

STAROSTWO POWIATOWE  
w Środzie Wielkopolskiej (2)  
Wydział Budownictwa i Dróg

**PROJEKT KONSTRUKCJI WIATY WYPOŻYCZALNI SPRZĘTÓW  
WODNYCH**





ArcelorMittal

STAROSTWO POWIATOWE  
w Srodzie Wielkopolskiej (2)  
Wydział Budownictwa i Dróg

# Software **PORTAL+** v 1.23

## PRELIMINARY DESIGN NOTE





## I - BUILDING PARAMETERS

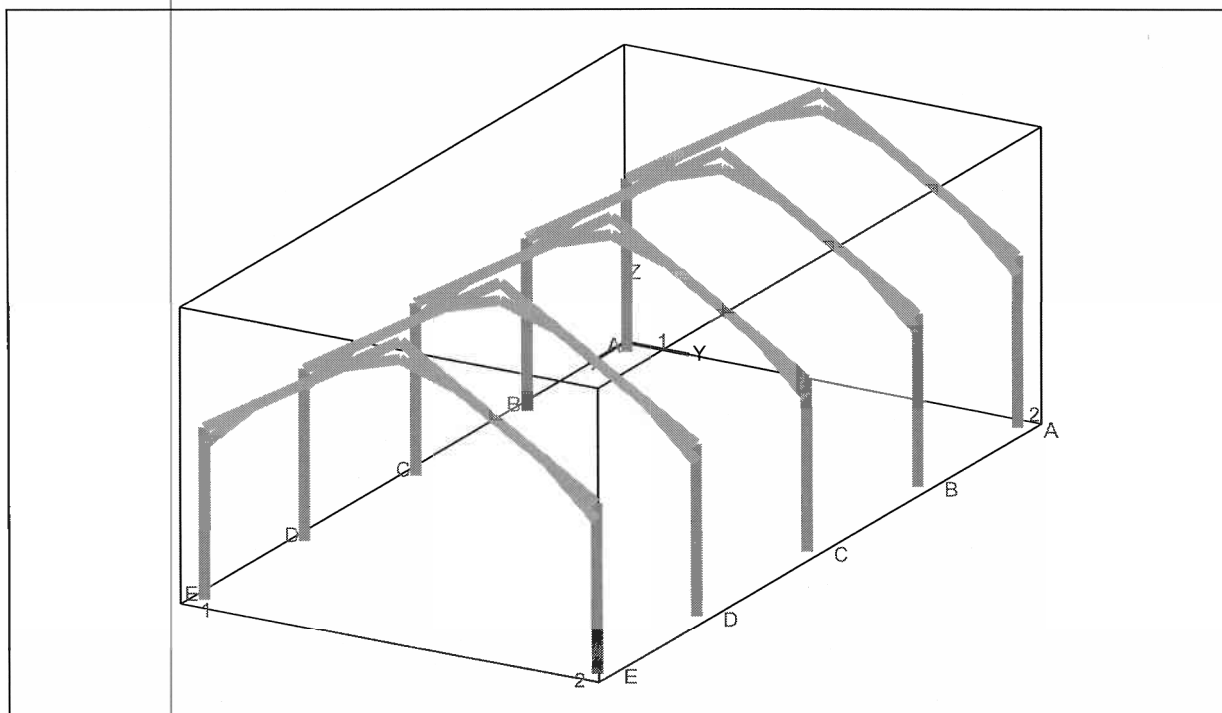


Figure 1 : Building in 3D

Type of dimensions :	Architect
Total length :	12 m
Number of portal frames :	5
Total width :	6,5 m
Number of spans :	1
Columns height :	2,5 m
Parapets :	No
Roof :	
Thickness :	0,1 m
Surface mass :	50 kg/m <sup>2</sup>
Gable cladding :	
Thickness :	0,2 m
Longpan cladding :	
Thickness :	0,1 m
Surface mass :	20 kg/m <sup>2</sup>

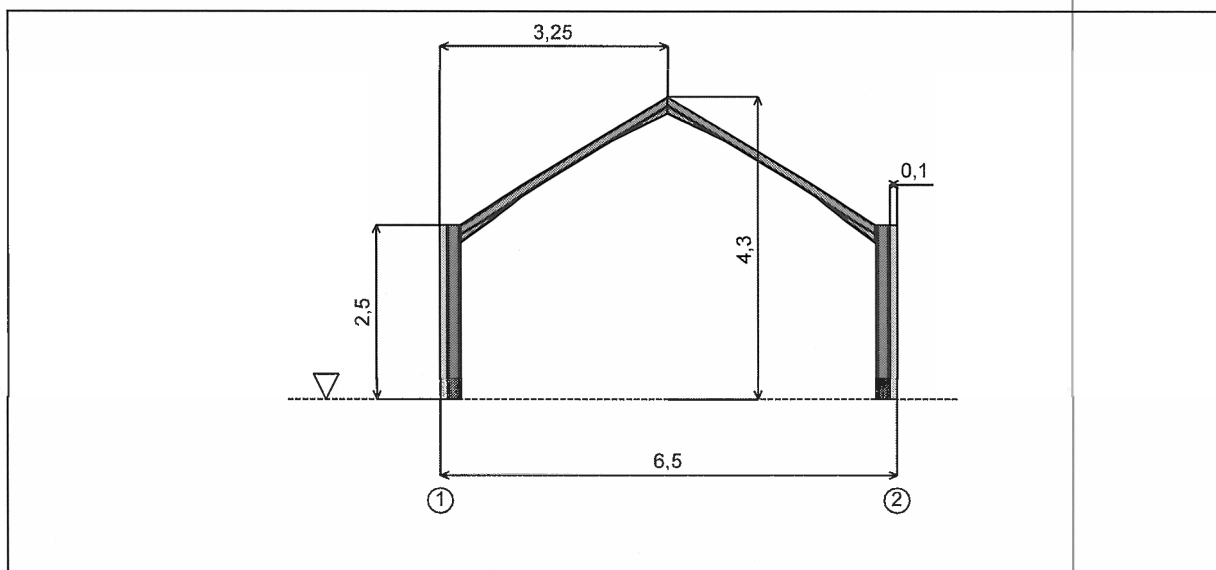


Figure 2 : Plan of the representative portal frame

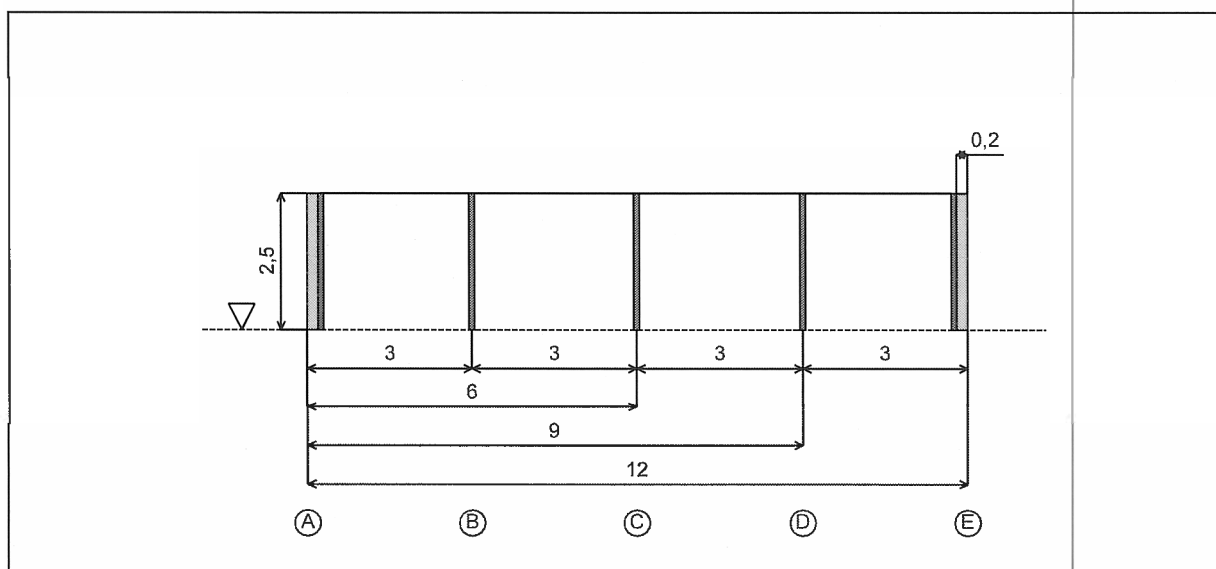


Figure 3 : Position of portal frames

Table 1 : Load factor for continuous purlins.

Portal frame	Load factor for continuous purlins
A	1
B	1
C	1
D	1
E	1

Version of the profiles database :

2015-01

Version of the steels database :

2015-01

## II - DESIGN PARAMETERS

### II.1 - Partial factors on loads

Permanent loads (unfavorable) :	$\gamma_{G,sup}$	= 1,35
Permanent loads (favorable) :	$\gamma_{G,inf}$	= 1,00
Variable loads :	$\gamma_Q$	= 1,50

### II.2 - Partial factors on resistances

With instability phenomenon :	$\gamma_{M,0}$	= 1,00
Without instability phenomenon :	$\gamma_{M,1}$	= 1,00

### II.3 - Combination factors for wind loads

Combination value :	$\psi_0$	= 0,60
Frequent value :	$\psi_1$	= 0,20
Quasi-permanent value :	$\psi_2$	= 0,00

### II.4 - Combination factors for snow loads

Combination value :	$\psi_0$	= 0,50
Frequent value :	$\psi_1$	= 0,20
Quasi-permanent value :	$\psi_2$	= 0,00

### III - PARAMETERS OF THE PORTAL FRAME E

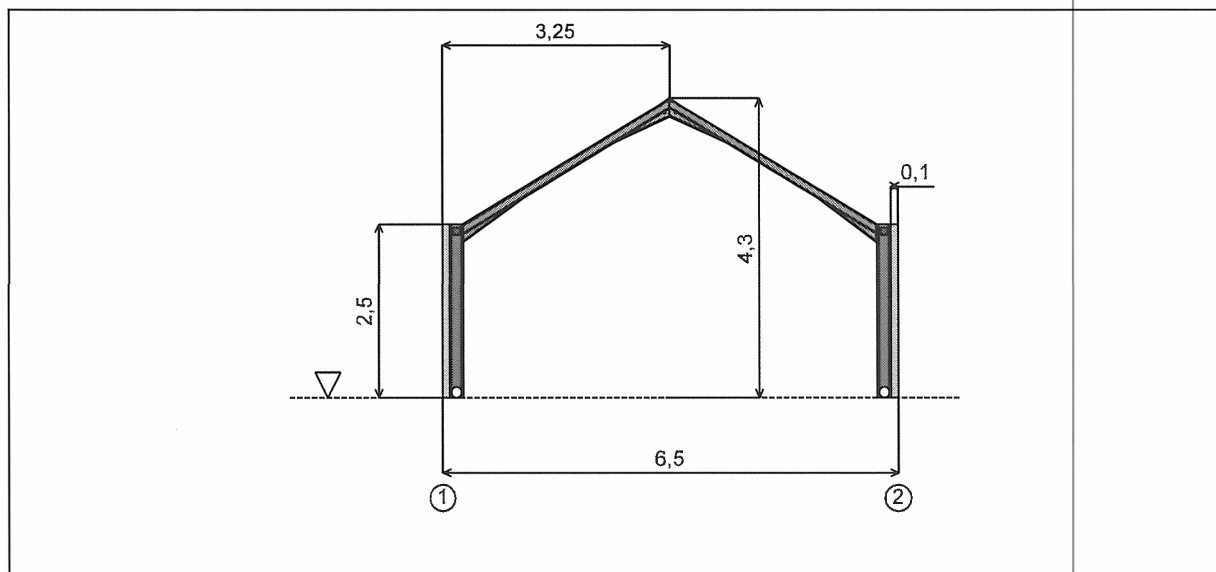


Figure 4 : Plan of the portal frame E

#### III.1 - Sections of elements - Steel grades

Table 2 : Sections of elements.

Element	Section	L cm	h mm	b <sub>f</sub> mm	t <sub>f</sub> mm	t <sub>w</sub> mm	r mm
Column 1	IPE 200	250	200	100	8,5	5,6	12
Column 2	IPE 200	250	200	100	8,5	5,6	12
Rafter 1	IPE 120	360,7	120	64	6,3	4,4	7
Rafter 2	IPE 120	360,7	120	64	6,3	4,4	7

Table 3 : Steel grades.

