

Project		Job. Ref.			
Structural Calculations					
Calc by.	Date	Chck'd by:	Date	App'd by:	Date
KK	07.11.2022	MK	07.11.2022	MP	

Garden Annexe Cradle



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1 General Notes

- These calculations and details are to be read in conjunction with all relevant Architect's and Engineer's drawings and specifications.
- Any dimensions stated in the calculations are for design purposes ONLY, and must not be used for ordering lengths of components. The contractor is to be responsible for obtaining all accurate site dimensions.

2 Construction Notes

- Any deviation from the design assumptions is to be reported to the Architect/Engineer prior to commencement of works.
- All new steelwork is to be Grade S275, unless noted otherwise in the calculations. Normal paint finish to be thoroughly wire brushed and painted with two coats of Zinc Phosphate primer. All damaged areas of paintwork are to be touched up after erection of the steelwork. All bolts are to be Grade 8.8, unless noted otherwise, and all welds are to be 6mm continuous fillet type, unless noted otherwise. All steels exposed to cavities and/or built into inner skin of external cavity wall to be painted with two coats of high build bituminous paint on site. Moment and splice connections are contractor's design responsibility.
- The contractor is expected to understand and follow the Construction (Design and Management) Regulations with regard to safety on site, even though they may not be legally applicable.

3 Codes and standards

The structure will be designed in accordance with Building Regulations and Eurocodes. the principal of which are listed below:

Building Regulations 2010	Approved Document A – Structure
BS 648:1964	Schedule of Weights of Building materials
BS EN 1990 to 1999 National Annexes	Eurocode: Basis of Structural Design and Eurocodes 1 to 9. with

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4 Design loads

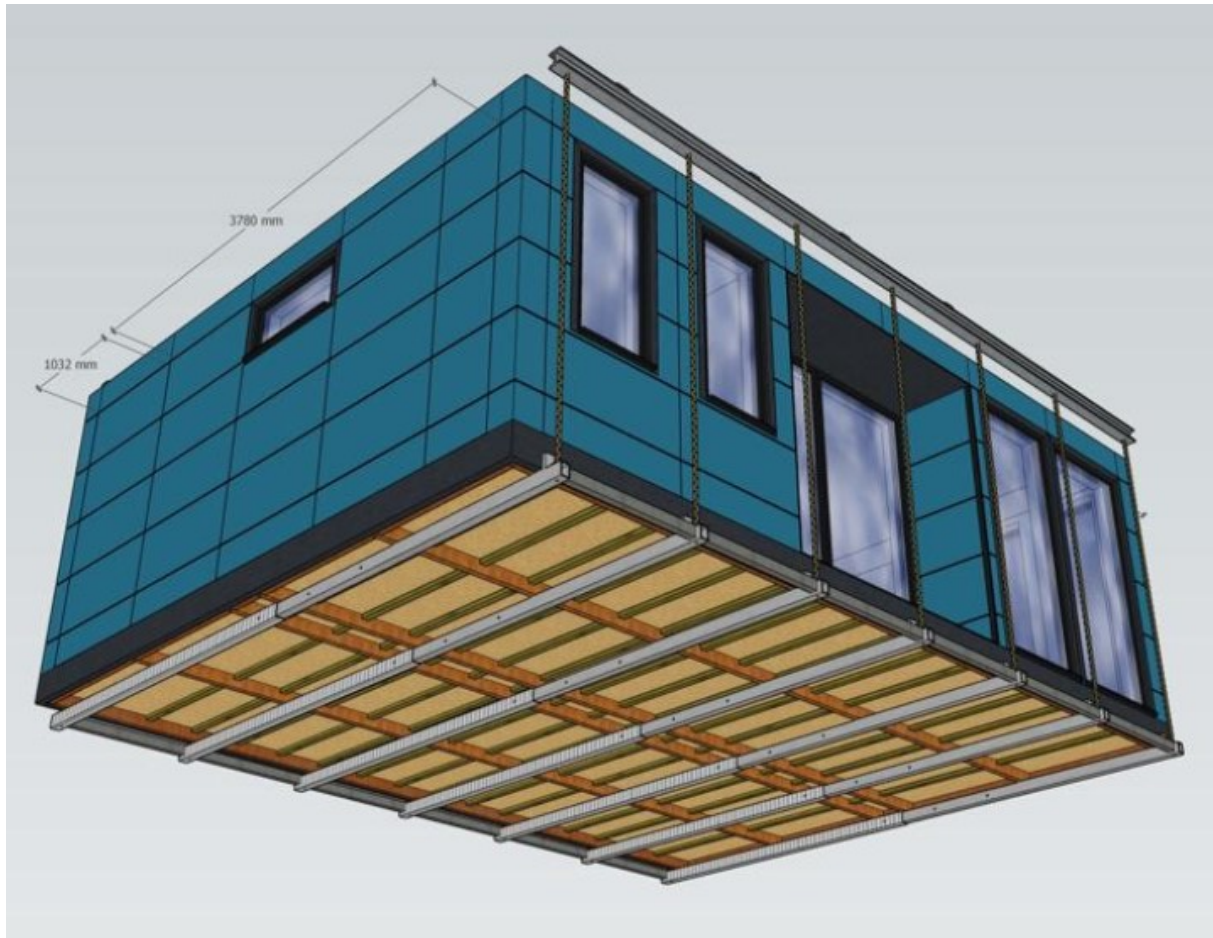
The load schedule has been prepared based on the given materials:

- 145mm floor joists @ 400mm c/c
- 145mm floor plate, wall plate
- 145mm wall plate
- 225mm rim board
- 225mm base rail
- 210 mm ceiling rafters @ 550mm c/c
- 9mm OSB Insulation bed between floor joists
- 18mm OSB roof board
- 9mm OSB sheathing to walls
- 15mm MTX cladding
- 15mm FR MDF lining
- 100mm Celotex insulation in 6 planes

The loads coming from particular parts of supported structure should not exceed the values given below:

Item	Loading
WALLS	0.85 kN/m ²
FLOOR	0.70 kN/m ²
FLAT ROOF	0.85 kN/m ²
LIVE LOAD	0.20 kN/m ²

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1. Timber floor reactions analysis

Floor span $2,55 / 2 = 1,28 \text{ m}$

Dead loads: $0,7 \times 1,275 = 0,89 \text{ kN/m}$

Live load: $0,20 \times 1,275 = 0,26 \text{ kN/m}$

TIMBER BEAM ANALYSIS & DESIGN TO EN1995-1-1:2004

In accordance with EN1995-1-1:2004 + A2:2014 and Corrigendum No.1 and the UK National Annex incorporating National Amendment No.1

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Analysis results

Design moment	M = 0.276 kNm	Design shear	F = 1.304 kN
Total load on member	W _{tot} = 11.901 kN		
Reactions at support A	R _{A_max} = 0.875 kN	R _{A_min} = 0.875 kN	
Unfactored permanent load reaction at support A		R _{A_Permanent} = 0.499 kN	
Unfactored variable load reaction at support A		R _{A_Variable} = 0.135 kN	
Reactions at support B	R _{B_max} = 2.363 kN	R _{B_min} = 2.363 kN	
Unfactored permanent load reaction at support B		R _{B_Permanent} = 1.346 kN	
Unfactored variable load reaction at support B		R _{B_Variable} = 0.364 kN	
Reactions at support C	R _{C_max} = 1.730 kN	R _{C_min} = 1.730 kN	
Unfactored permanent load reaction at support C		R _{C_Permanent} = 0.986 kN	
Unfactored variable load reaction at support C		R _{C_Variable} = 0.266 kN	
Reactions at support D	R _{D_max} = 1.963 kN	R _{D_min} = 1.963 kN	
Unfactored permanent load reaction at support D		R _{D_Permanent} = 1.119 kN	
Unfactored variable load reaction at support D		R _{D_Variable} = 0.302 kN	
Reactions at support E	R _{E_max} = 1.730 kN	R _{E_min} = 1.730 kN	
Unfactored permanent load reaction at support E		R _{E_Permanent} = 0.986 kN	
Unfactored variable load reaction at support E		R _{E_Variable} = 0.266 kN	
Reactions at support F	R _{F_max} = 2.363 kN	R _{F_min} = 2.363 kN	
Unfactored permanent load reaction at support F		R _{F_Permanent} = 1.346 kN	
Unfactored variable load reaction at support F		R _{F_Variable} = 0.364 kN	
Reactions at support G	R _{G_max} = 0.875 kN	R _{G_min} = 0.875 kN	
Unfactored permanent load reaction at support G		R _{G_Permanent} = 0.499 kN	
Unfactored variable load reaction at support G		R _{G_Variable} = 0.135 kN	

Timber section details

Breadth of section	b = 47 mm	Depth of section	h = 225 mm
Number of sections	N = 2	Breadth of member	b _b = 94 mm
Timber strength class	C24		

Member details

Service class of timber	1	Load duration	Medium-term
Length of span 1	L _{s1} = 1290 mm		
Length of span 2	L _{s2} = 1116 mm		
Length of span 3	L _{s3} = 1116 mm		
Length of span 4	L _{s4} = 1116 mm		
Length of span 5	L _{s5} = 1116 mm		
Length of span 6	L _{s6} = 1290 mm		
Length of bearing	L _b = 100 mm		

