



KILGALLEN & PARTNERS

CONSULTING ENGINEERS

Structural Calculations

OCTINK

SEGRO PARK HAYES

Octink

SEGRO Park Hayes, Signage

**Document
Reference**

19-504-C2-T01

**Kilgallen & Partners
Consulting Engineers**

**14 Cambridge Court
210 Shepherd's Bush Road
London W6 7NJ**

17th May 2019

DOCUMENT AMENDMENT HISTORY

Client	Octink
Project	SEGRO Park Hayes
Title	Structural Calculations for Octink

Date	Details of Issue	Issue No.	Origin	Checked	Approved
17/05/2019	Issue to Octink	T01	SJB	AD	

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4.0 Design check of Pad (2m length x 1.7m wide x 1.1m deep) and steel frame with connections

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APPENDIX A - MASTERSERIES CALCULATIONS

A1 – NODE NUMBERS & INPUT DATA

A2 – SUPPORT REACTIONS

A3 – WIND LOADING

A4 – MAXIMUM FORCES

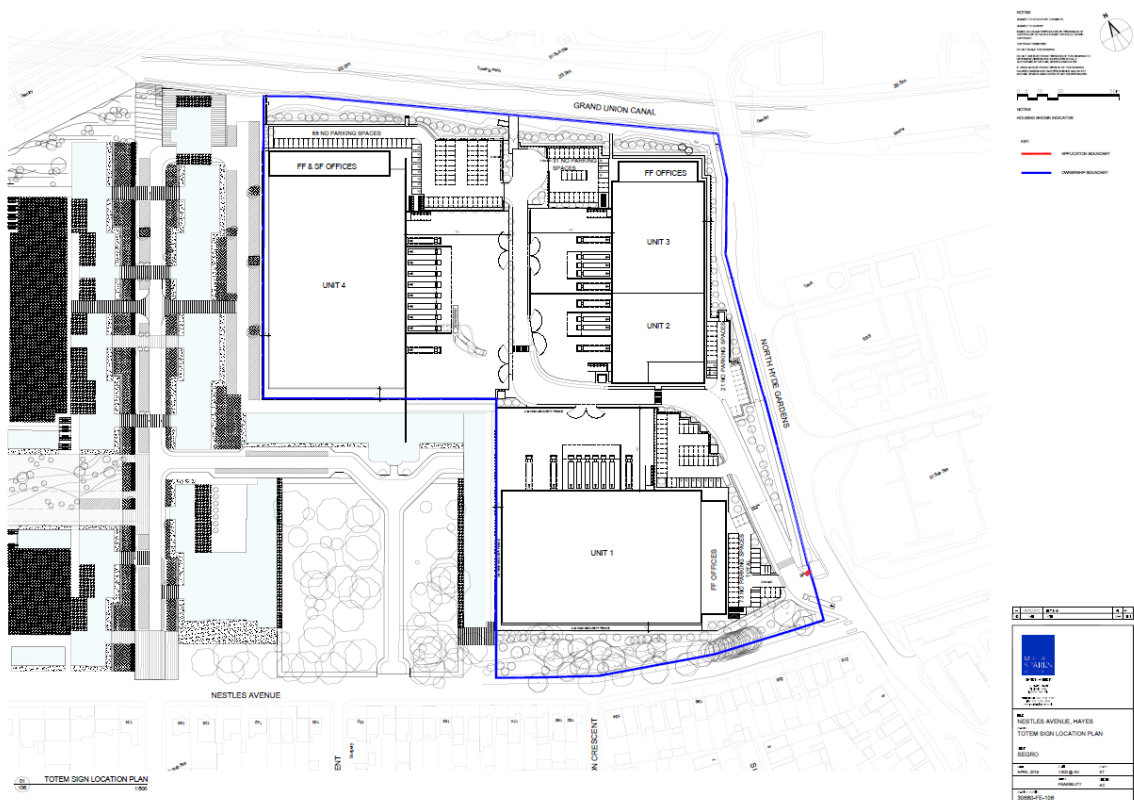
A5 – DESIGN OUTPUT (RHS/SHS)

1.0 Scope of Report

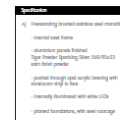
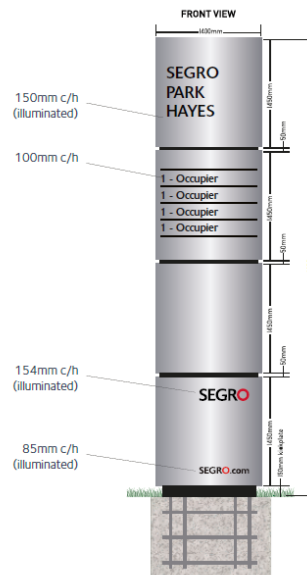
- 1.1 Kilgallen and Partners have been engaged to fulfil the role of Checking Structural Engineer for Octink for the proposed signage, concrete base and fixing details at SEGRO Park Hayes. Please find below Octink's most recent drawings for site plan & proposed structure. Photo 1 shows the location for the proposed 6.1m x 1.4m wide sign, refer to DWG.01 for the location of sign. DWG.02 shows typical signage information considered by Octink with their preferred sizes of members that will be checked throughout this report.



PHOTO 1 (Site Location, Hayes – Near UB3 4QG)



DWG. 01



Client: SEGRO Administration Limited
Job Title: SEGRO Park Hayes
Job No: TN115132
Drawn By: Darren
File name: TN115132 Hayes-V2
Date: 10th May 2019

Approved by:

octink

All structures are constructed to high standards and in accordance with good industry practice. By signing the drawings, the signatory certifies that the structures will be manufactured and erected in accordance with the specification and to standards outlined on this drawing. The signatory also certifies that the structures are not intended to be permanent and that the signatory is not aware of any other structures published by the British Standards Institution.

DWG. 02

2.0 Loading

- 2.1 Dead loading is calculated based on the self-weight of the new structure.
- 2.2 Proposed frame has not been checked for Live and Snow Loadings
- 2.3 Refer to Appendix A for MasterSeries results designed to EuroCodes



Stephen Banahan, Structural Engineer

Kilgallen and Partners Consulting Engineers

3.0 Wind Analysis and wind loadings

Wind loading has been calculated to Eurocode 1. The site is located at SEGRO Park Hayes. The wind analysis for the sign is denoted on the following pages.

