EUROCODES TOOLS

Calculer facilement, construire durablement

SYNTHÈSE

STRUCTURAL ANALYSIS DESIGN REPORT

Projet exemple rapport - Exemple de client

Project defined by :	xxx-xxx
E-mail :	contact@eurocodes-tools.com
Last update :	2024-12-17 10:16
Link for inspection agency :	https://app.eurocodes-tools.com/en/shelters/ xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx /inspection

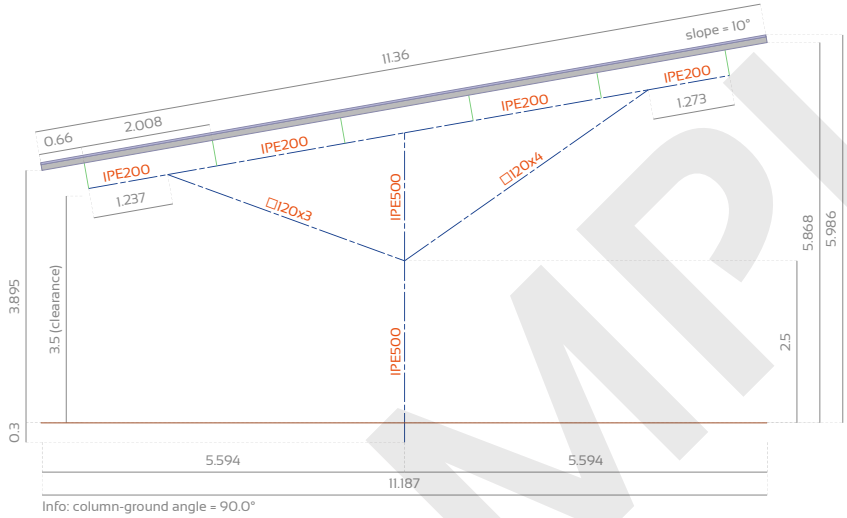
EUROCODESTOOLS
Calculer facilement, construire durablement

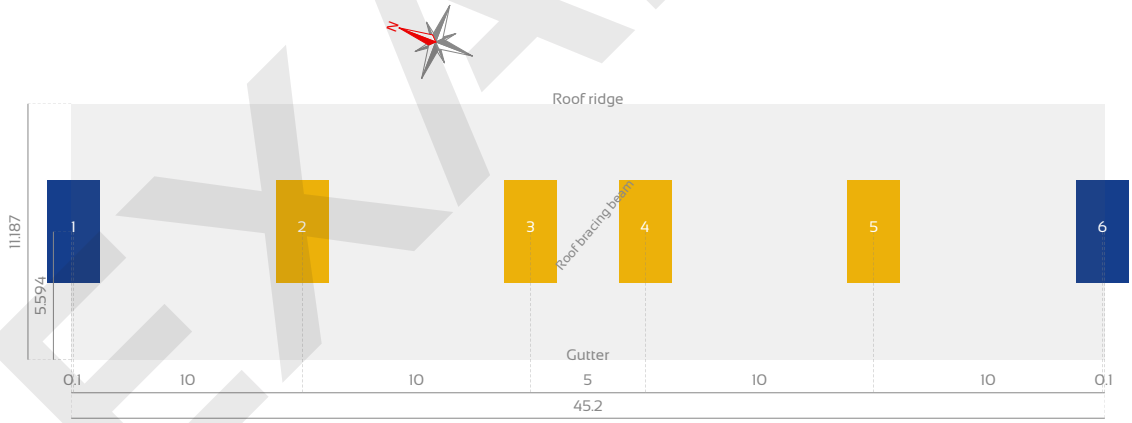
A - GENERAL INFORMATION

Project title : Projet exemple rapport
Customer name : Exemple de client
Last update : 2024-12-17 10:16 Software Version : 03-0916

B - DATA AND SUMMARY OF RESULTS

B 1 - Sketches and dimensions of the photovoltaic shelter





B 2 - Summary of checkings according to Eurocodes

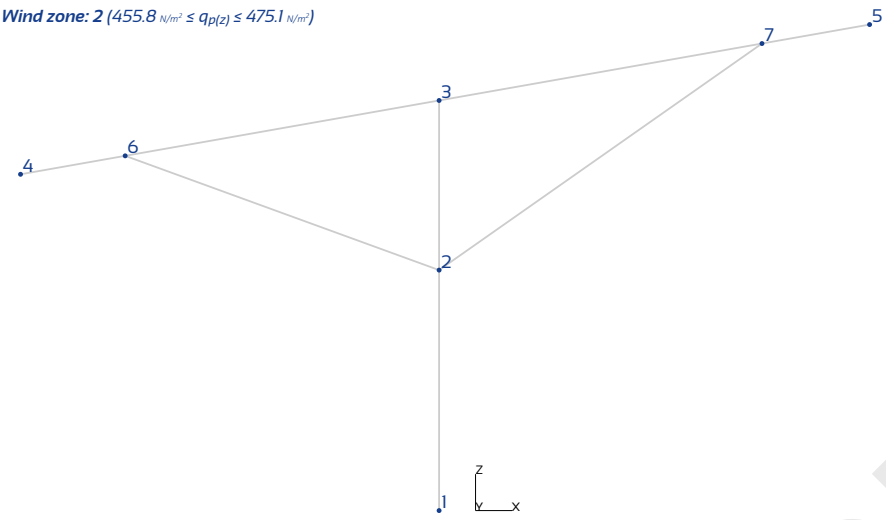
Element			Checking (It's okay if the rate is less than 100%)
Column	IPE500	S275	OK (91.8 %)
Rafter	IPE200	S275	OK (92.8 %)
Left diagonal brace	□120x3	S235	OK (79.0 %)
Right diagonal brace	□120x4	S235	OK (78.9 %)

Execution class according to EN 1090-2: EXC 2
Purlin laying system:unknown (with or without sleeve)

C - LOADS DISTRIBUTION REPORT

Snow zone: A1 *(s_n = 0.45 kN/m²)*

Wind zone: 2 *(455.8 N/m² ≤ $q_{p(z)}$ ≤ 475.1 N/m²)*



Axis	Loading width	Continuity factor
1	5.1 m	1.0
2	10.0 m	1.178
3	7.5 m	1.0
4	7.5 m	1.0
5	10.0 m	1.178
6	5.1 m	1.0

Axis 1 and 6

(Loading width: 5.1m, continuity factor: 1.0)

Node	F_X (daN)	F_Y (daN)	F_Z (daN)	M_X (m.daN)	M_Y (m.daN)	M_Z (m.daN)
Permanent loads						
1	0.0	-	-2684.7	-	-219.0	-
Normal snow						
1	0.0	-	-2054.4	-	-0.0	-
Accidental snow						
1	-0.0	-	-0.0	-	-0.0	-
Left wind sagging						
1	296.8	-	-1136.2	-	-2069.4	-
Left wind in uplift						
1	-339.8	-	2474.1	-	5073.5	-
Right wind sagging						
1	99.7	-	-1090.0	-	3977.0	-
Right wind in uplift						
1	-511.0	-	2373.6	-	-9204.4	-
Front wind sagging						
1	95.6	669.3	-542.3	-2719.9	495.4	-0.0
Front wind in uplift						
1	-339.0	669.3	1922.8	-2719.9	-1756.7	-0.0
Rear wind sagging						
1	95.6	-669.3	-542.3	2719.9	495.4	0.0
Rear wind in uplift						
1	-339.0	-669.3	1922.8	2719.9	-1756.7	0.0

Axis 2 , 3 , 4 and 5

(Loading width: 10.0m, continuity factor: 1.178)

Node	F_X (daN)	F_Y (daN)	F_Z (daN)	M_X (m.daN)	M_Y (m.daN)	M_Z (m.daN)
Permanent loads						
1	0.0	-	-4834.2	-	-592.5	-
Normal snow						
1	0.0	-	-4743.6	-	-0.0	-
Accidental snow						
1	-0.0	-	-0.0	-	-0.0	-
Left wind sagging						
1	559.0	-	-2623.3	-	-5079.5	-
Left wind in uplift						
1	-910.9	-	5712.6	-	11413.1	-
Right wind sagging						
1	351.3	-	-2516.8	-	9471.8	-
Right wind in uplift						
1	-1058.9	-	5480.5	-	-20963.6	-
Front wind sagging						
1	220.8	669.3	-1252.0	-2719.9	1143.9	-0.0
Front wind in uplift						
1	-782.8	669.3	4439.7	-2719.9	-4056.1	-0.0
Rear wind sagging						
1	220.8	-669.3	-1252.0	2719.9	1143.9	0.0
Rear wind in uplift						
1	-782.8	-669.3	4439.7	2719.9	-4056.1	0.0

Additional actions to consider for columns adjoining span containing the stability system (roof bracing beam) :

Position	F_X (daN)	F_Y (daN)	F_Z (daN)	M_X (m.daN)	M_Y (m.daN)	M_Z (m.daN)
Front wind sagging and Front wind in uplift						
Axis 4	44.8	-	7.9	-	214.1	-
Axis 3	-44.8	-	-7.9	-	-214.1	-
Rear wind sagging and Rear wind in uplift						
Axis 3	44.8	-	7.9	-	214.1	-
Axis 4	-44.8	-	-7.9	-	-214.1	-

D - STRUCTURAL BEHAVIOR AND CONSTRUCTION PRINCIPLES

The most stressed portal frame is used in the design calculations (axis 2).

D 1 - Purlins

D 1.1 - Recommended minimum thickness

The photovoltaic panels are fixed on an integration system.
The minimum purlins thickness is recommended by the supplier of the integration system (usually 2.5mm min thickness).

D 1.2 - Normal forces required for the design of cold-formed purlins

The cross-sections of the purlins must be sufficient to take up the normal forces crossing the roof cross-bracing, in particular compression (in red on the diagrams).

Diagram of the normal forces circulating in the roof plane during a front wind (Simple unweighted load case - rounded in daN)

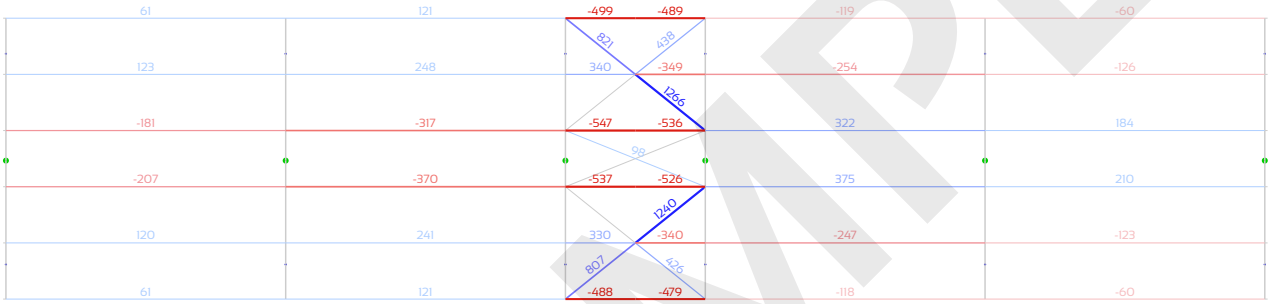
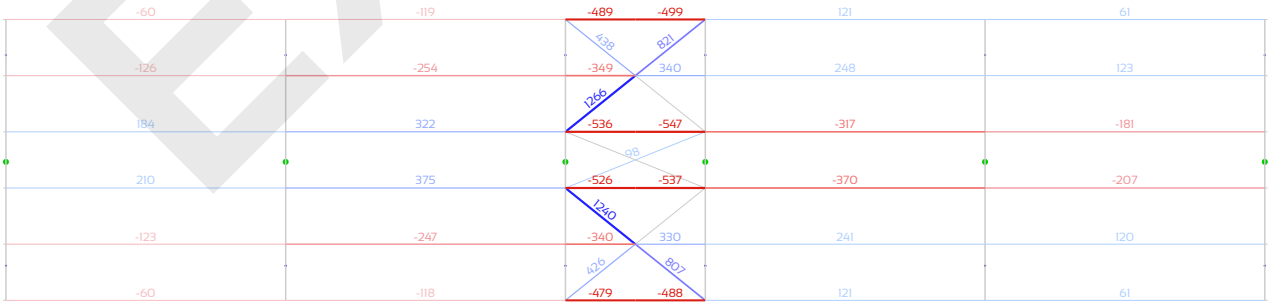


Diagram of the normal forces circulating in the roof plane during a rear wind (Simple unweighted load case - rounded in daN)



D 2 - Rafter

The top flange is restrained by the purlins. The purlins will be linked to the nodes of the roof cross-bracing. So the lateral-buckling length of the top flange is the distance between purlins.
The lower flange is restrained plumb with the column (torsional restraint) and the diagonal braces (torsion spring), so lateral-buckling is checked between these points without considering the influence of warping restraint at the supports. Lateral-buckling of the lower flange is checked for a double length in the cantilevered parts located after the diagonal braces.

D 3 - Column

Flexural buckling about y-y and z-z axis are calculated for a cantilever column with 2 nodal forces of varying intensities (the first at the top and the second at the intersection with the diagonal brace). For each force distribution (depending on the load combination), these buckling lengths therefore vary within an interval between 2 times the level of diagonal brace intersection and 2 times the total height of the column.

No vehicle impact on the columns is taken into account in this analysis.
If the risk is acceptable, it is not necessary to take special measures. Otherwise, risk mitigation measures are to be planned (signage / protection / additional structural analysis in an accident situation).

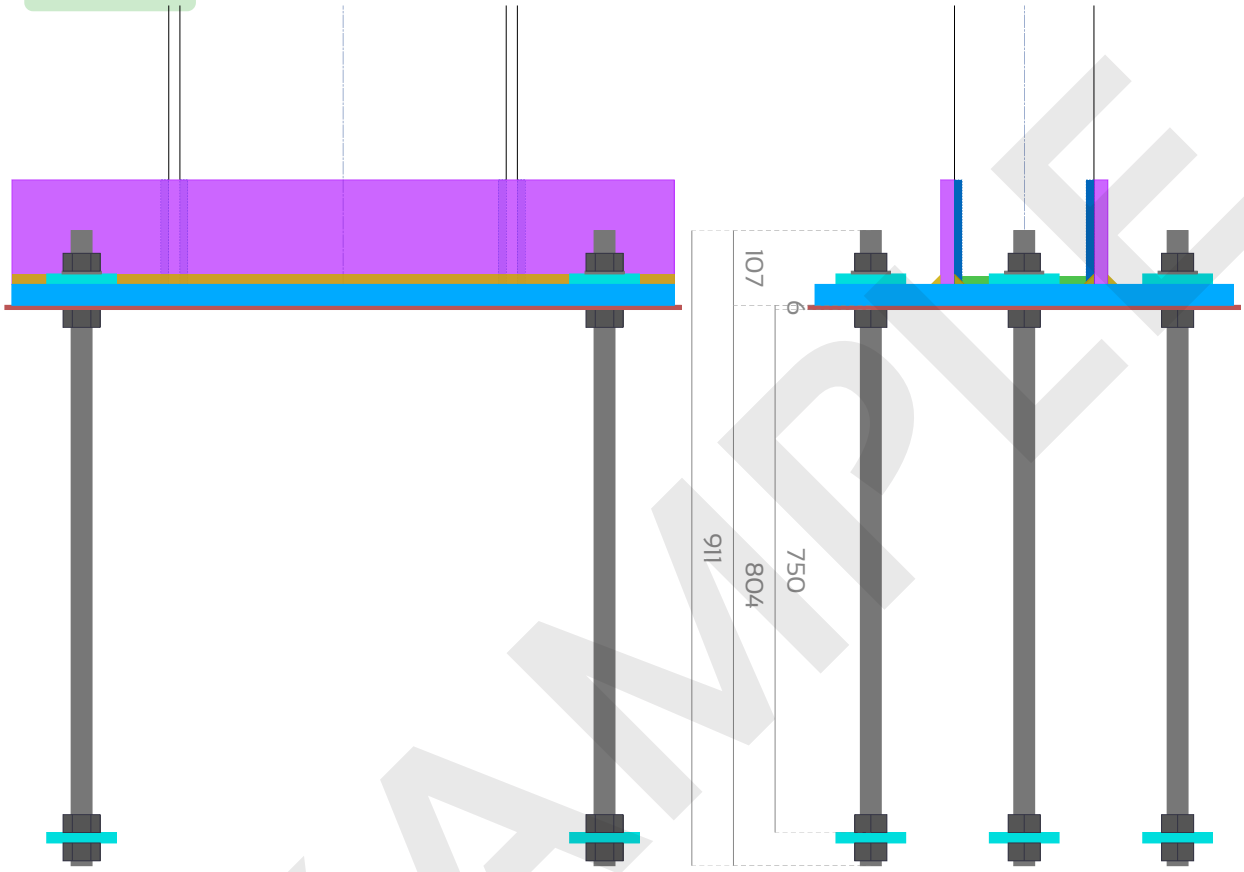
D 4 - Assemblies

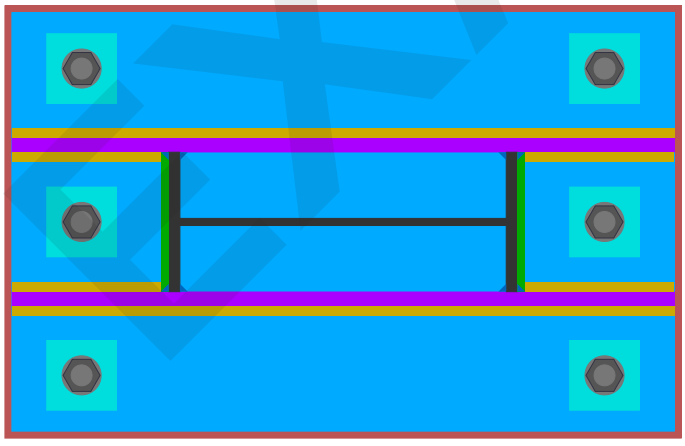
The connecting bolts of the steel parts will be of the SB type (Structural Bolt) and class 8.8 minimum.
Drillings will comply with standard EN 1090-2 §6.6.1 « Dimensions of holes ».

D 4.1 - Column base and anchorages

The rotation of the column base is blocked around the X and Y axes at -0.3m level on C25/30 concrete foundation blocks.
The anchorages consist of threaded rods each fitted with an anchor pad bolted to its end embedded in the concrete.
The positioning jig plate is useful for positioning anchors when pouring concrete and for obtaining a flat contact surface. A central hole 50 mm in diameter will be provided to serve as a vent during the pouring of the concrete.

Working rate: 0.813





Positioning jig plate : 970x620x6 (S235)
Column base plate : 950x600x30 (S235)
Stiffeners : 950x150x20 (S235)
Anchor pad and support pad : 100x100x15 (S235)
Anchor bolts: M30 8.8

Transverse spacing p_2	Edge distance e_2	Longitudinal spacing p_1	End distance e_1
220 mm > 79.2 mm	80.0 mm > 39.6 mm	750 mm > 79.2 mm	100.0 mm > 39.6 mm

Weld throats		
Horizontal on the column flanges a_f	Horizontal on the stiffeners a_s	Vertical on the column a_c
8 mm	10 mm	8 mm

Concrete foundation blocks C25/30: L ≥ 4.5m x B ≥ 2.3 m x H ≥ 0.95m
The minimum cross-section of concrete reinforcement to avoid splitting failure should be greater than 5.5 cm^2.

