Canham Consulting

Structural Civil Building

Engineers

Structural Calculations

Project Ref:	**212480-CCL-XX-XX-CA-S-0002-P01**
Site:	**Clematis House, Sandy Lane, Aylmerton, Norfolk. NR11 8QE**
Client:	**Mr & Mrs Hobart**
Project Overview:	**Calculations and details for structural elements.**
Prepared By:	**Nigel Evans EngTech TIStructE C.Build E MCABE**
Checked By:	**Jack Powell BEng (Hons) IEng AMIStructE**
Revision History:	**June 2023 – First Issue**

Design Information

Project Overview	Calculations and details for structural elements

Intended Building Usage	Residential

Subsoil Conditions	From BGS website assumed to be Briton's Lane Sand and Gravel Member - Sand and gravel. Assumed allowable ground bearing pressure of 100kN/m^2 TBC on site by L.A.B.C officer.	**S.I Report by**	None

Specialist Design by Others	Engineered timber floor joists,		
Relevant British Standards, Codes of Practice and Design Standards Used In This Project			
BS 648:1964 - Weights of Materials	☒	**BS 5268 Pt 2:1996 -** Timber	☒
BS 6399 Pt 1:1996 - Building Loads	☒	**BS 5628 Pt 1: 1992 -** Masonry	☒
BS 6399 Pt 2:2002 - Wind Loading	☒	**Building Regs Approved Doc. A: 2004 edition incorporating 2004, 2010 and 2013 amendments.**	☒
BS 6399 Pt 3:1988 - Snow Loading	☒		
BS 5950 Pt 1:2000 - Steelwork	☒	**NHBC Standards**	☒
BS 8110 Pt 1:1997 - Concrete	☒	**Product and Material Data Sheets**	☒

CDM 2015 Design Considerations	**Principal Designer:**	Others

This 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 difficult to manage, unusual, or not likely to be obvious to a suitably-experienced contractor or designer*

Area of Hazard	**Assessed** (Yes | No | N/A)	**Method of Hazard Elimination/Reduction**	**Residual Risk**	
			Risk	Significant
Access to work area	Yes	To be arranged by Client	☒	☐
Demolition	Yes	Demolition of existing structure	☒	☐
Services	Yes	Contractor to identify services prior to construction	☒	☐
Installation	Yes	Design elements as light as possible. Deliver elements as close as possible to installation point. Use mechanical plant for lifting were possible	☒	☐
Excavation	Yes	Contractor to provide all req'd shoring and propping	☒	☐
Sequencing	Yes	Contractor's choice	☒	☐
Falls from height	Yes	Contractor to provide scaffold, fall arrest and edge protection where required	☒	☐
Post-tensioning/ pre-tensioning	No		☐	☐
Materials	Yes	Contractor to adopt safe working practices. Wear PPE to prevent contact with hazardous materials.	☒	☐
Hotworks	Yes	Prefabricate elements offsite where possible	☒	☐
Future Maintenance	No		☐	☐
Final Demolition	No		☐	☐

Does this project require a separate Designers Risk Assessment?	Yes	☐	No	☒

Client and Contractor Notices

The following calculations and details should be read in conjunction with any available architectural drawings.

All dimensions within these calculations are for design purposes only. These are used in place of site derived dimensions and may vary from actual dimensions of structural members. The design dimensions must not be used for the procurement of any structural elements. Accurate on-site measurements for overall element sizes must be carried out prior to fabrication of any structural elements, by the contractor or specialist supplier. This must include the bearing lengths specified within this calculations package.

Design Statement

Canham Consulting (CCL) have been appointed to provide structural calculations in relation to the proposed works at the above address.

Within this calculation package are structural calculations for the proposed steelwork, as identified by the Architect, and listed below:

1) For calculations and details for support beam(s) and bearings in the following locations:
    a. Over new openings in extension
    b. Over opening in existing external wall into dining area extension
    c. Over opening between dining room and boot room
    d. Over glazing to dining room extension external walls
    e. Support post to item d. above
2) Foundations to extension – assumed to be mass concrete traditional strip or trench fill
3) Overall stability appraisal

Please refer to architectural drawings by SMG Architects, and the following structural calculations and CCL drawing numbers 212480-CCL-XX-XX-DR-S-1000, 2500 & 0050

Contents

Section	Title	Start	End	Rev
1	Conceptual			
2	Gravity loading	01	01	P01
3	Wind loading	01	02	P01
4	Superstructure	01	20	P01
5	Substructure			
6	Stability			
7	Temporary Works			
8	Sketches			

Loading Schedule:

Pitched Roof		
Tiles =	0.60	
Battens =	0.02	
Rafters =	0.10	
Felt =	0.02	
Insulation =	0.05	
	0.79	
Roof Angle =	30	
Plan Dead =	**0.91**	**kN/m^2**
Plan Live =	**0.60**	**kN/m^2**

Flat Roof		
Ply Membrane =	0.10	
22mm Ply =	0.20	
Insulation =	0.05	
Firring =	0.10	
Joists =	0.15	
Plaster & Skim =	0.18	
Plan Dead =	**0.78**	**kN/m^2**
Plan Live =	**0.75**	**kN/m^2**

Ceiling		
Joists =	0.07	
Insulation =	0.05	
Plaster & Skim =	0.18	
Plan Dead =	**0.30**	**kN/m^2**
Plan Live =	**0.25**	**kN/m^2**

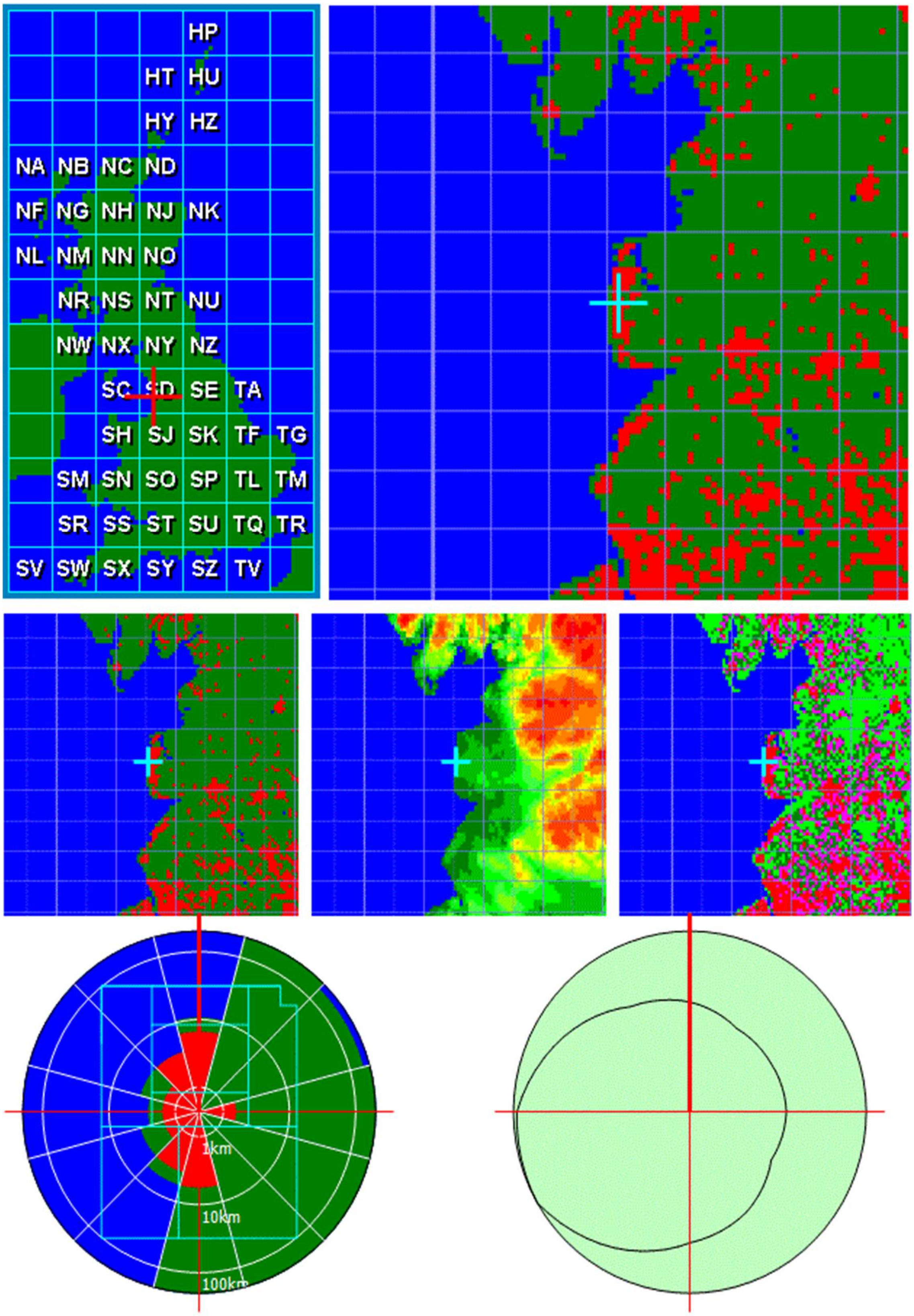
Internal Walls		
Plaster & Skim =	0.36	
200mm Blockwork =	3.00	
	3.36	**kN/m^2**

9" Solid Brick		
Plaster & Skim =	0.18	
9" Brickwork =	4.50	
Plan Dead =	**4.68**	**kN/m^2**

Cavity Walls		
Plaster & Skim =	0.18	
100mm Blockwork =	1.50	
Insulation =	0.05	
Facing Brick =	2.25	
Plan Dead =	**3.98**	**kN/m^2**

Timber Floor		
Finishes/Services =	0.17	
Boarding =	0.10	
Joists =	0.10	
Insulation =	0.05	
Plaster & Skim =	0.18	
Plan Dead =	**0.60**	**kN/m^2**
Plan Live =	**1.50**	**kN/m^2**