TEST PROJECT

Revision

Job No: 17516 Page: C/01
Prepared By: SJB Date: 14/05/2019

Section: WIND ANALYSIS

SITE AND BUILDING (STRUCTURE) DATA

Site location or nearest city: London
Site topography: non significant
Building (structure) orientation: unknown
Nearby buildings/obstructions: consider
Building (structure) height 'h' [m] = 6.0
Site altitude 'A' [m] = 20.0
Fundamental basic wind velocity ' $v_{b,ref}$ ' [m/s] = 21.4
Building (structure) design life [years] = 50.0
Season factor ' c_{season} ' = 1.00
Probability factor ' c_{prob} ' = 1.00
Altitude factor ' c_{alt} ' = 1.02

CALCULATIONS: BASIC WIND VELOCITY

Building (structure) rotation from North ' ϕ ' [deg] =	N/A			
Wind direction:	ANY	II	III	IV
Angle from North ' ϕ_r ' [deg] =	-	-	-	-
Direction factor ' c_{dir} ' =	1.00	-	-	-
Basic wind velocity ' v_b ' [m/s] =	21.83	-	-	-
Basic velocity pressure ' q_b ' [kN/m ²] =	0.292	-	-	-

CALCULATIONS: EFFECTIVE HEIGHT

Wind direction:	ANY	II	III	IV
Terrain in upwind direction:	town	-	-	-
Distance upwind to shoreline [km] =	78	-	-	-
Distance upwind inside town [km] =	2	-	-	-
NEARBY BUILDINGS DATA:				
Average height ' h_{ave} ' [m] =	2	-	-	-
Upwind spacing 'x' [m] =	-	-	-	-
Effective height ' h_{eff} ' [m] =	6.00	-	-	-

CALCULATIONS: PEAK VELOCITY PRESSURE

Wind direction:	ANY	II	III	IV
Topography factor ' c_{st} ' =	-	-	-	-
Roughness factor ' c_{rx} ' =	-	-	-	-
Correction factor ' $c_{r,T}$ ' =	-	-	-	-
Turbulence factor ' $I_{z,ref}$ ' =	-	-	-	-
Turbulence correction factor ' $c_{r,T}$ ' =	-	-	-	-
Exposure factor ' c_{ex} ' =	2.02	-	-	-
Exposure correction factor ' $c_{ex,T}$ ' =	0.82	-	-	-
Peak velocity pressure ' q_p ' [kN/m ²] =	0.48	-	-	-

Designer's Notes:

TEST PROJECT

Revision

Job No: 17516 Page: C/01
Prepared By: SJB Date: 14/05/2019

Section: WIND ANALYSIS

BUILDING (STRUCTURE) DATA

Structure: Free-standing walls
Type of surface: Steel building
Peak velocity pressure ' q_p ' [kN/m^2] = 0.48
Free-standing wall length ' L ' [m] = 1.00
Free-standing wall height ' h ' [m] = 6.00

SUMMARY OF RESULTS

Zone:	A	B	C	D
' w ' [kN/m^2] =	1.104	-	-	-

RETURN CORNERS, OPENINGS AND SHELTER FACTOR

Return corners: No
Length of return corners ' z ' [m] = N/A
Openings area ' A_i ' [m^2] = 0.00
Shelter factor ' ψ_s ' = 1.00

CALCULATIONS AND RESULTS: FRICTION FORCE (?)

Friction coefficient for free-standing walls ' c_{fr} ' = 0.01
Reference area ' A_{ref} ' [m^2] = 12.00
Friction force ' F_{fr} ' [kN] = 0.06

note: values for walls parallel to wind direction (like return corner)

CALCULATIONS: NET PRESSURE COEFFICIENTS

Solidity ' ψ ' = 1.00
Wall length to height ratio ' L/h ' = $L < 0.3h$
Recommended net pressure coefficients ' $c_{p,net}$ ':

Zone:	A	B	C	D
$c_{p,net}$ =	2.300	-	-	-

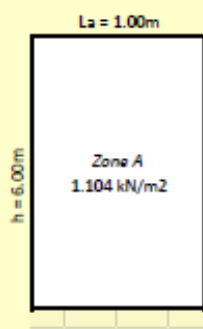
note: values for walls perpendicular to wind direction

RESULTS: WIND NET PRESSURES

Zone:	A	B	C	D
' w ' [kN/m^2] =	1.104	-	-	-

note: values for walls perpendicular to wind direction

DIAGRAM: ZONES OF FREE STANDING WALLS AND PARAPETS



note: diagram is not to scale, gives critical values per zone.

4.0 Design check of Pad and steel frame with connections

The structure and connections have been designed in accordance with Eurocodes and BS8110. The calculations for the various elements are outlined in the following pages.

Project Spreadsheets to BS8110 Client Advisory Group Location Base B3/B4 PAD FOUNDATION DESIGN to BS8110:1997 Originated from RCC81.xls on CD © 1999 BCA for RCC		 REINFORCED CONCRETE COUNCIL Combined base		REINFORCED CONCRETE COUNCIL <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Made by</td> <td>Date</td> <td>Page</td> </tr> <tr> <td>SJB</td> <td>17-May-19</td> <td>2</td> </tr> <tr> <td>Checked</td> <td>Revision</td> <td>Job No</td> </tr> <tr> <td>AD</td> <td>-</td> <td>17518</td> </tr> </table>			Made by	Date	Page	SJB	17-May-19	2	Checked	Revision	Job No	AD	-	17518
Made by	Date	Page																
SJB	17-May-19	2																
Checked	Revision	Job No																
AD	-	17518																

MATERIALS	fcu	30	N/mm ²	h agg	20	mm	γc	1.5	steel
	fy	460	N/mm ²	cover	50	mm	γs	1.05	concrete
Densities - Concrete		23.6	kN/m ³	Soil	18	kN/m ³			
Bearing pressure		100	kN/m ² (net allowable)						

COLUMN REACTIONS kN, kNm <i>characteristic</i>									
Column 1 (rhs)	DEAD	IMPOSED	WIND	Column 2 (lhs)	DEAD	IMPOSED	WIND		
Axial	9.2			Axial	9.2				
Mx			18.2	Mx			18.2		
My				My					
Hx			5.8	Hx			5.7		
Hy				Hy					

