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Alu15 – Alu12 BS6399

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ENCLOSURE 1 : Drawings of the structure Alu15m

ENCLOSURE 2 : Print out of calculation results by ESA PRIMA WIN (release 3.50.63).

N = 1 newton

kN := 1000newton

Project : Alu15m - Alu12m
UK

BS 6399 : wind = 25 m/s
snow = 20 kg/m²

mcd : Alu15+12_BS
esa : Alu15+12_BS
units : kN / m

date : 06/04/06

Structural calculation of the Alu 15m and 12m structure according to the BS 6399.

1. Introduction.

This note describes the structural calculations for the relocatable alu 15m structure manufactured by **Georges Veldeman N.V.** Belgium. The length of the structure can reach any value as long as it's a multiple of 5m. **This calculation note implies at the same time the alu 12m structure, because the main profiles and the load on the structure are the same.**

Distance between two arches	$\text{Span_distance} := 5\text{ m}$	
Height of the peak	$H_{\text{peak}} := 5.09\text{ m}$	
Height of the eave	$H_{\text{eave}} := 2.65\text{ m}$	
Width of structure	$\text{Width} := 15\text{ m}$	
Length of structure	$\text{Length} := 35\text{ m}$	
slope of the roof :	$\alpha_{\text{roof}} := 18\text{ deg}$	(α must be between 15 and 30 deg)
Mean recurrence interval :	$\text{Recurrence_Interval} := 1$ year	it is a temporary structure
Site in country (0) or site in town (1):	$\text{site} := 0$	
Distance to sea :	$\text{dist_to_sea} := 0\text{ km}$	

The external loadings on the fabric like wind, rain and snow, are transmitted directly to the main arch. The function of the purlins is to keep the distance between the arches and to ensure the longitudinal stability in combination with the cable bracing system.

The calculation is based on the finite element method and uses nodes which are connected by beams. Each beam has a material number. All materials are represented in a materials list. The connections of the arches with the base plates are considered as hinges. The connections of the cable connections are considered as hinges too, as well as the connection of the purlins to the arches.

The profile is calculated as being continuous. The splices are checked with the results from the general arch calculation.

2. Determination of the loads.

2.1. Dead load.

2.1.1. Uniform loading.

The self weight of the aluminium structure is calculated by the computerprogram Esa prima win.

Weight of the fabric :

$$\text{Weight}_{\text{fabric}} := 0.650 \cdot \frac{\text{kg}}{\text{m}^2} \cdot \text{Span_distance}$$

$$\text{Weight}_{\text{fabric}} = 3.25 \frac{\text{kg}}{\text{m}}$$

2.1.2. Local loadings.

Local loadings are for example the weight of the peak splice and the connection splices.

$$\text{Weight}_{\text{peak_splice}} := 22 \cdot \text{kg}$$

$$\text{Weight}_{\text{eaves_splice}} := 18 \cdot \text{kg}$$

$$\text{Weight}_{\text{heavy_purlin}} := 4.33 \cdot \frac{\text{kg}}{\text{m}} \cdot \text{Span_distance}$$

$$\text{Weight}_{\text{heavy_purlin}} = 21.65 \text{ kg}$$

$$\text{Weight}_{\text{weak_purlin}} := 1.74 \cdot \frac{\text{kg}}{\text{m}} \cdot \text{Span_distance}$$

$$\text{Weight}_{\text{weak_purlin}} = 8.7 \text{ kg}$$

2.1.3. Lighting weight

We put on every arc 2 points with an extra weight of 50 kg, to take into account the weight of the lights inside the structure.

$$\text{ExtraWeight}_{\text{lighting}} := 50 \cdot \text{kg}$$

x 2 points for every arc (symmetrical placed to the left and right of the peak)

