

HORIZON

STRUCTURES

DESIGN INFORMATION

Project Name:	Hedge End Green sculptures	Project No:	6474	Date:	30 March 2021
Client:	David Harris				
Project Description:	Sculpture post, base plate and concrete foundation design				
Architect:	-				
Intended Building Usage	Sculpture				

Subsoil Conditions	Earnley Sand Formation – sand, silt and clay – and Marsh Farm Formation – clay, silt and sand (British Geological Survey data)
Assuming GPB	100 kN m ⁻²

Specialist Design by Others	n/a
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Relevant Codes of Practice & Design Standard Used in This Project			
BS 648:1964 – Weights of Materials	☐	Eurocode 1 – Loads	☒
BS 6399 – Loading	☐	Eurocode 2 – Concrete Design	☒
BS5950 Pt 1:2000 – Steelwork	☐	Eurocode 3 – Steel Design	☒
BS 8110 Pt 1: 1997 Concrete	☐	Eurocode 4 – Composite Structures	☐
BS 5268 Pt2: 1996 – Timber	☐	Eurocode 5 – Timber Design	☐
NHBC Standards	☐	Eurocode 6 – Masonry Design	☐
BS 8103 – Foundations	☐	Other	☐

Building Regs	☐	Party Wall Act	☐	Listed Building	☐
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CDM 2015 Design Considerations		Principal Designer:		–		
The design has been considered under CDM 2015 – to eliminate, reduce or control foreseeable risks that may arise during construction, and the maintenance and use of a building once it is built.						
Risks – consider those unusual or not likely to be obvious to a suitably-experienced contractor or designer.						
Area of Hazard	Assessed (Yes / No / NA)	Method of Hazard Elimination / Reduction	Residual Risk			
			Risk	Significant		
Access to work area	Yes		☐	☐		
Demolition	Yes		☐	☐		
Services	Yes	Identify services prior to construction	☐	☐		
Installation	Yes		☐	☐		
Materials	Yes		☐	☐		
Temp Works	No		☐	☐		
Does the project require a separate Designers Risk Assessment?			Yes	☐	No	☒

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HORIZON

STRUCTURES

INFORMATION RECEIVED

DRAWINGS

No	Drawing	Date
	Hedge End Green Routes: Concept Wayfinding Artworks	03 March 2021

OTHER INFORMATION

Sketches with scale of 3 No. sculptures and photos	Date
	02 March 2021

REVISION HISTORY

Rev	Date	By	Sheets	Reason	Checked

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STRUCTURAL SCHEDULE

See following page for sketch details.

Foundations

1.25 m square, 1.25 m deep grade C25/30 concrete pad foundation

Base plate

400 x 400 x 15 mm thick grade S275 steel plate

- ▶ Fix to concrete foundation using 4 No. 16 mm diameter holding down or resin fixed bolts

Post

114.3 x 6.3 CHS grade S275 steel

- ▶ Provide 100 x 100 x 10 mm thick gussets
- ▶ Fully weld post and gussets to base plate with 8 mm welds

