J ROBERTS DESIGN LTD
STRUCTURAL AND CIVIL ENGINEERING CONSULTANTS

SEGRO PARK

N. Hyde Gardens

Hayes

UB3 4QR

STRUCTURAL CALCULATIONS
6.1m Tall Sign

1393 – 179 / Jan 2023

Introduction

The following calculations are in justification of the posts, baseplates and foundations required for a new sign.

Refer to all drawings and details.

Standards and References

BS EN 1990:2002+A1 Basis of Structural Design
BS EN 1991-1-1:2002 Actions on Structures – Densities, self-weight, Imposed Loads for buildings
BS EN 1991-1-3:2002 Actions on Structures – Snow Loads
BS EN 1991-1-4:2005 Actions on Structures – Wind Loads
BS EN 1991-1-7:2006 Actions on Structures – Accidental Actions
BS EN 1992-1-1:2004 Design of Concrete Structures – General Rules and rules for buildings
BS EN 1993-1-1:2005 Design of Steel Structures – General Rules and rules for buildings
BS EN 1995-1-1:2004+A1:2008 Design of Timber Structures – Common Rules and rules for buildings
BS EN 1996-1-1:2005 Design of Masonry Structures – General rules for reinforced and unreinforced masonry structures
BS EN 1996-3:2006 Design of Masonry Structures – Simplified calculation methods for unreinforced masonry structures
BS EN 1997-1:2004 Geotechnical Design – General Rules

All associated NA to the above codes of practice

BS 8004: 1986 Foundations.
BS 5977 – 1: 1981 Lintel Specification.
Concrete Centre – Concise Eurocode 2 Design Guide
Concrete Centre – How to Design Concrete Structures using Eurocode 2
IStructE Design Guides for Eurocode 1-7
CE Mark Standard BS EN 1090 - Execution Class 3

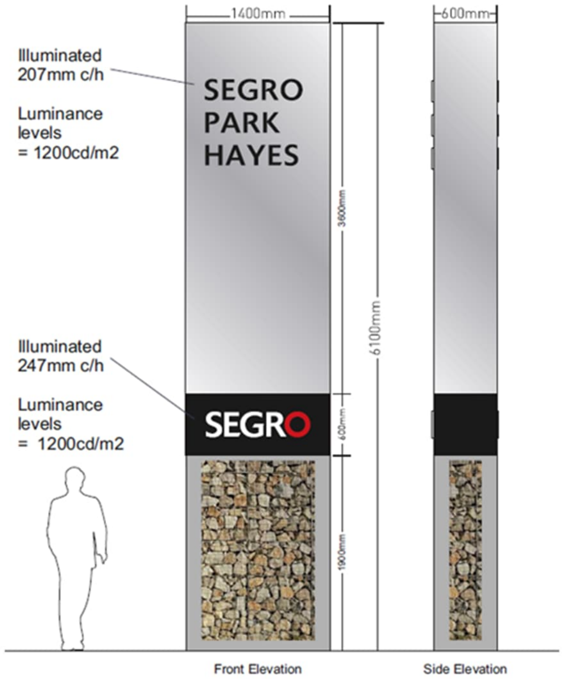
Building Regulations

It is the client’s responsibility to ensure these calculations are submitted to Building Control for Building Regulations approval under a Building Notice or Full Application as required.

J Roberts Design Ltd Structural and Civil Engineering Consultants	Project Segro Park Totem			Job Ref. 1393 -179	
	Section Signpost and Foundation Design			Sheet no./rev. 2	
	Calc. by LM	Date 24/01/2023	Chk'd by JR	Date 25/01/2023	App'd by	Date

LOADS

Wind loads



Post Code UB3 4QR
Grid Reference 510256E, 179158N
Altitude approx. 32.0maOD

Wind load; $q = 0.506\text{kN/m}^2$;

Rectangular Sign with 2 legs
Sign Dimensions;
Width; $b1 = 1.40\text{m}$;
Depth; $d1 = 6.10\text{m}$;

;b1/d1 = **0.230**; <1
Sign wind loading coefficient; cf = 1.8
Design wind load; $P = q \times cf =$ **0.911** kN/m^2;

Deflection limits; 1 in 100 for 50yr wind
; 1 in 150 for 1yr wind

SIGN

Sign Area; $Ae = b1 \times d1 =$ **8.540** m^2;
Number of posts; N1 = 4

Wind Load per post; $Wf1 = P \times b1 / 4 =$ **0.319** kN/m;

Steel

Beam Design

Beam Design Summary

Static

Member Reference	Group Ref.	Span	Section	Grade	Length [m]	No. Connectors	Camber	Utilization	Status
SB 3/C/1-3/C/3	SBR3	1	SHS 100x100x5.0	S355	0.600		0.0	0.024	✔ Pass
SB 3/A/3-3/C/3	SBR2	1	SHS 100x100x5.0	S355	1.400		0.0	0.001l	✔ Pass
SB 3/A/3-3/A/1	SBR4	1	SHS 100x100x5.0	S355	0.600		0.0	0.024	✔ Pass
SB 3/C/1-3/A/1	SBR5	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	✔ Pass
SB 2/A/1-2/C/1	SBR5	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	✔ Pass
SB 2/C/3-2/C/1	SBR4	1	SHS 100x100x5.0	S355	0.600		0.0	0.297	✔ Pass
SB 2/C/3-2/A/3	SBR5	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	✔ Pass
SB 2/A/3-2/A/1	SBR4	1	SHS 100x100x5.0	S355	0.600		0.0	0.297	✔ Pass
SB FRM C/%1-FRM C/3/#114	SBR6	1	SHS 100x100x5.0	S355	0.600		0.0	0.096	✔ Pass
SB FRM 3/C/#115-FRM 3/%2	SBR8	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	✔ Pass
SB FRM A/3/#116-FRM A/%3	SBR9	1	SHS 100x100x5.0	S355	0.600		0.0	0.096	✔ Pass
SB FRM 1/%4-FRM 1/C/#117	SBR7	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	✔ Pass

Column Design

Column Design Summary

Static

Member Reference	Group Ref.	Stack	Section	Grade	Length [m]	Utilization	Status
SC B/2	SCR4	1	SHS 100x100x5.0	S355	2.150	0.219	Pass
SC B/2	SCR4	2	SHS 100x100x5.0	S355	4.200	0.073	Pass
SC B/3	SCR4	1	SHS 100x100x5.0	S355	2.150	0.241	Pass
SC B/3	SCR4	2	SHS 100x100x5.0	S355	4.200	0.077	Pass
SC C/3	SCR4	1	SHS 100x100x5.0	S355	2.150	0.241	Pass
SC C/3	SCR4	2	SHS 100x100x5.0	S355	4.200	0.077	Pass
SC C/1	SCR4	1	SHS 100x100x5.0	S355	2.150	0.219	Pass
SC C/1	SCR4	2	SHS 100x100x5.0	S355	4.200	0.073	Pass

Concrete

Slab/Mat Design

Slab/Mat Design Summary

Static & RSA

No entity matches the filter for the current report item.

Steel

Beam Design

Beam Design Summary

Static

Member Reference	Group Ref.	Span	Section	Grade	Length [m]	No. Connectors	Camber	Utilization	Status
SB 3/C/1-3/C/3	SBR3	1	SHS 100x100x5.0	S355	0.600		0.0	0.024	Pass
SB 3/A/3-3/C/3	SBR2	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	Pass
SB 3/A/3-3/A/1	SBR4	1	SHS 100x100x5.0	S355	0.600		0.0	0.024	Pass
SB 3/C/1-3/A/1	SBR5	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	Pass
SB 2/A/1-2/C/1	SBR5	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	Pass
SB 2/C/3-2/C/1	SBR4	1	SHS 100x100x5.0	S355	0.600		0.0	0.297	Pass
SB 2/C/3-2/A/3	SBR5	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	Pass
SB 2/A/3-2/A/1	SBR4	1	SHS 100x100x5.0	S355	0.600		0.0	0.297	Pass
SB FRM C/%1-FRM C/3/#114	SBR6	1	SHS 100x100x5.0	S355	0.600		0.0	0.096	Pass
SB FRM 3/C/#115-FRM 3/%2	SBR8	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	Pass
SB FRM A/3/#116-FRM A/%3	SBR9	1	SHS 100x100x5.0	S355	0.600		0.0	0.096	Pass
SB FRM 1/%4-FRM 1/C/#117	SBR7	1	SHS 100x100x5.0	S355	1.400		0.0	0.001	Pass