WIND LOADING TO BS 6399 - PART 2
Results for site at SD320379 - Altitude 28 m
Wind Reference 1
Using the Standard Method



Site Basic Data

Location and Base wind speed	BREVe site data for SD320379 - Base wind speed, Vb 23.2 m/s
Site Range	500 m
Altitude and Obstructions	Site altitude 28 m - Shelter effect from obstructions is included
Seasonal factor, Ss	Season length is All year - Seasonal factor, Ss 1.000
Annual risk and probability factor	Design annual risk 0.02 - Probability factor, Sp 1.000
Topographic Increments	Topographic increment from internal parameters
Heights and Diagonals (m)	Heights above ground 3, Diagonals 5

Direction Factors - Using UK direction Factors

Direction (°N)	0	30	60	90	120	150	180	210	240	270	300	33
Direction factor, Sd	0.780	0.730	0.730	0.740	0.730	0.800	0.850	0.930	1.000	0.990	0.910	0.820

Topography

Crest Height (m)	16.0	8.0	8.0	13.0	7.0	11.0	9.0	1.0	25.5	28.0	5.0	8.
Site Location (m)	700.0	0.0	0.0	0.0	800.0	0.0	999.0	999.0	225.0	100.0	999.0	999.0
Upwind Length (m)	800.0	1600.0	10000	1560.0	700.0	1650.0	386.0	40.0	1275.0	1400.0	286.0	433.0
Downwind Length (m)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Base Altitude (m)	12.0	15.0	15.0	15.0	21.0	19.0	19.0	22.0	0.0	0.0	23.0	23.0
Upwind Slope	0.020	0.005	0.001	0.008	0.010	0.007	0.023	0.025	0.020	0.020	0.017	0.020

Standard Method

Site description — Site is in country, nearest distance to sea = 2.50km.

Height Above Ground = 3.0 m - Ve 32.9 m/s - q 665.5 N/m²

He 2.000 — a 5.0

Sa 1.028, Sb 1.382 — Ca 1.000

MasterFrame Wind Pressure Values

Dynamic Pressure Values, q (N/m²) for a = 5

Wind Direction to X Axis	0	90	180	270
q (N/m²) for H = 3	665.5	620.5	390.3	499.3

Ground level

Ground Level has been set by the user as always being at the bottom of the model

Design of New Timber Flat Roof Joists - Ref Span 01:

Section properties: $L_1 := 3.80\ m$ $B :=$ Width: 50 mm $\begin{bmatrix} D \\ K_7 \end{bmatrix} :=$ Depth: 170 mm Centres: $s := 0.4\ m$

Characteristic stresses:

$$\begin{bmatrix} \sigma_b \\ \sigma_{t\parallel} \\ \sigma_{c\parallel} \\ \sigma_{c;mean} \\ \sigma_{c;min} \\ \tau_{\parallel} \\ E_{mean} \\ E_{min} \end{bmatrix} := \text{Timber Grade: C24} = \begin{bmatrix} 7.50 \\ 4.50 \\ 7.90 \\ 2.40 \\ 1.90 \\ 0.71 \\ 10800.00 \\ 7200.00 \end{bmatrix} \frac{N}{mm^2}$$

Load duration factor: $K_3 :=$ Duration: Medium $= 1.25$

Exposure factor: $K_2 :=$ Exposure: Internal $= 1.00$

Depth factor: $K_7 = 1.06$

Load sharing system factor: $K_8 := 1.1$

Therefore permissible bending stress: $\sigma_{b;adm} := \sigma_b \cdot K_2 \cdot K_3 \cdot K_7 \cdot K_8$ $\sigma_{b;adm} = 10.93\ \frac{N}{mm^2}$

Loading:	Dead Loads	Live Loads
Flat Roof:	$G_{k1} := 0.78\ \frac{kN}{m^2} \cdot s = 0.31\ \frac{kN}{m}$	$Q_{k1} := 0.75\ \frac{kN}{m^2} \cdot s = 0.30\ \frac{kN}{m}$

Total Dead Load: $G_k := \sum G_k$ $G_k = 0.31\ \frac{kN}{m}$

Total Live Load: $Q_k := \sum Q_k$ $Q_k = 0.30\ \frac{kN}{m}$

Service UDL: $w_s := (G_k + Q_k)$ $w_s = 0.61\ \frac{kN}{m}$

Check section for bending:

Moment: $M := \frac{w_s \cdot L_1^2}{8}$ $M = 1.10\ kN \cdot m$

Zxx Required: $Z_{xxreq} := \frac{M}{\sigma_{b;adm}}$ $Z_{xxreq} = 101.06\ cm^3$

Zxx Provided: $Z_{xxprov} := \frac{(B \cdot D^2)}{6}$ $Z_{xxprov} = 240.83\ cm^3$

Check section for deflection:

Limiting Deflection: $\delta := \frac{L_1}{333}$ $\delta = 11.41\ mm$

Ixx Required: $I_{xxreq} := \frac{5 \cdot w_s \cdot L_1^4}{384 \cdot E_{mean} \cdot \delta}$ $I_{xxreq} = 1348.22\ cm^4$

Ixx Provided: $I_{xxprov} := \frac{(B \cdot D^3)}{12}$ $I_{xxprov} = 2047.08\ cm^4$

Bending: $Z_{xxprov} = 240.83\ cm^3$ > $Z_{xxreq} = 101.06\ cm^3$ $U_b = 0.42$ $Bending = \text{“OK”}$

Deflection: $I_{xxprov} = 2047.08\ cm^4$ > $I_{xxreq} = 1348.22\ cm^4$ $U_d = 0.66$ $Deflection = \text{“OK”}$

Therefore provide 50 x 170 C24 Flat Roof Joists at max 400mm c/c

Trimmers to Short Sides of Rooflights:

Span: $L_2 := 1.00\ m$ Number of: $\begin{bmatrix} N_o \\ K_9 \end{bmatrix} :=$ Number of: 2 Multiple member factor: $K_9 = 1.14$

Therefore permissible bending stress: $\sigma_{adm} := \sigma_b \cdot K_3 \cdot K_7$ $\sigma_{adm} = 9.94\ \frac{N}{mm^2}$

Loading: Dead Loads Live Loads

Flat Roof: $G_{k1} := 0.78\ \frac{kN}{m^2} \cdot \frac{L_1}{2} = 1.48\ \frac{kN}{m}$ $Q_{k1} := 0.75\ \frac{kN}{m^2} \cdot \frac{L_1}{2} = 1.43\ \frac{kN}{m}$

Total Dead Load: $G_k := \sum G_k$ $G_k = 1.48\ \frac{kN}{m}$

Total Live Load: $Q_k := \sum Q_k$ $Q_k = 1.43\ \frac{kN}{m}$

Service UDL: $w_s := (G_k + Q_k)$ $w_s = 2.91\ \frac{kN}{m}$

Check section for bending:

Moment: $M := \frac{w_s \cdot L_2^{\ 2}}{8}$ $M = 0.36\ kN \cdot m$

Zxx Required: $Z_{xxreq} := \frac{M}{\sigma_{adm}}$ $Z_{xxreq} = 36.57\ cm^3$

Zxx Provided: $Z_{xxprov} := N_o \cdot \frac{(B \cdot D^2)}{6}$ $Z_{xxprov} = 481.67\ cm^3$

Check section for deflection:

Limiting Deflection: $\delta := \frac{L_2}{333}$ $\delta = 3.00\ mm$

Ixx Required: $I_{xxreq} := \frac{5 \cdot w_s \cdot L_2^{\ 4}}{384 \cdot E_{min} \cdot K_9 \cdot \delta}$ $I_{xxreq} = 153.56\ cm^4$

Ixx Provided: $I_{xxprov} := N_o \cdot \frac{(B \cdot D^3)}{12}$ $I_{xxprov} = 4094.17\ cm^4$

Utilisation ratios:

Bending: $Z_{xxprov} = 481.67\ cm^3$ > $Z_{xxreq} = 36.57\ cm^3$ $U_b = 0.08$ $Bending = $ "OK"

Deflection: $I_{xxprov} = 4094.17\ cm^4$ > $I_{xxreq} = 153.56\ cm^4$ $U_d = 0.04$ $Deflection = $ "OK"

Therefore provide 2No. 50 x 170 C24 Flat Roof Joists bolted together with M10 bolts at maximum 600mm c/c staggered vertically at 1/3 heights

Trimmers to Long Sides of Rooflights:

Span: $L_1 = 3.80\ m$ Number of: $\begin{bmatrix} N_o \\ K_9 \end{bmatrix} :=$ Number of: 2 Multiple member factor: $K_9 = 1.14$

Therefore permissible bending stress: $\sigma_{adm} := \sigma_b \cdot K_3 \cdot K_7$ $\sigma_{adm} = 9.94\ \frac{N}{mm^2}$

Loading: Dead Loads Live Loads

Flat roof: $G_{k1} := 0.78\ \frac{kN}{m^2} \cdot \frac{L_2 + s}{2} = 0.55\ \frac{kN}{m}$ $Q_{k1} := 0.75\ \frac{kN}{m^2} \cdot \frac{L_2 + s}{2} = 0.53\ \frac{kN}{m}$

Total Dead Load: $G_k := \sum G_k$ $G_k = 0.55\ \frac{kN}{m}$

Total Live Load: $Q_k := \sum Q_k$ $Q_k = 0.53\ \frac{kN}{m}$

Service UDL: $w_s := (G_k + Q_k)$ $w_s = 1.07\ \frac{kN}{m}$

Check section for bending:

Moment: $M := \frac{w_s \cdot L_1^2}{8}$ $M = 1.93\ kN \cdot m$

Zxx Required: $Z_{xxreq} := \frac{M}{\sigma_{adm}}$ $Z_{xxreq} = 194.53\ cm^3$

Zxx Provided: $Z_{xxprov} := N_o \cdot \frac{(B \cdot D^2)}{6}$ $Z_{xxprov} = 481.67\ cm^3$

Check section for deflection:

Limiting Deflection: $\delta := \frac{L_1}{333}$ $\delta = 11.41\ mm$

Ixx Required: $I_{xxreq} := \frac{5 \cdot w_s \cdot L_1^4}{384 \cdot E_{min} \cdot K_9 \cdot \delta}$ $I_{xxreq} = 3104.46\ cm^4$

Ixx Provided: $I_{xxprov} := N_o \cdot \frac{(B \cdot D^3)}{12}$ $I_{xxprov} = 4094.17\ cm^4$

Utilisation ratios:

Bending: $Z_{xxprov} = 481.67\ cm^3$ > $Z_{xxreq} = 194.53\ cm^3$ $U_b = 0.40$ Bending = "OK"

Deflection: $I_{xxprov} = 4094.17\ cm^4$ > $I_{xxreq} = 3104.46\ cm^4$ $U_d = 0.76$ Deflection = "OK"

Therefore provide 2No. 50 x 170 C24 Flat Roof Joists bolted together with M10 bolts at maximum 600mm c/c staggered vertically at 1/3 heights.