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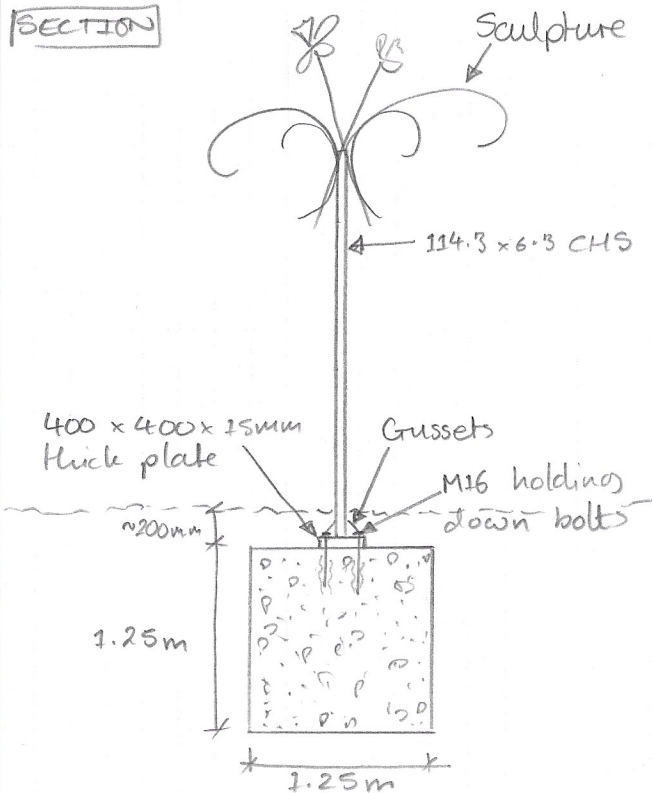
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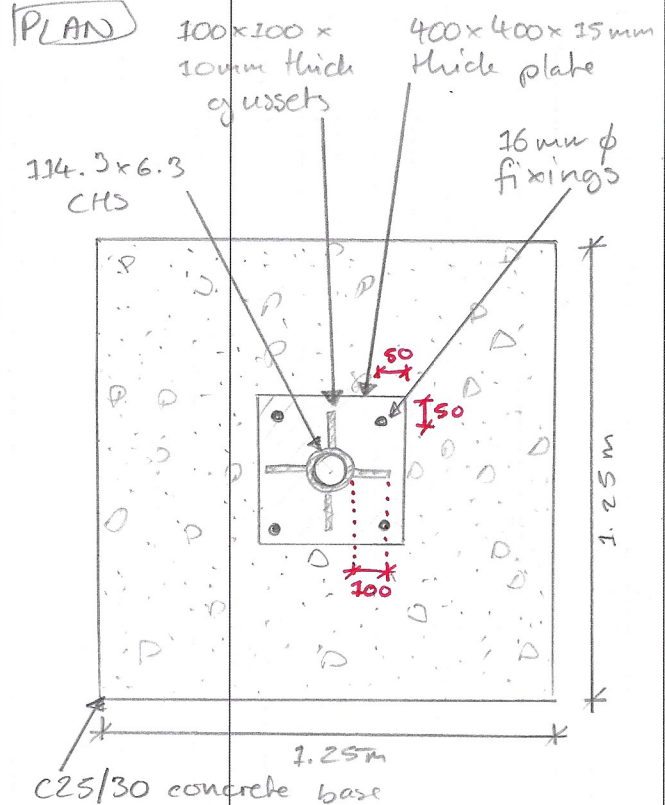
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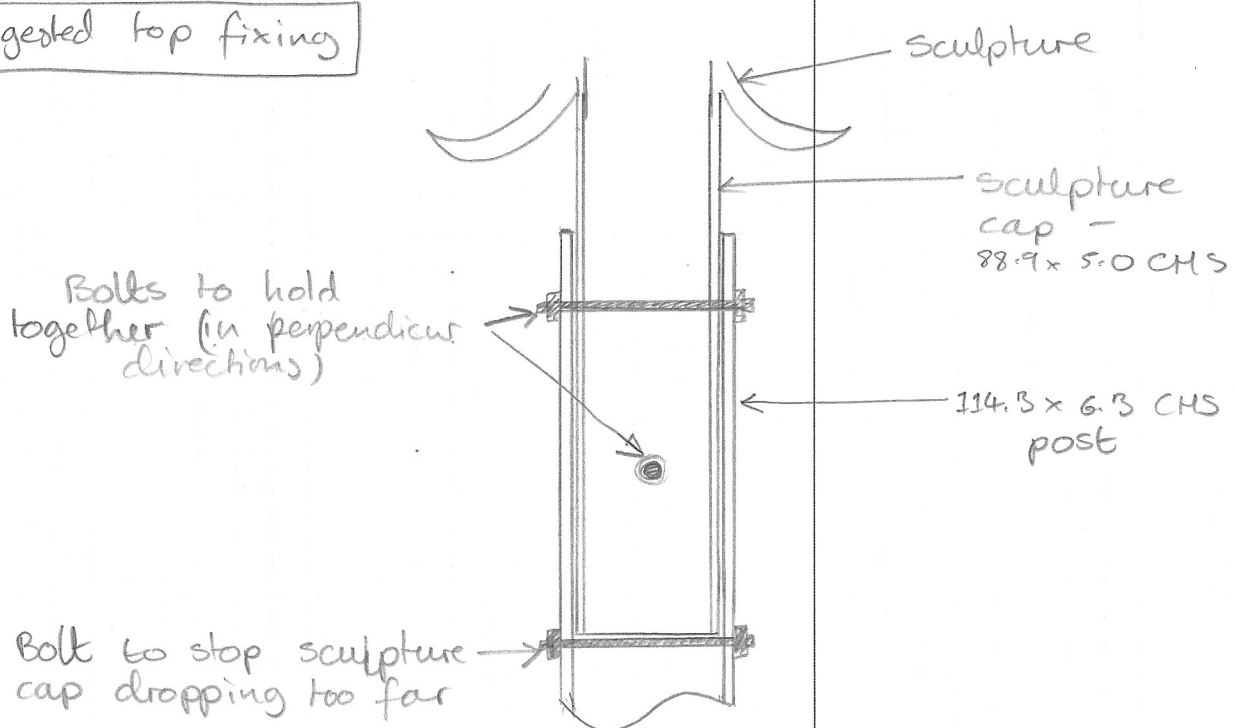
SECTION