Column Design

Column Design Summary

Static

Member Reference	Group Ref.	Stack	Section	Grade	Length [m]	Utilization	Status
SC B/2	SCR4	1	SHS 100x100x5.0	S355	2.150	0.219	Pass
SC B/2	SCR4	2	SHS 100x100x5.0	S355	4.200	0.073	Pass
SC B/3	SCR4	1	SHS 100x100x5.0	S355	2.150	0.241	Pass
SC B/3	SCR4	2	SHS 100x100x5.0	S355	4.200	0.077	Pass
SC C/3	SCR4	1	SHS 100x100x5.0	S355	2.150	0.241	Pass

Member Reference	Group Ref.	Stack	Section	Grade	Length [m]	Utilization	Status
SC C/3	SCR4	2	SHS 100x100x5.0	S355	4.200	0.077	✔ Pass
SC C/1	SCR4	1	SHS 100x100x5.0	S355	2.150	0.219	✔ Pass
SC C/1	SCR4	2	SHS 100x100x5.0	S355	4.200	0.073	✔ Pass

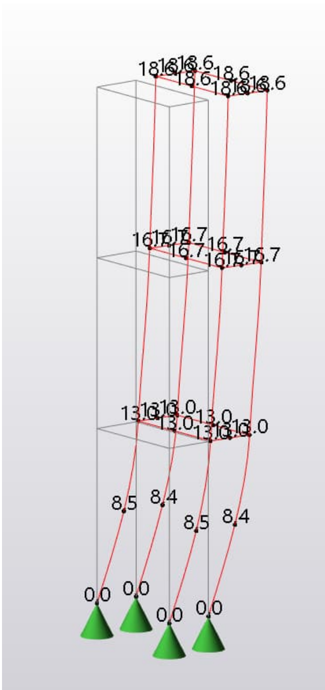
Concrete

Slab/Mat Design

Slab/Mat Design Summary

Static & RSA

No entity matches the filter for the current report item.



Deflection is in columns is h/300; Dlim = 6100mm / 300mm = **20.333**;mm

Design Deflection: Ddes = 18.6mm < 20.333mm, therefore satisfactory

The posts are tied together with a minimum of 3 levels of No 100x100x5.0SHS S355 using 6mm fillet weld cross members fully welded to the face of the posts. By inspection these will be satisfactory.

FOUNDATION NALYSIS & DESIGN (EN1992/EN1997)

FOUNDATION ANALYSIS

In accordance with EN1997-1:2004 + A1:2013 incorporating corrigendum February 2009 and the UK National Annex incorporating corrigendum No.1

Tedds calculation version 3.3.05

Summary table

Description	**Unit**	**Allowable**	**Actual**	**Utilisation**	**Result**
Uplift	kN	70	64.2	0.917	Pass
Sliding	kN	34.6	12	0.346	Pass
Base pressure	kN/m^2	50.1	28.9	0.576	Pass
Description	**Unit**	**Provided**	**Required**	**Utilisation**	**Result**
Reinforcement x-dir, top	mm^2	1728	1693	0.980	Pass
Reinforcement x-direction	mm^2	1728	1693	0.980	Pass
Reinforcement y-direction	mm^2	1728	1725	0.998	Pass
Description	**Unit**	**Allowable**	**Actual**	**Utilisation**	**Result**
Shear x-axis	kN	446	2	0.005	Pass
Shear y-axis	kN	446	11	0.024	Pass
Punching shear	N/mm^2	4.529	0.234	0.052	Pass

Pad foundation details

Length of foundation; L_x = **2200** mm;

Width of foundation; L_y = **2200** mm

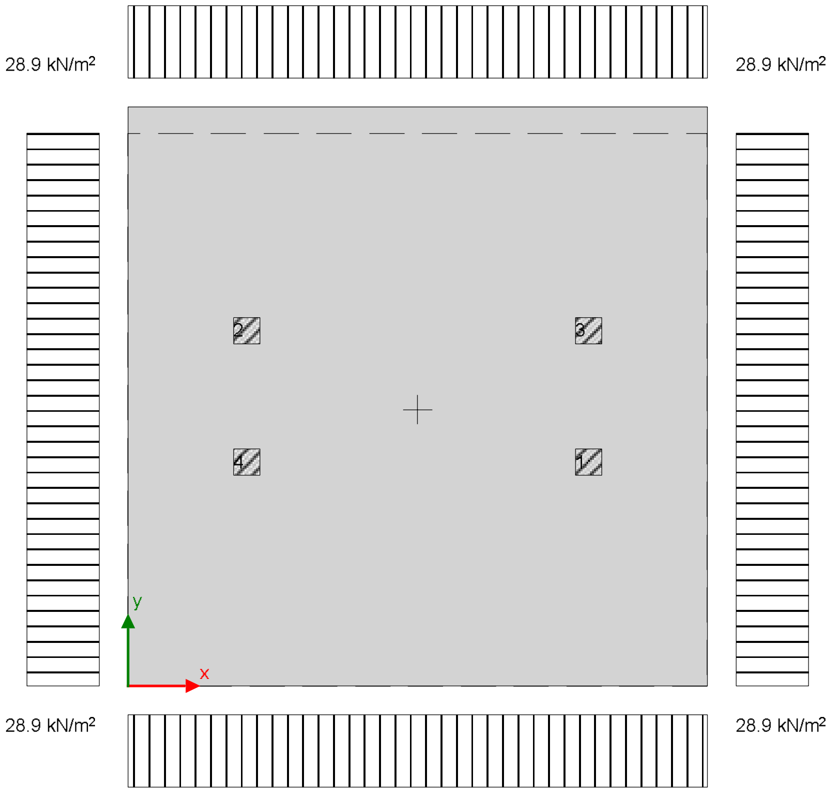
Depth of foundation; h = **600** mm;

Depth of soil over foundation; h_{soil} = **0** mm

Level of water; h_{water} = **0** mm;

Density of water; γ_{water} = **9.8** kN/m^3

Density of concrete; γ_{conc} = **25.0** kN/m^3



Column no.1 details

Length of column;	l_{x1} = **100** mm;	Width of column;	l_{y1} = **100** mm
position in x-direction;	x_1 = **1750** mm;	position in y-direction;	y_1 = **850** mm

Column no.2 details

Length of column;	l_{x2} = **100** mm;	Width of column;	l_{y2} = **100** mm
position in x-direction;	x_2 = **450** mm;	position in y-direction;	y_2 = **1350** mm

Column no.3 details

Length of column;	l_{x3} = **100** mm;	Width of column;	l_{y3} = **100** mm
position in x-direction;	x_3 = **1750** mm;	position in y-direction;	y_3 = **1350** mm

Column no.4 details

Length of column;	l_{x4} = **100** mm;	Width of column;	l_{y4} = **100** mm
position in x-direction;	x_4 = **450** mm;	position in y-direction;	y_4 = **850** mm

Soil properties

Density of soil;	γ_{soil} = **18.0** kN/m^3;	Undrained shear strength;	$c_{u.k}$ = **10** kN/m^2
Friction angle;	δ_k = **20** deg		

Foundation loads

Self weight;	F_{swt} = **15.0** kN/m^2

Column no.1 loads

Permanent axial load;	F_{Gz1} = **1.3** kN;	Wind load in y-dir;	F_{Wy1} = **2.3** kN
Wind axial load;	F_{Wz1} = **21.4** kN		

Column no.2 loads

Permanent axial load;	F_{Gz2} = **1.3** kN;	Wind load in y-dir;	F_{Wy2} = **2.3** kN

Wind axial load; F_{Wz2} = **-21.4** kN

Column no.3 loads

Permanent axial load; F_{Gz3} = **1.3** kN; Wind load in y-dir; F_{Wy3} = **2.3** kN

Wind axial load; F_{Wz3} = **-21.4** kN

Column no.4 loads

Permanent axial load; F_{Gz4} = **1.3** kN; Wind load in y-dir; F_{Wy4} = **2.3** kN

Wind axial load; F_{Wz4} = **21.4** kN

Design approach 1

Partial factors on actions - Combination1

Partial factor set; A1

Permanent action; γ_G = **1.35**; Variable action; γ_Q = **1.50**

;**Partial factors for soil parameters - Combination1**

Soil factor set; M1

Angle of shearing resistance; $\gamma_{\phi'}$ = **1.00**; Undrained cohesion; γ_{cu} = **1.00**

;**Partial factors for spread foundations - Combination1**

Resistance factor set; R1

Bearing; $\gamma_{R.v}$ = **1.00**; Sliding; $\gamma_{R.h}$ = **1.00**

;**Bearing resistance (Section 6.5.2)**

Forces on foundation

Force in y-direction; F_{dy} = **13.8** kN; Force in z-direction; F_{dz} = **169.2** kN

