Example Design and Verification to EN1995

Timber Platform Framed Bungalow

This set of calculations has been provided for your information and guidance. Every effort has been made to ensure it is correct, but it must still be subject to a peer review. Errors and omissions are accepted, its use is provided with a *caveat emptor* warning. Ensure your use of this method is checked and approved by your supervisor.

This document has been prepared using the Nationally approved parameters for the Republic of Ireland making use of an Excel Macro-Enabled Worksheet running on Windows 10 and Microsoft-365. The Worksheet will be available for down load soon.

This example is for a single storey detached bungalow or single-family domestic dwelling as shown in Figure 1.

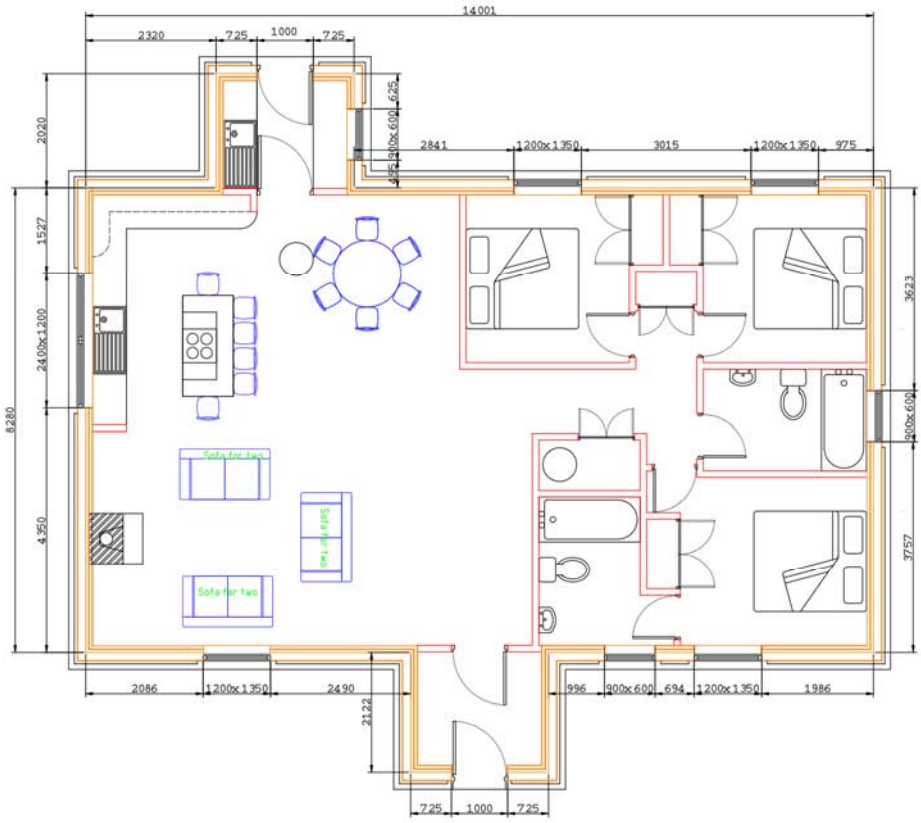


FIGURE 1: PLAN OF THE BUILDING

The building arrangement is defined by node points located in the finished corners of each room for external walls and the centre of internal walls. Walls are empty spatial units that set up local coordinates for the positioning of panels, openings, columns or posts, Beams and trusses locate relative to the walls and can be related to other beams, trusses, or posts. Unrelated loads and grouped elements are also handled.

The detailed information of each item is tabulated in the Data or Criteria sheet at the beginning of the set. When the macro module is run the Data is read and a virtual model is created from the

criteria listed. This takes only a matter of seconds and can be frequently run iteratively to build and correct the detailed data set.

A full detailed or part of the data verification can be printed as required so that information of the design and verification process can be checked by the designer and third-party checking personnel.

Items covered include:- Studs, fixings, fastenings, wind analysis, List, and individual walls, opening lintels, beams, trusses, columns, posts, and portals used in the design. Trusses are not analysed but detail is given to enable a thorough evaluation to be made with other software. The total and section run times are printed at the top of the data sheet on each run.

Name	Bungalow	03-Feb-22	17:12

Run time	00:02:21
Draw Plans	00:00:16
Draw Beams	00:00:25
Draw Portals	00:00:00

Basic Data	00:00:11
Draw Walls	00:01:15
Draw Posts	00:00:14
Design Check	00:00:13

Site Details								
Altitude (m ASL)	Map Wind Speed (m/s)	North (deg)	Location	Foundation type	Weather face	Roof Style	Roof Pitch	Terrain
20	25	90	Athlone	Raft	Masonry	Duopitch	25	Town

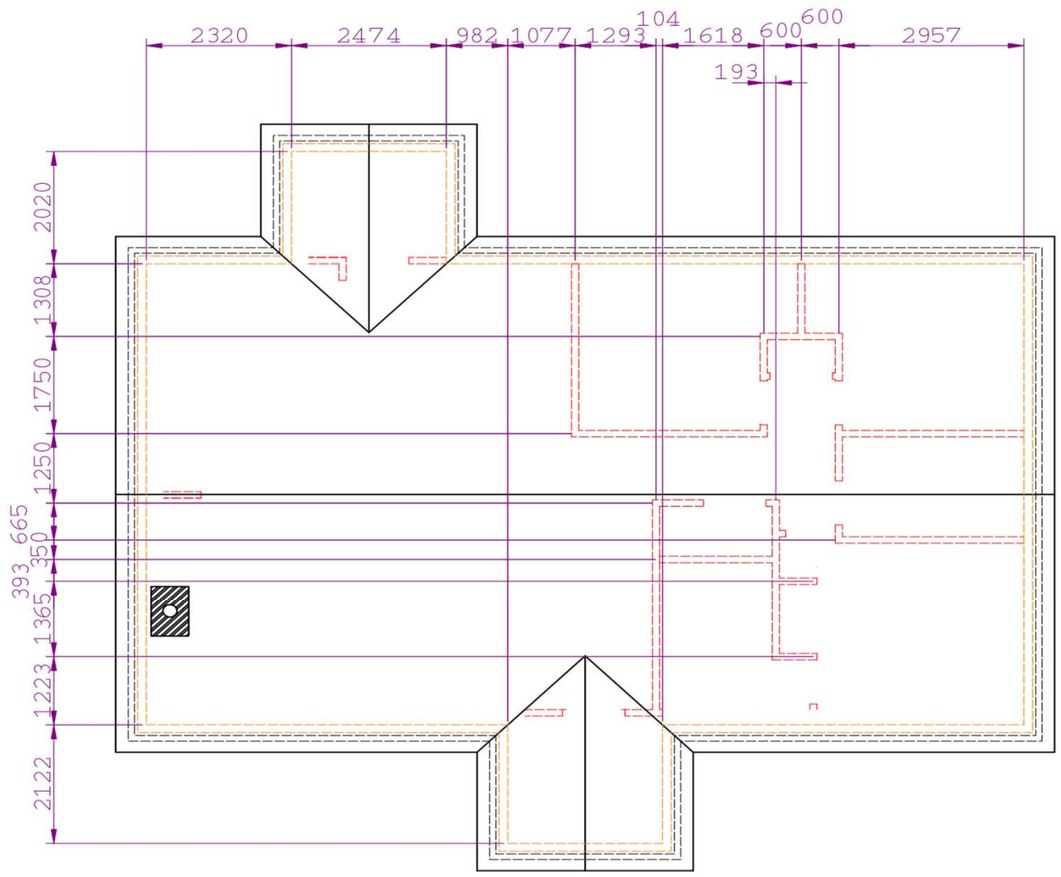
Unit loads	gk (kN/m²)	qk (kN/m²)	pk (kN)
Roof	0,65	0,75	1
Floor	1	1,5	1

Method Used
BS PD6693

Timber	Breadth (mm)	Depth (mm)	SC	Style
1	38	140	C16	Solid
2	38	89	C16	Solid
3	47	247	C18	Solid
4L	44	222	C18	Solid
5	38	222	C16	Solid
6	38	75	C16	Solid
7	47	272	C16	Solid
8	171	457	24h	Glulam

Cladding	Name	Thk (mm)	Density (kg/m³)	Material	Spec
1	Plasterboard	12,5	300	Plasterboard	PB01
2	OSB/3	9	515	OSB	
3	OSB/3	12	515	OSB	

Fastener	Material	Char Tens (N/mm²)	Dia (mm)	Length (mm)	Pull out (kN)	Shear (kN)	Head Dia (mm)	Style
1	Nail BRT	700	3,1	50	0,19	0,83	6,2	Round nails
2J	BRT ring shanked nail	700	3,1	70	0,19	0,83	6,2	Other nails
3S	Shot-fired smooth round nail	700	3,5	70	0,05	1,50	6,975	Other nails
4	BRT plasterboard screws	700	3,5	40	0,19	0,83	6,2	Screws



Levels	Name	Site (m)	AOD (m)	Hz (m)	Rest On	Unit Load	Wind 0 Hor (kN)	Wind 0 Vert (kN)	Wind 90 Hor (kN)	Wind 90 Vert (kN)	Racking	Sub Roof
Grnd	Ground Floor	2,55	20,15	2,400	0	Floor	3,76		3,76		**TRUE**	
Roof	Roof Level	4,53	22,55	1,756	Grnd	Roof	3,76	3,76	3,76	3,76	**FALSE**	

Nodes	X (m)	Y (m)
1	0,49	2,612
2	0,49	10,923
3	2,81	10,923
4	2,81	12,936
5	5,284	12,936
6	5,284	10,923
7	7,343	10,923
8	10,958	10,923
9	14,515	10,923
10	14,515	7,859
11	14,515	5,944
12	14,515	2,612
13	8,74	2,612
14	8,74	0,49
15	6,266	0,49
16	6,266	2,612
17	8,636	2,886
18	8,636	5,594
19	8,636	6,609
20	10,551	3,836

21	10,551	5,594
22	10,551	6,609
23	11,558	5,944
24	11,558	7,859
25	10,358	7,859
26	7,343	7,859
27	10,358	9,609
28	10,958	9,609
29	11,558	9,609

Walls	E1	E2	Lvl	Timber	Number	Shear Wall	Spc0 (mm)	Style	Clad 1	Clad 2	Fix1	Fix2	Spc1 (mm)	Spc2 (mm)	Top shape	Rest On
1	1	2	Grnd	1			600	Ext	2	1	1	4	150	150		
2	2	3	Grnd	1			600	Ext	2	1	1	4	150	150		
3	3	4	Grnd	1			600	Ext	2	1	1	4	150	150		
4	4	5	Grnd	1			600	Ext	2	1	1	4	150	150		
5	5	6	Grnd	1			600	Ext	2	1	1	4	150	150		
6	6	9	Grnd	1			600	Ext	2	1	1	4	150	150		
7	9	12	Grnd	1			600	Ext	2	1	1	4	150	150		
8	12	13	Grnd	1			600	Ext	2	1	1	4	150	150		
9	13	14	Grnd	1			600	Ext	2	1	1	4	150	150		
10	14	15	Grnd	1			600	Ext	2	1	1	4	150	150		
11	15	16	Grnd	1			600	Ext	2	1	1	4	150	150		
12	16	1	Grnd	1			600	Ext	2	1	1	4	150	150		
13	17	19	Grnd	2		No	600	Int	1	1	4	4	150	150		
14	19	22	Grnd	2		No	600	Int	1	1	4	4	150	150		
15	20	22	Grnd	2		No	600	Int	1	1	4	4	150	150		
16	18	21	Grnd	2		No	600	Int	1	1	4	4	150	150		
17	11	23	Grnd	2		No	600	Int	1	1	4	4	150	150		
18	23	29	Grnd	2		No	600	Int	1	1	4	4	150	150		
19	10	24	Grnd	2		No	600	Int	1	1	4	4	150	150		
20	29	27	Grnd	2		No	600	Int	1	1	4	4	150	150		
21	28	8	Grnd	2		No	600	Int	1	1	4	4	150	150		
22	27	25	Grnd	2		No	600	Int	1	1	4	4	150	150		
23	25	26	Grnd	2		No	600	Int	1	1	4	4	150	150		
24	26	7	Grnd	2		No	600	Int	1	1	4	4	150	150		
25	9	12	Roof	1			600	Ext	2	1	1	4	150	150	0,222(0;2	W7
26	1	2	Roof	1			600	Ext	2	1	1	4	150	150	0,222(0;2	W1
27	14	15	Roof	1			600	Ext	2	1	1	4	150	150	0,222(0;2	W10
28	4	5	Roof	1			600	Ext	2	1	1	4	150	150	0,222(0;2	W4

Panels	Wall	X (m)	Y (m)	L (m)	H (m)	Top
1	1	0	0	4,2	2,400	
2	1	4,2	0	4,251	2,400	
3	2	0	0	2,32	2,400	
4	3	0,14	0	2,013	2,400	
5	4	0	0	2,614	2,400	
6	5	0	0	2,013	2,400	
7	6	0	0	4,8	2,400	
8	6	4,8	0	4,571	2,400	
9	7	0	0	4,8	2,400	
10	7	4,8	0	3,651	2,400	
11	8	0	0	5,775	2,400	
12	9	0,14	0	2,122	2,400	
13	10	0	0	2,614	2,400	
14	11	0	0	1,982	2,400	
15	12	0	0	5,916	2,400	
16	13	0	0	3,778	2,400	
17	14	0,055	0	1,805	2,400	
18	15	0	0	2,828	2,400	
19	16	0,055	0	1,805	2,400	
20	17	0	0	2,902	2,400	
21	18	-0,055	0	3,775	2,400	

22	19	0	0	2,902	2,400
23	20	0,055	0	1,09	2,400
24	21	0,055	0	1,259	2,400
25	22	-0,055	0	1,86	2,400
26	23	0,055	0	2,905	2,400
27	24	-0,055	0	3,119	2,400
28	25	0	0	4,156	2,400
29	25	4,156	0	4,156	2,400
30	26	0	0	4,156	2,400
31	26	4,156	0	4,156	2,400
32	27	0	0	2,614	2,400
33	28	0	0	2,614	2,400

Opes	Wall	X (m)	Y (m)	L (m)	H (m)	NumLin	NumCr
1	1	4,35	2,1	2,4	1,2		
2	4	0,725	2,1	1	2,1		
3	5	0,625	2,1	0,9	0,6		
4	6	2,841	2,1	1,2	1,35		
5	6	7,056	2,1	1,2	1,35		
6	7	3,623	2,1	0,9	0,6		
7	8	1,986	2,1	1,2	1,35		
8	8	3,88	2,1	0,9	0,6		
9	10	0,725	2,1	1	2,1		
10	12	2,49	2,1	1,2	1,35		
11	14	0,7	2,1	1,1	2,1		
12	18	0,15	2,1	0,9	2,1		
13	18	2,165	2,1	0,9	2,1		
14	22	0,7	2,1	0,9	2,1		

Posts	OnIn	X (m)	Tim	No.
P1	W2	0,713	1	2
P2	W6	8,519	1	2
P3	W8	0,713	1	2
P4	W12	5,064	1	2
P5	W2	2,244	1	2
P6	W6	0,076	1	2
P7	W12	0,038	1	2
P8	W8	5,737	1	2

Portals	Wall	X (m)	L (m)	Fx (kN)

Beams	Style	W1	W1 item	W2	W2 item	Lvl	X (m)	Ex1	Ex2	Bg1	Bg2	Hos (m)	Thk(m)	Sp (m)	L (m)	Main	Web	Num	Load	W1On	W2On
B1	Beam	P7		P8		Roof	0	-0,14	0,14	0,14	0,14		0,047	1		4L	1	3			
B2	Beam	P5		P6		Roof	0	-0,14	0,14	0,14	0,14		0,044	2		3	2	3			
T3	Duopitch	P3		P2		Roof	0,000	-0,49	0,49	0,1	0,1		0,038	0,3	0	5	6				
T4	Duopitch	W8		W6		Roof	1,313	-0,49	0,49	0,1	0,1		0,038	0,6	11,4	5	6			B1;W12	B2;W2
T5	Duopitch	P1		P4		Roof	0,000	-0,49	0,49	0,1	0,1		0,038	0,3	0	5	6				
EG4	Gable or Valley	W25		T3		Roof															
EG5	Gable or Valley	W26		T5		Roof															
T6	Duopitch	W11		W9		Roof	0,6	-0,49	0,49	0,14	0,14		0,038	0,3	0	1	6				
T7	Duopitch	W11		W9		Roof	1,2	-0,49	0,49	0,14	0,14		0,038	0,6	0,6	1	6				
T8	Duopitch	W3		W5		Roof	1,413	-0,49	0,49	0,14	0,14		0,038	0,3	0	1	6				
T9	Duopitch	W3		W5		Roof	0,6	-0,49	0,49	0,14	0,14		0,038	0,6	0,6	1	6				
EG8	Gable or Valley	T6	1	W27		Roof															
EG9	Gable or Valley	T8	1	W28		Roof															
EV10	Gable or Valley	T7	3	T4		Roof															
EV11	Gable or Valley	T9	3	T4		Roof															

Groups	Origin	Members	Copy

Loads	Describe	Style	Support	X (m)	L (m)	Gk	Qk	Wk
L1	Water tank	P	W17	1,179		1,06		
L2	Water tank	P	W17	1,779		1,06		

L3	Water tank	P	W19	1,179	1,06
L4	Water tank	P	W19	1,779	1,06

Std-Grnd

Stud Ref-1Ext1600

Storey height = 2,4m | Head binder = 0,038m | Top rail = 0,038m
Bottom rail = 0,038m | Sole plate = 0,038m
Stud length = 2,248m | Effective length = 2,248m
Stud spacing = 0,600m
External walls are considered to have wind presssure.
Site altitude = 20,m ASL | Map Wind Speed = 25,m/s
I.S.EN 1991-1 Storey top, z = 22,55m ASL | Altitude Factor, C_{alt} = 1,003
Mean Wind Speed,V_m = 25,064m/s | Wind pressure, σ_{wp} = 0,385kN/m²
Wind force, F_{wk} = 0,519kN | Shear force, V_{wk} = 0,260kN
Design moment, W_{md} = 0,219kN/m²

	Depth H = 140mm	Breadth B = 38mm	Style = Solid	Class = C16
6.1.6(2)	No off = 1	Area = 53,2cm²	I_{yy} = 868,9cm^4	I_{zz} = 64,0cm^4
	W_{yy} = 124,13cm³	W_{zz} = 33,69cm³	r_{yy} = 4,04cm	r_{zz} = 1,10cm
Table 3.1	k_m = 0,7	k_{sys} = 1,1		
	σ_{myd} = 1,76N/mm²	f_{myk} = 16,00N/mm²	Service class = 2	

Stability in the zz direction is assured by the fixings of the panel to the stud.

	k_{mod} = 0,9	γ_m = 1,3	f_{myd} = 12,18N/mm²
	f_{c0d} = 12,95N/mm²		
6.3.2	λ_y = 55,62		
(6.21)	f_{c0k} = 17,00N/mm²	E_{05} = 5360N/mm²	λ_{rely} = 0,997
	β_c = 0,2	k_y = 1,067	
	k_{cy} = 0,691	Factor = 0,855	
	Limiting σ_{c0d} = 7,656N/mm²	Ultimate F_c = 40,73kN	
	K_{c90} = 2,57	f_{c90k} = 2,20N/mm²	f_{c90d} = 1,52N/mm²

Limiting Bearing = K_{c90} x Area x f_{c90d}/10 = 20,85kN **Available F_c = 20,85kN**

Stud Ref-2Int1600

Storey height = 2,4m | Head binder = 0,038m | Top rail = 0,038m
Bottom rail = 0,038m | Sole plate = 0,038m
Stud length = 2,248m | Effective length = 2,248m
Stud spacing = 0,600m
Internal walls are considered to have zero wind presssure.

	Depth H = 89mm	Breadth B = 38mm	Style = Solid	Class = C16
6.1.6(2)	No off = 1	Area = 33,8cm²	I_{yy} = 223,2cm^4	I_{zz} = 40,7cm^4
	W_{yy} = 50,17cm³	W_{zz} = 21,42cm³	r_{yy} = 2,57cm	r_{zz} = 1,10cm
Table 3.1	k_m = 0,7	k_{sys} = 1,1		
	σ_{myd} = ,00N/mm²	f_{myk} = 16,00N/mm²	Service class = 2	

Stability in the zz direction is assured by the fixings of the panel to the stud.

	k_{mod} = 0,9	γ_m = 1,3	f_{myd} = 12,18N/mm²
	f_{c0d} = 12,95N/mm²		
6.3.2	λ_y = 87,50		
(6.21)	f_{c0k} = 17,00N/mm²	E_{05} = 5360N/mm²	λ_{rely} = 1,569
	β_c = 0,2	k_y = 1,857	

k_{cy} = 0,351 Factor = 1,000

Limiting σ_{c0d} = 4,541N/mm² Ultimate F_c = 15,36kN

K_{c90} = 2,57 f_{c90k} = 2,20N/mm² f_{c90d} = 1,52N/mm²

Limiting Bearing = K_{c90} x Area x f_{c90d}/10 = 13,25kN **Available F_c = 13,25kN**

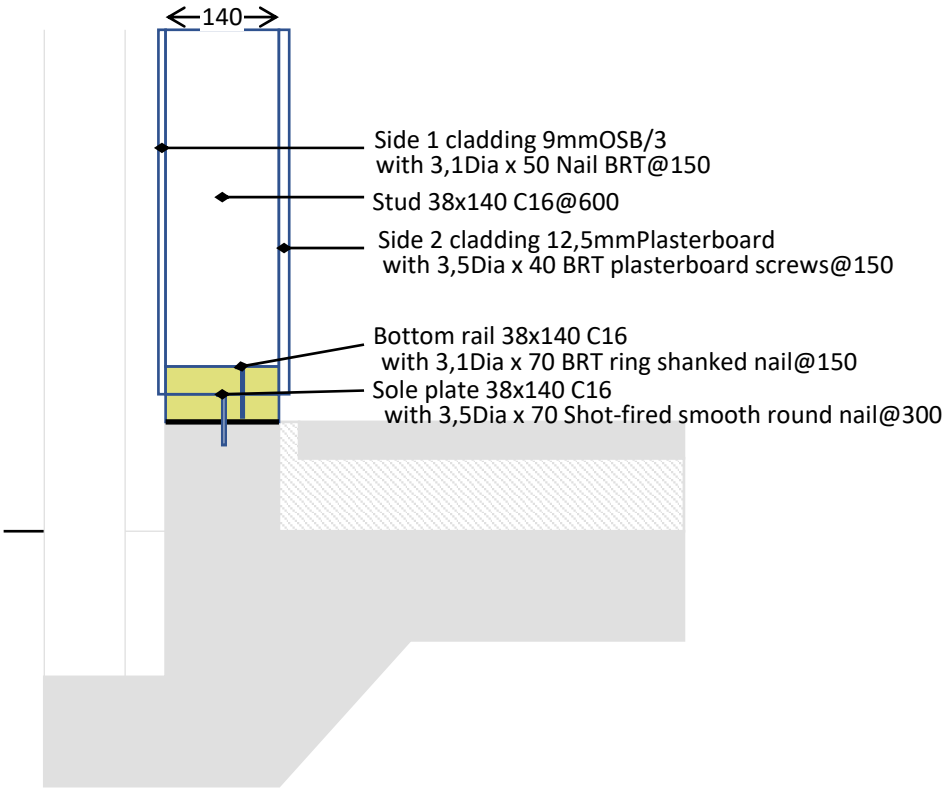
Std-Roof

Stud Ref-1Ext1600

	Storey height = 1,756m	Head binder = 0,038m	Top rail = 0,038m	
		Bottom rail = 0,038m	Sole plate = 0,038m	
	Stud length = 1,604m	Effective length = 1,604m		
	Stud spacing = 0,600m			
	External walls are considered to have wind presssure.			
	Site altitude = 20,m ASL	Map Wind Speed = 25,m/s		
I.S.EN 1991-1	Storey top, z = 24,306m ASL	Altitude Factor, C_{alt} = 1,004		
	Mean Wind Speed,V_m = 25,108m/s	Wind pressure, σ_{wp} = 0,386kN/m²		
	Wind force, F_{wk} = 0,372kN	Shear force, V_{wk} = 0,186kN		
	Design moment, W_{md} = 0,112kN/m²			
	Depth H = 140mm	Breadth B = 38mm	Style = Solid	Class = C16
6.1.6(2)	No off = 1	Area = 53,2cm²	I_{yy} = 868,9cm^4	I_{zz} = 64,0cm^4
	W_{yy} = 124,13cm³	W_{zz} = 33,69cm³	r_{yy} = 4,04cm	r_{zz} = 1,10cm
Table 3.1	k_m = 0,7	k_{sys} = 1,1		
	σ_{myd} = ,90N/mm²	f_{myk} = 16,00N/mm²	Service class = 2	
	Stability in the zz direction is assured by the fixings of the panel to the stud.			
	k_{mod} = 0,9	γ_m = 1,3	f_{myd} = 12,18N/mm²	
	f_{c0d} = 12,95N/mm²			
6.3.2	λ_y = 39,69			
(6.21)	f_{c0k} = 17,00N/mm²	E_{05} = 5360N/mm²	λ_{rely} = 0,712	
	β_c = 0,2	k_y = 0,794		
	k_{cy} = 0,872	Factor = 0,926		
	Limiting σ_{c0d} = 10,449N/mm²	Ultimate F_c = 55,59kN		
	K_{c90} = 2,57	f_{c90k} = 2,20N/mm²	f_{c90d} = 1,52N/mm²	
	Limiting Bearing = K_{c90} x Area x f_{c90d}/10 = 20,85kN	**Available F_c = 20,85kN**		

Fix1

Detail - 12114600150150



Sole plate fasteners

Sub-connection 1 - Bottom rail to sole plate

Detail of fastener -> BRT ring shanked nail 3,1dia x 70@150

Characteristic withdrawal capacity $F_{sp.w.k1}$ = 0,19kN

Characteristic shear capacity $F_{sp.v.k1}$ = 0,83kN

Number of fasteners perpendicular to grain n_{sp1} = 1

Spacing of the fasteners parallel to grain s_{sp1} = 150mm

Sub-connection 2 - Sole plate to foundations

Detail of fastener -> Shot-fired smooth round nail 3,5dia x 70@300

Characteristic withdrawal capacity $F_{sp.w.k1}$ = 0,05kN

Characteristic shear capacity $F_{sp.v.k1}$ = 1,50kN

Number of fasteners perpendicular to grain n_{sp1} = 1

Spacing of the fasteners parallel to grain s_{sp1} = 300mm

Partial Safety factors - EN 1995-1

2.3.1.3 Service class conditions

Racking wall panel SC = 1

Sole plate fixing SCsp = 2

Safety factors – Table NA.A1.2(A/B)