2.2. Snow load.

The snow load on a roof shall determined from : (acc. eurocode ENV 1991 - 2 - 3 : 1995, § 5.1)

$$s = \mu_i \cdot C_{es} \cdot C_{ts} \cdot s_k$$

the snow load shape coefficient μ_i

the exposure coefficient, which usually has the value 1

$$C_{es} := 1.0$$

the exposure coefficient, which usually has the value 1

$$C_{ts} := 1.0$$

the characteristic value of the snow load on the ground (kN/m²)

$$s_k := 0.20 \frac{\text{kN}}{\text{m}^2}$$

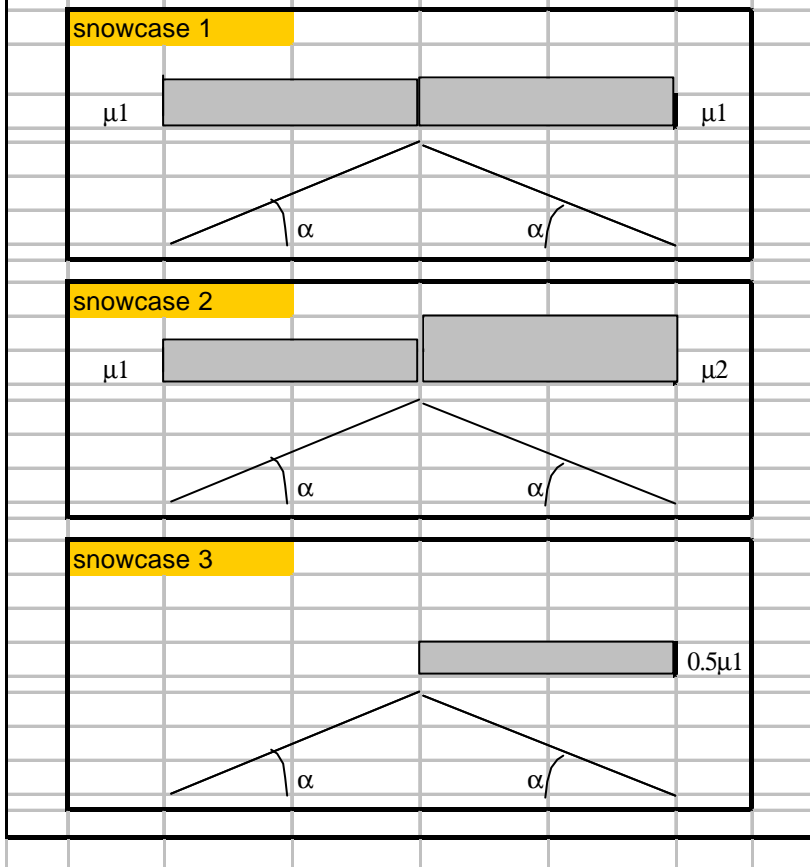
duopitch roof : acc eurocode env 1991-2-3 §7.2 (5), table 7.2

angle of pitch of roof : $\alpha_{\text{roof}} = 18 \text{ deg}$

$$\mu_1 := \begin{cases} 0.8 & \text{if } 0 \cdot \text{deg} \leq \alpha_{\text{roof}} \leq 15 \cdot \text{deg} \\ 0.8 & \text{if } 15 \cdot \text{deg} < \alpha_{\text{roof}} \leq 30 \cdot \text{deg} \\ \frac{0.8 \cdot \left(60 - \frac{\alpha_{\text{roof}}}{\text{deg}} \right)}{30} & \text{if } 30 \cdot \text{deg} < \alpha_{\text{roof}} \leq 60 \cdot \text{deg} \\ 0 & \text{if } \alpha_{\text{roof}} \geq 60 \cdot \text{deg} \end{cases} \quad \mu_1 = 0.8$$

$$\mu_2 := \begin{cases} 0.8 & \text{if } 0 \cdot \text{deg} \leq \alpha_{\text{roof}} \leq 15 \cdot \text{deg} \\ 0.8 + \frac{0.6 \cdot \left(\frac{\alpha_{\text{roof}}}{\text{deg}} - 15 \right)}{30} & \text{if } 15 \cdot \text{deg} < \alpha_{\text{roof}} \leq 30 \cdot \text{deg} \\ \frac{1.1 \cdot \left(60 - \frac{\alpha_{\text{roof}}}{\text{deg}} \right)}{30} & \text{if } 30 \cdot \text{deg} < \alpha_{\text{roof}} \leq 60 \cdot \text{deg} \\ 0 & \text{if } \alpha_{\text{roof}} \geq 60 \cdot \text{deg} \end{cases} \quad \mu_2 = 0.86$$