Moments on foundation

Moment in x-direction; M_{dx} = **186.2** kNm; Moment in y-direction; M_{dy} = **178.4** kNm

Eccentricity of base reaction

Eccentricity in x-direction; e_x = **0** mm; Eccentricity in y-direction; e_y = **-46** mm

Effective area of base

Effective length; L'_x = **2200** mm; Effective width; L'_y = **2108** mm

Effective area; A' = **4.638** m^2

Pad base pressure

Design base pressure; f_{dz} = **36.5** kN/m^2

Net ultimate bearing capacity under undrained conditions (Annex D.3)

Net ultimate bearing capacity; n_f = **67.1** kN/m^2

Library item: Undrained bearing summary

PASS - Ultimate bearing capacity exceeds design base pressure

Sliding resistance (Section 6.5.3)

Forces on foundation

Force in y-direction; F_{dy} = **13.8** kN; Force in z-direction; F_{dz} = **13.6** kN

Sliding resistance verification (Section 6.5.3)

Horizontal force on foundation; H = **13.8** kN; Sliding resistance; $R_{H.d}$ = **48.4** kN

$H / R_{H.d}$ = **0.285**

PASS - Foundation is not subject to failure by sliding

Library item: Check sliding summary

Design approach 1

Partial factors on actions - Combination2

Partial factor set; A2

Permanent action; γ_G = **1.00**; Variable action; γ_Q = **1.30**

;**Partial factors for soil parameters - Combination2**

Soil factor set; M2

Angle of shearing resistance; $\gamma_{\phi'}$ = **1.25**; Undrained cohesion; γ_{cu} = **1.40**

;**Partial factors for spread foundations - Combination2**

Resistance factor set; R1

Bearing; $\gamma_{R.v}$ = **1.00**; Sliding; $\gamma_{R.h}$ = **1.00**

;**Bearing resistance (Section 6.5.2)**

Forces on foundation

Force in y-direction; F_{dy} = **12.0** kN; Force in z-direction; F_{dz} = **133.4** kN

Moments on foundation

Moment in x-direction; M_{dx} = **146.8** kNm; Moment in y-direction; M_{dy} = **140.1** kNm

Eccentricity of base reaction

Eccentricity in x-direction; e_x = **0** mm; Eccentricity in y-direction; e_y = **-50** mm

Effective area of base

Effective length; L'_x = **2200** mm; Effective width; L'_y = **2099** mm

Effective area; A' = **4.618** m^2

Pad base pressure

Design base pressure; f_{dz} = **28.9** kN/m^2

Net ultimate bearing capacity under undrained conditions (Annex D.3)

Net ultimate bearing capacity; n_f = **50.1** kN/m^2

Library item: Undrained bearing summary

PASS - Ultimate bearing capacity exceeds design base pressure

Sliding resistance (Section 6.5.3)

Forces on foundation

Force in y-direction; F_{dy} = **12.0** kN; Force in z-direction; F_{dz} = **22.2** kN

Sliding resistance verification (Section 6.5.3)

Horizontal force on foundation; H = **12.0** kN; Sliding resistance; $R_{H.d}$ = **34.6** kN

H / $R_{H.d}$ = **0.346**

PASS - Foundation is not subject to failure by sliding

Library item: Check sliding summary

Partial factors for uplift limit state - Table A.NA.15

Permanent unfavourable action; $\gamma_{G.dst}$ = **1.10**; Permanent favourable action; $\gamma_{G.stb}$ = **0.90**

Variable favourable action; $\gamma_{Q.dst}$ = **1.50**

Uplift limit state verification

Vertical force; $F_{dz.u}$ = **5.8** kN

PASS - Foundation is not subject to failure by uplift

<u>FOUNDATION DESIGN</u>

In accordance with EN1992-1-1:2004 + A1:2014 incorporating corrigenda January 2008, November 2010 and January 2014 and the UK National Annex incorporating National Amendment No.1 and No.2

Tedds calculation version 3.3.05

Concrete details (Table 3.1 - Strength and deformation characteristics for concrete)

Concrete strength class; C28/35; Char.comp.cylinder strength; f_{ck} = **28** N/mm^2

Partial factor for concrete; γ_C = **1.50**; Maximum aggregate size; h_{agg} = **20** mm

Design compressive strength; f_{cd} = **17.0** N/mm^2; Design tensile strength, plain; $f_{ctd,pl}$ = **1.1** N/mm^2

Reinforcement details

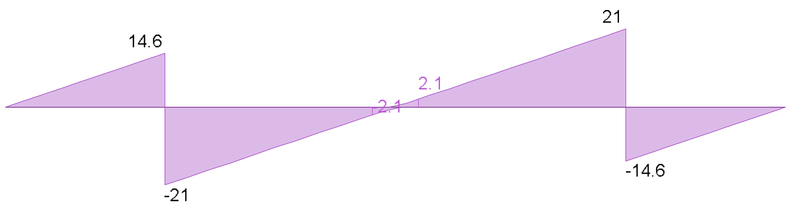
Characteristic yield strength; f_{yk} = **500** N/mm^2; Partial factor for reinforcment; γ_S = **1.15**

Design yield strength; f_{yd} = **435** N/mm^2; Nominal cover to top; c_{nom_t} = **50** mm

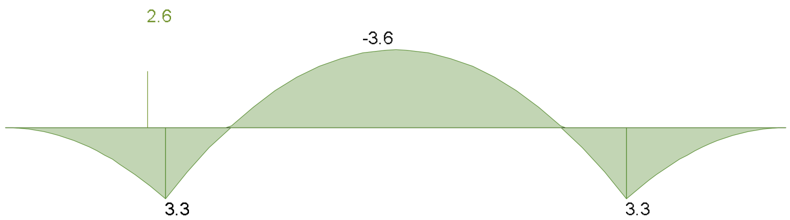
Nominal cover to bottom; c_{nom_b} = **50** mm; Nominal cover to side; c_{nom_s} = **50** mm

Nominal cover to top reinforcement; c_{nom_t} = **50** mm

Shear diagram, x axis (kN)



Moment diagram, x axis (kNm)



Rectangular section in flexure (Section 6.1)

Design bending moment; $M_{Ed.x.max}$ = **2.6** kNm; K = **0.000**; K' = **0.176**

K' > K - No compression reinforcement is required

Tens.reinforcement required; $A_{sx.bot.req}$ = **1693** mm^2

Tens.reinforcement provided; 10 ϕ bars @ 100 c/c bottom; $A_{sx.bot.prov}$ = **1728** mm^2

Min.area of reinforcement; $A_{s.min}$ = **1693** mm^2; Max.area of reinforcement; $A_{s.max}$ = **47080** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control (Section 7.3)

Limiting crack width; w_{max} = **0.3** mm; Maximum crack width; w_k = **0.001** mm

PASS - Maximum crack width is less than limiting crack width

Rectangular section in flexure (Section 6.1)

Design bending moment; abs($M_{Ed.x.min}$) = **3.6** kNm; K = **0.000**; K' = **0.176**

K' > K - No compression reinforcement is required

Tens.reinforcement required; $A_{sx.top.req}$ = **1693** mm^2

Tens.reinforcement provided; 10 ϕ bars @ 100 c/c top; $A_{sx.top.prov}$ = **1728** mm^2

Min.area of reinforcement; $A_{s.min}$ = **1693** mm^2; Max.area of reinforcement; $A_{s.max}$ = **47080** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control (Section 7.3)

Limiting crack width; w_{max} = **0.3** mm; Maximum crack width; w_k = **0.002** mm

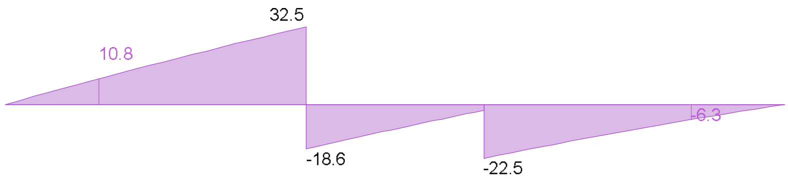
PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear (Section 6.2)