Design of New Lintel - Ref L1:

Span between supports: $L := 0.85\ m$

Loading:

	Dead Loads	Live Loads
Flat Roof:	$G_{k1} := 0.78\ \frac{kN}{m^2} \cdot 1.0\ m \cdot L = 0.66\ kN$	$Q_{k1} := 0.75\ \frac{kN}{m^2} \cdot 1.0\ m \cdot L = 0.64\ kN$
200mm Wall:	$G_{k10} := 3.36\ \frac{kN}{m^2} \cdot 0.60\ m \cdot L = 1.71\ kN$	

Total Dead Load: $G_k := \sum G_k$ $G_k = 2.38\ kN$

Total Live Load: $Q_k := \sum Q_k$ $Q_k = 0.64\ kN$

Service Load: $w_s := (G_k + Q_k)$ $w_s = 3.01\ kN$

From IG Lintel Guide: $Lintel :=$ L9

Safe working load: $swl = 6.00\ kN$

Utilisation ratios:

Loading: $swl = 6.00\ kN$ > $w_s = 3.01\ kN$ $U_L := \frac{w_s}{swl} = 0.50$ $Loading =$ "OK"

Therefore provide IG $Lintel =$ "L9" . Minimum 150mm end bearings.

Design of New Lintel - Ref L2:

Span between supports: $L := 1.20\ m$

Loading:

	Dead Loads	Live Loads
Flat Roof:	$G_{k1} := 0.78\ \frac{kN}{m^2} \cdot 0.40\ m \cdot L = 0.37\ kN$	$Q_{k1} := 0.75\ \frac{kN}{m^2} \cdot 0.40\ m \cdot L = 0.36\ kN$
Cavity Wall:	$G_{k10} := 3.98\ \frac{kN}{m^2} \cdot 0.66\ m \cdot L = 3.15\ kN$	

Total Dead Load: $G_k := \sum G_k$ $\qquad G_k = 3.53\ kN$

Total Live Load: $Q_k := \sum Q_k$ $\qquad Q_k = 0.36\ kN$

Service Load: $w_s := (G_k + Q_k)$ $\qquad w_s = 3.89\ kN$

From IG Lintel Guide: $Lintel :=$ L1/S 110

Safe working load: $swl = 13.00\ kN$

Utilisation ratios:

Loading: $swl = 13.00\ kN$ > $w_s = 3.89\ kN$ $\qquad U_L := \frac{w_s}{swl} = 0.30$ $\qquad Loading = \text{"OK"}$

Therefore provide IG $Lintel = \text{"L1/S 110"}$. Minimum 150mm end bearings.

Design of New Lintel - Ref L3:

Span between supports: $L := 0.60\ m$

Loading: Dead Loads / Live Loads

Flat Roof: $G_{k1} := 0.78\ \frac{kN}{m^2} \cdot \frac{2.40\ m}{2} \cdot L = 0.56\ kN$ $\quad Q_{k1} := 0.75\ \frac{kN}{m^2} \cdot \frac{2.40\ m}{2} \cdot L = 0.54\ kN$

Cavity Wall: $G_{k10} := 3.98\ \frac{kN}{m^2} \cdot 0.66\ m \cdot L = 1.58\ kN$

Total Dead Load: $G_k := \sum G_k$ $\quad G_k = 2.14\ kN$

Total Live Load: $Q_k := \sum Q_k$ $\quad Q_k = 0.54\ kN$

Service Load: $w_s := (G_k + Q_k)$ $\quad w_s = 2.68\ kN$

From IG Lintel Guide: $Lintel :=$ L1/S 110

Safe working load: $swl = 13.00\ kN$

Utilisation ratios:

Loading: $swl = 13.00\ kN$ > $w_s = 2.68\ kN$ $\quad U_L := \frac{w_s}{swl} = 0.21$ $\quad Loading =$ "OK"

Therefore provide IG $Lintel =$ "L1/S 110" . Minimum 150mm end bearings.

Design of New Strip Foundations:

Length: $B := 1\ m$ Width: $D := 600\ mm$ Thickness: $t := 300\ mm$

Loading:	Dead Loads	Live Loads
Flat Roof:	$G_{k1} := 0.78\ \frac{kN}{m^2} \cdot \frac{2.40\ m}{2} = 0.94\ \frac{kN}{m}$	$Q_{k1} := 0.75\ \frac{kN}{m^2} \cdot \frac{2.40\ m}{2} = 0.90\ \frac{kN}{m}$
Cavity Wall:	$G_{k5} := 3.98\ \frac{kN}{m^2} \cdot 3.0\ m = 11.94\ \frac{kN}{m}$	
S/W:	$G_{k10} := 24\ \frac{kN}{m^3} \cdot D \cdot t = 4.32\ \frac{kN}{m}$	

Total Dead Load: $G_k := \sum G_k$ $G_k = 17.20\ \frac{kN}{m}$

Total Live Load: $Q_k := \sum Q_k$ $Q_k = 0.90\ \frac{kN}{m}$

Service UDL: $w_s := (G_k + Q_k)$ $w_s = 18.10\ \frac{kN}{m}$

From British Geological Survey website:

Superficial Deposits Description: Briton's Lane Sand and Gravel Member - Sand and gravel. Sedimentary superficial deposit formed between 2.588 million and 11.8 thousand years ago during the Quaternary period.

Assumed allowable ground bearing pressure equals: $q_{adm} := 100\ \frac{kN}{m^2}$

Max applied bearing pressure: $q_{aMax} := \frac{w_s}{D}$ $q_{aMax} = 30\ \frac{kN}{m^2}$

Bearing Pressure Check:

Applied Bearing Pressure: $q_{aMax} = 30\ \frac{kN}{m^2}$ > $q_{adm} = 100\ \frac{kN}{m^2}$ $U_b := \frac{q_{aMax}}{q_{adm}} = 0.30$ $BP_{app} = \text{"OK"}$

Therefore provide new strip foundations $D = 0.60\ m$ wide x $t = 0.30\ m$ thick GEN3 concrete.

Foundation formation level to be a minimum of 200mm into natural competent material, capable of providing a minimum of 100 kN/m^2 allowable bearing pressure. The formation level is to be to the approval and satisfaction of the Local Authority Building Control Inspector.

Beam Ref B1 - Padstone Design Ref PS1 - Beam Parallel to Wall:

Block Strength: $f_k := 3.50 \frac{N}{mm^2}$

Material Safety Factor: $\gamma_m := 3.50$

Allowable bearing stress: $\sigma_p := 1.25 \cdot \frac{f_k}{\gamma_m}$ $\sigma_p = 1.25 \frac{N}{mm^2}$

Padstone size:
Length: $b := 440\ mm$
Width: $t := 100\ mm$
Depth: $d := 215\ mm$

Bearing length of beam: $b_b := 250\ mm$

Bearing length of load: $b_l = 440.00\ mm$ Therefore $Padstone\_Size = \text{"Full spread"}$

Beam reaction: $F := 37.53\ kN$ $F = 37.53\ kN$

Applied Bearing Stress: $\sigma_a := \frac{F}{t \cdot b_l}$ $\sigma_a = 0.85 \frac{N}{mm^2}$

$Bearing\_Stress := \text{if}\ (\sigma_p > \sigma_a, \text{"OK"}, \text{"FAIL"})$ $Bearing\_Stress = \text{"OK"}$

Therefore provide $b = 440\ mm$ Long x $t = 100\ mm$ Wide x $d = 215\ mm$ Deep engineering brick padstones, in class M12 Mortar.

Minimum end bearing: $b_b = 250.00\ mm$

Beam Ref B3 - Padstone Design Ref PS2 - Beam Perpendicular to Wall:

Block Strength: $f_k := 3.50 \frac{N}{mm^2}$

Material Safety Factor: $\gamma_m := 3.50$

Allowable bearing stress: $\sigma_p := 1.25 \cdot \frac{f_k}{\gamma_m}$ $\sigma_p = 1.25 \frac{N}{mm^2}$

Padstone size:
Length: $b := 330\ mm$
Width: $t := 100\ mm$
Depth: $d := 150\ mm$

Load spread length: $b_l = 330.00\ mm$ Therefore $Padstone\_Size = \text{"Full spread"}$

Beam reaction: $F := 12.95\ kN$ $F = 12.95\ kN$

Applied Bearing Stress: $\sigma_a := \frac{F}{t \cdot b_l}$ $\sigma_a = 0.39 \frac{N}{mm^2}$

$Bearing\_Stress := \text{if}\ (\sigma_p > \sigma_a, \text{"OK"}, \text{"FAIL"})$ $Bearing\_Stress = \text{"OK"}$

Therefore provide $b = 330\ mm$ Long x $t = 100\ mm$ Wide x $d = 150\ mm$ Deep engineering brick padstones, in class M12 Mortar. Minimum 100mm end bearing.

