural strength of the AS120 anchor has been assessed in a laboratory test up to a load of 222kN, at which point the 20mm diameter connection bar failed (not the anchor itself). Therefore, the anchor has adequate structural strength to resist the maximum design load of 212kN. The 25mm diameter threaded bar connecting the anchor to the waling beam has a yield strength of 246kN and is therefore adequate to resist the maximum design load on the anchor.

The anchor layout for these temporary works is summarised in Table 6.1.

Table 6.1. Summary of anchor layout

Design Section	***Horizontal spacing (m)***	***Lock-off anchor load (kN)***	***Anchor inclination α (°)***	***Anchor head level (m AOD)***	***Anchor base level (m AOD)***	***Anchor bar length (m)***
Design Case 1 Grid Line (1)	1.50	137.0	30	30.00	22.5	15.0
Design Case 2 Grid Line (8)	0.75	144.0	45	27.00	20.6	9.0
Design Case 3a Grid Line B-C	1.125	157.0	45	27.95	21.6	9.0
Design Case 3b Grid Line B-C	1.125	128.0	30	27.95	23.5	9.0

Notes:

1) All anchors are Duckbill Type AS120 with 25mm diameter proprietary threaded bar and mechanical couplers
2) Anchor bar length refers to the length of the installed steel bar BEFORE the anchor has been tensioned and rotated into the 'locked' position.
3) Anchors to be proof load tested to 180kN

Miller Piling West North Wharf Gardens

Site test carried out 15 July 2014
ASEI personel present,
Jordan Smith Works Manager & Gotham Selvadurai Graduate



Anchor Type	AS-140	Anchor length (m) 9-12m
Anchor Service load	140kN	Anchor Inclination 90°
Site Location	North Wharf Gardens	
Test Anchor Ref:	AS-140 (test 01,02)	Bar diameter 20 (mm)
Date Installed:	16/07/2014	Bar Ult Strength (kN) 188
Date Tested:	16/07/2014	70% of Ult Strength (kN) 132.0
Load required		140kN
Bar extraction during load		150mm - 630mm

Test number	Installation times	Instalation Depth	Bar exstension	Plate loss	Finished anchor depth	Load Achived
1	30 mins	9m	150mm	0mm	8850mm	133kN
2	40-45 mins	12m	630mm	0mm	11370mm	133kN

Notes
Observation of site test determind a recommended minimum drive depth of 9m to ensure swl are achived
Bearing plates to be placed perpendicularly to installation angle.
Displacement reading to be taken at start and finish of observation period (minimum)
20mm bar to be marked for supervisers to determine the drive depth of anchor head

Miller Piling West North Wharf Gardens

Site test carried out 18 July 2014
ASEI personel present,
Jordan Smith Works Manager & Gotham Selvadurai Graduate Engineer


Anchor Type	AS-120	Anchor length (m) 9-12m
Anchor Service load	120	Installed Vertical
Anchor ULS	222.5	
Site Location	North Wharf Gardens	
Test Anchor Ref:	AS-120 (test 01)	Bar diameter 20 (mm)
Date Installed:	18/07/2014	Bar Ult Strength (kN) 188
Date Tested:	18/07/2014	70% of Ult Strength (kN) 132.0
Load required		215kN
Bar extension at load		450mm

Test number	Installation times	Instalation Depth	Bar exstension	Plate loss	Finished anchor depth	Load Achieved
1	30 mins	9m	150mm	100mm	8750mm	224kN
2	30 mins	12m	830mm	150mm	1120mm	224kN

Notes
Observation of site test determind a minimum drive depth of 12m to ensure SWL is achieved
Bearing plates to be placed perpendicular to the angle of instalation.
Displacement reading to be taken at start and finish of observation period (minimum)
AS-120 SG iron anchor head to be used with 25mm Gewi LHT bar

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Anchor Systems (Europe) Limited
Unit 45, Rowfant Business Centre
Wallage Lane, Rowfant
West Sussex
RH10 4NQ

Report No:	13030278
PO Number:	KP/TEST/001
Date of Issue:	11/03/2013
Test Date :	08/03/2013
Tested in accordance with :	MTP2

Testing Report

Description: AS120 Utility Anchor – with 20mm diameter grade 75 B500/550 All Thread Bar (ATB)

Method of Test:

The samples were tested in a universal testing machine serial number T49 calibrated to national standards.
The samples were held using fittings suitable for both the machine and the items under test.
Loading was applied uniformally in tension until no further load could be applied or failure occurred.

Results:

Test Number	Marks	Maximum Load kN	Remarks
1	--	222.2	Fracture occurred in the rebar clear of the fastenings

Issued By:

B Bullen

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Report No:	9110097S
Issue Date:	08/03/2013
Order No:	51035/B
Test Date:	03/11/2009

Test Report

Method of Test:

The sample was tested in a universal testing machine serial number T49 calibrated to national standards.
The sample was held using fittings suitable for both the machine and the items under test.
Loading was applied uniformally in tension until no further load could be applied or failure occurred.

Results:

Description	Maximum Load		Remarks
	Tonne	kN	
AS200 Soil Anchor assembly with M30 threaded bar and nut	36.37	356.7	The anchor assembly deformed and cracked at the hollow section of the centre lug

This report has been issued supplementary to and replaces report serial no: 9110097

Issued by:
B A Bullen
Assistant Manager
Mechanical Testing