Additional provisions:
The column base plate can be lengthened and widened to eventually make oversized holes (the distance from the axis of the hole to the edge of the column base plate must be at least 1.5 times the diameter of the hole).
In this case, to allow the transfer of the shear force from the column base plate to the anchor bolts, it will be necessary to (several solutions to choose from):

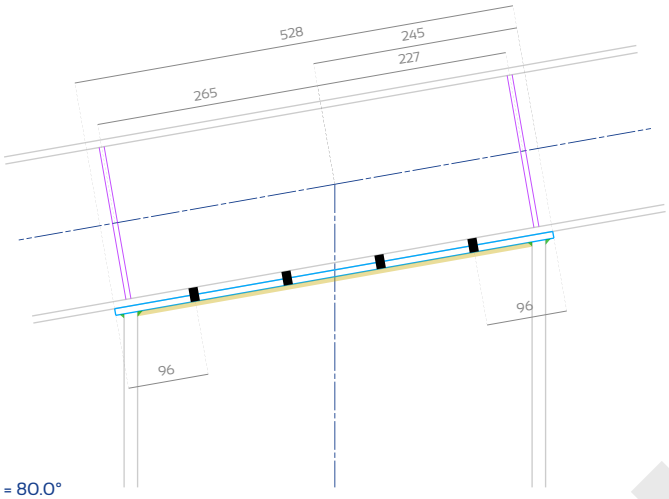
- Weld the top pads to the column base plate.
- Fill the annular space (with a suitable anchoring resin for example).
- Add 1 anchor peg on either side of the column in normal holes (direct take-up of shear by the anchor pegs).

If normal holes are provided, these additional provisions are not necessary.

D 4.2 - Column top end plate

The rafter is bolted to the column via an end plate made of S235 steel.
This connection is calculated as a pin.

Working rate: 0.911



Angle between elements = 80.0°

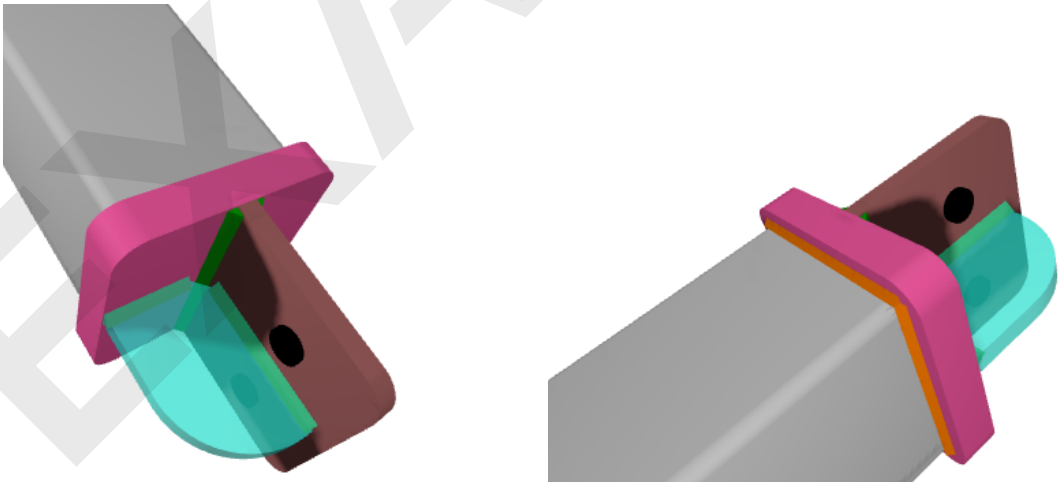
End plate	Thickness t_p	Width	Length	Drillings d_0	Weld throat on the flanges a_f	Weld throat on the web a_w
	8.0 mm	200.0 mm	*(See sketch)*	11 mm	4 mm	4 mm
Bolts	Designation	Screw diameter d	Washer diameter	Transverse spacing p_2	Edge distance (rafter) e_2	Longitudinal spacing p_1
	M10 8.8 SB	10 mm	20 mm	58 mm > 26.4 mm	21.0 mm > 13.2 mm	112 mm > 24.2 mm
Stiffener	Thickness t_s	Width b_s	Position			
	6 mm	40 mm	*(See sketch)*			

D 4.3 - Diagonal braces gussets

The diagonal braces gussets will be made of minimum S235 steel.

On the rafter/column side, the connection consists of a single gussets welded to the flange on both sides along its length (2 welding fillets per gusset) and centered on the web.

On the brace side, the connection consists of a single centered gusset welded on an end plate and forming a T.
This T are welded at the ends of the diagonal braces around its perimeter.

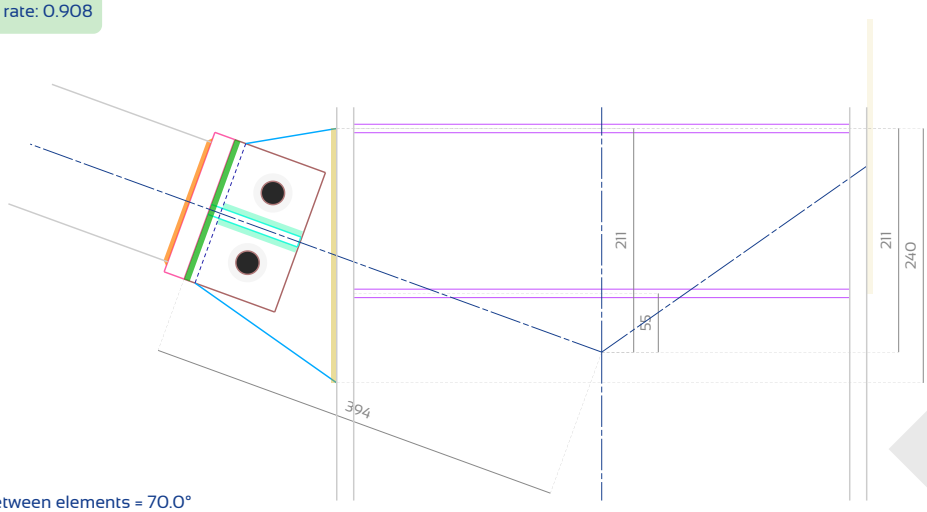


The gussets are connected to each other by two bolts (and hardened washers) functionning in simple shearing.

This connection system causes an eccentricity of the forces which pass through the diagonal brace from the other elements and, consequently, creates an out-of-plane moment in the diagonal brace. A lateral stiffener is therefore provided to prevent the the gussets centered on the diagonal braces and their welds from being stressed by out-of-plane bending.

Left diagonal brace - Column side

Working rate: 0.908

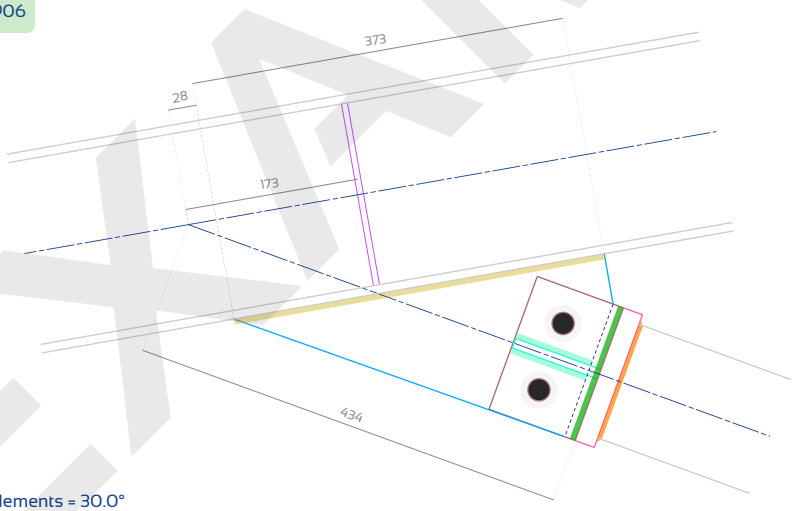


Angle between elements = 70.0°

Gusset attached to diagonal brace	Thickness $t_{b,g}$	Width	Length	Drillings d_0	Weld throat $a_{b,g}$	
	10 mm	140 mm	91 mm	22 mm	4 mm	
End plate attached to diagonal brace	Thickness $t_{b,p}$	Width	Length	Drillings d_0	Weld throat $a_{b,p}$	
	20 mm	140 mm	140 mm	10 mm (galvanizing)	3 mm	
Gusset attached to the other element	Thickness t_i	Dimensions and position	Drillings d_0	Clearance with end plate	Weld throat $a_{o,s,g}$	
	10 mm	*(See sketch)*	22 mm	11 mm	4 mm	
Bolts	Designation	Screw diameter d	Hardened washer diameter	Spacing p_2	Edge distance e_2	End distance e_1
	M20 8.8 SB	20 mm	37 mm	70 mm > 52.8 mm	35.0 mm > 26.4 mm	40 mm > 26.4 mm
Web stiffeners	Thickness x Width	Gusset lateral stiffener	Thickness $t_{l,s,g}$	Width $b_{l,s,g}$	Height $h_{l,s,g}$	Weld throat $a_{l,s,g}$
	8 mm x 90 mm		10 mm	65 mm	90 mm	4 mm

Left diagonal brace - Rafter side

Working rate: 0.906

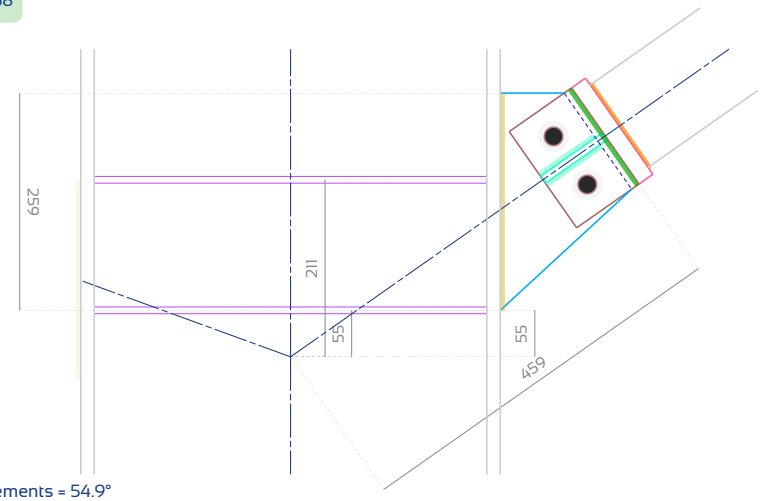


Angle between elements = 30.0°

Gusset attached to diagonal brace	Thickness $t_{b,g}$	Width	Length	Drillings d_0	Weld throat $a_{b,g}$	
	10 mm	140 mm	91 mm	22 mm	4 mm	
End plate attached to diagonal brace	Thickness $t_{b,p}$	Width	Length	Drillings d_0	Weld throat $a_{b,p}$	
	20 mm	140 mm	140 mm	10 mm (galvanizing)	3 mm	
Gusset attached to the other element	Thickness t_i	Dimensions and position	Drillings d_0	Clearance with end plate	Weld throat $a_{o,s,g}$	
	10 mm	*(See sketch)*	22 mm	11 mm	4 mm	
Bolts	Designation	Screw diameter d	Hardened washer diameter	Spacing p_2	Edge distance e_2	End distance e_1
	M20 8.8 SB	20 mm	37 mm	70 mm > 52.8 mm	35.0 mm > 26.4 mm	40 mm > 26.4 mm
Web stiffeners	Thickness x Width	Gusset lateral stiffener	Thickness $t_{l,s,g}$	Width $b_{l,s,g}$	Height $h_{l,s,g}$	Weld throat $a_{l,s,g}$
	6 mm x 40 mm		10 mm	65 mm	90 mm	4 mm

Right diagonal brace - Column side

Working rate: 0.858

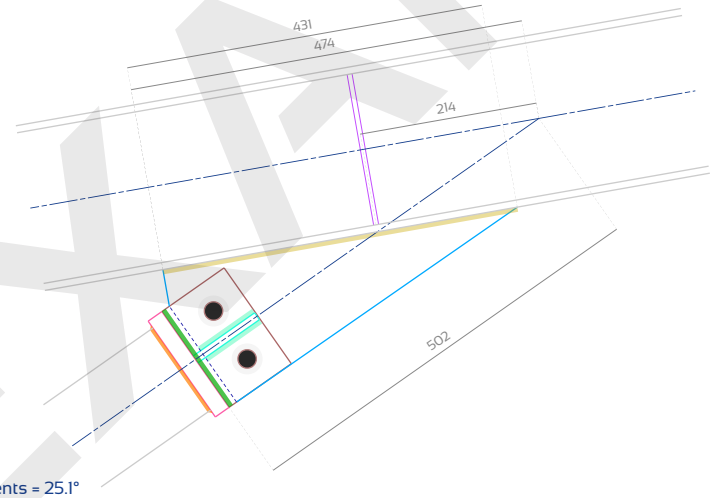


Angle between elements = 54.9°

Gusset attached to diagonal brace	Thickness $t_{b,g}$	Width	Length	Drillings d_0	Weld throat $a_{b,g}$	
	10 mm	140 mm	91 mm	22 mm	4 mm	
End plate attached to diagonal brace	Thickness $t_{b,p}$	Width	Length	Drillings d_0	Weld throat $a_{b,p}$	
	20 mm	140 mm	140 mm	10 mm (galvanizing)	3 mm	
Gusset attached to the other element	Thickness t_i	Dimensions and position	Drillings d_0	Clearance with end plate	Weld throat $a_{o,s,g}$	
	10 mm	*(See sketch)*	22 mm	11 mm	4 mm	
Bolts	Designation	Screw diameter d	Hardened washer diameter	Spacing p_2	Edge distance e_2	End distance e_1
	M20 8.8 SB	20 mm	37 mm	70 mm > 52.8 mm	35.0 mm > 26.4 mm	40 mm > 26.4 mm
Web stiffeners	Thickness x Width	Gusset lateral stiffener	Thickness $t_{s,g}$	Width $b_{s,g}$	Height $h_{s,g}$	Weld throat $a_{s,s,g}$
	8 mm x 90 mm		10 mm	65 mm	90 mm	4 mm

Right diagonal brace - Rafter side

Working rate: 0.855



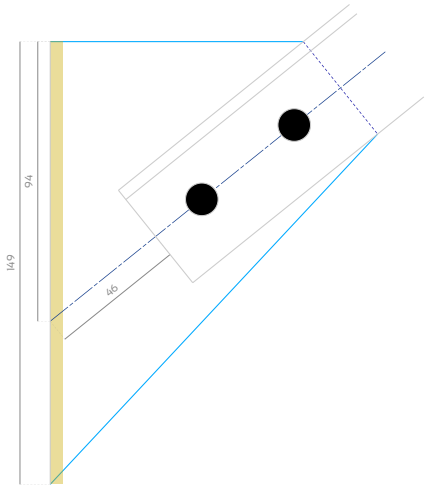
Angle between elements = 25.1°

Gusset attached to diagonal brace	Thickness $t_{b,g}$	Width	Length	Drillings d_0	Weld throat $a_{b,g}$	
	10 mm	140 mm	91 mm	22 mm	4 mm	
End plate attached to diagonal brace	Thickness $t_{b,p}$	Width	Length	Drillings d_0	Weld throat $a_{b,p}$	
	20 mm	140 mm	140 mm	10 mm (galvanizing)	3 mm	
Gusset attached to the other element	Thickness t_i	Dimensions and position	Drillings d_0	Clearance with end plate	Weld throat $a_{o,s,g}$	
	10 mm	*(See sketch)*	22 mm	11 mm	4 mm	
Bolts	Designation	Screw diameter d	Hardened washer diameter	Spacing p_2	Edge distance e_2	End distance e_1
	M20 8.8 SB	20 mm	37 mm	70 mm > 52.8 mm	35.0 mm > 26.4 mm	40 mm > 26.4 mm
Web stiffeners	Thickness x Width	Gusset lateral stiffener	Thickness $t_{s,g}$	Width $b_{s,g}$	Height $h_{s,g}$	Weld throat $a_{s,s,g}$
	6 mm x 40 mm		10 mm	65 mm	90 mm	4 mm

D 4.4 - Roof cross-bracing gussets

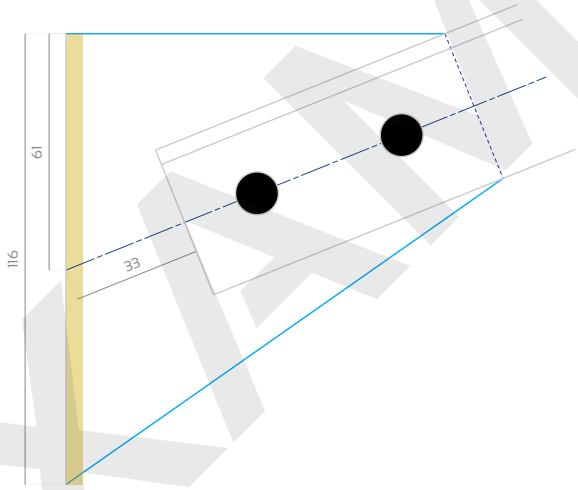
The roof plane is stiffened by installing an angle (cross) truss in the plane of the slope.
The angles are linked together and on the rafters by gussets.
The central gusset of each cross is fixed on the intermediate purlins.
These gussets are connected to the braces by several class 8.8 bolts functionning in simple shearing.

Working rate: 0.594



Angle = 38.8°

Element	Cross section	Gusset	Thickness t	Dimensions and position	Drillings d_0	Weld throat a_w
	L40x40x4		5 mm	*(See sketch)*	11 mm	3 mm
Bolts	Designation	Screw diameter d	Washer diameter	Edge distance e_2	Spacing p_1	End distance e_1
	M10 8.8 SB	10 mm	20 mm	20 mm > 13.2 mm	40 mm > 24.2 mm	20 mm > 13.2 mm



Angle = 21.9°

Element	Cross section	Gusset	Thickness t	Dimensions and position	Drillings d_0	Weld throat a_w
	L40x40x4		5 mm	*(See sketch)*	11 mm	3 mm
Bolts	Designation	Screw diameter d	Washer diameter	Edge distance e_2	Spacing p_1	End distance e_1
	M10 8.8 SB	10 mm	20 mm	20 mm > 13.2 mm	40 mm > 24.2 mm	20 mm > 13.2 mm

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ANNEXES

STRUCTURAL ANALYSIS DESIGN REPORT

Projet exemple rapport - Exemple de client

Project defined by : xxx-xxx

E-mail : contact@eurocodes-tools.com

Last update : 2024-12-17 10:16

Link for inspection agency : https://app.eurocodes-tools.com/en/shelters/ xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx /inspection

ANNEX 1 - MODEL FEATURES

Annex 1.1 - Nodes

Node Id	Coordinates		Restrained degrees of freedom
	X	Z	
1	5.594 m	-0.3 m	U_X U_Z R_Y
2	5.594 m	2.5 m	
3	5.594 m	4.475 m	
4	0.719 m	3.616 m	
5	10.607 m	5.359 m	
6	1.938 m	3.831 m	
7	9.354 m	5.138 m	

Annex 1.2 - Elements

Element Id	Start node	End node	Length	Cross section	Boundary conditions
1	1	2	2.8 m	IPE500	
2	2	3	1.975 m	IPE500	Pinned at end node
3	4	6	1.237 m	IPE200	
4	6	3	3.712 m	IPE200	
5	3	7	3.818 m	IPE200	
6	7	5	1.273 m	IPE200	
7	6	2	3.89 m	☐ 120x3	Pinned at start node and end node
8	2	7	4.593 m	☐ 120x4	Pinned at start node and end node

Annex 1.3 - Cross sections and materials

Cross section	Gross area A	Shear areas		Second moments of area		Polar moment of inertia I_O	Torsional constant I_t	Warping constant I_w
		on y-y A_{vY}	on z-z A_{vZ}	about y-y I_Y	about z-z I_Z			
IPE500	115.5 cm^2	72.1 cm^2	59.9 cm^2	48198.5 cm^4	2141.7 cm^4	50340.2 cm^4	89.29 cm^4	1249.37 $x\ 10^3\ cm^6$
IPE200	28.5 cm^2	19.6 cm^2	14.0 cm^2	1943.2 cm^4	142.4 cm^4	2085.5 cm^4	6.98 cm^4	12.99 $x\ 10^3\ cm^6$
☐ 120x3	13.8 cm^2	6.9 cm^2	6.9 cm^2	312.3 cm^4	312.3 cm^4	624.7 cm^4	487.72 cm^4	-
☐ 120x4	18.1 cm^2	9.1 cm^2	9.1 cm^2	402.3 cm^4	402.3 cm^4	804.6 cm^4	636.57 cm^4	-

Cross section	Material	Yield strength f_y	Young modulus E	Shear modulus G
IPE500	S275	275 MPa	210000.0 MPa	80769.2 MPa
IPE200	S275	275 MPa	210000.0 MPa	80769.2 MPa
☐ 120x3	S235	235 MPa	210000.0 MPa	80769.2 MPa
☐ 120x4	S235	235 MPa	210000.0 MPa	80769.2 MPa

ANNEX 2 - LOADINGS

Annex 2.1 - Dead loads

Name	Type	Intensity
Self-weight of steel structures	density	7698 daN/m³
Solar panels	uniformly distributed load	20.0 kg/m²
Purlins	uniformly distributed load	8.0 kg/m²
Gutter	linear load at the bottom edge	10.0 kg/m

Annex 2.2 - Maintenance imposed loads

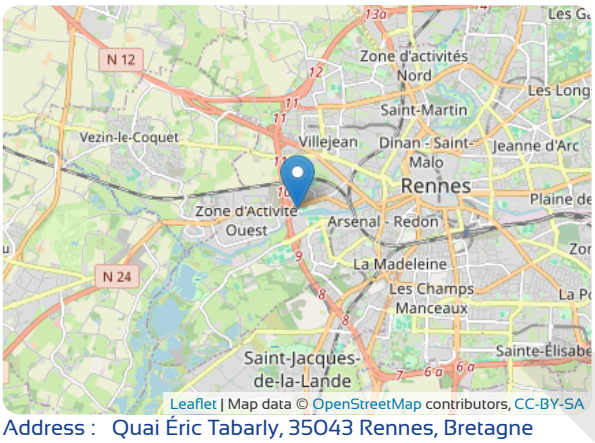
No maintenance loads is to be taken into account because it is not recommended to move on the solar panels.