Limit State(EQU and STR)

Permanent favourable actions $\gamma_{G.fav}$ = 1,00

Limit State(STR / GEO)

Variable unfavourable actions $\gamma_{Q.uf.str}$ = 1,50

Material factors – Table NA.3

Sheathing panel $\gamma_{M.sht1}$ = 1,20

Timber in frame $\gamma_{M.frm}$ = 1,30

Connections $\gamma_{M.conn}$ = 1,30

Table 3.1 Modification factors

Timber in the frame $k_{mod.frm}$ = 1,10

Primary sheathing material $k_{mod.sht1}$ = 1,10

Sheathed frame primary side

$k_{mod.wall1}$ = sqrt($k_{mod.frm}$ * $k_{mod.sht1}$) = 1,10

Sole plate shear plane 1 $k_{mod.sp1}$ = 1,10

Sole plate shear plane 2 $k_{mod.sp2}$ = 1,05

Determination of design fastener capacities

Sole plate fixing fasteners

Shear plane 1 - Bottom rail to sole plate

Design withdrawal capacity

$f_{sp.w.d1} = F_{sp.w.k1} \times k_{mod.sp1} \times n_{sp1} / (s_{sp1} \times \gamma_{M.conn})$ = 1,07kN/m

Design lateral load capacity

$f_{sp.v.d1} = F_{sp.v.k1} \times k_{mod.sp1} \times n_{sp1} / (s_{sp1} \times \gamma_{M.conn})$ = 4,68kN/m

Shear plane 2 - Sole plate to foundation

Design withdrawal capacity

Sole plate shear plane 2; $k_{mod.sp2}$ = 1,05

$f_{sp.w.d2} = F_{sp.w.k2} \times k_{mod.sp2} \times n_{sp2} / (s_{sp2} \times \gamma_{M.conn})$ = 0,13kN/m

Design lateral load capacity

$f_{sp.v.d2} = F_{sp.v.k2} \times k_{mod.sp2} \times n_{sp2} / (s_{sp2} \times \gamma_{M.conn})$ = 4,04kN/m

Minimum design withdrawal capacity; $f_{sp.w.d}$ = 0,13kN/m

Minimum design lateral load capacity; $f_{sp.v.d}$ = 4,04kN/m

Primary sheathing to frame - Side 1

Nail diameter; d_{n1} = 3,1mm

Nail head diameter; h_{n1} = 6,2mm

Nail length; l_{n1} = 50mm

Nail Profile Round nails

Headside penetration; t_{s1} = 9mm

Pointside penetration; $t_2 = l_{n1} - t_{s1}$ = 41mm

8.3.2(7) Pointside penetration factor; D_{ps} = 1

8.3.1.3(3) Embedment strength in panel; $f_{h.k.hs1}$ = 36,68N/mm²

8.3.1.1(5) Embedment strength in timber; $f_{h.k.ps1}$ = 18,10N/mm²

Ratio between embedment strengths; B_1 = 0,49

8.3.2(4) Characteristic withdrawal in panel; $f_{ax.k.hs1}$ = 5.30N/mm²

8.3.2(6) Characteristic withdrawal in timber; $f_{ax.k.ps1}$ = 1,92N/mm²

Characteristic pull-through in panel; $f_{head.k1}$ = 18,57N/mm²

Characteristic withdrawal capacity; $F_{ax.Rk1}$ = 244N

Characteristic nail yield moment; $M_{y.Rk1}$ = 3 979Nmm

Load-carrying capacity of connection

8.2.2(2) Maximum rope effect contribution; N_{Pro1} = 15%

Failure mode (a) $F_{m.a1}$ = 1,02kN

Failure mode (b) $F_{m.b1}$ = 2,30kN

Failure mode (c) $F_{m.c1}$ = 0,85kN

Failure mode (d) $F_{m.d1}$ = 0,61kN

Failure mode (e) $F_{m.e1}$ = 1,01kN

Failure mode (f) $F_{m.f1}$ = 0,90kN

Characteristic lateral nail shear resistance; $F_{v,Rk1}$ = 0,61kN

Failure Mode is (d)

Fastener spacing; s_1 = 150mm

Design lateral carrying capacity; $F_{v.Rd1}$ = 0,52kN

BS PD 20.5.2.4 Design shear for unit length; $f_{p.d1}$ = 5,72kN/m

Secondary sheathing to frame - Side 2

The sheathing to side 2 is plasterboard specified as follows:-

12,5 mm plasterboard fixed to one side of timber framing using plasterboard screws of 3,5 mm shank diameter at 300 mm spacing and penetrating at least 25 mm into timber framing.

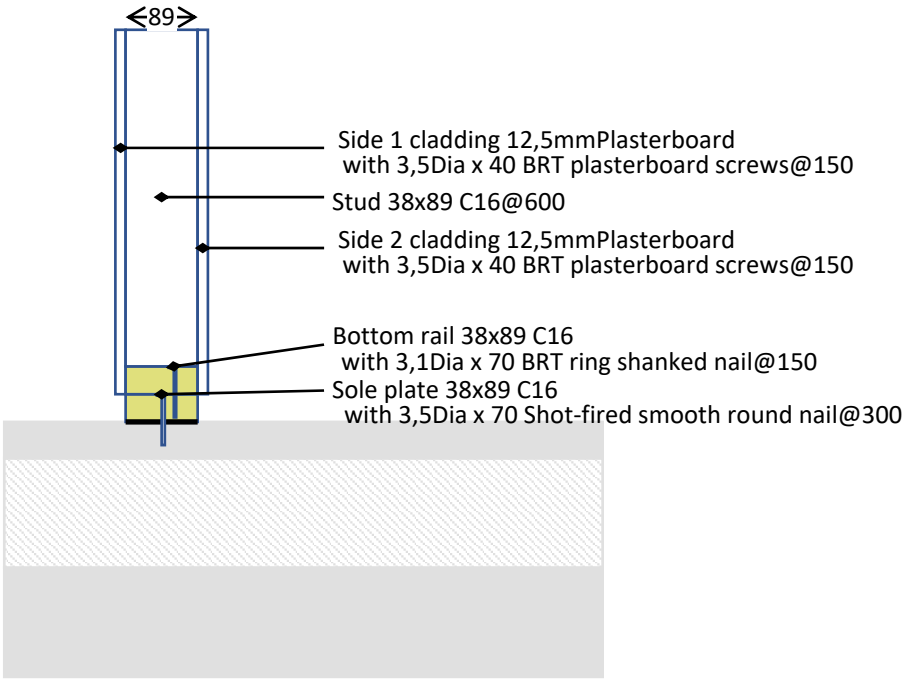
from table 7 of BS PD 6693-1:2019, the $f_{p.d.t}$ is 1,27kN/m

The plasterboard sheathing one side has no structural value in this design.

Total design shear capacity of perimeter fasteners; $f_{p.d.t}$ = 5,72kN/m

Fix2

Detail - 21144600150150



Sole plate fasteners

Sub-connection 1 - Bottom rail to sole plate

Detail of fastener -> BRT ring shanked nail 3,1dia x 70@150

Characteristic withdrawal capacity $F_{sp.w.k1}$ = 0,19kN

Characteristic shear capacity $F_{sp.v.k1}$ = 0,83kN

Number of fasteners perpendicular to grain n_{sp1} = 1

Spacing of the fasteners parallel to grain s_{sp1} = 150mm

Sub-connection 2 - Sole plate to foundations

Detail of fastener -> Shot-fired smooth round nail 3,5dia x 70@300

Characteristic withdrawal capacity $F_{sp.w.k1}$ = 0,05kN

Characteristic shear capacity $F_{sp.v.k1}$ = 1,50kN

Number of fasteners perpendicular to grain n_{sp1} = 1

Spacing of the fasteners parallel to grain s_{sp1} = 300mm

Partial Safety factors - EN 1995-1

2.3.1.3 Service class conditions

Racking wall panel SC = 1

Sole plate fixing SCsp = 2

Safety factors – Table NA.A1.2(A/B)

Limit State(EQU and STR)

Permanent favourable actions $\gamma_{G.fav}$ = 1,00

Limit State(STR / GEO)

Variable unfavourable actions $\gamma_{Q.uf.str}$ = 1,50

Material factors – Table NA.3

Sheathing panel $\gamma_{M.sht1}$ = 1,20

Timber in frame $\gamma_{M.frm}$ = 1,30

Connections $\gamma_{M.conn}$ = 1,30

Table 3.1 Modification factors

Timber in the frame $k_{mod.frm}$ = 1,10

Primary sheathing material $k_{mod.sht1}$ = 1,10

Sheathed frame primary side

$k_{mod.wall1}$ = sqrt($k_{mod.frm}$ * $k_{mod.sht1}$) = 1,10

Sole plate shear plane 1 $k_{mod.sp1}$ = 1,10

Sole plate shear plane 2 $k_{mod.sp2}$ = 1,05

Determination of design fastener capacities

Sole plate fixing fasteners

Shear plane 1 - Bottom rail to sole plate

Design withdrawal capacity

$f_{sp.w.d1} = F_{sp.w.k1} \times k_{mod.sp1} \times n_{sp1} / (s_{sp1} \times \gamma_{M.conn})$ = 1,07kN/m

Design lateral load capacity

$f_{sp.v.d1} = F_{sp.v.k1} \times k_{mod.sp1} \times n_{sp1} / (s_{sp1} \times \gamma_{M.conn})$ = 4,68kN/m

Shear plane 2 - Sole plate to foundation

Design withdrawal capacity

Sole plate shear plane 2; $k_{mod.sp2}$ = 1,05

$f_{sp.w.d2} = F_{sp.w.k2} \times k_{mod.sp2} \times n_{sp2} / (s_{sp2} \times \gamma_{M.conn})$ = 0,13kN/m

Design lateral load capacity

$f_{sp.v.d2} = F_{sp.v.k2} \times k_{mod.sp2} \times n_{sp2} / (s_{sp2} \times \gamma_{M.conn})$ = 4,04kN/m

Minimum design withdrawal capacity; $f_{sp.w.d}$ = 0,13kN/m

Minimum design lateral load capacity; $f_{sp.v.d}$ = 4,04kN/m

Primary sheathing to frame - Side 1

The sheathing to side 1 is plasterboard specified as follows:-

12,5 mm plasterboard fixed to one side of timber framing using plasterboard screws of 3,5 mm shank diameter at 300 mm spacing and penetrating at least 25 mm into timber framing.

from table 7 of BS PD 6693-1:2019, the $f_{p.d.t}$ is 1,27kN/m

Secondary sheathing to frame - Side 2

The sheathing to side 2 is plasterboard specified as follows:-

12,5 mm plasterboard fixed to both sides of timber framing using plasterboard screws of 3,5 mm shank diameter at 300 mm spacing and penetrating at least 25 mm into timber framing.

from table 7 of BS PD 6693-1:2019, the $f_{p.d.t}$ is 1,27kN/m

The sheathing to each side is the same in type, fixing style and spacing, hence the value of second side is factored in this design.

Total design shear capacity of perimeter fasteners; $f_{p.d.t}$ = 2,22kN/m

Site Wind Design

Refer to I.S. EN 1991-1-4:2005 Location Athlone

Wind speed velocity (Figure NA.1) $v_{b,map}$ = 25m/s

Altitude above sea level A_{alt} = 20m

Orography factor not significant c_o = 1.0

Terrain category is Town

Building Data

Type of roof is Duopitch

At this level the Length of building L = 14,515m

Width of building W = 12,936m

Height to eaves H = 2,550m

Pitch of roof a° = 25,0°

Total height h = 4,531m

Building Levels

					Wind 0		Wind 90	
Ref	**Name**	**AOD**	**Ht**	**Base**	**Hor**	**Vert**	**Hor**	**Vert**
Roof	Roof Level	22 550	1 756	4 531	3,76	3,76	3,76	3,76
Grnd	Ground Floo	20 150	2 400	2 550	3,76	0,00	3,76	0,00
				Design force	7,52		7,52	
				Wind centre is at	7,258m		6,468m	
				Shear centre is at	7,124m		6,604m	
				Lever arm effect	0,134m		-0,136m	
					1,004kNm		-1,019kNm	

Walls - Horizontal forces

Ref	*Level*	*Strength*	*Dir Y*	*Dir X*	*Fdy (kN)*	*Fdx (kN)*
1	Grnd	30,016	1,000		2,002	
2	Grnd	12,577		1,000		1,083
3	Grnd	10,913	1,000		0,983	
4	Grnd	8,750		1,000		0,696
5	Grnd	7,951	-1,000		0,716	
6	Grnd	33,028		1,000		2,600
7	Grnd	42,852	-1,000		2,858	
8	Grnd	19,458		-1,000		1,624
9	Grnd	11,504	-1,000		1,022	
10	Grnd	8,750		-1,000		0,631
11	Grnd	10,745	1,000		0,955	
12	Grnd	23,185		-1,000		1,887
				Totals	8,54kN	8,52kN

Trusses - Vertical forces

Total plan area of roof is 160,51m²

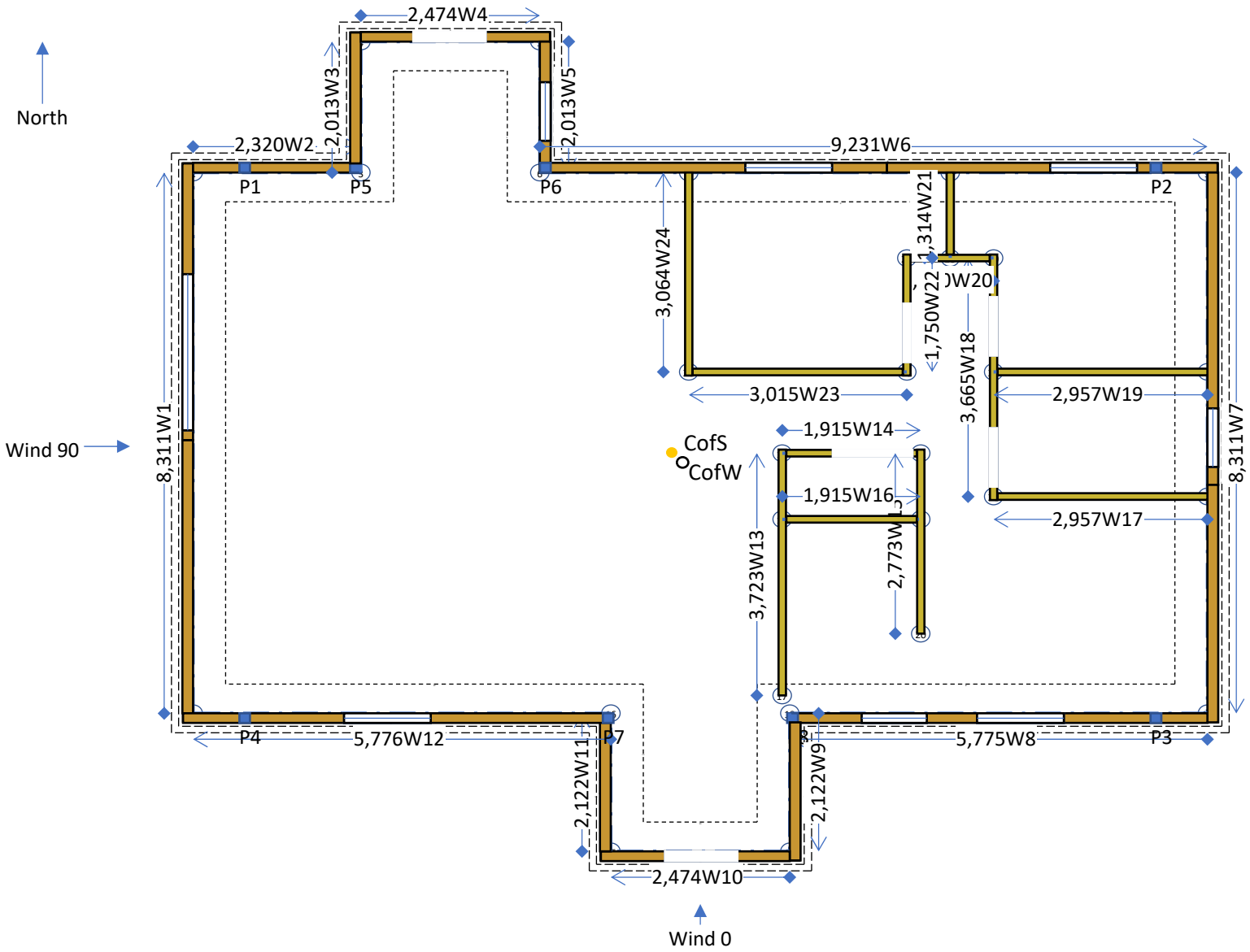
Maximum unit uplift is 0,02kN/m²

Unit permanent roof load is 0,65kN/m² and variable roof load is 0,75kN/m²

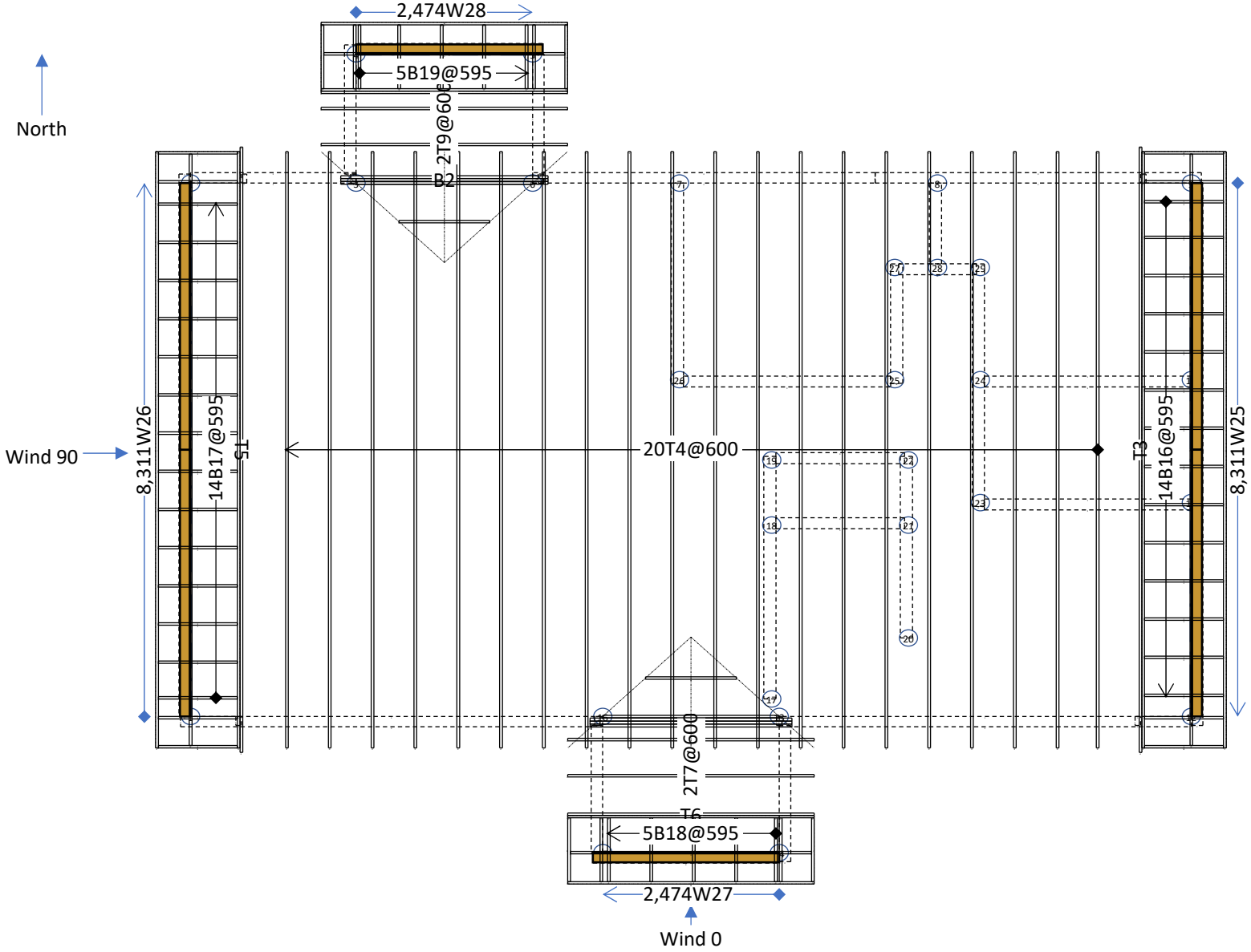
Ref	**Length**	**Spacing**	**Area**	**No.**	**Gk**	**Qk**	**Wk**
B1	2,83m	1,00m	2,83m²		0,74kN	0,75kN	0,07kN
B2	2,91m	2,00m	5,81m²		1,41kN	1,50kN	0,14kN
T3	9,43m	0,30m	2,83m²		3,12kN	3,11kN	0,07kN
T4	9,29m	0,60m	5,57m²	19	4,00kN	4,18kN	0,13kN
T5	9,43m	0,30m	2,83m²		3,12kN	3,11kN	0,07kN
T6	3,45m	0,30m	1,04m²		0,93kN	0,95kN	0,02kN
T7	3,45m	0,60m	2,07m²	2	1,45kN	1,55kN	0,05kN

T8	3,45m	0,30m	1,04m²		0,93kN	0,95kN	0,02kN
T9	3,45m	0,60m	2,07m²	2	1,45kN	1,55kN	0,05kN
B16	1,11m	0,59m	0,66m²	14	0,40kN	0,45kN	0,02kN
B17	1,11m	0,59m	0,66m²	14	0,40kN	0,45kN	0,02kN
B18	1,00m	0,59m	0,59m²	5	0,40kN	0,45kN	0,01kN
B19	0,99m	0,59m	0,59m²	5	0,40kN	0,45kN	0,01kN

Plan of Ground Floor



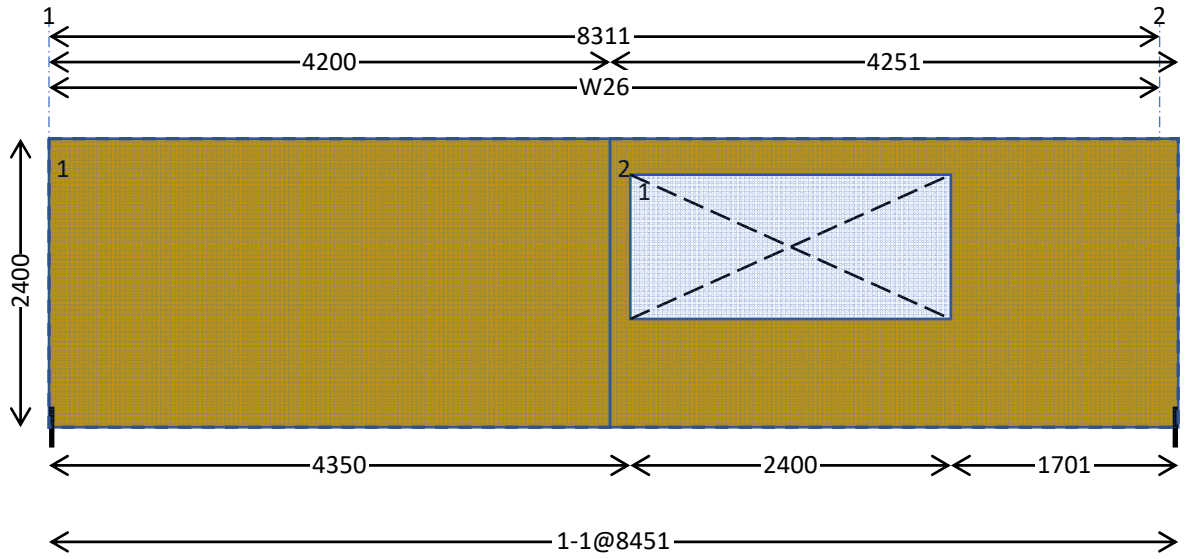
Plan of Roof Level



Wall List

Ref	E1	E2	Style	Fr	Fd	Ur
1	1	2	Ext	30,016	2,002	0,067
2	2	3	Ext	12,577	1,083	0,086
3	3	4	Ext	10,913	0,983	0,090
4	4	5	Ext	8,750	0,696	0,080
5	5	6	Ext	7,951	0,716	0,090
6	6	9	Ext	33,028	2,600	0,079
7	9	12	Ext	42,852	2,858	0,067
8	12	13	Ext	19,458	1,624	0,083
9	13	14	Ext	11,504	1,022	0,089
10	14	15	Ext	8,750	0,631	0,072
11	15	16	Ext	10,745	0,955	0,089
12	16	1	Ext	23,185	1,887	0,081
13	17	19	Int	0,000	0,000	0,000
14	19	22	Int	0,000	0,000	0,000
15	20	22	Int	0,000	0,000	0,000
16	18	21	Int	0,000	0,000	0,000
17	11	23	Int	0,000	0,000	0,000
18	23	29	Int	0,000	0,000	0,000
19	10	24	Int	0,000	0,000	0,000
20	29	27	Int	0,000	0,000	0,000
21	28	8	Int	0,000	0,000	0,000
22	27	25	Int	0,000	0,000	0,000
23	25	26	Int	0,000	0,000	0,000
24	26	7	Int	0,000	0,000	0,000
25	9	12	Ext	51,017	0,000	0,000
26	1	2	Ext	51,017	0,000	0,000
27	14	15	Ext	16,046	0,000	0,000
28	4	5	Ext	16,046	0,000	0,000

Wall - 1



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	8 451mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
1	2400	1200	4350	900	2,88	FALSE
				Total area A_t =	2,88	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Design loads acting on wall

W26 -> is supported by this wall

There are no additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
26-1	Group loads	0,000m	2,400kN	0,713kN	0,379kN	8,311m	

Max design top load is at '26-1' = 2,89kN <= 20,85kN

Min design top load is at '26-1' = 1,78kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 0,28kN/m

Characteristic variable udl q_k = 0,08kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,04kN/m

Design horizontal wind load $F_{W.d}$ = 2,00kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 1-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,284

Opening factor; $K_{opening} = 1 - 1{,}9p$ = 0,46

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1{,}1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 206,6kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 206,6kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 13,48kN

Resulting force at top from tie down; F_{hRd} = 16,53kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 30,02kN

Wall 1 has a horizontal resistance of 30,02kN;

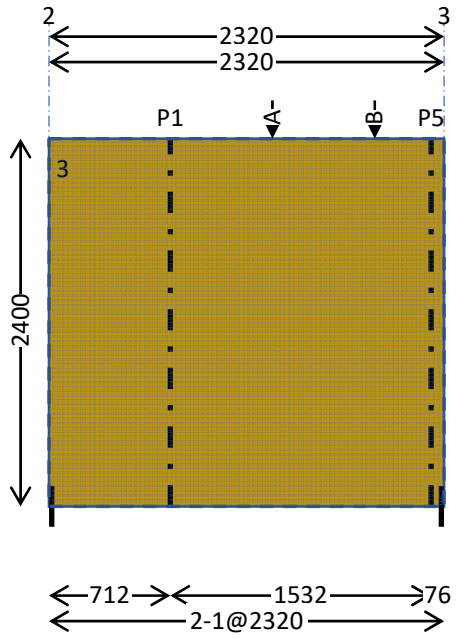
the required design force is 2,00kN

The utilisation factor U = 0,07; and passes the rule for this structural element.

