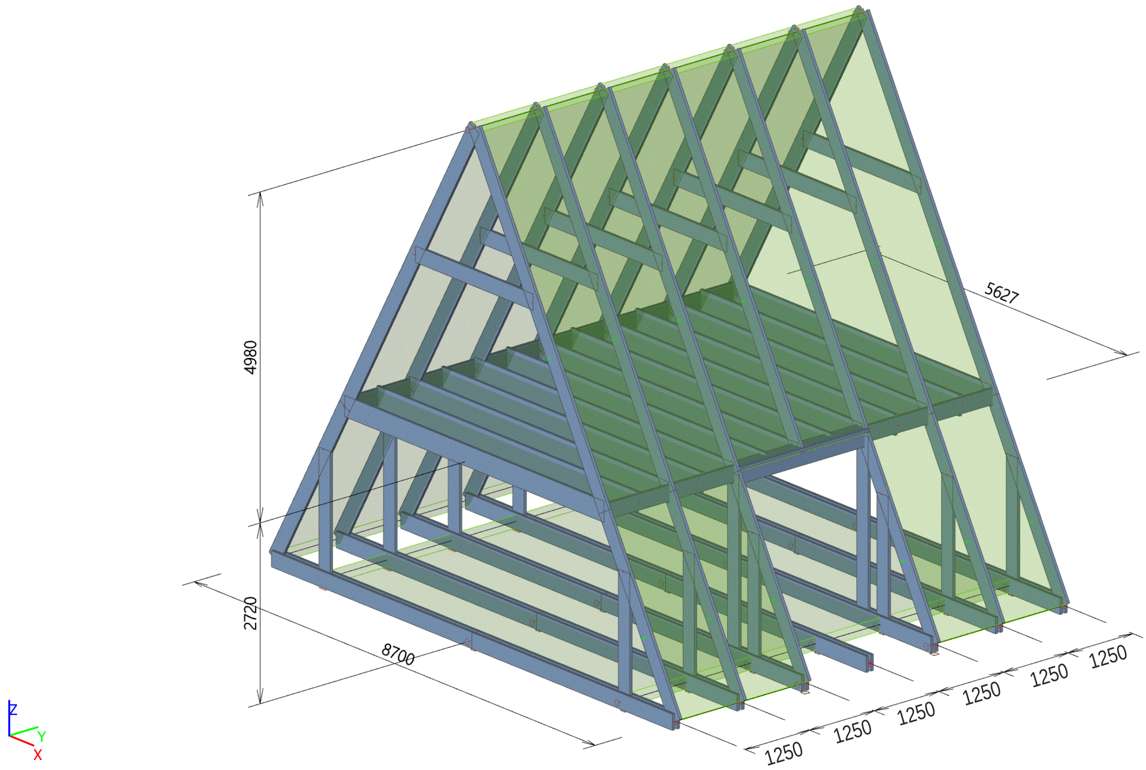
1. Table of contents

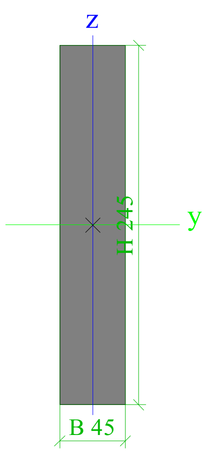
BOUNDARY CONDITIONS

The Report is valid for the model's Trio 75 and Trio 100. The calculation based on one standard frame, and frame next to the entrance. Loads are calculated based on the assumption, that the building length is up to 15m. Wind load calculation is shown in Annex 1 of this document.

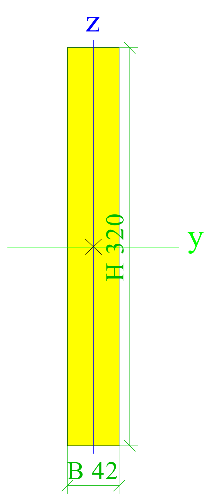
2. Overall structure dimensions



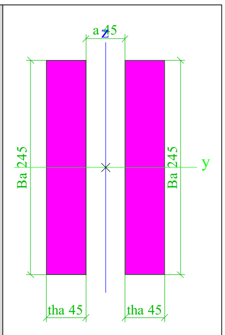
3. Cross-sections

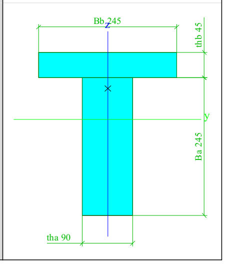
CS1	
Type	RECT
Detailed	45; 245
Item material	C24 (EN 338)
Fabrication	timber
A [m^2]	1.1025e-02
Picture	

CS2	
Type	RECT
Detailed	42; 320
Item material	GL 24h (EN 14080)
Fabrication	timber
A [m^2]	1.3440e-02

Picture	

CS4	
Type	2 Rect
Detailed	45; 245; 45
Item material	C24 (EN 338)
Fabrication	timber
A [m^2]	2.2050e-02