Annex 2.3 - Climatic loads

Annex 2.3.1 - Location

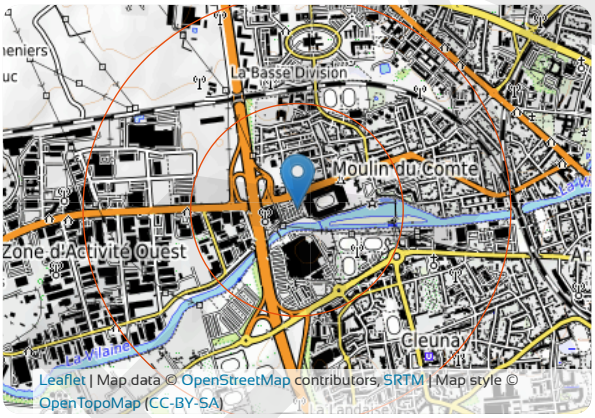
Coordinates in World Geodetic System 1984 (WGS84) :

48.10711776 ° , -1.71473623 °



Address : Quai Éric Tabarly, 35043 Rennes, Bretagne

Annex 2.3.2 - Elevations



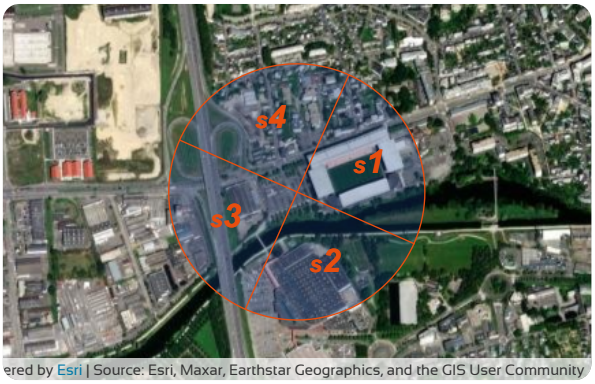
Distances / Direction	At the place of construction	500 m	1000 m
North	26 m	32 m	40 m
Northeast		33 m	43 m
East		24 m	24 m
Southeast		24 m	30 m
South		25 m	30 m
Southwest		23 m	25 m
West		26 m	26 m
Northwest		29 m	39 m

source : European digital elevation model Copernicus 25m

Annex 2.3.3 - Building

Type of building : common structure
Design working life category : 50 years
Max height : 5.986 m
Orientation from North : 69 °

Annex 2.3.4 - Terrain categories



Sectors	s1	s2	s3	s4
Categories	IV	IIIb	IIIb	IIIb

Radius R of the angular sector : 300 m

Annex 2.3.5 - Snow (NF EN 1991-1-3/NA (05/2007) + A1 (07/2011))

Annex 2.3.5.1 - On the ground

Zone : A1 ($s_{k,0}$ = 0.45 kN/m²) Criteria for zoning :ILLE-ET-VILAINE (35)

Characteristic value of snow on the ground at the relevant site :$s_{k,26\ m}$ = 0.45 kN/m²

Ground snow load with a return period of 50 years :$s_{50\ years}$ = 0.45 kN/m²

Annex 2.3.5.2 - On the roof

Name	Type	Characteristic value	Roof form factor	Design value (horizontal projection)
Normal snow	uniformly distributed load	45.0 daN/m²	0.8	35.45 daN/m²

Annex 2.3.6 - Wind (NF EN 1991-1-4/NA (03/2008) + A1 (07/2011) + A2 (09/2012) + A3 (04/2019))

Annex 2.3.6.1 - Wind - Peak velocity pressure

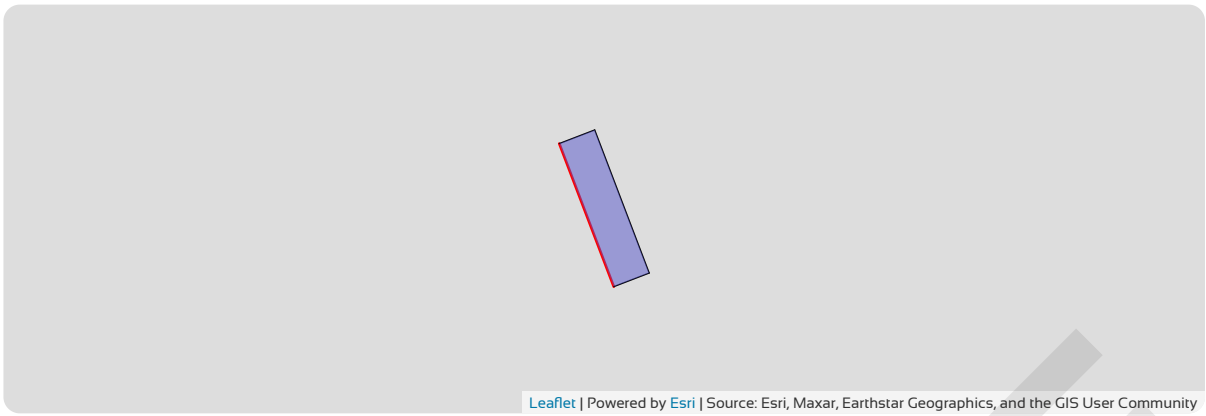
Zone : 2 ($v_{b,0}$ = 24.0 m/s) Criteria for zoning :ILLE-ET-VILAINE (35) Zone c_{dir} : 2

Sectors	s1	s2	s3	s4
Sector definition	from 24 ° to 114 °	from 114 ° to 204 °	from 204 ° to 294 °	from 294 ° to 24 °
Fundamental value of the basic wind velocity $v_{b,0}$	24.0 m/s			
Shape parameter K	0.2			
Exponent n	0.5			
Annual probability of exceedence p	0.02			
Probability factor c_{prob}	1.0			
Directional factor c_{dir}	1.0	1.0	1.0	1.0
Basic wind velocity v_b	24.0 m/s	24.0 m/s	24.0 m/s	24.0 m/s
Reference roughness length $z_{0,II}$	0.05 m			
Roughness length z_0	1.0 m	0.5 m	0.5 m	0.5 m
Terrain factor k_r	0.234	0.223	0.223	0.223
Height above ground z	5.986 m			
Minimum height z_{min}	15.0 m	9.0 m	9.0 m	9.0 m
Roughness factor $c_{r(z)}$	0.635	0.645	0.645	0.645
Orography factor* $c_{o(z)}$	1.0	1.0	1.0	1.0
Mean wind velocity $v_{m(z)}$	15.2 m/s	15.5 m/s	15.5 m/s	15.5 m/s
Turbulence factor k_I	0.854	0.923	0.923	0.923
Standard deviation of the turbulence σ_v	4.804 m/s	4.943 m/s	4.943 m/s	4.943 m/s
Turbulence intensity $I_{v(z)}$	0.315	0.319	0.319	0.319
Air density ρ	1.225 kg/m³			
Exposure factor $c_{e(z)}$	1.292	1.347	1.347	1.347
Peak velocity pressure $q_{p(z)}$	455.8 N/m²	475.1 N/m²	475.1 N/m²	475.1 N/m²
Peak wind velocity for Serviceability Limit States $v_{p(z),SLS}$	98.2 km/h	100.3 km/h	100.3 km/h	100.3 km/h
Peak wind velocity for Ultimate Limit States $v_{p(z),ULS}$	120.3 km/h	122.8 km/h	122.8 km/h	122.8 km/h

* Ici, le coefficient d'orographie est calculé selon la procédure I, pour une orographie constituée d'obstacles de hauteurs et de formes variées. Ce type d'orographie est le plus fréquemment rencontré, mais si le bâtiment est dans un cas d'orographie constitué d'obstacles bien individualisés (collines isolées ou en chaîne, falaises et escarpements), le coefficient d'orographie doit être calculé selon la procédure 2.Conformément à EN 1991-1-4 §4.3.3(1), le coefficient d'orographie calculé (1.0) n'est pas pris en compte car il n'augmente pas les vitesses du vent de plus de 5%.

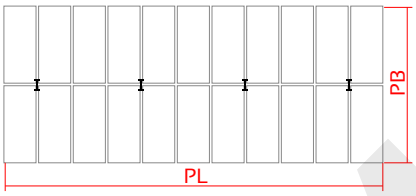
Low edge oriented towards the sector : s3

Low edge orientation relative to North : 249 °



Wind from left (gutter) q_{p1}	Wind from right (ridge) q_{p2}	Wind from front q_{p3}	Wind from rear q_{p4}
47.51 daN/m²	45.58 daN/m²	47.51 daN/m²	47.51 daN/m²

Annex 2.3.6.2 - Degree of blockage under the roof



Parking	Vehicle type	Number over length P_L	Face area	Total blockage area
		18	3.36 m²/vehicle	60.48 m²
		Number over width P_B	Profile area	Total blockage area
		2	7.14 m²/vehicle	14.28 m²

Position	Blockage area	Cross sectional area under the canopy	Blockage ratio φ
At left	60.48 m²	176.05 m²	0.344
At right	60.48 m²	265.22 m²	0.228
Profile	14.28 m²	54.61 m²	0.261

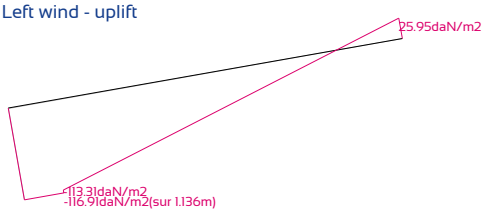
Annex 2.3.6.3 - Surface pressures on the roof

(EN 1991-1-4 §7.3 + cf distribution à partir de BNCM/CNC2M N0380 / REC EC1-CM : juillet 2017 Figure 22)

Left wind - sag

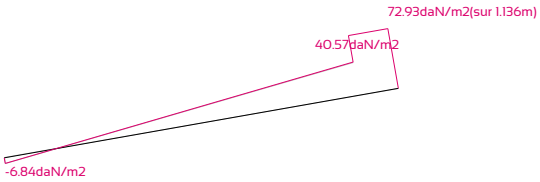
Force coefficient c_f	0.5	Table 7.6
Location of c_f	2.84 m	Figure 7.16

Left wind - uplift



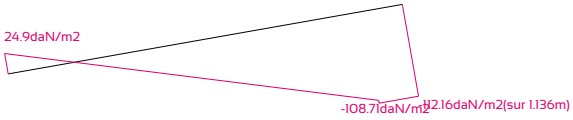
Force coefficient c_f	-1.072	Table 7.6
Location of c_f	2.84 m	Figure 7.16

Right wind - sag



Force coefficient c_f	0.5	Table 7.6
Location of c_f	8.52 m	Figure 7.16

Right wind - uplift

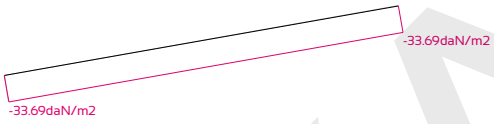


Force coefficient c_f	-1.072	Table 7.6
Location of c_f	8.52 m	Figure 7.16

Front wind - sag

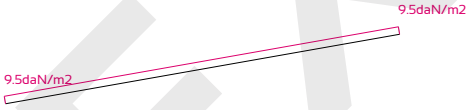
Force coefficient c_f	0.2	pour une pente de toit α = 0° - BNCM/CNC2M N0380 / REC EC1-CM: Juillet 2017 Tableau 3
Location of c_f	5.68 m	cf est uniforme sur tout le toit - BNCM/CNC2M N0380 / REC EC1-CM: Juillet 2017 §5.3

Front wind - uplift



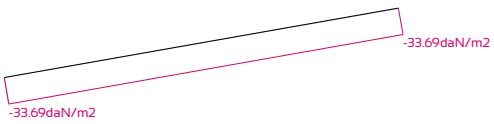
Force coefficient c_f	-0.709	pour une pente de toit α = 0° - BNCM/CNC2M N0380 / REC EC1-CM: Juillet 2017 Tableau 3
Location of c_f	5.68 m	cf est uniforme sur tout le toit - BNCM/CNC2M N0380 / REC EC1-CM: Juillet 2017 §5.3

Rear wind - sag



Force coefficient c_f	0.2	pour une pente de toit α = 0° - BNCM/CNC2M N0380 / REC EC1-CM: Juillet 2017 Tableau 3
Location of c_f	5.68 m	cf est uniforme sur tout le toit - BNCM/CNC2M N0380 / REC EC1-CM: Juillet 2017 §5.3

Rear wind - uplift



Force coefficient c_f	-0.709	pour une pente de toit α = 0° - BNCM/CNC2M N0380 / REC EC1-CM: Juillet 2017 Tableau 3
Location of c_f	5.68 m	cf est uniforme sur tout le toit - BNCM/CNC2M N0380 / REC EC1-CM: Juillet 2017 §5.3

Annex 2.3.6.4 - Friction on the elements

	Column		Rafter		Left diagonal brace		Right diagonal brace		Roof surface	
Load case	$c_{f,column}$	q_{column}	$c_{f,rafter}$	q_{rafter}	$c_{f,left\ diagonal\ brace}$	$q_{left\ diagonal\ brace}$	$c_{f,right\ diagonal\ brace}$	$q_{right\ diagonal\ brace}$	$c_{fr,roof}$	q_{roof}
Left wind - sag	0.85	20.2 daN/m	-	-	-	-	-	-	-	-
Left wind - uplift	0.85	20.2 daN/m	-	-	-	-	-	-	-	-
Right wind - sag	0.85	-19.4 daN/m	-	-	-	-	-	-	-	-
Right wind - uplift	0.85	-19.4 daN/m	-	-	-	-	-	-	-	-
Front wind - sag	2.0	47.5 daN/m	1.749	16.6 daN/m	1.84	10.5 daN/m	1.75	10.0 daN/m	0.05	17.9 daN/m
Front wind - uplift	2.0	47.5 daN/m	1.749	16.6 daN/m	1.84	10.5 daN/m	1.75	10.0 daN/m	0.05	17.9 daN/m
Rear wind - sag	2.0	-47.5 daN/m	1.749	-16.6 daN/m	1.84	-10.5 daN/m	1.75	-10.0 daN/m	0.05	-17.9 daN/m
Rear wind - uplift	2.0	-47.5 daN/m	1.749	-16.6 daN/m	1.84	-10.5 daN/m	1.75	-10.0 daN/m	0.05	-17.9 daN/m

Annex 2.3.6.5 - Structural factor $c_s c_d$ (NF EN 1991-1-4/NA (03/2008) §6)

The structural factor $c_s c_d$ should take into account the effect on wind actions from the non-simultaneous occurrence of peak wind pressures on the surface (c_s) together with the effect of the vibrations of the structure due to turbulence (c_d).

Load case	Left wind - sag	Left wind - uplift	Right wind - sag	Right wind - uplift	Reference standard
Turbulent length scale $L(z_s)$	41.83 m	41.83 m	52.89 m	52.89 m	§B.1(1)
Background factor B^2	0.494	0.494	0.531	0.531	§B.2(2)
Natural frequency of the structure $n_{1,x}$	3.531 Hz				-
Non-dimensional frequency $f_{L(zs,n1x)}$	9.529	9.529	12.289	12.289	§B.1(2)
Non-dimensional power spectral density function $S_{L(zs,n1x)}$	0.031	0.031	0.026	0.026	
η_h	6.588	6.588	6.718	6.718	§B.2(6)
Aerodynamic admittance function R_h	0.14	0.14	0.138	0.138	
η_b	47.37	47.37	48.305	48.305	
Aerodynamic admittance function R_b	0.021	0.021	0.02	0.02	
Logarithmic decrement of structural damping δ_s	0.05				table F.2
Mass per unit area of the structure μ	37.0 kg/m²				-
Equivalent mass per unit of frontal area ($H_s.L$) μ_e	209.9 kg/m²				§F.5(3)
Air density ρ	1.225 kg/m³				§4.5
Logarithmic decrement of aerodynamic damping δ_a	0.006	0.014	0.006	0.013	§F.5(4)
Logarithmic decrement of damping δ	0.056	0.064	0.056	0.063	§F.5(1)
Resonance response factor R^2	0.008	0.007	0.007	0.006	§B.2(5)
Up-crossing frequency ν	0.445 Hz	0.419 Hz	0.389 Hz	0.366 Hz	§B.2(4)
Peak factor k_p	3.522	3.505	3.484	3.467	§B.2(3)
Structural factor $c_s c_d$	0.85	0.85	0.85	0.85	§6.3.1(1)

The structural factor $c_s c_d$ is equal to 1.0 for the other wind directions.

Annex 2.4 - Thermal actions (NF EN 1991-1-5/NA (02/2008))

Annex 2.4.1 - Temperatures

Seasons	Shade air §6.1.3.2	Inner environment T_{in} §5.3	Outer environment T_{out} table 5.2	Environments averages §5.3(1) note 2	Initial temperature T_0 Annex A.1	Uniform temperature components of purlins ΔT_u equation 5.1
Winter	-15 °C	-15 °C	-15 °C	-15.0 °C	10 °C	-25.0 °C
Summer	35 °C	35 °C	45 °C (dark surface: + 10°C)	40.0 °C		+30.0 °C

Annex 2.4.2 - Expansion

Coefficient of linear expansion α_T Tableau C.1	12 x10⁻⁶/°C	Purlin drilling clearance	Cleat web drilling clearance	Strain capacity by span
		+/-1 mm	+/-1 mm	+/-4 mm
		Cleat flange drilling clearance	Rafter flange drilling clearance	Jointless overall strain capacity
		+/-1 mm	+/-1 mm	+/-4 mm

Span	Longitudinal strain of purlins	Longitudinal strain less clearances by span	Axis	Cumulative sums of longitudinal strains	Expansion joints	Cumulated sums with expansion joints
1	-3.0 mm / +3.6 mm	0.0 mm / +0.0 mm	2	0.0 mm / +0.0 mm	-	0.0 mm / +0.0 mm
2	-3.0 mm / +3.6 mm	0.0 mm / +0.0 mm	3	0.0 mm / +0.0 mm	-	0.0 mm / +0.0 mm
3	-1.5 mm / +1.8 mm	0.0 mm / +0.0 mm	4	0.0 mm / +0.0 mm	-	0.0 mm / +0.0 mm
4	-3.0 mm / +3.6 mm	0.0 mm / +0.0 mm	5	0.0 mm / +0.0 mm	-	0.0 mm / +0.0 mm
5	-3.0 mm / +3.6 mm	0.0 mm / +0.0 mm	6	0.0 mm / +0.0 mm	-	0.0 mm / +0.0 mm

Annex 2.5 - Earthquake (Code de l'environnement - Article D563-8-1 (09/01/2015) + JORF n°0248 du 24/10/2010 texte N°5)

Annex 2.5.1 - Construction data

Zone : 2 (a_{gR} = 0.7 m/s²) Criteria for zoning :ILLE-ET-VILAINE (35)

Importance class defined by the contracting authority: I - Buildings of minor importance for public safety, agricultural buildings, etc.