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	1-1	0,000m	2,400kN	0,000kN	0,000kN	4,350m
2	Op1-R1	4,350m	0,360kN	0,000kN	0,000kN	
3	Ope 1 sill	4,350m	0,900kN	0,000kN	0,000kN	2,400m
4	Op1-R2	6,750m	0,360kN	0,000kN	0,000kN	
5	1-3	6,750m	2,400kN	0,000kN	0,000kN	8,451m

Wall - 2



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	2 320mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Post or Columns

Ref	At(m)	Timber	Gk (kN)	Qk (kN)	Wk (kN)	UV (kN)

P1	0,712	2No 38 x 140 C16	1,566	1,563	0,831	5,705
P5	2,244	2No 38 x 140 C16	3,797	4,004	2,128	14,325

Design loads acting on wall

There are no walls supported by this wall

There are 2 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
B	T4 R2	1,913m	2,002kN	2,090kN	1,111kN		
A	T4 R2	1,313m	2,002kN	2,090kN	1,111kN		

Max design top load is at 'T4' = 7,34kN <= 20,85kN

Min design top load is at 'T4' = 3,67kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 1,73kN/m

Characteristic variable udl q_k = 1,80kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,96kN/m

Design horizontal wind load $F_{W.d}$ = 1,08kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 2-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 17,2kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 17,2kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t}L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening}K_{iw}f_{pdt}L$ = 8,04kN

Resulting force at top from tie down; F_{hRd} = 4,54kN

Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 12,58kN

Post or Columns

Ref	At(m)	Timber	Gk (kN)	Qk (kN)	Wk (kN)	UV (kN)
P1	0,712	2No 38 x 140 C16	1,566	1,563	0,831	5,705
P5	2,244	2No 38 x 140 C16	3,797	4,004	2,128	14,325

Wall Resist

Wall 2 has a horizontal resistance of 12,58kN;

the required design force is 1,08kN

The utilisation factor U = 0,09; and passes the rule for this structural element.

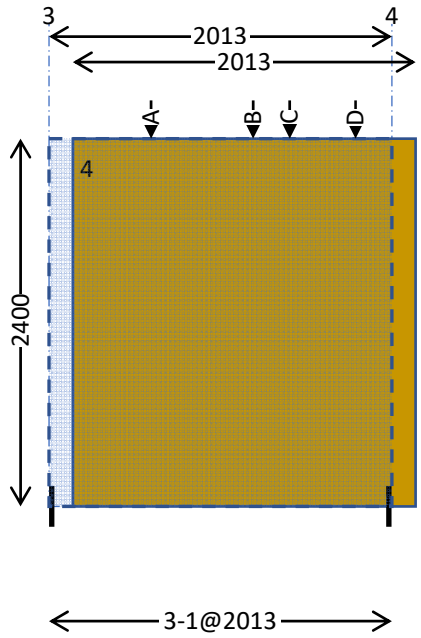
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	2-1 Group I	0,000m	4,126kN	1,802kN	0,958kN	2,320m
2	P1	0,713m	1,566kN	1,563kN	0,831kN	
3	P5	2,244m	3,797kN	4,004kN	2,128kN	

Note

1 +T4R2+T4R2

Wall - 3



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	2 013mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 4 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
D	T9 R1	1,800m	0,725kN	0,777kN	0,413kN		
C	T8 R1	1,413m	0,464kN	0,473kN	0,251kN		
B	T9 R1	1,200m	0,725kN	0,777kN	0,413kN		
A	T9 R1	0,600m	0,725kN	0,777kN	0,413kN		

Max design top load is at 'T9' = 2,70kN <= 20,85kN

Min design top load is at 'T8' = 0,84kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 1,31kN/m

Characteristic variable udl q_k = 1,39kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,74kN/m

Design horizontal wind load $F_{W.d}$ = 0,98kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 3-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1{,}9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1{,}1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 7,5kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 7,5kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 6,97kN

Resulting force at top from tie down; F_{hRd} = 3,94kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 10,91kN

Wall 3 has a horizontal resistance of 10,91kN;

the required design force is 0,98kN

The utilisation factor U = 0,09; and passes the rule for this structural element.

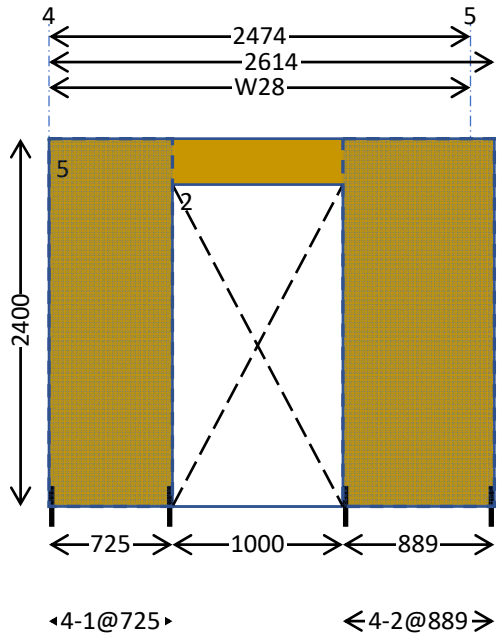
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	3-1 Group I	0,000m	3,711kN	1,393kN	0,740kN	2,013m

Note

1 +T8R1+T9R1+T9R1+T9R1

Wall - 4



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	2 614mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
2	1000	2100	725	0	2,10	TRUE
				Total area A_t =	2,10	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Design loads acting on wall

W28 -> is supported by this wall

There are no additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
28-1	Group loads	0,000m	2,465kN	0,785kN	0,417kN	2,614m	

Max design top load is at '28-1' = 3,04kN <= 20,85kN

Min design top load is at '28-1' = 1,85kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 0,94kN/m

Characteristic variable udl q_k = 0,30kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,16kN/m

Design horizontal wind load $F_{W.d}$ = 0,70kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There are 2 diapraghams on this wall

Diaphragm referenced 4-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 0,7kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 0,7kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 2,51kN

Resulting force at top from tie down; F_{hRd} = 1,42kN

Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 3,93kN

Diaphragm referenced 4-2->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 1,0kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 1,0kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 3,08kN

Resulting force at top from tie down; F_{hRd} = 1,74kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 4,82kN

Wall 4 has a horizontal resistance of 8,75kN;

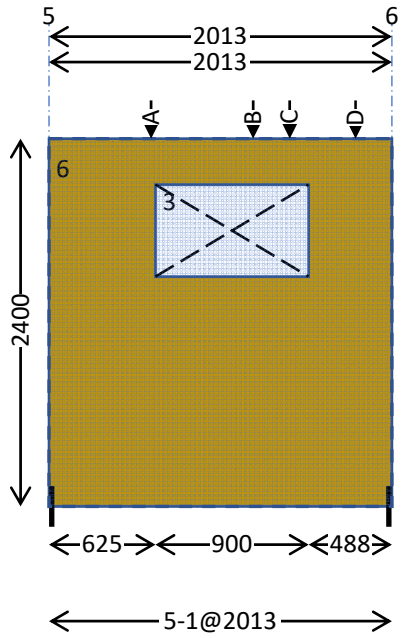
the required design force is 0,70kN

The utilisation factor U = 0,08; and passes the rule for this structural element.

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	4-1	0,000m	2,400kN	0,000kN	0,000kN	0,725m
2	Op2-R1	0,725m	0,150kN	0,000kN	0,000kN	
3	Op2-R2	1,725m	0,150kN	0,000kN	0,000kN	
4	4-3	1,725m	2,400kN	0,000kN	0,000kN	2,614m

Wall - 5



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	2 013mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
3	900	600	625	1500	,54	FALSE
				Total area A_t =	,54	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 4 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
D	T9 R2	1,800m	0,725kN	0,777kN	0,413kN		
C	T8 R2	1,413m	0,464kN	0,473kN	0,251kN		
B	T9 R2	1,200m	0,725kN	0,777kN	0,413kN		
A	T9 R2	0,600m	0,725kN	0,777kN	0,413kN		

Max design top load is at 'T9' = 2,70kN <= 20,85kN

Min design top load is at 'T8' = 0,84kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 1,31kN/m

Characteristic variable udl q_k = 1,39kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,74kN/m

Design horizontal wind load $F_{W.d}$ = 0,72kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 5-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,224

Opening factor; $K_{opening} = 1 - 1{,}9p$ = 0,58

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1{,}1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 17,3kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 17,3kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t}L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening}K_{iw}f_{pdt}L$ = 4,01kN

Resulting force at top from tie down; F_{hRd} = 3,94kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 7,95kN

Wall 5 has a horizontal resistance of 7,95kN;

the required design force is 0,72kN

The utilisation factor U = 0,09; and passes the rule for this structural element.

Base Loads

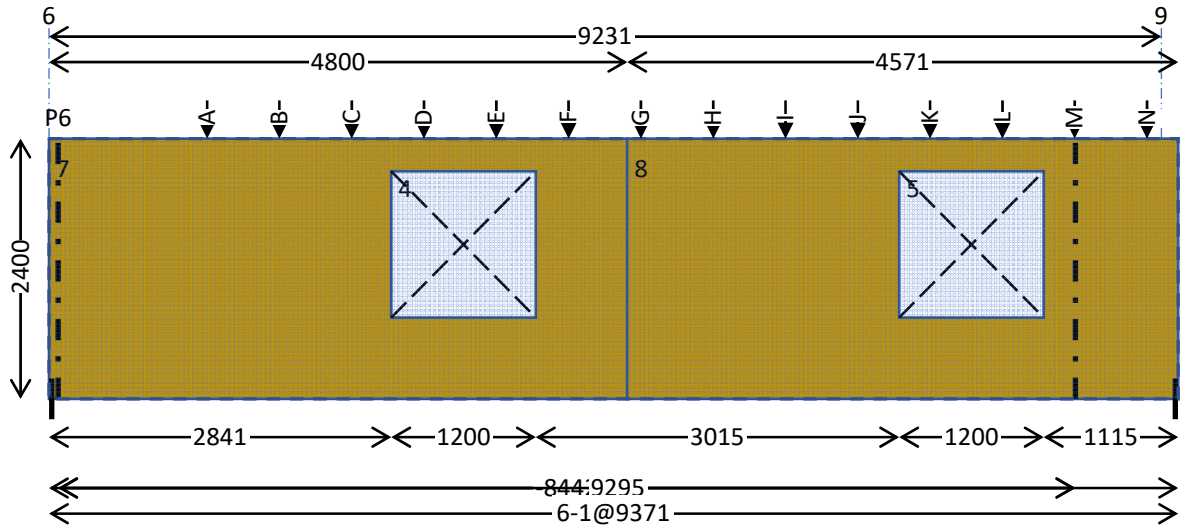
Ref	Source	at	Gk	Qk	Wk	L
1	5-1 Group I	0,000m	3,560kN	1,243kN	0,661kN	0,625m
2	Op3-R1	0,625m	0,454kN	0,339kN	0,180kN	
3	Ope 3 sill	0,625m	1,500kN	0,000kN	0,000kN	0,900m
4	Op3-R2	1,525m	1,004kN	0,910kN	0,484kN	
5	5-3 Group I	1,525m	2,760kN	0,386kN	0,205kN	2,013m

Note

1 +T9R2

5 +T9R2

Wall - 6



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	9 371mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
4	1200	1350	2841	750	1,62	FALSE
5	1200	1350	7056	750	1,62	FALSE
				Total area A_t =	3,24	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Post or Columns

Ref	At(m)	Timber	Gk (kN)	Qk (kN)	Wk (kN)	UV (kN)
P2	8,519	2No 38 x 140 C16	1,551	1,547	0,822	5,647
P6	0,076	2No 38 x 140 C16	6,304	6,626	6,273	27,859

Design loads acting on wall

There are no walls supported by this wall

There are 14 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
N	T4 R2	9,112m	2,002kN	2,090kN	1,111kN		
M	T4 R2	8,512m	2,002kN	2,090kN	1,111kN		
L	T4 R2	7,912m	2,002kN	2,090kN	1,111kN		
K	T4 R2	7,313m	2,002kN	2,090kN	1,111kN		
J	T4 R2	6,713m	2,002kN	2,090kN	1,111kN		
I	T4 R2	6,113m	2,002kN	2,090kN	1,111kN		
H	T4 R2	5,512m	2,002kN	2,090kN	1,111kN		
G	T4 R2	4,913m	2,002kN	2,090kN	1,111kN		
F	T4 R2	4,313m	2,002kN	2,090kN	1,111kN		
E	T4 R2	3,713m	2,002kN	2,090kN	1,111kN		
D	T4 R2	3,113m	2,002kN	2,090kN	1,111kN		
C	T4 R2	2,513m	2,002kN	2,090kN	1,111kN		
B	T4 R2	1,913m	2,002kN	2,090kN	1,111kN		
A	T4 R2	1,313m	2,002kN	2,090kN	1,111kN		

Max design top load is at 'T4' = 7,34kN <= 20,85kN

Min design top load is at 'T4' = 3,67kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 2,99kN/m

Characteristic variable udl q_k = 3,12kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 1,66kN/m

Design horizontal wind load $F_{W.d}$ = 2,60kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 6-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,288

Opening factor; $K_{opening} = 1 - 1{,}9p$ = 0,45

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1{,}1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 274,1kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 274,1kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 14,69kN

Resulting force at top from tie down; F_{hRd} = 18,33kN

Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 33,03kN

Post or Columns

	Ref	At(m)	Timber	Gk (kN)	Qk (kN)	Wk (kN)	UV (kN)
	P2	8,519	2No 38 x 140 C16	1,551	1,547	0,822	5,647
Wall Resist	P6	0,076	2No 38 x 140 C16	6,304	6,626	6,273	27,859

Wall 6 has a horizontal resistance of 33,03kN;
the required design force is 2,60kN

The utilisation factor U = 0,08; and passes the rule for this structural element.

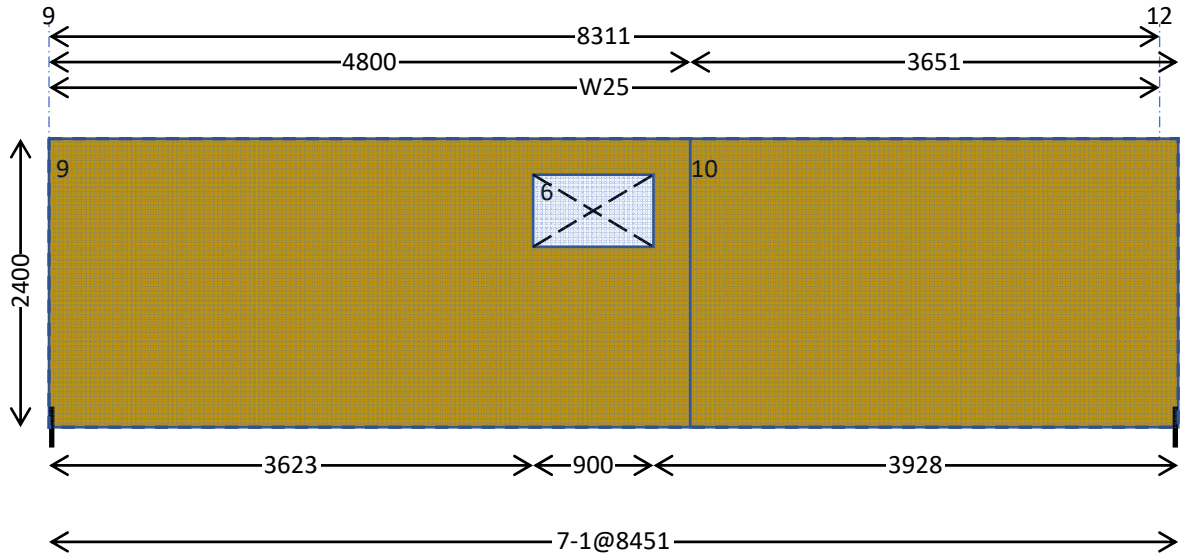
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	6-1 Group I	0,000m	5,391kN	3,123kN	1,660kN	9,371m
2	P6	0,076m	6,304kN	6,626kN	6,273kN	
3	P2	8,519m	1,551kN	1,547kN	0,822kN	

Note

1 Stud strength should increase to 3,898xStud!

Wall - 7



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	8 451mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
6	900	600	3623	1500	,54	FALSE
				Total area A_t =	,54	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Design loads acting on wall

W25 -> is supported by this wall

There are no additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
25-1	Group loads	0,000m	2,400kN	0,713kN	0,379kN	8,311m	

Max design top load is at '25-1' = 2,89kN <= 20,85kN

Min design top load is at '25-1' = 1,78kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 0,28kN/m

Characteristic variable udl q_k = 0,08kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,04kN/m

Design horizontal wind load $F_{W.d}$ = 2,86kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 7-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,053

Opening factor; $K_{opening} = 1 - 1{,}9p$ = 0,90

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1{,}1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 226,1kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 226,1kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 26,32kN

Resulting force at top from tie down; F_{hRd} = 16,53kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 42,85kN

Wall 7 has a horizontal resistance of 42,85kN;

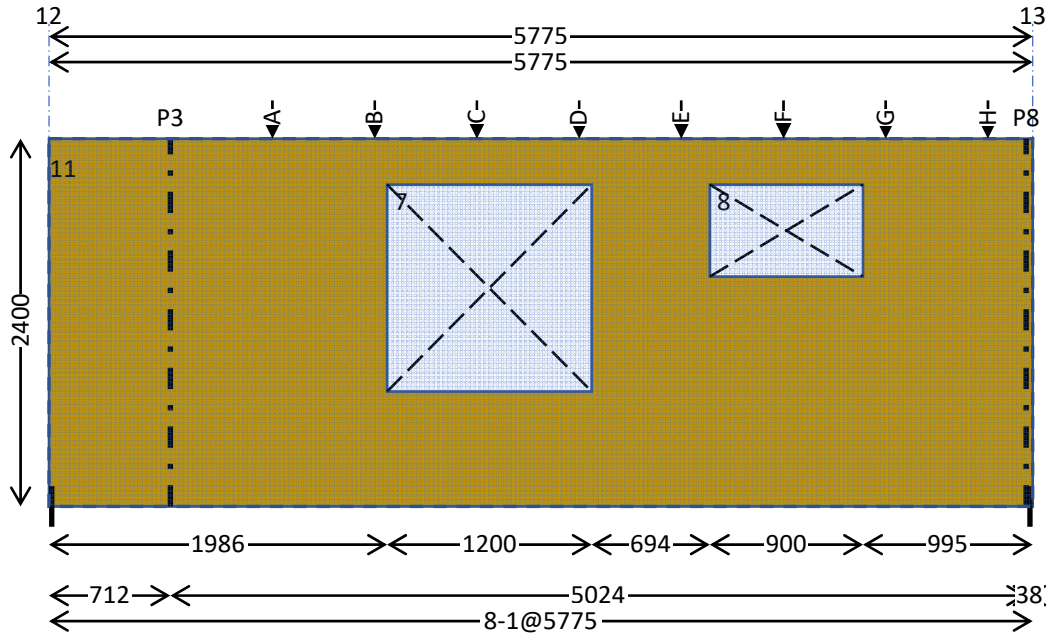
the required design force is 2,86kN

The utilisation factor U = 0,07; and passes the rule for this structural element.

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	7-1	0,000m	2,400kN	0,000kN	0,000kN	3,623m
2	Op6-R1	3,623m	0,135kN	0,000kN	0,000kN	
3	Ope 6 sill	3,623m	1,500kN	0,000kN	0,000kN	0,900m
4	Op6-R2	4,523m	0,135kN	0,000kN	0,000kN	
5	7-3	4,523m	2,400kN	0,000kN	0,000kN	8,451m

Wall - 8



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	5 775mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
7	1200	1350	1986	750	1,62	FALSE
8	900	600	3880	1500	,54	FALSE
				Total area A_t =	2,16	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Post or Columns

Ref	At(m)	Timber	Gk (kN)	Qk (kN)	Wk (kN)	UV (kN)
P3	0,712	2No 38 x 140 C16	1,566	1,563	0,831	5,705
P8	5,737	2No 38 x 140 C16	5,375	5,575	5,770	24,274

Design loads acting on wall

There are no walls supported by this wall

There are 8 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
H	T4 R1	5,513m	2,002kN	2,090kN	1,111kN		
G	T4 R1	4,912m	2,002kN	2,090kN	1,111kN		
F	T4 R1	4,313m	2,002kN	2,090kN	1,111kN		
E	T4 R1	3,713m	2,002kN	2,090kN	1,111kN		
D	T4 R1	3,113m	2,002kN	2,090kN	1,111kN		
C	T4 R1	2,513m	2,002kN	2,090kN	1,111kN		
B	T4 R1	1,913m	2,002kN	2,090kN	1,111kN		
A	T4 R1	1,313m	2,002kN	2,090kN	1,111kN		

Max design top load is at 'T4' = 7,34kN <= 20,85kN

Min design top load is at 'T4' = 3,67kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 2,77kN/m

Characteristic variable udl q_k = 2,90kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 1,54kN/m

Design horizontal wind load $F_{W.d}$ = 1,62kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 8-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,312

Opening factor; $K_{opening} = 1 - 1{,}9p$ = 0,41

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1{,}1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 106,8kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 106,8kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t}L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening}K_{iw}f_{pdt}L$ = 8,16kN

Resulting force at top from tie down; F_{hRd} = 11,30kN

Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 19,46kN

Post or Columns

Ref	At(m)	Timber	Gk (kN)	Qk (kN)	Wk (kN)	UV (kN)
P3	0,712	2No 38 x 140 C16	1,566	1,563	0,831	5,705
P8	5,737	2No 38 x 140 C16	5,375	5,575	5,770	24,274

Wall Resist

Wall 8 has a horizontal resistance of 19,46kN;

the required design force is 1,62kN

The utilisation factor U = 0,08; and passes the rule for this structural element.

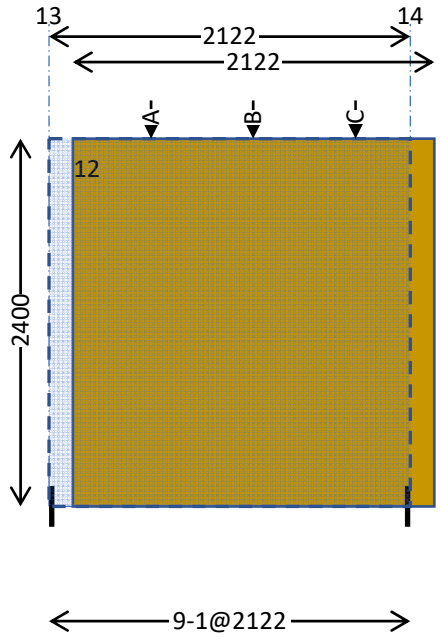
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	8-1 Group I	0,000m	5,173kN	2,896kN	1,539kN	5,775m
2	P3	0,713m	1,566kN	1,563kN	0,831kN	
3	P8	5,737m	5,375kN	5,575kN	5,770kN	

Note

1 Stud strength should increase to 2,267xStud!

Wall - 9



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	2 122mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 3 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
C	T7 R2	1,800m	0,725kN	0,777kN	0,413kN		
B	T7 R2	1,200m	0,725kN	0,777kN	0,413kN		
A	T6 R2	0,600m	0,464kN	0,473kN	0,251kN		

Max design top load is at 'T7' = 2,70kN <= 20,85kN

Min design top load is at 'T6' = 0,84kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 0,90kN/m

Characteristic variable udl q_k = 0,96kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,51kN/m

Design horizontal wind load $F_{W.d}$ = 1,02kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 9-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 7,4kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 7,4kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 7,35kN

Resulting force at top from tie down; F_{hRd} = 4,15kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 11,50kN

Wall 9 has a horizontal resistance of 11,50kN;

the required design force is 1,02kN

The utilisation factor U = 0,09; and passes the rule for this structural element.

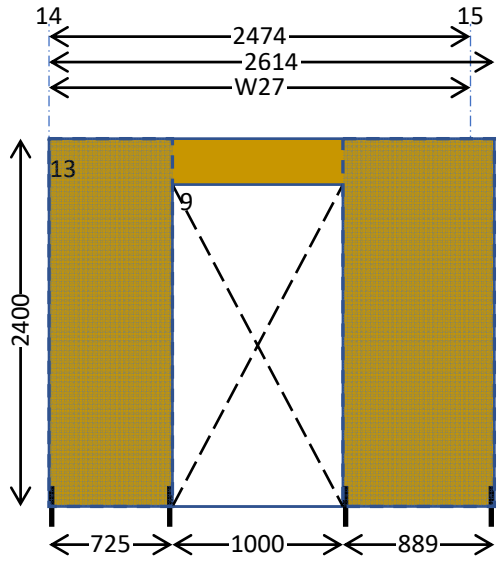
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	9-1 Group I	0,000m	3,302kN	0,955kN	0,508kN	2,122m

Note

1 +T6R2+T7R2+T7R2

Wall - 10



10-1@725 10-2@889

This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	2 614mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
9	1000	2100	725	0	2,10	TRUE
				Total area A_t =	2,10	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Design loads acting on wall

W27 -> is supported by this wall

There are no additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
27-1	Group loads	0,000m	2,465kN	0,785kN	0,417kN	2,614m	

Max design top load is at '27-1' = 3,04kN <= 20,85kN

Min design top load is at '27-1' = 1,85kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 0,94kN/m

Characteristic variable udl q_k = 0,30kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,16kN/m

Design horizontal wind load $F_{W.d}$ = 0,63kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There are 2 diapraghams on this wall

Diaphragm referenced 10-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 0,7kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 0,7kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 2,51kN

Resulting force at top from tie down; F_{hRd} = 1,42kN

Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 3,93kN

Diaphragm referenced 10-2->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 1,0kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 1,0kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 3,08kN

Resulting force at top from tie down; F_{hRd} = 1,74kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 4,82kN

Wall 10 has a horizontal resistance of 8,75kN;

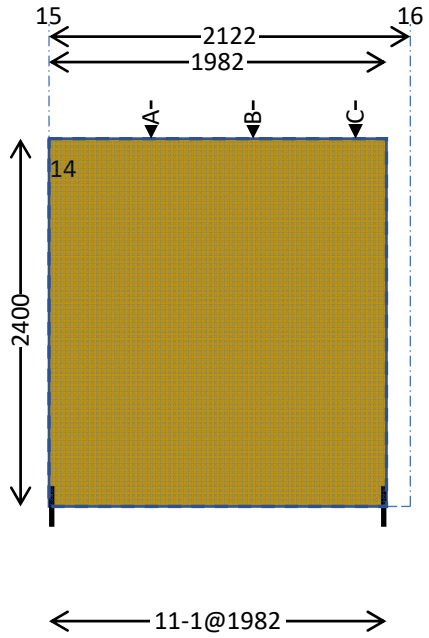
the required design force is 0,63kN

The utilisation factor U = 0,07; and passes the rule for this structural element.