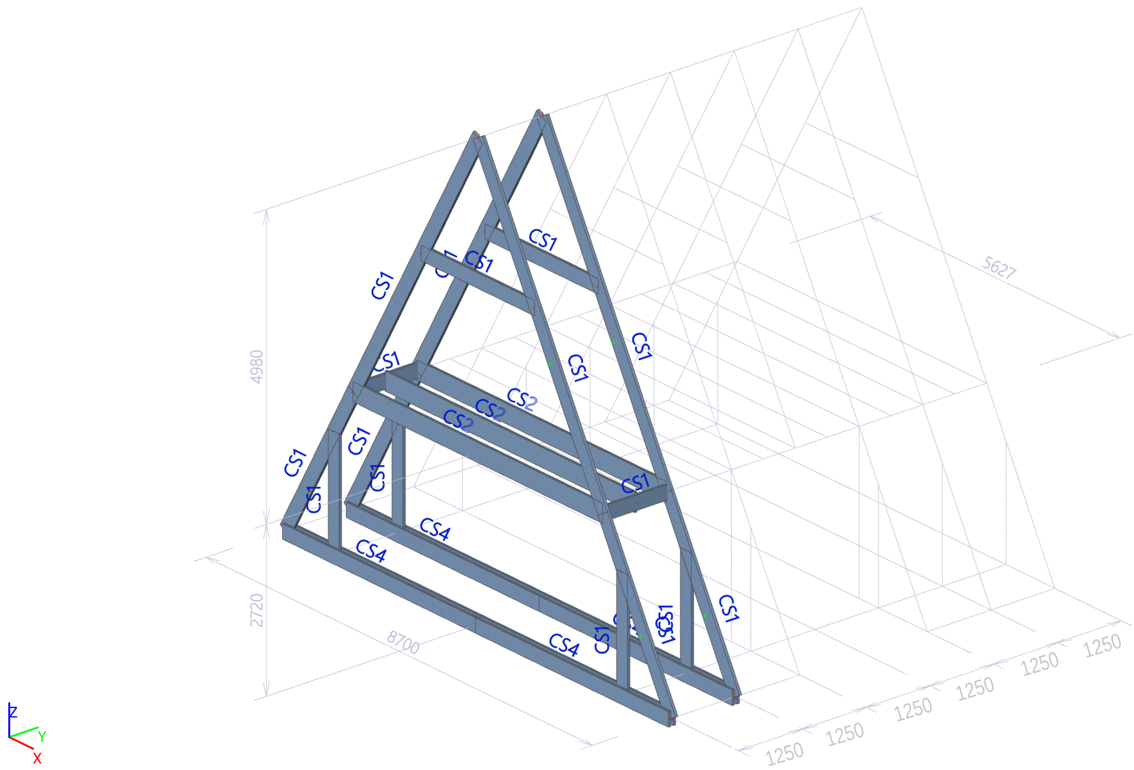
Picture	

CS6	
Type	T profile
Detailed	245; 90; 245; 45
Item material	C24 (EN 338)
Fabrication	timber
A [m^2]	3.3075e-02
Picture	

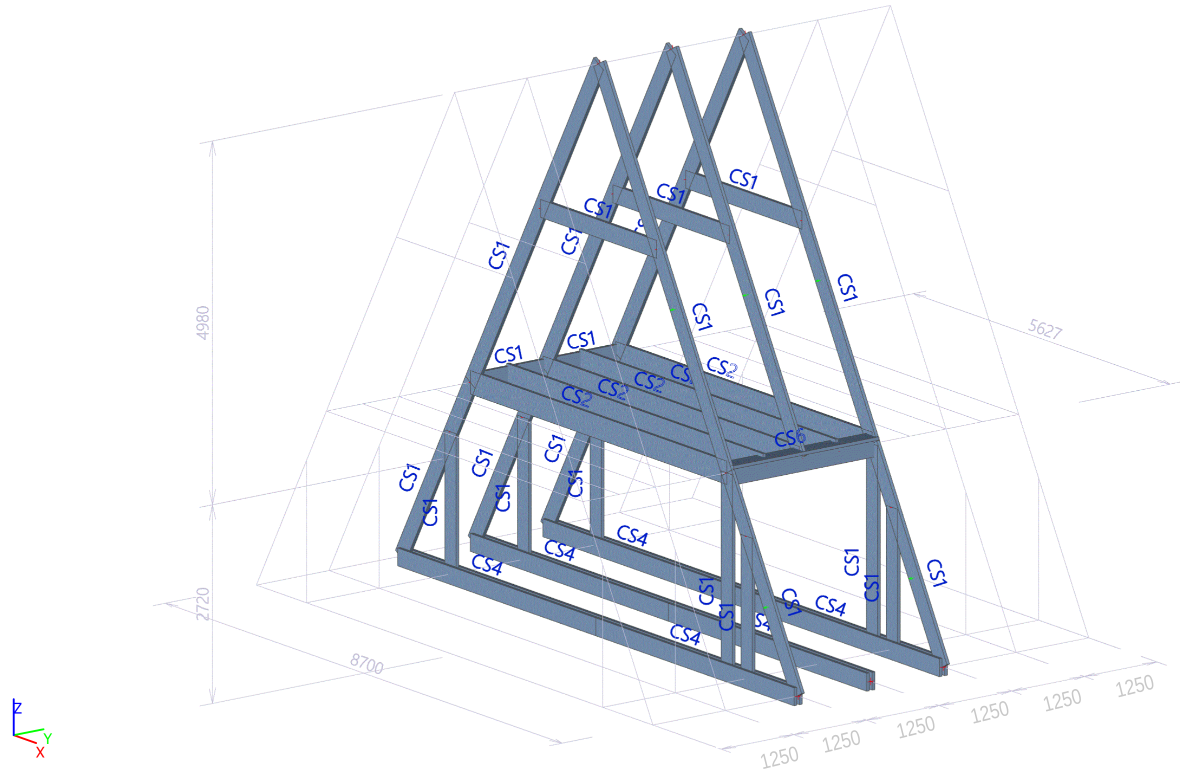
Explanations of symbols	
A	Area
$I_{Y.LCS}$	Second moment of area about the YLCS axis
$I_{Z.LCS}$	Second moment of area about the ZLCS axis

Remark: Cross section 2 is given as reference CS. Actual cross section is builded up as a beam with two components and nailed with nail plates (calculated separately).