DIMENSIONS mm		
BASE	COLUMN 1 (rhs)	COLUMN 2 (lhs)
L = 2000	h1 = 100	h2 = 100
B = 1700	b1 = 150	b2 = 150
depth H = 1100		
Σex = 1400	ex1 = 700	ex2 = 700
Σey = 0	ey1 = 0	ey2 = 0

STATUS VALID DESIGN

BEARING PRESSURES kN/m ² <i>characteristic</i>	CORNER	1	2	3	4
no wind		11.6	11.6	11.6	11.6
with wind		0.0	57.7	0.0	57.7

REINFORCEMENT

Btm Mxx - 100.0 kNm b = 1700 mm d = 1040 mm As = 231 mm ²	Myy - 4.6 b = 2000 d = 1020 As = 11
---	--

PROVIDE 8 T20 @ 250 B1 & 10 T20 @ 225 B2

Asprov = 2513 mm² Asprov = 3142

Top Mxx + 1.9 kNm d = 1040 mm As = 4 mm ²	Myy + 0.0 d = 1020 As = 0
--	---------------------------------

PROVIDE 8 T20 @ 250 T1 & 10 T20 @ 225 T2

Asprov = 2513 mm² Asprov = 3142

BEAM SHEAR

Vxx = 128.0 kN at d v = 0.072 N/mm ² or Vxx = 128.0 kN at 2d v = 0.072 N/mm ² vc = 0.351 N/mm ²	Vyy = 0.0 v = 0.000 or Vyy = 0.0 v = 0.000 vc = 0.360
--	---

PUNCHING SHEAR

d ave = 1030 mm	u crit = 0 mm
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PLOT (to-scale)

Efficiency'

Mx Diagram

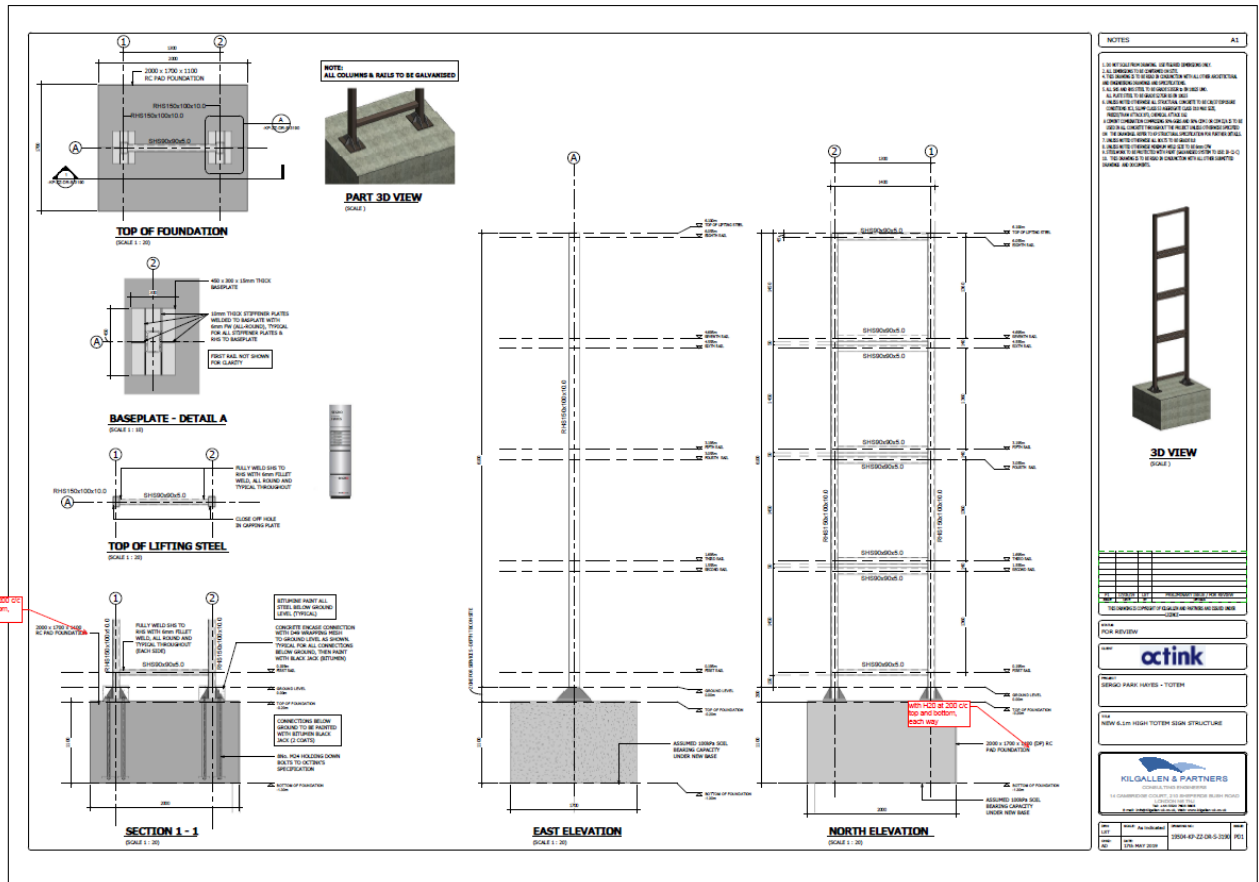
This calculation proves that a 2m long x 1.7m wide x 1.1m foundation is within limits & has been checked for overturning.