Annex 2.5.2 - Seismic verification condition

In France, no seismic analysis is required for buildings in importance class I.

Annex 2.6 - Loads tables

Annex 2.6.1 - Loads due to self-weight *(G)*

Element Id	Distributed loads (including a 10% increase to take assembly parts into account)				
	System	Abscissa	q_X	q_Y	q_Z
1	global	0.0 m	0.0 daN/m	0 daN/m	-97.8 daN/m
		2.8 m	0.0 daN/m	0 daN/m	-97.8 daN/m
2	global	0.0 m	0.0 daN/m	0 daN/m	-97.8 daN/m
		1.975 m	0.0 daN/m	0 daN/m	-97.8 daN/m
3	global	0.0 m	0.0 daN/m	0 daN/m	-24.1 daN/m
		1.237 m	0.0 daN/m	0 daN/m	-24.1 daN/m
4	global	0.0 m	0.0 daN/m	0 daN/m	-24.1 daN/m
		3.712 m	0.0 daN/m	0 daN/m	-24.1 daN/m
5	global	0.0 m	0.0 daN/m	0 daN/m	-24.1 daN/m
		3.818 m	0.0 daN/m	0 daN/m	-24.1 daN/m
6	global	0.0 m	0.0 daN/m	0 daN/m	-24.1 daN/m
		1.273 m	0.0 daN/m	0 daN/m	-24.1 daN/m
7	global	0.0 m	0.0 daN/m	0 daN/m	-11.7 daN/m
		3.89 m	0.0 daN/m	0 daN/m	-11.7 daN/m
8	global	0.0 m	0.0 daN/m	0 daN/m	-15.4 daN/m
		4.593 m	0.0 daN/m	0 daN/m	-15.4 daN/m

Annex 2.6.2 - Concentrated loads

Element Id	Loads				
	System	Abscissa	F_X	F_Z	C_Y
Permanent loads (G)					
1	global	0.028 m	0.0 daN	-217.2 daN	0.0 m.daN
3	global	0.0 m	4.3 daN	-680.2 daN	-45.6 m.daN
4	global	0.771 m	-5.5 daN	-618.2 daN	-45.1 m.daN
	global	2.779 m	1.8 daN	-659.7 daN	-45.1 m.daN
5	global	1.075 m	-1.8 daN	-639.3 daN	-45.1 m.daN
	global	3.083 m	5.3 daN	-679.6 daN	-45.1 m.daN
6	global	1.273 m	-4.1 daN	-514.6 daN	-37.4 m.daN
Normal snow (Sn)					
3	global	0.0 m	-5.3 daN	-664.7 daN	-48.3 m.daN
4	global	0.771 m	6.6 daN	-876.1 daN	-58.2 m.daN
	global	2.779 m	-1.3 daN	-830.9 daN	-58.2 m.daN
5	global	1.075 m	-1.3 daN	-830.9 daN	-58.2 m.daN
	global	3.083 m	6.6 daN	-876.1 daN	-58.2 m.daN
6	global	1.273 m	-5.3 daN	-664.7 daN	-48.3 m.daN
Accidental snow (Sa)					
Left wind sagging (Wl-)					
3	global	0.0 m	186.8 daN	-1059.6 daN	-0.0 m.daN
4	global	0.771 m	124.7 daN	-707.3 daN	0.0 m.daN
	global	2.779 m	87.1 daN	-494.1 daN	0.0 m.daN
5	global	1.075 m	54.2 daN	-307.5 daN	0.0 m.daN
	global	3.083 m	20.1 daN	-113.9 daN	0.0 m.daN
6	global	1.273 m	-10.4 daN	58.9 daN	0.0 m.daN
Left wind in uplift (Wl+)					
3	global	0.0 m	-319.2 daN	1810.0 daN	-0.0 m.daN
4	global	0.771 m	-343.5 daN	1948.3 daN	-0.0 m.daN
	global	2.779 m	-221.6 daN	1256.7 daN	-0.0 m.daN
5	global	1.075 m	-133.5 daN	757.1 daN	-0.0 m.daN
	global	3.083 m	-34.9 daN	198.1 daN	-0.0 m.daN
6	global	1.273 m	45.4 daN	-257.7 daN	-0.0 m.daN
Right wind sagging (Wr-)					
3	global	0.0 m	-10.0 daN	56.5 daN	0.0 m.daN
4	global	0.771 m	19.3 daN	-109.2 daN	0.0 m.daN
	global	2.779 m	52.0 daN	-295.0 daN	0.0 m.daN
5	global	1.075 m	83.6 daN	-474.0 daN	0.0 m.daN
	global	3.083 m	119.6 daN	-678.5 daN	0.0 m.daN

Element Id	Loads				
	System	Abscissa	F_X	F_Z	C_Y
6	global	1.273 m	179.2 daN	-1016.5 daN	-0.0 m.daN
Right wind in uplift (Wr+)					
3	global	0.0 m	43.6 daN	-247.2 daN	-0.0 m.daN
4	global	0.771 m	-33.5 daN	190.1 daN	-0.0 m.daN
	global	2.779 m	-128.1 daN	726.4 daN	-0.0 m.daN
5	global	1.075 m	-212.6 daN	1205.7 daN	-0.0 m.daN
	global	3.083 m	-329.6 daN	1869.1 daN	-0.0 m.daN
6	global	1.273 m	-306.2 daN	1736.5 daN	-0.0 m.daN
Front wind sagging (Wf-)					
3	global	0.0 m	30.9 daN	-175.2 daN	0.0 m.daN
4	global	0.771 m	40.8 daN	-231.6 daN	0.0 m.daN
	global	2.779 m	38.7 daN	-219.3 daN	0.0 m.daN
5	global	1.075 m	38.7 daN	-219.3 daN	0.0 m.daN
	global	3.083 m	40.8 daN	-231.6 daN	0.0 m.daN
6	global	1.273 m	30.9 daN	-175.2 daN	0.0 m.daN
Front wind in uplift (Wf+)					
3	global	0.0 m	-109.5 daN	621.3 daN	-0.0 m.daN
4	global	0.771 m	-144.8 daN	821.1 daN	-0.0 m.daN
	global	2.779 m	-137.1 daN	777.5 daN	-0.0 m.daN
5	global	1.075 m	-137.1 daN	777.5 daN	-0.0 m.daN
	global	3.083 m	-144.8 daN	821.1 daN	-0.0 m.daN
6	global	1.273 m	-109.5 daN	621.3 daN	-0.0 m.daN
Rear wind sagging (Wb-)					
3	global	0.0 m	30.9 daN	-175.2 daN	0.0 m.daN
4	global	0.771 m	40.8 daN	-231.6 daN	0.0 m.daN
	global	2.779 m	38.7 daN	-219.3 daN	0.0 m.daN
5	global	1.075 m	38.7 daN	-219.3 daN	0.0 m.daN
	global	3.083 m	40.8 daN	-231.6 daN	0.0 m.daN
6	global	1.273 m	30.9 daN	-175.2 daN	0.0 m.daN
Rear wind in uplift (Wb+)					
3	global	0.0 m	-109.5 daN	621.3 daN	-0.0 m.daN
4	global	0.771 m	-144.8 daN	821.1 daN	-0.0 m.daN
	global	2.779 m	-137.1 daN	777.5 daN	-0.0 m.daN
5	global	1.075 m	-137.1 daN	777.5 daN	-0.0 m.daN
	global	3.083 m	-144.8 daN	821.1 daN	-0.0 m.daN
6	global	1.273 m	-109.5 daN	621.3 daN	-0.0 m.daN
Earthquake on X+ (EX+)					
Earthquake on X- (EX-)					
Earthquake on Y+ (EY+)					
Earthquake on Y- (EY-)					

Annex 2.7 - Loadings combinations (NF EN 1990/NA (12/2011))

Annex 2.7.1 - Ultimate Limit States

Id	Combination	γ_{M0}	γ_{M1}	γ_{M2}
ULS 1	G	1.0	1.0	1.25
ULS 2	1.35 G	1.0	1.0	1.25
ULS 3	G + 1.5 S	1.0	1.0	1.25
ULS 4	1.35 G + 1.5 S	1.0	1.0	1.25
ULS 5	G + 1.5 (S + 0.6 Wl-)	1.0	1.0	1.25
ULS 6	1.35 G + 1.5 (S + 0.6 Wl-)	1.0	1.0	1.25
ULS 7	G + 1.5 (S + 0.6 Wl+)	1.0	1.0	1.25
ULS 8	1.35 G + 1.5 (S + 0.6 Wl+)	1.0	1.0	1.25
ULS 9	G + 1.5 (S + 0.6 Wr-)	1.0	1.0	1.25
ULS 10	1.35 G + 1.5 (S + 0.6 Wr-)	1.0	1.0	1.25
ULS 11	G + 1.5 (S + 0.6 Wr+)	1.0	1.0	1.25
ULS 12	1.35 G + 1.5 (S + 0.6 Wr+)	1.0	1.0	1.25
ULS 13	G + 1.5 (S + 0.6 Wf-)	1.0	1.0	1.25
ULS 14	1.35 G + 1.5 (S + 0.6 Wf-)	1.0	1.0	1.25
ULS 15	G + 1.5 (S + 0.6 Wf+)	1.0	1.0	1.25
ULS 16	1.35 G + 1.5 (S + 0.6 Wf+)	1.0	1.0	1.25
ULS 17	G + 1.5 (S + 0.6 Wb-)	1.0	1.0	1.25
ULS 18	1.35 G + 1.5 (S + 0.6 Wb-)	1.0	1.0	1.25
ULS 19	G + 1.5 (S + 0.6 Wb+)	1.0	1.0	1.25
ULS 20	1.35 G + 1.5 (S + 0.6 Wb+)	1.0	1.0	1.25
ULS 21	G + 1.5 Wl-	1.0	1.0	1.25
ULS 22	1.35 G + 1.5 Wl-	1.0	1.0	1.25
ULS 23	G + 1.5 (Wl- + 0.5 * S)	1.0	1.0	1.25
ULS 24	1.35 G + 1.5 (Wl- + 0.5 * S)	1.0	1.0	1.25
ULS 25	G + 1.5 Wl+	1.0	1.0	1.25
ULS 26	1.35 G + 1.5 Wl+	1.0	1.0	1.25
ULS 27	G + 1.5 (Wl+ + 0.5 * S)	1.0	1.0	1.25
ULS 28	1.35 G + 1.5 (Wl+ + 0.5 * S)	1.0	1.0	1.25
ULS 29	G + 1.5 Wr-	1.0	1.0	1.25
ULS 30	1.35 G + 1.5 Wr-	1.0	1.0	1.25
ULS 31	G + 1.5 (Wr- + 0.5 * S)	1.0	1.0	1.25
ULS 32	1.35 G + 1.5 (Wr- + 0.5 * S)	1.0	1.0	1.25
ULS 33	G + 1.5 Wr+	1.0	1.0	1.25
ULS 34	1.35 G + 1.5 Wr+	1.0	1.0	1.25
ULS 35	G + 1.5 (Wr+ + 0.5 * S)	1.0	1.0	1.25
ULS 36	1.35 G + 1.5 (Wr+ + 0.5 * S)	1.0	1.0	1.25
ULS 37	G + 1.5 Wf-	1.0	1.0	1.25
ULS 38	1.35 G + 1.5 Wf-	1.0	1.0	1.25
ULS 39	G + 1.5 (Wf- + 0.5 * S)	1.0	1.0	1.25
ULS 40	1.35 G + 1.5 (Wf- + 0.5 * S)	1.0	1.0	1.25
ULS 41	G + 1.5 Wf+	1.0	1.0	1.25
ULS 42	1.35 G + 1.5 Wf+	1.0	1.0	1.25
ULS 43	G + 1.5 (Wf+ + 0.5 * S)	1.0	1.0	1.25
ULS 44	1.35 G + 1.5 (Wf+ + 0.5 * S)	1.0	1.0	1.25
ULS 45	G + 1.5 Wb-	1.0	1.0	1.25
ULS 46	1.35 G + 1.5 Wb-	1.0	1.0	1.25
ULS 47	G + 1.5 (Wb- + 0.5 * S)	1.0	1.0	1.25
ULS 48	1.35 G + 1.5 (Wb- + 0.5 * S)	1.0	1.0	1.25
ULS 49	G + 1.5 Wb+	1.0	1.0	1.25
ULS 50	1.35 G + 1.5 Wb+	1.0	1.0	1.25
ULS 51	G + 1.5 (Wb+ + 0.5 * S)	1.0	1.0	1.25
ULS 52	1.35 G + 1.5 (Wb+ + 0.5 * S)	1.0	1.0	1.25
ULS 53	G + Sa	1.0	1.0	1.25

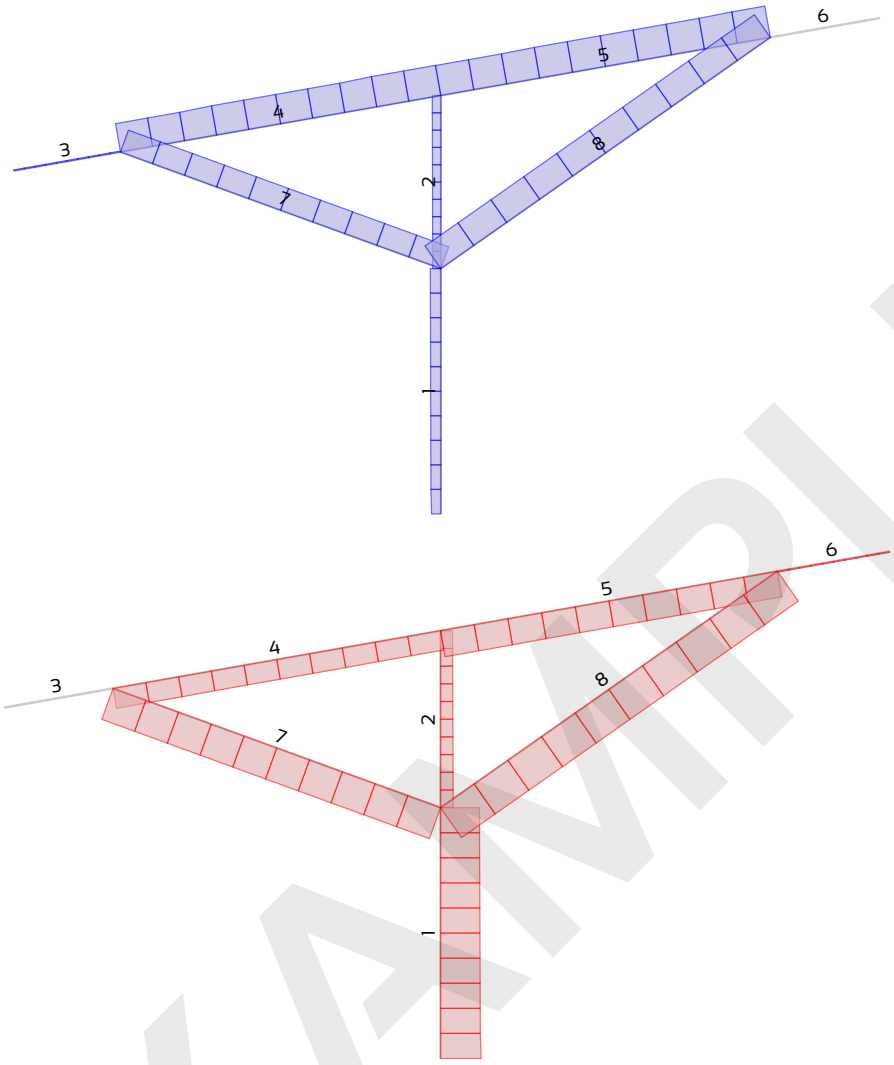
Annex 2.7.2 - Serviceability Limit States

Id	Combination
SLS 1	G
SLS 2	G + S
SLS 3	G + S + 0.6 Wl-
SLS 4	G + S + 0.6 Wl+
SLS 5	G + S + 0.6 Wr-
SLS 6	G + S + 0.6 Wr+
SLS 7	G + S + 0.6 Wf-
SLS 8	G + S + 0.6 Wf+
SLS 9	G + S + 0.6 Wb-
SLS 10	G + S + 0.6 Wb+
SLS 11	G + Wl-
SLS 12	G + Wl- + 0.5 * S
SLS 13	G + Wl+
SLS 14	G + Wl+ + 0.5 * S
SLS 15	G + Wr-
SLS 16	G + Wr- + 0.5 * S
SLS 17	G + Wr+
SLS 18	G + Wr+ + 0.5 * S
SLS 19	G + Wf-
SLS 20	G + Wf- + 0.5 * S
SLS 21	G + Wf+
SLS 22	G + Wf+ + 0.5 * S
SLS 23	G + Wb-
SLS 24	G + Wb- + 0.5 * S
SLS 25	G + Wb+
SLS 26	G + Wb+ + 0.5 * S

ANNEX 3 - MECHANICAL CALCULATION RESULTS

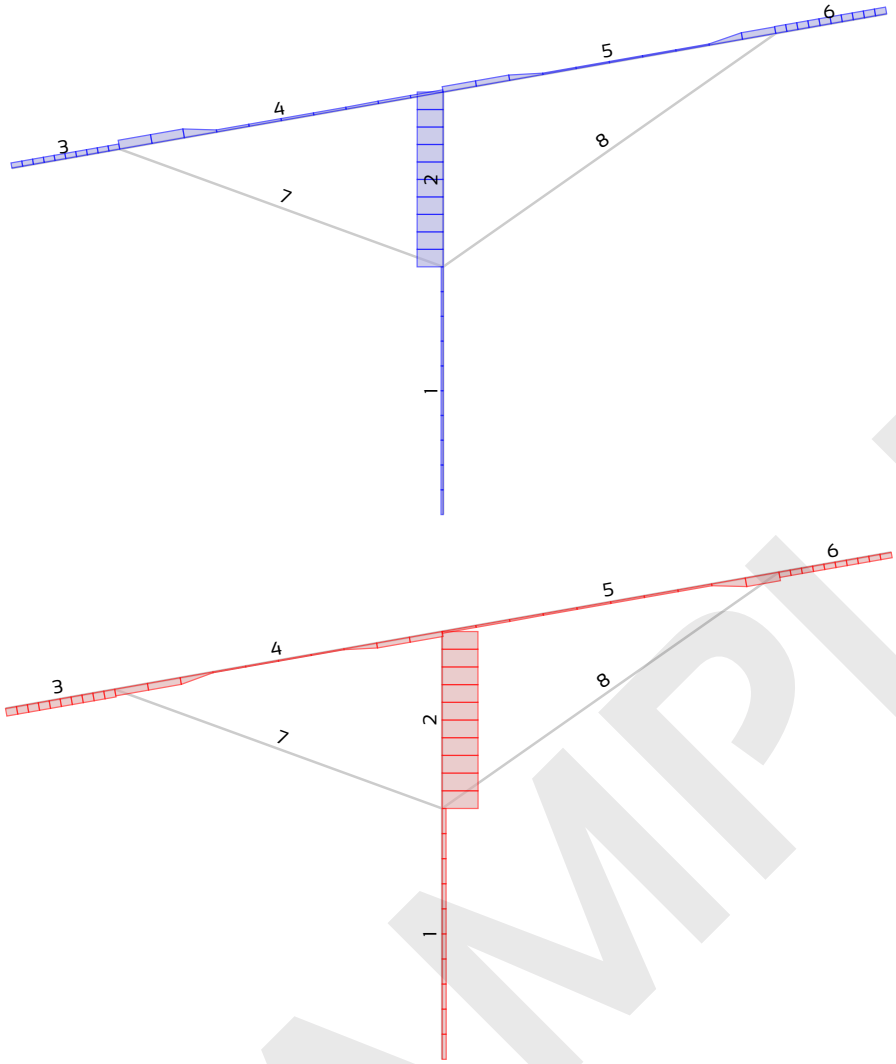
When calculating, items are sub divided by 10.