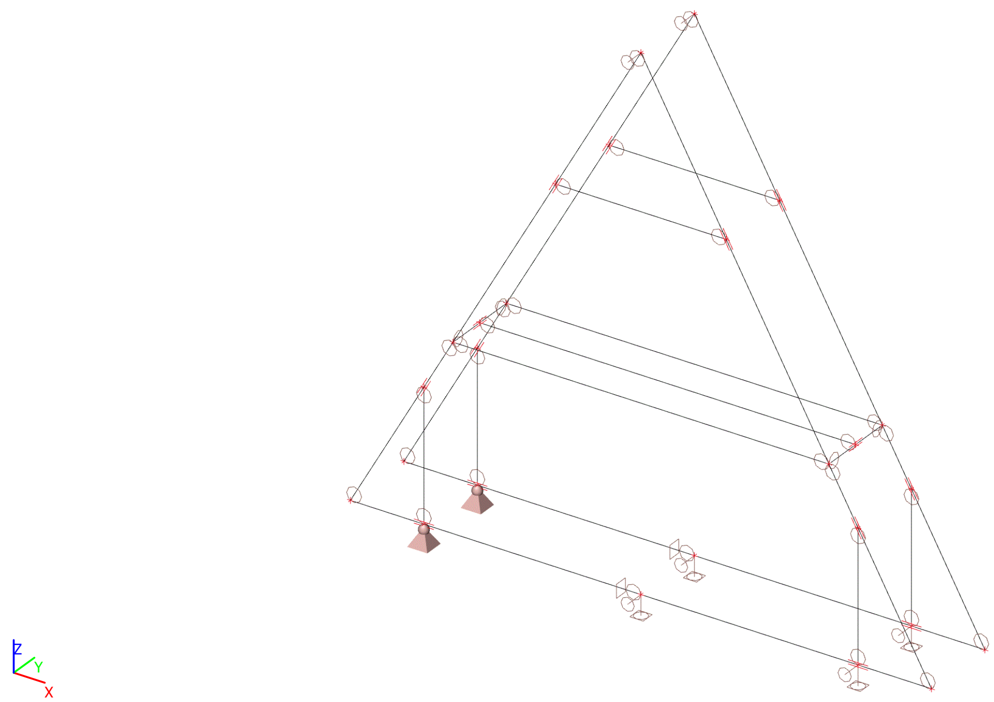
4. Main frame and floor beams



5. Middle frames and beam



6. Boundary conditions and supports based on typical frame

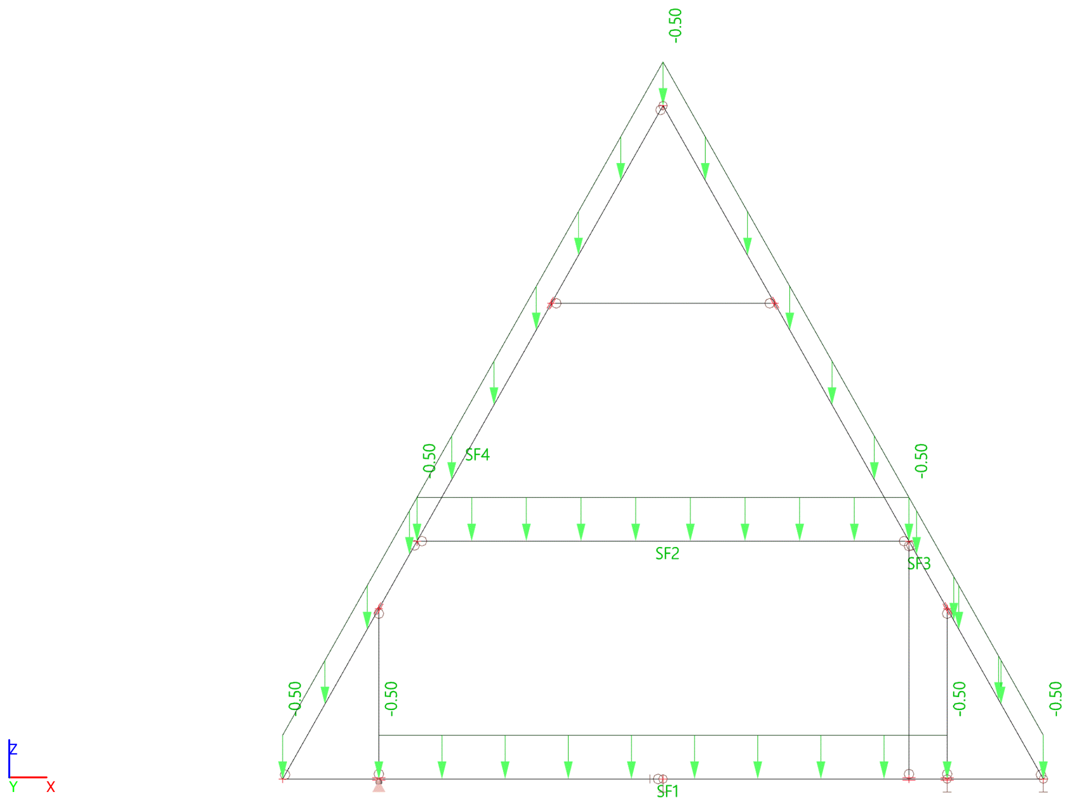


Remarks: circle is showing hinge at the end or beginning of the 1D member; on supports, square mark indicates in which direction support is rigid, circle shows support against sliding

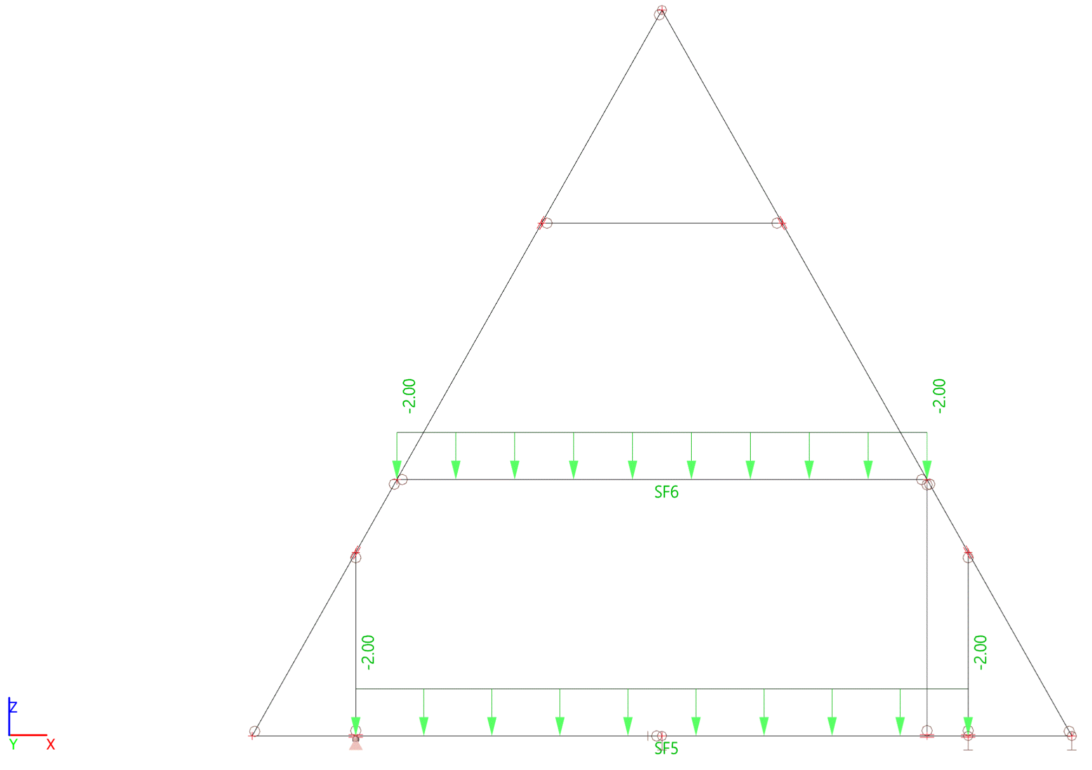
7. Load cases

Name	Description	Action type	LoadGroup	Direction	Duration
	Spec	Load type			
SW	selfweight	Permanent	Dead load	-Z	
		Self weight			
LL	domestic Cat:A	Variable	Live load		Medium
	Standard	Static			
W	wind load	Variable	Wind load		Short
	Standard	Static			
Structure weight	roof and floor selfweight	Permanent	Dead load		
		Standard			