Snowcase according to eurocode 1991-2-3, table 7.2



snowcase 1: $s_{1_windward} := \mu_1 \cdot (C_{es} \cdot C_{ts} \cdot s_k) \cdot \text{Span_distance}$

$$s_{1_windward} = 0.8 \frac{\text{kN}}{\text{m}}$$

$s_{1_leeward} := \mu_1 \cdot (C_{es} \cdot C_{ts} \cdot s_k) \cdot \text{Span_distance}$

$$s_{1_leeward} = 0.8 \frac{\text{kN}}{\text{m}}$$

snowcase 2: $s_{2_windward} := \mu_1 \cdot (C_{es} \cdot C_{ts} \cdot s_k) \cdot \text{Span_distance}$

$$s_{2_windward} = 0.8 \frac{\text{kN}}{\text{m}}$$

$s_{2_leeward} := \mu_2 \cdot (C_{es} \cdot C_{ts} \cdot s_k) \cdot \text{Span_distance}$

$$s_{2_leeward} = 0.86 \frac{\text{kN}}{\text{m}}$$

snowcase 3: $s_{3_leeward} := 0.5\mu_1 \cdot (C_{es} \cdot C_{ts} \cdot s_k) \cdot \text{Span_distance}$

$$s_{3_leeward} = 0.4 \frac{\text{kN}}{\text{m}}$$

2.3. Wind load.

The wind load is calculated according to "BS 6399 part 2"

Basic wind speed

Basic wind speed acc. to fig. 6

$$V_b := 25.0 \frac{\text{m}}{\text{s}}$$

Altitude factor : $S_a := 1$

Direction factor : $S_d := 1$

Seasonal factor : $S_s := 1$

Probability factor (2.2.2.5) : S_p

Annex D, 1 year storm: the most likely annual maximum value

$$Q := \begin{cases} 0.632 & \text{if Recurrence}_{\text{Interval}} = 1 \\ 0.02 & \text{if Recurrence}_{\text{Interval}} = 50 \\ 0.0083 & \text{if Recurrence}_{\text{Interval}} = 120 \\ 5.7 \cdot 10^{-4} & \text{if Recurrence}_{\text{Interval}} = 1754 \\ 10^{-4} & \text{if Recurrence}_{\text{Interval}} = 10000 \end{cases}$$

$$S_p := \sqrt{\frac{5 - \ln(-\ln(1 - Q))}{5 - \ln(-\ln(0.98))}} \quad S_p = 0.749$$

Site wind speed

$$V_s := V_b \cdot S_a \cdot S_d \cdot S_s \cdot S_p$$

$$V_s = 18.737 \frac{\text{m}}{\text{s}}$$

Terrain and building factor (2.2.3.3)

Interpolation of table 4 gives us:

Effective height

Closest distance to sea:

$$H_e := \begin{pmatrix} 2\text{m} \\ 5\text{m} \\ 10\text{m} \\ 15\text{m} \\ 20\text{m} \\ 30\text{m} \\ 50\text{m} \\ 100\text{m} \end{pmatrix} \quad D_{s_c} := \begin{pmatrix} 0\text{km} \\ 0.1\text{km} \\ 2\text{km} \\ 10\text{km} \\ 100\text{km} \end{pmatrix} \quad D_{s_t} := \begin{pmatrix} 2\text{km} \\ 10\text{km} \\ 100\text{km} \end{pmatrix}$$

$$D_{s1} := \begin{pmatrix} 1.48 \\ 1.65 \\ 1.78 \\ 1.85 \\ 1.90 \\ 1.96 \\ 2.04 \\ 2.12 \end{pmatrix} \quad D_{s2} := \begin{pmatrix} 1.48 \\ 1.65 \\ 1.78 \\ 1.85 \\ 1.90 \\ 1.96 \\ 2.04 \\ 2.12 \end{pmatrix} \quad D_{s3} := \begin{pmatrix} 1.40 \\ 1.62 \\ 1.78 \\ 1.85 \\ 1.90 \\ 1.96 \\ 2.04 \\ 2.12 \end{pmatrix} \quad D_{s4} := \begin{pmatrix} 1.35 \\ 1.57 \\ 1.73 \\ 1.82 \\ 1.89 \\ 1.96 \\ 2.04 \\ 2.12 \end{pmatrix} \quad D_{s5} := \begin{pmatrix} 1.26 \\ 1.45 \\ 1.62 \\ 1.71 \\ 1.77 \\ 1.85 \\ 1.95 \\ 2.07 \end{pmatrix}$$