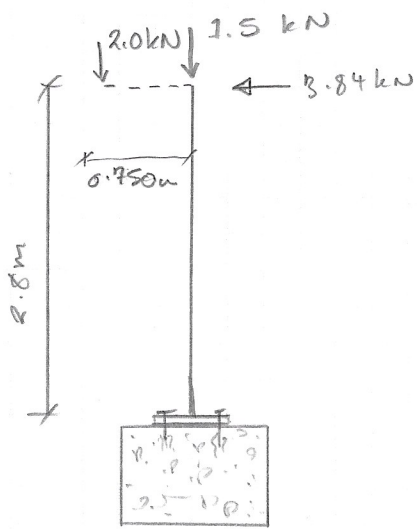


PLAN



Suggested top fixing



HORIZON STRUCTURES	Project: HEDGE END GREEN SCULPTURES		Job Ref: 6474	
	Part of Structure: POST AND BASE		Calc Sheet No.	Rev:
51 Yarmouth Road, Norwich, NR7 0ET T: 01603 706290 F: 01603 700001 www.horizon-structures.com	Dwg Ref:	Calc by: SRF	Date: 30/03/2021	Checked by: Date:
Calculation			Output	
Weight of sculpture: 150 kg ≈ load of person: Wind: 1.6 m × 2.0 m × 1.2 kN m² =  <u>Axial load</u> Total = 1.5(2.0) + 1.35(1.50) = <u>Moment</u> Total = 1.5[(2.0 × 0.75) + (3.84 × 2.8)] + 1.35(1.5 × 0.3) = <u>Shear</u> Total = 1.5(3.84) =			1.5 kN 2.0 kN 3.84 kN 5.025 kN 18.986 kNm 5.76 kN	
*** Assume GROUND BEARING CAPACITY OF 100 kN m² *** => 114.3 × 6.3 CHS (S275) post 400 × 400 × 15 mm thick base plate, 8 mm welds 100 mm, 10 mm thick gussets. 1.25 m square, 1.25 m deep C25/30 concrete base				

Project Hedge End Green Sculptures				Job no. 6474	
Calcs for Post				Start page no./Revision 1	
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STEEL MEMBER DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

Tedds calculation version 4.4.05

Partial factors - Section 6.1 $\gamma_{M0} = 1$

$\gamma_{M1} = 1$

$\gamma_{M2} = 1.1$

Design section 1

Section details

CHS 114.3x6.3 (Tata Steel Celsius)