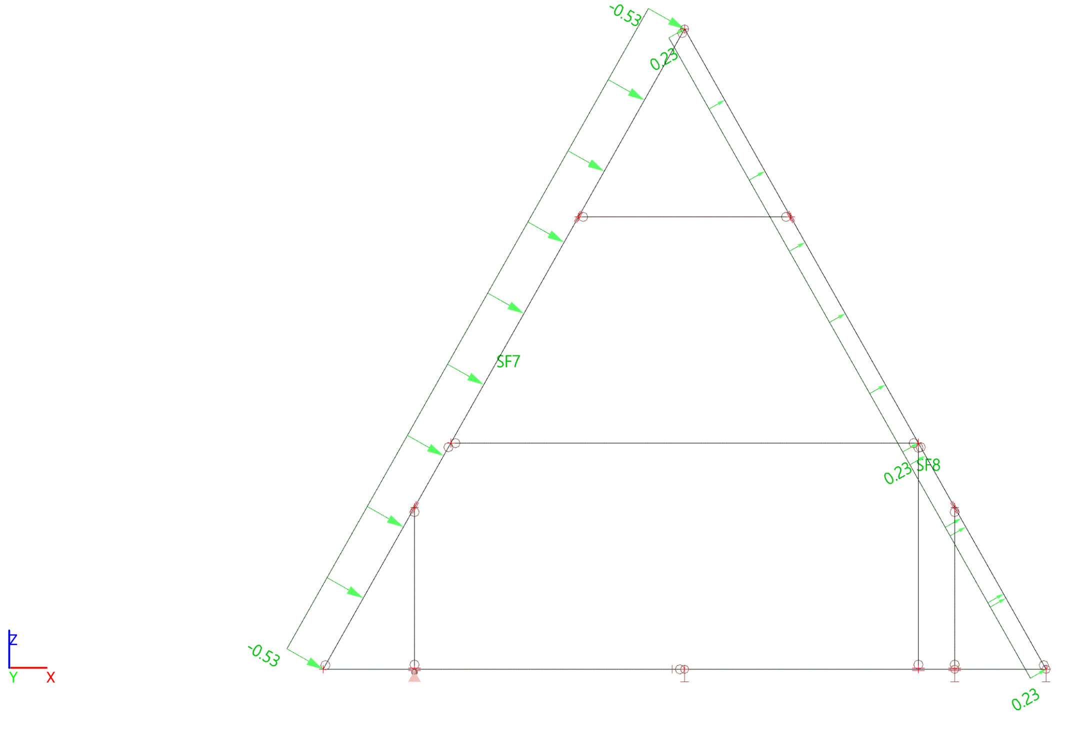
8. Structure weight on roof and floors



9. Live load on floors



10. Wind load X+



Remark: wind load on roof is calculated based on velocity pressure $q_p(z)$ = 0,73kN/m ^{2}

11. Combinations

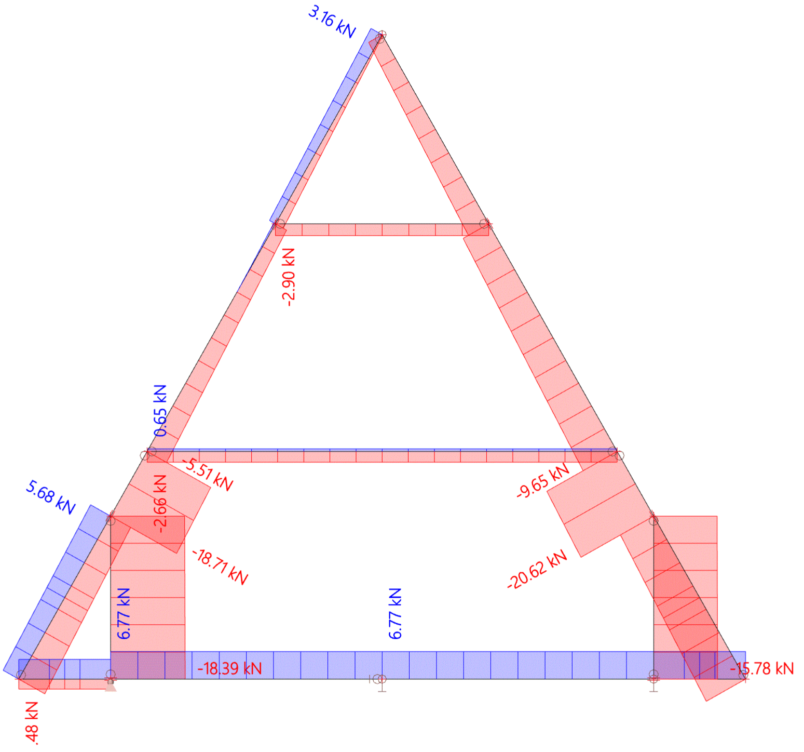
Name	Description	Type	Load cases	Coeff. [-]
CO1		EN-ULS (STR/GEO) Set B	SW - selfweight	1.00
			Structure weight - roof and floor selfweight	1.00
			LL - domestic Cat:A	1.00
			W - wind load	1.00
CO2		EN-SLS Characteristic	SW - selfweight	1.00
			Structure weight - roof and floor selfweight	1.00
			LL - domestic Cat:A	1.00
			W - wind load	1.00

12. Content of combinations

Name	Description	Type	Load cases	Coeff. [-]
CO1.1		Envelope - ultimate	SW - selfweight	1.35
			Structure weight - roof and floor selfweight	1.35
CO1.2		Envelope - ultimate	SW - selfweight	1.00
			Structure weight - roof and floor selfweight	1.00
CO1.3		Envelope - ultimate	SW - selfweight	1.35
			Structure weight - roof and floor selfweight	1.35
			LL - domestic Cat:A	1.50
			W - wind load	0.90
CO1.4		Envelope - ultimate	SW - selfweight	1.00
			Structure weight - roof and floor selfweight	1.00
			LL - domestic Cat:A	1.50
			W - wind load	0.90
CO1.5		Envelope - ultimate	SW - selfweight	1.35
			Structure weight - roof and floor selfweight	1.35
			LL - domestic Cat:A	1.05
			W - wind load	1.50
CO1.6		Envelope - ultimate	SW - selfweight	1.00
			Structure weight - roof and floor selfweight	1.00
			LL - domestic Cat:A	1.05
			W - wind load	1.50
CO2.1		Envelope - serviceability	SW - selfweight	1.00
			Structure weight - roof and floor selfweight	1.00
CO2.2		Envelope - serviceability	SW - selfweight	1.00
			Structure weight - roof and floor selfweight	1.00
			LL - domestic Cat:A	1.00
			W - wind load	0.60
CO2.3		Envelope - serviceability	SW - selfweight	1.00
			Structure weight - roof and floor selfweight	1.00
			LL - domestic Cat:A	0.70
			W - wind load	1.00