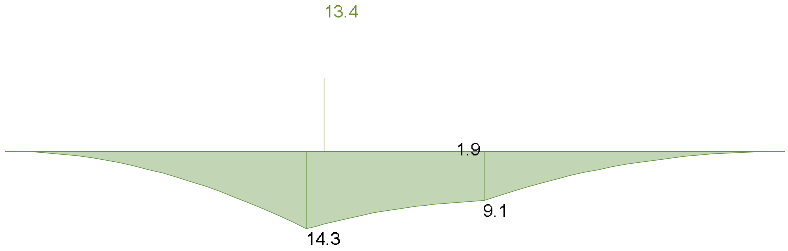
Design shear force; $V_{Ed.x.max}$ = **2.1** kN; Design shear resistance; $V_{Rd.c}$ = **445.9** kN

PASS - Design shear resistance exceeds design shear force

Shear diagram, y axis (kN)



Moment diagram, y axis (kNm)



Rectangular section in flexure (Section 6.1)

Design bending moment; $M_{Ed.y.max}$ = **13.4** kNm; K = **0.001**; K' = **0.176**

K' > K - No compression reinforcement is required

Tens.reinforcement required; $A_{sy.bot.req}$ = **1725** mm^2

Tens.reinforcement provided; 10 ϕ bars @ 100 c/c bottom; $A_{sy.bot.prov}$ = **1728** mm^2

Min.area of reinforcement; $A_{s.min}$ = **1725** mm^2; Max.area of reinforcement; $A_{s.max}$ = **47960** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control (Section 7.3)

Limiting crack width; w_{max} = **0.3** mm; Maximum crack width; w_k = **0.006** mm

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear (Section 6.2)

Design shear force; $V_{Ed.y.max}$ = **10.8** kN; Design shear resistance; $V_{Rd.c}$ = **445.9** kN

PASS - Design shear resistance exceeds design shear force

Punching shear (Section 6.4)

Maximum shear resiastance; $v_{Rd.max}$ = **4.529** N/mm^2; Punching shear resistance; $v_{Rd.c}$ = **0.379** N/mm^2

Column No.1 - Punching shear perimeter at column face

Punching shear perimeter; u_0 = **400** mm; Area within shear perimeter; A_0 = **0.010** m^2

Max.punching shear force; $V_{Ed.max}$ = **33.7** kN

Punching shear stress factor; β = **1.500**; Max.punching shear stress; $v_{Ed.max}$ = **0.234** N/mm^2

PASS - Maximum punching shear resistance exceeds maximum punching shear stress

Column No.1 - Punching shear perimeter at 1d from column face

Punching shear perimeter; u_1 = **2897** mm; Area within shear perimeter; A_1 = **1.058** m^2

Design punching shear force; $V_{Ed.1}$ = **16.7** kN

Punching shear stress factor; β = **1.500**; Design punching shear stress; $v_{Ed.1}$ = **0.016** N/mm^2

PASS - Design punching shear resistance exceeds increased design punching shear stress

Column No.2 - Punching shear perimeter at column face

Punching shear perimeter; u_0 = **400** mm; Area within shear perimeter; A_0 = **0.010** m^2

Max.punching shear force; $V_{Ed.max}$ = **1.6** kN

Punching shear stress factor; β = **1.500**; Max.punching shear stress; $v_{Ed.max}$ = **0.011** N/mm^2

PASS - Maximum punching shear resistance exceeds maximum punching shear stress

Column No.3 - Punching shear perimeter at column face

Punching shear perimeter; u_0 = **400** mm; Area within shear perimeter; A_0 = **0.010** m^2

Max.punching shear force; $V_{Ed.max}$ = **1.6** kN

Punching shear stress factor; β = **1.500**; Max.punching shear stress; $v_{Ed.max}$ = **0.011** N/mm^2

PASS - Maximum punching shear resistance exceeds maximum punching shear stress

Column No.4 - Punching shear perimeter at column face

Punching shear perimeter; u_0 = **400** mm; Area within shear perimeter; A_0 = **0.010** m^2

Max.punching shear force; $V_{Ed.max}$ = **33.7** kN

Punching shear stress factor; β = **1.500**; Max.punching shear stress; $v_{Ed.max}$ = **0.234** N/mm^2

PASS - Maximum punching shear resistance exceeds maximum punching shear stress

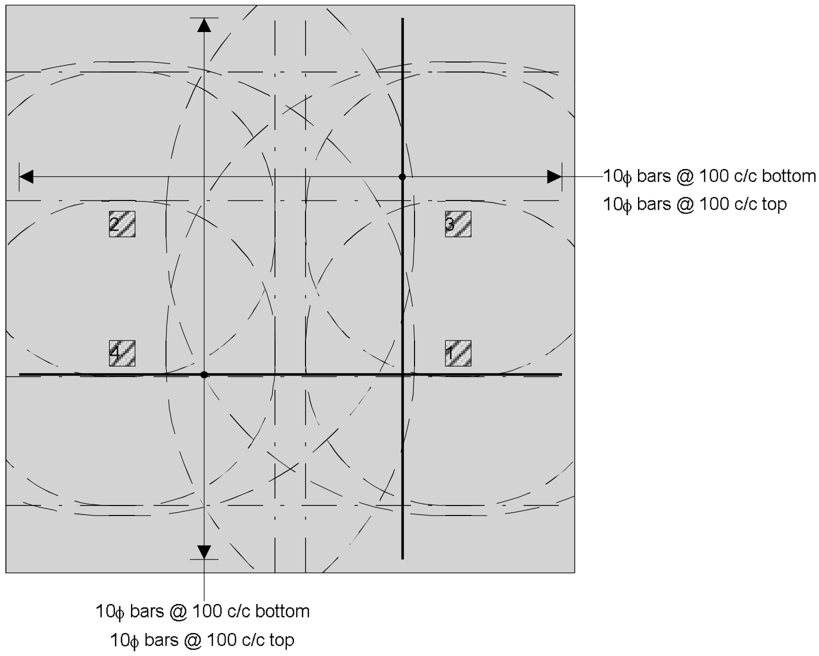
Column No.4 - Punching shear perimeter at 1d from column face

Punching shear perimeter; u_1 = **2897** mm; Area within shear perimeter; A_1 = **1.058** m^2

Design punching shear force; $V_{Ed.1}$ = **16.7** kN

Punching shear stress factor; β = **1.500**; Design punching shear stress; $v_{Ed.1}$ = **0.016** N/mm^2

PASS - Design punching shear resistance exceeds increased design punching shear stress

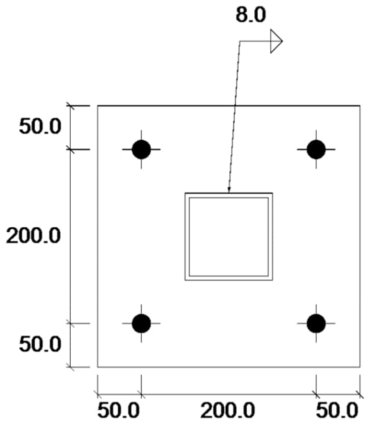


BASEPLATE

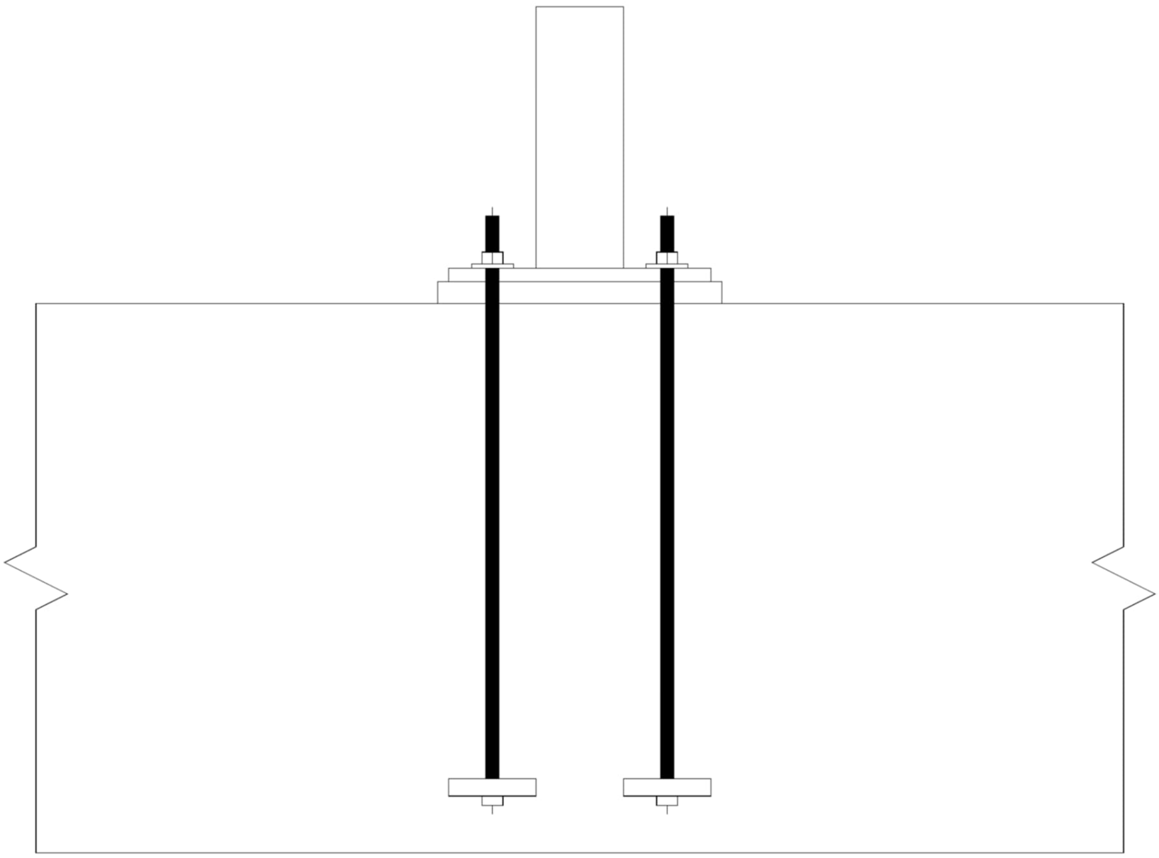
The base plate design is based on the M bolts having sufficient pull-out capacity to resist the applied loads.