Annex 3.1 - Normal forces N_X



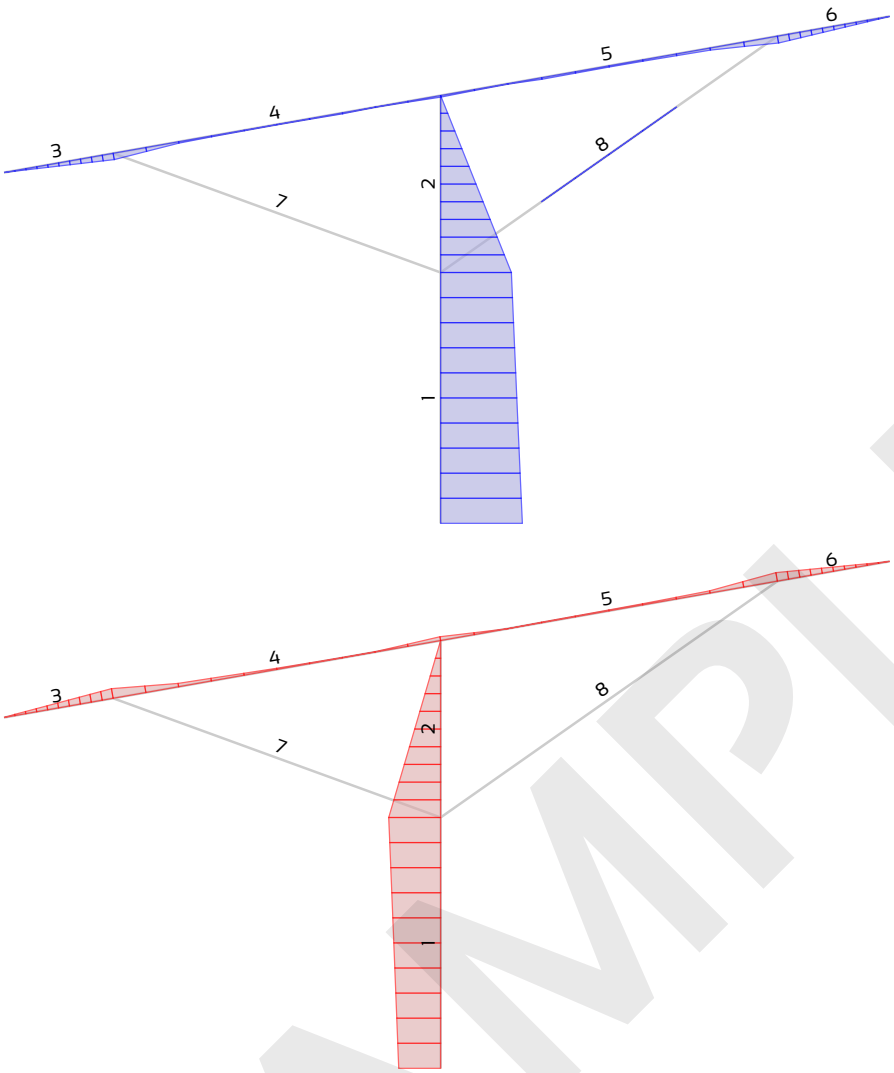
Element (Id)	$N_{X,max}$(tension)	$N_{X,min}$(compression)
Column - lower part (1)	4225.7 daN (ULS 25)	-16002.5 daN (ULS 6)
Column - upper part (2)	3446.1 daN (ULS 25)	-4968.5 daN (ULS 6)
Rafter - cantilever (3)	341.7 daN (ULS 10)	-
Rafter - span (4)	12335.7 daN (ULS 6)	-7956.8 daN (ULS 25)
Rafter - span (5)	12805.0 daN (ULS 32)	-10416.2 daN (ULS 33)
Rafter - cantilever (6)	-	-314.3 daN (ULS 12)
Left diagonal brace (7)	9337.5 daN (ULS 25)	-12985.8 daN (ULS 24)
Right diagonal brace (8)	11136.0 daN (ULS 33)	-14418.7 daN (ULS 32)

Annex 3.2 - Shear forces V_Z



Element (Id)	$V_{Z,max}$	$V_{Z,min}$
Column - lower part (1)	838.5 daN (ULS 24)	-1588.3 daN (ULS 33)
Column - upper part (2)	10394.5 daN (ULS 25)	-14160.2 daN (ULS 36)
Rafter - cantilever (3)	2086.3 daN (ULS 25)	-3049.2 daN (ULS 24)
Rafter - span (4)	3557.4 daN (ULS 6)	-2648.0 daN (ULS 25)
Rafter - span (5)	2642.7 daN (ULS 33)	-3409.7 daN (ULS 10)
Rafter - cantilever (6)	2762.6 daN (ULS 32)	-2138.8 daN (ULS 33)
Left diagonal brace (7)	28.9 daN (ULS 30)	-28.9 daN (ULS 30)
Right diagonal brace (8)	39.0 daN (ULS 22)	-39.0 daN (ULS 22)

Annex 3.3 - Bending moments M_Y



Element (Id)	$M_{Y,max}$	$M_{Y,min}$
Column - lower part (1)	32245.1 m.daN (ULS 36)	-20471.6 m.daN (ULS 25)
Column - upper part (2)	27911.8 m.daN (ULS 36)	-20471.6 m.daN (ULS 25)
Rafter - cantilever (3)	2517.7 m.daN (ULS 25)	-3846.1 m.daN (ULS 24)
Rafter - span (4)	2517.7 m.daN (ULS 25)	-3846.1 m.daN (ULS 24)
Rafter - span (5)	2740.0 m.daN (ULS 33)	-3403.2 m.daN (ULS 32)
Rafter - cantilever (6)	2740.0 m.daN (ULS 33)	-3403.2 m.daN (ULS 32)
Left diagonal brace (7)	28.1 m.daN (ULS 2)	-0.0 m.daN
Right diagonal brace (8)	44.8 m.daN (ULS 2)	-0.0 m.daN

Annex 3.4 - Shear forces V_Y

Element (Id)	$V_{Y,max}$	$V_{Y,min}$
Column - lower part (1)	1003.9 daN (ULS 45)	-1003.9 daN (ULS 37)
Column - upper part (2)	760.9 daN (ULS 45)	-760.9 daN (ULS 37)
Rafter - cantilever (3)	31.1 daN (ULS 45)	-32.9 daN (ULS 37)
Rafter - span (4)	328.4 daN (ULS 37)	-329.3 daN (ULS 45)
Rafter - span (5)	291.3 daN (ULS 45)	-290.4 daN (ULS 37)
Rafter - cantilever (6)	33.3 daN (ULS 37)	-31.5 daN (ULS 45)
Left diagonal brace (7)	30.6 daN (ULS 45)	-30.6 daN (ULS 37)
Right diagonal brace (8)	34.4 daN (ULS 45)	-34.4 daN (ULS 37)

Annex 3.5 - Bending moments M_Z

Element (Id)	$M_{Z,max}$	$M_{Z,min}$
Column - lower part (1)	4079.9 m.daN (ULS 45)	-4079.9 m.daN (ULS 37)
Column - upper part (2)	1491.5 m.daN (ULS 45)	-1491.5 m.daN (ULS 37)
Rafter - cantilever (3)	19.4 m.daN (ULS 45)	-21.6 m.daN (ULS 37)
Rafter - span (4)	233.6 m.daN (ULS 37)	-232.3 m.daN (ULS 45)
Rafter - span (5)	233.6 m.daN (ULS 37)	-232.3 m.daN (ULS 45)
Rafter - cantilever (6)	19.9 m.daN (ULS 45)	-22.2 m.daN (ULS 37)
Left diagonal brace (7)	129.9 m.daN (ULS 24)	-117.9 m.daN (ULS 18)
Right diagonal brace (8)	144.2 m.daN (ULS 32)	-134.0 m.daN (ULS 18)

Annex 3.6 - Nodes displacements

Annex 3.6.1 - Horizontal translations U_X

Node		1	2	3	4	5	6	7
Combination Id	1	0.0 mm	-0.2 mm	-0.6 mm	0.1 mm	-0.1 mm	-0.5 mm	-0.4 mm
	2	0.0 mm	-0.2 mm	-0.6 mm	0.6 mm	0.7 mm	-0.5 mm	0.1 mm
	3	0.0 mm	-1.5 mm	-4.3 mm	-1.5 mm	-4.2 mm	-3.4 mm	-4.4 mm
	4	0.0 mm	2.6 mm	7.5 mm	5.6 mm	11.4 mm	5.9 mm	10.0 mm
	5	0.0 mm	1.9 mm	5.1 mm	4.7 mm	9.0 mm	4.1 mm	7.4 mm
	6	0.0 mm	-4.9 mm	-13.1 mm	-8.3 mm	-16.8 mm	-10.3 mm	-15.7 mm
	7	0.0 mm	-0.0 mm	-0.1 mm	1.1 mm	1.5 mm	-0.0 mm	0.8 mm
	8	0.0 mm	-1.0 mm	-2.5 mm	-1.1 mm	-2.2 mm	-2.0 mm	-2.5 mm
	9	0.0 mm	-0.0 mm	-0.1 mm	1.1 mm	1.5 mm	-0.0 mm	0.8 mm
	10	0.0 mm	-1.0 mm	-2.5 mm	-1.1 mm	-2.2 mm	-2.0 mm	-2.5 mm
	11	0.0 mm	-2.4 mm	-6.8 mm	-3.4 mm	-8.3 mm	-5.3 mm	-7.9 mm
	12	0.0 mm	-2.4 mm	-6.8 mm	-3.2 mm	-7.9 mm	-5.3 mm	-7.7 mm
	13	0.0 mm	4.5 mm	12.9 mm	8.4 mm	17.8 mm	10.1 mm	16.1 mm
	14	0.0 mm	4.5 mm	12.9 mm	8.7 mm	18.2 mm	10.1 mm	16.3 mm
	15	0.0 mm	3.3 mm	8.9 mm	6.9 mm	13.6 mm	7.1 mm	11.8 mm
	16	0.0 mm	3.3 mm	8.9 mm	7.1 mm	14.0 mm	7.1 mm	12.0 mm
	17	0.0 mm	-8.0 mm	-21.3 mm	-14.6 mm	-29.3 mm	-17.0 mm	-26.7 mm
	18	0.0 mm	-8.0 mm	-21.3 mm	-14.4 mm	-28.9 mm	-17.0 mm	-26.4 mm
	19	0.0 mm	0.1 mm	0.3 mm	0.9 mm	1.2 mm	0.2 mm	0.8 mm
	20	0.0 mm	0.1 mm	0.3 mm	1.1 mm	1.7 mm	0.3 mm	1.1 mm
	21	0.0 mm	-1.5 mm	-3.8 mm	-2.6 mm	-5.0 mm	-3.0 mm	-4.6 mm
	22	0.0 mm	-1.5 mm	-3.8 mm	-2.4 mm	-4.6 mm	-3.0 mm	-4.4 mm
	23	0.0 mm	0.1 mm	0.3 mm	0.9 mm	1.2 mm	0.2 mm	0.8 mm
	24	0.0 mm	0.1 mm	0.3 mm	1.1 mm	1.7 mm	0.3 mm	1.1 mm
	25	0.0 mm	-1.5 mm	-3.8 mm	-2.6 mm	-5.0 mm	-3.0 mm	-4.6 mm
	26	0.0 mm	-1.5 mm	-3.8 mm	-2.4 mm	-4.6 mm	-3.0 mm	-4.4 mm

Annex 3.6.2 - Horizontal translations U_Y

Node		1	2	3	4	5	6	7
Combination Id	7	0.0 mm	11.1 mm	26.3 mm	27.9 mm	28.5 mm	28.0 mm	28.5 mm
	8	0.0 mm	11.1 mm	26.3 mm	27.9 mm	28.5 mm	28.0 mm	28.5 mm
	9	0.0 mm	-11.1 mm	-26.3 mm	-27.9 mm	-28.4 mm	-28.0 mm	-28.4 mm
	10	0.0 mm	-11.1 mm	-26.3 mm	-27.9 mm	-28.4 mm	-28.0 mm	-28.4 mm
	19	0.0 mm	18.4 mm	43.8 mm	46.4 mm	47.4 mm	46.7 mm	47.5 mm
	20	0.0 mm	18.4 mm	43.8 mm	46.4 mm	47.4 mm	46.7 mm	47.5 mm
	21	0.0 mm	18.4 mm	43.8 mm	46.4 mm	47.4 mm	46.7 mm	47.5 mm
	22	0.0 mm	18.4 mm	43.8 mm	46.4 mm	47.4 mm	46.7 mm	47.5 mm
	23	0.0 mm	-18.4 mm	-43.8 mm	-46.4 mm	-47.4 mm	-46.6 mm	-47.4 mm
	24	0.0 mm	-18.4 mm	-43.8 mm	-46.4 mm	-47.4 mm	-46.6 mm	-47.4 mm
	25	0.0 mm	-18.4 mm	-43.8 mm	-46.4 mm	-47.4 mm	-46.6 mm	-47.4 mm
	26	0.0 mm	-18.4 mm	-43.8 mm	-46.4 mm	-47.4 mm	-46.6 mm	-47.4 mm

Annex 3.6.3 - Vertical translations U_Z

Node		1	2	3	4	5	6	7
Combination Id	1	0.0 mm	-0.1 mm	-0.1 mm	-5.3 mm	-1.9 mm	-2.0 mm	-0.5 mm
	2	0.0 mm	-0.1 mm	-0.1 mm	-9.2 mm	-5.6 mm	-3.3 mm	-2.0 mm

Node		1	2	3	4	5	6	7
	3	0.0 mm	-0.1 mm	-0.2 mm	-19.2 mm	1.0 mm	-8.7 mm	2.5 mm
	4	0.0 mm	-0.1 mm	-0.1 mm	10.0 mm	-20.4 mm	8.3 mm	-12.1 mm
	5	0.0 mm	-0.1 mm	-0.1 mm	0.0 mm	-19.1 mm	3.3 mm	-10.0 mm
	6	0.0 mm	-0.1 mm	-0.1 mm	-29.6 mm	21.2 mm	-17.7 mm	15.1 mm
	7	0.0 mm	-0.1 mm	-0.1 mm	-9.0 mm	-7.1 mm	-2.9 mm	-2.9 mm
	8	0.0 mm	-0.1 mm	-0.1 mm	-10.0 mm	-0.4 mm	-4.6 mm	1.0 mm
	9	0.0 mm	-0.1 mm	-0.1 mm	-9.0 mm	-7.1 mm	-2.9 mm	-2.9 mm
	10	0.0 mm	-0.1 mm	-0.1 mm	-10.0 mm	-0.4 mm	-4.6 mm	1.0 mm
	11	0.0 mm	-0.1 mm	-0.1 mm	-22.0 mm	9.2 mm	-11.0 mm	7.1 mm
	12	0.0 mm	-0.1 mm	-0.1 mm	-23.9 mm	7.3 mm	-11.6 mm	6.3 mm
	13	0.0 mm	0.0 mm	0.0 mm	26.7 mm	-26.6 mm	17.3 mm	-17.3 mm
	14	0.0 mm	-0.0 mm	-0.0 mm	24.8 mm	-28.4 mm	16.7 mm	-18.0 mm
	15	0.0 mm	-0.1 mm	-0.1 mm	10.1 mm	-24.4 mm	9.0 mm	-13.8 mm
	16	0.0 mm	-0.1 mm	-0.1 mm	8.1 mm	-26.3 mm	8.4 mm	-14.6 mm
	17	0.0 mm	0.0 mm	0.0 mm	-39.3 mm	42.8 mm	-26.1 mm	28.0 mm
	18	0.0 mm	-0.0 mm	-0.0 mm	-41.3 mm	40.9 mm	-26.7 mm	27.2 mm
	19	0.0 mm	-0.1 mm	-0.1 mm	-5.0 mm	-4.4 mm	-1.3 mm	-2.0 mm
	20	0.0 mm	-0.1 mm	-0.1 mm	-7.0 mm	-6.2 mm	-2.0 mm	-2.7 mm
	21	0.0 mm	-0.0 mm	-0.0 mm	-6.5 mm	6.8 mm	-4.2 mm	4.5 mm
	22	0.0 mm	-0.0 mm	-0.0 mm	-8.5 mm	4.9 mm	-4.9 mm	3.8 mm
	23	0.0 mm	-0.1 mm	-0.1 mm	-5.0 mm	-4.4 mm	-1.3 mm	-2.0 mm
	24	0.0 mm	-0.1 mm	-0.1 mm	-7.0 mm	-6.2 mm	-2.0 mm	-2.7 mm
	25	0.0 mm	-0.0 mm	-0.0 mm	-6.5 mm	6.8 mm	-4.2 mm	4.5 mm
	26	0.0 mm	-0.0 mm	-0.0 mm	-8.5 mm	4.9 mm	-4.9 mm	3.8 mm