Element	Steel grade	Quality	Reduction curve	f <sub>y</sub> N/mm <sup>2</sup>	ε
Column 1	S355	JR/J0/J2/K2	EN 10025-2	355	0,814
Column 2	S355	JR/J0/J2/K2	EN 10025-2	355	0,814
Rafter 1	S355	JR/J0/J2/K2	EN 10025-2	355	0,814
Rafter 2	S355	JR/J0/J2/K2	EN 10025-2	355	0,814

Table 4 : Mechanical properties of sections.

Section	A cm <sup>2</sup>	A <sub>v,y</sub> cm <sup>2</sup>	A <sub>v,z</sub> cm <sup>2</sup>	I <sub>y</sub> cm <sup>4</sup>	I <sub>z</sub> cm <sup>4</sup>	W <sub>el,y</sub> cm <sup>3</sup>	W <sub>el,z</sub> cm <sup>3</sup>	W <sub>pl,y</sub> cm <sup>3</sup>	W <sub>pl,z</sub> cm <sup>3</sup>	I <sub>t</sub> cm <sup>4</sup>	I <sub>w</sub> 1000cm <sup>6</sup>
IPE 200	28,48	17	14	1943,2	142,4	194,3	28,47	220,6	44,61	6,916	13,05
IPE 120	13,21	8,064	6,305	317,8	27,67	52,96	8,646	60,73	13,58	1,69	0,894

Table 5 : Informations about masses of profiles.

Section	L m	Mass kg
IPE 200	5	111,8
IPE 120	7,214	74,8
Total masses		186,6

Note: The mass of haunches is not taken into account

### III.2 - Haunches

Table 6 : Haunches.

Element	L cm	Section	Haunch	Type	L <sub>h</sub> / L	D <sub>h</sub> / h
Rafter 1	360,7	IPE 120	Yes	1	0,27	2,138
Rafter 2	360,7	IPE 120	Yes	1	0,27	2,138

Table 7 : Haunch at apex.

Span	L <sub>g</sub> cm	Section	Haunch	Type	L <sub>h</sub> / L <sub>g</sub>	D <sub>h</sub> / h
1	360,7	IPE 120	Yes	1	0,27	2,138

Note :

- Type 1 : Rolled profile with haunch
- Type 2 : Welded profile without haunch
- L<sub>h</sub>/L : Length of haunch / Length of profile
- D<sub>h</sub>/h : Total height of haunch / Height of profile
- L<sub>g</sub> : Length of the left beam

### III.3 - Supports

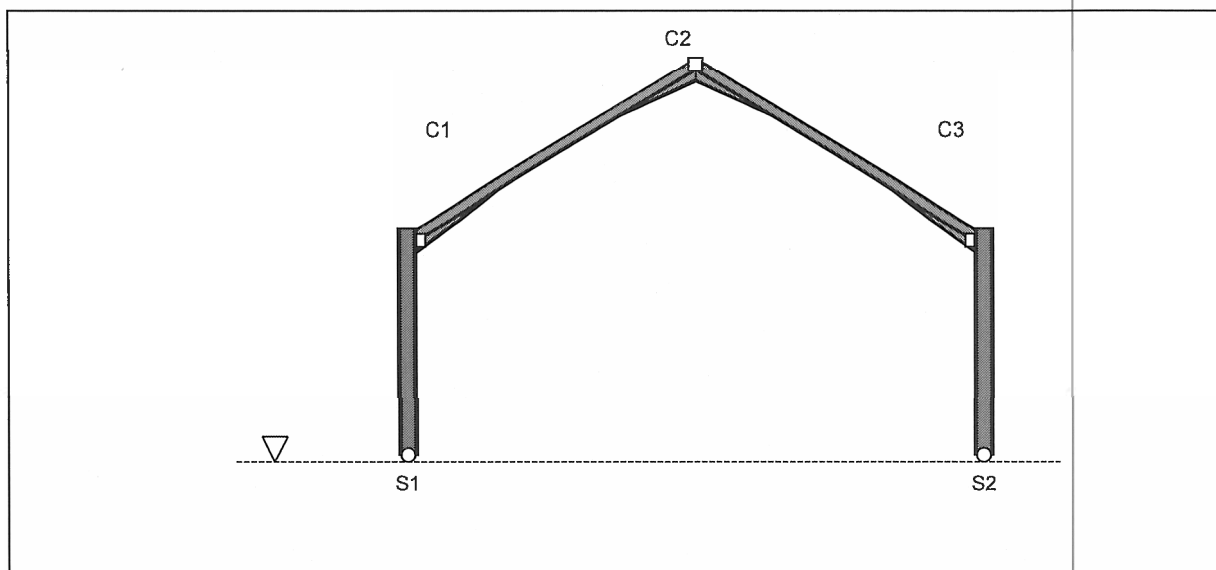


Figure 5 : Supports and Connexions

Table 8 : Supports.

Support	Type	Support level <i>m</i>	Stiffness <i>kN.m/rad</i>
S1	Free	0	
S2	Free	0	

Table 9 : Connexions.

Connexion	Type	Stiffness <i>kN.m/rad</i>
C1	Fixed	
C2	Fixed	
C3	Fixed	

#### III.4 - Lateral restraints

All the elements are assumed to be fully restrained against lateral displacements at both ends

No intermediate lateral restraint is defined

#### III.5 - User-defined load cases

Table 10 : User-defined load cases.

Load case	Notation	Description	$\psi_0$	$\psi_1$	$\psi_2$
1	G	Permanent loads			

- Load case 1 (G)

Table 11 : Members weight

Element	No.	$x_1$ cm	$x_2$ cm	Position	System	$q_{x,1}$ kN/m	$q_{x,2}$ kN/m	$q_{y,1}$ kN/m	$q_{y,2}$ kN/m
Column 1	1	0	250	Gravity centre	global	0	0	-0,219	-0,219
	2	0	250	Gravity centre	global	0	0	-0,265	-0,265
Column 2	1	0	250	Gravity centre	global	0	0	-0,219	-0,219
	2	0	250	Gravity centre	global	0	0	-0,265	-0,265
Rafter 1	1	0	360,7	Gravity centre	global	0	0	-0,102	-0,102
	2	0	360,7	sup. flange	global	0	0	-0,662	-0,662
Rafter 2	1	0	360,7	Gravity centre	global	0	0	-0,102	-0,102
	2	0	360,7	sup. flange	global	0	0	-0,662	-0,662

Note :  $x_1$ ,  $x_2$  - distance from the left end

No concentrated load is defined

No distributed load is defined

### III.6 - Snow load cases

see the snow calculation sheet

### III.7 - Wind load cases

see the wind calculation sheet

### III.8 - Load cases in combinations

Table 12 : Load cases in combinations.

No.	Notation	Load case
1	G	Permanent loads
2	W1	Wind on gable A, $C_{pi}=0,2$ , $C_{pe}(FGH)$ , $C_{pe}(IJ)$
3	W2	Wind on gable A, $C_{pi}=-0,3$ , $C_{pe}(FGH)$ , $C_{pe}(IJ)$
4	W3	Wind on gable E, $C_{pi}=0,2$ , $C_{pe}(FGH)$ , $C_{pe}(IJ)$
5	W4	Wind on gable E, $C_{pi}=-0,3$ , $C_{pe}(FGH)$ , $C_{pe}(IJ)$

Table 12 (Next) : Load cases in combinations.

No.	Notation	Load case
6	W5	Wind on longpan 1, Cpi=0,2, Cpe(FGH)<=0, Cpe(IJ)<=0
7	W6	Wind on longpan 1, Cpi=0,2, Cpe(FGH)<=0, Cpe(IJ)>=0
8	W7	Wind on longpan 1, Cpi=0,2, Cpe(FGH)>=0, Cpe(IJ)<=0
9	W8	Wind on longpan 1, Cpi=0,2, Cpe(FGH)>=0, Cpe(IJ)>=0
10	W9	Wind on longpan 1, Cpi=-0,3, Cpe(FGH)<=0, Cpe(IJ)<=0
11	W10	Wind on longpan 1, Cpi=-0,3, Cpe(FGH)<=0, Cpe(IJ)>=0
12	W11	Wind on longpan 1, Cpi=-0,3, Cpe(FGH)>=0, Cpe(IJ)<=0
13	W12	Wind on longpan 1, Cpi=-0,3, Cpe(FGH)>=0, Cpe(IJ)>=0
14	W13	Wind on longpan 2, Cpi=0,2, Cpe(FGH)<=0, Cpe(IJ)<=0
15	W14	Wind on longpan 2, Cpi=0,2, Cpe(FGH)<=0, Cpe(IJ)>=0
16	W15	Wind on longpan 2, Cpi=0,2, Cpe(FGH)>=0, Cpe(IJ)<=0
17	W16	Wind on longpan 2, Cpi=0,2, Cpe(FGH)>=0, Cpe(IJ)>=0
18	W17	Wind on longpan 2, Cpi=-0,3, Cpe(FGH)<=0, Cpe(IJ)<=0
19	W18	Wind on longpan 2, Cpi=-0,3, Cpe(FGH)<=0, Cpe(IJ)>=0
20	W19	Wind on longpan 2, Cpi=-0,3, Cpe(FGH)>=0, Cpe(IJ)<=0
21	W20	Wind on longpan 2, Cpi=-0,3, Cpe(FGH)>=0, Cpe(IJ)>=0
22	S1	Snow without drift
23	S2	Snow with drift
24	S3	Snow with drift

### III.9 - Ultimate Limit States Combinations

Generation of ULS combinations according to EN 1990 (up to 2 variable actions) : Yes

Table 13 : Ultimate Limit States Combinations.

No.	Load case	ULS001	ULS002	ULS003	ULS004	ULS005	ULS006	ULS007	ULS008	ULS009	ULS010
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W1	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	-	-
3	W2	-	-	-	-	-	-	-	-	1,50	1,50
4	S1	-	-	0,75	0,75	-	-	-	-	-	-
5	S2	-	-	-	-	0,75	0,75	-	-	-	-
6	S3	-	-	-	-	-	-	0,75	0,75	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS011	ULS012	ULS013	ULS014	ULS015	ULS016	ULS017	ULS018	ULS019	ULS020
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W2	1,50	1,50	1,50	1,50	1,50	1,50	-	-	-	-



Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS011	ULS012	ULS013	ULS014	ULS015	ULS016	ULS017	ULS018	ULS019	ULS020
3	W3	-	-	-	-	-	-	1,50	1,50	1,50	1,50
4	S1	0,75	0,75	-	-	-	-	-	-	0,75	0,75
5	S2	-	-	0,75	0,75	-	-	-	-	-	-
6	S3	-	-	-	-	0,75	0,75	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS021	ULS022	ULS023	ULS024	ULS025	ULS026	ULS027	ULS028	ULS029	ULS030
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W3	1,50	1,50	1,50	1,50	-	-	-	-	-	-
3	W4	-	-	-	-	1,50	1,50	1,50	1,50	1,50	1,50
4	S1	-	-	-	-	-	-	0,75	0,75	-	-
5	S2	0,75	0,75	-	-	-	-	-	-	0,75	0,75
6	S3	-	-	0,75	0,75	-	-	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS031	ULS032	ULS033	ULS034	ULS035	ULS036	ULS037	ULS038	ULS039	ULS040
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W4	1,50	1,50	-	-	-	-	-	-	-	-
3	W5	-	-	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50
4	S1	-	-	-	-	0,75	0,75	-	-	-	-
5	S2	-	-	-	-	-	-	0,75	0,75	-	-
6	S3	0,75	0,75	-	-	-	-	-	-	0,75	0,75

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS041	ULS042	ULS043	ULS044	ULS045	ULS046	ULS047	ULS048	ULS049	ULS050
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W6	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	-	-
3	W7	-	-	-	-	-	-	-	-	1,50	1,50
4	S1	-	-	0,75	0,75	-	-	-	-	-	-
5	S2	-	-	-	-	0,75	0,75	-	-	-	-
6	S3	-	-	-	-	-	-	0,75	0,75	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS051	ULS052	ULS053	ULS054	ULS055	ULS056	ULS057	ULS058	ULS059	ULS060
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W7	1,50	1,50	1,50	1,50	1,50	1,50	-	-	-	-
3	W8	-	-	-	-	-	-	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS051	ULS052	ULS053	ULS054	ULS055	ULS056	ULS057	ULS058	ULS059	ULS060
4	S1	0,75	0,75	-	-	-	-	-	-	0,75	0,75
5	S2	-	-	0,75	0,75	-	-	-	-	-	-
6	S3	-	-	-	-	0,75	0,75	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS061	ULS062	ULS063	ULS064	ULS065	ULS066	ULS067	ULS068	ULS069	ULS070
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W8	1,50	1,50	1,50	1,50	-	-	-	-	-	-
3	W9	-	-	-	-	1,50	1,50	1,50	1,50	1,50	1,50
4	S1	-	-	-	-	-	-	0,75	0,75	-	-
5	S2	0,75	0,75	-	-	-	-	-	-	0,75	0,75
6	S3	-	-	0,75	0,75	-	-	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS071	ULS072	ULS073	ULS074	ULS075	ULS076	ULS077	ULS078	ULS079	ULS080
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W9	1,50	1,50	-	-	-	-	-	-	-	-
3	W10	-	-	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50
4	S1	-	-	-	-	0,75	0,75	-	-	-	-
5	S2	-	-	-	-	-	-	0,75	0,75	-	-
6	S3	0,75	0,75	-	-	-	-	-	-	0,75	0,75