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	10-1	0,000m	2,400kN	0,000kN	0,000kN	0,725m
2	Op9-R1	0,725m	0,150kN	0,000kN	0,000kN	
3	Op9-R2	1,725m	0,150kN	0,000kN	0,000kN	
4	10-3	1,725m	2,400kN	0,000kN	0,000kN	2,614m

Wall - 11



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	1 982mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 3 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
C	T7 R1	1,800m	0,725kN	0,777kN	0,413kN		
B	T7 R1	1,200m	0,725kN	0,777kN	0,413kN		
A	T6 R1	0,600m	0,464kN	0,473kN	0,251kN		

Max design top load is at 'T7' = 2,70kN <= 20,85kN

Min design top load is at 'T6' = 0,84kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 0,97kN/m

Characteristic variable udl q_k = 1,02kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,54kN/m

Design horizontal wind load $F_{W.d}$ = 0,95kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 11-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 6,6kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 6,6kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 6,87kN

Resulting force at top from tie down; F_{hRd} = 3,88kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 10,74kN

Wall 11 has a horizontal resistance of 10,74kN;

the required design force is 0,95kN

The utilisation factor U = 0,09; and passes the rule for this structural element.

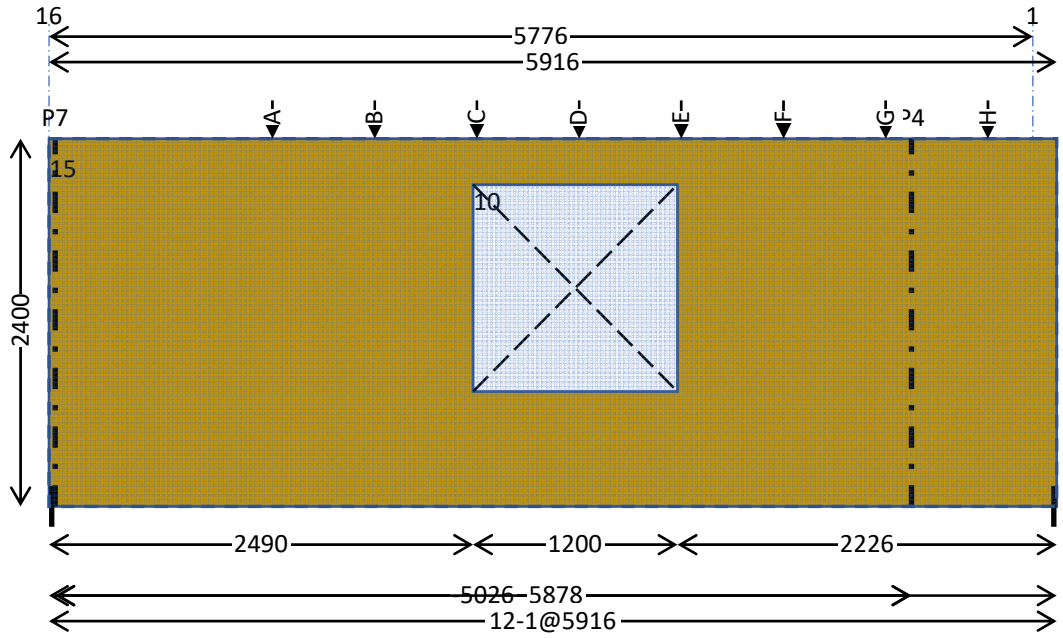
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	11-1 Group	0,000m	3,365kN	1,023kN	0,544kN	1,982m

Note

1 +T6R1+T7R1+T7R1

Wall - 12



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	2 400mm	Wall length L =	5 916mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
10	1200	1350	2490	750	1,62	FALSE
				Total area A_t =	1,62	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,12kN/m²

Post or Columns

Ref	At(m)	Timber	Gk (kN)	Qk (kN)	Wk (kN)	UV (kN)
P4	5,063	2No 38 x 140 C16	1,551	1,547	0,822	5,647
P7	0,038	2No 38 x 140 C16	2,731	2,819	1,498	10,162

Design loads acting on wall

There are no walls supported by this wall

There are 8 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
H	T4 R1	5,513m	2,002kN	2,090kN	1,111kN		
G	T4 R1	4,913m	2,002kN	2,090kN	1,111kN		
F	T4 R1	4,313m	2,002kN	2,090kN	1,111kN		
E	T4 R1	3,713m	2,002kN	2,090kN	1,111kN		
D	T4 R1	3,113m	2,002kN	2,090kN	1,111kN		
C	T4 R1	2,513m	2,002kN	2,090kN	1,111kN		
B	T4 R1	1,913m	2,002kN	2,090kN	1,111kN		
A	T4 R1	1,313m	2,002kN	2,090kN	1,111kN		

Max design top load is at 'T4' = 7,34kN <= 20,85kN

Min design top load is at 'T4' = 3,67kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,29kN/m

Characteristic permanent udl g_k = 2,71kN/m

Characteristic variable udl q_k = 2,83kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 1,50kN/m

Design horizontal wind load $F_{W.d}$ = 1,89kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 12-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,228

Opening factor; $K_{opening} = 1 - 1{,}9p$ = 0,57

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1{,}1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 174,0kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 174,0kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t}L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening}K_{iw}f_{pdt}L$ = 11,61kN

Resulting force at top from tie down; F_{hRd} = 11,57kN

Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 23,18kN

Post or Columns

Ref	At(m)	Timber	Gk (kN)	Qk (kN)	Wk (kN)	UV (kN)
P4	5,063	2No 38 x 140 C16	1,551	1,547	0,822	5,647
P7	0,038	2No 38 x 140 C16	2,731	2,819	1,498	10,162

Wall Resist

Wall 12 has a horizontal resistance of 23,18kN;

the required design force is 1,89kN

The utilisation factor U = 0,08; and passes the rule for this structural element.

Base Loads

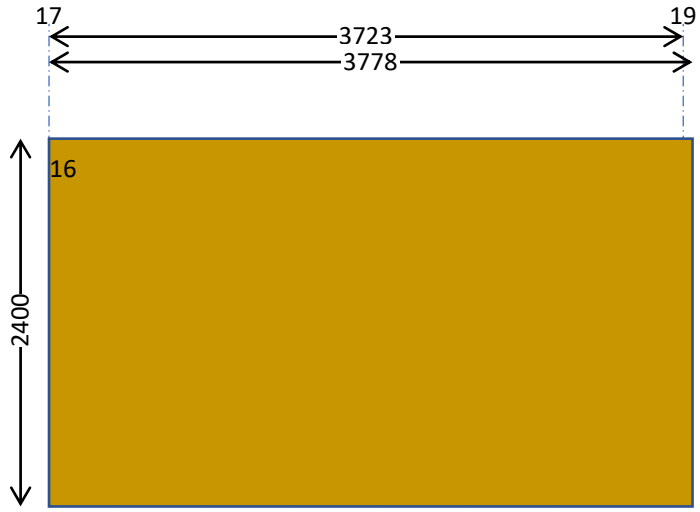
Ref	Source	at	Gk	Qk	Wk	L
1	12-1 Group	0,000m	4,008kN	1,679kN	0,892kN	2,490m
2	P7	0,038m	2,731kN	2,819kN	1,498kN	
3	Op10-R1	2,490m	3,108kN	3,057kN	1,625kN	
4	Ope 10 sill	2,490m	0,750kN	0,000kN	0,000kN	1,200m
5	Op10-R2	3,690m	1,256kN	1,124kN	0,597kN	
6	12-3 Group	3,690m	3,754kN	1,413kN	0,751kN	5,916m
7	P4	5,064m	1,551kN	1,547kN	0,822kN	

Note

1 +T4R1+T4R1

6 Stud strength should increase to 1,416xStud!

Wall - 13



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	3 778mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

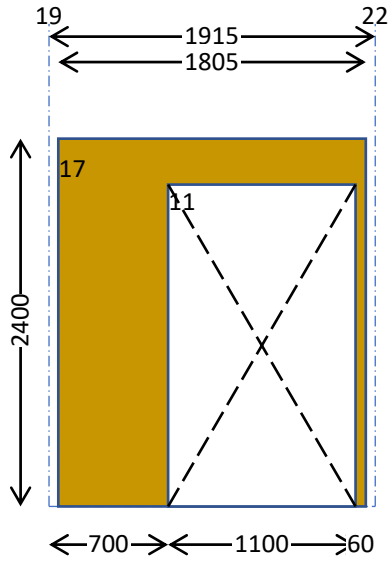
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	13-1	0,000m	2,400kN	0,000kN	0,000kN	3,778m

Wall - 14



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	1 805mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
11	1100	2100	700	0	2,31	FALSE
				Total area A_t =	2,31	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

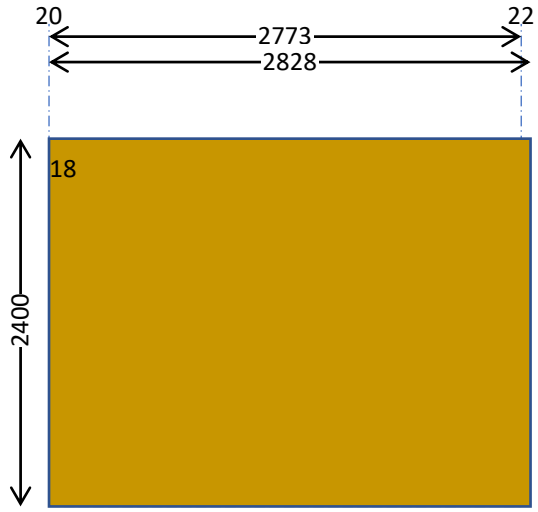
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	14-1	0,000m	2,400kN	0,000kN	0,000kN	0,700m
2	Op11-R1	0,700m	0,165kN	0,000kN	0,000kN	
3	Op11-R2	1,800m	0,165kN	0,000kN	0,000kN	
4	14-3	1,800m	2,400kN	0,000kN	0,000kN	1,805m

Wall - 15



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	2 828mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

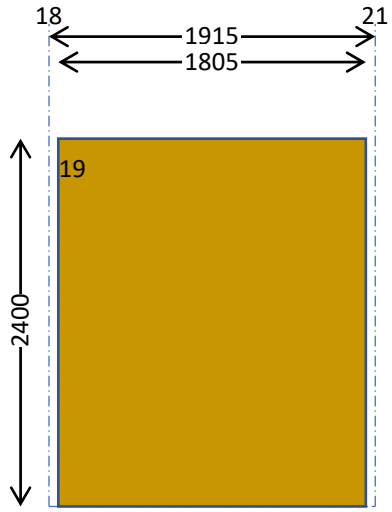
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	15-1	0,000m	2,400kN	0,000kN	0,000kN	2,828m

Wall - 16



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	1 805mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

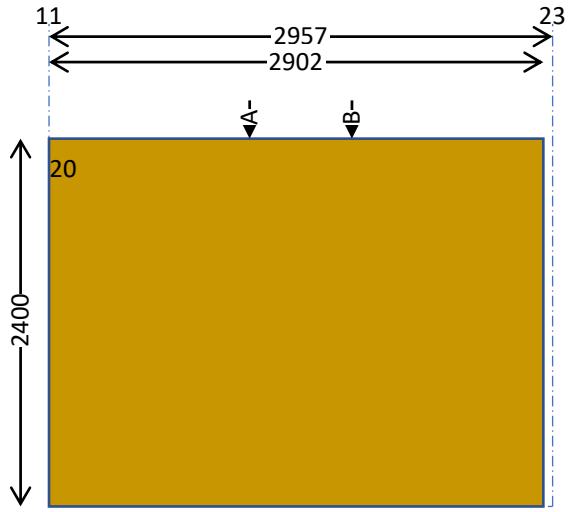
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	16-1	0,000m	2,400kN	0,000kN	0,000kN	1,805m

Wall - 17



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	2 902mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 2 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
B	XL W17 L2	1,779m	1,060kN	0,000kN	0,000kN		
A	XL W17 L1	1,179m	1,060kN	0,000kN	0,000kN		

Max design top load is at 'XL' = 1,43kN <= 13,25kN

Min design top load is at 'XL' = 1,06kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,24kN/m

Characteristic permanent udl g_k = 0,73kN/m

Characteristic variable udl q_k = 0,00kN/m

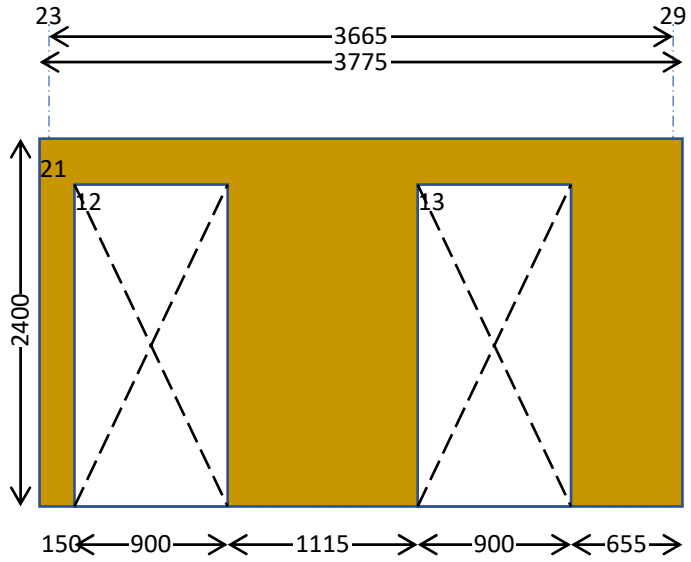
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	17-1 Group	0,000m	3,131kN	0,000kN	0,000kN	2,902m

Note

1 +XLW17 L1+XLW17 L2

Wall - 18



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	3 775mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
12	900	2100	150	0	1,89	FALSE
13	900	2100	2165	0	1,89	FALSE
				Total area A_t =	3,78	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

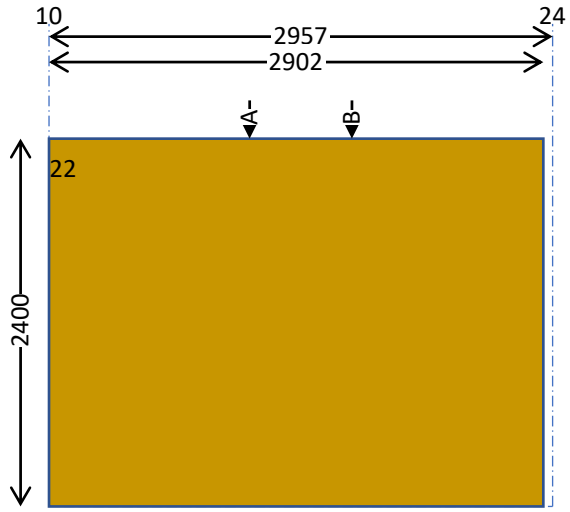
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	18-1	0,000m	2,400kN	0,000kN	0,000kN	3,775m

Wall - 19



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	2 902mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 2 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
B	XL W19 L4	1,779m	1,060kN	0,000kN	0,000kN		
A	XL W19 L3	1,179m	1,060kN	0,000kN	0,000kN		

Max design top load is at 'XL' = 1,43kN <= 13,25kN

Min design top load is at 'XL' = 1,06kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,24kN/m

Characteristic permanent udl g_k = 0,73kN/m

Characteristic variable udl q_k = 0,00kN/m

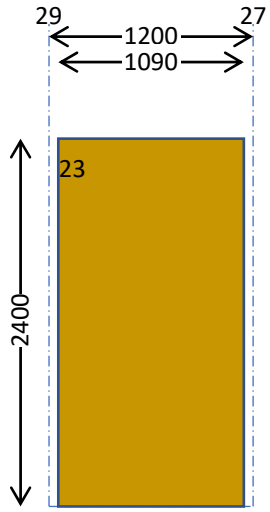
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	19-1 Group	0,000m	3,131kN	0,000kN	0,000kN	2,902m

Note

1 +XLW19 L3+XLW19 L4

Wall - 20



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	1 090mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

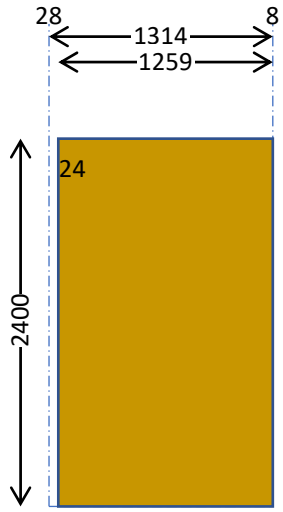
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	20-1	0,000m	2,400kN	0,000kN	0,000kN	1,090m

Wall - 21



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	1 259mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

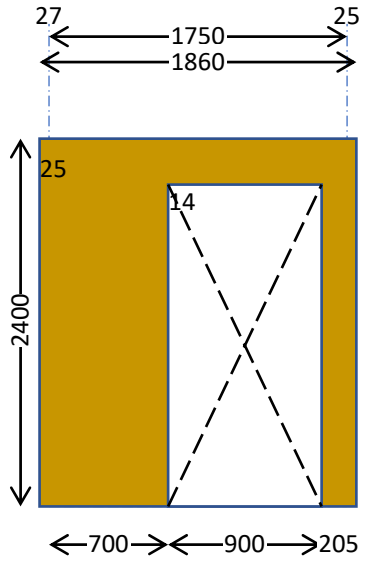
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	21-1	0,000m	2,400kN	0,000kN	0,000kN	1,259m

Wall - 22



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	1 860mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Ref	W(mm)	H(mm)	lso(mm)	bro(mm)	Ao(m²)	Break
14	900	2100	700	0	1,89	FALSE
				Total area A_t =	1,89	m²

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

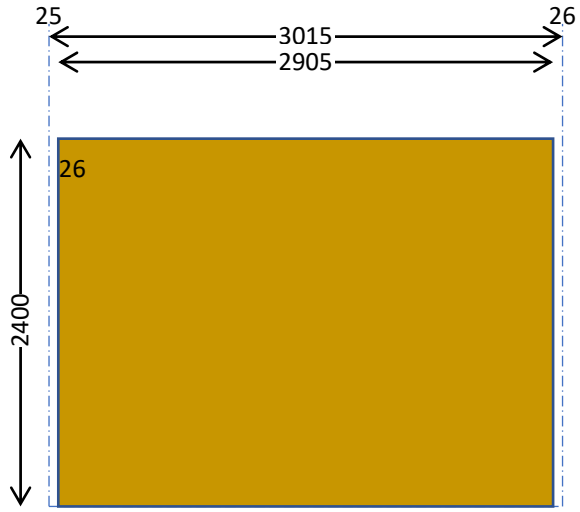
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	22-1	0,000m	2,400kN	0,000kN	0,000kN	0,700m
2	Op14-R1	0,700m	0,135kN	0,000kN	0,000kN	
3	Op14-R2	1,600m	0,135kN	0,000kN	0,000kN	
4	22-3	1,600m	2,400kN	0,000kN	0,000kN	1,860m

Wall - 23



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	2 905mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

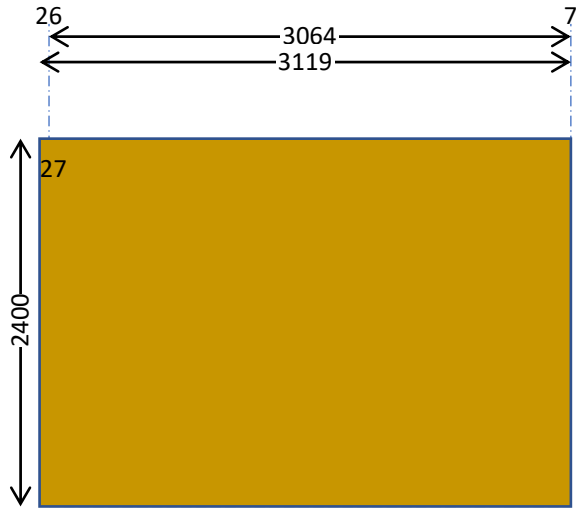
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	23-1	0,000m	2,400kN	0,000kN	0,000kN	2,905m

Wall - 24



This wall is NOT used for wind stability.

Wall panel properties

Geometry

Wall height H =	2 400mm	Wall length L =	3 119mm
Width of stud bs =	38mm	Depth of stud hs =	89mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 89 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is Plasterboard

Thickness of sheathing t_{s1} = 12,5mm

Characteristic density g_{k1} = 300kg/m³

Fastener Try BRT plasterboard screws f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,5mm

Fastener Length l_{n1} = 40mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,10kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are no additional loads acting on this wall

Self-weight of the wall panel sw_k = 0,24kN/m

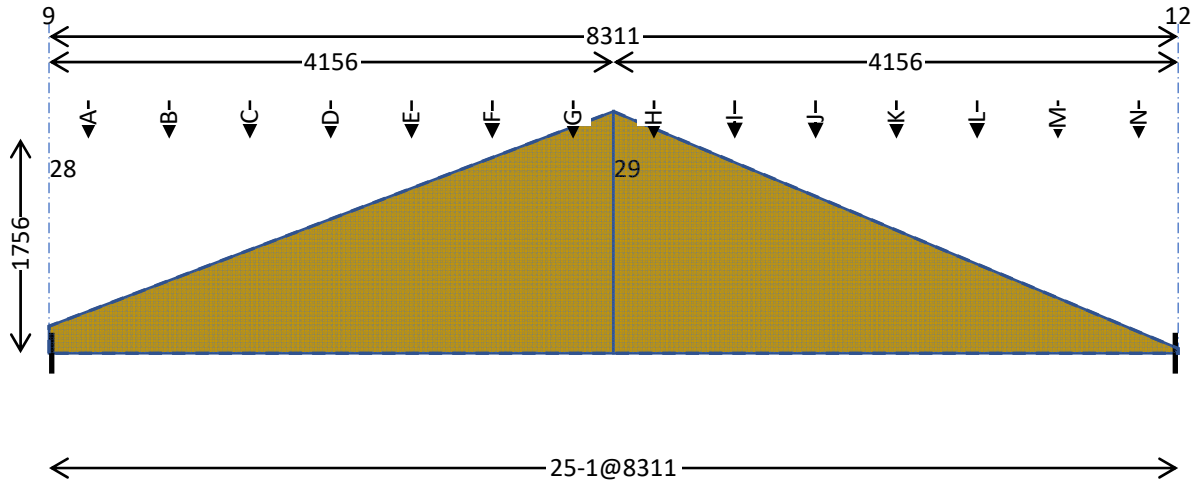
Characteristic permanent udl g_k = 0,00kN/m

Characteristic variable udl q_k = 0,00kN/m

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	24-1	0,000m	2,400kN	0,000kN	0,000kN	3,119m

Wall - 25



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	1 756mm	Wall length L =	8 311mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,13kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 14 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
N	B16 R1	8,021m	0,382kN	0,423kN	0,225kN		
M	B16 R1	7,426m	0,382kN	0,423kN	0,225kN		
L	B16 R1	6,832m	0,382kN	0,423kN	0,225kN		
K	B16 R1	6,237m	0,382kN	0,423kN	0,225kN		
J	B16 R1	5,642m	0,382kN	0,423kN	0,225kN		
I	B16 R1	5,048m	0,382kN	0,423kN	0,225kN		
H	B16 R1	4,453m	0,382kN	0,423kN	0,225kN		
G	B16 R1	3,858m	0,382kN	0,423kN	0,225kN		
F	B16 R1	3,263m	0,382kN	0,423kN	0,225kN		
E	B16 R1	2,669m	0,382kN	0,423kN	0,225kN		
D	B16 R1	2,074m	0,382kN	0,423kN	0,225kN		
C	B16 R1	1,479m	0,382kN	0,423kN	0,225kN		
B	B16 R1	0,885m	0,382kN	0,423kN	0,225kN		
A	B16 R1	0,290m	0,382kN	0,423kN	0,225kN		

Max design top load is at 'B16' = 1,46kN <= 20,85kN

Min design top load is at 'B16' = 0,72kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,22kN/m

Characteristic permanent udl g_k = 0,64kN/m

Characteristic variable udl q_k = 0,71kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,38kN/m

Design horizontal wind load $F_{W.d}$ = 0,00kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 25-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1{,}9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1{,}1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 82,9kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 82,9kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t}L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening}K_{iw}f_{pdt}L$ = 28,79kN

Resulting force at top from tie down; F_{hRd} = 22,22kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 51,02kN

Wall 25 has a horizontal resistance of 51,02kN;

the required design force is 0,00kN

The utilisation factor U = 0,00; and passes the rule for this structural element.