Node		1	2	3	4	5	6	7
Combination Id	1	0.0 e-3 rad	-0.2 e-3 rad	0.1 e-3 rad	-3.3 e-3 rad	1.4 e-3 rad	-1.9 e-3 rad	0.5 e-3 rad
	2	0.0 e-3 rad	-0.2 e-3 rad	0.2 e-3 rad	-5.9 e-3 rad	3.5 e-3 rad	-3.1 e-3 rad	1.4 e-3 rad
	3	0.0 e-3 rad	-1.1 e-3 rad	-0.8 e-3 rad	-10.0 e-3 rad	1.8 e-3 rad	-6.0 e-3 rad	-0.2 e-3 rad
	4	0.0 e-3 rad	1.9 e-3 rad	2.8 e-3 rad	1.1 e-3 rad	7.4 e-3 rad	1.8 e-3 rad	5.0 e-3 rad
	5	0.0 e-3 rad	1.3 e-3 rad	1.9 e-3 rad	-3.7 e-3 rad	8.3 e-3 rad	-1.0 e-3 rad	5.0 e-3 rad
	6	0.0 e-3 rad	-3.4 e-3 rad	-3.7 e-3 rad	-10.9 e-3 rad	-5.0 e-3 rad	-7.8 e-3 rad	-4.9 e-3 rad
	7	0.0 e-3 rad	-0.0 e-3 rad	0.4 e-3 rad	-6.1 e-3 rad	4.1 e-3 rad	-3.1 e-3 rad	1.8 e-3 rad
	8	0.0 e-3 rad	-0.7 e-3 rad	-0.4 e-3 rad	-5.1 e-3 rad	1.5 e-3 rad	-3.0 e-3 rad	0.2 e-3 rad
	9	0.0 e-3 rad	-0.0 e-3 rad	0.4 e-3 rad	-6.1 e-3 rad	4.1 e-3 rad	-3.1 e-3 rad	1.8 e-3 rad
	10	0.0 e-3 rad	-0.7 e-3 rad	-0.4 e-3 rad	-5.1 e-3 rad	1.5 e-3 rad	-3.0 e-3 rad	0.2 e-3 rad
	11	0.0 e-3 rad	-1.8 e-3 rad	-1.6 e-3 rad	-10.2 e-3 rad	-1.4 e-3 rad	-6.7 e-3 rad	-2.2 e-3 rad
	12	0.0 e-3 rad	-1.8 e-3 rad	-1.5 e-3 rad	-11.5 e-3 rad	-0.4 e-3 rad	-7.3 e-3 rad	-1.7 e-3 rad
	13	0.0 e-3 rad	3.4 e-3 rad	4.4 e-3 rad	8.4 e-3 rad	7.9 e-3 rad	6.3 e-3 rad	6.4 e-3 rad
	14	0.0 e-3 rad	3.4 e-3 rad	4.4 e-3 rad	7.1 e-3 rad	8.9 e-3 rad	5.7 e-3 rad	6.9 e-3 rad
	15	0.0 e-3 rad	2.3 e-3 rad	2.8 e-3 rad	0.4 e-3 rad	9.4 e-3 rad	1.7 e-3 rad	6.5 e-3 rad
	16	0.0 e-3 rad	2.3 e-3 rad	2.9 e-3 rad	-0.9 e-3 rad	10.5 e-3 rad	1.1 e-3 rad	7.0 e-3 rad
	17	0.0 e-3 rad	-5.6 e-3 rad	-6.5 e-3 rad	-11.6 e-3 rad	-12.7 e-3 rad	-9.7 e-3 rad	-10.1 e-3 rad
	18	0.0 e-3 rad	-5.6 e-3 rad	-6.4 e-3 rad	-12.9 e-3 rad	-11.6 e-3 rad	-10.3 e-3 rad	-9.6 e-3 rad
	19	0.0 e-3 rad	0.1 e-3 rad	0.4 e-3 rad	-3.6 e-3 rad	2.3 e-3 rad	-1.9 e-3 rad	1.1 e-3 rad
	20	0.0 e-3 rad	0.1 e-3 rad	0.4 e-3 rad	-4.9 e-3 rad	3.4 e-3 rad	-2.5 e-3 rad	1.5 e-3 rad
	21	0.0 e-3 rad	-1.0 e-3 rad	-0.9 e-3 rad	-2.0 e-3 rad	-1.9 e-3 rad	-1.8 e-3 rad	-1.6 e-3 rad
	22	0.0 e-3 rad	-1.0 e-3 rad	-0.9 e-3 rad	-3.3 e-3 rad	-0.9 e-3 rad	-2.4 e-3 rad	-1.1 e-3 rad
	23	0.0 e-3 rad	0.1 e-3 rad	0.4 e-3 rad	-3.6 e-3 rad	2.3 e-3 rad	-1.9 e-3 rad	1.1 e-3 rad
	24	0.0 e-3 rad	0.1 e-3 rad	0.4 e-3 rad	-4.9 e-3 rad	3.4 e-3 rad	-2.5 e-3 rad	1.5 e-3 rad
	25	0.0 e-3 rad	-1.0 e-3 rad	-0.9 e-3 rad	-2.0 e-3 rad	-1.9 e-3 rad	-1.8 e-3 rad	-1.6 e-3 rad
	26	0.0 e-3 rad	-1.0 e-3 rad	-0.9 e-3 rad	-3.3 e-3 rad	-0.9 e-3 rad	-2.4 e-3 rad	-1.1 e-3 rad

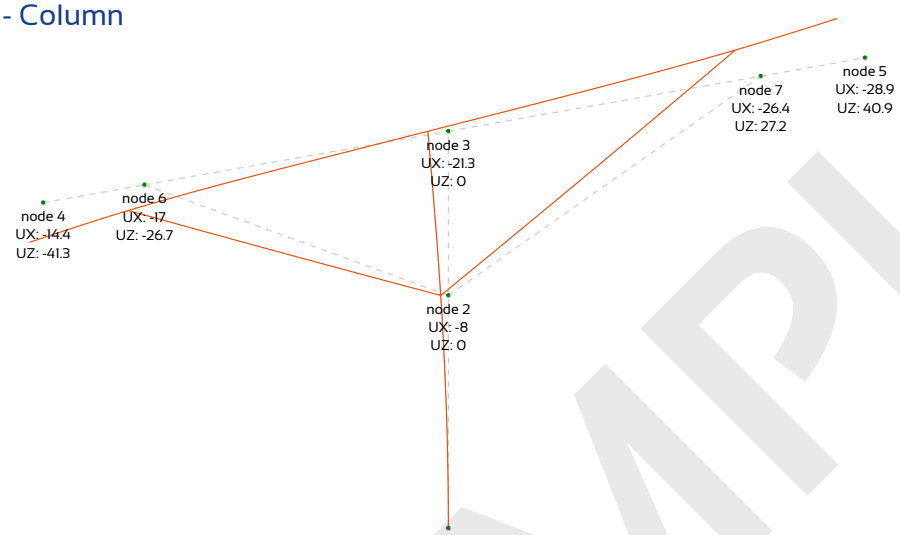
Node		1	2	3	4	5	6	7
Combination Id	7	0.0 e-3 rad	6.8 e-3 rad	8.2 e-3 rad	8.2 e-3 rad	8.2 e-3 rad	8.2 e-3 rad	8.2 e-3 rad
	8	0.0 e-3 rad	6.8 e-3 rad	8.2 e-3 rad	8.2 e-3 rad	8.2 e-3 rad	8.2 e-3 rad	8.2 e-3 rad
	9	0.0 e-3 rad	-6.8 e-3 rad	-8.2 e-3 rad	-8.2 e-3 rad	-8.2 e-3 rad	-8.2 e-3 rad	-8.2 e-3 rad
	10	0.0 e-3 rad	-6.8 e-3 rad	-8.2 e-3 rad	-8.2 e-3 rad	-8.2 e-3 rad	-8.2 e-3 rad	-8.2 e-3 rad
	19	0.0 e-3 rad	11.4 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad
	20	0.0 e-3 rad	11.4 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad
	21	0.0 e-3 rad	11.4 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad	13.7 e-3 rad

Node		1	2	3	4	5	6	7
	22	0.0 e^{-3} rad	11.4 e^{-3} rad	13.7 e^{-3} rad	13.7 e^{-3} rad	13.7 e^{-3} rad	13.7 e^{-3} rad	13.7 e^{-3} rad
	23	0.0 e^{-3} rad	-11.4 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad
	24	0.0 e^{-3} rad	-11.4 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad
	25	0.0 e^{-3} rad	-11.4 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad
	26	0.0 e^{-3} rad	-11.4 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad	-13.7 e^{-3} rad

ANNEX 4 - DETAILED CHECKINGS OF THE ELEMENTS (NF EN 1993-1-1/NA (08/2013))

Element (Id)	Cross section	Material	ULS ratio	ULS combination	SLS ratio	SLS combination
Column - lower part (1)	IPE500	S275	0.704	ULS 36	0.918	SLS 19
Column - upper part (2)	IPE500	S275	0.622	ULS 36		
Rafter - cantilever (3)	IPE200	S275	0.735	ULS 24	0.336	SLS 12
Rafter - span (4)	IPE200	S275	0.928	ULS 24		
Rafter - span (5)	IPE200	S275	0.748	ULS 32	0.289	SLS 17
Rafter - cantilever (6)	IPE200	S275	0.655	ULS 32		
Left diagonal brace (7)	☐ 120x3	S235	0.79	ULS 24	-	-
Right diagonal brace (8)	☐ 120x4	S235	0.789	ULS 32	-	-

Annex 4.1 - Column



Maximum displacement at the top of the column on X-axis : U_X = -21.3 mm (SLS 18) < H/100 = 47.8 mm

Maximum displacement at the top of the column on Y-axis : U_Y = 43.8 mm (SLS 19) < H/100 = 47.8 mm

Element 1

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations	Abscissa on the element
Compression (buckling) (§6.3.1)	0.188	ULS 6	0.0 m
Shear on z-z axis (§6.2.6)	0.017	ULS 33	0.0 m
Shear on y-y axis (§6.2.6)	0.009	ULS 37	0.0 m
Bending about y-y axis (§6.2.5)	0.534	ULS 36	0.0 m
Bending about z-z axis (§6.2.5)	0.442	ULS 37	0.0 m
Lateral-torsional buckling (§6.3.2)	0.679	ULS 36	0.0 m
Bending about y-y and shear on z-z (§6.2.8)	0.534	ULS 36	0.0 m
Bending about z-z and shear on y-y (§6.2.8)	0.442	ULS 37	0.0 m
Bending about y-y and axial force (§6.2.9)	0.534	ULS 36	0.0 m
Bending about z-z and axial force (§6.2.9)	0.442	ULS 37	0.0 m
Bi-axial bending (§6.2.9)	0.455	ULS 44	0.0 m
Lateral-torsional buckling, bending about z-z and flexural bucking about y-y (eq. 6.61)	**0.704**	**ULS 36**	**0.0 m**
Lateral-torsional buckling, bending about z-z and flexural bucking about z-z (eq. 6.62)	0.506	ULS 40	0.0 m

Slenderness $\lambda_{y,max}$	Slenderness $\lambda_{z,max}$	Critical factor $\alpha_{cr,y,min}$	Critical factor $\alpha_{cr,z,min}$
45.0	213.4	147.73	6.56

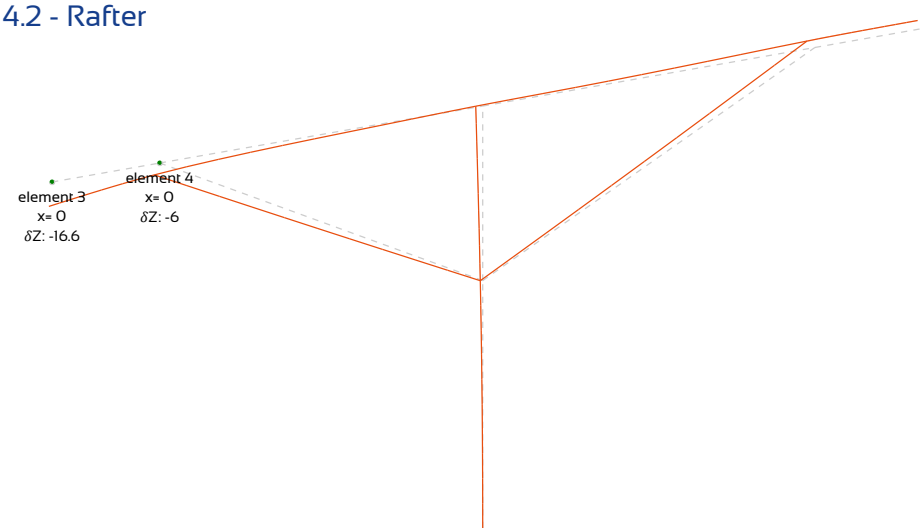
Element 2

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations	Abscissa on the element
Compression (buckling) (§6.3.1)	0.06	ULS 36	0.0 m
Shear on z-z axis (§6.2.6)	0.149	ULS 36	0.0 m
Shear on y-y axis (§6.2.6)	0.007	ULS 37	0.0 m
Bending about y-y axis (§6.2.5)	0.463	ULS 36	0.0 m
Bending about z-z axis (§6.2.5)	0.161	ULS 37	0.0 m
Lateral-torsional buckling (§6.3.2)	0.588	ULS 36	0.0 m
Bending about y-y and shear on z-z (§6.2.8)	0.463	ULS 36	0.0 m
Bending about z-z and shear on y-y (§6.2.8)	0.161	ULS 37	0.0 m
Bending about y-y and axial force (§6.2.9)	0.463	ULS 36	0.0 m
Bending about z-z and axial force (§6.2.9)	0.161	ULS 37	0.0 m
Bi-axial bending (§6.2.9)	0.165	ULS 44	0.0 m
Lateral-torsional buckling, bending about z-z and flexural bucking about y-y (eq. 6.61)	**0.622**	**ULS 36**	**0.0 m**
Lateral-torsional buckling, bending about z-z and flexural bucking about z-z (eq. 6.62)	0.378	ULS 36	0.0 m

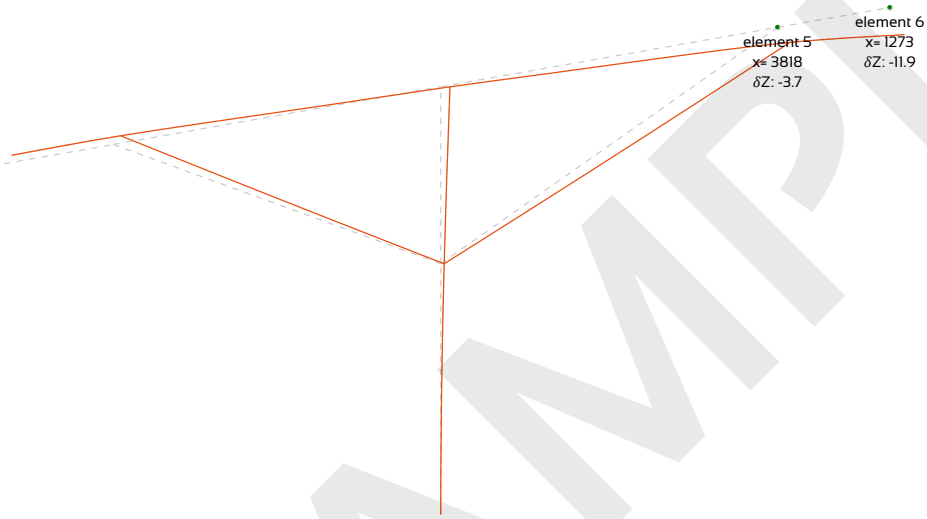
Slenderness $\lambda_{y,max}$	Slenderness $\lambda_{z,max}$	Critical factor $\alpha_{cr,y,min}$	Critical factor $\alpha_{cr,z,min}$
45.0	213.4	432.73	19.23

Annex 4.2 - Rafter



Maximum total deflection on the left side : δ_Z = -16.6 mm(SLS 12) < L/100 = 49.5 mm

Maximum variable deflection on the left side : $\delta_{var,Z}$ = 11.2 mm(SLS 13 - SLS 1) < L/125 = 39.6 mm



Maximum total deflection on the right side : δ_Z = -11.9 mm(SLS 16) < L/100 = 50.9 mm

Maximum variable deflection on the right side : $\delta_{var,Z}$ = 11.8 mm(SLS 17 - SLS 1) < L/125 = 40.7 mm

Element 3

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations	Abscissa on the element
Tension (§6.2.3)	0.004	ULS 10	1.237 m
Shear on z-z axis (§6.2.6)	0.137	ULS 24	1.237 m
Shear on y-y axis (§6.2.6)	0.001	ULS 37	0.0 m
Bending about y-y axis (§6.2.5)	0.634	ULS 24	1.237 m
Bending about z-z axis (§6.2.5)	0.018	ULS 37	1.237 m
Lateral-torsional buckling (§6.3.2)	**0.735**	**ULS 24**	**1.237 m**
Bending about y-y and shear on z-z (§6.2.8)	0.634	ULS 24	1.237 m
Bending about z-z and shear on y-y (§6.2.8)	0.018	ULS 37	1.237 m
Bending about y-y and axial force (§6.2.9)	0.634	ULS 24	1.237 m
Bending about z-z and axial force (§6.2.9)	0.018	ULS 37	1.237 m
Bi-axial bending (§6.2.9)	0.207	ULS 14	1.237 m

Slenderness $\lambda_{y,max}$	Slenderness $\lambda_{z,max}$
30.0	89.8

Element 4

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations	Abscissa on the element
Compression (buckling) (§6.3.1)	0.177	ULS 25	0.0 m
Shear on z-z axis (§6.2.6)	0.16	ULS 6	0.0 m
Shear on y-y axis (§6.2.6)	0.011	ULS 45	3.712 m
Bending about y-y axis (§6.2.5)	0.634	ULS 24	0.0 m
Bending about z-z axis (§6.2.5)	0.19	ULS 37	3.712 m
Lateral-torsional buckling (§6.3.2)	**0.928**	**ULS 24**	**0.0 m**
Bending about y-y and shear on z-z (§6.2.8)	0.634	ULS 24	0.0 m
Bending about z-z and shear on y-y (§6.2.8)	0.19	ULS 37	3.712 m
Bending about y-y and axial force (§6.2.9)	0.634	ULS 24	0.0 m
Bending about z-z and axial force (§6.2.9)	0.19	ULS 37	3.712 m
Bi-axial bending (§6.2.9)	0.228	ULS 40	3.712 m
Lateral-torsional buckling, bending about z-z and flexural bucking about y-y (eq. 6.61)	0.586	ULS 25	0.0 m
Lateral-torsional buckling, bending about z-z and flexural bucking about z-z (eq. 6.62)	0.433	ULS 25	0.0 m

Slenderness $\lambda_{y,max}$	Slenderness $\lambda_{z,max}$
31.5	89.8

Element 5

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations	Abscissa on the element
Compression (buckling) (§6.3.1)	0.231	ULS 33	0.0 m
Shear on z-z axis (§6.2.6)	0.153	ULS 10	3.818 m
Shear on y-y axis (§6.2.6)	0.009	ULS 45	0.0 m
Bending about y-y axis (§6.2.5)	0.561	ULS 32	3.818 m
Bending about z-z axis (§6.2.5)	0.19	ULS 37	0.0 m
Lateral-torsional buckling (§6.3.2)	**0.748**	**ULS 32**	**3.818 m**
Bending about y-y and shear on z-z (§6.2.8)	0.561	ULS 32	3.818 m
Bending about z-z and shear on y-y (§6.2.8)	0.19	ULS 37	0.0 m
Bending about y-y and axial force (§6.2.9)	0.561	ULS 32	3.818 m
Bending about z-z and axial force (§6.2.9)	0.19	ULS 37	0.0 m
Bi-axial bending (§6.2.9)	0.228	ULS 40	0.0 m
Lateral-torsional buckling, bending about z-z and flexural bucking about y-y (eq. 6.61)	0.685	ULS 33	3.818 m
Lateral-torsional buckling, bending about z-z and flexural bucking about z-z (eq. 6.62)	0.52	ULS 33	3.818 m

Slenderness $\lambda_{y,max}$	Slenderness $\lambda_{z,max}$
32.4	89.8

Element 6

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations	Abscissa on the element
Compression (buckling) (§6.3.1)	0.007	ULS 12	0.0 m
Shear on z-z axis (§6.2.6)	0.124	ULS 32	0.0 m
Shear on y-y axis (§6.2.6)	0.001	ULS 37	1.273 m
Bending about y-y axis (§6.2.5)	0.561	ULS 32	0.0 m
Bending about z-z axis (§6.2.5)	0.018	ULS 37	0.0 m
Lateral-torsional buckling (§6.3.2)	**0.655**	**ULS 32**	**0.0 m**
Bending about y-y and shear on z-z (§6.2.8)	0.561	ULS 32	0.0 m
Bending about z-z and shear on y-y (§6.2.8)	0.018	ULS 37	0.0 m
Bending about y-y and axial force (§6.2.9)	0.561	ULS 32	0.0 m
Bending about z-z and axial force (§6.2.9)	0.018	ULS 37	0.0 m
Bi-axial bending (§6.2.9)	0.145	ULS 14	0.0 m
Lateral-torsional buckling, bending about z-z and flexural bucking about y-y (eq. 6.61)	0.65	ULS 32	0.0 m
Lateral-torsional buckling, bending about z-z and flexural bucking about z-z (eq. 6.62)	0.343	ULS 32	0.0 m