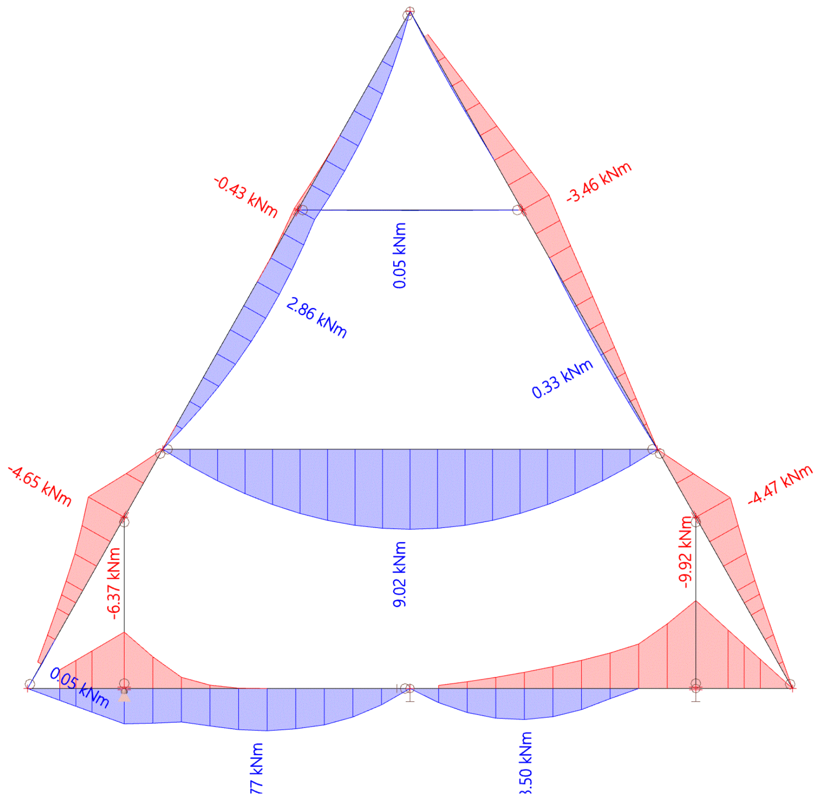
13. Normal forces in typical frame

Values: **N**
Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Member
Selection: All



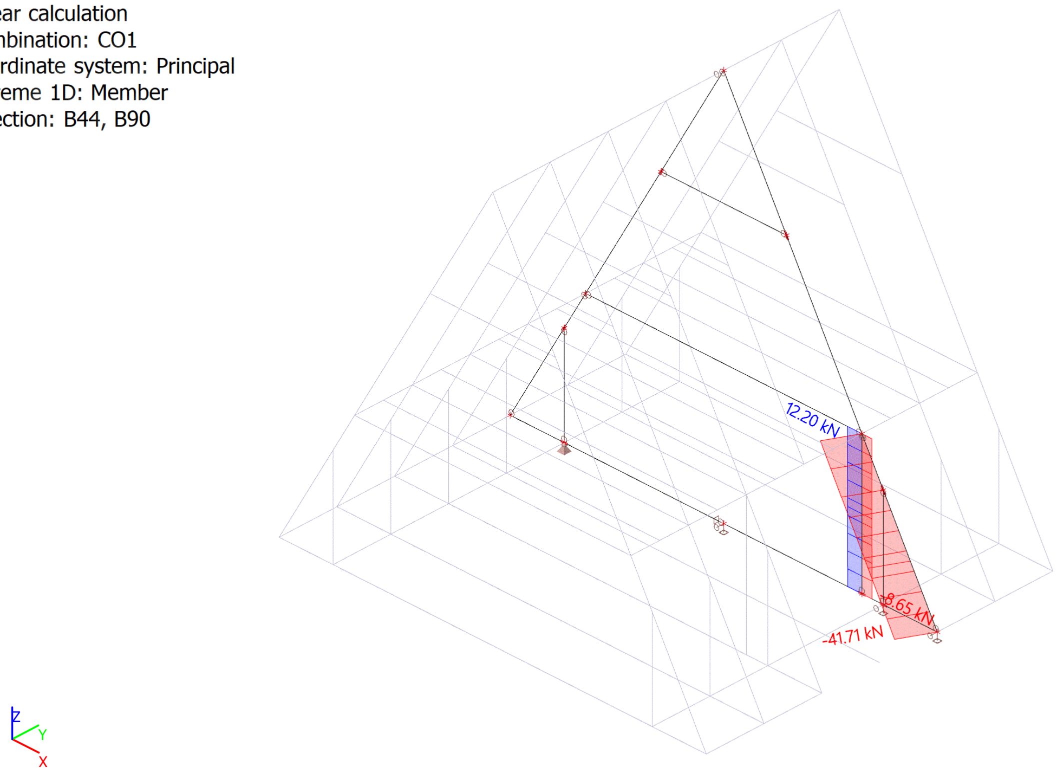
14. Bending moments My in typical frame

Values: **M_y**
Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Member
Selection: All