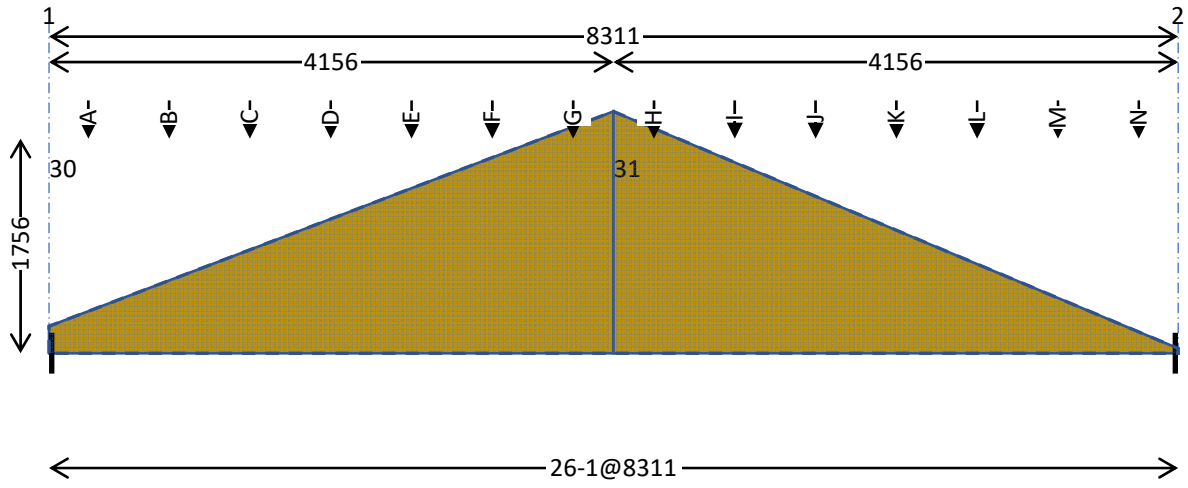
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	25-1 Group	0,000m	2,400kN	0,713kN	0,379kN	8,311m

Note

1 Stud strength should increase to 1,167xStud!

Wall - 26



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	1 756mm	Wall length L =	8 311mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,13kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 14 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
N	B17 R1	8,021m	0,382kN	0,423kN	0,225kN		
M	B17 R1	7,426m	0,382kN	0,423kN	0,225kN		
L	B17 R1	6,832m	0,382kN	0,423kN	0,225kN		
K	B17 R1	6,237m	0,382kN	0,423kN	0,225kN		
J	B17 R1	5,642m	0,382kN	0,423kN	0,225kN		
I	B17 R1	5,048m	0,382kN	0,423kN	0,225kN		
H	B17 R1	4,453m	0,382kN	0,423kN	0,225kN		
G	B17 R1	3,858m	0,382kN	0,423kN	0,225kN		
F	B17 R1	3,263m	0,382kN	0,423kN	0,225kN		
E	B17 R1	2,669m	0,382kN	0,423kN	0,225kN		
D	B17 R1	2,074m	0,382kN	0,423kN	0,225kN		
C	B17 R1	1,479m	0,382kN	0,423kN	0,225kN		
B	B17 R1	0,885m	0,382kN	0,423kN	0,225kN		
A	B17 R1	0,290m	0,382kN	0,423kN	0,225kN		

Max design top load is at 'B17' = 1,46kN <= 20,85kN

Min design top load is at 'B17' = 0,72kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,22kN/m

Characteristic permanent udl g_k = 0,64kN/m

Characteristic variable udl q_k = 0,71kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,38kN/m

Design horizontal wind load $F_{W.d}$ = 0,00kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 26-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 82,9kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 82,9kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t}L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening}K_{iw}f_{pdt}L$ = 28,79kN

Resulting force at top from tie down; F_{hRd} = 22,22kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 51,02kN

Wall 26 has a horizontal resistance of 51,02kN;

the required design force is 0,00kN

The utilisation factor U = 0,00; and passes the rule for this structural element.

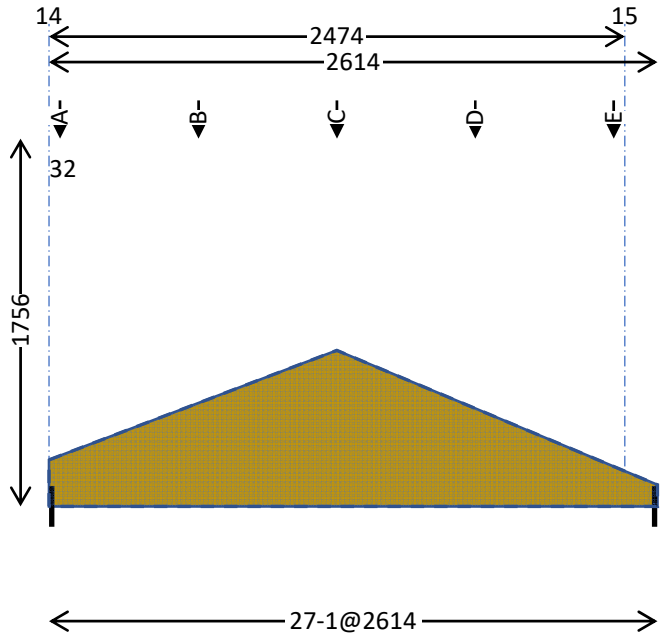
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	26-1 Group	0,000m	2,400kN	0,713kN	0,379kN	8,311m

Note

1 Stud strength should increase to 1,167xStud!

Wall - 27



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	1 756mm	Wall length L =	2 614mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,13kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 5 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
E	B18 R1	2,426m	0,370kN	0,410kN	0,218kN		
D	B18 R1	1,832m	0,370kN	0,410kN	0,218kN		
C	B18 R1	1,237m	0,370kN	0,410kN	0,218kN		
B	B18 R1	0,642m	0,370kN	0,410kN	0,218kN		
A	B18 R1	0,048m	0,370kN	0,410kN	0,218kN		

Max design top load is at 'B18' = 1,41kN <= 20,85kN

Min design top load is at 'B18' = 0,70kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,22kN/m

Characteristic permanent udl g_k = 0,71kN/m

Characteristic variable udl q_k = 0,78kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,42kN/m

Design horizontal wind load $F_{W.d}$ = 0,00kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 27-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 8,4kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 8,4kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 9,06kN

Resulting force at top from tie down; F_{hRd} = 6,99kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 16,05kN

Wall 27 has a horizontal resistance of 16,05kN;

the required design force is 0,00kN

The utilisation factor U = 0,00; and passes the rule for this structural element.

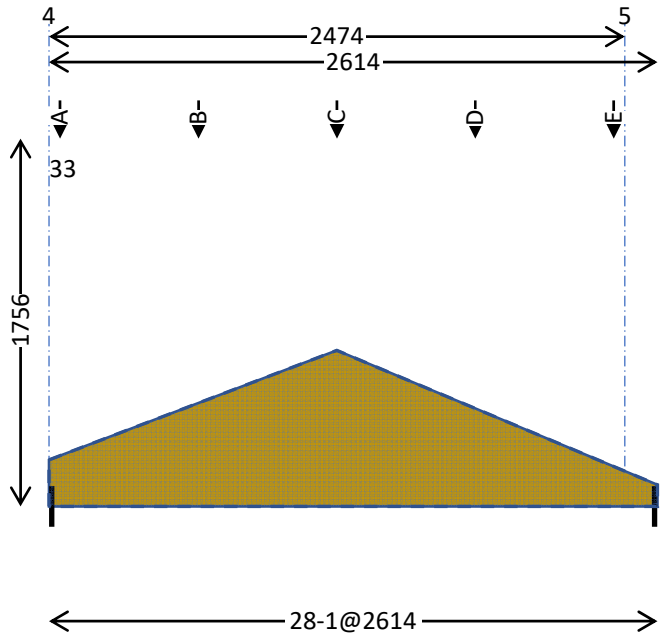
Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	27-1 Group	0,000m	2,465kN	0,785kN	0,417kN	2,614m

Note

1 +B18R1+B18R1+B18R1+B18R1+B18R1

Wall - 28



This wall must take wind force for stability.

Wall panel properties using BS PD6693

Geometry

Wall height H =	1 756mm	Wall length L =	2 614mm
Width of stud bs =	38mm	Depth of stud hs =	140mm
Stud spacing ss =	600mm	Sheathing layers sl =	2

Description of openings

Number of openings within the wall panel N_{ope} = 0

Timber frame material

Timber material is Solid Strength class is C16

Characteristic density of timbers ρ_k = 310kg/m³

BS PD 6693-1:2019

20.1.1.1 Spacing not to exceed 610mm: 600 <= 610 -> complies

Minimum thickness B 38mm: 38 >= 38 -> complies

Minimum depth H 72mm: 140 >= 72 -> complies

EN 338 Minimum strength class C16: C16 >= C16 -> complies

Sheathing material

Material and grade is OSB/3

Thickness of sheathing t_{s1} = 9mm

Characteristic density g_{k1} = 515kg/m³

Fastener Try Nail BRT f_{u1} = 700N/mm²

Fastener diameter d_{n1} = 3,1mm

Fastener Length l_{n1} = 50mm

Perimeter spacing s_1 = 150mm

Connection to substrate

Sole plate detail is Open panel sole plate detail

Holding down restraint Strap dimensions 50 x 610mm and 4No. nails

Characteristic restraint capacity $F_{hd.k}$ = 5,40kN

Self weight $q_{sw.k}$ = 0,13kN/m²

Design loads acting on wall

There are no walls supported by this wall

There are 5 additional loads acting on this wall

Ref	Source	at	Gk	Qk	Wk	L	Note
E	B19 R1	2,426m	0,370kN	0,410kN	0,218kN		
D	B19 R1	1,832m	0,370kN	0,410kN	0,218kN		
C	B19 R1	1,237m	0,370kN	0,410kN	0,218kN		
B	B19 R1	0,642m	0,370kN	0,410kN	0,218kN		
A	B19 R1	0,048m	0,370kN	0,410kN	0,218kN		

Max design top load is at 'B19' = 1,41kN <= 20,85kN

Min design top load is at 'B19' = 0,70kN; Use standard holding down detail.

Self-weight of the wall panel sw_k = 0,22kN/m

Characteristic permanent udl g_k = 0,71kN/m

Characteristic variable udl q_k = 0,78kN/m

Characteristic wind uplift udl $q_{uplift.d}$ = 0,42kN/m

Design horizontal wind load $F_{W.d}$ = 0,00kN

Design tension from holding down restraint $F_{hd.d}$ = 4,57kN

Use standard minimum spacing for HD straps.

Diaphragms Using BS PD 6693-1:2019

There is 1 diapragham on this wall

Diaphragm referenced 28-1->Design racking strength

20.5.2.8 Opening ratio p = A/HL = 0,000

Opening factor; $K_{opening} = 1 - 1,9p$ = 1,00

20.5.2.5 Panel shape factor K_{iw}

(10) Shear fix ratio; $\mu = \min [1; 1,1(f_{w.d} / f_{p.d.t})]$ = 0,340

Stabilsing moment $M_{dstb} = g_k L^2/2$ = 8,4kNm

Destabilsing moment $M_{ddstb} = w_k L^2/2$ = 0,0kNm

Normalised stabilsing moment $M_{dstbn} = M_{dstb} - M_{ddstb}$ = 8,4kNm

(8) $K_{iw} = \min(1;[1+(H/\mu L)^2+(2M_{dstbn}/\mu f_{p.d.t} L^2)]^{0.5} -(H/\mu L))$ = 1,00

(5) Design racking capacity for diaphragm;

$F_{i,v,Rd} = K_{opening} K_{iw} f_{pdt} L$ = 9,06kN

Resulting force at top from tie down; F_{hRd} = 6,99kN

Wall Resistance Resisting force at top ; $F_{Rd} = F_{ivRd} + F_{hRd}$ = 16,05kN

Wall 28 has a horizontal resistance of 16,05kN;

the required design force is 0,00kN

The utilisation factor U = 0,00; and passes the rule for this structural element.

Base Loads

Ref	Source	at	Gk	Qk	Wk	L
1	28-1 Group	0,000m	2,465kN	0,785kN	0,417kN	2,614m

Note

1 +B19R1+B19R1+B19R1+B19R1+B19R1

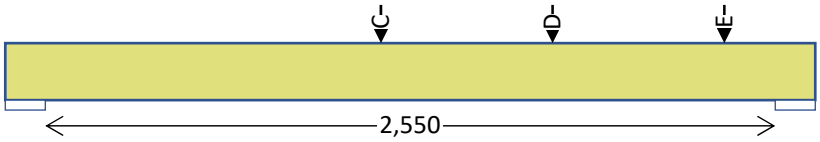
Lintel List

Ref	Section	Span	Ub	Uv	Um	Ud
Op1	44x222 C18	2,400	0,03	0,03	0,04	0,03
Op2	44x222 C18	1,000	0,08	0,06	0,00	0,00
Op3	44x222 C18	0,900	0,07	0,06	0,00	0,00
Op4	44x222 C18	1,200	0,02	0,01	0,01	0,00
Op5	44x222 C18	1,200	0,02	0,01	0,01	0,00
Op6	44x222 C18	0,900	0,01	0,01	0,01	0,00
Op7	44x222 C18	1,200	0,02	0,01	0,01	0,00
Op8	44x222 C18	0,900	0,01	0,01	0,01	0,00
Op9	44x222 C18	1,000	0,08	0,06	0,00	0,00
Op10	44x222 C18	1,200	0,02	0,01	0,01	0,00
Op11	44x222 C18	1,100	0,08	0,07	0,00	0,00
Op12	44x222 C18	0,900	0,01	0,01	0,01	0,00
Op13	44x222 C18	0,900	0,01	0,01	0,01	0,00
Op14	44x222 C18	0,900	0,07	0,06	0,00	0,00

Beam List

Ref	*E1*	*E2*	*Section*	*Span*	*Ub*	*Uv*	*Um*	*Ud*
B1	P7	P8	3No.44x222 C18 Solid	2,550	0,30	0,57	0,77	0,13
B2	P5	P6	3No.47x247 C18 Solid	2,626	0,33	0,57	0,77	0,18
T3	P3	P2	1No.38x222 C16 Solid	8,451		N/A		
T4	W8	W6	1No.38x222 C16 Solid	8,311		N/A		
T5	P1	P4	1No.38x222 C16 Solid	8,451		N/A		
T6	W11	W9	1No.38x140 C16 Solid	2,474		N/A		
T7	W11	W9	1No.38x140 C16 Solid	2,474		N/A		
T8	W3	W5	1No.38x140 C16 Solid	2,474		N/A		
T9	W3	W5	1No.38x140 C16 Solid	2,474		N/A		
B16	W25	T3	1No.38x140 C16 Solid	0,713	0,06	0,19	0,08	0,03
B17	W26	T5	1No.38x140 C16 Solid	0,712	0,06	0,19	0,08	0,03
B18	W27	T6	1No.38x140 C16 Solid	0,600	0,05	0,18	0,06	0,02
B19	W28	T8	1No.38x140 C16 Solid	0,600	0,05	0,18	0,06	0,02

Beam - B1



Clear span is 2,550m Spacing is 1,000m
Bearing 1 is 0,140m Bearing 2 is 0,140m
Design span is 2,690m and the beam length is 2,830m
TRY 3No. Solid 44x222 C18

Applied loading

Roof Level loads are G_k = 0,65kN/m²; Q_k= 0,75kN/m²; W_k =0,02kN/m²; P_k= 1kN

Permanent self weight of beam SW = 0,092kN/m-> SW x L_e =0,260kN

Dead load as Permanent UDL G_k = 0,742kN/m-> (SW+g_k) x L_e =2,360kN

Imposed as Variable UDL Q_k = 0,750kN/m-> q_k x L_e =2,123kN

Wind load as UDlm-> w_k x L_e =1,128kN

Ref	Source	at	Gk	Qk	Wk	L	Note
A	B1 SW	-0,140m	0,092kN	0,000kN	0,000kN	2,830m	
B	B1 UL	-0,140m	0,650kN	0,750kN	0,399kN	2,830m	
C	T4 R1	1,313m	2,002kN	2,090kN	1,111kN		+ B1.1
D	T4 R1	1,913m	2,002kN	2,090kN	1,111kN		
E	T4 R1	2,513m	2,002kN	2,090kN	1,111kN		

Reactions

	Gk	Qk	Wk
LH reaction =	2,731kN	2,819kN	1,498kN
RH reaction =	5,375kN	5,575kN	5,770kN
Mispan moment(kNm) =	2,94kNm	3,05kNm	1,62kNm

Load combinations

$FE_d = \gamma_G \times G_k + \gamma_Q \times Q_k = 1.35 \times G_k + 1.5 \times Q_k$

Ultimate reactions R1 =7,915kN; R2 = 15,619kN

Design shear V_d = 15,619kN

Total load on beam W_t = 16,500kN

Design moment M_d = 8,543kNm

Timber section details

Breadth of timber sections b = 44mm
Depth of timber sections h = 222mm
Number of timber sections in member N = 3
Overall breadth of timber member bb = $N \times b$ = 132mm
Timber strength class - EN 338:2009 Table 1 C18

Member Details

cl.2.3.1.2 Load duration class = 3
cl.2.3.1.3 Service class = 2
Bearing stress at R1 = 0,14 and at R2 = 0,14; the maximum bearing stress is 0,14N/mm²

Section Properties

Cross sectional area of member A = N x b x h = 293cm²
Section modulus Wy = N x b x h² / 6 = 1 084cm³
Wz = h x (N x b)² / 6 = 645cm³
Second moment of area Iy = N x b x h³ / 12 = 12 035cm⁴

I_z = h x (N x b)³ / 12 = 4 255cm⁴

Radius of gyration ry = (Iy / A)^0.5 = 6,4cm

rz = (Iz / A)^0.5 = 3,8cm

Modification factors

Table 2.3	Partial factor for material properties γ_M =	1,30
Table 3.1	Load duration and moisture content K_{mod} =	0,8
Table 3.2	Deformation factor for service classes K_{def} =	0,8
(3.1)	Depth factor for bending K_{hm} =	0,92
	Depth factor for tension K_{ht} =	1,28
6.1.6(2)	Bending stress re-distribution factor K_m =	0,7
6.1.7(2)	Crack factor for shear resistance K_{cr} =	0,67
(6.4)	Load configuration factor K_{c90} =	2,06
6.6	System strength factor K_{sys} =	1,0
6.3.3(5)	Lateral buckling factor K_{crit} =	1,0

6.1.5 Compression perpendicular to the grain

Bearing stress sc.90.d = Vd / (N x b x Lb) = 0,845N/mm²

Bearing strength fc.90.d = kmod x ksys x kc.90 x fc90k / GamM = 2,79N/mm²

Ub = sc90d / fc90d = 0,303

PASS - Design bearing strength exceeds design bearing stress

6.1.6 Bending

Bending stress smd = Md / Wy = 7,879N/mm²

Bending strength fmd = khm x kmod x ksys x kcrit x fmk / GamM = 10,242N/mm²

$U_m = \sigma_{md} / f_{md} = 0,769$

PASS - Design bending strength exceeds design bending stress

6.1.7 Shear

Applied shear stress svd = 3 x Vd / (2 x Kcr x A) = 1,193N/mm²

Permissible shear stress fvd = kmod x ksys x fvk / GamM = 2,092N/mm²

Uv = svd / fvd = 0,57

PASS - Design shear strength exceeds design shear stress

7,2 Deflection

Deflection limit ulim = min(14 mm, 0.004 x Le) = 10,2mm

Instantaneous deflection due to permanent load uinstG = 0,419mm

Final deflection due to permanent load ufinG = uinstG x (1 + kdef) = 0,753mm

Instantaneous deflection due to variable load uinstQ = 0,423mm

Factor for quasi-permanent variable action Phi2 = 0,3

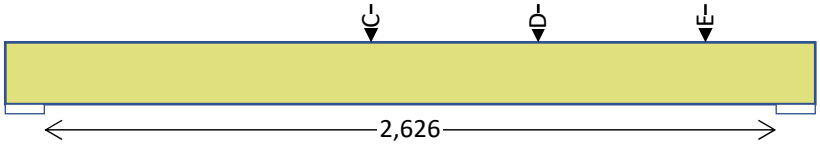
Final deflection due to variable load ufinQ = uinstQ x (1 + Phi2 x kdef) = 0,525mm

Total final deflection ufin = ufinG + ufinQ = 1,278mm

Ud = ufin / ulim = 0,125

PASS - Design deflection is less than the deflection limit

Beam - B2



Clear span is 2,626m Spacing is 2,000m
Bearing 1 is 0,140m Bearing 2 is 0,140m
Design span is 2,766m and the beam length is 2,906m
TRY 3No. Solid 47x247 C18

Applied loading

Roof Level loads are G_k = 0,65kN/m²; Q_k= 0,75kN/m²; W_k =0,02kN/m²; P_k= 1kN

Permanent self weight of beam SW = 0,109kN/m-> SW x L_e =0,318kN

Dead load as Permanent UDL G_k = 1,409kN/m-> (SW+g_k) x L_e =4,413kN

Imposed as Variable UDL Q_k = 1,500kN/m-> q_k x L_e =4,359kN

Wind load as UDlm-> w_k x L_e =2,317kN

Ref	Source	at	Gk	Qk	Wk	L	Note
A	B2 SW	-0,140m	0,109kN	0,000kN	0,000kN	2,906m	
B	B2 UL	-0,140m	1,300kN	1,500kN	0,797kN	2,906m	
C	T4 R2	1,313m	2,002kN	2,090kN	1,111kN		+ B2.1
D	T4 R2	1,913m	2,002kN	2,090kN	1,111kN		
E	T4 R2	2,513m	2,002kN	2,090kN	1,111kN		

Reactions

	Gk	Qk	Wk
LH reaction =	3,797kN	4,004kN	2,128kN
RH reaction =	6,304kN	6,626kN	6,273kN
Mispan moment(kNm) =	3,77kNm	3,96kNm	2,11kNm

Load combinations

$FE_d = \gamma_G \times G_k + \gamma_Q \times Q_k = 1.35 \times G_k + 1.5 \times Q_k$

Ultimate reactions R1 =11,133kN; R2 = 18,450kN

Design shear V_d = 18,450kN

Total load on beam W_t = 20,732kN

Design moment M_d = 11,034kNm

Timber section details

Breadth of timber sections b = 47mm
Depth of timber sections h = 247mm
Number of timber sections in member N = 3
Overall breadth of timber member bb = $N \times b$ = 141mm
Timber strength class - EN 338:2009 Table 1 C18

Member Details

cl.2.3.1.2 Load duration class = 3
cl.2.3.1.3 Service class = 2

Bearing stress at R1 = 0,14 and at R2 = 0,14; the maximum bearing stress is 0,14N/mm²

Section Properties

Cross sectional area of member A = N x b x h = 348cm²
Section modulus Wy = N x b x h² / 6 = 1 434cm³
Wz = h x (N x b)² / 6 = 818cm³
Second moment of area Iy = N x b x h³ / 12 = 17 706cm^4

I_z = h x (N x b)³ / 12 = 5 770cm⁴

Radius of gyration ry = (Iy / A)^0.5 = 7,1cm

rz = (Iz / A)^0.5 = 4,1cm

Modification factors

Table 2.3	Partial factor for material properties γ_M =	1,30
Table 3.1	Load duration and moisture content K_{mod} =	0,8
Table 3.2	Deformation factor for service classes K_{def} =	0,8
(3.1)	Depth factor for bending K_{hm} =	0,91
	Depth factor for tension K_{ht} =	1,26
6.1.6(2)	Bending stress re-distribution factor K_m =	0,7
6.1.7(2)	Crack factor for shear resistance K_{cr} =	0,67
(6.4)	Load configuration factor K_{c90} =	2,09
6.6	System strength factor K_{sys} =	1,0
6.3.3(5)	Lateral buckling factor K_{crit} =	1,0

6.1.5 Compression perpendicular to the grain

Bearing stress sc.90.d = Vd / (N x b x Lb) = 0,935N/mm²

Bearing strength fc.90.d = kmod x ksys x kc.90 x fc90k / GamM = 2,826N/mm²

Ub = sc90d / fc90d = 0,331

PASS - Design bearing strength exceeds design bearing stress

6.1.6 Bending

Bending stress smd = Md / Wy = 7,696N/mm²

Bending strength fmd = khm x kmod x ksys x kcrit x fmk / GamM = 10,025N/mm²

$U_m = \sigma_{md} / f_{md} = 0,768$

PASS - Design bending strength exceeds design bending stress

6.1.7 Shear

Applied shear stress svd = 3 x Vd / (2 x Kcr x A) = 1,186N/mm²

Permissible shear stress fvd = kmod x ksys x fvk / GamM = 2,092N/mm²

Uv = svd / fvd = 0,567

PASS - Design shear strength exceeds design shear stress

7,2 Deflection

Deflection limit ulim = min(14 mm, 0.004 x Le) = 10,5mm

Instantaneous deflection due to permanent load uinstG = 0,606mm

Final deflection due to permanent load ufinG = uinstG x (1 + kdef) = 1,091mm

Instantaneous deflection due to variable load uinstQ = 0,645mm

Factor for quasi-permanent variable action Phi2 = 0,3

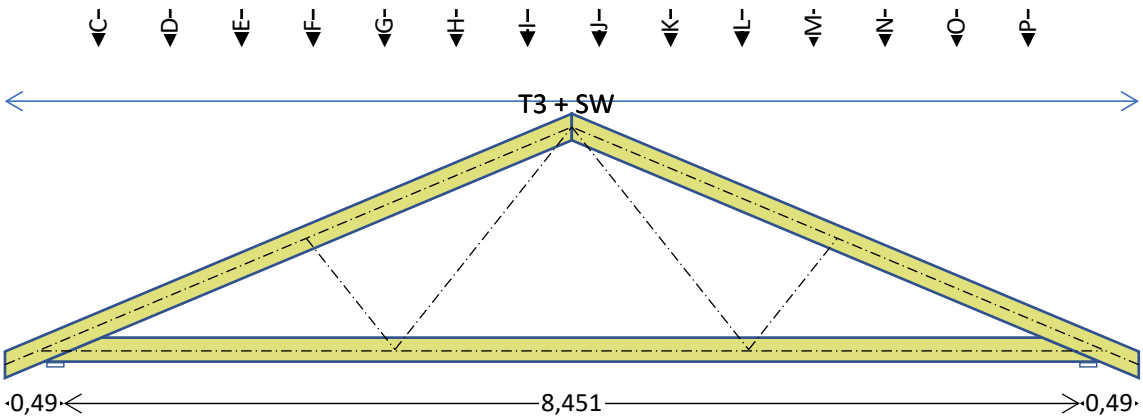
Final deflection due to variable load ufinQ = uinstQ x (1 + Phi2 x kdef) = 0,8mm