Beam Ref B4 - Padstone Design Ref PS3 - Beam Parallel to Wall:

Block Strength: $f_k := 3.50 \frac{N}{mm^2}$

Material Safety Factor: $\gamma_m := 3.50$

Allowable bearing stress: $\sigma_p := 1.25 \cdot \frac{f_k}{\gamma_m}$ $\qquad \sigma_p = 1.25 \frac{N}{mm^2}$

Padstone size:
- Length: $b := 330\ mm$
- Width: $t := 100\ mm$
- Depth: $d := 150\ mm$

Bearing length of beam: $b_b := 250\ mm$

Bearing length of load: $b_l = 330.00\ mm$ Therefore $Padstone\_Size = \text{“Full spread”}$

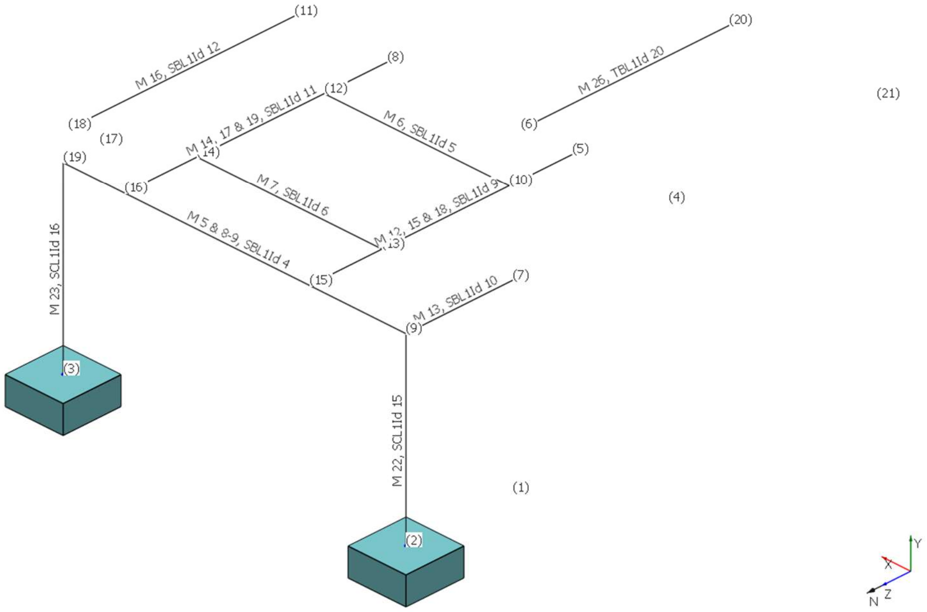
Beam reaction: $F := 7.60\ kN$ $\qquad F = 7.60\ kN$

Applied Bearing Stress: $\sigma_a := \frac{F}{t \cdot b_l}$ $\qquad \sigma_a = 0.23 \frac{N}{mm^2}$

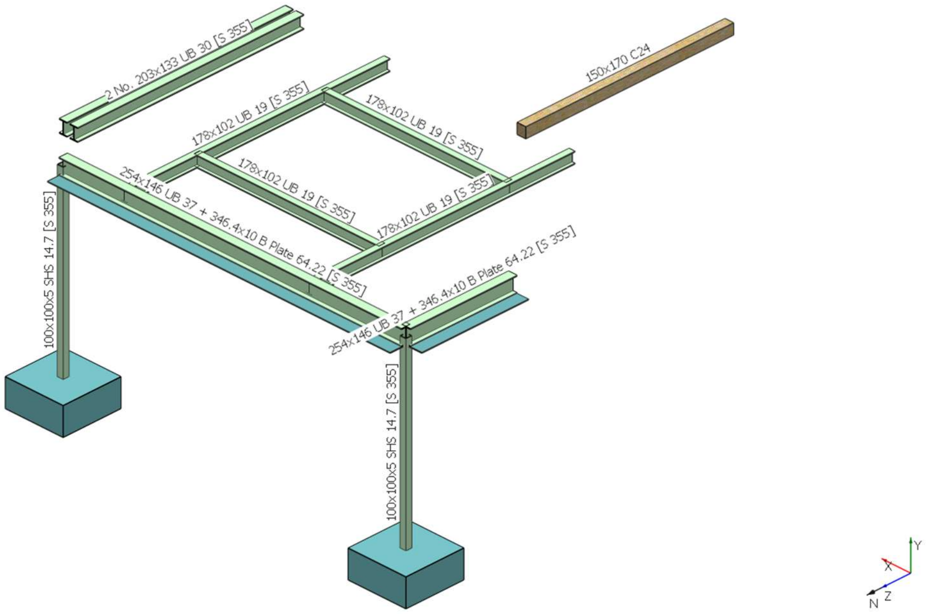
$Bearing\_Stress := \text{if} \left(\sigma_p > \sigma_a, \text{“OK”}, \text{“FAIL”}\right)$ $\qquad Bearing\_Stress = \text{“OK”}$

Therefore provide $b = 330\ mm$ Long x $t = 100\ mm$ Wide x $d = 150\ mm$ Deep engineering brick padstones, in class M12 Mortar.

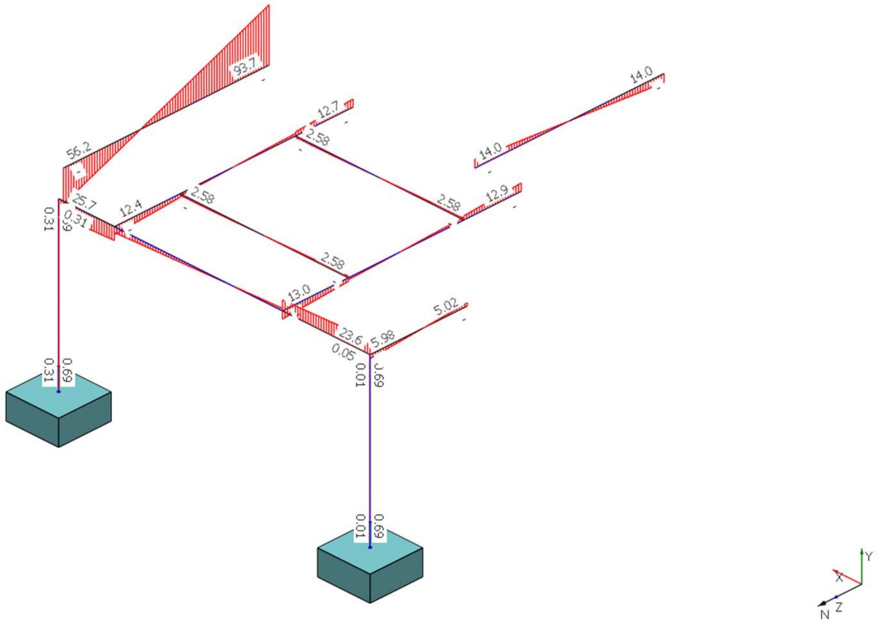
Minimum end bearing: $b_b = 250.00\ mm$



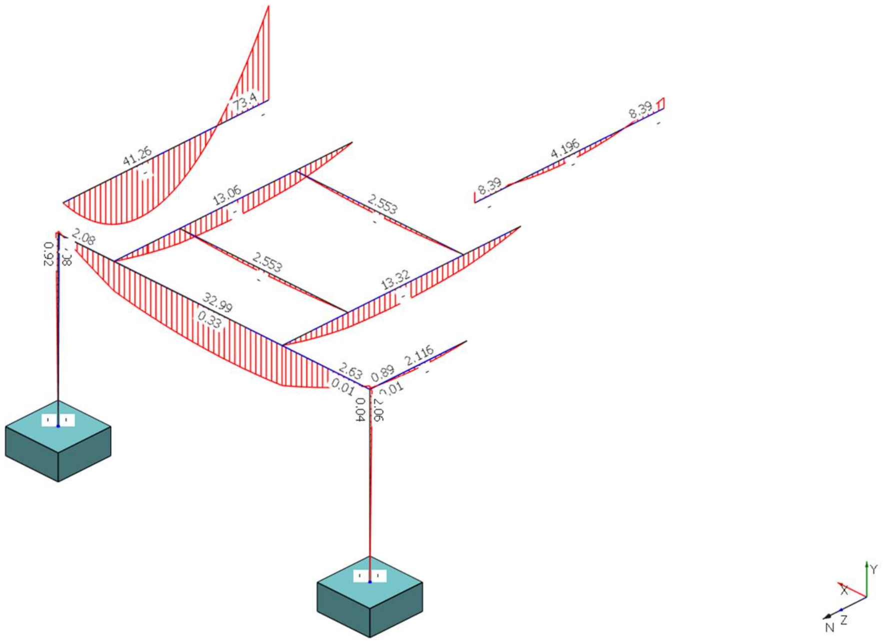
Frame Geometry - Full Frame - X+030 Y-135 Z+000



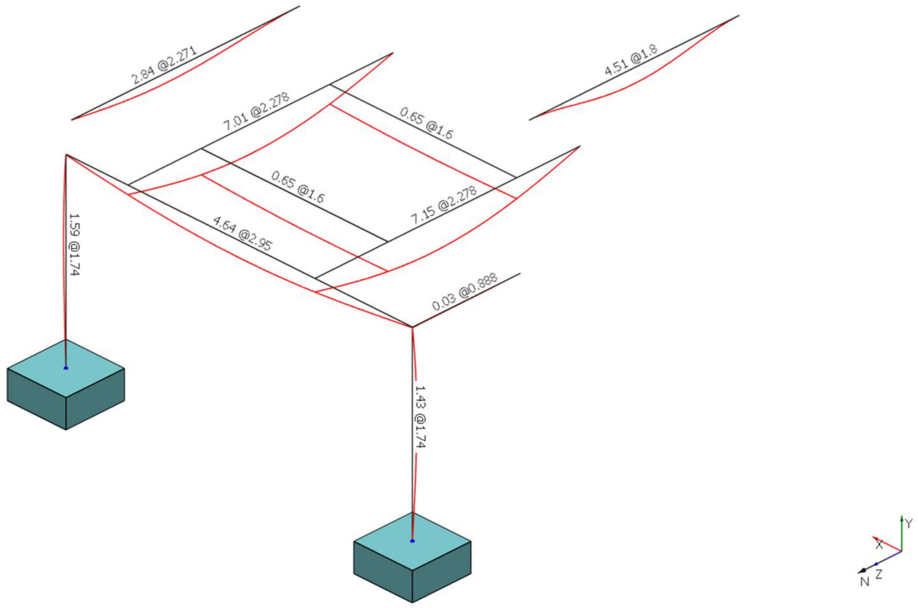
Frame Geometry - Full Frame - X+030 Y-135 Z+000