Project SEGRO PARK HAYES.			 KILGALLEN & PARTNERS CONSULTING ENGINEERS
Part of Structure CHECK RESTORANT MOMENT / OVERTURNING FOR 6.1m.			
Job No. 17516.	Drawing Ref.	Date 15th MAY 2019.	14 Cambridge Court 210 Shepherd's Bush Road London W6 7NJ Email: info@kilgallen-uk.co.uk Web: www.kilgallen-uk.co.uk
Sheet No. 1.	Calculation By S.O.B.	Checked By	

Ref.	Calculations	Output
	<u>OVERTURNING / RESTORING MOMENT IN FOUNDATION. (REFER TO PAGE 1a FOR EXCEL SHEET).</u> <u>150 x 100 x 10 RHS OK.</u>  <u>REFER TO APPENDIX A FOR CALCULATIONS OF RHS & STS.</u> <u>OVERTURNING.</u> WIND LOAD = $1.1 \text{ kN/m}^2 \text{ (ENAD.)}$ $= 1.1 \times 1.5 = 1.65 \text{ kN/m}^2 \text{ (WIND.)}$ OVERTURNING MOMENT = $1.65 \times 6.1 \times 1.7 / 2 \times \left(\frac{6.1}{2} + 1 \right) = 19 \text{ kNm/corr.} = 28.5 \text{ kNm (WIND.)}$ RESTORING MOMENT = $(29.7 \times 1.1 / 3) + (24 \times 1.1 \times 1.7 \times 1.1 \times (1.7 / 2))$ $= 10.89 + 28.2 = 49 \text{ kNm/corr.} \quad \text{OK.}$ Passive Pressure $= K_p p_h = 3 \times 18 \times 1 = 54 \text{ kN/m}^2 \therefore F_p = 0.5 \times 54 \times 1.1 = 29.7 \text{ kN.}$ SLIDING = $(24 \times 1.7 \times 1.7 \times 1.1) + 29.7$ $= 77 + 29.7 = 107 \text{ kN} \therefore \text{OK.}$ <u>REFER TO APPENDIX A FOR CALCULATIONS FOR SIGN & MAXIMUM MOMENTS / SHEAR FORCES.</u>	REFER TO APPENDIX A FOR CALCULATIONS OF RHS & STS. REFER TO 'ACTIVE' DWGS. OK ✓ OK ✓ OK ✓ OK ✓

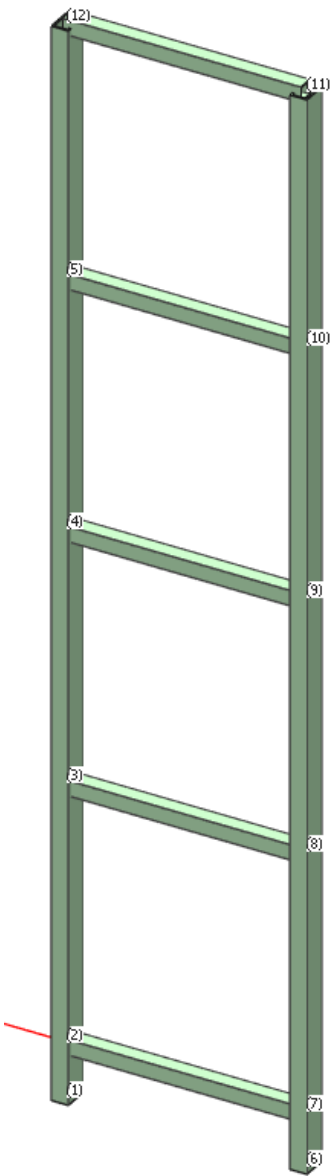
Project SEGRO PARK HAYES.			 KILGALLEN & PARTNERS CONSULTING ENGINEERS
Part of Structure STEEL CONNECTIONS / B2P BOLTS.			
Job No. 17516.	Drawing Ref.	Date 15th MAY 2019.	14 Cambridge Court 210 Shepherd's Bush Road London W6 7NJ E-mail: info@kilgallen.co.uk Web: www.kilgallen.co.uk
Sheet No. 2.	Calculation By SSB.	Checked By	

Ref.	Calculations	Output
	<u>CHECK M2A STUDS.</u> MAXIMUM MOMENT IN COLUMN FROM MASTER/SLAVE MOOR, REFER TO APPENDIX A = 18.2 kN/m. PUSH/PULL IN COLUMN = $18.2 / 0.2 = 91 \text{ kN/m}$. CAPACITY OF ONE STUD = 158 kN (GABRIEL 8.8). $\therefore$ PROVIDE 4 NO. M2A STUDS. (REFER TO DETAILING DWGS). GROUNDING CABLE $\rightarrow$ PROVIDE 4 NO M2A STUDS (B2P) WITH $40 \times 40 \times 3$ MILD STEEL ANGLE TIES & MDF TEMPLATE. BASEPLATES. PROVIDE 300×450 BASEPLATE $\times 15 \text{ mm}$. WALDS. CONCRETE STRENGTH $f_{cd} = 0.85 \times 30 / 1.5 = 17 \text{ N/mm}^2$ MINIMUM AREA REQUIRED = $120 \times 1000 / 17 = 7059 \text{ mm}^2$ MINIMUM C PROJECTION = 30 mm $b_p = C \left(\frac{3 f_{cd}}{t_f \times \gamma_m} \right)^{0.5} = 30 \times \left(\frac{3 \times 17}{275 \times 1.0} \right)^{0.5} = 12.9 \text{ mm}$ WALDS. $7 \text{ kN} / (4 \times 70) = 0.0194 < 0.60 \text{ kN/m}$ $\therefore \text{OK}$. PROVIDE 6m FILLET WELDS TO ALL CONNECTIONS.	



APPENDIX A - MASTERSERIES CALCULATIONS

A1 Node Numbers & Input Data



MASTERFRAME DATA FILE

LOADING CASES AND LOAD COMBINATION

Load Group Labels

Load Group UT	Unity Load Factor (All Cases)
Load Group D0	Dead Load
Load Group D1	Dead Load
Load Group L1	Live Load
Load Group W1	Wind Lo (Fetches 225 to 315 Degrees)
Load Group W2	Wind Load

Load Case 001 : Dead plus Live b (Ultimate)

Load Combination + 1.00 UT + 1.25 D1 + 1.50 L1

Load Case 002 : Dead plus Live a (Ultimate)

Load Combination + 1.00 UT + 1.35 D1 + 1.05 L1

Load Case 003 : Dead Only 1.00D0+1.00D1 (Serviceability)

Load Combination + 1.00 UT + 1.00 D0 + 1.00 D1

Load Case 004 : Dead+Wind 1.00D0+1.00D1+1.50W1+EHL@0 (Local Wind)

Load Combination + 1.00 UT + 1.00 D0 + 1.00 D1 + 1.50 W1

Notional Loads Apply horizontal notional loads at 0.0 degrees from X axis equal to 0.5% of the factored vertical loads in case 4