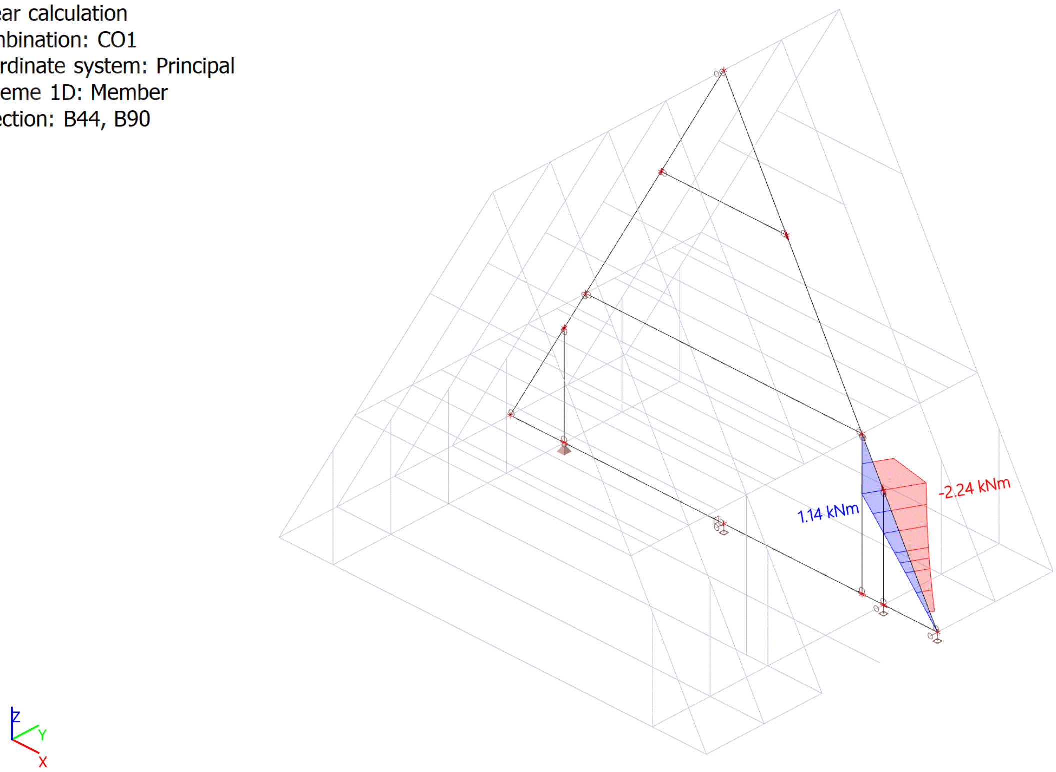
15. Normal forces in middle frame

Values: **N**
Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Member
Selection: B44, B90



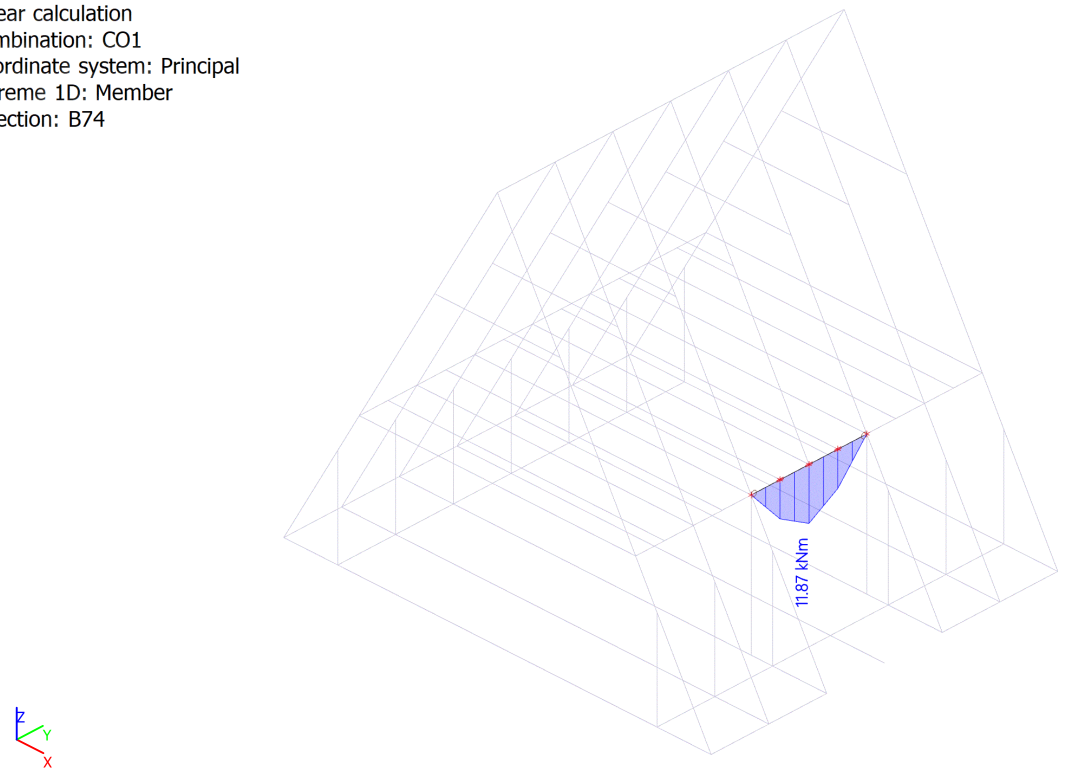
16. Bending moments My in middle frame

Values: $\mathbf{M_y}$
Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Member
Selection: B44, B90

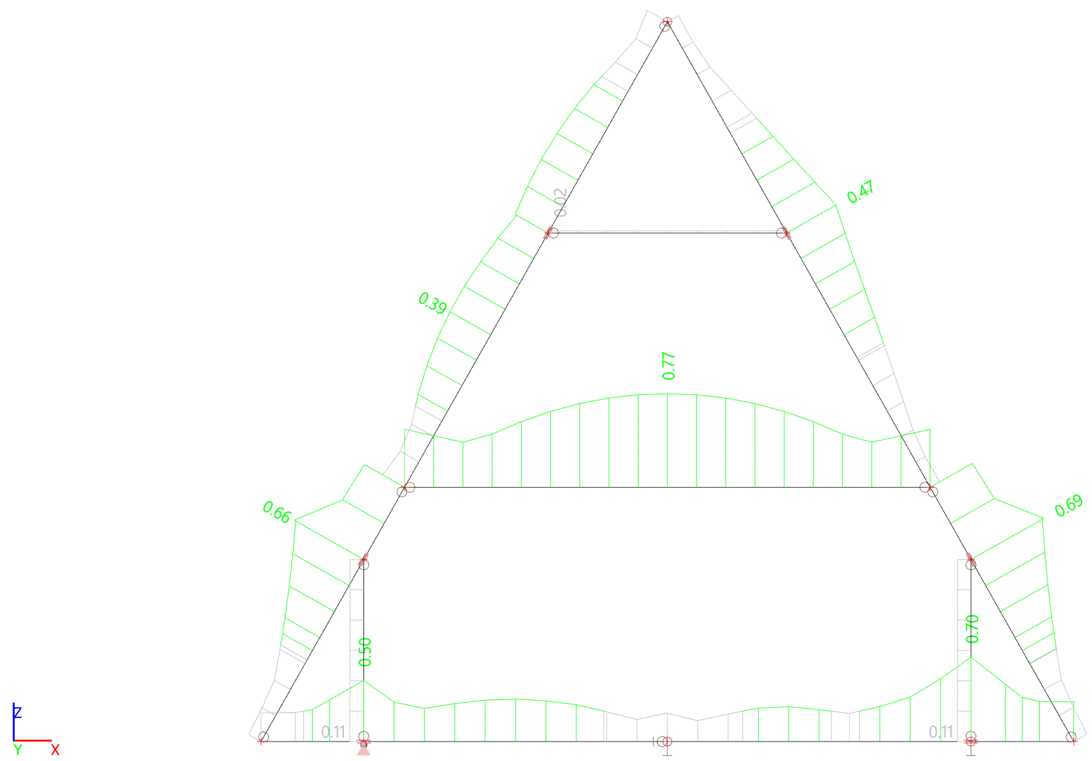


17. Bending moment My in middle beam

Values: M_y
Linear calculation
Combination: CO1
Coordinate system: Principal
Extreme 1D: Member
Selection: B74