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS081	ULS082	ULS083	ULS084	ULS085	ULS086	ULS087	ULS088	ULS089	ULS090
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W11	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	-	-
3	W12	-	-	-	-	-	-	-	-	1,50	1,50
4	S1	-	-	0,75	0,75	-	-	-	-	-	-
5	S2	-	-	-	-	0,75	0,75	-	-	-	-
6	S3	-	-	-	-	-	-	0,75	0,75	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS091	ULS092	ULS093	ULS094	ULS095	ULS096	ULS097	ULS098	ULS099	ULS100
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W12	1,50	1,50	1,50	1,50	1,50	1,50	-	-	-	-
3	W13	-	-	-	-	-	-	1,50	1,50	1,50	1,50
4	S1	0,75	0,75	-	-	-	-	-	-	0,75	0,75

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS091	ULS092	ULS093	ULS094	ULS095	ULS096	ULS097	ULS098	ULS099	ULS100
5	S2	-	-	0,75	0,75	-	-	-	-	-	-
6	S3	-	-	-	-	0,75	0,75	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS101	ULS102	ULS103	ULS104	ULS105	ULS106	ULS107	ULS108	ULS109	ULS110
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W13	1,50	1,50	1,50	1,50	-	-	-	-	-	-
3	W14	-	-	-	-	1,50	1,50	1,50	1,50	1,50	1,50
4	S1	-	-	-	-	-	-	0,75	0,75	-	-
5	S2	0,75	0,75	-	-	-	-	-	-	0,75	0,75
6	S3	-	-	0,75	0,75	-	-	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS111	ULS112	ULS113	ULS114	ULS115	ULS116	ULS117	ULS118	ULS119	ULS120
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W14	1,50	1,50	-	-	-	-	-	-	-	-
3	W15	-	-	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50
4	S1	-	-	-	-	0,75	0,75	-	-	-	-
5	S2	-	-	-	-	-	-	0,75	0,75	-	-
6	S3	0,75	0,75	-	-	-	-	-	-	0,75	0,75

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS121	ULS122	ULS123	ULS124	ULS125	ULS126	ULS127	ULS128	ULS129	ULS130
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W16	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	-	-
3	W17	-	-	-	-	-	-	-	-	1,50	1,50
4	S1	-	-	0,75	0,75	-	-	-	-	-	-
5	S2	-	-	-	-	0,75	0,75	-	-	-	-
6	S3	-	-	-	-	-	-	0,75	0,75	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS131	ULS132	ULS133	ULS134	ULS135	ULS136	ULS137	ULS138	ULS139	ULS140
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W17	1,50	1,50	1,50	1,50	1,50	1,50	-	-	-	-
3	W18	-	-	-	-	-	-	1,50	1,50	1,50	1,50
4	S1	0,75	0,75	-	-	-	-	-	-	0,75	0,75
5	S2	-	-	0,75	0,75	-	-	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS131	ULS132	ULS133	ULS134	ULS135	ULS136	ULS137	ULS138	ULS139	ULS140
6	S3	-	-	-	-	0,75	0,75	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS141	ULS142	ULS143	ULS144	ULS145	ULS146	ULS147	ULS148	ULS149	ULS150
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W18	1,50	1,50	1,50	1,50	-	-	-	-	-	-
3	W19	-	-	-	-	1,50	1,50	1,50	1,50	1,50	1,50
4	S1	-	-	-	-	-	-	0,75	0,75	-	-
5	S2	0,75	0,75	-	-	-	-	-	-	0,75	0,75
6	S3	-	-	0,75	0,75	-	-	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS151	ULS152	ULS153	ULS154	ULS155	ULS156	ULS157	ULS158	ULS159	ULS160
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W19	1,50	1,50	-	-	-	-	-	-	-	-
3	W20	-	-	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50
4	S1	-	-	-	-	0,75	0,75	-	-	-	-
5	S2	-	-	-	-	-	-	0,75	0,75	-	-
6	S3	0,75	0,75	-	-	-	-	-	-	0,75	0,75

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS161	ULS162	ULS163	ULS164	ULS165	ULS166	ULS167	ULS168	ULS169	ULS170
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W1	-	-	0,90	0,90	-	-	-	-	-	-
3	W2	-	-	-	-	0,90	0,90	-	-	-	-
4	W3	-	-	-	-	-	-	0,90	0,90	-	-
5	W4	-	-	-	-	-	-	-	-	0,90	0,90
6	S1	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS171	ULS172	ULS173	ULS174	ULS175	ULS176	ULS177	ULS178	ULS179	ULS180
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W5	0,90	0,90	-	-	-	-	-	-	-	-
3	W6	-	-	0,90	0,90	-	-	-	-	-	-
4	W7	-	-	-	-	0,90	0,90	-	-	-	-
5	W8	-	-	-	-	-	-	0,90	0,90	-	-
6	W9	-	-	-	-	-	-	-	-	0,90	0,90

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS171	ULS172	ULS173	ULS174	ULS175	ULS176	ULS177	ULS178	ULS179	ULS180
7	S1	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS181	ULS182	ULS183	ULS184	ULS185	ULS186	ULS187	ULS188	ULS189	ULS190
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W10	0,90	0,90	-	-	-	-	-	-	-	-
3	W11	-	-	0,90	0,90	-	-	-	-	-	-
4	W12	-	-	-	-	0,90	0,90	-	-	-	-
5	W13	-	-	-	-	-	-	0,90	0,90	-	-
6	W14	-	-	-	-	-	-	-	-	0,90	0,90
7	S1	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS191	ULS192	ULS193	ULS194	ULS195	ULS196	ULS197	ULS198	ULS199	ULS200
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W15	0,90	0,90	-	-	-	-	-	-	-	-
3	W16	-	-	0,90	0,90	-	-	-	-	-	-
4	W17	-	-	-	-	0,90	0,90	-	-	-	-
5	W18	-	-	-	-	-	-	0,90	0,90	-	-
6	W19	-	-	-	-	-	-	-	-	0,90	0,90
7	S1	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS201	ULS202	ULS203	ULS204	ULS205	ULS206	ULS207	ULS208	ULS209	ULS210
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W1	-	-	-	-	0,90	0,90	-	-	-	-
3	W2	-	-	-	-	-	-	0,90	0,90	-	-
4	W3	-	-	-	-	-	-	-	-	0,90	0,90
5	W20	0,90	0,90	-	-	-	-	-	-	-	-
6	S1	1,50	1,50	-	-	-	-	-	-	-	-
7	S2	-	-	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS211	ULS212	ULS213	ULS214	ULS215	ULS216	ULS217	ULS218	ULS219	ULS220
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W4	0,90	0,90	-	-	-	-	-	-	-	-
3	W5	-	-	0,90	0,90	-	-	-	-	-	-

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS211	ULS212	ULS213	ULS214	ULS215	ULS216	ULS217	ULS218	ULS219	ULS220
4	W6	-	-	-	-	0,90	0,90	-	-	-	-
5	W7	-	-	-	-	-	-	0,90	0,90	-	-
6	W8	-	-	-	-	-	-	-	-	0,90	0,90
7	S2	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS221	ULS222	ULS223	ULS224	ULS225	ULS226	ULS227	ULS228	ULS229	ULS230
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W9	0,90	0,90	-	-	-	-	-	-	-	-
3	W10	-	-	0,90	0,90	-	-	-	-	-	-
4	W11	-	-	-	-	0,90	0,90	-	-	-	-
5	W12	-	-	-	-	-	-	0,90	0,90	-	-
6	W13	-	-	-	-	-	-	-	-	0,90	0,90
7	S2	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS231	ULS232	ULS233	ULS234	ULS235	ULS236	ULS237	ULS238	ULS239	ULS240
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W14	0,90	0,90	-	-	-	-	-	-	-	-
3	W15	-	-	0,90	0,90	-	-	-	-	-	-
4	W16	-	-	-	-	0,90	0,90	-	-	-	-
5	W17	-	-	-	-	-	-	0,90	0,90	-	-
6	W18	-	-	-	-	-	-	-	-	0,90	0,90
7	S2	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS241	ULS242	ULS243	ULS244	ULS245	ULS246	ULS247	ULS248	ULS249	ULS250
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W1	-	-	-	-	-	-	0,90	0,90	-	-
3	W2	-	-	-	-	-	-	-	-	0,90	0,90
4	W19	0,90	0,90	-	-	-	-	-	-	-	-
5	W20	-	-	0,90	0,90	-	-	-	-	-	-
6	S2	1,50	1,50	1,50	1,50	-	-	-	-	-	-
7	S3	-	-	-	-	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS251	ULS252	ULS253	ULS254	ULS255	ULS256	ULS257	ULS258	ULS259	ULS260
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W3	0,90	0,90	-	-	-	-	-	-	-	-
3	W4	-	-	0,90	0,90	-	-	-	-	-	-
4	W5	-	-	-	-	0,90	0,90	-	-	-	-
5	W6	-	-	-	-	-	-	0,90	0,90	-	-
6	W7	-	-	-	-	-	-	-	-	0,90	0,90
7	S3	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS261	ULS262	ULS263	ULS264	ULS265	ULS266	ULS267	ULS268	ULS269	ULS270
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W8	0,90	0,90	-	-	-	-	-	-	-	-
3	W9	-	-	0,90	0,90	-	-	-	-	-	-
4	W10	-	-	-	-	0,90	0,90	-	-	-	-
5	W11	-	-	-	-	-	-	0,90	0,90	-	-
6	W12	-	-	-	-	-	-	-	-	0,90	0,90
7	S3	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS271	ULS272	ULS273	ULS274	ULS275	ULS276	ULS277	ULS278	ULS279	ULS280
1	G	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00	1,35	1,00
2	W13	0,90	0,90	-	-	-	-	-	-	-	-
3	W14	-	-	0,90	0,90	-	-	-	-	-	-
4	W15	-	-	-	-	0,90	0,90	-	-	-	-
5	W16	-	-	-	-	-	-	0,90	0,90	-	-
6	W17	-	-	-	-	-	-	-	-	0,90	0,90
7	S3	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50

Table 13 (Next) : Ultimate Limit States Combinations.

No.	Load case	ULS281	ULS282	ULS283	ULS284	ULS285	ULS286
1	G	1,35	1,00	1,35	1,00	1,35	1,00
2	W18	0,90	0,90	-	-	-	-
3	W19	-	-	0,90	0,90	-	-
4	W20	-	-	-	-	0,90	0,90
5	S3	1,50	1,50	1,50	1,50	1,50	1,50



### III.10 - Serviceability Limit States Combinations

Generation of SLS combinations according to EN 1990 (up to 2 variable actions) : Yes

Table 14 : Serviceability Limit States Combinations.