Level			Level			Level		
@ (m)	F (kN)		@ (m)	F (kN)		@ (m)	F (kN)	
0	0.000	0.001	1	0.320	0.015	2	1.840	0.017
3	3.330	0.017	4	4.810	0.017	5	6.300	0.003
Node	F (kN)	Node	F (kN)	Node	F (kN)	Node	F (kN)	
1	0.000	2	0.007	3	0.008	4	0.008	
5	0.008	6	0.000	7	0.007	8	0.008	
9	0.008	10	0.008	11	0.002	12	0.002	

Load Case 005 : Dead+Wind 1.00D0+1.00D1+1.00W1 (Serviceability) (Local Wind)

Load Combination + 1.00 UT + 1.00 D0 + 1.00 D1 + 1.00 W1

Load Case 006 : Dead+Live 1.25D0+1.25D1+1.50W1+0.75W2+EHL@0 (Local Wind)

Load Combination + 1.00 UT + 1.25 D0 + 1.25 D1 + 1.50 W1 + 0.75 W2

Notional Loads Apply horizontal notional loads at 0.0 degrees from X axis equal to 0.5% of the factored vertical loads in case 6

Level	@ (m)	F (kN)	Level	@ (m)	F (kN)	Level	@ (m)	F (kN)	
0	0.000	0.001	1	0.320	0.018	2	1.840	0.021	
3	3.330	0.021	4	4.810	0.021	5	6.300	0.004	
Node	F (kN)	Node	F (kN)	Node	F (kN)	Node	F (kN)	Node	F (kN)
1	0.000	2	0.009	3	0.010	4	0.010		
5	0.010	6	0.000	7	0.009	8	0.010		
9	0.010	10	0.010	11	0.002	12	0.002		

Load Case 007 : Dead+Live 1.35D0+1.35D1+0.75W1+0.75W2+EHL@0 (Local Wind)

Load Combination + 1.00 UT + 1.35 D0 + 1.35 D1 + 0.75 W1 + 0.75 W2

Notional Loads Apply horizontal notional loads at 0.0 degrees from X axis equal to 0.5% of the factored vertical loads in case 7

Level	@ (m)	F (kN)	Level	@ (m)	F (kN)	Level	@ (m)	F (kN)	
0	0.000	0.001	1	0.320	0.020	2	1.840	0.022	
3	3.330	0.022	4	4.810	0.022	5	6.300	0.005	
Node	F (kN)	Node	F (kN)	Node	F (kN)	Node	F (kN)	Node	F (kN)
1	0.000	2	0.010	3	0.011	4	0.011		
5	0.011	6	0.000	7	0.010	8	0.011		
9	0.011	10	0.011	11	0.002	12	0.002		

Load Case 008 : Dead+Live 1.00D0+1.00D1+1.00W1+0.50W2 (Serviceability) (Local Wind)

Load Combination + 1.00 UT + 1.00 D0 + 1.00 D1 + 1.00 W1 + 0.50 W2

THE NODAL CO-ORDINATES

Node	X (m)	Y (m)	Z (m)	Node	X (m)	Y (m)	Z (m)
1	2.600	0.000	-2.600	2	2.600	0.320	-2.600
3	2.600	1.840	-2.600	4	2.600	3.330	-2.600
5	2.600	4.810	-2.600	6	4.000	0.000	-2.600
7	4.000	0.320	-2.600	8	4.000	1.840	-2.600
9	4.000	3.330	-2.600	10	4.000	4.810	-2.600
11	4.000	6.300	-2.600	12	2.600	6.300	-2.600

MEMBER PROPERTIES

Members 1-5 & 7-11

M 150x100x10 RHS 35.3 [S 275]
A 44.93E-4 Iy 1282E-8 Iz 665.4E-8 It 1432E-8
E 210.0E6 G 80.77E6

Members 6 & 12-15

M 90x90x5 SHS 13.1 [S 275]
A 16.73E-4 Iy 199.6E-8 Iz 199.6E-8 It 315.5E-8
E 210.0E6 G 80.77E6

MEMBER LOADING

Member Self Weight Density Load Included in Load Group D1, defined by Modulus of Elasticity

E kN/mm² Density kN/m³
>= 200.00 77.01
>= 20.00 24.00
>= 2.00 10.00

Members 1-5 & 7-11 - MasterFrame Pro Loads

D1 D 077.010 (kN/m³)
W1 UDLZ -000.770 (Co/m)

Members 6 & 12-15 - MasterFrame Pro Loads

D1 D 077.010 (kN/m³)

Members 12-15

D1 UDLY -001.500 (kN/m)

MEMBER ORIENTATION

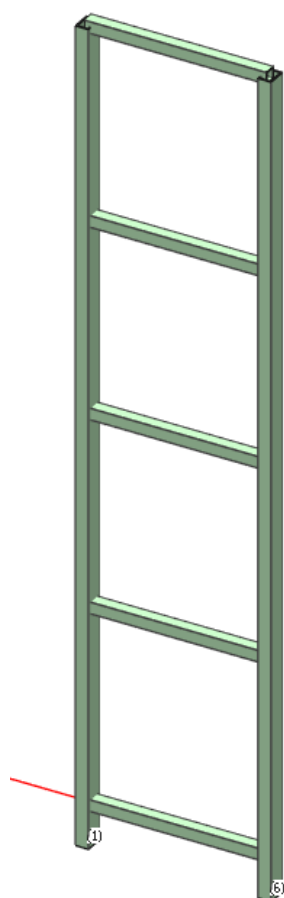
Members 1-5 & 7-11 β +090.00

NODAL LOADING AND SUPPORT CONDITIONS

NODES 1 & 6

UT Rs 1 1 1 1 1 1 (Fixed)