$$D_{s6} := \begin{pmatrix} 1.18 \\ 1.50 \\ 1.73 \\ 1.85 \\ 1.90 \\ 1.96 \\ 2.04 \\ 2.12 \end{pmatrix} \quad D_{s7} := \begin{pmatrix} 1.15 \\ 1.45 \\ 1.69 \\ 1.82 \\ 1.89 \\ 1.96 \\ 2.04 \\ 2.12 \end{pmatrix} \quad D_{s8} := \begin{pmatrix} 1.07 \\ 1.36 \\ 1.58 \\ 1.71 \\ 1.77 \\ 1.85 \\ 1.95 \\ 2.07 \end{pmatrix}$$

$$S_{b1}(H_{\text{peak}}) := \text{linterp}(H_e, D_{s1}, H_{\text{peak}})$$

$$S_{b6}(H_{\text{peak}}) := \text{linterp}(H_e, D_{s6}, H_{\text{peak}})$$

$$S_{b2}(H_{\text{peak}}) := \text{linterp}(H_e, D_{s2}, H_{\text{peak}})$$

$$S_{b7}(H_{\text{peak}}) := \text{linterp}(H_e, D_{s7}, H_{\text{peak}})$$

$$S_{b3}(H_{\text{peak}}) := \text{linterp}(H_e, D_{s3}, H_{\text{peak}})$$

$$S_{b8}(H_{\text{peak}}) := \text{linterp}(H_e, D_{s8}, H_{\text{peak}})$$

$$S_{b4}(H_{\text{peak}}) := \text{linterp}(H_e, D_{s4}, H_{\text{peak}})$$

$$S_{b5}(H_{\text{peak}}) := \text{linterp}(H_e, D_{s5}, H_{\text{peak}})$$

$$S_{b_c}(H_{\text{peak}}) := \begin{pmatrix} S_{b1}(H_{\text{peak}}) \\ S_{b2}(H_{\text{peak}}) \\ S_{b3}(H_{\text{peak}}) \\ S_{b4}(H_{\text{peak}}) \\ S_{b5}(H_{\text{peak}}) \end{pmatrix} \quad S_{b_t}(H_{\text{peak}}) := \begin{pmatrix} S_{b6}(H_{\text{peak}}) \\ S_{b7}(H_{\text{peak}}) \\ S_{b8}(H_{\text{peak}}) \end{pmatrix}$$

So we become:

$$S_b(H_{\text{peak}}, \text{dist_to_sea}, \text{site}) := \begin{cases} \text{linterp}(D_{s_c}, S_{b_c}(H_{\text{peak}}), \text{dist_to_sea}) & \text{if site} = 0 \\ \text{linterp}(D_{s_t}, S_{b_t}(H_{\text{peak}}), \text{dist_to_sea}) & \text{if site} = 1 \end{cases}$$

$$S_b(H_{\text{peak}}, \text{dist_to_sea}, \text{site}) = 1.652$$

Effective wind speed

$$V_e := V_s \cdot S_b(H_{\text{peak}}, \text{dist_to_sea}, \text{site})$$

$$V_e = 30.96 \frac{\text{m}}{\text{s}}$$

Dynamic pressure

$$q_s := 0.613 \cdot \left(\frac{\text{sec}^2 \cdot \text{N}}{\text{m}^4} \right) \cdot V_e^2$$

$$q_s = 0.588 \frac{\text{kN}}{\text{m}^2}$$

Size effect factor Ca : (fig. 4)

$$a_{\text{side_w}} := \sqrt{\text{Length}^2 + H_{\text{eave}}^2}$$

$$a_{\text{side_w}} = 35.1 \text{ m}$$

$$a_{\text{side_r}} := \sqrt{\text{Length}^2 + \left(\frac{\text{Width}}{2 \cos(\alpha_{\text{roof}})} \right)^2}$$