No.	Load case	SLS001	SLS002	SLS003	SLS004	SLS005	SLS006	SLS007	SLS008	SLS009	SLS010
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W1	1,00	1,00	1,00	1,00	-	-	-	-	-	-
3	W2	-	-	-	-	1,00	1,00	1,00	1,00	-	-
4	W3	-	-	-	-	-	-	-	-	1,00	1,00
5	S1	-	0,50	-	-	-	0,50	-	-	-	0,50
6	S2	-	-	0,50	-	-	-	0,50	-	-	-
7	S3	-	-	-	0,50	-	-	-	0,50	-	-

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS011	SLS012	SLS013	SLS014	SLS015	SLS016	SLS017	SLS018	SLS019	SLS020
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W3	1,00	1,00	-	-	-	-	-	-	-	-
3	W4	-	-	1,00	1,00	1,00	1,00	-	-	-	-
4	W5	-	-	-	-	-	-	1,00	1,00	1,00	1,00
5	S1	-	-	-	0,50	-	-	-	0,50	-	-
6	S2	0,50	-	-	-	0,50	-	-	-	0,50	-
7	S3	-	0,50	-	-	-	0,50	-	-	-	0,50

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS021	SLS022	SLS023	SLS024	SLS025	SLS026	SLS027	SLS028	SLS029	SLS030
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W6	1,00	1,00	1,00	1,00	-	-	-	-	-	-
3	W7	-	-	-	-	1,00	1,00	1,00	1,00	-	-
4	W8	-	-	-	-	-	-	-	-	1,00	1,00
5	S1	-	0,50	-	-	-	0,50	-	-	-	0,50
6	S2	-	-	0,50	-	-	-	0,50	-	-	-
7	S3	-	-	-	0,50	-	-	-	0,50	-	-

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS031	SLS032	SLS033	SLS034	SLS035	SLS036	SLS037	SLS038	SLS039	SLS040
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W8	1,00	1,00	-	-	-	-	-	-	-	-
3	W9	-	-	1,00	1,00	1,00	1,00	-	-	-	-
4	W10	-	-	-	-	-	-	1,00	1,00	1,00	1,00
5	S1	-	-	-	0,50	-	-	-	0,50	-	-



Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS031	SLS032	SLS033	SLS034	SLS035	SLS036	SLS037	SLS038	SLS039	SLS040
6	S2	0,50	-	-	-	0,50	-	-	-	0,50	-
7	S3	-	0,50	-	-	-	0,50	-	-	-	0,50

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS041	SLS042	SLS043	SLS044	SLS045	SLS046	SLS047	SLS048	SLS049	SLS050
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W11	1,00	1,00	1,00	1,00	-	-	-	-	-	-
3	W12	-	-	-	-	1,00	1,00	1,00	1,00	-	-
4	W13	-	-	-	-	-	-	-	-	1,00	1,00
5	S1	-	0,50	-	-	-	0,50	-	-	-	0,50
6	S2	-	-	0,50	-	-	-	0,50	-	-	-
7	S3	-	-	-	0,50	-	-	-	0,50	-	-

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS051	SLS052	SLS053	SLS054	SLS055	SLS056	SLS057	SLS058	SLS059	SLS060
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W13	1,00	1,00	-	-	-	-	-	-	-	-
3	W14	-	-	1,00	1,00	1,00	1,00	-	-	-	-
4	W15	-	-	-	-	-	-	1,00	1,00	1,00	1,00
5	S1	-	-	-	0,50	-	-	-	0,50	-	-
6	S2	0,50	-	-	-	0,50	-	-	-	0,50	-
7	S3	-	0,50	-	-	-	0,50	-	-	-	0,50

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS061	SLS062	SLS063	SLS064	SLS065	SLS066	SLS067	SLS068	SLS069	SLS070
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W16	1,00	1,00	1,00	1,00	-	-	-	-	-	-
3	W17	-	-	-	-	1,00	1,00	1,00	1,00	-	-
4	W18	-	-	-	-	-	-	-	-	1,00	1,00
5	S1	-	0,50	-	-	-	0,50	-	-	-	0,50
6	S2	-	-	0,50	-	-	-	0,50	-	-	-
7	S3	-	-	-	0,50	-	-	-	0,50	-	-

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS071	SLS072	SLS073	SLS074	SLS075	SLS076	SLS077	SLS078	SLS079	SLS080
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W18	1,00	1,00	-	-	-	-	-	-	-	-

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS071	SLS072	SLS073	SLS074	SLS075	SLS076	SLS077	SLS078	SLS079	SLS080
3	W19	-	-	1,00	1,00	1,00	1,00	-	-	-	-
4	W20	-	-	-	-	-	-	1,00	1,00	1,00	1,00
5	S1	-	-	-	0,50	-	-	-	0,50	-	-
6	S2	0,50	-	-	-	0,50	-	-	-	0,50	-
7	S3	-	0,50	-	-	-	0,50	-	-	-	0,50

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS081	SLS082	SLS083	SLS084	SLS085	SLS086	SLS087	SLS088	SLS089	SLS090
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W1	-	0,60	-	-	-	-	-	-	-	-
3	W2	-	-	0,60	-	-	-	-	-	-	-
4	W3	-	-	-	0,60	-	-	-	-	-	-
5	W4	-	-	-	-	0,60	-	-	-	-	-
6	W5	-	-	-	-	-	0,60	-	-	-	-
7	W6	-	-	-	-	-	-	0,60	-	-	-
8	W7	-	-	-	-	-	-	-	0,60	-	-
9	W8	-	-	-	-	-	-	-	-	0,60	-
10	W9	-	-	-	-	-	-	-	-	-	0,60
11	S1	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS091	SLS092	SLS093	SLS094	SLS095	SLS096	SLS097	SLS098	SLS099	SLS100
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W10	0,60	-	-	-	-	-	-	-	-	-
3	W11	-	0,60	-	-	-	-	-	-	-	-
4	W12	-	-	0,60	-	-	-	-	-	-	-
5	W13	-	-	-	0,60	-	-	-	-	-	-
6	W14	-	-	-	-	0,60	-	-	-	-	-
7	W15	-	-	-	-	-	0,60	-	-	-	-
8	W16	-	-	-	-	-	-	0,60	-	-	-
9	W17	-	-	-	-	-	-	-	0,60	-	-
10	W18	-	-	-	-	-	-	-	-	0,60	-
11	W19	-	-	-	-	-	-	-	-	-	0,60
12	S1	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS101	SLS102	SLS103	SLS104	SLS105	SLS106	SLS107	SLS108	SLS109	SLS110
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W1	-	-	0,60	-	-	-	-	-	-	-
3	W2	-	-	-	0,60	-	-	-	-	-	-
4	W3	-	-	-	-	0,60	-	-	-	-	-
5	W4	-	-	-	-	-	0,60	-	-	-	-
6	W5	-	-	-	-	-	-	0,60	-	-	-
7	W6	-	-	-	-	-	-	-	0,60	-	-
8	W7	-	-	-	-	-	-	-	-	0,60	-
9	W8	-	-	-	-	-	-	-	-	-	0,60
10	W20	0,60	-	-	-	-	-	-	-	-	-
11	S1	1,00	-	-	-	-	-	-	-	-	-
12	S2	-	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS111	SLS112	SLS113	SLS114	SLS115	SLS116	SLS117	SLS118	SLS119	SLS120
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W9	0,60	-	-	-	-	-	-	-	-	-
3	W10	-	0,60	-	-	-	-	-	-	-	-
4	W11	-	-	0,60	-	-	-	-	-	-	-
5	W12	-	-	-	0,60	-	-	-	-	-	-
6	W13	-	-	-	-	0,60	-	-	-	-	-
7	W14	-	-	-	-	-	0,60	-	-	-	-
8	W15	-	-	-	-	-	-	0,60	-	-	-
9	W16	-	-	-	-	-	-	-	0,60	-	-
10	W17	-	-	-	-	-	-	-	-	0,60	-
11	W18	-	-	-	-	-	-	-	-	-	0,60
12	S2	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS121	SLS122	SLS123	SLS124	SLS125	SLS126	SLS127	SLS128	SLS129	SLS130
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W1	-	-	-	0,60	-	-	-	-	-	-
3	W2	-	-	-	-	0,60	-	-	-	-	-
4	W3	-	-	-	-	-	0,60	-	-	-	-
5	W4	-	-	-	-	-	-	0,60	-	-	-
6	W5	-	-	-	-	-	-	-	0,60	-	-
7	W6	-	-	-	-	-	-	-	-	0,60	-

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS121	SLS122	SLS123	SLS124	SLS125	SLS126	SLS127	SLS128	SLS129	SLS130
8	W7	-	-	-	-	-	-	-	-	-	0,60
9	W19	0,60	-	-	-	-	-	-	-	-	-
10	W20	-	0,60	-	-	-	-	-	-	-	-
11	S2	1,00	1,00	-	-	-	-	-	-	-	-
12	S3	-	-	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS131	SLS132	SLS133	SLS134	SLS135	SLS136	SLS137	SLS138	SLS139	SLS140
1	G	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2	W8	0,60	-	-	-	-	-	-	-	-	-
3	W9	-	0,60	-	-	-	-	-	-	-	-
4	W10	-	-	0,60	-	-	-	-	-	-	-
5	W11	-	-	-	0,60	-	-	-	-	-	-
6	W12	-	-	-	-	0,60	-	-	-	-	-
7	W13	-	-	-	-	-	0,60	-	-	-	-
8	W14	-	-	-	-	-	-	0,60	-	-	-
9	W15	-	-	-	-	-	-	-	0,60	-	-
10	W16	-	-	-	-	-	-	-	-	0,60	-
11	W17	-	-	-	-	-	-	-	-	-	0,60
12	S3	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 14 (Next) : Serviceability Limit States Combinations.

No.	Load case	SLS141	SLS142	SLS143
1	G	1,00	1,00	1,00
2	W18	0,60	-	-
3	W19	-	0,60	-
4	W20	-	-	0,60
5	S3	1,00	1,00	1,00

### III.11 - Finite Element Modelling

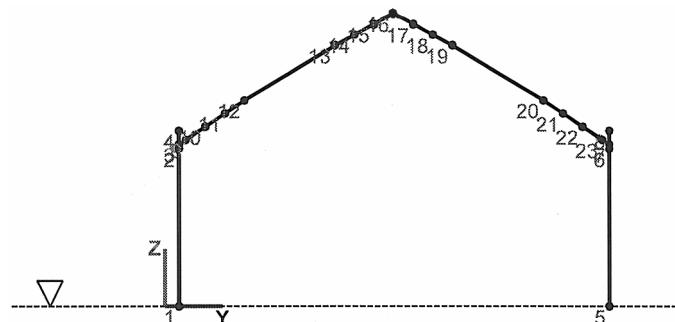


Figure 6 : Numbering of nodes

Table 15 : Coordinates of nodes - Stiffness of support nodes.

No. Node	Y mm	Z mm	Spring Y kN/m	Spring Z kN/m	Spring Rotation kN.m/rad
1	200	0	Fixed	Fixed	0
2	200	2243,5	0	0	0
3	200	2303,8	0	0	0
4	200	2500	0	0	0
5	6300	0	Fixed	Fixed	0
6	6300	2243,5	0	0	0
7	6300	2303,8	0	0	0
8	6300	2500	0	0	0
9	300	2371,7	0	0	0
10	577,4	2560,3	0	0	0
11	854,9	2749	0	0	0
12	1132,3	2937,6	0	0	0
13	2417,7	3721,9	0	0	0
14	2695,1	3871,8	0	0	0
15	2972,6	4021,8	0	0	0
16	3250	4171,7	0	0	0
17	3527,4	4021,8	0	0	0
18	3804,9	3871,8	0	0	0
19	4082,3	3721,9	0	0	0
20	5367,7	2937,6	0	0	0
21	5645,1	2749	0	0	0

Table 15 (Next) : Coordinates of nodes - Stiffness of support nodes.

No. Node	Y mm	Z mm	Spring Y kN/m	Spring Z kN/m	Spring Rotation kN.m/rad
22	5922,6	2560,3	0	0	0
23	6200	2371,7	0	0	0

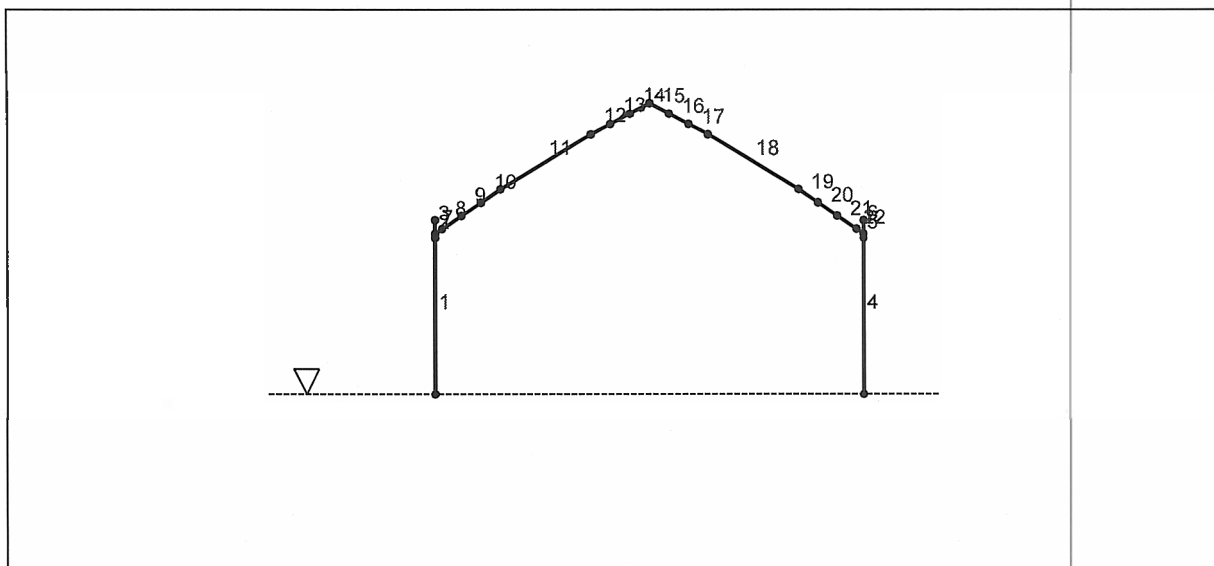


Figure 7 : Numbering of bar elements

Table 16 : Properties of bar elements.