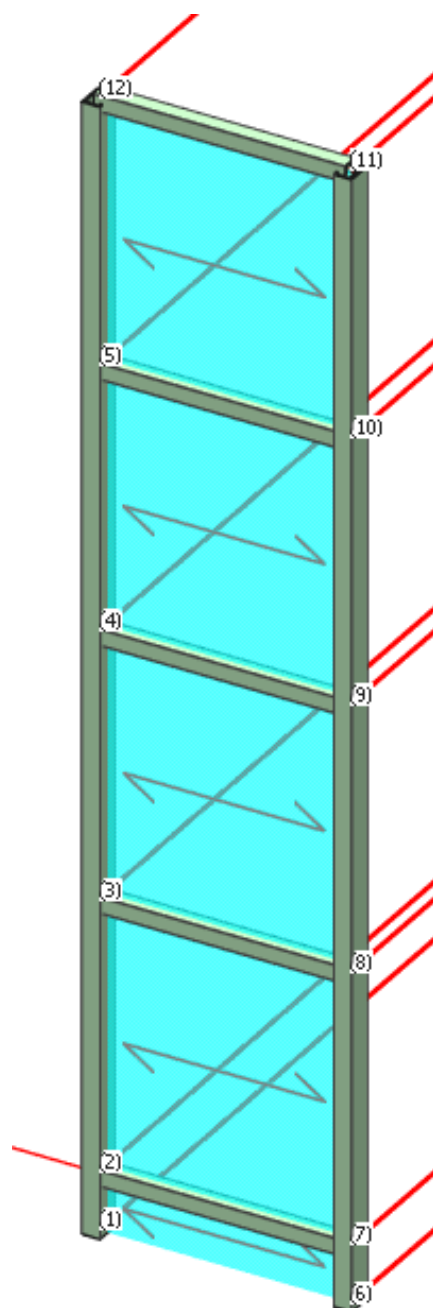
A2 Support Reactions



Support Reactions (Maximum Values Serviceability)						
Node	Directional Reactions (kN)			Moment Reactions (kN.m)		
	Rx → (kN)	Ry ↑ (kN)	Rz ↗ (kN)	Mx → (kN.m)	My ↑ (kN.m)	Mz ↗ (kN.m)
1	0.618	6.830	3.825	12.117	0.000	-0.041
6	-0.618	6.831	3.874	12.135	0.036	0.040
Total	0.000	13.662	7.699	24.252	0.036	-0.001

Support Reactions (Maximum Values Ultimate)						
Node	Directional Reactions (kN)			Moment Reactions (kN.m)		
	Rx → (kN)	Ry ↑ (kN)	Rz ↗ (kN)	Mx → (kN.m)	My ↑ (kN.m)	Mz ↗ (kN.m)
1	0.835	9.221	5.737	18.175	0.000	-0.055
6	-0.881	9.351	5.811	18.203	0.054	0.093
Total	-0.092	18.443	11.549	36.378	0.054	0.077

A3 Wind Loading



A4 Maximum Forces

Member Forces Ultimate (Maximum Values)										
Member No.	Node End1 End2	Axial Force (kN)	Torque Moment (kNm)	Shear Force (kN)		Bending Moment (kNm)		Maximum Moment (kNm @ m)		Max Def (mm @ m)
				x-x	y-y	x-x	y-y	x-x	y-y	
1	6	9.35C	0.05	5.81	-0.88	-18.20	0.09	0.44	-0.31	11.97
	7	9.20C	-0.05	5.52	-0.88	-16.39	-0.21	@ 5.779	@ 4.795	@ 2.585
2	7	7.64C	0.07	5.54	-0.23	-16.39	0.17	0.44	-0.31	11.97
	8	6.93C	-0.07	4.14	-0.23	-9.03	-0.18	@ 5.779	@ 4.795	@ 2.585
3	8	5.35C	0.18	4.26	-0.24	-9.03	0.18	0.44	-0.31	11.97
	9	4.66C	-0.18	2.89	-0.24	-3.70	-0.17	@ 5.779	@ 4.795	@ 2.585
4	9	3.09C	0.35	3.02	-0.34	-3.64	0.20	0.44	-0.31	11.97
	10	2.40C	-0.35	1.67	-0.34	-0.18	-0.31	@ 5.779	@ 4.795	@ 2.585
5	10	0.87C	0.00	0.90	-0.04	0.00	0.00	0.44	-0.31	11.97
	11	0.17C	0.00	-0.47	-0.04	0.32	-0.06	@ 5.779	@ 4.795	@ 2.585
6	11	0.04C	0.32	-0.17	-0.47	0.06	0.00	-0.02		0.20
	12	0.04C	-0.32	0.08	-0.47	-0.01	-0.66	@ 0.938		@ 0.812
7	1	9.22C	0.00	5.74	0.83	-18.18	-0.05		0.28	11.13
	2	9.07C	0.00	5.44	0.83	-16.39	0.24	@ 4.795		@ 2.406
8	2	7.53C	0.01	5.43	0.20	-16.39	-0.14		0.28	11.13
	3	6.82C	-0.01	4.03	0.20	-9.20	0.17	@ 4.795		@ 2.406
9	3	5.28C	0.06	3.92	0.21	-9.21	-0.17		0.28	11.13
	4	4.58C	-0.06	2.55	0.21	-4.39	0.14	@ 4.795		@ 2.406
10	4	3.04C	0.07	2.42	0.33	-4.44	-0.21		0.28	11.13
	5	2.35C	-0.07	1.07	0.33	-1.86	0.28	@ 4.795		@ 2.406
11	5	0.77C	-0.66	1.83	0.04	-2.03	-0.06		0.28	11.13
	12	0.08C	0.66	0.47	0.04	-0.32	-0.01	@ 4.795		@ 2.406
12	2	0.64C	0.00	1.54	0.02	-0.35	-0.01	0.19		0.06
	7	0.64C	0.00	-1.56	0.02	-0.36	0.02	@ 0.686		@ 0.686
13	3	0.01T	-0.01	1.54	0.12	-0.34	-0.05	0.20		0.07
	8	0.01T	0.01	-1.58	0.12	-0.37	0.11	@ 0.658		@ 0.686
14	4	0.12T	-0.05	1.55	0.13	-0.35	-0.01	0.19		0.07
	9	0.12T	0.05	-1.57	0.13	-0.37	0.17	@ 0.672		@ 0.728
15	5	0.29C	-0.18	1.57	-0.77	-0.34	0.73	0.22		0.14
	10	0.29C	0.18	-1.53	-0.77	-0.31	-0.35	@ 0.700		@ 0.518