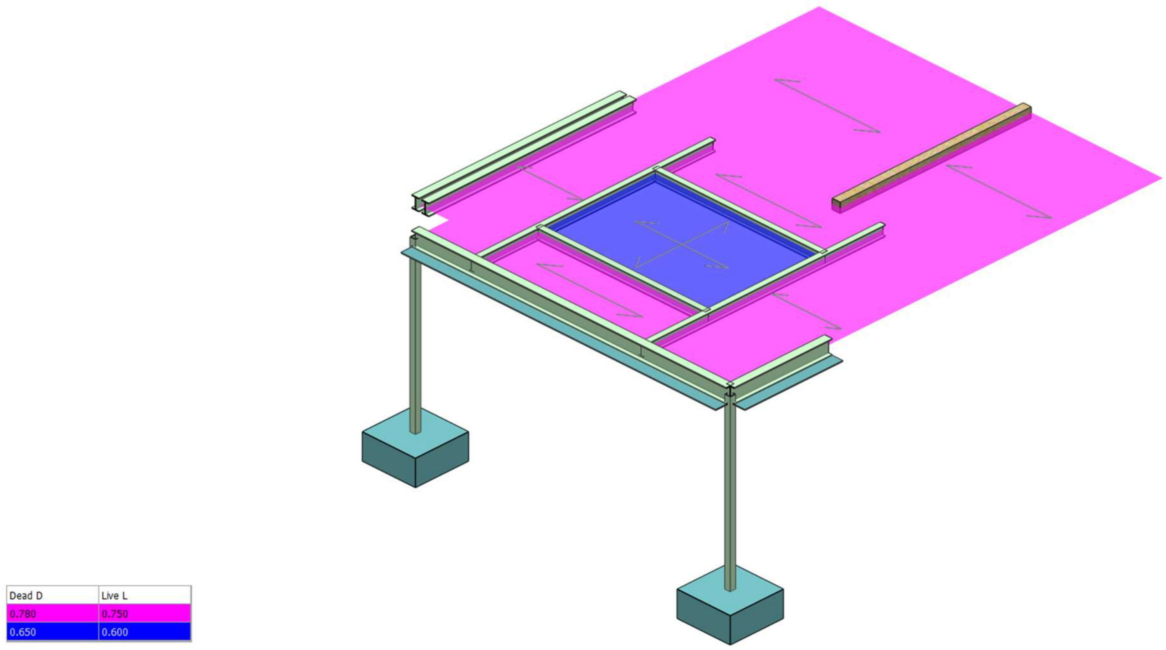
Load Case 002 : Dead plus Live (Ultimate)
Shear Force Diagram - Full Frame - X+030 Y-135 Z+000
Shear Force Values (kN)



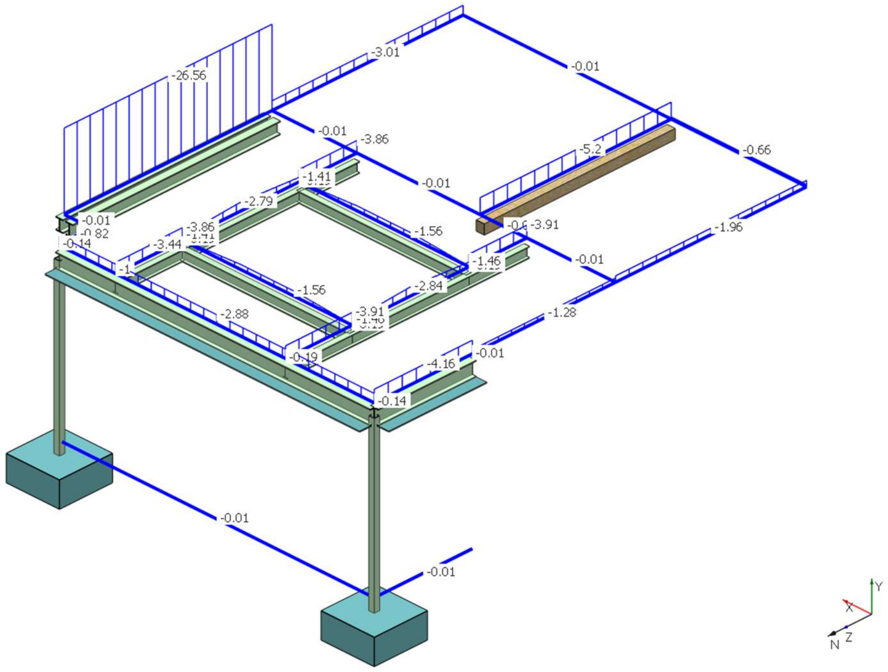
Load Case 002 : Dead plus Live (Ultimate)
Bending Moment Diagram - Full Frame - X+030 Y-135 Z+000
Bending Moment Values (kN.m)



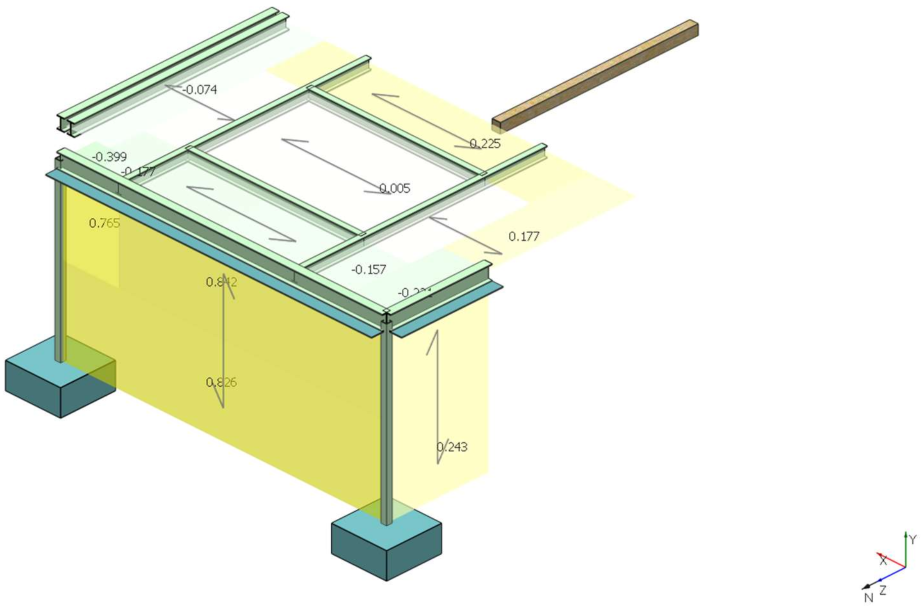
Load Case 001 : Dead Plus Live (Serviceability)
Deflected Shape - Full Frame - X+030 Y-135 Z+000
Member Deflection (mm)



Load Case 001 : Dead Plus Live (Serviceability)
Frame Geometry - Full Frame - X+030 Y-135 Z+000



Load Diagram - 001 : Dead Plus Live (Serviceability) - All Groups
Frame Geometry - Full Frame - X+030 Y-135 Z+000



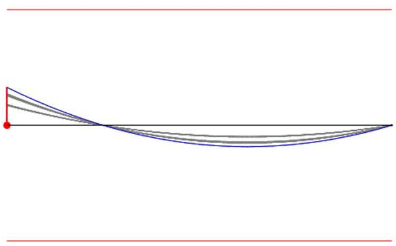
Load Case 001 : Wind Pressures (Serviceability)
Frame Geometry - Full Frame - X+030 Y-135 Z+000

AXIAL WITH MOMENTS (MEMBER)
Member SBL1Id 12 @ Level 1 in Load Case 2

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 UDLY -000.624            ( kN/m )
L1 UDLY -000.600            ( kN/m )
D1 D     077.010            ( kN/m³)
D1 UDLY -001.680            ( kN/m )
L1 UDLY -001.110            ( kN/m )
D1 UDLY -000.560            ( kN/m )
L1 UDLY -000.460            ( kN/m )
D1 UDLY -012.170            ( kN/m )
D1 UDLY -005.400            ( kN/m )
L1 UDLY -003.370            ( kN/m )
```



Member Forces in Load Case 2 and Maximum Deflection from Load Case 1										
Mem ber No.	Node End1 End2	Axial Force (kN)	Torque Moment (kN.m)	Shear Force (kN)		Bending Moment (kN.m)		Maximum Moment (kN.m @ m)		Maximum Deflection (mm @ m)
				x-x	y-y	x-x	y-y	x-x	y-y	
16	11	0.00C	0.00	93.70	0.00	-73.37	0.00	41.26		2.84
	18	0.00C	0.00	-56.22	0.00	0.00	0.00	@ 2.427		@ 2.271

Classification and Properties (BS 5950: 2000)

Section (29.99 kg/m)	2 No. 203x133 UB 30 [S 355]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.97, 26.94, 355, 0, 73.37, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	2, 4, 6, 8, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56 & 58		

Moment Capacity Check Mc - Fully Restrained Beam

Fv/Pv	93.704 / 563.82 =	0.166	Low Shear
Mc = py.Sxx≤1.2 py.Zxx	355 x 628.8≤1.2 x 355 x 560.26 =	223.224 kN.m	
MA/Mc	-73.37 / 223.224 =	0.329	OK

Deflection Check - Load Case 1

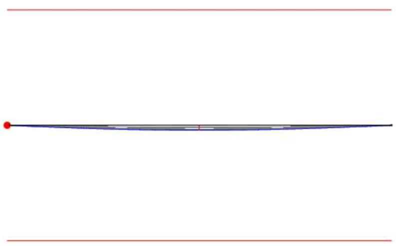
In-span δ ≤ Span/500	2.84 ≤ 3915 / 500	2.84 mm	OK

AXIAL WITH MOMENTS (MEMBER)
Member SBL1Id 6 @ Level 1 in Load Case 2

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 TRY  -001.502 1.100 2.100 (kN,m,m)
L1 TRY  -001.386 1.100 2.100 (kN,m,m)
D1 D     077.010             ( kN/m³)
```