Shear; V1 = 2.3kN * 1.5 = **3.450**kN
Axial; N1 = -21.4kN * 1.5 = -**32.100**kN

Sign Baseplate



Base Plate : 300.0x15.0x300.0mm S355
4 No. M16(Grade 8.8) x 665.0mm Long, Hole Diameter 22.0mm
Anchor Plates 100x20 (100mm Edge Distance)



Euro SHS 100x100x5.0 S355
Mortar 20.0N/mm²
Concrete C35
Top Reinforcement - X - T10@100.0, Y - T10@100.0
Bottom Reinforcement - X - T10@100.0, Y - T10@100.0

Design Code: BS 5950-1 : 2000

Design Summary

Item	Combination	Utilisation	Status
Base plate	1	0.342	Pass
Bolts and anchorage	1	0.114	Pass
Shear	1	0.171	Pass
Weld	1	0.116	Pass

Basic Details

Unfactored

No.	Combination Name	Shear Force [kN]	Axial Load [kN]	Moment [kNm]
1	Wind	0.0	0.0	0.0

Factored

No.	Combination Name	Shear Force [kN]	Axial Load [kN]	Moment [kNm]	Fire Base Condition
1	Wind	3.5	-32.1	0.0	No

Item	Value	Units	Remarks
Column:			
Euro SHS 100x100x5.0			
Design strength, f_y	355.0	N/mm²	
Eccentricity to base plate, e_{bp}	0.0	mm	
Base plate			
Width, W	300.0	mm	
Thickness, T	15.0	mm	
Length, L	300.0	mm	
Design strength, f_y	355.0	N/mm²	
Eccentricity to concrete base, e_{cb}	0.0	mm	
Concrete base			
Size of base unknown			
Shear key			
Length	50.0	mm	
Depth	100.0	mm	

Design Combination: Wind

Base Plate

Item	Value	Units	Remarks
Tension force, T	32.1	kN	
Moment, m_t	0.7	kNm	
Base plate thickness, $t_{t\ reqd.}$	5.1	mm	
Utilisation	0.342		
Pass			

Bolts & Anchorage

Item	Value	Units	Remarks
Holding Down Bolts			
Tension force [Plastic Properties], T	32.1	kN	
Number of bolts in tension, n_g	4		
Bolt group capacity, c_g	351.7	kN	
Reduced bolt group capacity, c_g	281.3	kN	
Utilisation	0.114		
Pass			
Anchor Plates			
Bolt diameter, d	16.0	mm	Adjustable
Anchorage length, L	530.0	mm	
Reinforcement area provided, A_s	6095	mm²	
Concrete cube strength, f_{cu}	20.0	N/mm²	
Punching shear perimeter, p_{sp}	7760.0	mm	
Average shear stress, f_v	0.0	N/mm²	
Concrete shear stress, v_c	0.3	N/mm²	
Utilisation	0.025		
Pass			

Shear

Item	Value	Units	Remarks
Shear Transfer to Concrete			
Shear force, F	3.5	kN	
Bearing strength (base plate), P_b	66.0	kN	
Bearing capacity (concrete)	5.1	kN	
Shear capacity (bolt)	58.9	kN	
Number of bolts in tension, n_g	4		
Individual bolt shear capacity, P_{tt}	5.1	kN	
Shear resistance (bolts), v_{hb}	20.5	kN	
Shear resistance, v_h	20.5	kN	
Utilisation	0.171		
Pass			

Weld

Item	Value	Units	Remarks
Tension weld $_{\text{side A}}$	Pass		
Tension weld $_{\text{side C}}$	Pass		
Web Weld	Pass		

Library: ColumnBaseConnections.dll, version: 22.2.0.0

A root cage is to be provided to retain the bolts in the correct positions whilst casting the base. The bolts will be spot welded top and bottom of each 50x50x3RSA with a minimum of 6mm weld x 8mm wide, 8No locations minimum on each bolt.

Tension Capacity per bolt; cap = 1.25kN/mm × 8mm × 8 = **80.000**kN; 32.1kN/2 = **16.050**kN; therefore satisfactory.

The root cage will provide sufficient area to resist the pull-out forces by inspection.

Or provide Rawl Chemical Resin Anchors as per the design over the page.

Project:
Subject:
Address:
Calculations made by: LM

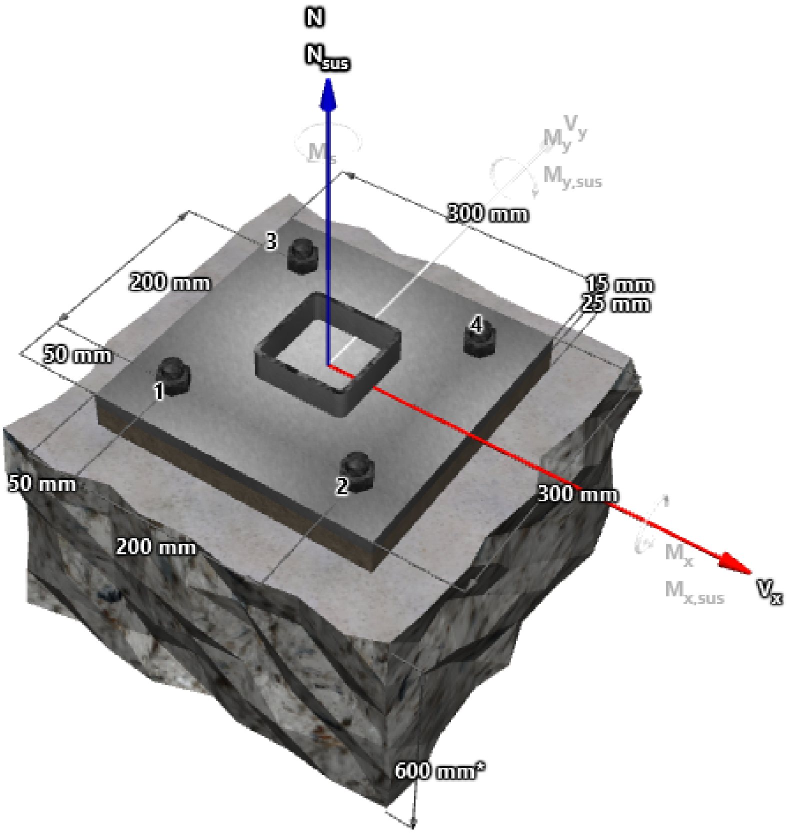
Date: 2023-01-24 **Page:** 1/7
Organization: J Roberts Design Ltd
Address: 11 the Point, S60 1BP Rotherham
Contact:

Checked by: JR 2023-01-12

Notes

Input data

Anchor type and size	R-KERII+R-STUDS-20260-88FL High performance resin for use with metric threaded rods - steel class 8.8
Nominal depth (h_{nom})	80 mm (h_{ef} = 80 mm)
Base material	Cracked concrete (C25/30) Temp. short/long None
Reinforcement	Spacing ≥150 mm or spacing ≥100 mm with ≤Ø10 A concentrated reinforcement in both directions is present in the region of the anchorage, which limits the crack width to wk~0.3mm.
Longitudinal edge reinf.	Without edge reinforcement or stirrups
Installation	Hammer drilling, Installation conditions: Dry concrete
Lever arm	Stand-off 25 mm with grouting Compression strength (grout): 30 MPa
Fixture	Baseplate (x=300 mm, y=300 mm) Declared thickness: t_{fix} = 15 mm Recommended thickness: Not checked
Steel profile	SQt 100x100x5 (h=100 mm, b=100 mm)
Proof	EN 1992-4:2018 ETA-21/0242 v.11/03/2021 Working life of 50 years



Design loads

N	32.1 kN
N_{sus}	0 kN
M_x	0 kNm
$M_{x,sus}$	0 kNm
M_y	0 kNm
$M_{y,sus}$	0 kNm
V_x	3.45 kN
V_y	0 kN
M_s	0 kNm

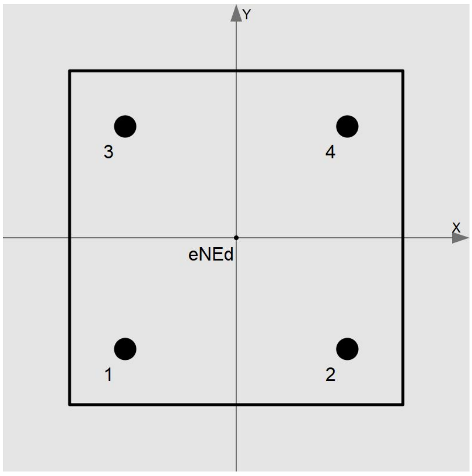
sus - Sustained loads

*Not a real scale

National regulations, environmental and application conditions must be considered when designing the anchorage.

Resulting anchor forces

Anchor	N	V	V_x	V_y
1	8.025 kN	862.5 N	862.5 N	0 kN
2	8.025 kN	862.5 N	862.5 N	0 kN
3	8.025 kN	862.5 N	862.5 N	0 kN
4	8.025 kN	862.5 N	862.5 N	0 kN



Max. concrete compressive stress: -356.667 kPa

eNEd - Resulting tension force in (0 mm, 0 mm): 32.1 kN

N - Tension force
V - Shear force
V_x - Shear force x
V_y - Shear force y

Tensile load (EN 1992-4:2018, Section 7.2.1)

Steel failure calculated for anchor: 1	β_{N1} = 6.2%

$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}}$$

$N_{Rk,s}$	γ_{Ms}	$N_{Rd,s}$	N_{Ed}
196 kN	1.5	130.67 kN	8.03 kN

Combined pullout-concrete cone failure	β_{N2} = 37.3%

$$N_{Ed} \leq \frac{N_{Rk,p}}{\gamma_{Mp}}$$

$$N_{Rk,p} = N^0_{Rk,p} \cdot \frac{A_{p,N}}{A^0_{p,N}} \cdot \psi_{s,Np} \cdot \psi_{re,Np} \cdot \psi_{ec,Np} \cdot \psi_{g,Np}$$

$$N^0_{Rk,p} = \psi_{sus} \cdot \tau_{Rk} \cdot \pi \cdot d \cdot h_{ef}$$

$N^0_{Rk,p}$	ψ^0_{sus}	α_{sus}	ψ_{sus}	$\tau_{Rk,cr}$	$\tau_{Rk,ucr}$	ψ_c	τ_{Rk}
38.45 kN	0.72	0.0	1.0	7.5 MPa	10 MPa	1.02	7.65 MPa

d	h_{ef}	$A^0_{p,N}$	$A_{p,N}$	$c_{cr,Np}$	$s_{cr,Np}$	c_{min}	$\psi_{s,Np}$
20 mm	80 mm	57600 mm²	193600 mm²	120 mm	240 mm	∞	1.0

$\psi_{re,Np}$	$e_{N,x}$	$\psi_{ec,Np,x}$	$e_{N,y}$	$\psi_{ec,Np,y}$	$\psi_{ec,Np}$	k_8	$\psi^0_{g,Np}$
1.0	0 mm	1.0	0 mm	1.0	1.0	7.7	1.0

$\psi_{g,Np}$	$N_{Rk,p}$	γ_{Mp}	$N_{Rd,p}$	N_{Ed}
1.0	129.25 kN	1.5	86.16 kN	32.1 kN

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Calculations made by:	LM	**Contact:**		

Concrete cone failure	β_{N3} = 52.1%

$$N_{Ed} \leq \frac{N_{Rk,c}}{\gamma_{Mc}}$$

$$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec,N} \cdot \psi_{MN}$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5}$$

$N^0_{Rk,c}$	k_1	f_{ck}	h_{ef}	$A^0_{c,N}$	$A_{c,N}$	$c_{cr,N}$	$s_{cr,N}$
27.55 kN	7.7	25 MPa	80 mm	57600 mm²	193600 mm²	120 mm	240 mm

c_{min}	$\psi_{s,N}$	$\psi_{re,N}$	$e_{N,x}$	$\psi_{ec,N,x}$	$e_{N,y}$	$\psi_{ec,N,y}$	$\psi_{ec,N}$
∞	1.0	1.0	0 mm	1.0	0 mm	1.0	1.0

ψ_{MN}	$N_{Rk,c}$	γ_{Mc}	$N_{Rd,c}$	N_{Ed}
1.0	92.59 kN	1.5	61.73 kN	32.1 kN

Splitting failure	β_{N4} = ND

Blow-out failure	β_{N5} = ND

Shear load (EN 1992-4:2018, Section 7.2.2)

Steel failure without lever arm calculated for anchor: 1	β_{V1} = 1.4%

$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}}$$

$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s}$$

k_{hef}	$V^0_{Rk,s}$	k_7	$V_{Rk,s}$	γ_{Ms}	$V_{Rd,s}$	V_{Ed}
1.0	98 kN	0.8	78.4 kN	1.25	62.72 kN	863 N

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Calculations made by:	LM	Contact:			

Steel failure with lever arm calculated for anchor: 1	β_{V2} = 3.6%

$$V_{Ed} \leq \frac{V_{Rk,s,M}}{\gamma_{Ms}}$$

$$V_{Rk,s,M} = \frac{\alpha_M \cdot M_{Rk,s}}{l_a}$$

l_a	α_M	$N_{Ed}/N_{Rd,s}$	$M^0_{Rk,s}$	$M_{Rk,s}$	$V_{Rk,s,M}$	γ_{Ms}	$V_{Rd,s,M}$
33 mm	2.0	0.061	519 Nm	487 Nm	29.98 kN	1.25	23.98 kN

V_{Ed}
863 N

Concrete pry-out failure	β_{V3} = 2.8%

$$V_{Ed} \leq \frac{V_{Rk,cp}}{\gamma_{Mc}}$$

$$V_{Rk,cp} = k_8 \cdot \min\left(N_{Rk,c}; N_{Rk,p}\right)$$

$$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec,N}$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5}$$

$N^0_{Rk,c}$	k_1	f_{ck}	h_{ef}	$A^0_{c,N}$	$A_{c,N}$	$c_{cr,N}$	$s_{cr,N}$
27.55 kN	7.7	25 MPa	80 mm	57600 mm²	193600 mm²	120 mm	240 mm

c_{min}	$\psi_{s,N}$	$\psi_{re,N}$	$e_{V,x}$	$\psi_{ec,N,x}$	$e_{V,y}$	$\psi_{ec,N,y}$	$\psi_{ec,N}$
∞	1.0	1.0	0 mm	1.0	0 mm	1.0	1.0

k_8	$V_{Rk,cp}$	γ_{Mc}	$V_{Rd,cp}$	V_{Ed}
2.0	185.19 kN	1.5	123.46 kN	3.45 kN

Concrete edge failure	β_{V4} = ND

Utilisation - Steel failure calculated for anchor: 1

Tension	Shear		Combined	Shear load with lever arm
β_{Ns}	β_{Vs}	α	$\beta_{Ns}^{\alpha} + \beta_{Vs}^{\alpha}$	β_{V2}
6.2%	1.4%	2.0	0.4%	3.6%
correct connection				

Utilisation - Concrete failure

Tension	Shear		Combined
β_{Nc}	β_{Vc}	α	$\beta_{Nc}^{\alpha} + \beta_{Vc}^{\alpha}$
52.1%	2.8%	1.5	38%
correct connection			

Hints for the calculations and the program

- According to the current guidelines for the design of anchorages, the calculations in EasyFix4 base on the assumption that the base plate is rigid, which means that redistribution of loads on the anchors due to elastic deformation of the base plate is not taken into account. In the software, the recommended thickness of the base plate can be determined, however the correctness of the installation of the rigid base plate must be checked and confirmed separately.