No. Element	Node Origin	Node End	Area cm <sup>2</sup>	Inertia cm <sup>4</sup>	Spring Origin kN.m/rad	Spring End kN.m/rad
1	1	2	28,5	1943,2	Continue	Continue
2	2	3	28,5	1943,2	Continue	Continue
3	3	4	28,5	1943,2	Continue	Continue
4	5	6	28,5	1943,2	Continue	Continue
5	6	7	28,5	1943,2	Continue	Continue
6	7	8	28,5	1943,2	Continue	Continue
7	3	9	21,7	1348,0	Continue	Continue
8	9	10	21,3	1198,6	Continue	Continue
9	10	11	19,9	849,7	Continue	Continue
10	11	12	18,5	591,2	Continue	Continue
11	12	13	13,2	317,8	Continue	Continue
12	13	14	20,4	964,1	Continue	Continue
13	14	15	23,6	2030,6	Continue	Continue

Table 16 (Next) : Properties of bar elements.

No. Element	Node Origin	Node End	Area $cm^2$	Inertia $cm^4$	Spring Origin $kN.m/rad$	Spring End $kN.m/rad$
14	15	16	26,8	3709,5	Continue	Continue
15	16	17	26,8	3709,5	Continue	Continue
16	17	18	23,6	2030,6	Continue	Continue
17	18	19	20,4	964,1	Continue	Continue
18	19	20	13,2	317,8	Continue	Continue
19	20	21	18,5	591,2	Continue	Continue
20	21	22	19,9	849,7	Continue	Continue
21	22	23	21,3	1198,6	Continue	Continue
22	23	7	21,7	1348,0	Continue	Continue

- Parameters for the 2nd order calculation

Number of sections : 10

Number max of iterations : 100

Calculation tolerance : 0,01

## IV - CALCULATION RESULTS OF THE PORTAL FRAME E

### IV.1 - Critical load factors and Global imperfection

Minimum critical load factor :  $\alpha_{cr,min} = 36,75$  (Comb. ULS091)

Global imperfection (5.3.2.3.a - EN 1993-1-1) :  $H / 231$

Table 17 : Critical load factors and Mean rotations of columns

Comb.	ULS001	ULS002	ULS003	ULS004	ULS005	ULS006	ULS007	ULS008
$\alpha_{cr}$	>100*	>100*	>100*	>100*	>100*	>100*	>100*	>100*
$\phi_m \times 10^3$	-0,06	-0,06	-0,06	-0,06	-0,02	-0,02	-0,10	-0,10
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS009	ULS010	ULS011	ULS012	ULS013	ULS014	ULS015	ULS016
$\alpha_{cr}$	95,07	>100	86,81	>100	88,72	>100	88,76	>100
$\phi_m \times 10^3$	-0,02	-0,02	-0,02	-0,02	0,02	0,02	-0,06	-0,06
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Comb.	ULS017	ULS018	ULS019	ULS020	ULS021	ULS022	ULS023	ULS024
$\alpha_{cr}$	>100*	>100*	>100*	>100*	>100*	>100*	>100*	>100*
$\phi_m \times 10^3$	-0,11	-0,11	-0,12	-0,11	-0,08	-0,07	-0,15	-0,15
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS025	ULS026	ULS027	ULS028	ULS029	ULS030	ULS031	ULS032
$\alpha_{cr}$	>100*	>100*	>100*	>100*	>100*	>100*	>100*	>100*
$\phi_m \times 10^3$	-0,07	-0,07	-0,07	-0,07	-0,03	-0,03	-0,11	-0,11
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS033	ULS034	ULS035	ULS036	ULS037	ULS038	ULS039	ULS040
$\alpha_{cr}$	>100	>100*	>100	>100	>100	>100	>100	>100
$\phi_m \times 10^3$	-4,51	-4,51	-4,51	-4,51	-4,47	-4,47	-4,55	-4,55
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No



Comb.	ULS041	ULS042	ULS043	ULS044	ULS045	ULS046	ULS047	ULS048
$\alpha_{cr}$	>100	>100	>100	>100	>100	>100	>100	>100
$\phi_m \times 10^3$	-2,02	-2,02	-2,02	-2,02	-1,98	-1,98	-2,06	-2,05
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS049	ULS050	ULS051	ULS052	ULS053	ULS054	ULS055	ULS056
$\alpha_{cr}$	88,19	>100	81,09	>100	82,71	>100	82,80	>100
$\phi_m \times 10^3$	-9,07	-9,07	-9,07	-9,07	-9,03	-9,03	-9,11	-9,11
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS057	ULS058	ULS059	ULS060	ULS061	ULS062	ULS063	ULS064
$\alpha_{cr}$	65,44	86,98	61,42	80,03	62,36	81,63	62,40	81,70
$\phi_m \times 10^3$	-6,57	-6,57	-6,58	-6,57	-6,54	-6,53	-6,61	-6,61
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS065	ULS066	ULS067	ULS068	ULS069	ULS070	ULS071	ULS072
$\alpha_{cr}$	66,19	88,28	62,08	81,14	63,04	82,77	63,08	82,86
$\phi_m \times 10^3$	-4,47	-4,47	-4,47	-4,47	-4,43	-4,43	-4,51	-4,51
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS073	ULS074	ULS075	ULS076	ULS077	ULS078	ULS079	ULS080
$\alpha_{cr}$	52,34	65,29	49,73	61,28	50,35	62,22	50,37	62,25
$\phi_m \times 10^3$	-1,97	-1,97	-1,97	-1,97	-1,94	-1,93	-2,01	-2,01
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Comb.	ULS081	ULS082	ULS083	ULS084	ULS085	ULS086	ULS087	ULS088
$\alpha_{cr}$	45,02	54,26	43,08	51,47	43,54	52,12	43,56	52,15
$\phi_m \times 10^3$	-9,03	-9,03	-9,03	-9,03	-8,99	-8,99	-9,07	-9,07
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS089	ULS090	ULS091	ULS092	ULS093	ULS094	ULS095	ULS096
$\alpha_{cr}$	38,15	44,60	36,75	42,69	37,08	43,15	37,10	43,16
$\phi_m \times 10^3$	-6,53	-6,53	-6,53	-6,53	-6,49	-6,49	-6,57	-6,57
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS097	ULS098	ULS099	ULS100	ULS101	ULS102	ULS103	ULS104
$\alpha_{cr}$	>100	>100	>100	>100	>100	>100	>100	>100
$\phi_m \times 10^3$	4,50	4,50	4,50	4,50	4,53	4,54	4,46	4,46
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS105	ULS106	ULS107	ULS108	ULS109	ULS110	ULS111	ULS112
$\alpha_{cr}$	>100	>100	>100	>100	>100	>100	>100	>100
$\phi_m \times 10^3$	2,04	2,04	2,04	2,04	2,08	2,08	2,00	2,00
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS113	ULS114	ULS115	ULS116	ULS117	ULS118	ULS119	ULS120
$\alpha_{cr}$	87,62	>100	80,60	>100	82,26	>100	82,24	>100
$\phi_m \times 10^3$	8,94	8,94	8,94	8,94	8,98	8,98	8,90	8,90
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS121	ULS122	ULS123	ULS124	ULS125	ULS126	ULS127	ULS128
$\alpha_{cr}$	65,53	87,14	61,50	80,17	62,46	81,80	62,46	81,80
$\phi_m \times 10^3$	6,48	6,48	6,48	6,48	6,52	6,52	6,44	6,45
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS129	ULS130	ULS131	ULS132	ULS133	ULS134	ULS135	ULS136
$\alpha_{cr}$	65,48	87,02	61,45	80,06	62,41	81,70	62,41	81,69
$\phi_m \times 10^3$	4,54	4,54	4,54	4,54	4,58	4,58	4,50	4,50
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS137	ULS138	ULS139	ULS140	ULS141	ULS142	ULS143	ULS144
$\alpha_{cr}$	52,16	65,00	49,56	61,03	50,19	61,98	50,19	61,98
$\phi_m \times 10^3$	2,08	2,08	2,08	2,08	2,12	2,12	2,04	2,04
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Comb.	ULS145	ULS146	ULS147	ULS148	ULS149	ULS150	ULS151	ULS152
$\alpha_{cr}$	44,85	54,02	42,93	51,25	43,39	51,91	43,39	51,92
$\phi_m \times 10^3$	8,98	8,99	8,98	8,99	9,02	9,02	8,95	8,95
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS153	ULS154	ULS155	ULS156	ULS157	ULS158	ULS159	ULS160
$\alpha_{cr}$	38,18	44,63	36,77	42,73	37,11	43,19	37,12	43,19
$\phi_m \times 10^3$	6,53	6,53	6,53	6,53	6,57	6,57	6,49	6,49
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	No	No

Comb.	ULS161	ULS162	ULS163	ULS164	ULS165	ULS166	ULS167	ULS168
$\alpha_{cr}$	59,98	77,70	>100	>100	70,54	96,37	>100	>100*
$\phi_m \times 10^3$	-0,01	0,00	-0,04	-0,04	-0,01	-0,01	-0,07	-0,07
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Comb.	ULS169	ULS170	ULS171	ULS172	ULS173	ULS174	ULS175	ULS176
$\alpha_{cr}$	>100	>100	96,23	>100	78,26	>100	68,33	92,20
$\phi_m \times 10^3$	-0,05	-0,04	-2,71	-2,71	-1,21	-1,21	-5,44	-5,44
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	Yes	No	No	Yes	Yes	No	No

Comb.	ULS177	ULS178	ULS179	ULS180	ULS181	ULS182	ULS183	ULS184
$\alpha_{cr}$	58,73	75,59	59,10	76,19	51,74	64,40	47,21	57,51
$\phi_m \times 10^3$	-3,95	-3,95	-2,68	-2,68	-1,19	-1,19	-5,42	-5,42
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	Yes	Yes	No	No

Comb.	ULS185	ULS186	ULS187	ULS188	ULS189	ULS190	ULS191	ULS192
$\alpha_{cr}$	42,40	50,53	95,35	>100	78,02	>100	68,11	91,82
$\phi_m \times 10^3$	-3,92	-3,92	2,70	2,70	1,22	1,22	5,36	5,36
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	Yes	Yes	No	No

Comb.	ULS193	ULS194	ULS195	ULS196	ULS197	ULS198	ULS199	ULS200
$\alpha_{cr}$	58,78	75,66	58,76	75,62	51,64	64,23	47,10	57,35
$\phi_m \times 10^3$	3,89	3,89	2,72	2,72	1,25	1,25	5,39	5,39
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	Yes	Yes	No	No

Comb.	ULS201	ULS202	ULS203	ULS204	ULS205	ULS206	ULS207	ULS208
$\alpha_{cr}$	42,42	50,56	61,83	80,83	>100	>100	73,10	>100
$\phi_m \times 10^3$	3,91	3,91	0,07	0,07	0,04	0,04	0,06	0,06
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	Yes	Yes	Yes	Yes	Yes	Yes

Comb.	ULS209	ULS210	ULS211	ULS212	ULS213	ULS214	ULS215	ULS216
$\alpha_{cr}$	>100*	>100*	>100	>100	>100	>100	81,39	>100
$\phi_m \times 10^3$	0,01	0,01	0,03	0,03	-2,63	-2,63	-1,13	-1,13
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	Yes	Yes	No	No	Yes	Yes

Comb.	ULS217	ULS218	ULS219	ULS220	ULS221	ULS222	ULS223	ULS224
$\alpha_{cr}$	70,70	96,55	60,48	78,51	60,87	79,16	53,10	66,51
$\phi_m \times 10^3$	-5,37	-5,37	-3,87	-3,87	-2,61	-2,60	-1,11	-1,11
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	Yes	Yes

Comb.	ULS225	ULS226	ULS227	ULS228	ULS229	ULS230	ULS231	ULS232
$\alpha_{cr}$	48,33	59,18	43,30	51,82	>100	>100	81,18	>100
$\phi_m \times 10^3$	-5,34	-5,34	-3,84	-3,84	2,77	2,77	1,30	1,30
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	Yes	No

Comb.	ULS233	ULS234	ULS235	ULS236	ULS237	ULS238	ULS239	ULS240
$\alpha_{cr}$	70,51	96,22	60,55	78,63	60,53	78,58	53,00	66,36
$\phi_m \times 10^3$	5,44	5,44	3,97	3,97	2,80	2,80	1,32	1,33
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	No	No	Yes	Yes