Slenderness $\lambda_{y,max}$	Slenderness $\lambda_{z,max}$
30.8	89.8

Annex 4.3 - Diagonal braces

Element 7

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations	Abscissa on the element
Compression (buckling) (§6.3.1)	0.648	ULS 24	3.89 m
Shear on z-z axis (§6.2.6)	0.003	ULS 30	0.0 m
Shear on y-y axis (§6.2.6)	0.003	ULS 37	0.0 m
Bending about y-y axis (§6.2.5)	0.02	ULS 2	1.945 m
Bending about z-z axis (§6.2.5)	0.092	ULS 24	3.89 m
Bending about y-y and shear on z-z (§6.2.8)	0.02	ULS 2	1.945 m
Bending about z-z and shear on y-y (§6.2.8)	0.092	ULS 24	3.89 m
Bending about y-y and axial force (§6.2.9)	0.025	ULS 24	1.945 m
Bending about z-z and axial force (§6.2.9)	0.092	ULS 24	3.89 m
Bi-axial bending (§6.2.9)	0.011	ULS 40	1.945 m
Lateral-torsional buckling, bending about z-z and flexural bucking about y-y (eq. 6.61)	0.721	ULS 24	1.945 m
Lateral-torsional buckling, bending about z-z and flexural bucking about z-z (eq. 6.62)	**0.79**	**ULS 24**	**1.945 m**

Slenderness $\lambda_{y,max}$	Slenderness $\lambda_{z,max}$
73.6	81.8

Element 8

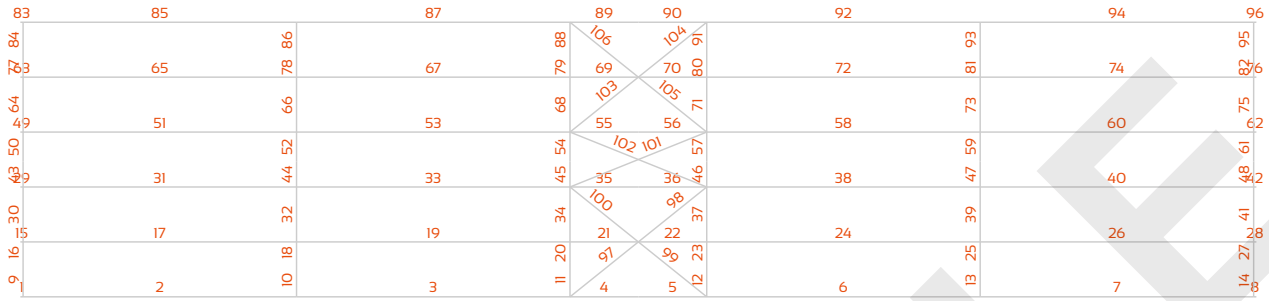
Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations	Abscissa on the element
Compression (buckling) (§6.3.1)	0.653	ULS 32	0.0 m
Shear on z-z axis (§6.2.6)	0.003	ULS 22	0.0 m
Shear on y-y axis (§6.2.6)	0.003	ULS 37	0.0 m
Bending about y-y axis (§6.2.5)	0.024	ULS 2	2.297 m
Bending about z-z axis (§6.2.5)	0.078	ULS 32	0.0 m
Bending about y-y and shear on z-z (§6.2.8)	0.024	ULS 2	2.297 m
Bending about z-z and shear on y-y (§6.2.8)	0.078	ULS 32	0.0 m
Bending about y-y and axial force (§6.2.9)	0.028	ULS 32	2.297 m
Bending about z-z and axial force (§6.2.9)	0.078	ULS 32	0.0 m
Bi-axial bending (§6.2.9)	0.011	ULS 40	2.297 m
Lateral-torsional buckling, bending about z-z and flexural bucking about y-y (eq. 6.61)	0.72	ULS 32	2.297 m
Lateral-torsional buckling, bending about z-z and flexural bucking about z-z (eq. 6.62)	**0.789**	**ULS 32**	**2.297 m**

Slenderness $\lambda_{y,max}$	Slenderness $\lambda_{z,max}$
87.8	97.6

ANNEX 5 - LONGITUDINAL STABILITY SYSTEM (NF EN 1993-1-1/NA (08/2013))

Annex 5.1 - Roof cross-bracing



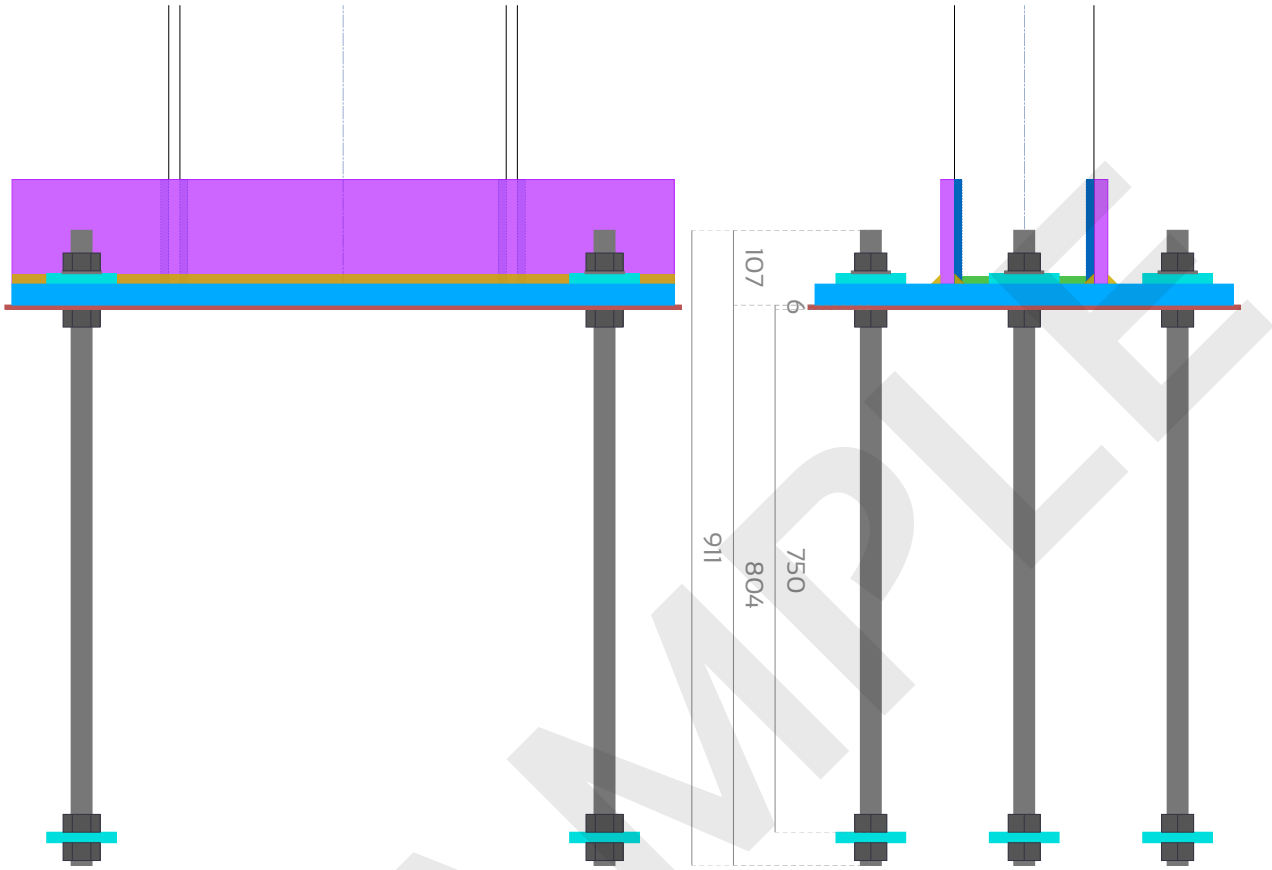
Maximum working rates per element and associated combinations

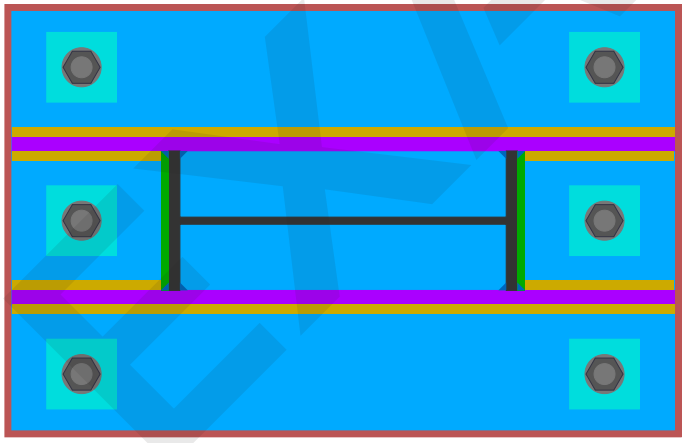
Element (Id)	Cross section	Material	ULS ratio	ULS combination
Roof bracing (97)	L40x40x4	S235	0.358	1.5 x Wf-
Roof bracing (98)	L40x40x4	S235	0.55	1.5 x Wf-
Roof bracing (99)	L40x40x4	S235	0.358	1.5 x Wb-
Roof bracing (100)	L40x40x4	S235	0.55	1.5 x Wb-
Roof bracing (101)	L40x40x4	S235	0.044	1.5 x Wb-
Roof bracing (102)	L40x40x4	S235	0.044	1.5 x Wf-
Roof bracing (103)	**L40x40x4**	**S235**	**0.561**	**1.5 x Wb-**
Roof bracing (104)	L40x40x4	S235	0.364	1.5 x Wb-
Roof bracing (105)	L40x40x4	S235	0.561	1.5 x Wf-
Roof bracing (106)	L40x40x4	S235	0.364	1.5 x Wf-

ANNEX 6 - DETAILED CHECKINGS OF THE CONNECTIONS (NF EN 1993-1-8/NA (07/2007))

Annex 6.1 - Column base and anchorages

Sketch and dimension table





Weld throats		
Horizontal on the column flanges a_f	Horizontal on the stiffeners a_s	Vertical on the column a_c
8 mm	10 mm	8 mm

Angle between elements = 90.0°

Anchor bolts	Designation	Threaded rod diameter d	Washer diameter	Transverse spacing p_2	Edge distance e_2	Longitudinal spacing p_1	End distance e_1
	M30 8.8	30 mm	56 mm	220 mm > 79.2 mm	80.0 mm > 39.6 mm	750 mm > 79.2 mm	100.0 mm > 39.6 mm
Positioning jig plate	Thickness t_{jp}	Width B_{jp}	Length L_{jp}	Anchor pad and support pad	Thickness t_{ap}	Width B_{ap}	Distance under positioning jig plate d_{ap}
	6 mm	620 mm	970 mm		15 mm	100 mm	750 mm
Column base plate	Thickness t_p	Width B_p	Length L_p	Drillings d_0	Stiffeners	Thickness t_s	Height h_s
	30 mm	600 mm	950 mm	33 mm		20 mm	150 mm

Envelopes of maximum stresses in global coordinate system

Dominant stress	N_Z	V_X	M_Y	V_Y	M_X	T_Z	Combination
tension	**3734.7** daN	-1366.3 daN	16527.2 m.daN	0.0 daN	0.0 m.daN	0.0 m.daN	ULS 25
compression	**-16002.5** daN	503.1 daN	-5371.3 m.daN	0.0 daN	0.0 m.daN	0.0 m.daN	ULS 6
shear on x-x	3386.6 daN	**-1588.3** daN	-32037.8 m.daN	0.0 daN	0.0 m.daN	0.0 m.daN	ULS 33
bending moment about y-y	-1863.1 daN	-1588.3 daN	**-32245.1** m.daN	0.0 daN	0.0 m.daN	0.0 m.daN	ULS 36
shear on y-y	1825.3 daN	-1174.3 daN	-6676.6 m.daN	**1003.9** daN	-4079.9 m.daN	-0.0 m.daN	ULS 41
bending moment about x-x	-3424.3 daN	-1174.3 daN	-6884.0 m.daN	1003.9 daN	**-4079.9** m.daN	-0.0 m.daN	ULS 44
torsional moment about z-z	1825.3 daN	-1174.3 daN	-6676.6 m.daN	1003.9 daN	-4079.9 m.daN	**-0.0** m.daN	ULS 41

Maximum working rates by type of stress and associated combinations

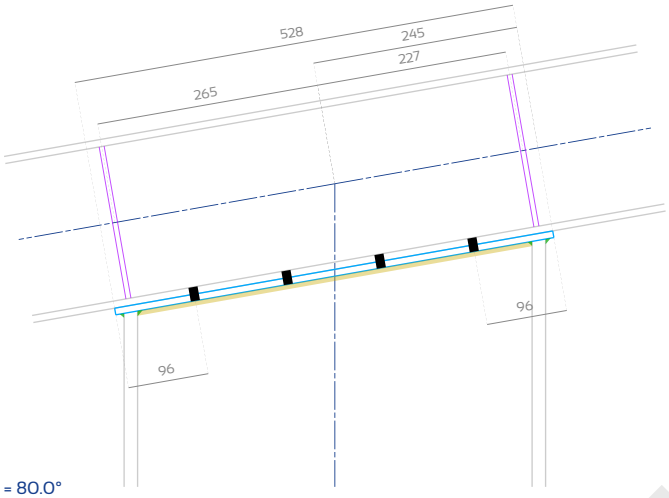
Checkings	Working rates	Associated combinations
Assembly axial strength (EN 1993-1-8 equation 6.24)	0.032	ULS 25
Assembly compound bending strength around y-y (EN 1993-1-8 equation 6.23)	**0.813**	**ULS 33**
Assembly compound bending strength around z-z (EN 1993-1-8 equation 6.23)	0.279	ULS 41
Assembly compound bi-axial bending strength (EN 1993-1-8 equation 6.24)	0.437	ULS 41
Shear failure of the anchor bolts (EN 1993-1-8 §6.2.2(7))	0.03	ULS 33
Tension failure of the anchor bolts (BNCM / CNC2M – N0175 §6(9))	0.621	ULS 33
Combined tension and shear failure of the anchor bolts (BNCM / CNC2M – N0175 §6(9))	0.473	ULS 33
Stiffness of the anchor pads (CTICM 1982 Y.LESCOUARC'H §II.6.d)	0.378	ULS 33
Tensioned stiffeners - bending strength (EN 1993-1-1 §6.2.5)	0.742	ULS 33
Compressed stiffeners - bending strength (EN 1993-1-1 §6.2.5)	0.391	ULS 36
Tensioned stiffeners - shear strength (EN 1993-1-1 §6.2.6)	0.59	ULS 33
Compressed stiffeners - shear strength (EN 1993-1-1 §6.2.6)	0.584	ULS 36
Welds of the tensioned baseplate to column (EN 1993-1-8 §4.5.3.2)	0.453	ULS 33
Welds of the compressed baseplate to column (EN 1993-1-8 §4.5.3.2)	0.451	ULS 36
Welds of the tensioned stiffeners to column (EN 1993-1-8 §4.5.3.2)	0.539	ULS 33
Welds of the compressed stiffeners to column (EN 1993-1-8 §4.5.3.2)	0.534	ULS 36
Welds of the tensioned stiffeners to baseplate (EN 1993-1-8 §4.5.3.2)	0.521	ULS 33
Welds of the compressed stiffeners to baseplate (EN 1993-1-8 §4.5.3.2)	0.516	ULS 36

Checkings	Status	Information
Stiffness condition of the stiffener cantilever (CTICM 1988 Y.LESCOUARC'H §II.3-3.a)	OK	-
Plasticity condition of the stiffener cantilever (EN 1993-1-1 §5.6)	OK	Class 1
Plasticity condition of the stiffener part between the column flanges (EN 1993-1-1 §5.6)	OK	Class 1

The minimum cross-section of concrete reinforcement to avoid splitting failure should be greater than 5.5 cm^2.

Annex 6.2 - Column top end plate

Sketch and dimension table



Angle between elements = 80.0°

End plate	Thickness t_p	Width	Length	Drillings d_0	Weld throat on the flanges a_f	Weld throat on the web a_w
	8.0 mm	200.0 mm	*(See sketch)*	11 mm	4 mm	4 mm
Bolts	Designation	Screw diameter d	Washer diameter	Transverse spacing p_2	Edge distance (rafter) e_2	Longitudinal spacing p_1
	M10 8.8 SB	10 mm	20 mm	58 mm > 26.4 mm	21.0 mm > 13.2 mm	112 mm > 24.2 mm
Stiffener	Thickness t_s	Width b_s	Position			
	6 mm	40 mm	*(See sketch)*			

Envelopes of maximum stresses in local coordinate system of the column top end plate

Dominant stress	$F_{N,Ed}$	$F_{Vx,Ed}$	$F_{Vy,Ed}$	Combination
tension	**1599.1** daN	10776.0 daN	0.0 daN	ULS 25
compression	**-4043.2** daN	-4180.1 daN	0.0 daN	ULS 6
shear on z-z	14.1 daN	**-14317.9** daN	0.0 daN	ULS 36
shear on y-y	928.9 daN	-1578.4 daN	**-620.1** daN	ULS 41

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations
Shear strength of bolts (EN 1993-1-8 table 3.4)	0.886	ULS 36
Tensile strength of bolts (EN 1993-1-8 table 3.4)	0.074	ULS 25
Combined shear and tensile strength of bolts (EN 1993-1-8 table 3.4)	**0.911**	**ULS 33**
Bearing strength of the bottom flange of the rafter (EN 1993-1-8 table 3.4)	0.886	ULS 36
Bearing strength of the column top end plate (EN 1993-1-8 table 3.4)	0.886	ULS 36
Punching shear strength of the bottom flange of the rafter (EN 1993-1-8 table 3.4)	0.024	ULS 25
Punching shear strength of the column top end plate (EN 1993-1-8 table 3.4)	0.031	ULS 25
Bending strength of the bottom flange of the rafter (EN 1993-1-8 §6.2)	0.065	ULS 25
Bending strength of the column top end plate (EN 1993-1-8 §6.2)	0.074	ULS 25
Compressive strength of web stiffeners (BNCM / CNC2M – N0175 table 18)	0.037	ULS 6
Weldings strength of plate to column web (EN 1993-1-8 §4.5.3.3)	0.203	ULS 36
Weldings strength of plate to column flanges (EN 1993-1-8 §4.5.3.3)	0.014	ULS 41

Annex 6.3 - Diagonal braces gussets

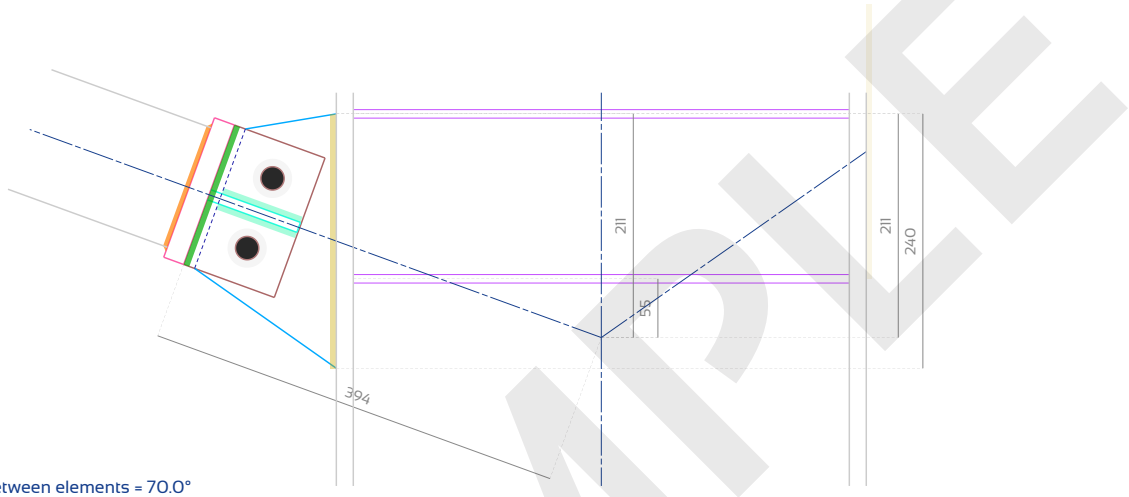
Element 7 (Left)

Envelopes of maximum stresses in the element

Gusset attached to	Column			Rafter		
Dominant stress	N_X	V_Z	Combination	N_X	V_Z	Combination
tension	9321.9 daN	-21.4 daN	ULS 25	9337.5 daN	21.4 daN	ULS 25
compression	-12985.8 daN	-28.9 daN	ULS 24	-12964.8 daN	28.9 daN	ULS 24