- The size of the holes in the base plate must not be larger than it is allowed in the table with installation parameters. Otherwise, all gaps in the holes between the anchors and the fixed element must be filled, e.g. by filling the gaps with resin of adequate compressive strength.

- Preparation of holes and installation of fasteners must be performed in accordance with the installation instruction, taking into account the entered input data.

- The information and data contained in EasyFix4 apply only to Rawlplug products. The results of the calculations carried out with the use of the Software are based on data entered by the User, who is exclusively responsible for the correctness of the input data and any errors. In addition, the User is exclusively responsible for the verification and recognition of the calculation results by a competent person, in particular with regard to compliance with applicable standards and regulations.

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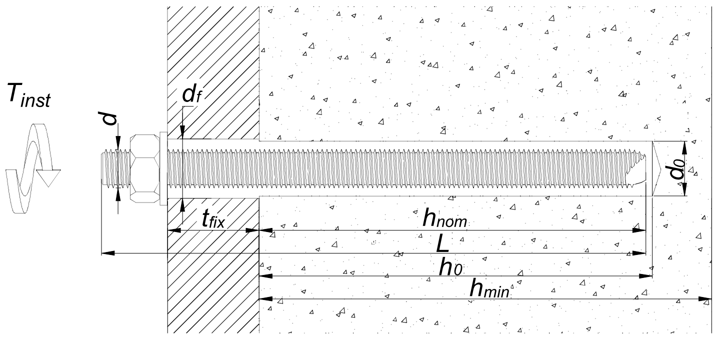
Installation data for R-KERII+R-STUDS-20260-88FL

Thread diameter	d	20 mm
Hole diameter in substrate	d_0	24 mm
Min. hole depth in substrate	h_0	85 mm
Nominal depth	h_{nom}	80 mm
Calculated min. substrate thickness	h_{min}	600 mm
Installation torque	T_{inst}	120 Nm
Anchor length	L	260 mm
Fixture thickness	t_{fix}	15 mm
Hole diameter in fixture	d_f	22 mm
Amount of resin per one mount (normal loss)		24 ml



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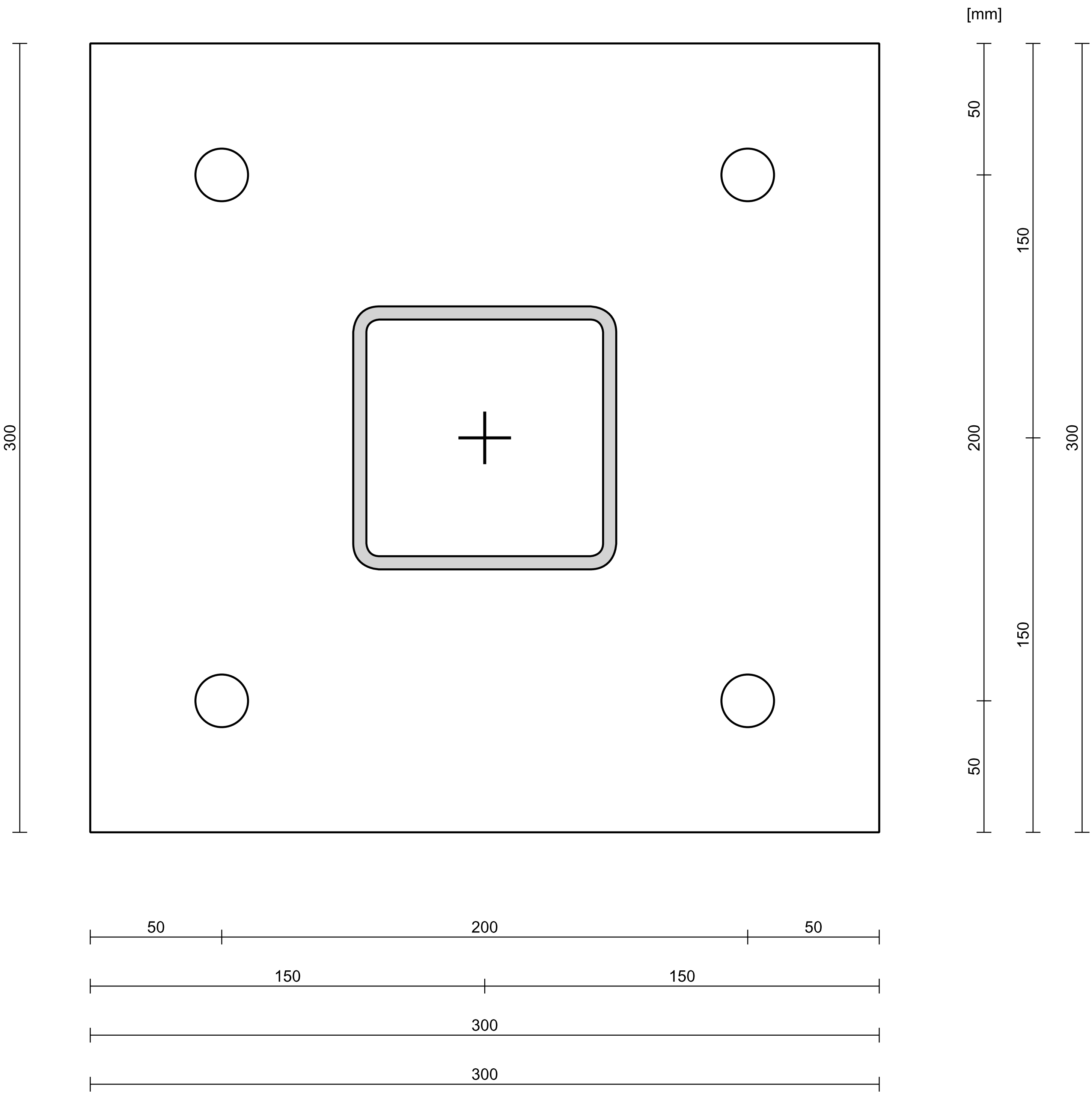
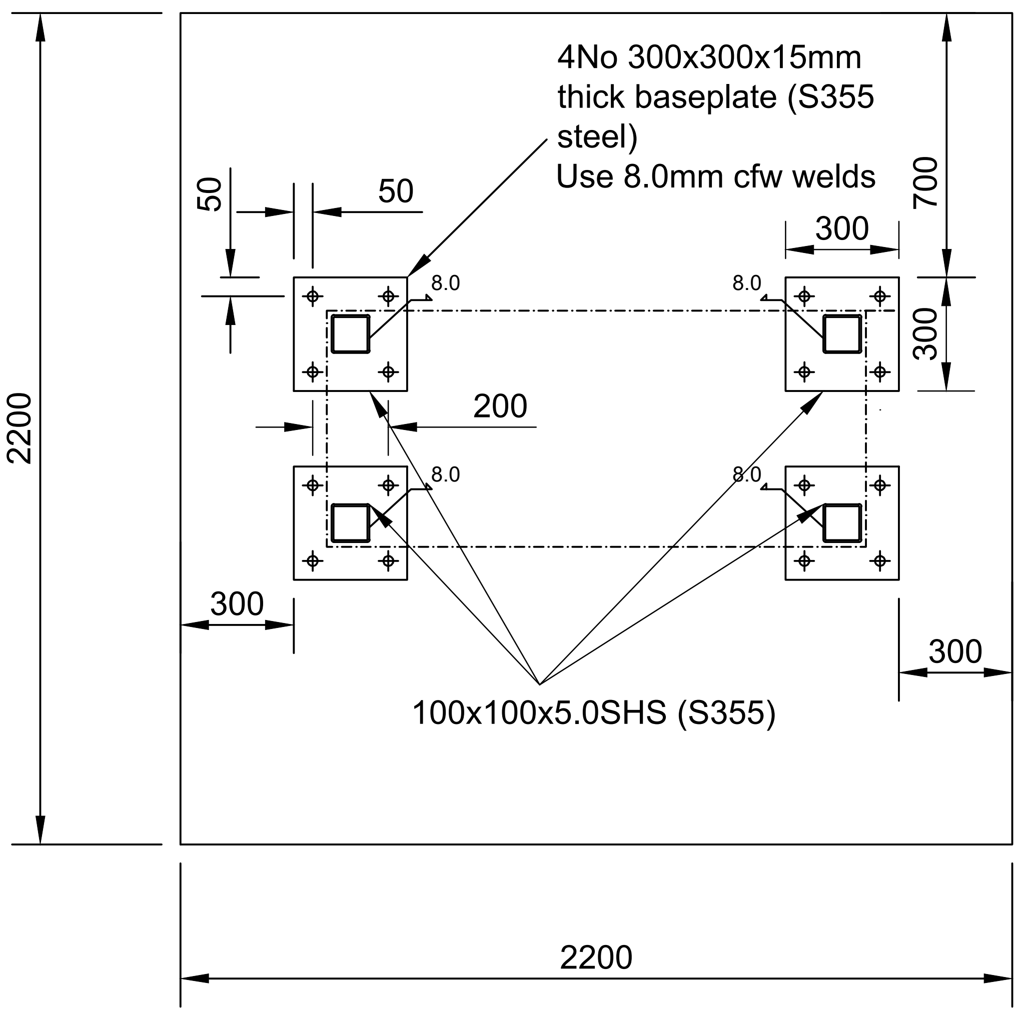
Calculations made by:	LM	**Contact:**	