Support Reactions Ultimate (Maximum Values)						
Node	Directional Reactions (kN)			Moment Reactions (kNm)		
	Rx → (kN)	Ry ↑ (kN)	Rz ↗ (kN)	Mx → (kNm)	My ↑ (kNm)	Mz ↗ (kNm)
1	0.835	9.221	5.737	18.175	0.000	-0.055
6	-0.881	9.351	5.811	18.203	0.054	0.093
Total	-0.092	18.443	11.549	36.378	0.054	0.077

AXIAL WITH MOMENTS (MEMBER)

Member SCL1Id 3 @ Level 1

Between 0.000 and 1.800 m, in Load Case 6

Member Loading and Member Forces

Loading Combination : 1 UT + 1.25 D0 + 1.25 D1 + 1.5 W1

+ 0.75 W2

D1 D 077.010 (kN/m³)
W1 UDLZ -000.770 (Co/m)



Member Forces in Load Case 6 and Maximum Deflection from Load Case 5										
Member No.	Node End 1 End 2	Axial Force (kN)	Torque Moment (kNm)	Shear Force (kN)		Bending Moment (kNm)		Maximum Moment (kNm @ m)		Max Def (mm @ m)
				x-x	y-y	x-x	y-y	x-x	y-y	
	1	8.42C	0.00	5.74	0.73	-18.18	-0.01		0.24	7.42
	12	0.07C	0.66	0.47	0.03	-0.32	-0.01		@ 4.795	@ 2.406

Additional Nominal Moments

M_{zUp} 0.01 kN.m

Classification and Effective Area (EN 1993: 2006)

Section (35.3 kg/m) 150x100x10 RHS 35.3 [S 275]

Class = $F_n(b/t, d/t, f_y, N, M_y, M_z)$ 7, 12, 275, 8.418, 18.175, 0.252

(Axial: Non-Slender)

Class 1

Auto Design Load Cases

1-2, 4 & 6-7

Local Capacity Check

$V_{y,Ed}/V_{pl,y,Rd}$	$5.737 / 428.016 =$	0.013	Low Shear
$M_{c,y,Rd} = f_y \cdot W_{pl,y} / \gamma_{M0}$	$275 \times 216.05 / 1$	59.414 kN.m	
$V_{z,Ed}/V_{pl,z,Rd}$	$0.731 / 285.344 =$	0.003	Low Shear
$M_{c,z,Rd} = f_y \cdot W_{pl,z} / \gamma_{M0}$	$275 \times 161.23 / 1$	44.338 kN.m	
$N_{pl,Rd} = A_g \cdot f_y / \gamma_{M0}$	$44.93 \times 275 / 1 =$	1235.575 kN	
$n = N_{Ed} / N_{pl,Rd}$	$0.066 / 1235.575 =$	0.000	OK
$W_{pl,N,y} = F_n(W_{pl,y}, A_{vfy})$	$216.05, 26.958, 0$	216.05 cm ³	
$M_{N,y,Rd} = W_{pl,N,y} \cdot f_y / \gamma_{M0}$	$216.05 \times 275 / 1$	59.414 kN.m	
$W_{pl,N,z} = F_n(W_{pl,z}, A_{vfy})$	$161.23, 17.972, 0$	161.23 cm ³	
$M_{N,z,Rd} = W_{pl,N,z} \cdot f_y / \gamma_{M0}$	$161.23 \times 275 / 1$	44.338 kN.m	
$(M_{y,Ed} / M_{N,y,Rd} + (M_{z,Ed} / M_{N,z,Rd}))^{1.66} =$	$(18.175 / 59.414)^{1.66} + (0.015 / 44.338)^{1.66} =$	0.14	OK

Compression Resistance N.b.Rd

$L_{ey} = K_y \cdot L_y$	$1 \times 6.3 =$	6.3	
$\lambda_y = \sqrt{A \cdot f_y / N_{cr}}$	$\sqrt{44.93 \times 275 / 669.66}$	1.359	
$N_{b,y,Rd} = A_{eff} \cdot c \cdot f_y / \gamma_{M1}$	$44.93 \times 0.439 \times 275 / 10 / 1 =$	541.859 kN	Curve a
$L_{ez} = K_z \cdot L_z$	$1 \times 1.8 =$	1.8	
$\lambda_z = \sqrt{A \cdot f_y / N_{crz}}$	$\sqrt{44.93 \times 275 / 4256.67}$	0.539	
$N_{b,z,Rd} = A_{eff} \cdot c \cdot f_y / \gamma_{M1}$	$44.93 \times 0.912 \times 275 / 10 / 1 =$	1126.676 kN	Curve a

Equivalent Uniform Moment Factor C1

$C_1 = f_n(M_1, M_2, \sim y)$	$-18.2, -9.4, 0.515$	1.288	Not Loaded
$C_{mLT} = \text{Max}(0.6 + 0.4 \sim y, 0.4)$	$M = -18.17, \sim y = 0.515$	0.806	Table B.3
$C_{mz} = \text{Max}(0.1(1 - \sim y) - 0.8a_s, 0.4)$	$M_h = 0.14, M_s = 0, \sim y = -0.104, a_s = -0.007$	0.4	Table B.3
$C_{my} = \text{Max}(0.6 + 0.4 \sim y, 0.4)$	$M = -18.18, \sim y = 0.018$	0.607	Table B.3

Lateral Buckling Check M.b.Rd

$M_{b,Rd} = M_{c,y,Rd}$ Section not susceptible to lateral torsional buckling 59.414 kN.m

Buckling Resistance

$U_{N,y} = N_{Ed} / (C_y \cdot N_{Rk} / \gamma_{M1})$	$8.418 / 541.859$	0.016	OK
$U_{N,z} = N_{Ed} / (C_z \cdot N_{Rk} / \gamma_{M1})$	$8.418 / 1126.676$	0.007	OK
$U_{M,y} = M_{y,Ed} / (C_{LT} \cdot M_{y,Rk} / \gamma_{M1})$	$18.175 / 59.414$	0.306	OK
$U_{M,z} = M_{z,Ed} / (M_{z,Rk} / \gamma_{M1})$	$0.015 / 44.338$	0.000	OK
$k_y \gamma = C_{my} \{1 + 0.8 U_{N,y}\}$		0.615	