Total final deflection ufin = ufinG + ufinQ = 1,891mm

Ud = ufin / ulim = 0,18

PASS - Design deflection is less than the deflection limit

Truss - T3



Clear span is 8,451m Design span Ld = 8,591m

Node coor Rafter and Chord from 38x222 C16 Solid

Ref	*X (m)*	*Y (m)*	*Fx*	*Fz*	*Fr*
1	0,000	0,000	TRUE	TRUE	TRUE
2	0,301	0,140	TRUE	TRUE	TRUE
3	2 507	1 169	TRUE	TRUE	TRUE
4	4 713	2 198	TRUE	TRUE	TRUE
5	6 920	1 169	TRUE	TRUE	TRUE
6	9 126	0,140	TRUE	TRUE	TRUE
7	9 427	0,000	TRUE	TRUE	TRUE
8	3 243	0,140	TRUE	TRUE	TRUE
9	6 184	0,140	TRUE	TRUE	TRUE
10	0,420	0,140	FALSE	FALSE	TRUE
11	9 011	0,140	TRUE	FALSE	TRUE

Members

Ref	*E1*	*E2*	*Material*
1	1	2	38x222 C16 Solid
2	2	3	38x222 C16 Solid
3	3	4	38x222 C16 Solid
4	4	5	38x222 C16 Solid
5	5	6	38x222 C16 Solid
6	6	7	38x222 C16 Solid
7	2	10	38x222 C16 Solid
8	10	8	38x222 C16 Solid
9	8	9	38x222 C16 Solid
10	9	11	38x222 C16 Solid
11	11	6	38x222 C16 Solid
12	3	8	38x75 C16 Solid
13	8	4	38x75 C16 Solid
14	4	9	38x75 C16 Solid
15	9	5	38x75 C16 Solid

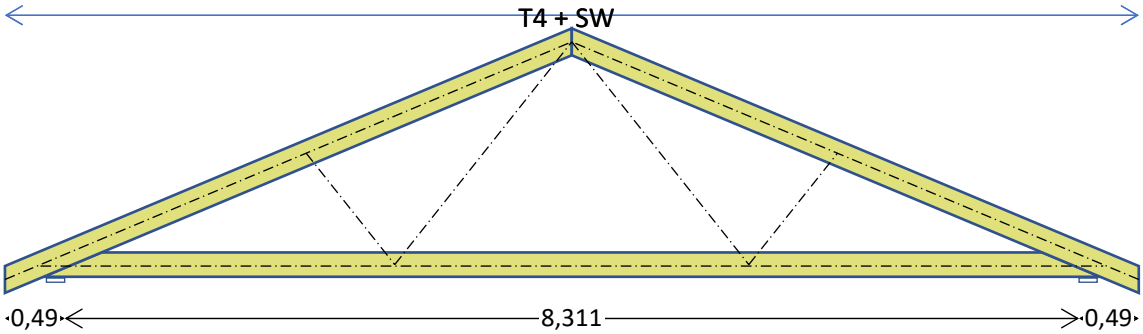
Loads

Ref	*Load*	*@*	*Gk*	*Qk*	*Wk*	*Style*
A	T3	-0,490m	0,04	0,00	0,000	U-kN/m
B	T3	-0,490m	0,20	0,23	0,120	U-kN/m

C	B16	0,290m	0,12	0,13	0,014	P-kN
D	B16	0,885m	0,12	0,13	0,014	P-kN
E	B16	1,479m	0,12	0,13	0,014	P-kN
F	B16	2,074m	0,12	0,13	0,014	P-kN
G	B16	2,669m	0,12	0,13	0,014	P-kN
H	B16	3,263m	0,12	0,13	0,014	P-kN
I	B16	3,858m	0,12	0,13	0,014	P-kN
J	B16	4,453m	0,12	0,13	0,014	P-kN
K	B16	5,048m	0,12	0,13	0,014	P-kN
L	B16	5,642m	0,12	0,13	0,014	P-kN
M	B16	6,237m	0,12	0,13	0,014	P-kN
N	B16	6,832m	0,12	0,13	0,014	P-kN
O	B16	7,426m	0,12	0,13	0,014	P-kN
P	B16	8,021m	0,12	0,13	0,014	P-kN

	Gk	***Qk***	***Wk***	***Uv***
End R1	1,95	1,99	0,66	6,61
End R2	1,93	1,96	0,66	6,53

Truss - T4



Clear span is 8,311m Design span Ld = 8,460m

Node coor Rafter and Chord from 38x222 C16 Solid

Ref	*X (m)*	*Y (m)*	*Fx*	*Fz*	*Fr*
1	0,000	0,000	TRUE	TRUE	TRUE
2	0,292	0,136	TRUE	TRUE	TRUE
3	2 468	1 151	TRUE	TRUE	TRUE
4	4 643	2 165	TRUE	TRUE	TRUE
5	6 819	1 151	TRUE	TRUE	TRUE
6	8 995	0,136	TRUE	TRUE	TRUE
7	9 287	0,000	TRUE	TRUE	TRUE
8	3 193	0,136	TRUE	TRUE	TRUE
9	6 094	0,136	TRUE	TRUE	TRUE
10	0,416	0,136	FALSE	FALSE	TRUE
11	8 876	0,136	TRUE	FALSE	TRUE

Members

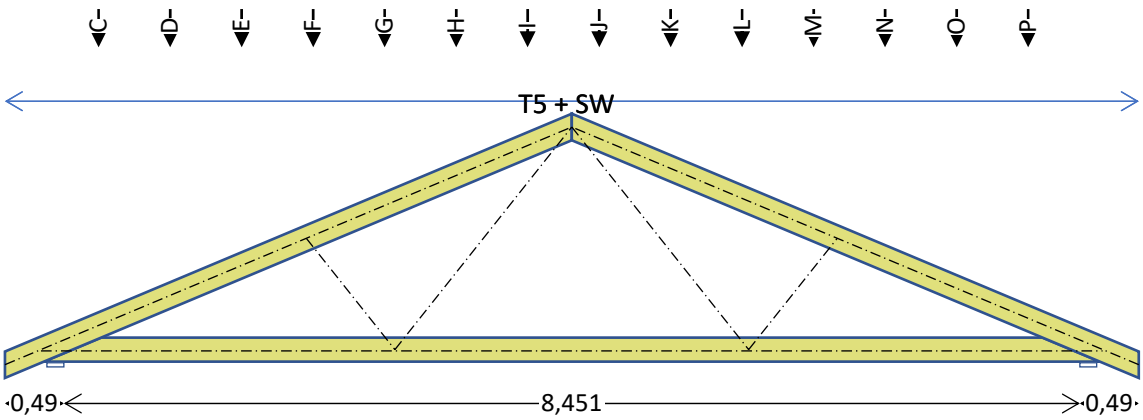
Ref	*E1*	*E2*	*Material*
1	1	2	38x222 C16 Solid
2	2	3	38x222 C16 Solid
3	3	4	38x222 C16 Solid
4	4	5	38x222 C16 Solid
5	5	6	38x222 C16 Solid
6	6	7	38x222 C16 Solid
7	2	10	38x222 C16 Solid
8	10	8	38x222 C16 Solid
9	8	9	38x222 C16 Solid
10	9	11	38x222 C16 Solid
11	11	6	38x222 C16 Solid
12	3	8	38x75 C16 Solid
13	8	4	38x75 C16 Solid
14	4	9	38x75 C16 Solid
15	9	5	38x75 C16 Solid

Loads

Ref	*Load*	*@*	*Gk*	*Qk*	*Wk*	*Style*
A	T4	-0,490m	0,04	0,00	0,000	U-kN/m
B	T4	-0,490m	0,39	0,45	0,239	U-kN/m

	Gk	*Qk*	*Wk*	*Uv*
End R1	2,00	2,09	1,11	7,51
End R2	2,00	2,09	1,11	7,51

Truss - T5



Clear span is 8,451m Design span Ld = 8,591m

Node coor Rafter and Chord from 38x222 C16 Solid

Ref	*X (m)*	*Y (m)*	*Fx*	*Fz*	*Fr*
1	0,000	0,000	TRUE	TRUE	TRUE
2	0,301	0,140	TRUE	TRUE	TRUE
3	2 507	1 169	TRUE	TRUE	TRUE
4	4 713	2 198	TRUE	TRUE	TRUE
5	6 920	1 169	TRUE	TRUE	TRUE
6	9 126	0,140	TRUE	TRUE	TRUE
7	9 427	0,000	TRUE	TRUE	TRUE
8	3 243	0,140	TRUE	TRUE	TRUE
9	6 184	0,140	TRUE	TRUE	TRUE
10	0,420	0,140	FALSE	FALSE	TRUE
11	9 011	0,140	TRUE	FALSE	TRUE

Members

Ref	*E1*	*E2*	*Material*
1	1	2	38x222 C16 Solid
2	2	3	38x222 C16 Solid
3	3	4	38x222 C16 Solid
4	4	5	38x222 C16 Solid
5	5	6	38x222 C16 Solid
6	6	7	38x222 C16 Solid
7	2	10	38x222 C16 Solid
8	10	8	38x222 C16 Solid
9	8	9	38x222 C16 Solid
10	9	11	38x222 C16 Solid
11	11	6	38x222 C16 Solid
12	3	8	38x75 C16 Solid
13	8	4	38x75 C16 Solid
14	4	9	38x75 C16 Solid
15	9	5	38x75 C16 Solid

Loads

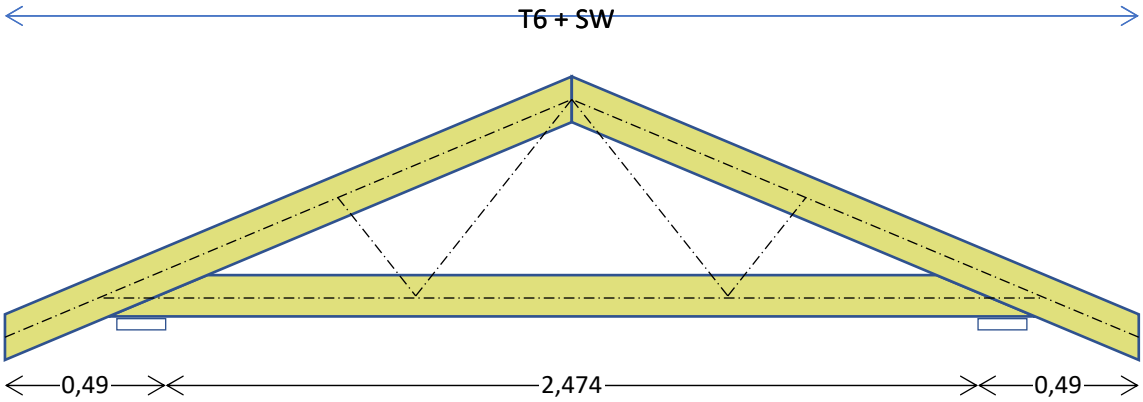
Ref	*Load*	*@*	*Gk*	*Qk*	*Wk*	*Style*
A	T5	-0,490m	0,04	0,00	0,000	U-kN/m
B	T5	-0,490m	0,20	0,23	0,120	U-kN/m

C	B17	0,290m	0,12	0,13	0,014	P-kN
D	B17	0,885m	0,12	0,13	0,014	P-kN
E	B17	1,479m	0,12	0,13	0,014	P-kN
F	B17	2,074m	0,12	0,13	0,014	P-kN
G	B17	2,669m	0,12	0,13	0,014	P-kN
H	B17	3,263m	0,12	0,13	0,014	P-kN
I	B17	3,858m	0,12	0,13	0,014	P-kN
J	B17	4,453m	0,12	0,13	0,014	P-kN
K	B17	5,048m	0,12	0,13	0,014	P-kN
L	B17	5,642m	0,12	0,13	0,014	P-kN
M	B17	6,237m	0,12	0,13	0,014	P-kN
N	B17	6,832m	0,12	0,13	0,014	P-kN
O	B17	7,426m	0,12	0,13	0,014	P-kN
P	B17	8,021m	0,12	0,13	0,014	P-kN

	Gk	***Qk***	***Wk***	***Uv***
End R1	1,95	1,99	0,66	6,61
End R2	1,93	1,96	0,66	6,53

Truss - T6

C D E F G



Clear span is 2,474m Design span Ld = 2,623m

Node coor Rafter and Chord from 38x140 C16 Solid

Ref	*X (m)*	*Y (m)*	*Fx*	*Fz*	*Fr*
1	0,000	0,000	TRUE	TRUE	TRUE
2	0,301	0,140	TRUE	TRUE	TRUE
3	1 009	0,470	TRUE	TRUE	TRUE
4	1 716	0,800	TRUE	TRUE	TRUE
5	2 424	0,470	TRUE	TRUE	TRUE
6	3 132	0,140	TRUE	TRUE	TRUE
7	3 433	0,000	TRUE	TRUE	TRUE
8	1 245	0,140	TRUE	TRUE	TRUE
9	2 188	0,140	TRUE	TRUE	TRUE
10	0,416	0,140	FALSE	FALSE	TRUE
11	3 039	0,140	TRUE	FALSE	TRUE

Members

Ref	*E1*	*E2*	*Material*
1	1	2	38x140 C16 Solid
2	2	3	38x140 C16 Solid
3	3	4	38x140 C16 Solid
4	4	5	38x140 C16 Solid
5	5	6	38x140 C16 Solid
6	6	7	38x140 C16 Solid
7	2	10	38x140 C16 Solid
8	10	8	38x140 C16 Solid
9	8	9	38x140 C16 Solid
10	9	11	38x140 C16 Solid
11	11	6	38x140 C16 Solid
12	3	8	38x75 C16 Solid
13	8	4	38x75 C16 Solid
14	4	9	38x75 C16 Solid
15	9	5	38x75 C16 Solid

Loads

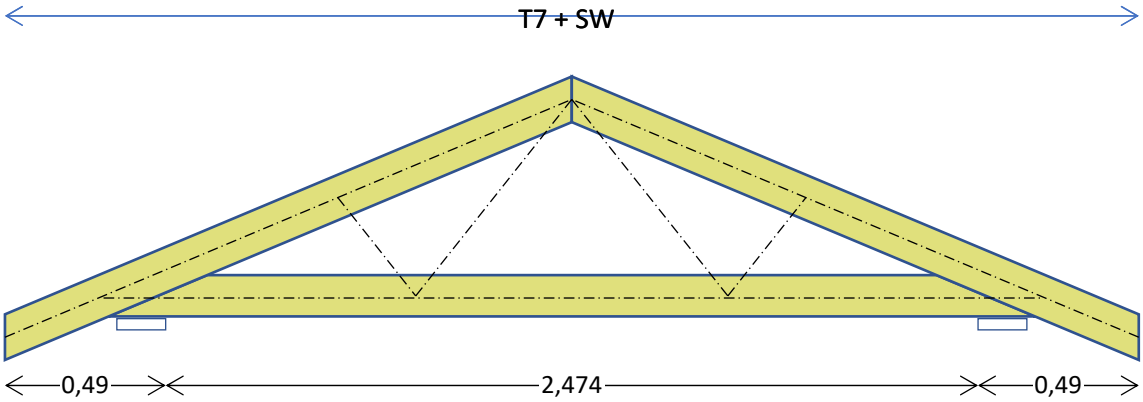
Ref	*Load*	*@*	*Gk*	*Qk*	*Wk*	*Style*
A	T6	-0,490m	0,03	0,00	0,000	U-kN/m
B	T6	-0,490m	0,20	0,23	0,120	U-kN/m

C	B18	0,048m	0,09	0,10	0,005	P-kN
D-1	B18	0,642m	0,09	0,10	0,005	P-kN
E-1	B18	1,237m	0,09	0,10	0,005	P-kN
F-1	B18	1,832m	0,09	0,10	0,005	P-kN
G-1	B18	2,426m	0,09	0,10	0,005	P-kN

The number after the Reference hyphen shows which iteration of the truss the load applies to.

	Gk	***Qk***	***Wk***	***Uv***
End R1	0,62	0,64	0,22	2,12
End R2	0,62	0,64	0,22	2,12

Truss - T7



Clear span is 2,474m Design span Ld = 2,623m

Node coor Rafter and Chord from 38x140 C16 Solid

Ref	*X (m)*	*Y (m)*	*Fx*	*Fz*	*Fr*
1	0,000	0,000	TRUE	TRUE	TRUE
2	0,301	0,140	TRUE	TRUE	TRUE
3	1 009	0,470	TRUE	TRUE	TRUE
4	1 716	0,800	TRUE	TRUE	TRUE
5	2 424	0,470	TRUE	TRUE	TRUE
6	3 132	0,140	TRUE	TRUE	TRUE
7	3 433	0,000	TRUE	TRUE	TRUE
8	1 245	0,140	TRUE	TRUE	TRUE
9	2 188	0,140	TRUE	TRUE	TRUE
10	0,416	0,140	FALSE	FALSE	TRUE
11	3 039	0,140	TRUE	FALSE	TRUE

Members

Ref	*E1*	*E2*	*Material*
1	1	2	38x140 C16 Solid
2	2	3	38x140 C16 Solid
3	3	4	38x140 C16 Solid
4	4	5	38x140 C16 Solid
5	5	6	38x140 C16 Solid
6	6	7	38x140 C16 Solid
7	2	10	38x140 C16 Solid
8	10	8	38x140 C16 Solid
9	8	9	38x140 C16 Solid
10	9	11	38x140 C16 Solid
11	11	6	38x140 C16 Solid
12	3	8	38x75 C16 Solid
13	8	4	38x75 C16 Solid
14	4	9	38x75 C16 Solid
15	9	5	38x75 C16 Solid

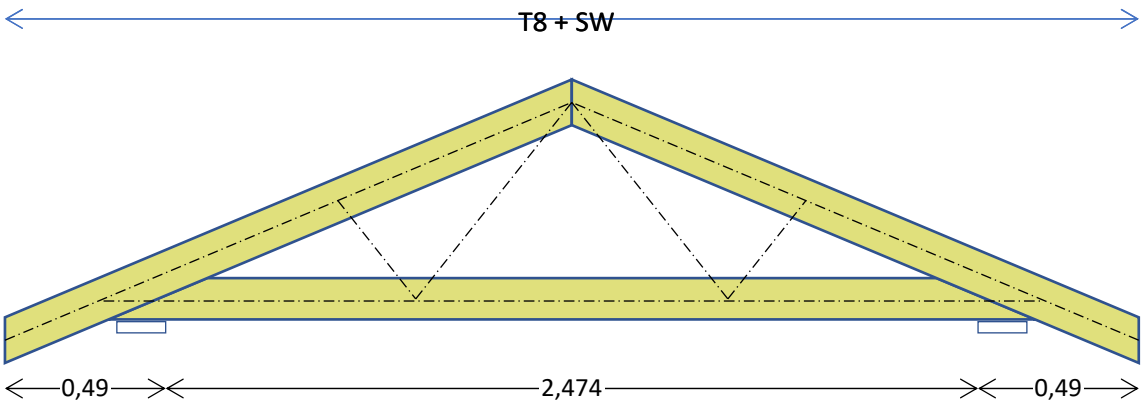
Loads

Ref	*Load*	*@*	*Gk*	*Qk*	*Wk*	*Style*
A	T7	-0,490m	0,03	0,00	0,000	U-kN/m
B	T7	-0,490m	0,39	0,45	0,239	U-kN/m

	Gk	*Qk*	*Wk*	*Uv*
End R1	0,72	0,78	0,41	2,76
End R2	0,72	0,78	0,41	2,76

Truss - T8

C D E F G



Clear span is 2,474m Design span Ld = 2,623m

Node coor Rafter and Chord from 38x140 C16 Solid

Ref	*X (m)*	*Y (m)*	*Fx*	*Fz*	*Fr*
1	0,000	0,000	TRUE	TRUE	TRUE
2	0,301	0,140	TRUE	TRUE	TRUE
3	1 009	0,470	TRUE	TRUE	TRUE
4	1 716	0,800	TRUE	TRUE	TRUE
5	2 424	0,470	TRUE	TRUE	TRUE
6	3 132	0,140	TRUE	TRUE	TRUE
7	3 433	0,000	TRUE	TRUE	TRUE
8	1 245	0,140	TRUE	TRUE	TRUE
9	2 188	0,140	TRUE	TRUE	TRUE
10	0,416	0,140	FALSE	FALSE	TRUE
11	3 039	0,140	TRUE	FALSE	TRUE

Members

Ref	*E1*	*E2*	*Material*
1	1	2	38x140 C16 Solid
2	2	3	38x140 C16 Solid
3	3	4	38x140 C16 Solid
4	4	5	38x140 C16 Solid
5	5	6	38x140 C16 Solid
6	6	7	38x140 C16 Solid
7	2	10	38x140 C16 Solid
8	10	8	38x140 C16 Solid
9	8	9	38x140 C16 Solid
10	9	11	38x140 C16 Solid
11	11	6	38x140 C16 Solid
12	3	8	38x75 C16 Solid
13	8	4	38x75 C16 Solid
14	4	9	38x75 C16 Solid
15	9	5	38x75 C16 Solid

Loads

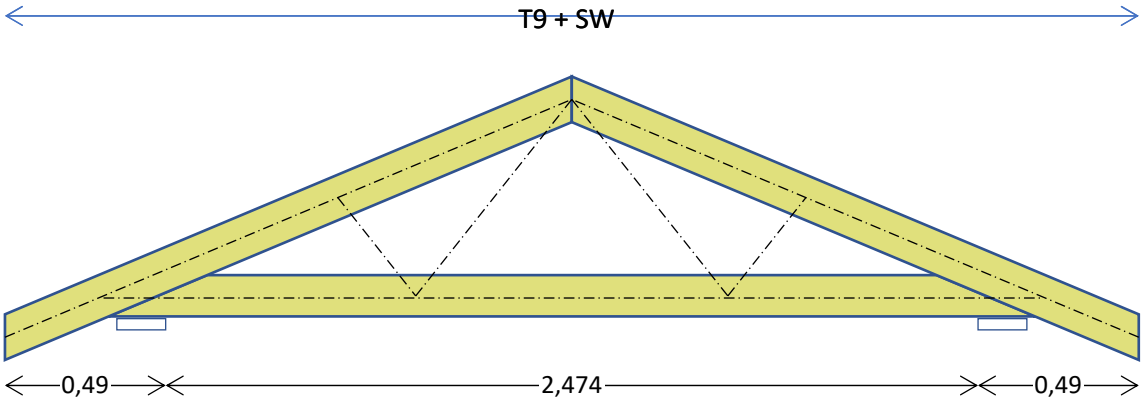
Ref	*Load*	*@*	*Gk*	*Qk*	*Wk*	*Style*
A	T8	-0,490m	0,03	0,00	0,000	U-kN/m
B	T8	-0,490m	0,20	0,23	0,120	U-kN/m

C	B19	0,048m	0,09	0,10	0,005	P-kN
D-1	B19	0,642m	0,09	0,10	0,005	P-kN
E-1	B19	1,237m	0,09	0,10	0,005	P-kN
F-1	B19	1,832m	0,09	0,10	0,005	P-kN
G-1	B19	2,426m	0,09	0,10	0,005	P-kN

The number after the Reference hyphen shows which iteration of the truss the load applies to.