Steel grade

S275H

Modulus of elasticity

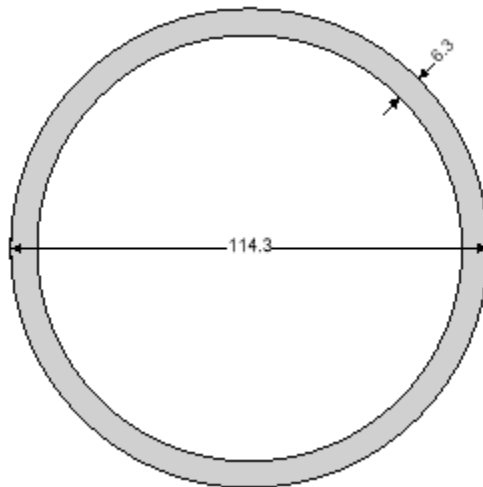
$E = 210000 \text{ N/mm}^2$

Nominal yield strength

$f_y = 275 \text{ N/mm}^2$

Nominal ult.tensile strength

$f_u = 410 \text{ N/mm}^2$



CHS 114.3x6.3 (Tata Steel Celsius)

Diameter, d , 114.3 mm

Mass of section, Mass, 16.8 kg/m

Section thickness, t , 6.3 mm

Area of section, A , 2138 mm²

Radius of gyration about y-axis, i_y , 38.249 mm

Radius of gyration about z-axis, i_z , 38.249 mm

Elastic section modulus about y-axis, $W_{el,y}$, 54718 mm³

Elastic section modulus about z-axis, $W_{el,z}$, 54718 mm³

Plastic section modulus about y-axis, $W_{pl,y}$, 73587 mm³

Plastic section modulus about z-axis, $W_{pl,z}$, 73587 mm³

Second moment of area about y-axis, I_y , 3127138 mm⁴

Second moment of area about z-axis, I_z , 3127138 mm⁴

Analysis results

Design bending moment - Major axis

$M_{y,Ed} = 18.986 \text{ kNm}$

Design shear force - Major axis

$V_{y,Ed} = 5.76 \text{ kN}$

Design axial compression force

$N_{Ed} = 5.025 \text{ kN}$

Restraint spacing

Major axis lateral restraint $L_y = 2800 \text{ mm}$

Minor axis lateral restraint $L_z = 2800 \text{ mm}$

Torsional restraint $L_T = 2800 \text{ mm}$

Classification of cross sections - Section 5.5

Tubular sections Class 1

Section is class 1

Check compression - Section 6.2.4

Design compression force $N_{Ed} = 5 \text{ kN}$

Design resistance of section $N_{c,Rd} = N_{pl,Rd} = 587.8 \text{ kN}$

$N_{Ed} / N_{c,Rd} = 0.009$

PASS - Design compression resistance exceeds design compression

Check y-y axis flexural buckling resistance - Section 6.3.1.1

Design buckling resistance $N_{b,y,Rd} = 452.7 \text{ kN}$

$N_{Ed} / N_{b,y,Rd} = 0.011$

PASS - Design buckling resistance exceeds design compression

Check z-z axis flexural buckling resistance - Section 6.3.1.1

Design buckling resistance $N_{b,z,Rd} = 452.7 \text{ kN}$

$N_{Ed} / N_{b,z,Rd} = 0.011$

PASS - Design buckling resistance exceeds design compression

Project Hedge End Green Sculptures				Job no. 6474	
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Check shear - Section 6.2.6

Design shear force $V_{y,Ed} = 5.8$ kN Design shear resistance $V_{c,y,Rd} = V_{pl,y,Rd} = 216.1$ kN
 $V_{y,Ed} / V_{c,y,Rd} = 0.027$
PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment $M_{y,Ed} = 19$ kNm Bending resistance moment $M_{c,y,Rd} = 20.2$ kNm
 $M_{y,Ed} / M_{c,y,Rd} = 0.938$
PASS - Design bending resistance moment exceeds design bending moment

Check bending and axial force - Section 6.2.9

Reduced plastic mom.resist $M_{N,y,Rd} = 20.2$ kNm $M_{y,Ed} / M_{N,y,Rd} = 0.939$
PASS - Reduced bending resistance moment exceeds design bending moment