Member Forces in Load Case 2 and Maximum Deflection from Load Case 1										
Mem ber No.	Node End1 End2	Axial Force (kN)	Torque Moment (kN.m)	Shear Force (kN)		Bending Moment (kN.m)		Maximum Moment (kN.m @ m)		Maximum Deflection (mm @ m)
				x-x	y-y	x-x	y-y	x-x	y-y	
7	13	0.00C	0.00	2.58	0.00	0.00	0.00	2.55	0.00	0.65
	14	0.00C	0.00	-2.58	0.00	0.00	0.00	@ 1.600	@ 0.000	@ 1.600

Classification and Properties (BS 5950: 2000)

Section (19.04 kg/m)	178x102 UB 19 [S 355]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.41, 30.58, 355, 0, 2.55, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	2, 4, 6, 8, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56 & 58		

Shear Capacity Check

Fvx/Pvx	2.581 / 181.783 =	0.014	OK

Moment Capacity Check Mc - Fully Restrained Beam

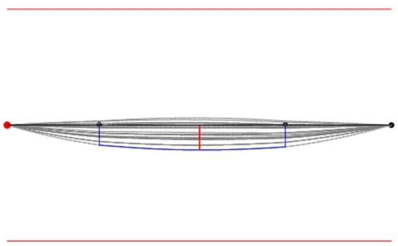
Fv/Pv	0.002 / 181.783 =	0	Low Shear
Mc = py.Sxx≤1.2 py.Zxx	355 x 171.3≤1.2 x 355 x 152.63 =	60.812 kN.m	
MA/Mc	2.55 / 60.812 =	0.042	OK

Deflection Check - Load Case 1

In-span δ ≤ Span/500	0.65 ≤ 3200 / 500	0.65 mm	OK

AXIAL WITH MOMENTS (MEMBER)
Member SBL1Id 11 @ Level 1
Between 1.090 and 3.290 m, in Load Case 2

Member Loading and Member Forces



```
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D     077.010             ( kN/m³)
D1 PTRY -001.872 0.000 1.090 -001.872
L1 PTRY -001.800 0.000 1.090 -001.800
D1 PTRY -000.624 1.090 3.289 -000.624
L1 PTRY -000.600 1.090 3.289 -000.600
D1 PTY2 -000.393 1.090 2.190 (kN,m,m)
D1 PTY1 -000.393 2.190 3.289 (kN,m,m)
L1 PTY2 -000.363 1.090 2.190 (kN,m,m)
L1 PTY1 -000.363 2.190 3.289 (kN,m,m)
D1 PDLY -000.390 3.290 3.915 (kN,m,m)
D1 PDLY -000.260 3.915 4.545 (kN,m,m)
L1 PDLY -000.375 3.290 3.915 (kN,m,m)
L1 PDLY -000.250 3.915 4.545 (kN,m,m)
D1 PTRY -001.248 3.290 4.544 -001.248
L1 PTRY -001.200 3.290 4.544 -001.200
```

Member Forces in Load Case 2 and Maximum Deflection from Load Case 1

Mem ber No.	Node End1 End2	Axial Force (kN)	Torque Moment (kN.m)	Shear Force (kN)		Bending Moment (kN.m)		Maximum Moment (kN.m @ m)		Maximum Deflection (mm @ m)
				x-x	y-y	x-x	y-y	x-x	y-y	
-	8	0.44T	0.00	12.73	0.00	0.00	0.00	13.06	0.00	7.01
	16	0.44T	0.00	-12.42	0.00	0.00	0.00	@ 2.300	@ 0.000	@ 2.278

Classification and Properties (BS 5950: 2000)

Section (19.04 kg/m)	178x102 UB 19 [S 355]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.41, 30.58, 355, 0, 13.05, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	2, 4, 6, 8, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56 & 58		

Shear Capacity Check

Fvx/Pvx	6.452 / 181.783 =	0.035	OK

Local Capacity Check

Fvx/Pvx	0.09 / 181.783 =	0	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	355 x 171.3≤1.2 x 355 x 152.63 =	60.812 kN.m	
Ae = Fn(Ag,A.net,py,Us)	24.26,24.26,355,470	24.26 cm²	
Pz = Ae.py	24.26x355	861.23 kN	
n = F/Pz	-0.438 / 861.23 =	0.001	OK
Srx = Fn(Sxx, n)	171.3, 0.001	171.3 cm³	
Mrx = Srx.py	171.3 x 355	60.811 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(13.052/60.811)^2+(0)^1=$	0.046	OK

Lateral Buckling Check Mb

Mb = Mc	Fully Restrained	60.812 kN.m	

Simplified Approach

py.Zx	355x152.63	54.184 kN.m	
F/Pc+mx.Mx/py.Zx	0+0.963x13.1/54.2	0.232	OK
$F/Pcy+m_{LT}.M_{LT}/Mb$	0+0.985x13.1/60.8	0.211	OK

More Exact Approach

Max=Mcx/(1+.5F/Pcx)	60.8/(1+.5x0/718.5)	60.812 kN.m	
F/Pcx+mx.Mx/Max	0/718.5+0.963x13.1/60.8	0.207	OK
$F/Pcy+m_{LT}.M_{LT}/Mb$	0/861.2+0.985x13.1/60.8	0.211	OK

Deflection Check - Load Case 1

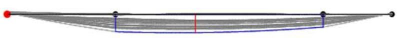
In-span δ ≤ Span/500	7.01 ≤ 4545 / 500	7.01 mm	OK

AXIAL WITH MOMENTS (MEMBER) (FAIL)
Includes Design for Torsion with Span Warping , Ends Free to Warp
Member SBL1Id 4 @ Level 1
Between 1.670 and 4.870 m, in Load Case 2