	Gk	***Qk***	***Wk***	***Uv***
End R1	0,62	0,64	0,22	2,12
End R2	0,62	0,64	0,22	2,12

Truss - T9



Clear span is 2,474m Design span Ld = 2,623m

Node coor Rafter and Chord from 38x140 C16 Solid

Ref	*X (m)*	*Y (m)*	*Fx*	*Fz*	*Fr*
1	0,000	0,000	TRUE	TRUE	TRUE
2	0,301	0,140	TRUE	TRUE	TRUE
3	1 009	0,470	TRUE	TRUE	TRUE
4	1 716	0,800	TRUE	TRUE	TRUE
5	2 424	0,470	TRUE	TRUE	TRUE
6	3 132	0,140	TRUE	TRUE	TRUE
7	3 433	0,000	TRUE	TRUE	TRUE
8	1 245	0,140	TRUE	TRUE	TRUE
9	2 188	0,140	TRUE	TRUE	TRUE
10	0,416	0,140	FALSE	FALSE	TRUE
11	3 039	0,140	TRUE	FALSE	TRUE

Members

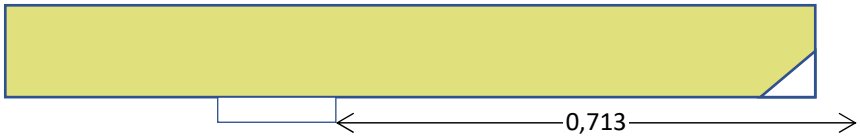
Ref	*E1*	*E2*	*Material*
1	1	2	38x140 C16 Solid
2	2	3	38x140 C16 Solid
3	3	4	38x140 C16 Solid
4	4	5	38x140 C16 Solid
5	5	6	38x140 C16 Solid
6	6	7	38x140 C16 Solid
7	2	10	38x140 C16 Solid
8	10	8	38x140 C16 Solid
9	8	9	38x140 C16 Solid
10	9	11	38x140 C16 Solid
11	11	6	38x140 C16 Solid
12	3	8	38x75 C16 Solid
13	8	4	38x75 C16 Solid
14	4	9	38x75 C16 Solid
15	9	5	38x75 C16 Solid

Loads

Ref	*Load*	*@*	*Gk*	*Qk*	*Wk*	*Style*
A	T9	-0,490m	0,03	0,00	0,000	U-kN/m
B	T9	-0,490m	0,39	0,45	0,239	U-kN/m

	Gk	*Qk*	*Wk*	*Uv*
End R1	0,72	0,78	0,41	2,76
End R2	0,72	0,78	0,41	2,76

Beam - B16



Clear span is 0,713m Spacing is 0,595m
Bearing 1 is 0,162m Bearing 2 is 0,075m
Design span is 0,831m and the beam length is 0,949m
TRY 1No. Solid 38x140 C16

Applied loading

Roof Level loads are G_k = 0,65kN/m²; Q_k= 0,75kN/m²; W_k =0,02kN/m²; P_k= 1kN

Permanent self weight of beam SW = 0,016kN/m-> SW x L_e =0,015kN

Dead load as Permanent UDL G_k = 0,403kN/m-> (SW+g_k) x L_e =0,398kN

Imposed as Variable UDL Q_k = 0,446kN/m-> q_k x L_e =0,423kN

Wind load as UDL W_k = 0,015kN/m-> w_k x L_e =0,225kN

Reactions	**Gk**	**Qk**	**Wk**
LH reaction =	0,328kN	0,363kN	0,193kN
RH reaction =	0,118kN	0,131kN	0,014kN
Mispan moment(kNm) =	0,03kNm	0,04kNm	0,02kNm

Load combinations

$FE_d = \gamma_G \times G_k + \gamma_Q \times Q_k = 1.35 \times G_k + 1.5 \times Q_k$

Ultimate reactions R1 =0,987kN; R2 = 0,356kN

Design shear V_d = 0,987kN

Total load on beam W_t = 0,940kN

Design moment M_d = 0,105kNm

Timber section details

Breadth of timber sections b = 38mm
Depth of timber sections h = 140mm
Number of timber sections in member N = 1
Overall breadth of timber member bb = $N \times b$ = 38mm
Timber strength class - EN 338:2009 Table 1 C16

Member Details

cl.2.3.1.2 Load duration class = 3
cl.2.3.1.3 Service class = 2
Bearing stress at R1 = 0,16 and at R2 = 0,08; the maximum bearing stress is 0,16N/mm²

Section Properties

Cross sectional area of member A = N x b x h = 53cm²
Section modulus Wy = N x b x h² / 6 = 124cm³
Wz = h x (N x b)² / 6 = 34cm³
Second moment of area Iy = N x b x h³ / 12 = 869cm⁴
I_z = h x (N x b)³ / 12 = 64cm⁴
Radius of gyration ry = (Iy / A)^0.5 = 4,cm
rz = (Iz / A)^0.5 = 1,1cm

Modification factors

Table 2.3	Partial factor for material properties γ_M =	1,30
Table 3.1	Load duration and moisture content K_{mod} =	0,8

Table 3.2	Deformation factor for service classes K_{def} =	0,8
(3.1)	Depth factor for bending K_{hm} =	1,01
	Depth factor for tension K_{ht} =	1,3
6.1.6(2)	Bending stress re-distribution factor K_m =	0,7
6.1.7(2)	Crack factor for shear resistance K_{cr} =	0,67
(6.4)	Load configuration factor K_{c90} =	1,86
6.6	System strength factor K_{sys} =	1,1
6.3.3(5)	Lateral buckling factor K_{crit} =	1,0

6.1.5 Compression perpendicular to the grain

Bearing stress sc.90.d = Vd / (N x b x Lb) = 0,161N/mm²

Bearing strength fc.90.d = kmod x ksys x kc.90 x fc90k / GamM = 2,769N/mm²

Ub = sc90d / fc90d = 0,058

PASS - Design bearing strength exceeds design bearing stress

6.1.6 Bending

Bending stress smd = Md / Wy = 0,843N/mm²

Bending strength fmd = khm x kmod x ksys x kcrit x fmk / GamM = 10,981N/mm²

$U_m = \sigma_{md} / f_{md} = 0,077$

PASS - Design bending strength exceeds design bending stress

6.1.7 Shear

Applied shear stress svd = 3 x Vd / (2 x Kcr x A) = 0,416N/mm²

Permissible shear stress fvd = kmod x ksys x fvk / GamM = 2,166N/mm²

Uv = svd / fvd = 0,192

PASS - Design shear strength exceeds design shear stress

7,2 Deflection

Deflection limit ulim = min(14 mm, 0.004 x Le) = 2,9mm

Instantaneous deflection due to permanent load uinstG = 0,026mm

Final deflection due to permanent load ufinG = uinstG x (1 + kdef) = 0,047mm

Instantaneous deflection due to variable load uinstQ = 0,029mm

Factor for quasi-permanent variable action Phi2 = 0,3

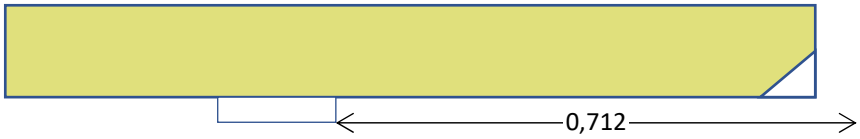
Final deflection due to variable load ufinQ = uinstQ x (1 + Phi2 x kdef) = 0,036mm

Total final deflection ufin = ufinG + ufinQ = 0,082mm

Ud = ufin / ulim = 0,029

PASS - Design deflection is less than the deflection limit

Beam - B17



Clear span is 0,712m Spacing is 0,595m
Bearing 1 is 0,162m Bearing 2 is 0,075m
Design span is 0,831m and the beam length is 0,949m
TRY 1No. Solid 38x140 C16

Applied loading

Roof Level loads are G_k = 0,65kN/m²; Q_k= 0,75kN/m²; W_k =0,02kN/m²; P_k= 1kN

Permanent self weight of beam SW = 0,016kN/m-> SW x L_e =0,015kN

Dead load as Permanent UDL G_k = 0,403kN/m-> (SW+g_k) x L_e =0,398kN

Imposed as Variable UDL Q_k = 0,446kN/m-> q_k x L_e =0,423kN

Wind load as UDL W_k = 0,015kN/m-> w_k x L_e =0,225kN

Reactions	**Gk**	**Qk**	**Wk**
LH reaction =	0,328kN	0,363kN	0,193kN
RH reaction =	0,118kN	0,131kN	0,014kN
Mispan moment(kNm) =	0,03kNm	0,04kNm	0,02kNm

Load combinations

$FE_d = \gamma_G \times G_k + \gamma_Q \times Q_k = 1.35 \times G_k + 1.5 \times Q_k$

Ultimate reactions R1 =0,987kN; R2 = 0,356kN

Design shear V_d = 0,987kN

Total load on beam W_t = 0,940kN

Design moment M_d = 0,105kNm

Timber section details

Breadth of timber sections b = 38mm
Depth of timber sections h = 140mm
Number of timber sections in member N = 1
Overall breadth of timber member bb = $N \times b$ = 38mm
Timber strength class - EN 338:2009 Table 1 C16

Member Details

cl.2.3.1.2 Load duration class = 3
cl.2.3.1.3 Service class = 2
Bearing stress at R1 = 0,16 and at R2 = 0,08; the maximum bearing stress is 0,16N/mm²

Section Properties

Cross sectional area of member A = N x b x h = 53cm²
Section modulus Wy = N x b x h² / 6 = 124cm³
Wz = h x (N x b)² / 6 = 34cm³
Second moment of area Iy = N x b x h³ / 12 = 869cm⁴
I_z = h x (N x b)³ / 12 = 64cm⁴
Radius of gyration ry = (Iy / A)^0.5 = 4,cm
rz = (Iz / A)^0.5 = 1,1cm

Modification factors

Table 2.3	Partial factor for material properties γ_M =	1,30
Table 3.1	Load duration and moisture content K_{mod} =	0,8

Table 3.2	Deformation factor for service classes K_{def} =	0,8
(3.1)	Depth factor for bending K_{hm} =	1,01
	Depth factor for tension K_{ht} =	1,3
6.1.6(2)	Bending stress re-distribution factor K_m =	0,7
6.1.7(2)	Crack factor for shear resistance K_{cr} =	0,67
(6.4)	Load configuration factor K_{c90} =	1,86
6.6	System strength factor K_{sys} =	1,1
6.3.3(5)	Lateral buckling factor K_{crit} =	1,0

6.1.5 Compression perpendicular to the grain

Bearing stress sc.90.d = Vd / (N x b x Lb) = 0,161N/mm²

Bearing strength fc.90.d = kmod x ksys x kc.90 x fc90k / GamM = 2,769N/mm²

Ub = sc90d / fc90d = 0,058

PASS - Design bearing strength exceeds design bearing stress

6.1.6 Bending

Bending stress smd = Md / Wy = 0,843N/mm²

Bending strength fmd = khm x kmod x ksys x kcrit x fmk / GamM = 10,981N/mm²

$U_m = \sigma_{md} / f_{md} = 0,077$

PASS - Design bending strength exceeds design bending stress

6.1.7 Shear

Applied shear stress svd = 3 x Vd / (2 x Kcr x A) = 0,416N/mm²

Permissible shear stress fvd = kmod x ksys x fvk / GamM = 2,166N/mm²

Uv = svd / fvd = 0,192

PASS - Design shear strength exceeds design shear stress

7,2 Deflection

Deflection limit ulim = min(14 mm, 0.004 x Le) = 2,8mm

Instantaneous deflection due to permanent load uinstG = 0,026mm

Final deflection due to permanent load ufinG = uinstG x (1 + kdef) = 0,047mm

Instantaneous deflection due to variable load uinstQ = 0,029mm

Factor for quasi-permanent variable action Phi2 = 0,3

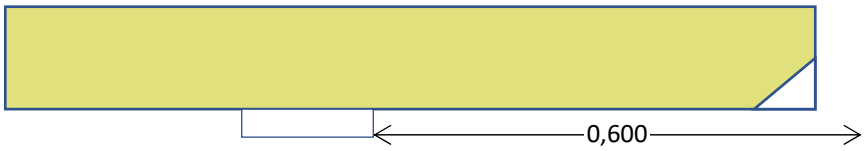
Final deflection due to variable load ufinQ = uinstQ x (1 + Phi2 x kdef) = 0,036mm

Total final deflection ufin = ufinG + ufinQ = 0,082mm

Ud = ufin / ulim = 0,029

PASS - Design deflection is less than the deflection limit

Beam - B18



Clear span is 0,600m Spacing is 0,595m
Bearing 1 is 0,162m Bearing 2 is 0,075m
Design span is 0,718m and the beam length is 0,837m
TRY 1No. Solid 38x140 C16

Applied loading

Roof Level loads are G_k = 0,65kN/m²; Q_k= 0,75kN/m²; W_k =0,02kN/m²; P_k= 1kN

Permanent self weight of beam SW = 0,016kN/m-> SW x L_e =0,014kN

Dead load as Permanent UDL G_k = 0,403kN/m-> (SW+g_k) x L_e =0,350kN

Imposed as Variable UDL Q_k = 0,446kN/m-> q_k x L_e =0,373kN

Wind load as UDL W_k = 0,014kN/m-> w_k x L_e =0,198kN

Reactions	**Gk**	**Qk**	**Wk**
LH reaction =	0,309kN	0,343kN	0,182kN
RH reaction =	0,091kN	0,101kN	0,005kN
Mispan moment(kNm) =	0,03kNm	0,03kNm	0,02kNm

Load combinations

$FE_d = \gamma_G \times G_k + \gamma_Q \times Q_k = 1.35 \times G_k + 1.5 \times Q_k$

Ultimate reactions R1 =0,932kN; R2 = 0,275kN

Design shear V_d = 0,932kN

Total load on beam W_t = 0,845kN

Design moment M_d = 0,078kNm

Timber section details

Breadth of timber sections b = 38mm
Depth of timber sections h = 140mm
Number of timber sections in member N = 1
Overall breadth of timber member bb = $N \times b$ = 38mm
Timber strength class - EN 338:2009 Table 1 C16

Member Details

cl.2.3.1.2 Load duration class = 3
cl.2.3.1.3 Service class = 2
Bearing stress at R1 = 0,16 and at R2 = 0,08; the maximum bearing stress is 0,16N/mm²

Section Properties

Cross sectional area of member A = N x b x h = 53cm²
Section modulus Wy = N x b x h² / 6 = 124cm³
Wz = h x (N x b)² / 6 = 34cm³
Second moment of area Iy = N x b x h³ / 12 = 869cm⁴
I_z = h x (N x b)³ / 12 = 64cm⁴
Radius of gyration ry = (Iy / A)^0.5 = 4,cm
rz = (Iz / A)^0.5 = 1,1cm

Modification factors

Table 2.3	Partial factor for material properties γ_M =	1,30
Table 3.1	Load duration and moisture content K_{mod} =	0,8

Table 3.2	Deformation factor for service classes K_{def} =	0,8
(3.1)	Depth factor for bending K_{hm} =	1,01
	Depth factor for tension K_{ht} =	1,3
6.1.6(2)	Bending stress re-distribution factor K_m =	0,7
6.1.7(2)	Crack factor for shear resistance K_{cr} =	0,67
(6.4)	Load configuration factor K_{c90} =	1,86
6.6	System strength factor K_{sys} =	1,1
6.3.3(5)	Lateral buckling factor K_{crit} =	1,0

6.1.5 Compression perpendicular to the grain

Bearing stress sc.90.d = Vd / (N x b x Lb) = 0,152N/mm²

Bearing strength fc.90.d = kmod x ksys x kc.90 x fc90k / GamM = 2,769N/mm²

Ub = sc90d / fc90d = 0,055

PASS - Design bearing strength exceeds design bearing stress

6.1.6 Bending

Bending stress smd = Md / Wy = 0,63N/mm²

Bending strength fmd = khm x kmod x ksys x kcrit x fmk / GamM = 10,981N/mm²

$U_m = \sigma_{md} / f_{md} = 0,057$

PASS - Design bending strength exceeds design bending stress

6.1.7 Shear

Applied shear stress svd = 3 x Vd / (2 x Kcr x A) = 0,392N/mm²

Permissible shear stress fvd = kmod x ksys x fvk / GamM = 2,166N/mm²

Uv = svd / fvd = 0,181

PASS - Design shear strength exceeds design shear stress

7,2 Deflection

Deflection limit ulim = min(14 mm, 0.004 x Le) = 2,4mm

Instantaneous deflection due to permanent load uinstG = 0,014mm

Final deflection due to permanent load ufinG = uinstG x (1 + kdef) = 0,025mm

Instantaneous deflection due to variable load uinstQ = 0,015mm

Factor for quasi-permanent variable action Phi2 = 0,3

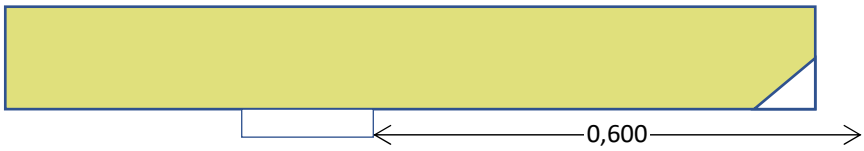
Final deflection due to variable load ufinQ = uinstQ x (1 + Phi2 x kdef) = 0,019mm

Total final deflection ufin = ufinG + ufinQ = 0,043mm

Ud = ufin / ulim = 0,018

PASS - Design deflection is less than the deflection limit

Beam - B19



Clear span is 0,600m Spacing is 0,595m
Bearing 1 is 0,162m Bearing 2 is 0,075m
Design span is 0,718m and the beam length is 0,836m
TRY 1No. Solid 38x140 C16

Applied loading

Roof Level loads are G_k = 0,65kN/m²; Q_k= 0,75kN/m²; W_k =0,02kN/m²; P_k= 1kN

Permanent self weight of beam SW = 0,016kN/m-> SW x L_e =0,014kN

Dead load as Permanent UDL G_k = 0,403kN/m-> (SW+g_k) x L_e =0,350kN

Imposed as Variable UDL Q_k = 0,446kN/m-> q_k x L_e =0,373kN

Wind load as UDL W_k = 0,014kN/m-> w_k x L_e =0,198kN

Reactions	**Gk**	**Qk**	**Wk**
LH reaction =	0,309kN	0,343kN	0,182kN
RH reaction =	0,091kN	0,101kN	0,005kN
Mispan moment(kNm) =	0,03kNm	0,03kNm	0,02kNm

Load combinations

$FE_d = \gamma_G \times G_k + \gamma_Q \times Q_k = 1.35 \times G_k + 1.5 \times Q_k$

Ultimate reactions R1 =0,932kN; R2 = 0,275kN

Design shear V_d = 0,932kN

Total load on beam W_t = 0,845kN

Design moment M_d = 0,078kNm

Timber section details

Breadth of timber sections b = 38mm
Depth of timber sections h = 140mm
Number of timber sections in member N = 1
Overall breadth of timber member bb = $N \times b$ = 38mm
Timber strength class - EN 338:2009 Table 1 C16

Member Details

cl.2.3.1.2 Load duration class = 3
cl.2.3.1.3 Service class = 2
Bearing stress at R1 = 0,16 and at R2 = 0,08; the maximum bearing stress is 0,16N/mm²

Section Properties

Cross sectional area of member A = N x b x h = 53cm²
Section modulus Wy = N x b x h² / 6 = 124cm³
Wz = h x (N x b)² / 6 = 34cm³
Second moment of area Iy = N x b x h³ / 12 = 869cm⁴
I_z = h x (N x b)³ / 12 = 64cm⁴
Radius of gyration ry = (Iy / A)^0.5 = 4,cm
rz = (Iz / A)^0.5 = 1,1cm

Modification factors

Table 2.3	Partial factor for material properties γ_M =	1,30
Table 3.1	Load duration and moisture content K_{mod} =	0,8

Table 3.2	Deformation factor for service classes K_{def} =	0,8
(3.1)	Depth factor for bending K_{hm} =	1,01
	Depth factor for tension K_{ht} =	1,3
6.1.6(2)	Bending stress re-distribution factor K_m =	0,7
6.1.7(2)	Crack factor for shear resistance K_{cr} =	0,67
(6.4)	Load configuration factor K_{c90} =	1,86
6.6	System strength factor K_{sys} =	1,1
6.3.3(5)	Lateral buckling factor K_{crit} =	1,0

6.1.5 Compression perpendicular to the grain

Bearing stress sc.90.d = Vd / (N x b x Lb) = 0,152N/mm²

Bearing strength fc.90.d = kmod x ksys x kc.90 x fc90k / GamM = 2,769N/mm²

Ub = sc90d / fc90d = 0,055

PASS - Design bearing strength exceeds design bearing stress

6.1.6 Bending

Bending stress smd = Md / Wy = 0,63N/mm²

Bending strength fmd = khm x kmod x ksys x kcrit x fmk / GamM = 10,981N/mm²

$U_m = \sigma_{md} / f_{md} = 0,057$

PASS - Design bending strength exceeds design bending stress

6.1.7 Shear

Applied shear stress svd = 3 x Vd / (2 x Kcr x A) = 0,392N/mm²

Permissible shear stress fvd = kmod x ksys x fvk / GamM = 2,166N/mm²

Uv = svd / fvd = 0,181

PASS - Design shear strength exceeds design shear stress

7,2 Deflection

Deflection limit ulim = min(14 mm, 0.004 x Le) = 2,4mm

Instantaneous deflection due to permanent load uinstG = 0,014mm

Final deflection due to permanent load ufinG = uinstG x (1 + kdef) = 0,025mm

Instantaneous deflection due to variable load uinstQ = 0,015mm

Factor for quasi-permanent variable action Phi2 = 0,3

Final deflection due to variable load ufinQ = uinstQ x (1 + Phi2 x kdef) = 0,019mm

Total final deflection ufin = ufinG + ufinQ = 0,043mm

Ud = ufin / ulim = 0,018

PASS - Design deflection is less than the deflection limit

Post List

Ref	Wall	Fd	Uc	Ucmy	Ucmz	Plate
P1	W2	5,705	0,108	0,078	0,000	FALSE
P2	W6	5,647	0,107	0,077	0,000	FALSE
P3	W8	5,705	0,108	0,078	0,000	FALSE
P4	W12	5,647	0,107	0,077	0,000	FALSE
P5	W2	14,325	0,272	0,195	0,000	FALSE
P6	W6	27,859	0,529	0,379	0,000	FALSE
P7	W12	10,162	0,193	0,138	0,000	FALSE
P8	W8	24,274	0,461	0,330	0,000	FALSE

Post P1 The post is inside a panel in wall W2

Storey height = 2,4m | Wall Class = C16

Head binder = 0,038m | Top rail = 0,038m

Bottom rail = 0,038m | Sole plate = 0,038m

Post length = 2,248m | Effective length = 2,248m | Eccentricity e = ,006m

Depth H =140mm | Breadth B =38mm | Style = Solid | Post Class = C16

No off = 2 | Area = 106,4cm² | I_{yy} = 1 737,9cm^4

W_{yy} = 248,27cm³ | r_{yy} = 4,04cm

6.1.6 k_m = 0,7 | k_{sys} = 1,0

Wind pressure is not considered on this post.

Stability in the zz direction is assured by the fixings of the panel to the stud.

f_{myk} = 16,0N/mm² | f_{c0k} = 17,0N/mm² | E_{05} = 5 360N/mm² | Service class = 2

Table 3.1 k_{mod} = 0,9 | γ_m = 1,3 | f_{myd} = 11,08N/mm² | f_{c0d} = 11,77N/mm²

Actions	**Ref**	**Gk**	**Qk**	**Wk**		
	T5-R1	1,566kN	1,563kN	0,831kN		
	Post P1	1,566kN	1,563kN	0,831kN	-> UV = 5,705kN	-> σ_{c0d} = 0,536N/mm²

M_d =0,032kNm | M_{yd} =0,032kNm

σ_{myd} =0,129N/mm²

6.3.2 λ_{yy} = 55,6

(6.21) λ_{rely} = 0,997 | From 6.3.2(3) Use expressions (6.23-29)

β_c = 0,2 | k_y = 1,067 | k_{cy} = 0,691

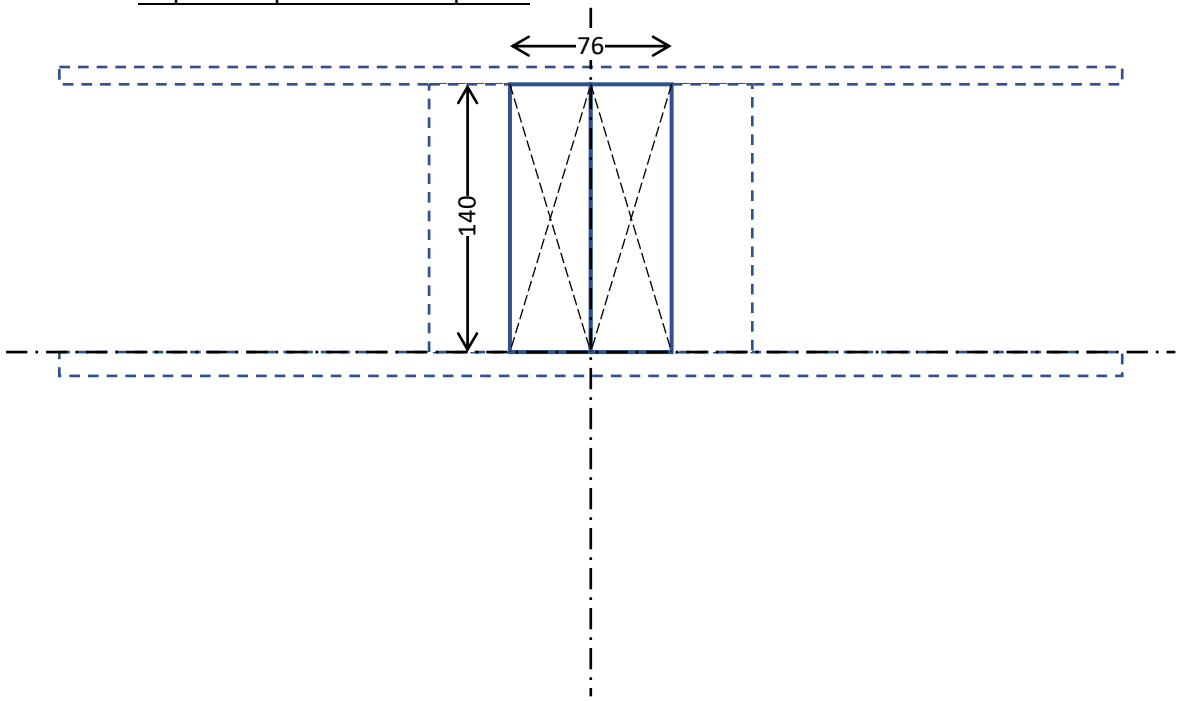
U_{cmy} = 0,078

PASS Combined Bending and Compression rules

(6.5) Bearing f_{c90k} = 2,20N/mm² | k_{c90} = 2,25 | f_{c90d} = 4,95N/mm²

Limiting load F_{c90} = 52,64kN

A spreader plate is not required.



Post P2 The post is inside a panel in wall W6

Storey height = 2,4m | Wall Class = C16

Head binder = 0,038m | Top rail = 0,038m

Bottom rail = 0,038m | Sole plate = 0,038m

Post length = 2,248m | Effective length = 2,248m | Eccentricity e = ,006m

Depth H =140mm | Breadth B =38mm | Style = Solid | Post Class = C16

No off = 2 | Area = 106,4cm² | I_{yy} = 1 737,9cm^4

W_{yy} = 248,27cm³ | r_{yy} = 4,04cm

6.1.6 k_m = 0,7 | k_{sys} = 1,0

Wind pressure is not considered on this post.

Stability in the zz direction is assured by the fixings of the panel to the stud.

f_{myk} = 16,0N/mm² | f_{c0k} = 17,0N/mm² | E_{05} = 5 360N/mm² | Service class = 2

Table 3.1 k_{mod} = 0,9 | γ_m = 1,3 | f_{myd} = 11,08N/mm² | f_{c0d} = 11,77N/mm²

Actions	**Ref**	**Gk**	**Qk**	**Wk**		
	T3-R2	1,551kN	1,547kN	0,822kN		
	Post P2	1,551kN	1,547kN	0,822kN	-> UV = 5,647kN	-> σ_{c0d} = 0,531N/mm²

M_d =0,032kNm | M_{yd} =0,032kNm

σ_{myd} =0,128N/mm²

6.3.2 λ_{yy} = 55,6

(6.21) λ_{rely} = 0,997 | From 6.3.2(3) Use expressions (6.23-29)

β_c = 0,2 | k_y = 1,067 | k_{cy} = 0,691

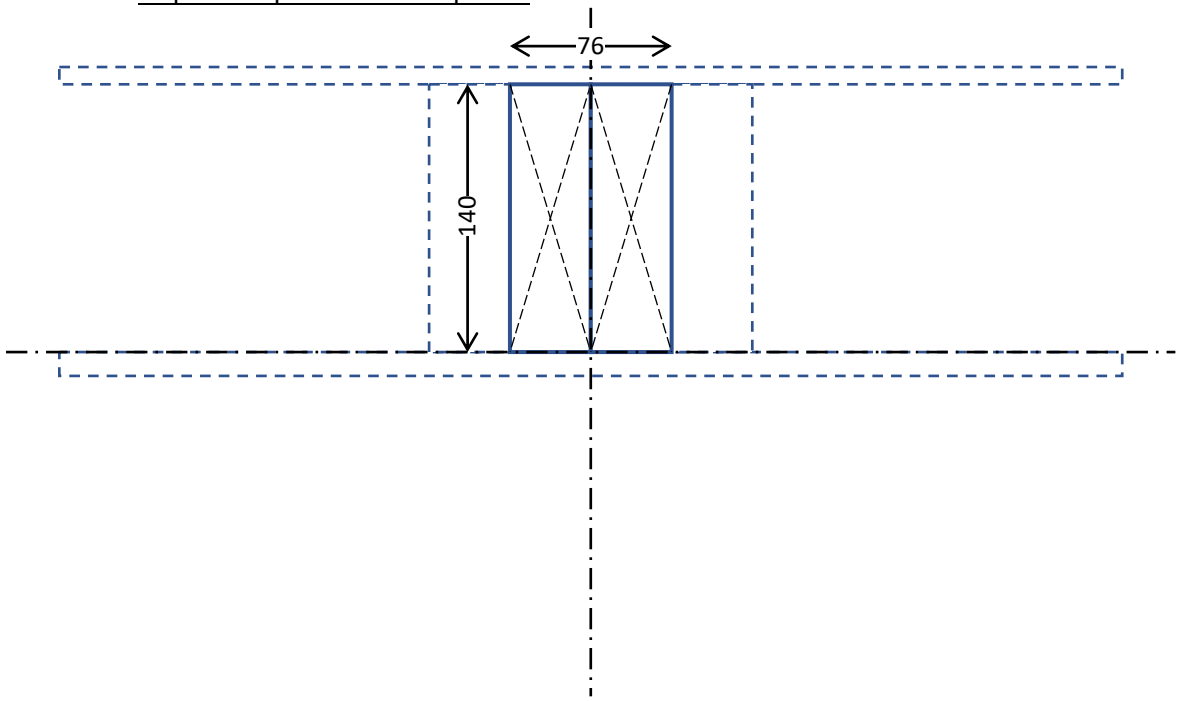
U_{cmy} = 0,077

PASS Combined Bending and Compression rules

(6.5) Bearing f_{c90k} = 2,20N/mm² | k_{c90} = 2,25 | f_{c90d} = 4,95N/mm²

Limiting load F_{c90} = 52,64kN

A spreader plate is not required.