18. ULS utilisation ratio for typical frame - buckling NOT concidered



ANNEX 1

Wind load calculation according to EN 1991-1-4: 2005 |

Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions

- Basic wind velocity $v_b = c_{dir} \cdot c_{season} \cdot v_{b,0} = 1 \cdot 1 \cdot 21 = \mathbf{21 m/s}$

  $v_{b,0} = 21 m/s$ according to Estonian NA
- The basic velocity pressure $q_b = 0{,}276 kN/m^2$
- Terrain category I
- **The peak velocity pressure at height 8m (height of the building)**

  $\boldsymbol{q_p(z) = 0,73 kN/m^2}$

According to the geometry of the building:

wind pressure on the windward side

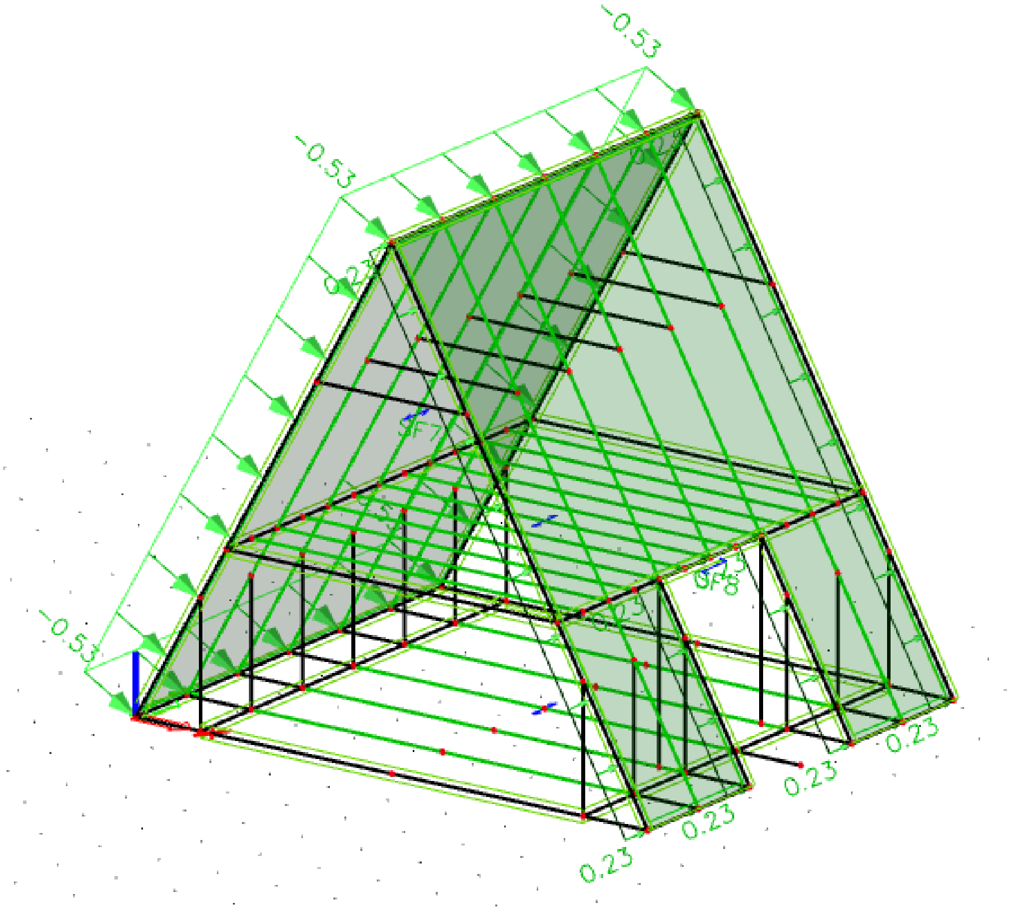
$$\boldsymbol{q_k = 0,73 \cdot 0,7 = 0,53 kN/m^2}$$

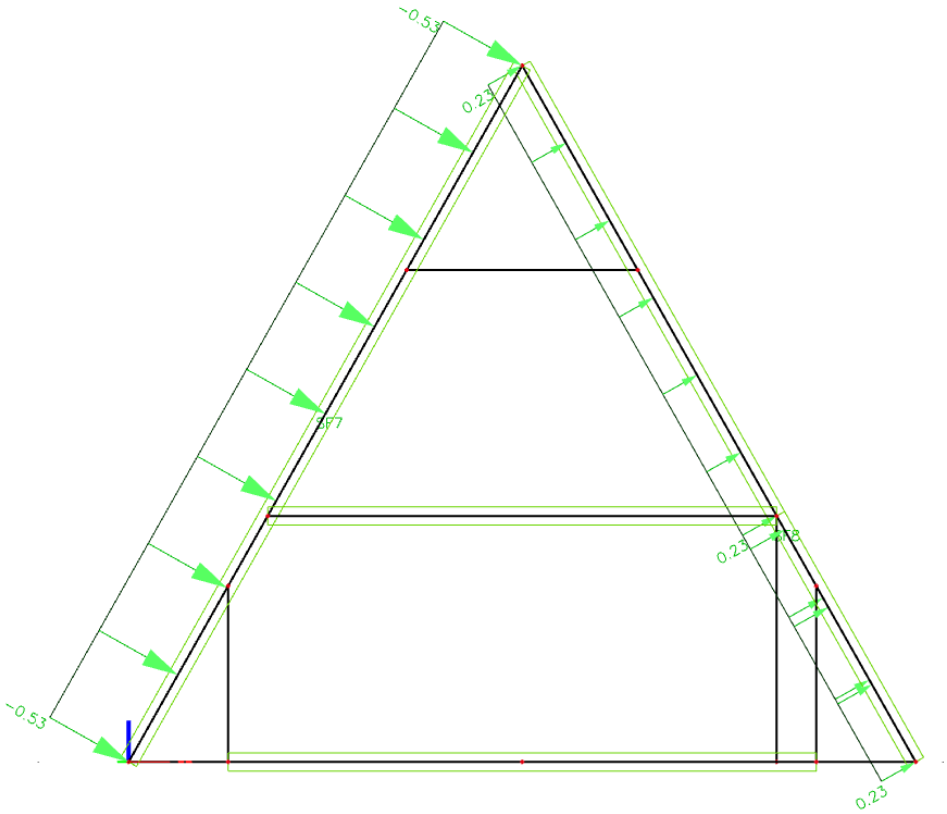
negative pressure on the leeward side

$$\boldsymbol{q_k = 0,73 \cdot 0,3 = 0,23 kN/m^2}$$

See the pictures on the next page

The calculated loads are characteristic values, for the design loads are multiplied by a factor $\gamma = 1{,}5$