$$a_{\text{side_r}} = 35.877 \text{ m}$$

diagonal of loaded areas (fig. 5)

$$a_{\text{gable}} := \sqrt{\text{Width}^2 + H_{\text{eave}}^2}$$

$$a_{\text{gable}} = 15.232 \text{ m}$$

$$a_{\text{in}} := 10 \cdot \left[\left(\text{Width} \cdot \text{Length} \cdot H_{\text{eave}} \right) + \frac{\text{Width} \cdot (H_{\text{peak}} - H_{\text{eave}})}{2} \cdot \text{Length} \right]^{\frac{1}{3}}$$

$$a_{\text{in}} = 126.655 \text{ m}$$

diagonal dimension for internal pressure 2.6.1.1

$$\text{curve} := \left[\begin{array}{l} \left[\begin{array}{l} \left(\begin{array}{l} \text{"A"} \text{ if } \text{dist_to_sea} < 2\text{km} \\ \text{"B"} \text{ if } \text{dist_to_sea} \geq 2\text{km} \end{array} \right) \text{ if } 0\text{m} < H_{\text{peak}} \leq 5\text{m} \\ \left(\begin{array}{l} \text{"A"} \text{ if } \text{dist_to_sea} < 10\text{km} \\ \text{"B"} \text{ if } \text{dist_to_sea} \geq 10\text{km} \end{array} \right) \text{ if } 5\text{m} < H_{\text{peak}} \leq 20\text{m} \\ \left(\begin{array}{l} \text{"A"} \text{ if } \text{dist_to_sea} < 100\text{km} \\ \text{"B"} \text{ if } \text{dist_to_sea} \geq 100\text{km} \end{array} \right) \text{ if } H_{\text{peak}} > 20\text{m} \end{array} \right] \text{ if } \text{site} = 0 \\ \left[\begin{array}{l} \left(\begin{array}{l} \text{"A"} \text{ if } \text{dist_to_sea} < 2\text{km} \\ \text{"C"} \text{ if } \text{dist_to_sea} \geq 2\text{km} \end{array} \right) \text{ if } 0\text{m} < H_{\text{peak}} \leq 5\text{m} \\ \left(\begin{array}{l} \text{"A"} \text{ if } \text{dist_to_sea} < 10\text{km} \\ \text{"C"} \text{ if } \text{dist_to_sea} \geq 10\text{km} \end{array} \right) \text{ if } 5\text{m} < H_{\text{peak}} \leq 10\text{m} \\ \left(\begin{array}{l} \text{"A"} \text{ if } \text{dist_to_sea} < 10\text{km} \\ \text{"B"} \text{ if } \text{dist_to_sea} \geq 10\text{km} \end{array} \right) \text{ if } 10\text{m} < H_{\text{peak}} \leq 20\text{m} \\ \left(\begin{array}{l} \text{"A"} \text{ if } \text{dist_to_sea} < 100\text{km} \\ \text{"B"} \text{ if } \text{dist_to_sea} \geq 100\text{km} \end{array} \right) \text{ if } H_{\text{peak}} > 20\text{m} \end{array} \right] \text{ if } \text{site} = 1 \end{array} \right]$$

curve = "A"

$$C_{a_w} := \begin{cases} \left[\frac{\left(\log\left(\frac{a_{side_w}}{m}\right) - \log(5) \right) \cdot (0.67 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "A"} \\ \left[\frac{\left(\log\left(\frac{a_{side_w}}{m}\right) - \log(5) \right) \cdot (0.61 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "B"} \\ \left[\frac{\left(\log\left(\frac{a_{side_w}}{m}\right) - \log(5) \right) \cdot (0.52 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "C"} \end{cases} \quad C_{a_w} = 0.879$$

$$C_{a_r} := \begin{cases} \left[\frac{\left(\log\left(\frac{a_{side_r}}{m}\right) - \log(5) \right) \cdot (0.67 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "A"} \\ \left[\frac{\left(\log\left(\frac{a_{side_r}}{m}\right) - \log(5) \right) \cdot (0.61 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "B"} \\ \left[\frac{\left(\log\left(\frac{a_{side_r}}{m}\right) - \log(5) \right) \cdot (0.52 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "C"} \end{cases} \quad C_{a_r} = 0.877$$