Compression perpendicular to grain - cl.6.1.4

Design compressive stress N/mm ²	σ _{c,90,d} = 0.251 N/mm ²	Design compressive strength	f _{c,90,d} = 1.538
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PASS - Design compressive strength exceeds design compressive stress at bearing

Bending - cl 6.1.6

Design bending stress N/mm ²	σ _{m,d} = 0.349 N/mm ²	Design bending strength	f _{m,d} = 14.769
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PASS - Design bending strength exceeds design bending stress

Shear - cl.6.1.7

Applied shear stress N/mm ²	τ _d = 0.138 N/mm ²	Permissible shear stress	f _{v,d} = 2.462
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PASS - Design shear strength exceeds design shear stress

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Deflection - cl.7.2

Deflection limit
mm

$\delta_{lim} = 5.160$ mm

Total final deflection

$\delta_{fin} = 0.057$

PASS - Total final deflection is less than the deflection limit

2. Steel RHS section

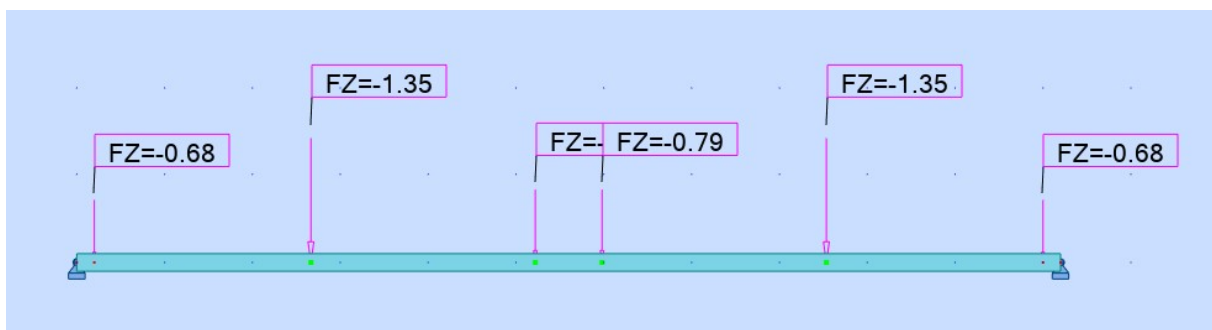


Figure: Dead loads

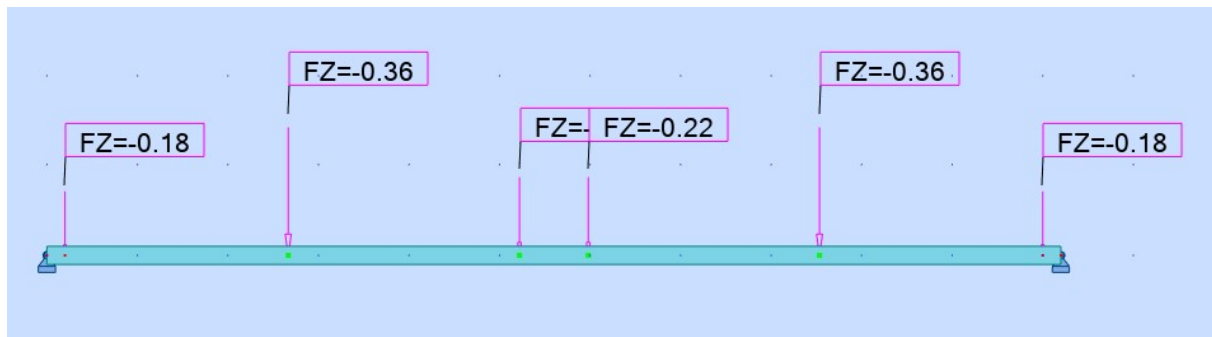


Figure: Live loads

Check RHS 120x80x8:

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(uz)	Case (uz)
1 Beam_1	RHSH 120x80	S275	131.16	181.89	0.26	3 ULS /1/	0.00		0.78	6 SLS /1/

Correct section - use RHS 120x80x8 S275

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STEEL DESIGN

CODE: *BS-EN 1993-1:2005/NA:2008/A1:2014, Eurocode 3: Design of steel structures.*

ANALYSIS TYPE: *Member Verification*

CODE GROUP:

MEMBER: *1 Beam_1*

POINT: *2*

COORDINATE: *x = 0.50 L = 2.80 m*

LOADS:

*Governing Load Case: 3 ULS /1/ 1*1.35 + 2*1.50*

MATERIAL:

S275 (S275) $f_y = 275.00 \text{ MPa}$



SECTION PARAMETERS: RHS 120x80x8

$h=120 \text{ mm}$	$gM0=1.00$	$gM1=1.00$	
$b=80 \text{ mm}$	$A_y=1152 \text{ mm}^2$	$A_z=1728 \text{ mm}^2$	$A_x=2880 \text{ mm}^2$
$t_w=8 \text{ mm}$	$I_y=5250000 \text{ mm}^4$	$I_z=2730000 \text{ mm}^4$	$I_x=5870000 \text{ mm}^4$
$t_f=8 \text{ mm}$	$W_{ply}=111000 \text{ mm}^3$	$W_{plz}=82600 \text{ mm}^3$	