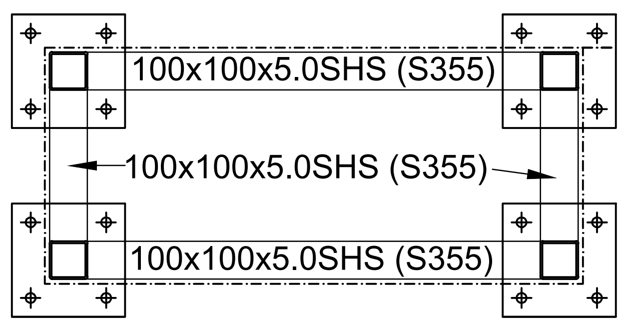
Fixture shape





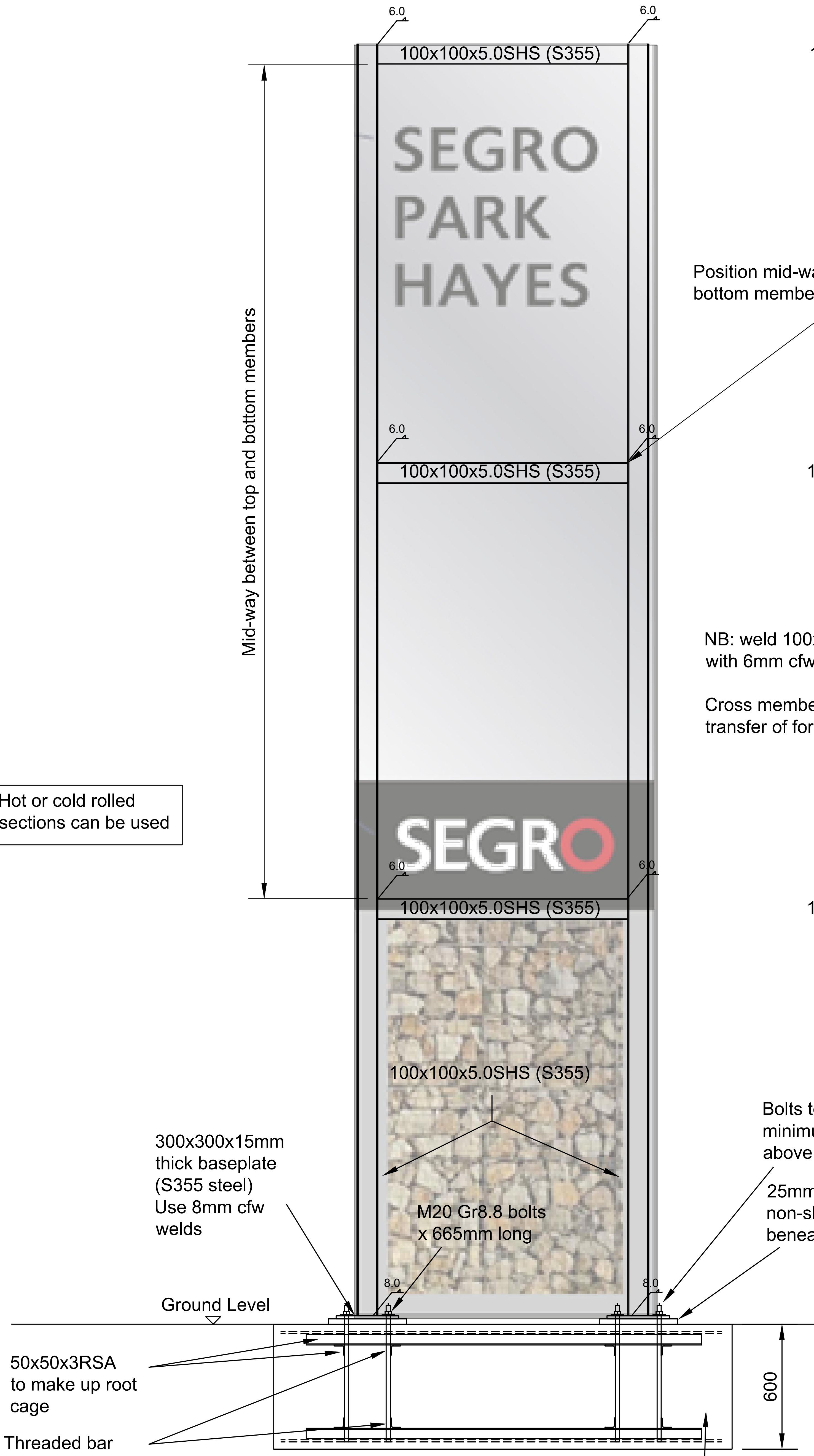
BASE LAYOUT

NB: weld 100x100x5.0SHS S355 with 6mm cfw UNO



Cross members required for transfer of forces

SECTION A - A

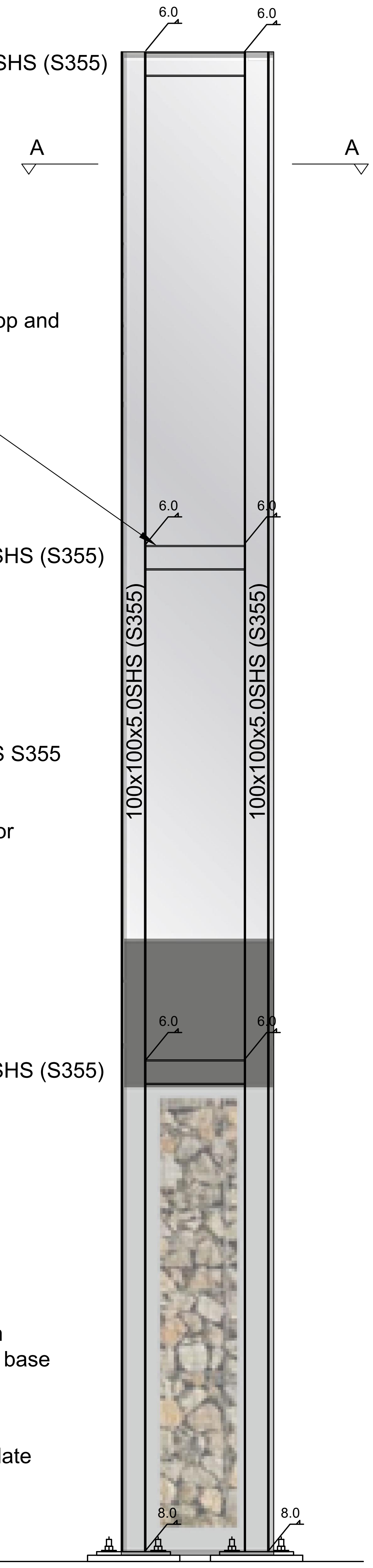


TYPICAL SECTION WITH ROOT CAGE

Hot or cold rolled sections can be used

NB: weld 100x100x5.0SHS S355 with 6mm cfw UNO

Cross members required for transfer of forces.



SIDE ELEVATION

RC35 concrete with 2No layers of A393 mesh T&B (35mm cover)
NB - Mesh to be provided above and below the 50x50RSA root cage.

Design Bearing Pressure 50kN/m^2. Bearing Capacity to be checked on site by Contractor

Alternative Chemical Fixings
RAWL R-KERII+R-Studs M20 (8.8) Anchors (or similar)
100mm min depth of embedment
NB - Mesh reinforcement as specified is required when using resin anchors. Resin anchors to be installed fully in accordance with the suppliers recommendations

6.1m Tall (4 Post)

179 - Segro Park