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D      077.010             ( kN/m³)
D1 UDLY -000.760              ( kN/m )
D1 Torq  ex +0.150 ey -0.150  ( m, m )
D1 UDLY -001.490              ( kN/m )
```



Member Forces in Load Case 2 and Maximum Deflection from Load Case 1										
Mem ber No.	Node End1 End2	Axial Force (kN)	Torque Moment (kN.m)	Shear Force (kN)		Bending Moment (kN.m)		Maximum Moment (kN.m @ m)		Maximum Deflection (mm @ m)
				x-x	y-y	x-x	y-y	x-x	y-y	
-	9	0.69C	-0.93	23.58	-0.05	-2.63	-0.01	32.99	0.33	4.64
	19	0.69C	-0.92	-25.71	-0.31	-2.08	0.00	@ 2.630	@ 4.870	@ 2.950

Classification and Properties (BS 5950: 2000)

Section (64.22 kg/m)	254x146 UB 37 + 346.4x10 B Plate 64.22 [S 355]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.72, 34.76, 355, 0.69, 32.99, 0.33	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	2, 4, 6, 8, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56 & 58		

Bottom plate in compression along member axis - Check classification < = flange classification

Greater than Plastic - Increase plate thickness or reduce plate projection — Warning

Shear Capacity Check

Fvx/Pvx	16.85 / 343.526 =	0.049	OK
Fvy/Pvy	0.307 / 611.814 =	0.001	OK

Local Capacity Check

Fvx/Pvx	1.078 / 343.526 =	0.003	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	355 x 617.9≤1.2 x 355 x 492.2 =	209.677 kN.m	
Fvy/Pvy	0.13 / 611.814 =	0	Low Shear
Mcy = py.Syy≤1.2 py.Zyy	355 x 419.4≤1.2 x 355 x 232.9 =	99.215 kN.m	
Pz = Ag.py	81.81 x 355 =	2904.255 kN	
n = F/Pz	0.693 / 2904.255 =	0.000	OK
Srx = Fn(Sxx, n)	617.9, 0	617.9 cm^3	
Mrx = Srx.py	617.9 x 355	209.677 kN.m	
Sry = Fn(Syy, n)	419.4, 0	419.4 cm^3	
Mry = Sry.py	419.4 x 355	99.215 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(32.845/209.677)^2+(0.069/99.215)^1$=	0.025	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x5.93/10.53 =	56.3	OK
Pcx = Area.pcx	81.81x306.402/10 =	2506.674 kN	Table 24 a

Lateral Buckling Check Mb

Mb = Mc	Fully Restrained	209.677 kN.m	

Simplified Approach

py.Zx	355x492.2	174.731 kN.m	
py.Zy	355x232.9	82.68 kN.m	
F/Pc+mx.Mx/py.Zx+my.My/py.Zy	0.693/2506.674+0.961x33/174.7+0.542x0.1/82.7	0.182	OK
$F/Pcy+m_{LT}.M_{LT}/Mb+my.My/py.Zy$	0.693/2904.255+0.969x32.8/209.7+0.542x0.1/82.7	0.152	OK

More Exact Approach

Max=Mcx/(1+.5F/Pcx)	209.7/(1+.5x0.7/2506.7)	209.648 kN.m	
May=Mcy/(1+F/Pcy)	99.2/(1+0.7/2904.3)	99.192 kN.m	
F/Pcx+mx.Mx/Max+.5myx.My/Mcy	0.7/2506.7+0.961x33/209.6+.5x0.667x0.3/99.2	0.153	OK
$F/Pcy+m_{LT}.M_{LT}/Mb+my.My/May$	0.7/2904.3+0.969x32.8/209.7+0.542x0.1/99.2	0.152	OK
Max=Mcx(1-F/Pcx)/(1+.5F/Pcx)	209.7(1-0.7/2506.7)/(1+.5x0.7/2506.7)	209.59 kN.m	
May=Mcy(1-F/Pcy)/(1+F/Pcy)	99.2(1-0.7/2904.3)/(1+0.7/2904.3)	99.168 kN.m	

m.Mx/Max+m.My/May	0.961x32.845/209.59+0.542x0.069/99.168	0.152	OK

Torsion Design

J, H, a, Q_f, Q_w	26.88 cm^4, 0.1719 dm^6, 1290 mm, 93.57 cm^3, 242.9 cm^3		
W_{n0}, S_{w1}	173.3 cm^2, 357.9 cm^4		
K_v= 1+0.5 m.Mx/Mb	1 + 0.5 • 0.961 • 32.99 / 209.7	1.076	

Torsion Bending Design @ 2.901

M_{yt}= M_{xb}. θ	32.85 • 45.23•10^{-3}	1.486 kN.m	
σ_{byt} = M_{yt}/ Z_y	1.486 / 551.2	2.70 N/mm²	
σ_w = E . W_n . θ"	205 • 173.3 • 11.81•10^{-9}	41.95 N/mm²	
Modified Local Capacity Check	0.188 + (2.70 + 41.95) / 355	0.314	OK
Modified Buckling Check	0.153 + (2.70 + 41.95) • 1.076 / 355	0.288	OK

Torsion Shear Design @ 4.870

τ_{bw} = F_v. Q_w / (I_x. t)	21.44 • 242.9 / (5471 • 6.3)	15.11 N/mm²	
τ_{tw} = G . t . θ'	78.85 • 6.3 • 20.26•10^{-6}	10.06 N/mm²	
τ_{bf}= F_v. Q_f/ (I_x.T)	21.44 • 93.57 / (5471 • 10.9)	3.36 N/mm²	
τ_{tf} = G . T . θ'	78.85 • 10.9 • 20.26•10^{-6}	17.41 N/mm²	
τ_{wf} = E . S_{w1}. θ" / T	205.0 • 357.9 • 4.733•10^{-12} / 10.9	0.32 N/mm²	
Web Shear = (τ_{bw}+ τ_{tw}.K_v) / p_v	15.11 + 10.06 • 1.076 = 25.93 N/mm² / 213	0.122	OK
Flange = (τ_{bf}+ (τ_{tf}+ τ_{wf}) . K_v) / p_v	3.36 + (17.41 + 0.32) • 1.076 = 22.43 N/mm² / 213	0.105	OK

Deflection Check - Load Case 1

In-span δ ≤ Span/1000	4.64 ≤ 5930 / 1000	4.64 mm	OK
Torq in Case 1 @ 2.965 m	θ_{max}= 32.33•10^{-3} Radian = 1.853° ≤ 2.00°	1.853°	OK

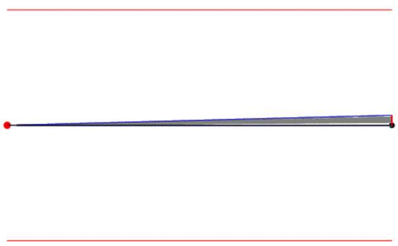
AXIAL WITH MOMENTS (MEMBER)

Member SCL1Id 15 @ Level 1 in Load Case 2

Member Loading and Member Forces

Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



Member Forces in Load Case 2 and Maximum Deflection from Load Case 1										
Mem ber No.	Node End1 End2	Axial Force (kN)	Torque Moment (kN.m)	Shear Force (kN)		Bending Moment (kN.m)		Maximum Moment (kN.m @ m)		Maximum Deflection (mm @ m)
				x-x	y-y	x-x	y-y	x-x	y-y	
22	2	30.17C	0.00	-0.69	0.01	0.00	0.00			1.43
	9	29.56C	0.00	-0.69	0.01	-2.06	0.04			@ 1.740

Classification and Properties (BS 5950: 2000)

Section (14.7 kg/m)	100x100x5 SHS 14.7 [S 355]		
Class = Fn(b/t,d/t,py,F,Mx,My)	17, 17, 355, 30.168, 2.056, 0.041	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	2, 4, 6, 8, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56 & 58		

Local Capacity Check

Fvx/Pvx	0.685 / 199.475 =	0.003	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	355 x 66.36≤1.2 x 355 x 55.89 =	23.558 kN.m	
Fvy/Pvy	0.014 / 199.475 =	0	Low Shear
Mcy = py.Syy≤1.2 py.Zyy	355 x 66.36≤1.2 x 355 x 55.89 =	23.558 kN.m	
Pz = Ag.py	18.73 x 355 =	664.915 kN	
n = F/Pz	30.168 / 664.915 =	0.045	OK
Srx = Fn(Sxx, n)	66.36, 0.045	66.18 cm³	
Mrx = Srx.py	66.18 x 355	23.494 kN.m	
Sry = Fn(Syy, n)	66.36, 0.045	66.18 cm³	
Mry = Sry.py	66.18 x 355	23.494 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(2.056/23.494)^{1.667}+(0.041/23.494)^{1.667}=$	0.017	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x3/3.86 =	77.7	OK
Pcx = Area.pcx	18.73x243.427/10 =	455.939 kN	Table 24 a
λy = Ley/ryy	100x1x3/3.86 =	77.7	OK
Pcy = Area.pcy	18.73x243.43/10 =	455.939 kN	Table 24 a

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x1+.5x1+.15x2)/2 = 0.44	0.6	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	0.6	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-1+.6x-1+.1x-2)/2 = .8x2/2	0.6	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	0.588	Table 26

Lateral Buckling Check Mb

Mb = Mc	Section not susceptible to lateral torsional buckling	23.558 kN.m	

Simplified Approach

py.Zx	355x55.89	19.841 kN.m	
py.Zy	355x55.89	19.841 kN.m	
F/Pc+mx.Mx/py.Zx+my.My/py.Zy	30.168/455.939+0.6x2.1/19.8+0.6x0/19.8	0.130	OK
$F/Pcy+m_{LT}.M_{LT}/Mb+my.My/py.Zy$	30.168/455.939+0.6x-2.1/23.6+0.6x0/19.8	0.120	OK

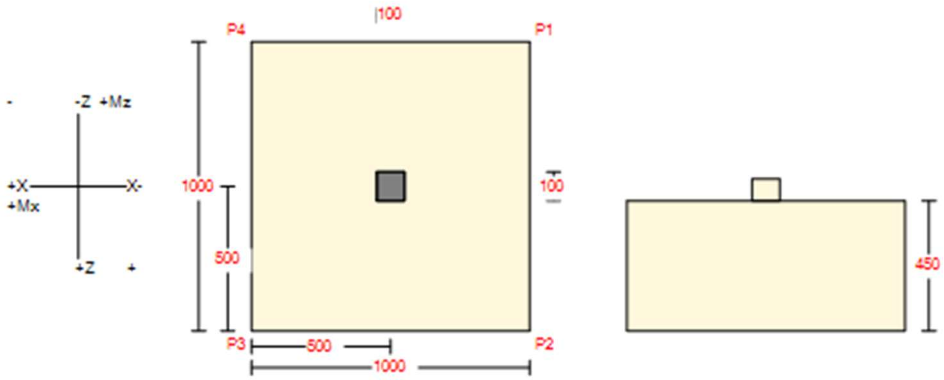
More Exact Approach

Max=Mcx/(1+.5F/Pcx)	23.6/(1+.5x30.2/455.9)	22.803 kN.m	
May=Mcy/(1+.5F/Pcy)	23.6/(1+.5x30.2/455.9)	22.803 kN.m	
F/Pcx+mx.Mx/Max+.5myx.My/Mcy	30.2/455.9+0.6x2.1/22.8+.5x0.588x0/23.6	0.121	OK
$F/Pcy+.5m_{LT}.M_{LT}/Mcx+my.My/May$	30.2/455.9+.50.6x-2.1/23.6+0.6x0/22.8	0.093	OK
Max=Mcx(1-F/Pcx)/(1+.5F/Pcx)	23.6(1-30.2/455.9)/(1+.5x30.2/455.9)	21.295 kN.m	
May=Mcy(1-F/Pcy)/(1+.5F/Pcy)	23.6(1-30.2/455.9)/(1+.5x30.2/455.9)	21.295 kN.m	
m.Mx/Max+m.My/May	0.6x2.056/21.295+0.6x0.041/21.295	0.059	OK

Deflection Check - Load Case 1

In-span δ ≤ Span/360	1.43 ≤ 3000 / 360	1.43 mm	OK

PAD @ END OF COLUMN SCL1ID 15



Basic Properties

Design to	BS 8110: 1997		
Fy, Fcu, Covers T, B, S	500 N/mm², 30 N/mm², 50 mm, 50 mm, 50 mm		Gross:
Area, Area1, Z zz, Z xx	1.0, 0.01, 0.167, 0.167		Conc
Den, Surcharge, LFsrv , LFult, SWP23.4,	2.5, 1.0, 1.0, 100		

Mass Concrete Pad Design

x-x projections	450, 450	450 mm	OK
z-z projections	450, 450	450 mm	OK

Critical Serviceability : 5 : Dead+Live 1.00D0+1.00D1+0.80L1+0.80W1+0.80W2+0.80W3+0.80W4 (a=5)

Fpad = Den•d•Area•LF	23.4 x 0.45 x 1.0 x 1.00	10.5 kN		Fsur =
Sur•(Area-Area1)•LF	2.5 x (1.0 - 0.01) x 1.00	2.5 kN		Fcol =
F 10.6 +	10.6 kN			Fres = F +
Fpad + Fsur	10.6 + 10.5 + 2.5	23.6 kN		Mzz =
Mzz + Vx•D + Fcol•ezz	0.0 + (-1.9 x 0.45) + (10.6 x 0.0)	-0.8 kN.m		Mxx
res = Mxx + Vz•D + Fcol•exx	0.0 + (4.2 x 0.45) + (10.6 x 0.0)	1.9 kN.m		
Effective L (Le) = Fn(Mzz,Fres,L)	-0.8, 23.6, 1000	1000 mm		
Effective B (Be) = Fn(Mzz,Fres,B)	1.9, 23.6, 1000	1000 mm		

Pressure

Pmax = Fn(Pa, Pzz, Pxx, p1-4)	23.6, ±5.1, ±11.3, 29.9, 7.3, 17.4, 40.0	40.0 kN/m²	OK	
Check for up-lift	Le 1000 >=1000 Be 1000 >=1000		OK	

FOS Overturning

Mzz Rest = (F)•e+(pad+sur)•L/2	(11) x 0.500 + (11 + 2) x 0.500	12 kN.m		FOS
OT zz = Mzz Rest / Mzz ot	12 / 1	13.97 > 1.5	OK	
Mxx Rest = (F)•e+(pad+sur)•L/2	(11) x 0.500 + (11 + 2) x 0.500	12 kN.m		FOS
OT xx = Mxx Rest / Mxx ot	12 / 2	6.29 > 1.5	OK	

FOS Sliding

Resultant Shear = Sqr(Fvxx²+Fvzz²)	Sqr(-1.88² + 4²)	4.58 kN		FOS
Sliding = 0.30 • F / Fv	(0.30 x 24) / 5	1.55 > 1.5	OK	

Combined Axial & Horizontal loads

$F/P_v + F_v/P_h < 1$ (BS 8004: 2.3.2.4.7)	23.6 / 100.0 + 4.6 / 7.1 = 0.24 + 0.65	0.88	OK

The Building Regulations

Building Regulations apply to most new buildings and many alterations of existing buildings in England and Wales, whether for domestic, commercial, and industrial use. Compliance is a legal requirement.

Unless specifically requested, we assume that the Lead Consultant, Contractor or Client will communicate and coordinate with Building Control or an Approved Inspector throughout the project. This will include the timely issue of information.

Planning Permission

Most projects will require Planning Permission.

Unless specifically requested, we assume that the Lead Consultant, Contractor or Client will communicate and coordinate with the Planning Authority.

There will be instances when we communicate with the Planning Officers, for example on projects which may be sensitive in terms of conservation. However, unless specifically stated the lead will be taken by others.

The Party Wall etc Act 1996

The Party Wall etc Act 1996 provides a framework for preventing and resolving disputes in relation to party walls, boundary walls and excavations near neighbouring buildings.

A building owner proposing to start work covered by the Act must give adjoining owners notice of their intentions in the way set down in the Act. Adjoining owners can agree or disagree with what is proposed. Where they disagree, the Act provides a mechanism for resolving disputes. The Act is separate from obtaining planning permission or building regulations approval.