Column side

Sketch and dimension table



Angle between elements = 70.0°

Gusset attached to diagonal brace	Thickness $t_{b,g}$	Width	Length	Drillings d_0	Weld throat $a_{b,g}$	
	10 mm	140 mm	91 mm	22 mm	4 mm	
End plate attached to diagonal brace	Thickness $t_{b,p}$	Width	Length	Drillings d_0	Weld throat $a_{b,p}$	
	20 mm	140 mm	140 mm	10 mm (galvanizing)	3 mm	
Gusset attached to the other element	Thickness t_1	Dimensions and position	Drillings d_0	Clearance with end plate	Weld throat $a_{o,s,g}$	
	10 mm	*(See sketch)*	22 mm	11 mm	4 mm	
Bolts	Designation	Screw diameter d	Hardened washer diameter	Spacing p_2	Edge distance e_2	End distance e_1
	M20 8.8 SB	20 mm	37 mm	70 mm > 52.8 mm	35.0 mm > 26.4 mm	40 mm > 26.4 mm
Web stiffeners	Thickness x Width	Gusset lateral stiffener	Thickness $t_{s,g}$	Width $b_{s,g}$	Height $h_{s,g}$	Weld throat $a_{s,s,g}$
	8 mm x 90 mm		10 mm	65 mm	90 mm	4 mm

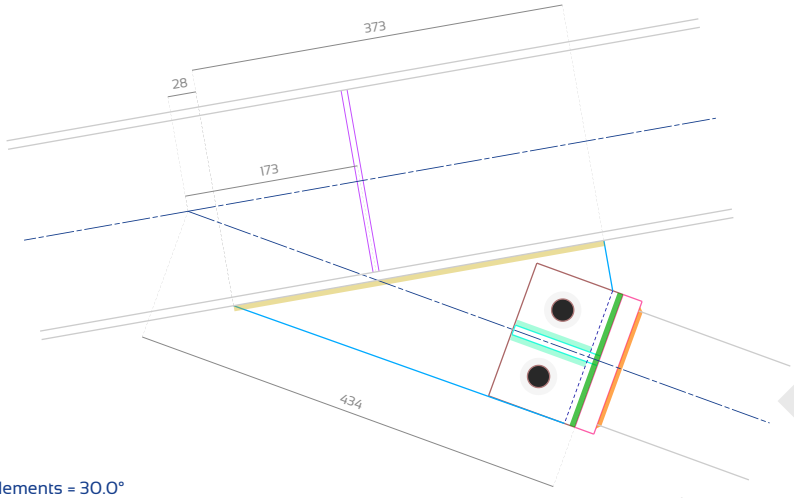
Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations
Shear strength of bolts (EN 1993-1-8 table 3.4)	0.691	ULS 24
Tensile strength of bolts (EN 1993-1-8 table 3.4)	0.115	ULS 24
Combined shear and tensile strength of bolts (EN 1993-1-8 table 3.4)	0.773	ULS 24
Bearing strength of the gussets (EN 1993-1-8 table 3.4)	0.751	ULS 24
Tension in the gussets (EN 1993-1-1 §6.2.3)	0.375	ULS 25
Block tearing of the gussets (EN 1993-1-8 §3.10.2)	0.43	ULS 25
Compressive strength of web stiffeners (BNCM / CNC2M – N0175 table 18)	0.095	ULS 24
Resistance of the lateral stiffener to bending (EN 1993-1-1 §6.2.5)	0.371	ULS 24
Local failure of the diagonal brace walls due to gusset pressure (CIDECT DG 1 - §7.4)	**0.908**	**ULS 24**
Local failure of the gusset due to diagonal brace pressure (CIDECT DG 1 - §7.4)	0.524	ULS 24
Local failure of the diagonal brace lateral wall due to stiffener pressure (CIDECT DG 1 - §7.4)	0.383	ULS 24
Weldings strength of the end plate on the diagonal brace (EN 1993-1-8 §4.5.3.3)	0.546	ULS 24
Weldings strength of the gusset to the end plate (EN 1993-1-8 §4.5.3.3)	0.707	ULS 24
Weldings strength of the gusset to the other element (EN 1993-1-8 §4.5.3.3)	0.337	ULS 24

Checkings	Status	Information
Plasticity condition of the lateral stiffener (EN 1993-1-1 §5.6)	OK	Class 1

Rafter side

Sketch and dimension table



Angle between elements = 30.0°

Gusset attached to diagonal brace	Thickness $t_{b,g}$	Width	Length	Drillings d_0	Weld throat $a_{b,g}$	
	10 mm	140 mm	91 mm	22 mm	4 mm	
End plate attached to diagonal brace	Thickness $t_{b,p}$	Width	Length	Drillings d_0	Weld throat $a_{b,p}$	
	20 mm	140 mm	140 mm	10 mm (galvanizing)	3 mm	
Gusset attached to the other element	Thickness t_i	Dimensions and position	Drillings d_0	Clearance with end plate	Weld throat $a_{o,s,g}$	
	10 mm	*(See sketch)*	22 mm	11 mm	4 mm	
Bolts	Designation	Screw diameter d	Hardened washer diameter	Spacing p_2	Edge distance e_2	End distance e_1
	M20 8.8 SB	20 mm	37 mm	70 mm > 52.8 mm	35.0 mm > 26.4 mm	40 mm > 26.4 mm
Web stiffeners	Thickness x Width	Gusset lateral stiffener	Thickness $t_{s,g}$	Width $b_{s,g}$	Height $h_{s,g}$	Weld throat $a_{s,s,g}$
	6 mm x 40 mm		10 mm	65 mm	90 mm	4 mm

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations
Shear strength of bolts (EN 1993-1-8 table 3.4)	0.69	ULS 24
Tensile strength of bolts (EN 1993-1-8 table 3.4)	0.115	ULS 24
Combined shear and tensile strength of bolts (EN 1993-1-8 table 3.4)	0.772	ULS 24
Bearing strength of the gussets (EN 1993-1-8 table 3.4)	0.75	ULS 24
Tension in the gussets (EN 1993-1-1 §6.2.3)	0.375	ULS 25
Block tearing of the gussets (EN 1993-1-8 §3.10.2)	0.43	ULS 25
Compressive strength of web stiffeners (BNCM / CNC2M – N0175 table 18)	0.096	ULS 24
Resistance of the lateral stiffener to bending (EN 1993-1-1 §6.2.5)	0.371	ULS 24
Local failure of the diagonal brace walls due to gusset pressure (CIDECT DG 1 - §7.4)	**0.906**	**ULS 24**
Local failure of the gusset due to diagonal brace pressure (CIDECT DG 1 - §7.4)	0.523	ULS 24
Local failure of the diagonal brace lateral wall due to stiffener pressure (CIDECT DG 1 - §7.4)	0.383	ULS 24
Weldings strength of the end plate on the diagonal brace (EN 1993-1-8 §4.5.3.3)	0.545	ULS 24
Weldings strength of the gusset to the end plate (EN 1993-1-8 §4.5.3.3)	0.706	ULS 24
Weldings strength of the gusset to the other element (EN 1993-1-8 §4.5.3.3)	0.276	ULS 24

Checkings	Status	Information
Plasticity condition of the lateral stiffener (EN 1993-1-1 §5.6)	OK	Class 1

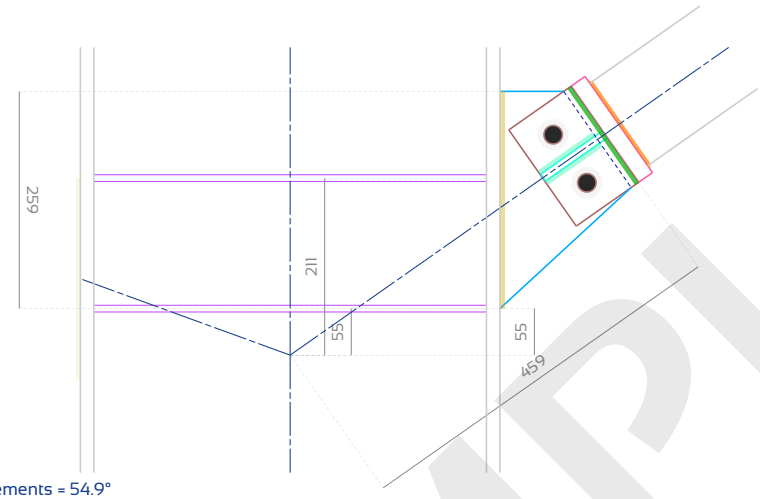
Element 8 (Right)

Envelopes of maximum stresses in the element

Gusset attached to	Column			Rafter		
Dominant stress	N_X	V_Z	Combination	N_X	V_Z	Combination
tension	11095.5 daN	28.9 daN	ULS 33	11136.0 daN	-28.9 daN	ULS 33
compression	-14418.7 daN	39.0 daN	ULS 32	-14363.9 daN	-39.0 daN	ULS 32

Column side

Sketch and dimension table



Angle between elements = 54.9°

Gusset attached to diagonal brace	Thickness $t_{b,g}$	Width	Length	Drillings d_0	Weld throat $a_{b,g}$	
	10 mm	140 mm	91 mm	22 mm	4 mm	
End plate attached to diagonal brace	Thickness $t_{b,p}$	Width	Length	Drillings d_0	Weld throat $a_{b,p}$	
	20 mm	140 mm	140 mm	10 mm (galvanizing)	3 mm	
Gusset attached to the other element	Thickness t_i	Dimensions and position	Drillings d_0	Clearance with end plate	Weld throat $a_{os,g}$	
	10 mm	*(See sketch)*	22 mm	11 mm	4 mm	
Bolts	Designation	Screw diameter d	Hardened washer diameter	Spacing p_2	Edge distance e_2	End distance e_1
	M20 8.8 SB	20 mm	37 mm	70 mm > 52.8 mm	35.0 mm > 26.4 mm	40 mm > 26.4 mm
Web stiffeners	Thickness x Width	Gusset lateral stiffener	Thickness $t_{s,g}$	Width $b_{s,g}$	Height $h_{s,g}$	Weld throat $a_{s,g}$
	8 mm x 90 mm		10 mm	65 mm	90 mm	4 mm

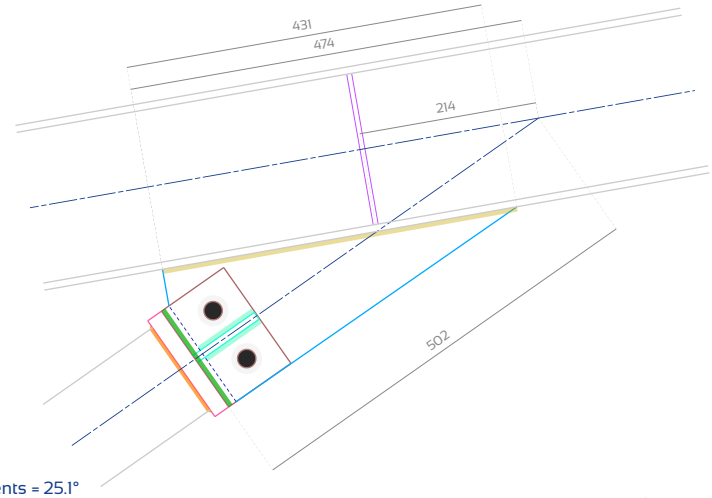
Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations
Shear strength of bolts (EN 1993-1-8 table 3.4)	0.767	ULS 32
Tensile strength of bolts (EN 1993-1-8 table 3.4)	0.128	ULS 32
Combined shear and tensile strength of bolts (EN 1993-1-8 table 3.4)	**0.858**	**ULS 32**
Bearing strength of the gussets (EN 1993-1-8 table 3.4)	0.834	ULS 32
Tension in the gussets (EN 1993-1-1 §6.2.3)	0.446	ULS 33
Block tearing of the gussets (EN 1993-1-8 §3.10.2)	0.511	ULS 33
Compressive strength of web stiffeners (BNCM / CNC2M – N0175 table 18)	0.092	ULS 32
Resistance of the lateral stiffener to bending (EN 1993-1-1 §6.2.5)	0.412	ULS 32
Local failure of the diagonal brace walls due to gusset pressure (CIDECT DG 1 - §7.4)	0.756	ULS 32
Local failure of the gusset due to diagonal brace pressure (CIDECT DG 1 - §7.4)	0.573	ULS 32
Local failure of the diagonal brace lateral wall due to stiffener pressure (CIDECT DG 1 - §7.4)	0.326	ULS 32
Weldings strength of the end plate on the diagonal brace (EN 1993-1-8 §4.5.3.3)	0.606	ULS 32
Weldings strength of the gusset to the end plate (EN 1993-1-8 §4.5.3.3)	0.785	ULS 32
Weldings strength of the gusset to the other element (EN 1993-1-8 §4.5.3.3)	0.374	ULS 32

Checkings	Status	Information
Plasticity condition of the lateral stiffener (EN 1993-1-1 §5.6)	OK	Class 1

Rafter side

Sketch and dimension table



Angle between elements = 25.1°

Gusset attached to diagonal brace	Thickness $t_{b,g}$	Width	Length	Drillings d_0	Weld throat $a_{b,g}$	
	10 mm	140 mm	91 mm	22 mm	4 mm	
End plate attached to diagonal brace	Thickness $t_{b,p}$	Width	Length	Drillings d_0	Weld throat $a_{b,p}$	
	20 mm	140 mm	140 mm	10 mm (galvanizing)	3 mm	
Gusset attached to the other element	Thickness t_i	Dimensions and position	Drillings d_0	Clearance with end plate	Weld throat $a_{os,g}$	
	10 mm	*(See sketch)*	22 mm	11 mm	4 mm	
Bolts	Designation	Screw diameter d	Hardened washer diameter	Spacing p_2	Edge distance e_2	End distance e_1
	M20 8.8 SB	20 mm	37 mm	70 mm > 52.8 mm	35.0 mm > 26.4 mm	40 mm > 26.4 mm
Web stiffeners	Thickness x Width	Gusset lateral stiffener	Thickness $t_{s,g}$	Width $b_{s,g}$	Height $h_{s,g}$	Weld throat $a_{s,g}$
	6 mm x 40 mm		10 mm	65 mm	90 mm	4 mm

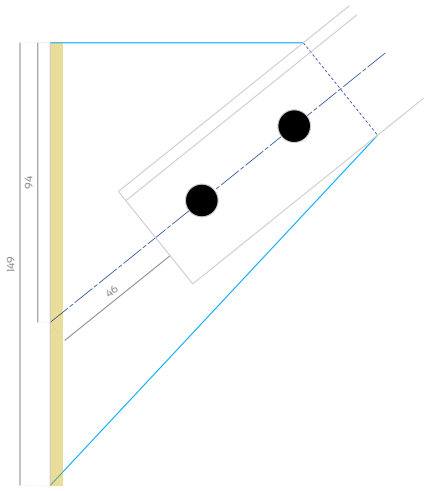
Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations
Shear strength of bolts (EN 1993-1-8 table 3.4)	0.764	ULS 32
Tensile strength of bolts (EN 1993-1-8 table 3.4)	0.127	ULS 32
Combined shear and tensile strength of bolts (EN 1993-1-8 table 3.4)	**0.855**	**ULS 32**
Bearing strength of the gussets (EN 1993-1-8 table 3.4)	0.831	ULS 32
Tension in the gussets (EN 1993-1-1 §6.2.3)	0.448	ULS 33
Block tearing of the gussets (EN 1993-1-8 §3.10.2)	0.513	ULS 33
Compressive strength of web stiffeners (BNCM / CNC2M – N0175 table 18)	0.081	ULS 32
Resistance of the lateral stiffener to bending (EN 1993-1-1 §6.2.5)	0.411	ULS 32
Local failure of the diagonal brace walls due to gusset pressure (CIDECT DG 1 - §7.4)	0.753	ULS 32
Local failure of the gusset due to diagonal brace pressure (CIDECT DG 1 - §7.4)	0.571	ULS 32
Local failure of the diagonal brace lateral wall due to stiffener pressure (CIDECT DG 1 - §7.4)	0.325	ULS 32
Weldings strength of the end plate on the diagonal brace (EN 1993-1-8 §4.5.3.3)	0.604	ULS 32
Weldings strength of the gusset to the end plate (EN 1993-1-8 §4.5.3.3)	0.782	ULS 32
Weldings strength of the gusset to the other element (EN 1993-1-8 §4.5.3.3)	0.26	ULS 32

Checkings	Status	Information
Plasticity condition of the lateral stiffener (EN 1993-1-1 §5.6)	OK	Class 1

Annex 6.4 - Roof cross-bracing gussets

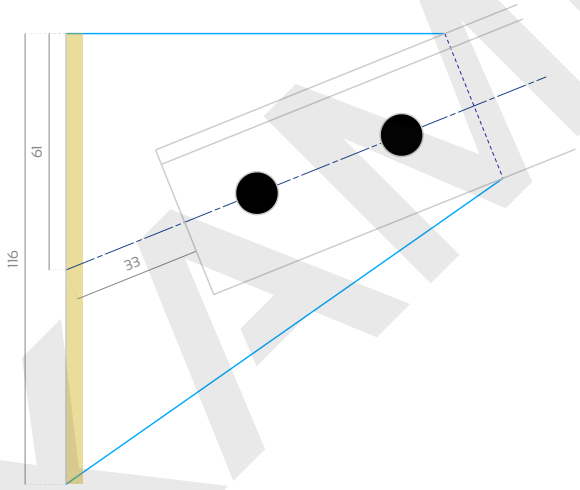
Sketch and dimension table



Angle = 38.8°

Element	Cross section	Gusset	Thickness t	Dimensions and position	Drillings d_0	Weld throat a_w
	L40x40x4		5 mm	*(See sketch)*	11 mm	3 mm
Bolts	Designation	Screw diameter d	Washer diameter	Edge distance e_2	Spacing p_1	End distance e_1
	M10 8.8 SB	10 mm	20 mm	20 mm > 13.2 mm	40 mm > 24.2 mm	20 mm > 13.2 mm

Sketch and dimension table



Angle = 21.9°

Element	Cross section	Gusset	Thickness t	Dimensions and position	Drillings d_0	Weld throat a_w
	L40x40x4		5 mm	*(See sketch)*	11 mm	3 mm
Bolts	Designation	Screw diameter d	Washer diameter	Edge distance e_2	Spacing p_1	End distance e_1
	M10 8.8 SB	10 mm	20 mm	20 mm > 13.2 mm	40 mm > 24.2 mm	20 mm > 13.2 mm

Maximum working rates by type of stress and associated combinations

Checkings	Working rates	Associated combinations
Shear strength of bolts (EN 1993-1-8 table 3.4)	0.466	1.5 x Wb-
Bearing resistance of the steel angle on x-x axis (EN 1993-1-8 table 3.4)	0.544	1.5 x Wb-
Bearing resistance of the steel angle on y-y axis (EN 1993-1-8 table 3.4)	0.24	1.5 x Wb-
Bearing resistance interaction on x-x and y-y axis of the steel angle (BNCM /CNC2M – N0175 §2.1(5))	0.354	1.5 x Wb-
Bearing resistance of the gusset on x-x axis (EN 1993-1-8 table 3.4)	0.435	1.5 x Wb-
Bearing resistance of the gusset on y-y axis (EN 1993-1-8 table 3.4)	0.192	1.5 x Wb-
Bearing resistance interaction on x-x and y-y axis of the gusset (BNCM /CNC2M – N0175 §2.1(5))	0.226	1.5 x Wb-
Block tearing of the steel angle (EN 1993-1-8 §3.10.2)	**0.594**	**1.5 x Wb-**
Block tearing of the gusset (EN 1993-1-8 §3.10.2)	0.476	1.5 x Wb-
Weldings strength of the gusset (EN 1993-1-8 §4.5.3.3)	0.146	1.5 x Wb-