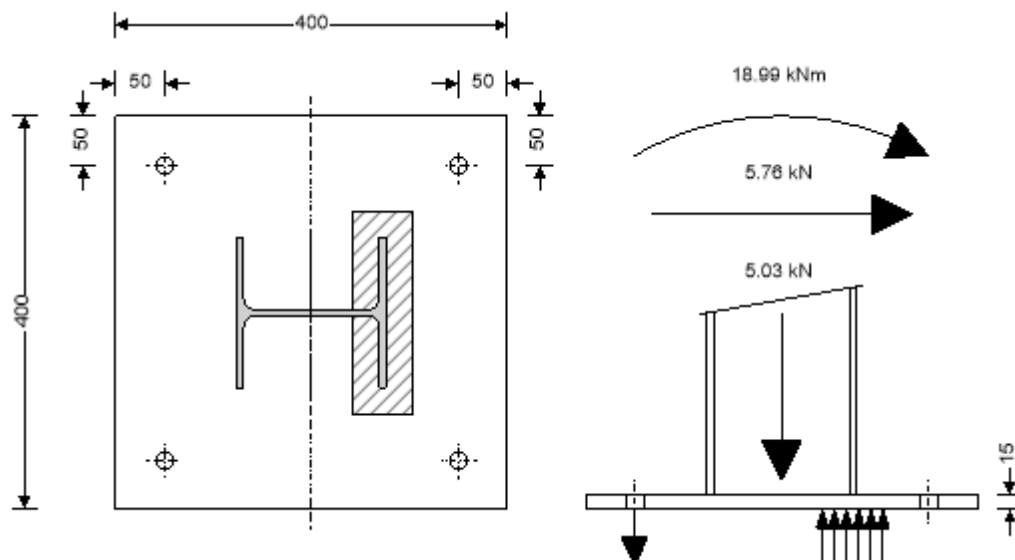
Interaction factors k_{ij} for members not susceptible to torsional deformations - Table B.1

Interaction formulae $\max(0.956, 0.578) = 0.956$
PASS - Combined bending and compression checks are satisfied

COLUMN BASE PLATE DESIGN

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009, and EN1993-1-8:2005 incorporating Corrigenda December 2005, September 2006 and July 2009, and the UK national annex

Tedds calculation version 2.0.09



Design forces

Design axial force

$N_{Ed} = 5 \text{ kN}$

Design moment

$M_{Ed} = 19 \text{ kNm}$

Design shear force

$V_{Ed} = 5.8 \text{ kN}$

Column Details

Column section

UC 152x152x23

Width

$B = 152.2 \text{ mm}$

Web thickness

$t = 5.8 \text{ mm}$

Depth

$D = 152.4 \text{ mm}$

Flange thickness

$T = 6.8 \text{ mm}$

Base plate details

Length

$b_p = 400 \text{ mm}$

Thickness

$t_p = 15 \text{ mm}$

Width

$b_p = 400 \text{ mm}$

Column eccentricity in x-axis

$e_{bpx} = 0 \text{ mm}$

Anchor details

Number of anchors LHS

$n_1 = 2$

Edge distance x-axis

$e_{x1} = 50 \text{ mm}$

Edge distance y-axis

$e_{y1} = 50 \text{ mm}$

Anchor diameter

$d_{a,b} = 16 \text{ mm}$

Number of anchors RHS

$n_2 = 2$

Edge distance x-axis

$e_{x2} = 50 \text{ mm}$

Edge distance y-axis

$e_{y2} = 50 \text{ mm}$

Foundation details

Bottom edge distance

$C_1 = 100 \text{ mm}$

Right edge distance

$C_2 = 100 \text{ mm}$

Left edge distance

$C_3 = 100 \text{ mm}$

Top edge distance

$C_4 = 100 \text{ mm}$

Foundation depth

$t_{fnd} = 500 \text{ mm}$

Concrete details

Concrete strength class

C25/30

Partial factor for concrete

$\gamma_c = 1.50$

Comp strength coeff

$\alpha_{cc} = 0.85$

Char comp cylinder strength

$f_{ck} = 25 \text{ N/mm}^2$

Char comp cube strength

$f_{ck,cube} = 30 \text{ N/mm}^2$

Design comp strength

$f_{cd} = 14.17 \text{ N/mm}^2$

Project Hedge End Green sculptures				Job no. 6474	
Calcs for Base plate				Start page no./Revision 2	
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Steel details