Post P3 The post is inside a panel in wall W8

Storey height = 2,4m | Wall Class = C16

Head binder = 0,038m | Top rail = 0,038m

Bottom rail = 0,038m | Sole plate = 0,038m

Post length = 2,248m | Effective length = 2,248m | Eccentricity e = ,006m

Depth H =140mm | Breadth B =38mm | Style = Solid | Post Class = C16

No off = 2 | Area = 106,4cm² | I_{yy} = 1 737,9cm^4

W_{yy} = 248,27cm³ | r_{yy} = 4,04cm

6.1.6 k_m = 0,7 | k_{sys} = 1,0

Wind pressure is not considered on this post.

Stability in the zz direction is assured by the fixings of the panel to the stud.

f_{myk} = 16,0N/mm² | f_{c0k} = 17,0N/mm² | E_{05} = 5 360N/mm² | Service class = 2

Table 3.1 k_{mod} = 0,9 | γ_m = 1,3 | f_{myd} = 11,08N/mm² | f_{c0d} = 11,77N/mm²

Actions	**Ref**	**Gk**	**Qk**	**Wk**		
	T3-R1	1,566kN	1,563kN	0,831kN		
	Post P3	1,566kN	1,563kN	0,831kN	-> UV = 5,705kN	-> σ_{c0d} = 0,536N/mm²

M_d =0,032kNm | M_{yd} =0,032kNm

σ_{myd} =0,129N/mm²

6.3.2 λ_{yy} = 55,6

(6.21) λ_{rely} = 0,997 | From 6.3.2(3) Use expressions (6.23-29)

β_c = 0,2 | k_y = 1,067 | k_{cy} = 0,691

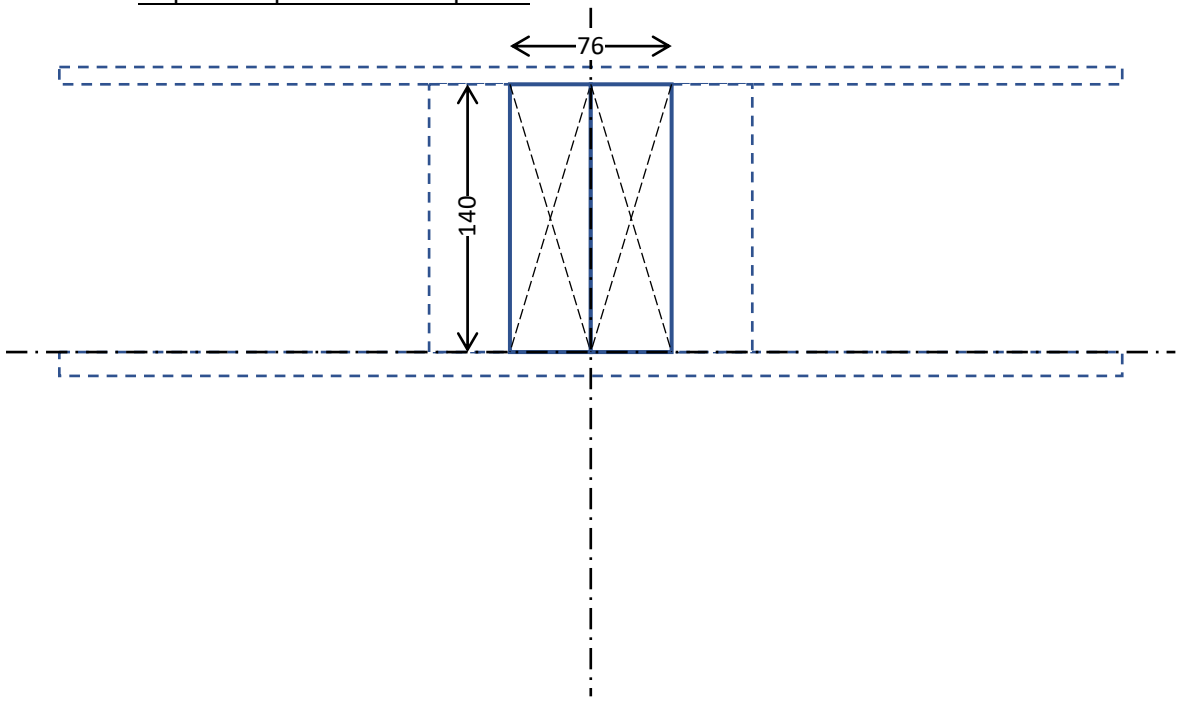
U_{cmy} = 0,078

PASS Combined Bending and Compression rules

(6.5) Bearing f_{c90k} = 2,20N/mm² | k_{c90} = 2,25 | f_{c90d} = 4,95N/mm²

Limiting load F_{c90} = 52,64kN

A spreader plate is not required.



Post P4 The post is inside a panel in wall W12

Storey height = 2,4m | Wall Class = C16

Head binder = 0,038m | Top rail = 0,038m

Bottom rail = 0,038m | Sole plate = 0,038m

Post length = 2,248m | Effective length = 2,248m | Eccentricity e = ,006m

Depth H =140mm | Breadth B =38mm | Style = Solid | Post Class = C16

No off = 2 | Area = 106,4cm² | I_{yy} = 1 737,9cm^4

W_{yy} = 248,27cm³ | r_{yy} = 4,04cm

6.1.6 k_m = 0,7 | k_{sys} = 1,0

Wind pressure is not considered on this post.

Stability in the zz direction is assured by the fixings of the panel to the stud.

f_{myk} = 16,0N/mm² | f_{c0k} = 17,0N/mm² | E_{05} = 5 360N/mm² | Service class = 2

Table 3.1 k_{mod} = 0,9 | γ_m = 1,3 | f_{myd} = 11,08N/mm² | f_{c0d} = 11,77N/mm²

Actions	**Ref**	**Gk**	**Qk**	**Wk**		
	T5-R2	1,551kN	1,547kN	0,822kN		
	Post P4	1,551kN	1,547kN	0,822kN	-> UV = 5,647kN	-> σ_{c0d} = 0,531N/mm²

M_d =0,032kNm | M_{yd} =0,032kNm

σ_{myd} =0,128N/mm²

6.3.2 λ_{yy} = 55,6

(6.21) λ_{rely} = 0,997 | From 6.3.2(3) Use expressions (6.23-29)

β_c = 0,2 | k_y = 1,067 | k_{cy} = 0,691

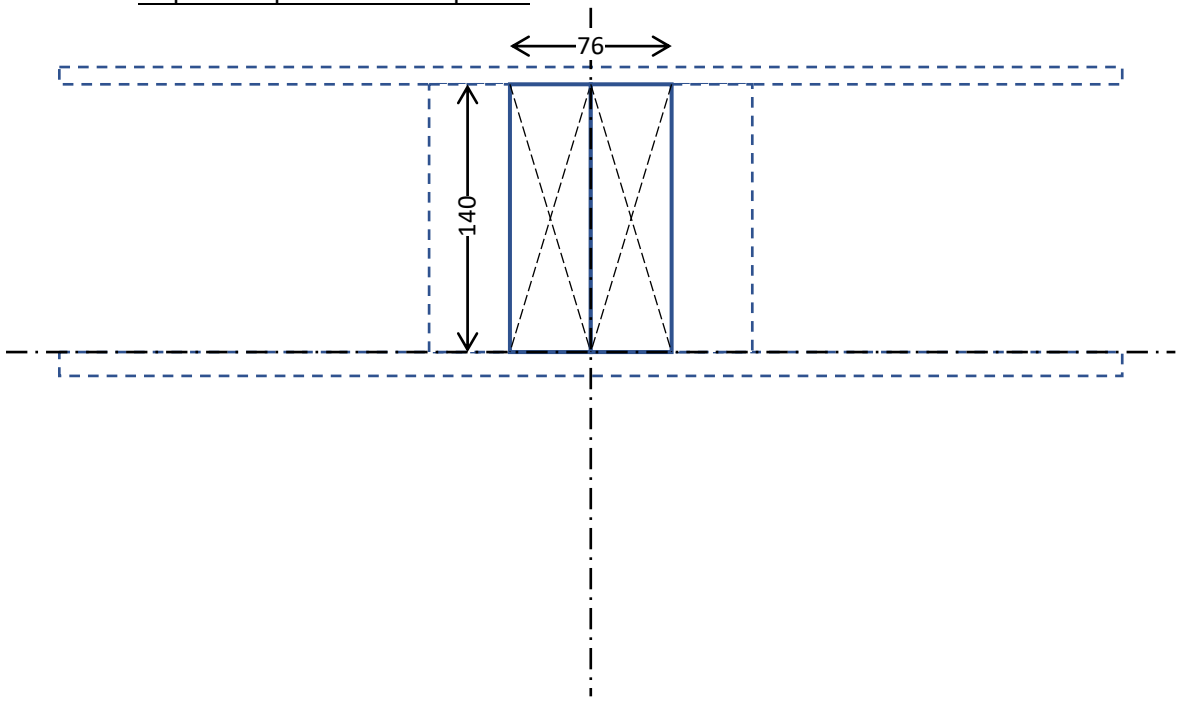
U_{cmy} = 0,077

PASS Combined Bending and Compression rules

(6.5) Bearing | f_{c90k} = 2,20N/mm² | k_{c90} = 2,25 | f_{c90d} = 4,95N/mm²

Limiting load F_{c90} = 52,64kN

A spreader plate is not required.



Post P5 The post is inside a panel in wall W2

Storey height = 2,4m | Wall Class = C16

Head binder = 0,038m | Top rail = 0,038m

Bottom rail = 0,038m | Sole plate = 0,038m

Post length = 2,248m | Effective length = 2,248m | Eccentricity e = ,006m

Depth H =140mm | Breadth B =38mm | Style = Solid | Post Class = C16

No off = 2 | Area = 106,4cm² | I_{yy} = 1 737,9cm^4

W_{yy} = 248,27cm³ | r_{yy} = 4,04cm

6.1.6 k_m = 0,7 | k_{sys} = 1,0

Wind pressure is not considered on this post.

Stability in the zz direction is assured by the fixings of the panel to the stud.

f_{myk} = 16,0N/mm² | f_{c0k} = 17,0N/mm² | E_{05} = 5 360N/mm² | Service class = 2

Table 3.1 k_{mod} = 0,9 | γ_m = 1,3 | f_{myd} = 11,08N/mm² | f_{c0d} = 11,77N/mm²

Actions	**Ref**	**Gk**	**Qk**	**Wk**		
	B2-R1	3,797kN	4,004kN	2,128kN		
	Post P5	3,797kN	4,004kN	2,128kN	-> UV = 14,325kN	-> σ_{c0d} = 1,346N/mm²

M_d =0,081kNm | M_{yd} =0,081kNm

σ_{myd} =0,324N/mm²

6.3.2 λ_{yy} = 55,6

(6.21) λ_{rely} = 0,997 | From 6.3.2(3) Use expressions (6.23-29)

β_c = 0,2 | k_y = 1,067 | k_{cy} = 0,691

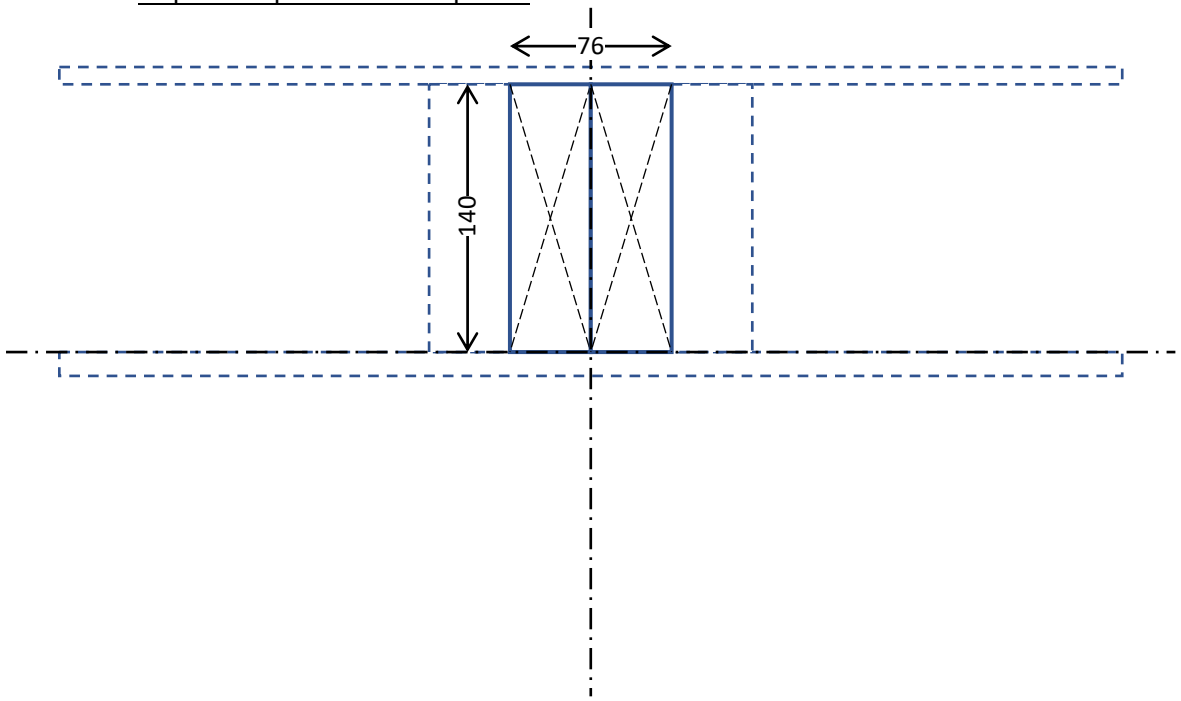
U_{cmy} = 0,195

PASS Combined Bending and Compression rules

(6.5) Bearing | f_{c90k} = 2,20N/mm² | k_{c90} = 2,25 | f_{c90d} = 4,95N/mm²

Limiting load F_{c90} = 52,64kN

A spreader plate is not required.



Post P6 The post is inside a panel in wall W6

Storey height = 2,4m | Wall Class = C16

Head binder = 0,038m | Top rail = 0,038m

Bottom rail = 0,038m | Sole plate = 0,038m

Post length = 2,248m | Effective length = 2,248m | Eccentricity e = ,006m

Depth H =140mm | Breadth B =38mm | Style = Solid | Post Class = C16

No off = 2 | Area = 106,4cm² | I_{yy} = 1 737,9cm^4

W_{yy} = 248,27cm³ | r_{yy} = 4,04cm

6.1.6 k_m = 0,7 | k_{sys} = 1,0

Wind pressure is not considered on this post.

Stability in the zz direction is assured by the fixings of the panel to the stud.

f_{myk} = 16,0N/mm² | f_{c0k} = 17,0N/mm² | E_{05} = 5 360N/mm² | Service class = 2

Table 3.1 k_{mod} = 0,9 | γ_m = 1,3 | f_{myd} = 11,08N/mm² | f_{c0d} = 11,77N/mm²

Actions	**Ref**	**Gk**	**Qk**	**Wk**		
	B2-R2	6,304kN	6,626kN	6,273kN		
	Post P6	6,304kN	6,626kN	6,273kN	-> UV = 27,859kN	-> σ_{c0d} = 2,618N/mm²

M_d =0,157kNm | M_{yd} =0,157kNm

σ_{myd} =0,631N/mm²

6.3.2 λ_{yy} = 55,6

(6.21) λ_{rely} = 0,997 | From 6.3.2(3) Use expressions (6.23-29)

β_c = 0,2 | k_y = 1,067 | k_{cy} = 0,691

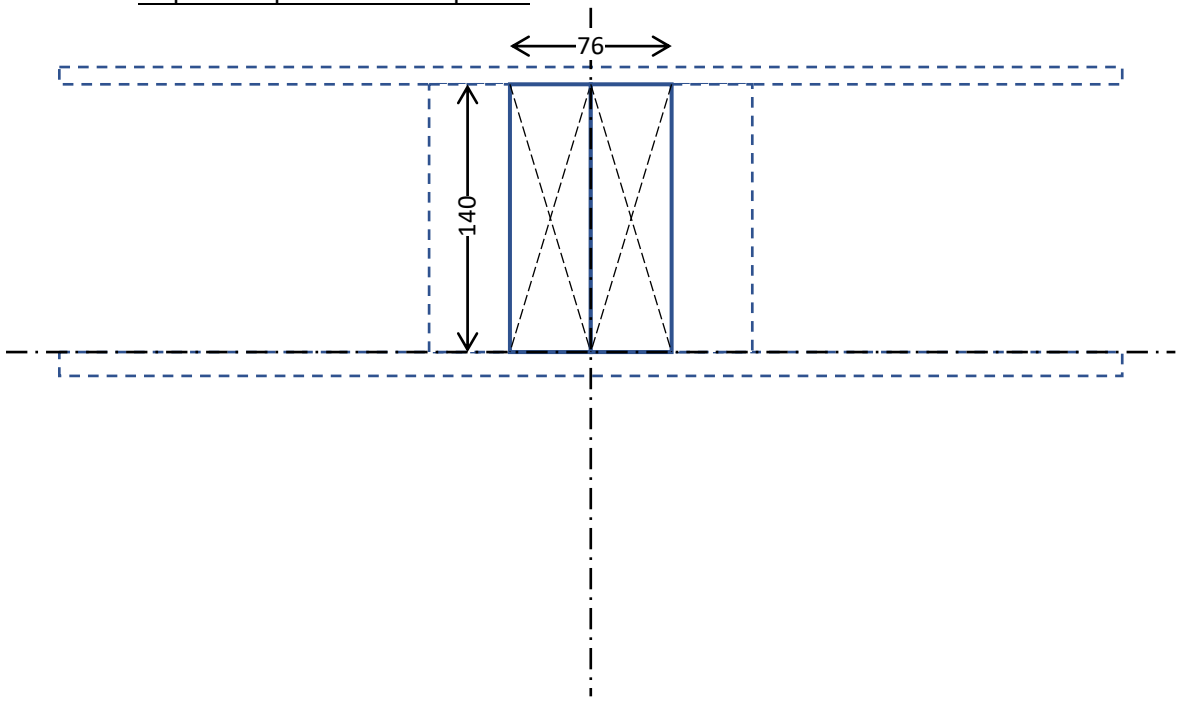
U_{cmy} = 0,379

PASS Combined Bending and Compression rules

(6.5) Bearing f_{c90k} = 2,20N/mm² | k_{c90} = 2,25 | f_{c90d} = 4,95N/mm²

Limiting load F_{c90} = 52,64kN

A spreader plate is not required.



Post P7 The post is inside a panel in wall W12

Storey height = 2,4m | Wall Class = C16

Head binder = 0,038m | Top rail = 0,038m

Bottom rail = 0,038m | Sole plate = 0,038m

Post length = 2,248m | Effective length = 2,248m | Eccentricity e = ,006m

Depth H =140mm | Breadth B =38mm | Style = Solid | Post Class = C16

No off = 2 | Area = 106,4cm² | I_{yy} = 1 737,9cm^4

W_{yy} = 248,27cm³ | r_{yy} = 4,04cm

6.1.6 k_m = 0,7 | k_{sys} = 1,0

Wind pressure is not considered on this post.

Stability in the zz direction is assured by the fixings of the panel to the stud.

f_{myk} = 16,0N/mm² | f_{c0k} = 17,0N/mm² | E_{05} = 5 360N/mm² | Service class = 2

Table 3.1 k_{mod} = 0,9 | γ_m = 1,3 | f_{myd} = 11,08N/mm² | f_{c0d} = 11,77N/mm²

Actions	**Ref**	**Gk**	**Qk**	**Wk**		
	B1-R1	2,731kN	2,819kN	1,498kN		
	Post P7	2,731kN	2,819kN	1,498kN	-> UV = 10,162kN	-> σ_{c0d} = 0,955N/mm²

M_d =0,057kNm | M_{yd} =0,057kNm

σ_{myd} =0,230N/mm²

6.3.2 λ_{yy} = 55,6

(6.21) λ_{rely} = 0,997 | From 6.3.2(3) Use expressions (6.23-29)

β_c = 0,2 | k_y = 1,067 | k_{cy} = 0,691

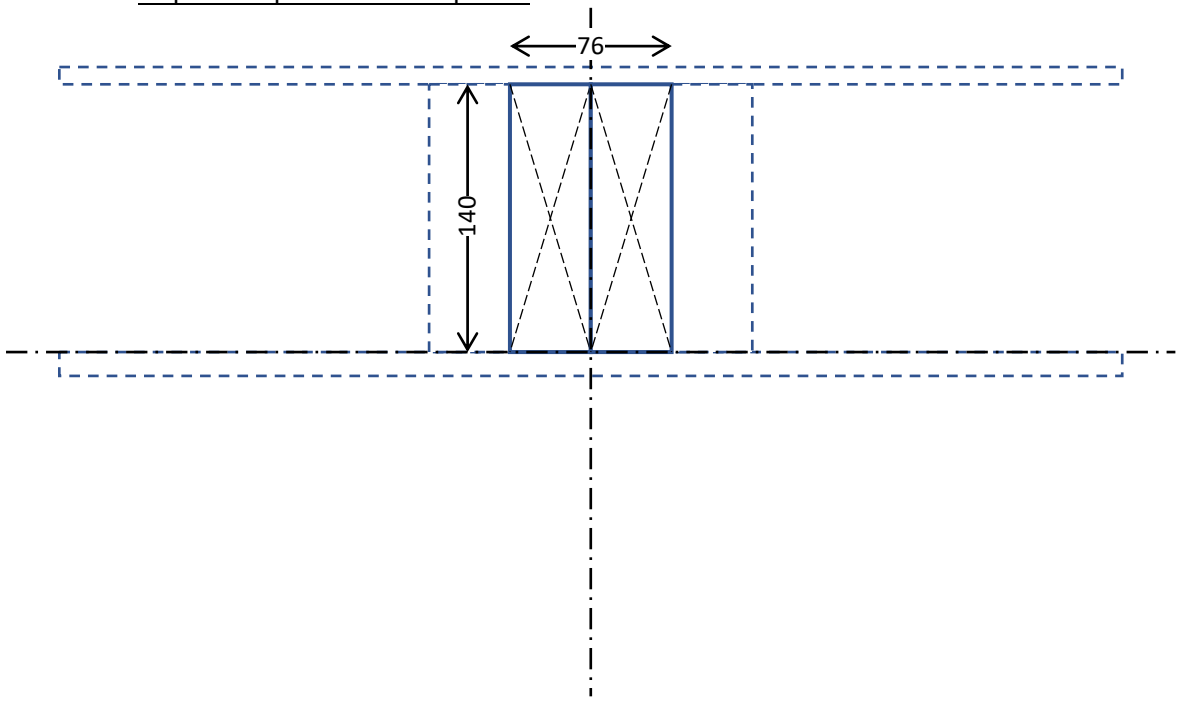
U_{cmy} = 0,138

PASS Combined Bending and Compression rules

(6.5) Bearing f_{c90k} = 2,20N/mm² | k_{c90} = 2,25 | f_{c90d} = 4,95N/mm²

Limiting load F_{c90} = 52,64kN

A spreader plate is not required.



Post P8 The post is inside a panel in wall W8

Storey height = 2,4m | Wall Class = C16

Head binder = 0,038m | Top rail = 0,038m

Bottom rail = 0,038m | Sole plate = 0,038m

Post length = 2,248m | Effective length = 2,248m | Eccentricity e = ,006m

Depth H =140mm | Breadth B =38mm | Style = Solid | Post Class = C16

No off = 2 | Area = 106,4cm² | I_{yy} = 1 737,9cm^4

W_{yy} = 248,27cm³ | r_{yy} = 4,04cm

6.1.6 k_m = 0,7 | k_{sys} = 1,0

Wind pressure is not considered on this post.

Stability in the zz direction is assured by the fixings of the panel to the stud.

f_{myk} = 16,0N/mm² | f_{c0k} = 17,0N/mm² | E_{05} = 5 360N/mm² | Service class = 2

Table 3.1 k_{mod} = 0,9 | γ_m = 1,3 | f_{myd} = 11,08N/mm² | f_{c0d} = 11,77N/mm²

Actions	**Ref**	**Gk**	**Qk**	**Wk**		
	B1-R2	5,375kN	5,575kN	5,770kN		
	Post P8	5,375kN	5,575kN	5,770kN	-> UV = 24,274kN	-> σ_{c0d} = 2,281N/mm²

M_d =0,136kNm | M_{yd} =0,136kNm

σ_{myd} =0,549N/mm²

6.3.2 λ_{yy} = 55,6

(6.21) λ_{rely} = 0,997 | From 6.3.2(3) Use expressions (6.23-29)

β_c = 0,2 | k_y = 1,067 | k_{cy} = 0,691

U_{cmy} = 0,330

PASS Combined Bending and Compression rules

(6.5) Bearing f_{c90k} = 2,20N/mm² | k_{c90} = 2,25 | f_{c90d} = 4,95N/mm²

Limiting load F_{c90} = 52,64kN

A spreader plate is not required.