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$k_z Z = C_{mz} \{1 + (\lambda_z - 0.2) U_{N,z}\}$		0.401	
$k_y Z = 0.6 k_z Z$		0.241	
$k_z Y = 0.6 k_y Y$		0.369	
$U_{N,y} + k_y Y \cdot U_{M,y} + k_y Z \cdot U_{M,z}$	$0.016 + 0.615 \times 0.306 + 0.241 \times 0.000$	0.204	OK
$U_{N,z} + k_z Y \cdot U_{M,y} + k_z Z \cdot U_{M,z}$	$0.007 + 0.369 \times 0.306 + 0.401 \times 0.000$	0.120	OK

Deflection Check - Load Case 5

Cantilever $\delta \leq \text{Span}/100$	$45.74 \leq 6300 / 100$	45.74 mm	OK
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AXIAL WITH MOMENTS (MEMBER)

Member SBL1Id 6 @ Level 1 in Load Case 6

Member Loading and Member Forces

Loading Combination : 1 UT + 1.25 D0 + 1.25 D1 + 1.5 W1

+ 0.75 W2

D1 D 077.010 (kN/m³)
D1 UDLY -001.500 (kN/m)



Member Forces in Load Case 6 and Maximum Deflection from Load Case 5										
Member No.	Node End 1 End 2	Axial Force (kN)	Torque Moment (kNm)	Shear Force (kN)		Bending Moment (kNm)		Maximum Moment (kNm @ m)		Max Def (mm @ m)
				x-x	y-y	x-x	y-y	x-x	y-y	
14	4	0.11T	-0.05	1.40	0.13	-0.30	-0.01	0.18		0.05
	9	0.11T	0.05	-1.45	0.13	-0.34	0.17	@ 0.672		@ 0.728

Classification and Effective Area (EN 1993: 2006)

Section (13.1 kg/m)	90x90x5 SHS 13.1 [S 275]		
Class = $F_n(b/t, d/t, f_y, N, M_y, M_z)$	15, 15, 275, 0, 0.339, 0.168	(Axial: Non-Slender)	Class 1
Auto Design Load Cases	1-2, 4 & 6-7		

Local Capacity Check

$V_{y,Ed}/V_{pl,y,Rd}$	$1.451 / 132.812 =$	0.011	Low Shear
$M_{c,y,Rd} = f_y \cdot W_{pl,y} / \gamma_{M0}$	$275 \times 52.99 / 1$	14.572 kN.m	
$V_{z,Ed}/V_{pl,z,Rd}$	$0.128 / 132.812 =$	0.001	Low Shear
$M_{c,z,Rd} = f_y \cdot W_{pl,z} / \gamma_{M0}$	$275 \times 52.99 / 1$	14.572 kN.m	
$N_{pl,Rd} = A_g \cdot f_y / \gamma_{M0}$	$16.73 \times 275 / 1$ (No bearing / block tearing design)	460.075 kN	
$n = N_{Ed} / N_{pl,Rd}$	$-0.109 / 460.075 =$	0.000	OK
$W_{pl,N,y} = F_n(W_{pl,y}, A_{y,r})$	$52.99, 8.365, 0$	52.99 cm ³	
$M_{N,y,Rd} = W_{pl,N,y} \cdot f_y / \gamma_{M0}$	$52.99 \times 275 / 1$	14.572 kN.m	
$W_{pl,N,z} = F_n(W_{pl,z}, A_{z,r})$	$52.99, 8.365, 0$	52.99 cm ³	
$M_{N,z,Rd} = W_{pl,N,z} \cdot f_y / \gamma_{M0}$	$52.99 \times 275 / 1$	14.572 kN.m	
$(M_{y,Ed} / M_{N,y,Rd} + (M_{z,Ed} / M_{N,z,Rd}))^{1.66} + (0.168 / 14.572)^{1.66} =$		0.003	OK

Equivalent Uniform Moment Factors C1, C.mLT, C.mz, and C.my

$C_1 = f_n(M_1, M_2, M_0, \sim y, \sim m)$	$-0.3, -0.3, 0.5, 0.893, -1.466$	2.491	Uniform
$C_{mLT} = \text{Max}(0.1 - 0.8 a_s, 0.4)$	$M_h = -0.34, M_s = 0.18, \sim y = 0.893, a_s = -0.519$	0.515	Table B.3
$C_{mz} = \text{Max}(0.6 + 0.4 \sim y, 0.4)$	$M = 0.17, \sim y = -0.060$	0.576	Table B.3
$C_{my} = \text{Max}(0.1 - 0.8 a_s, 0.4)$	$M_h = -0.34, M_s = 0.18, \sim y = 0.894, a_s = -0.516$	0.513	Table B.3

Lateral Buckling Check M.b.Rd

$M_{b,Rd} = M_{c,y,Rd}$	Section not susceptible to lateral torsional buckling	14.572 kN.m
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Buckling Resistance

$U_{N,y} = N_{Ed} / (C_y \cdot N_{Rk} / \gamma_{M1})$	$0 / 429.751$	0.000	OK
$U_{N,z} = N_{Ed} / (C_z \cdot N_{Rk} / \gamma_{M1})$	$0 / 429.751$	0.000	OK
$U_{M,y} = M_{y,Ed} / (C_{LT} \cdot M_{y,Rk} / \gamma_{M1})$	$0.339 / 14.572$	0.023	OK
$U_{M,z} = M_{z,Ed} / (C_{LT} \cdot M_{z,Rk} / \gamma_{M1})$	$0.168 / 14.572$	0.012	OK
$k_y Y = C_{my} \{1 + (\lambda_y - 0.2) U_{N,y}\}$		0.513	
$k_z Z = C_{mz} \{1 + (\lambda_z - 0.2) U_{N,z}\}$		0.576	
$k_y Z = 0.6 k_z Z$		0.346	
$k_z Y = 0.6 k_y Y$		0.308	
$U_{N,y} + k_y Y \cdot U_{M,y} + k_y Z \cdot U_{M,z}$	$0.000 + 0.513 \times 0.023 + 0.346 \times 0.012$	0.016	OK
$U_{N,z} + k_z Y \cdot U_{M,y} + k_z Z \cdot U_{M,z}$	$0.000 + 0.308 \times 0.023 + 0.576 \times 0.012$	0.014	OK

Deflection Check - Load Case 5

Cantilever $\delta \leq \text{Span}/360$	$0.15 \leq 1400 / 360$	0.15 mm	OK
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