Base steel grade	S275	Base nom yield strength	$f_{yp_plt} = 275 \text{ N/mm}^2$
Base nom ult tensile strength	$f_{u_plt} = 410 \text{ N/mm}^2$	Column steel grade	S275
Column nom yield strength	$f_{yp_col} = 275 \text{ N/mm}^2$	Column nom ult strength	$f_{u_col} = 410 \text{ N/mm}^2$
Partial factor cross sections	$\gamma_{M0} = 1.00$	Partial factor welds	$\gamma_{M2} = 1.25$

Tension and compression lever arms

LHS comp lever arm	$Z_{C,l} = 72.8 \text{ mm}$	RHS comp lever arm	$Z_{C,r} = 72.8 \text{ mm}$
LHS tension lever arm	$Z_{T,l} = 150 \text{ mm}$	RHS tension lever arm	$Z_{T,r} = 150 \text{ mm}$

Design forces in T-stubs

Force in left hand T-stub	$N_{L,T} = -83.6 \text{ kN}$	Force in right hand T-stub	$N_{R,T} = 88.6 \text{ kN}$
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Foundation bearing strength under right hand flange - EN1992-1-1 Section 6.7

Design bearing strength joint	$f_{jd,RF} = 27.36 \text{ N/mm}^2$	Additional bearing width	$c_{RF} = 27.5 \text{ mm}$
Eff width T-stub flange	$b_{eff1,RF} = 61.7 \text{ mm}$	Eff length T-Stub flange	$l_{eff1,RF} = 207.1 \text{ mm}$

Baseplate in bending under tension under left hand flange - Section 6.2.6.11

Mom resist of T-stub flange	$M_{pl1,Rd1} = 3.1 \text{ kNm}$	Design resist of T-stub	$F_{T,1,2,Rd1} = 91.8 \text{ kN}$
Base plate in bending	$F_{t,pl,Rd} = 91.8 \text{ kN}$		

Equivalent T-stub in compression under right hand flange - Section 6.2.5

Design comp resist T-stub	$F_{C,Rd} = 349.7 \text{ kN}$
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Concrete in compression under right hand flange - Section 6.2.6.9

Design resist conc comp	$F_{c,pl,Rd} = 349.7 \text{ kN}$
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Bending resistance of column - EN1993-1-1 Section 6.2.5

Design resist bend	$M_{c,Rd} = 50 \text{ kNm}$
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Beam flange and web in compression - Section 6.2.6.7

Design comp resist flange	$F_{c,fc,Rd} = 343.7 \text{ kN}$
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Column bases subjected to axial forces and bending moments - Section 6.2.8.3

Design tension resist LHS	$F_{T,l,Rd} = 91.8 \text{ kN}$	Design tension resist RHS	$F_{T,r,Rd} = 91.8 \text{ kN}$
Design comp resist LHS	$F_{C,l,Rd} = 343.7 \text{ kN}$	Design comp resist RHS	$F_{C,r,Rd} = 343.7 \text{ kN}$

Design moment resistance of column base

Loading type	Left side tension & Right side compression	Lever arm	$z = 222.8 \text{ mm}$
Design moment resist	$M_{j,Rd} = 20.9 \text{ kNm}$		

PASS - Design moment of resistance exceeds applied moment

Weld resistance

Weld leg length	$s_w = 8 \text{ mm}$	Weld throat size	$a_w = 5.7 \text{ mm}$
Material strength for weld	$f_{u_weld} = 410 \text{ N/mm}^2$	Design shear strength	$f_{vw,d} = 222.8 \text{ N/mm}^2$
Design resist per unit length	$f_{w,Rd} = 1260.3 \text{ N/mm}$		

Tension weld

Force in tension weld	$F_{w,t,Ed} = 127.89 \text{ kN}$	Length of weld	$L_{w,t} = 283.4 \text{ mm}$
Design resistance	$F_{w,t,Rd} = 357.2 \text{ kN}$		