Comb.	ULS241	ULS242	ULS243	ULS244	ULS245	ULS246	ULS247	ULS248
$\alpha_{cr}$	48,23	59,04	43,33	51,86	61,86	80,89	>100	>100
$\phi_m \times 10^3$	5,47	5,47	3,99	3,99	-0,08	-0,08	-0,12	-0,12
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	No	No	No	No	Yes	Yes	Yes	Yes

Comb.	ULS249	ULS250	ULS251	ULS252	ULS253	ULS254	ULS255	ULS256
$\alpha_{cr}$	73,15	>100	>100*	>100*	>100	>100	>100	>100
$\phi_m \times 10^3$	-0,09	-0,09	-0,15	-0,15	-0,12	-0,12	-2,79	-2,79
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	Yes	No	No	Yes	Yes	No	No

Comb.	ULS257	ULS258	ULS259	ULS260	ULS261	ULS262	ULS263	ULS264
$\alpha_{cr}$	81,51	>100	70,79	96,75	60,54	78,62	60,94	79,27
$\phi_m \times 10^3$	-1,29	-1,29	-5,52	-5,52	-4,03	-4,02	-2,76	-2,76
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	No	No	No	No	No	No	No

Comb.	ULS265	ULS266	ULS267	ULS268	ULS269	ULS270	ULS271	ULS272
$\alpha_{cr}$	53,14	66,58	48,37	59,25	43,33	51,87	>100	>100
$\phi_m \times 10^3$	-1,26	-1,26	-5,50	-5,50	-4,00	-4,00	2,62	2,62
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	Yes	No	No	No	No	No	No

Comb.	ULS273	ULS274	ULS275	ULS276	ULS277	ULS278	ULS279	ULS280
$\alpha_{cr}$	81,21	>100	70,52	96,23	60,57	78,65	60,55	78,61
$\phi_m \times 10^3$	1,14	1,14	5,28	5,29	3,81	3,81	2,64	2,64
2nd order analysis	No	No	No	No	No	No	No	No
Global imperfection	Yes	Yes	No	No	No	No	No	No

Comb.	ULS281	ULS282	ULS283	ULS284	ULS285	ULS286
$\alpha_{cr}$	53,02	66,38	48,25	59,05	43,35	51,88
$\phi_m \times 10^3$	1,17	1,17	5,31	5,31	3,84	3,84
2nd order analysis	No	No	No	No	No	No
Global imperfection	Yes	Yes	No	No	No	No

Note:  $\phi_m$  - Mean rotation of columns (1st order analysis without imperfection)

#### IV.2 - Reactions at supports

- Reactions at supports under ULS combinations

Table 18 : Max reactions at supports under ULS combinations.

Support	Max/Min	$R_{H,Ed}$ kN	$R_{V,Ed}$ kN	$M_{Ed}$ kN.m
S1	Max	5,137 (ULS115)	9,817 (ULS155)	0 (ULS001)
	Min	-4,215 (ULS082)	-2,719 (ULS018)	0 (ULS001)
S2	Max	4,189 (ULS146)	9,784 (ULS091)	0 (ULS001)
	Min	-5,158 (ULS051)	-2,607 (ULS018)	0 (ULS001)

## V - ULS VERIFICATION RESULTS OF THE PORTAL FRAME E

### V.1 - Notations

$\Gamma_N$ :	Section resistance to axial force
$\Gamma_V$ :	Section resistance to shear force
$\Gamma_M$ :	Section resistance to bending moment
$\Gamma_{MN}$ :	Section resistance to M-N interaction
$\Gamma_{MV}$ :	Section resistance to M-V interaction
$\Gamma_{MNV}$ :	Section resistance to M-N-V interaction
$\Gamma_{Vb}$ :	Web resistance - Shear buckling
$\Gamma_{MNVb}$ :	Web resistance - M-N-V interaction
$\Gamma_{by}$ :	Resistance to flexural buckling about the strong axis
$\Gamma_{bz}$ :	Resistance to flexural buckling about the weak axis
$\Gamma_{LT}$ :	Resistance to lateral torsional buckling
$\Gamma_{bMN1}$ :	Resistance to M-N interaction (Criterion 6.61)
$\Gamma_{bMN2}$ :	Resistance to M-N interaction (Criterion 6.62)
$\Gamma_{op}$ :	Overall resistance to out-of-plane buckling (Criterion 6.63)

### V.2 - Column 1

#### - Section resistance to axial force (Comb. ULS155) :

Axial force (x = 0,0 cm) :	$N_{Ed} = 9,817 \text{ kN}$
Criterion :	$\Gamma_N = 0,010 < 1 \Rightarrow \text{Satisfied}$

#### - Section resistance to shear force (Comb. ULS115) :

Shear force (x = 0,0 cm) :	$V_{Ed} = 5,137 \text{ kN}$
Criterion :	$\Gamma_V = 0,018 < 1 \Rightarrow \text{Satisfied}$

#### - Section resistance to bending moment (Comb. ULS147) :

Bending moment (x = 224,3 cm) :	$M_{Ed} = -9,564 \text{ kN.m}$
Criterion :	$\Gamma_M = 0,122 < 1 \Rightarrow \text{Satisfied}$

#### - Section resistance to M-N interaction (Comb. ULS147) :

Associated internal forces (x = 224,3 cm):	$N_{Ed} = 7,428 \text{ kN}$ $M_{Ed} = -9,564 \text{ kN.m}$
Criterion :	$\Gamma_{MN} = 0,122 < 1 \Rightarrow \text{Satisfied}$

#### - Section resistance to M-V interaction (Comb. ULS147) :

Associated internal forces (x = 224,3 cm):	$V_{Ed} = 4,070 \text{ kN}$ $M_{Ed} = -9,564 \text{ kN.m}$
--	---

Criterion :  $\Gamma_{MV} = 0,122 < 1 \Rightarrow \text{Satisfied}$

- **Section resistance to M-N-V interaction (Comb. ULS147) :**

Associated internal forces (x = 224,3 cm) :  
 $N_{Ed} = 7,428 \text{ kN}$   
 $V_{Ed} = 4,070 \text{ kN}$   
 $M_{Ed} = -9,564 \text{ kN.m}$

Criterion :  $\Gamma_{MNV} = \Gamma_{MN} = 0,122 < 1 \Rightarrow \text{Satisfied}$

- **Web resistance - Shear buckling**

$\eta = 1,200$   
 $h_w/t_w = 28,393 < 72\epsilon/\eta = 48,817 \Rightarrow \text{No verification required}$

- **Web resistance - M-N-V interaction**

No verification required

- **Resistance to flexural buckling about the strong axis (Comb. ULS155) :**

Axial force :  $N_{Ed,max} = 9,817 \text{ kN}$

Criterion:  $\Gamma_{by} = 0,010 < 1 \Rightarrow \text{Satisfied}$

- **Resistance to flexural buckling about the weak axis (Comb. ULS155) :**

Axial force :  $N_{Ed,max} = 9,817 \text{ kN}$

Criterion:  $\Gamma_{bz} = 0,024 < 1 \Rightarrow \text{Satisfied}$

- **Resistance to lateral torsional buckling (Comb. ULS286) :**

Maximum bending moment:  $|M_{Ed}|_{max} = 5,782 \text{ kN.m}$

$M_{Ed}/M_{cr} = 0,043 < \lambda_{LT,0}^2 = 0,160 \Rightarrow \text{No verification required}$

- **Resistance to M-N interaction (Comb. ULS147) :**

Axial force:  $N_{Ed} = 8,895 \text{ kN}$   
 Maximum bending moment:  $|M_{Ed}|_{max} = 9,564 \text{ kN.m}$

Criterion 6.61 :  $\Gamma_{bMN1} = 0,133 < 1 \Rightarrow \text{Satisfied}$

Criterion 6.62 :  $\Gamma_{bMN2} = 0,086 < 1 \Rightarrow \text{Satisfied}$

- **Overall resistance to out-of-plane buckling**

The general method is not used for this element

**V.3 - Column 2**

- **Section resistance to axial force (Comb. ULS091) :**



Axial force (x = 0,0 cm) :

$$N_{Ed} = 9,784 \text{ kN}$$

Criterion :

$$\Gamma_N = 0,010 < 1 \Rightarrow \text{Satisfied}$$

**- Section resistance to shear force (Comb. ULS051) :**

Shear force (x = 0,0 cm) :

$$V_{Ed} = -5,158 \text{ kN}$$

Criterion :

$$\Gamma_V = 0,018 < 1 \Rightarrow \text{Satisfied}$$

**- Section resistance to bending moment (Comb. ULS083) :**

Bending moment (x = 224,3 cm) :

$$M_{Ed} = 9,538 \text{ kN.m}$$

Criterion :

$$\Gamma_M = 0,122 < 1 \Rightarrow \text{Satisfied}$$

**- Section resistance to M-N interaction (Comb. ULS083) :**

Associated internal forces (x = 224,3 cm):

$$N_{Ed} = 7,388 \text{ kN}$$

$$M_{Ed} = 9,538 \text{ kN.m}$$

Criterion :

$$\Gamma_{MN} = 0,122 < 1 \Rightarrow \text{Satisfied}$$

**- Section resistance to M-V interaction (Comb. ULS083) :**

Associated internal forces (x = 224,3 cm):

$$V_{Ed} = -4,058 \text{ kN}$$

$$M_{Ed} = 9,538 \text{ kN.m}$$

Criterion :

$$\Gamma_{MV} = 0,122 < 1 \Rightarrow \text{Satisfied}$$

**- Section resistance to M-N-V interaction (Comb. ULS083) :**

Associated internal forces (x = 224,3 cm) :

$$N_{Ed} = 7,388 \text{ kN}$$

$$V_{Ed} = -4,058 \text{ kN}$$

$$M_{Ed} = 9,538 \text{ kN.m}$$

Criterion :

$$\Gamma_{MNV} = \Gamma_{MN} = 0,122 < 1 \Rightarrow \text{Satisfied}$$

**- Web resistance - Shear buckling**

$$\eta = 1,200$$

$$h_w/t_w = 28,393 < 72\epsilon/\eta = 48,817 \Rightarrow \text{No verification required}$$

**- Web resistance - M-N-V interaction**

No verification required

**- Resistance to flexural buckling about the strong axis (Comb. ULS091) :**

Axial force :

$$N_{Ed,max} = 9,784 \text{ kN}$$

Criterion:

$$\Gamma_{by} = 0,010 < 1 \Rightarrow \text{Satisfied}$$



- Resistance to flexural buckling about the weak axis (Comb. ULS091) :

Axial force :  $N_{Ed,max} = 9,784 \text{ kN}$

Criterion:  $\Gamma_{bz} = 0,024 < 1 \Rightarrow \text{Satisfied}$

- Resistance to lateral torsional buckling (Comb. ULS286) :

Maximum bending moment:  $|M_{Ed}|_{max} = 0,907 \text{ kN.m}$

$M_{Ed}/M_{cr} = 0,011 < \lambda_{LT,0}^2 = 0,160 \Rightarrow \text{No verification required}$

- Resistance to M-N interaction (Comb. ULS083) :

Axial force:  $N_{Ed} = 8,855 \text{ kN}$

Maximum bending moment:  $|M_{Ed}|_{max} = 9,538 \text{ kN.m}$

Criterion 6.61 :  $\Gamma_{bMN1} = 0,132 < 1 \Rightarrow \text{Satisfied}$

Criterion 6.62 :  $\Gamma_{bMN2} = 0,086 < 1 \Rightarrow \text{Satisfied}$

- Overall resistance to out-of-plane buckling

The general method is not used for this element

V.4 - Rafter 1

- Section resistance to axial force (Comb. ULS155) :

Axial force (x = 100,6 cm) :  $N_{Ed} = 6,967 \text{ kN}$

Criterion :  $\Gamma_N = 0,015 < 1 \Rightarrow \text{Satisfied}$

- Section resistance to shear force (Comb. ULS155) :

Shear force (x = 100,6 cm) :  $V_{Ed} = -3,339 \text{ kN}$

Criterion :  $\Gamma_V = 0,026 < 1 \Rightarrow \text{Satisfied}$

- Section resistance to bending moment (Comb. ULS117) :

Bending moment (x = 100,6 cm) :  $M_{Ed} = -6,228 \text{ kN.m}$

Criterion :  $\Gamma_M = 0,289 < 1 \Rightarrow \text{Satisfied}$

- Section resistance to M-N interaction (Comb. ULS117) :

Associated internal forces (x = 100,6 cm):  
 $N_{Ed} = 3,692 \text{ kN}$   
 $M_{Ed} = -6,228 \text{ kN.m}$