INTERNAL FORCES AND CAPACITIES:

$$M_{y,Ed} = 8.09 \text{ kN}\cdot\text{m}$$

$$M_{y,pl,Rd} = 30.52 \text{ kN}\cdot\text{m}$$

$$M_{y,c,Rd} = 30.52 \text{ kN}\cdot\text{m}$$

$$M_{b,Rd} = 30.52 \text{ kN}\cdot\text{m}$$

Class of section = 1



LATERAL BUCKLING PARAMETERS:

$$z = 1.00$$

$$M_{cr} = 312.21 \text{ kN}\cdot\text{m}$$

Curve,LT - d

$$XLT = 1.00$$

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Lcr,upp=5.60 m		Lam_LT = 0.31		fi,LT = 0.50	
				XLT,mod = 1.00	

BUCKLING PARAMETERS:



About y axis:



About z axis:

VERIFICATION FORMULAS:

Section strength check:

$$M_{y,Ed}/M_{y,c,Rd} = 0.26 < 1.00 \quad (6.2.5.(1))$$

Global stability check of member:

$$M_{y,Ed}/M_{b,Rd} = 0.26 < 1.00 \quad (6.3.2.1.(1))$$

LIMIT DISPLACEMENTS



Deflections (LOCAL SYSTEM):

$$u_y = 0 \text{ mm} < u_{y \text{ max}} = L/250.00 = 22 \text{ mm} \quad \text{Verified}$$

Governing Load Case: 1 DL1

$$u_z = 17 \text{ mm} < u_{z \text{ max}} = L/250.00 = 22 \text{ mm} \quad \text{Verified}$$

Governing Load Case: 6 SLS /1/ 1*1.00 + 2*1.00

$$u_{\text{inst},y} = 0 \text{ mm} < u_{\text{inst,max},y} = L/360.00 = 16 \text{ mm} \quad \text{Verified}$$

Governing Load Case:

$$u_{\text{inst},z} = 3 \text{ mm} < u_{\text{inst,max},z} = L/360.00 = 16 \text{ mm} \quad \text{Verified}$$

Governing Load Case: 1*2



Displacements (GLOBAL SYSTEM): Not analyzed

Section OK !!!

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3. Steel chain calculation

Specifications of Chain DIN 763

Size d mm	Dimensions		Weight kg/ 100 m	Working Load kg	Test Load kn	Breaking Load kn
	t mm	b mm				
3	26	12	15	55	1.05	3.2
4	32	16	27	100	2	6
5	35	20	43	160	3.15	10
6	42	24	63	224	4.5	14
7	49	28	86	300	6	18
8	52	32	110	400	8	25
9	59	36	141	530	10.5	32
10	65	40	175	630	12.5	40
11	72	44	211	790	15.8	47.5
12	78	48	255	940	18.8	56.5
13	82	52	295	1000	21.2	63
16	100	64	445	1600	33	100
18	113	70	565	2120	42.3	127
19	119	72	625	2370	47.3	142
20	120	75	700	2500	50	160
22	127	82	855	3170	63.3	190
25	140	88	1090	4090	81.7	245
Note	Please contact us for more specifications.					

Total weight of annexe calculation:

Floor loads:

DL: $7.04 \times 5.39 \times 0.70 = 26.56 \text{ kN}$

LL: $7.04 \times 5.39 \times 0.20 = 7.59 \text{ kN}$

Ceiling:

DL: $7.04 \times 5.39 \times 0.85 = 32.25 \text{ kN}$

External walls

Long: $7.04 \times 2.70 \times 0.85 \times 2 = 32.31 \text{ kN}$

Short: $5.39 \times 2.70 \times 0.85 \times 2 = 24.74 \text{ kN}$

RHS Rails:

$0.226 \times 5.60 \times 7 = 8.86 \text{ kN}$

Total DL: $26.56 + 32.25 + 32.31 + 24.75 + 8.86 = 124.72 \text{ kN}$

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Safety factors:

DL: 1.35

LL: 1.50

$124.72 \times 1.35 = 168.37 \text{ kN}$

$7.59 \times 1.50 = 11.39 \text{ kN}$

Total loads: 179.76 kN

Total number of chains used: 14

78x48mm chain tested load: 18.8 kN

$14 \times 18.8 = 263.2 \text{ kN} > 179.76 \text{ kN}$ passed - use 78x48 DIN 763 chain

Utilisation ratio: $179.76 / 263.2 = 0.68$