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The CDM Regulations 2015

The Construction (Design and Management) 2015 regulations set out what people involved in construction work need to do to protect themselves from harm and anyone the work affects, improving health and safety in the construction industry.

The role of CDM Co-ordinator from CDM 2007 has been removed within CDM 2015 with those duties being placed on other members of the project team, namely the Client, Principal Contractor and the new role of the Principal Designer. In effect the structure of the new regulations has been simplified and introduces early participation and additional duties from the appointed professionals and client in respect to Health and Safety matters on construction projects.

Domestic clients not previously encompassed by CDM must also take on duties, although domestic clients may discharge their duties onto the contractor or agreeing with the designer that they coordinate and manage the project through the construction phase rather than the role automatically passing to the contractor.

When working with domestic clients and being the only designer involved in the project, Canham Consulting will have fulfilled their duties as a Principal Designer under the CDM 2015 Regulations on completion of our appointment. On appointment of either a Contractor or Principal Contractor under The CDM Regulations 2015, they will become responsible for carrying out the Client's duties.

Extract from CDM 2015 - Table 1: A summary of roles and duties under CDM Dutyholders*

Clients - are organisations or individuals for whom a construction project is carried out.
Roles/Duties - Make suitable arrangements for managing a project. This includes making sure:
- other dutyholders are appointed;
- sufficient time and resources are allocated;

Making sure:
- relevant information is prepared and provided to other dutyholders;
- the principal designer and principal contractor carry out their duties;
- welfare facilities are provided.

Domestic clients - are people who have construction work carried out on their own home, or the home of a family member that is not done as part of a business, whether for profit or not.

Domestic clients are in scope of CDM 2015, but their duties as a client are normally transferred to:
- the contractor, on a single contractor project; or;
- the principal contractor, on a project involving more than one contractor.

However, the domestic client can choose to have a written agreement with the principal designer to carry out the client duties.

Designers – are those, who as part of a business, prepare or modify designs for a building, product or system relating to construction work.
Roles/Duties - When preparing or modifying designs, to eliminate, reduce or control foreseeable risks that may arise during construction; and the maintenance and use of a building once it is built.
Provide information to other members of the project team to help them fulfil their duties.

Principal designers – are designers appointed by the client in projects involving more than one contractor. They can be an organisation or an individual with sufficient knowledge, experience and ability to carry out the role.
Roles/Duties - Plan, manage, monitor and coordinate health and safety in the pre-construction phase of a project. This includes:
- identifying, eliminating or controlling foreseeable risks;
- ensuring designers carry out their duties;

Prepare and provide relevant information to other dutyholders;

Liaise with the principal contractor to help in the planning, management, monitoring and coordination of the construction phase.

Principal contractors – are contractors appointed by the client to coordinate the construction phase of a project where it involves more than one contractor.
Roles/Duties - Plan, manage, monitor and coordinate the construction phase of a project. This includes:

- liaising with the client and principal designer;
- preparing the construction phase plan;
- organising cooperation between contractors and coordinating their work.

Ensure:

- suitable site inductions are provided;
- reasonable steps are taken to prevent unauthorised access;
- workers are consulted and engaged in securing their health and safety; and
- welfare facilities are provided

Contractors - Are those who do the actual construction work and can be either an individual or a company
Roles/Duties - Plan, manage and monitor construction work under their control so that it is carried out without risks to health and safety;
For projects involving more than one contractor, coordinate their activities with others in the project team – in particular, comply with directions given to them by the principal designer or principal contractor;
For single-contractor projects, prepare a construction phase plan.

Workers - Are the people who work for or under the control of contractors on a construction site
Roles/Duties - They must:

- be consulted about matters which affect their health, safety and welfare;
- take care of their own health and safety and others who may be affected by their actions;
- report anything they see which is likely to endanger either their own or others' health and safety;
- cooperate with their employer, fellow workers, contractors and other dutyholders.

For more information on CDM 2015 please follow the link:
http://www.hse.gov.uk/construction/cdm/2015/index.htm
* Organisations or individuals can carry out the role of more than one dutyholder, provided they have the skills, knowledge, experience and (if an organisation) the organisational capability necessary to carry out those roles in a way that secures health and safety.

Canham Consulting

Temporary Works

We frequently design structures which are classified as 'Temporary Works'.

Temporary works (TW) are the parts of a construction project that are needed to enable the permanent works to be built. Usually the TW are removed after use - e.g. access scaffolds, props, shoring, excavation support, falsework and formwork, etc. Sometimes the TW is incorporated into the permanent works - e.g. haul road foundations and crane or piling platforms may be used for hardstanding or road foundations.

It is very important that the same degree of care and attention is given to the design and construction of temporary works (TW) as to the design and construction of the permanent works. As TW may be in place for only a short while there is a tendency to assume they are less important. This is incorrect. Lack of care with design, selection, assembly, etc leaves TW liable to fail or collapse. This places people at risk of injury and can cause the project to be delayed.

British Standard 5975 sets out one way of managing temporary works (TW) that has been found to work well on medium and large projects and uses the job title Temporary Works Coordinator (TWC). There is no legal requirement to use this job title or the BS recommended process, but you should remember that BS5975 provides an industry consensus view on what is considered to be good practice. The legal requirement is that the party in control must ensure that work is allocated and carried out in a manner that does not create unacceptable risk of harm to workers or members of the public. On projects with relatively simple TW needs, you may choose not to appoint a TWC. However, you must still make sure that TW are properly managed to ensure safety.

Unless specifically instructed to do so, Canham Consulting Ltd will not undertake the role of Temporary Works Coordinator.

Canham Consulting

Design Assumptions

Most designs will carry a certain degree of assumptions. As designers we will ensure that these are reasonable assumptions and frequently ask that these assumptions are verified by the Contractor on site.

In the absence of information regarding ground conditions we will often make educated assumptions which must be verified on site. It is the Clients and Contractors responsibility to ensure that our recommendations concerning investigation and verification of our assumptions are followed through. A typical example of this is as follows:

A modest residential project, incorporating an extension to an existing property. Our brief is to design a series of steel beams and supports. We will design the supports and foundation requirements, assuming a certain stratum. This is often stated as "assume medium dense / dense granular material with a net allowable bearing pressure of $100kN/m^2$ or greater, all to be confirmed by Contractor and Building Control on site, refer to Engineer for further information".

Where ground investigations have been undertaken, it is imperative to note that any investigation will only determine the ground conditions at the very location investigated. Differing ground conditions can and do exist elsewhere on the site and no assurance can be given this that is not the case. We will, however, make reasonable design assumptions and design with a degree of robustness and redundancy to accommodate slight variations in ground conditions.

We will typically make certain assumptions regarding forms of construction and existing materials, which must be confirmed and verified on site. This is particularly relevant with existing buildings; assumptions can be made with regards to wall construction, floor span and depth and roof construction. It is not always feasible for us to visit the site prior to undertaking our design and as such we will state any assumption which must be verified on site by the Client and Contractor.

Canham Consulting

Structural Civil Building Engineers

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