PASS - Available strength of weld exceeds force in weld

Shear weld

Force in shear weld	$F_{w,v,Ed} = 5.8 \text{ kN}$	Length of weld	$L_{w,v} = 247.2 \text{ mm}$
Design resistance	$F_{w,v,Rd} = 311.5 \text{ kN}$		

PASS - Available strength of weld exceeds force in weld

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Calcs for Base plate				Start page no./Revision 3	
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Project Hedge Edn Green sculptures				Job no. 6474	
Calcs for Concrete pad foundation				Start page no./Revision 1	
Calcs by SRF	Calcs date 30/03/2021	Checked by	Checked date	Approved by	Approved date

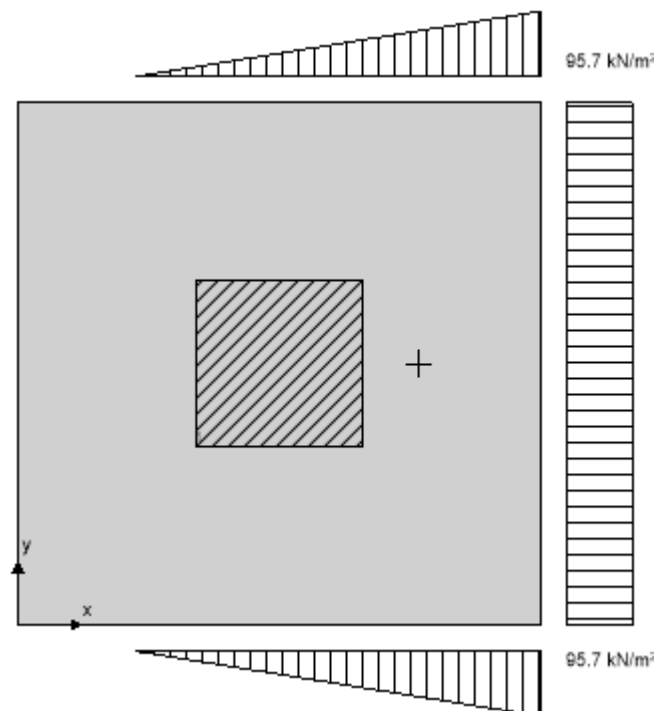
FOUNDATION ANALYSIS (EN1992-1:2004)

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 3.2.21

Pad foundation details

Length of foundation	$L_x = 1250 \text{ mm}$	Width of foundation	$L_y = 1250 \text{ mm}$
Depth of foundation	$h = 1250 \text{ mm}$	Depth of soil over foundation	$h_{\text{soil}} = 200 \text{ mm}$
Level of water	$h_{\text{water}} = 0 \text{ mm}$	Density of water	$\gamma_{\text{water}} = 9.8 \text{ kN/m}^3$
Density of concrete	$\gamma_{\text{conc}} = 25.0 \text{ kN/m}^3$		



Column no.1 details

Length of column	$l_{x1} = 400 \text{ mm}$	Width of column	$l_{y1} = 400 \text{ mm}$
position in x-axis	$x_1 = 625 \text{ mm}$	position in y-axis	$y_1 = 625 \text{ mm}$

Soil properties

Density of soil	$\gamma_{\text{soil}} = 18.0 \text{ kN/m}^3$	Net ultimate bearing pressure	$n_f = 100 \text{ kN/m}^2$
Friction angle	$\delta_k = 20 \text{ deg}$		

Foundation loads

Self weight	$F_{\text{swt}} = 31.3 \text{ kN/m}^2$	Soil weight	$F_{\text{soil}} = 3.6 \text{ kN/m}^2$
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Column no.1 loads

Permanent load in z	$F_{Gz1} = 1.5 \text{ kN}$	Variable load in x	$F_{Qx1} = 3.8 \text{ kN}$
Variable load in z	$F_{Qz1} = 2.0 \text{ kN}$		
Permanent moment in x	$M_{Gx1} = 0.5 \text{ kNm}$	Variable moment in x	$M_{Qx1} = 12.3 \text{ kNm}$

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Calcs for Concrete pad foundation				Start page no./Revision 2	
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Bearing resistance (Section 6.5.2)