-0.53
-0.53
-0.53
0.23
0.23
0.23
0.23
0.23
SF7


-0.53
0.23
SF7
0.23
-0.53
0.23

ANNEX 2: FLOOR BEAM WITH KERTO-S

Floor beam 45x(120+245) replaced with Kerto S 45x360mm; s.625mm; span length L=5,7m

Kerto- S: bending strength $f_{m,k} = 44MPa$ | shear strength $f_{v,k} = 4,1MPa$

Structure weight on the floor:

$$g_k = 0,5kN/m^2$$

Imposed load on the floor (Cat A):

$$q_k = 2,0kN/m^2$$

Design load for one beam:

$$p_d = 0,625 \cdot (1,35 \cdot 0,5 + 1.5 \cdot 2,0) = 2,2kN/m^2$$

Internal forces:

$$M_d = \frac{2,3 \cdot 5,7^2}{8} = 9{,}4kNm \mid V_d = \frac{2{,}3 \cdot 5,7}{2} = 6,7kN$$

Bending stress:

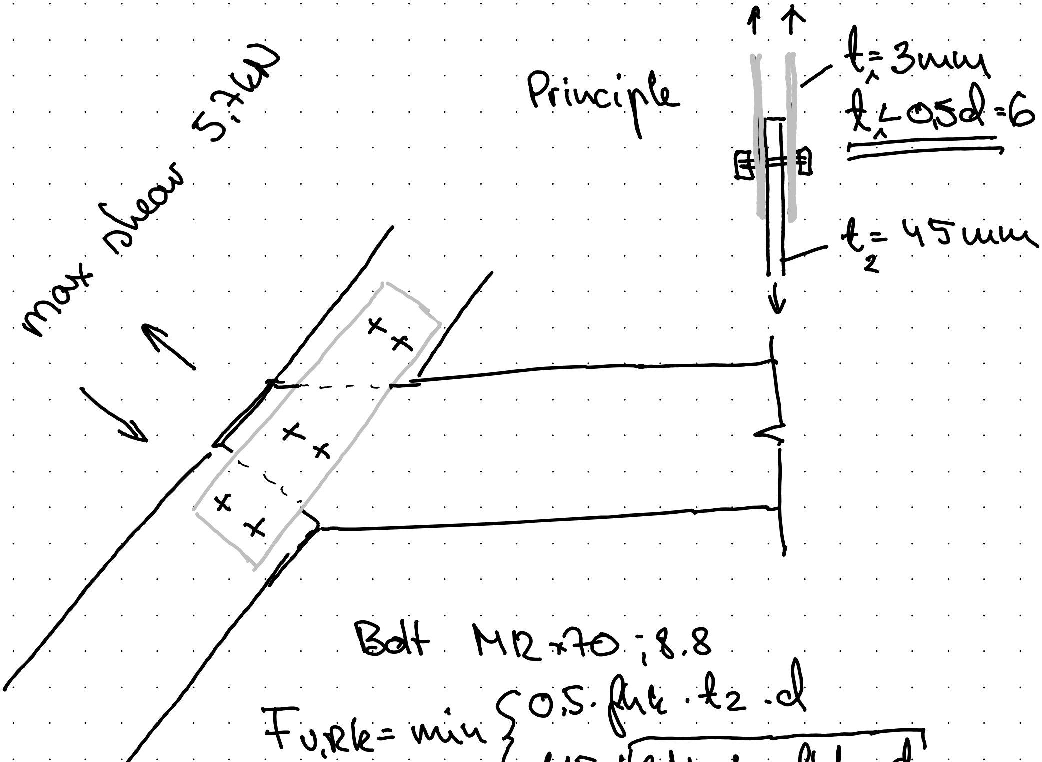
$$\sigma_{m,d} = \frac{9{,}4 \cdot 10^6 \cdot 6}{45 \cdot 360^2} = 9,7MPa < f_{m,d} = \frac{44 \cdot 0,8}{1,25} = 28MPa$$

Shear stress:

$$\tau_{v,d} = 1,5 \cdot \frac{6,7 \cdot 10^3}{45 \cdot 360} = 0,62MPa < f_{v,d} = \frac{4,1 \cdot 0,8}{1,25} = 2,6MPa$$

Frame beams 45×(120+245) connected with punched metal plates can be replaced with Kerto-S beam 45×360mm.

ANNEX 3: BOLTED CONNECTION



Bolt M12×70 ; 8.8

$$F_{v,Rk} = \min \begin{cases} 0.5 \cdot f_{h,k} \cdot t_2 \cdot d \\ 1.15 \cdot \sqrt{2 M_{y,k} \cdot f_{h,k} \cdot d} \end{cases}$$

$$f_{h,0,k} = 37\, k_q (1 - 0{,}01 d) = 37 \cdot 0{,}83 \cdot (1 - 0{,}01 \cdot 12) = 27\ \text{MPa}$$

$$k_q = 1 - \frac{2}{d} = 0{,}83$$

$$f_{h,90,k} = \frac{2}{k_{90} + 1} \cdot f_{h,0,k} = \frac{2}{1{,}33 + 1} \cdot 27 = 23{,}1\ \text{MPa}$$

$$k_{90} = 1{,}15 + 0{,}015 d = 1{,}33$$

$$M_{y,Rk} = 0{,}3 \cdot f_{u,k} \cdot d^{2,6} = 0{,}3 \cdot 800 \cdot 12^{2,6} = 153491\ \text{Nmm}$$

$F_{vR} = 0{,}5 \cdot 23{,}1 \cdot 4{,}5 \cdot 12 = \boxed{6{,}2\,kN}$ $\times 2) = 12{,}4\,kN$

$1{,}15 \cdot \sqrt{2 \cdot 153491 \cdot 23{,}1 \cdot 12} = 10{,}6\,kN$

Load carrying capaciti of two bolts = 24.8 kN >> 5,7 ok!