Criterion :  $\Gamma_{MN} = 0,289 < 1 \Rightarrow \text{Satisfied}$

- Section resistance to M-V interaction (Comb. ULS117) :

Associated internal forces (x = 100,6 cm):  $V_{Ed} = -2,403 \text{ kN}$

	$M_{Ed} = -6,228 \text{ kN.m}$	
Criterion :	$\Gamma_{MV} = 0,289 < 1 \Rightarrow \text{Satisfied}$	
<b>- Section resistance to M-N-V interaction (Comb. ULS117) :</b>		
Associated internal forces (x = 100,6 cm) :	$N_{Ed} = 3,692 \text{ kN}$ $V_{Ed} = -2,403 \text{ kN}$ $M_{Ed} = -6,228 \text{ kN.m}$	
Criterion :	$\Gamma_{MNV} = \Gamma_{MN} = 0,289 < 1 \Rightarrow \text{Satisfied}$	
<b>- Web resistance - Shear buckling</b>		
	$\eta = 1,200$ $h_w/t_w = 21,227 < 72\epsilon/\eta = 48,817 \Rightarrow \text{No verification required}$	
<b>- Web resistance - M-N-V interaction</b>		
No verification required		
<b>- Resistance to flexural buckling about the strong axis (Comb. ULS155) :</b>		
Axial force :	$N_{Ed,max} = 7,552 \text{ kN}$	
Criterion:	$\Gamma_{by} = 0,067 < 1 \Rightarrow \text{Satisfied}$	
<b>- Resistance to flexural buckling about the weak axis</b>		
The general method (6.3.4 - EN 1993-1-1) is used to check the resistance to lateral and lateral-torsional buckling		
<b>- Resistance to lateral torsional buckling</b>		
The general method (6.3.4 - EN 1993-1-1) is used to check the resistance to lateral and lateral-torsional buckling		
<b>- Resistance to M-N interaction</b>		
The general method (6.3.4 - EN 1993-1-1) is used to check the resistance to lateral and lateral-torsional buckling		
<b>- Overall resistance to out-of-plane buckling (Comb. ULS087) :</b>		
Position of the most critical section:	$x = 1,006 \text{ m}$ $N_{Ed} = 2,656 \text{ kN}$ $N_{Rk} = 468,963 \text{ kN}$ $M_{Ed} = 5,572 \text{ kN.m}$ $M_{Rk} = 21,557 \text{ kN.m}$	
Minimum load amplifier of the design loads without taking into account of lateral or lateral-torsional buckling:	$\alpha_{ult,k} = 3,524 > 1$	
Minimum load amplifier of the design loads, taking into account of lateral or lateral-torsional buckling:	$\alpha_{cr,op} = 1,603 > 1$	
Criterion:	$\Gamma_{op} = 0,758 < 1 \Rightarrow \text{Satisfied}$	

## V.5 - Rafter 2

### - Section resistance to axial force (Comb. ULS091) :

Axial force ( $x = 245,2$  cm) :  $N_{Ed} = 6,937$  kN

Criterion :  $\Gamma_N = 0,015 < 1 \Rightarrow \text{Satisfied}$

### - Section resistance to shear force (Comb. ULS091) :

Shear force ( $x = 245,2$  cm) :  $V_{Ed} = 3,318$  kN

Criterion :  $\Gamma_V = 0,026 < 1 \Rightarrow \text{Satisfied}$

### - Section resistance to bending moment (Comb. ULS055) :

Bending moment ( $x = 245,2$  cm) :  $M_{Ed} = -6,286$  kN.m

Criterion :  $\Gamma_M = 0,292 < 1 \Rightarrow \text{Satisfied}$

### - Section resistance to M-N interaction (Comb. ULS055) :

Associated internal forces ( $x = 245,2$  cm):  
 $N_{Ed} = 3,588$  kN  
 $M_{Ed} = -6,286$  kN.m

Criterion :  $\Gamma_{MN} = 0,292 < 1 \Rightarrow \text{Satisfied}$

### - Section resistance to M-V interaction (Comb. ULS055) :

Associated internal forces ( $x = 245,2$  cm):  
 $V_{Ed} = 2,573$  kN  
 $M_{Ed} = -6,286$  kN.m

Criterion :  $\Gamma_{MV} = 0,292 < 1 \Rightarrow \text{Satisfied}$

### - Section resistance to M-N-V interaction (Comb. ULS055) :

Associated internal forces ( $x = 245,2$  cm) :  
 $N_{Ed} = 3,588$  kN  
 $V_{Ed} = 2,573$  kN  
 $M_{Ed} = -6,286$  kN.m

Criterion :  $\Gamma_{MNV} = \Gamma_{MN} = 0,292 < 1 \Rightarrow \text{Satisfied}$

### - Web resistance - Shear buckling

$\eta = 1,200$

$h_w/t_w = 21,227 < 72\epsilon/\eta = 48,817 \Rightarrow \text{No verification required}$

### - Web resistance - M-N-V interaction

No verification required

### - Resistance to flexural buckling about the strong axis (Comb. ULS091) :

Axial force :  $N_{Ed,max} = 7,522$  kN

Criterion:

$$\Gamma_{by} = 0,067 < 1 \Rightarrow \text{Satisfied}$$

**- Resistance to flexural buckling about the weak axis**

The general method (6.3.4 - EN 1993-1-1) is used to check the resistance to lateral and lateral-torsional buckling

**- Resistance to lateral torsional buckling**

The general method (6.3.4 - EN 1993-1-1) is used to check the resistance to lateral and lateral-torsional buckling

**- Resistance to M-N interaction**

The general method (6.3.4 - EN 1993-1-1) is used to check the resistance to lateral and lateral-torsional buckling

**- Overall resistance to out-of-plane buckling (Comb. ULS149) :**

Position of the most critical section:

$$x = 2,452 \text{ m}$$

$$N_{Ed} = 2,679 \text{ kN}$$

$$N_{Rk} = 468,963 \text{ kN}$$

$$M_{Ed} = 5,506 \text{ kN.m}$$

$$M_{Rk} = 21,557 \text{ kN.m}$$

Minimum load amplifier of the design loads without taking into account of lateral or lateral-torsional buckling:

$$\alpha_{ult,k} = 3,560 > 1$$

Minimum load amplifier of the design loads, taking into account of lateral or lateral-torsional buckling:

$$\alpha_{cr,op} = 1,610 > 1$$

Criterion:

$$\Gamma_{op} = 0,752 < 1 \Rightarrow \text{Satisfied}$$

## VI - SLS VERIFICATION RESULTS OF THE PORTAL FRAME E

### VI.1 - Notations

$u$ :	Horizontal displacement
$w$ :	Vertical displacement under G+Q
$w_3$ :	Vertical displacement under Q only

### VI.2 - Horizontal deflection at the top of columns

Table 19 : Horizontal deflection at the top of columns.

Combination	Element	$u$ mm	H/n	$ u  \leq H/150$
SLS001	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS002	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS003	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS004	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS005	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS006	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS007	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS008	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS009	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS010	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS011	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS012	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS013	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes

Table 19 (Next) : Horizontal deflection at the top of columns.

Combination	Element	u mm	H/n	$ u  \leq H/150$
SLS014	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS015	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS016	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS017	Column 1	8,6	H/291	Yes
	Column 2	8,0	H/311	Yes
SLS018	Column 1	8,6	H/291	Yes
	Column 2	8,0	H/311	Yes
SLS019	Column 1	8,6	H/291	Yes
	Column 2	8,0	H/311	Yes
SLS020	Column 1	8,6	H/291	Yes
	Column 2	8,0	H/311	Yes
SLS021	Column 1	4,0	H/623	Yes
	Column 2	3,7	H/667	Yes
SLS022	Column 1	4,0	H/623	Yes
	Column 2	3,7	H/667	Yes
SLS023	Column 1	4,0	H/623	Yes
	Column 2	3,7	H/667	Yes
SLS024	Column 1	4,0	H/623	Yes
	Column 2	3,7	H/667	Yes
SLS025	Column 1	16,6	H/151	Yes
	Column 2	16,3	H/154	Yes
SLS026	Column 1	16,6	H/151	Yes
	Column 2	16,3	H/154	Yes
SLS027	Column 1	16,6	H/151	Yes
	Column 2	16,3	H/154	Yes
SLS028	Column 1	16,6	H/151	Yes
	Column 2	16,3	H/154	Yes
SLS029	Column 1	12,0	H/208	Yes
	Column 2	12,0	H/209	Yes
SLS030	Column 1	12,0	H/208	Yes
	Column 2	12,0	H/209	Yes
SLS031	Column 1	12,0	H/208	Yes
	Column 2	12,0	H/209	Yes

Table 19 (Next) : Horizontal deflection at the top of columns.

Combination	Element	u mm	H/n	$ u  \leq H/150$
SLS032	Column 1	12,0	H/208	Yes
	Column 2	12,0	H/209	Yes
SLS033	Column 1	8,5	H/293	Yes
	Column 2	8,0	H/314	Yes
SLS034	Column 1	8,5	H/293	Yes
	Column 2	8,0	H/314	Yes
SLS035	Column 1	8,5	H/293	Yes
	Column 2	8,0	H/314	Yes
SLS036	Column 1	8,5	H/293	Yes
	Column 2	8,0	H/314	Yes
SLS037	Column 1	3,9	H/635	Yes
	Column 2	3,7	H/682	Yes
SLS038	Column 1	3,9	H/635	Yes
	Column 2	3,7	H/682	Yes
SLS039	Column 1	3,9	H/635	Yes
	Column 2	3,7	H/682	Yes
SLS040	Column 1	3,9	H/635	Yes
	Column 2	3,7	H/682	Yes
SLS041	Column 1	16,5	H/151	Yes
	Column 2	16,2	H/154	Yes
SLS042	Column 1	16,5	H/151	Yes
	Column 2	16,2	H/154	Yes
SLS043	Column 1	16,5	H/151	Yes
	Column 2	16,2	H/154	Yes
SLS044	Column 1	16,5	H/151	Yes
	Column 2	16,2	H/154	Yes
SLS045	Column 1	11,9	H/209	Yes
	Column 2	11,9	H/210	Yes
SLS046	Column 1	11,9	H/209	Yes
	Column 2	11,9	H/210	Yes
SLS047	Column 1	11,9	H/209	Yes
	Column 2	11,9	H/210	Yes
SLS048	Column 1	11,9	H/209	Yes
	Column 2	11,9	H/210	Yes
SLS049	Column 1	-8,0	H/311	Yes
	Column 2	-8,6	H/291	Yes

Table 19 (Next) : Horizontal deflection at the top of columns.

Combination	Element	u mm	H/n	$ u  \leq H/150$
SLS050	Column 1	-8,0	H/311	Yes
	Column 2	-8,6	H/291	Yes
SLS051	Column 1	-8,0	H/311	Yes
	Column 2	-8,6	H/291	Yes
SLS052	Column 1	-8,0	H/311	Yes
	Column 2	-8,6	H/291	Yes
SLS053	Column 1	-3,8	H/659	Yes
	Column 2	-4,1	H/614	Yes
SLS054	Column 1	-3,8	H/659	Yes
	Column 2	-4,1	H/614	Yes
SLS055	Column 1	-3,8	H/659	Yes
	Column 2	-4,1	H/614	Yes
SLS056	Column 1	-3,8	H/659	Yes
	Column 2	-4,1	H/614	Yes
SLS057	Column 1	-16,1	H/155	Yes
	Column 2	-16,4	H/153	Yes
SLS058	Column 1	-16,1	H/155	Yes
	Column 2	-16,4	H/153	Yes
SLS059	Column 1	-16,1	H/155	Yes
	Column 2	-16,4	H/153	Yes
SLS060	Column 1	-16,1	H/155	Yes
	Column 2	-16,4	H/153	Yes
SLS061	Column 1	-11,9	H/211	Yes
	Column 2	-11,9	H/211	Yes
SLS062	Column 1	-11,9	H/211	Yes
	Column 2	-11,9	H/211	Yes
SLS063	Column 1	-11,9	H/211	Yes
	Column 2	-11,9	H/211	Yes
SLS064	Column 1	-11,9	H/211	Yes
	Column 2	-11,9	H/211	Yes
SLS065	Column 1	-8,1	H/308	Yes
	Column 2	-8,7	H/289	Yes
SLS066	Column 1	-8,1	H/308	Yes
	Column 2	-8,7	H/289	Yes
SLS067	Column 1	-8,1	H/308	Yes
	Column 2	-8,7	H/289	Yes



Table 19 (Next) : Horizontal deflection at the top of columns.