Forces on foundation

Force in x-axis $F_{dx} = 3.8$ kN Force in z-axis $F_{dz} = 58.0$ kN

Moments on foundation

Moment in x-axis $M_{dx} = 53.7$ kNm Moment in y-axis $M_{dy} = 36.2$ kNm

Eccentricity of base reaction

Eccentricity in x-axis $e_x = 302$ mm Eccentricity in y-axis $e_y = 0$ mm

Eccentricity of base reaction

Eccentricity in x-axis $e_x = 302$ mm Eccentricity in y-axis $e_y = 0$ mm

Pad base pressure

$q_1 = 0.0$ kN/m² $q_2 = 0.0$ kN/m² $q_3 = 95.7$ kN/m² $q_4 = 95.7$ kN/m²
Minimum base pressure $q_{min} = 0.0$ kN/m² Maximum base pressure $q_{max} = 95.7$ kN/m²

Presumed bearing capacity

Presumed bearing capacity $P_{bearing} = 100.0$ kN/m²

PASS - Presumed bearing capacity exceeds design base pressure

Design approach 1

Partial factors on actions - Combination1

Partial factor set A1
Permanent action $\gamma_G = 1.35$ Variable action $\gamma_Q = 1.50$

Partial factors for spread foundations - Combination1

Resistance factor set R1
Bearing $\gamma_{R,v} = 1.00$ Sliding $\gamma_{R,h} = 1.00$

Forces on foundation

Force in x-axis $F_{dx} = 5.8$ kN Force in z-axis $F_{dz} = 78.5$ kN

Moments on foundation

Moment in x-axis $M_{dx} = 75.3$ kNm Moment in y-axis $M_{dy} = 49.1$ kNm

Eccentricity of base reaction

Eccentricity in x-axis $e_x = 333$ mm Eccentricity in y-axis $e_y = 0$ mm

Effective area of base

Effective length $L'_x = 583$ mm Effective width $L'_y = 1250$ mm
Effective area $A' = 0.729$ m²

Pad base pressure

Design base pressure $f_{dz} = 107.7$ kN/m²

Sliding resistance (Section 6.5.3)

Forces on foundation

Force in x-axis $F_{dx} = 5.8$ kN Force in z-axis $F_{dz} = 56.0$ kN

Sliding resistance verification (Section 6.5.3)

Horizontal force on foundation $H = 5.8$ kN Sliding resistance $R_{H,d} = 20.4$ kN
 $H / R_{H,d} = 0.283$

PASS - Foundation is not subject to failure by sliding

Library item: Check sliding summary

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Calcs for Concrete pad foundation				Start page no./Revision 3	
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Design approach 1

Partial factors on actions - Combination2

Partial factor set A2

Permanent action $\gamma_G = 1.00$ Variable action $\gamma_Q = 1.30$

Partial factors for spread foundations - Combination2

Resistance factor set R1

Bearing $\gamma_{R,v} = 1.00$ Sliding $\gamma_{R,h} = 1.00$

Forces on foundation

Force in x-axis $F_{dx} = 5.0$ kN Force in z-axis $F_{dz} = 58.6$ kN

Moments on foundation

Moment in x-axis $M_{dx} = 59.2$ kNm Moment in y-axis $M_{dy} = 36.6$ kNm

Eccentricity of base reaction

Eccentricity in x-axis $e_x = 386$ mm Eccentricity in y-axis $e_y = 0$ mm

Effective area of base

Effective length $L'_x = 477$ mm Effective width $L'_y = 1250$ mm

Effective area $A' = 0.597$ m²

Pad base pressure

Design base pressure $f_{dz} = 98.1$ kN/m²

Sliding resistance (Section 6.5.3)

Forces on foundation

Force in x-axis $F_{dx} = 5.0$ kN Force in z-axis $F_{dz} = 56.0$ kN

Sliding resistance verification (Section 6.5.3)

Horizontal force on foundation $H = 5.0$ kN Sliding resistance $R_{H,d} = 16.3$ kN

$H / R_{H,d} = 0.306$

PASS - Foundation is not subject to failure by sliding

Library item: Check sliding summary