Combination	Element	u mm	H/n	$ u  \leq H/150$
SLS068	Column 1	-8,1	H/308	Yes
	Column 2	-8,7	H/289	Yes
SLS069	Column 1	-3,9	H/646	Yes
	Column 2	-4,2	H/602	Yes
SLS070	Column 1	-3,9	H/646	Yes
	Column 2	-4,2	H/602	Yes
SLS071	Column 1	-3,9	H/646	Yes
	Column 2	-4,2	H/602	Yes
SLS072	Column 1	-3,9	H/646	Yes
	Column 2	-4,2	H/602	Yes
SLS073	Column 1	-16,2	H/155	Yes
	Column 2	-16,4	H/152	Yes
SLS074	Column 1	-16,2	H/155	Yes
	Column 2	-16,4	H/152	Yes
SLS075	Column 1	-16,2	H/155	Yes
	Column 2	-16,4	H/152	Yes
SLS076	Column 1	-16,2	H/155	Yes
	Column 2	-16,4	H/152	Yes
SLS077	Column 1	-11,9	H/210	Yes
	Column 2	-11,9	H/209	Yes
SLS078	Column 1	-11,9	H/210	Yes
	Column 2	-11,9	H/209	Yes
SLS079	Column 1	-11,9	H/210	Yes
	Column 2	-11,9	H/209	Yes
SLS080	Column 1	-11,9	H/210	Yes
	Column 2	-11,9	H/209	Yes
SLS081	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS082	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS083	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS084	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS085	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes

Table 19 (Next) : Horizontal deflection at the top of columns.

Combination	Element	u mm	H/n	$ u  \leq H/150$
SLS086	Column 1	5,2	H/485	Yes
	Column 2	4,8	H/518	Yes
SLS087	Column 1	2,4	H/1038	Yes
	Column 2	2,2	H/1111	Yes
SLS088	Column 1	10,0	H/251	Yes
	Column 2	9,8	H/256	Yes
SLS089	Column 1	7,2	H/347	Yes
	Column 2	7,2	H/348	Yes
SLS090	Column 1	5,1	H/489	Yes
	Column 2	4,8	H/523	Yes
SLS091	Column 1	2,4	H/1058	Yes
	Column 2	2,2	H/1136	Yes
SLS092	Column 1	9,9	H/252	Yes
	Column 2	9,7	H/257	Yes
SLS093	Column 1	7,2	H/349	Yes
	Column 2	7,1	H/350	Yes
SLS094	Column 1	-4,8	H/519	Yes
	Column 2	-5,1	H/486	Yes
SLS095	Column 1	-2,3	H/1098	Yes
	Column 2	-2,4	H/1023	Yes
SLS096	Column 1	-9,7	H/259	Yes
	Column 2	-9,8	H/255	Yes
SLS097	Column 1	-7,1	H/351	Yes
	Column 2	-7,1	H/352	Yes
SLS098	Column 1	-4,9	H/514	Yes
	Column 2	-5,2	H/481	Yes
SLS099	Column 1	-2,3	H/1077	Yes
	Column 2	-2,5	H/1003	Yes
SLS100	Column 1	-9,7	H/258	Yes
	Column 2	-9,9	H/253	Yes
SLS101	Column 1	-7,2	H/349	Yes
	Column 2	-7,2	H/349	Yes
SLS102	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS103	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes

Table 19 (Next) : Horizontal deflection at the top of columns.

Combination	Element	u mm	H/n	$ u  \leq H/150$
SLS104	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS105	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS106	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS107	Column 1	5,2	H/485	Yes
	Column 2	4,8	H/518	Yes
SLS108	Column 1	2,4	H/1038	Yes
	Column 2	2,2	H/1111	Yes
SLS109	Column 1	10,0	H/251	Yes
	Column 2	9,8	H/256	Yes
SLS110	Column 1	7,2	H/347	Yes
	Column 2	7,2	H/348	Yes
SLS111	Column 1	5,1	H/489	Yes
	Column 2	4,8	H/523	Yes
SLS112	Column 1	2,4	H/1058	Yes
	Column 2	2,2	H/1136	Yes
SLS113	Column 1	9,9	H/252	Yes
	Column 2	9,7	H/257	Yes
SLS114	Column 1	7,2	H/349	Yes
	Column 2	7,1	H/350	Yes
SLS115	Column 1	-4,8	H/519	Yes
	Column 2	-5,1	H/486	Yes
SLS116	Column 1	-2,3	H/1098	Yes
	Column 2	-2,4	H/1023	Yes
SLS117	Column 1	-9,7	H/259	Yes
	Column 2	-9,8	H/255	Yes
SLS118	Column 1	-7,1	H/351	Yes
	Column 2	-7,1	H/352	Yes
SLS119	Column 1	-4,9	H/514	Yes
	Column 2	-5,2	H/481	Yes
SLS120	Column 1	-2,3	H/1077	Yes
	Column 2	-2,5	H/1003	Yes
SLS121	Column 1	-9,7	H/258	Yes
	Column 2	-9,9	H/253	Yes

Table 19 (Next) : Horizontal deflection at the top of columns.

Combination	Element	u mm	H/n	$ u  \leq H/150$
SLS122	Column 1	-7,2	H/349	Yes
	Column 2	-7,2	H/349	Yes
SLS123	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS124	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS125	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS126	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS127	Column 1	0,0	-	Yes
	Column 2	0,0	-	Yes
SLS128	Column 1	5,2	H/485	Yes
	Column 2	4,8	H/518	Yes
SLS129	Column 1	2,4	H/1038	Yes
	Column 2	2,2	H/1111	Yes
SLS130	Column 1	10,0	H/251	Yes
	Column 2	9,8	H/256	Yes
SLS131	Column 1	7,2	H/347	Yes
	Column 2	7,2	H/348	Yes
SLS132	Column 1	5,1	H/489	Yes
	Column 2	4,8	H/523	Yes
SLS133	Column 1	2,4	H/1058	Yes
	Column 2	2,2	H/1136	Yes
SLS134	Column 1	9,9	H/252	Yes
	Column 2	9,7	H/257	Yes
SLS135	Column 1	7,2	H/349	Yes
	Column 2	7,1	H/350	Yes
SLS136	Column 1	-4,8	H/519	Yes
	Column 2	-5,1	H/486	Yes
SLS137	Column 1	-2,3	H/1098	Yes
	Column 2	-2,4	H/1023	Yes
SLS138	Column 1	-9,7	H/259	Yes
	Column 2	-9,8	H/255	Yes
SLS139	Column 1	-7,1	H/351	Yes
	Column 2	-7,1	H/352	Yes

Table 19 (Next) : Horizontal deflection at the top of columns.

Combination	Element	u mm	H/n	$ u  \leq H/150$
SLS140	Column 1	-4,9	H/514	Yes
	Column 2	-5,2	H/481	Yes
SLS141	Column 1	-2,3	H/1077	Yes
	Column 2	-2,5	H/1003	Yes
SLS142	Column 1	-9,7	H/258	Yes
	Column 2	-9,9	H/253	Yes
SLS143	Column 1	-7,2	H/349	Yes
	Column 2	-7,2	H/349	Yes

### VI.3 - Vertical displacement at the apex

Table 20 : Vertical displacement at the apex.

Combination	Span	w mm	$L_1/n$	$ w  \leq L_1/200$	$w_3$ mm	$L_1/n$	$ w_3  \leq L_1/300$
SLS001	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS002	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS003	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS004	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS005	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS006	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS007	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS008	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS009	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS010	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS011	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS012	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS013	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS014	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS015	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS016	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS017	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS018	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS019	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS020	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes



Table 20 (Next) : Vertical displacement at the apex.

Combination	Span	w mm	$L_1/n$	$ w  \leq L_1/200$	$w_3$ mm	$L_1/n$	$ w_3  \leq L_1/300$
SLS021	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS022	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS023	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS024	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS025	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS026	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS027	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS028	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS029	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS030	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS031	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS032	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS033	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS034	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS035	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS036	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS037	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS038	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS039	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS040	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS041	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS042	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS043	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS044	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS045	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS046	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS047	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS048	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS049	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS050	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS051	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS052	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS053	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS054	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS055	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS056	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes

Table 20 (Next) : Vertical displacement at the apex.

Combination	Span	w mm	$L_1/n$	$ w  \leq L_1/200$	$w_3$ mm	$L_1/n$	$ w_3  \leq L_1/300$
SLS057	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS058	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS059	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS060	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS061	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS062	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS063	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS064	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS065	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS066	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS067	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS068	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS069	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS070	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS071	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS072	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS073	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS074	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS075	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS076	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS077	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS078	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS079	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS080	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS081	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS082	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS083	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS084	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS085	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS086	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS087	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS088	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS089	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS090	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS091	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS092	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes

Table 20 (Next) : Vertical displacement at the apex.

Combination	Span	w mm	$L_1/n$	$ w  \leq L_1/200$	$w_3$ mm	$L_1/n$	$ w_3  \leq L_1/300$
SLS093	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS094	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS095	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS096	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS097	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS098	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS099	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS100	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS101	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS102	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS103	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS104	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS105	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS106	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS107	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS108	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS109	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS110	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS111	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS112	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS113	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS114	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS115	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS116	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS117	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS118	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS119	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS120	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS121	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS122	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS123	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS124	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS125	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS126	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS127	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS128	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes



Table 20 (Next) : Vertical displacement at the apex.

Combination	Span	w mm	$L_1/n$	$ w  \leq L_1/200$	$w_3$ mm	$L_1/n$	$ w_3  \leq L_1/300$
SLS129	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS130	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS131	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS132	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS133	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS134	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS135	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS136	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS137	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS138	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS139	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS140	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS141	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS142	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes
SLS143	1	-1,2	$L_1/5195$	Yes	0,0	-	Yes

## VII - VERIFICATIONS SYNTHESIS OF THE PORTAL FRAME E

### VII.1 - ULS verification results of the portal frame E

#### - Resistance of sections

Table 21 : Resistance of sections - Web resistance.

Physical bar	$\Gamma_N$	$\Gamma_V$	$\Gamma_M$	$\Gamma_{MN}$	$\Gamma_{MV}$	$\Gamma_{MNV}$	$\Gamma_{Vb}$	$\Gamma_{MNVb}$
Column 1 (ULS comb.)	0,010 (155)	0,018 (115)	<b>0,122</b> (147)	<b>0,122</b> (147)	<b>0,122</b> (147)	<b>0,122</b> (147)	-	-
Column 2 (ULS comb.)	0,010 (091)	0,018 (051)	<b>0,122</b> (083)	<b>0,122</b> (083)	<b>0,122</b> (083)	<b>0,122</b> (083)	-	-
Rafter 1 (ULS comb.)	0,015 (155)	0,026 (155)	<b>0,289</b> (117)	<b>0,289</b> (117)	<b>0,289</b> (117)	<b>0,289</b> (117)	-	-
Rafter 2 (ULS comb.)	0,015 (091)	0,026 (091)	<b>0,292</b> (055)	<b>0,292</b> (055)	<b>0,292</b> (055)	<b>0,292</b> (055)	-	-

Note :

(-) No verification required

#### - Resistance of elements

Table 22 : Resistance of elements.

Physical bar	$\Gamma_{by}$	$\Gamma_{bz}$	$\Gamma_{LT}$	$\Gamma_{bMN1}$	$\Gamma_{bMN2}$	$\Gamma_{op}$
Column 1 (ULS comb.)	0,010 (155)	0,024 (155)	-	<b>0,133</b> (147)	0,086 (147)	-
Column 2 (ULS comb.)	0,010 (091)	0,024 (091)	-	<b>0,132</b> (083)	0,086 (083)	-
Rafter 1 (ULS comb.)	0,067 (155)	-	-	-	-	<b>0,758</b> (087)
Rafter 2 (ULS comb.)	0,067 (091)	-	-	-	-	<b>0,752</b> (149)

Note :

(-) No verification required

### VII.2 - SLS verification results of the portal frame E

- Horizontal deflection at the top of columns

Column 1 :  $|u_{\max}| = |16,6| \text{ mm} = H/151$  (Combination SLS025)  
 $|u_{\max}| < H/150 \Rightarrow \text{Satisfied}$

Column 2 :  $|u_{\max}| = |-16,4| \text{ mm} = H/152$  (Combination SLS073)  
 $|u_{\max}| < H/150 \Rightarrow \text{Satisfied}$

- Vertical displacement at the apex

Span 1 :  $|w_{\max}| = |-1,2| \text{ mm} = L_1/5195$  (Combination SLS001)  
 $|w_{\max}| < L/200 \Rightarrow \text{Satisfied}$

Span 1 :  $w_{3,\max} = 0 \text{ mm}$   
 $|w_{3,\max}| < L/300 \Rightarrow \text{Satisfied}$

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