$$C_{a_g} := \begin{cases} \left[\frac{\left(\log\left(\frac{a_{gable}}{m}\right) - \log(5) \right) \cdot (0.67 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "A"} \\ \left[\frac{\left(\log\left(\frac{a_{gable}}{m}\right) - \log(5) \right) \cdot (0.61 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "B"} \\ \left[\frac{\left(\log\left(\frac{a_{gable}}{m}\right) - \log(5) \right) \cdot (0.52 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "C"} \end{cases} \quad C_{a_g} = 0.931$$

$$C_{a_i} := \begin{cases} \left[\frac{\left(\log\left(\frac{a_{in}}{m}\right) - \log(5) \right) \cdot (0.67 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "A"} \\ \left[\frac{\left(\log\left(\frac{a_{in}}{m}\right) - \log(5) \right) \cdot (0.61 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "B"} \\ \left[\frac{\left(\log\left(\frac{a_{in}}{m}\right) - \log(5) \right) \cdot (0.52 - 1)}{\log(1000) - \log(5)} + 1 \right] & \text{if curve = "C"} \end{cases} \quad C_{a_i} = 0.799$$

Effective dynamic pressure

wind on side

$$q_w := q_s \cdot C_{a_w}$$

$$q_w = 0.516 \frac{\text{kN}}{\text{m}^2}$$

$$q_r := q_s \cdot C_{a_r}$$

$$q_r = 0.515 \frac{\text{kN}}{\text{m}^2}$$

wind on gable

$$q_g := q_s \cdot C_{a_g}$$

$$q_g = 0.547 \frac{\text{kN}}{\text{m}^2}$$

internal windpressure

$$q_i := q_s \cdot C_{a_i}$$

$$q_i = 0.469 \frac{\text{kN}}{\text{m}^2}$$

2.3.1. External wind pressure coefficients.

2.3.1.1. Walls

Wind load normal to the sidewall of the structure.

Side wall ($D < B$) :

$B :=$ Length

$D :=$ Width

$H := H_{\text{peak}}$

$b_s := \min(B, 2 \cdot H) \quad b_s = 10.18 \text{ m}$

$b_{0.2s} := 0.2 \cdot b_s \quad b_{0.2s} = 2.036 \text{ m}$

Windward

$$C_{pe_s_ww} := \begin{cases} \left[\frac{\left(\frac{D}{H} - 4 \right) (0.85 - 0.6)}{1 - 4} + 0.6 \right] & \text{if } 1 < \frac{D}{H} < 4 \\ 0.85 & \text{if } \frac{D}{H} \leq 1 \\ 0.6 & \text{if } \frac{D}{H} \geq 4 \end{cases} \quad C_{pe_s_ww} = 0.688 \quad \text{Table 5}$$

Leeward

$$C_{pe_s_lw} := -0.5$$

Table 5

Gable wall :

$$C_{pe_s_gA} := -1.3$$

$$C_{pe_s_gB} := -0.8$$

$$C_{pe_s_gC} := -0.5$$

Table 5

Wind load normal to the gablewall of the structure.Gable wall ($D > B$) :

B := Width

D := Length

H := H_{peak}

$$b_g := \min(B, 2 \cdot H) \quad b_g = 10.18 \text{ m}$$

$$b_{0.2g} := 0.2 \cdot b_g \quad b_{0.2g} = 2.036 \text{ m}$$

Windward

$$C_{pe_g_ww} := \begin{cases} \left[\frac{\left(\frac{D}{H} - 4 \right) (0.85 - 0.6)}{1 - 4} + 0.6 \right] & \text{if } 1 < \frac{D}{H} < 4 \\ 0.85 & \text{if } \frac{D}{H} \leq 1 \\ 0.6 & \text{if } \frac{D}{H} \geq 4 \end{cases} \quad C_{pe_g_ww} = 0.6 \quad \text{Table 5}$$

Leeward

$$C_{pe_g_lw} := -0.5 \quad \text{Table 5}$$

Side wall :

$$C_{pe_g_sA} := -1.3 \quad C_{pe_g_sB} := -0.8 \quad C_{pe_g_sC} := -0.5 \quad \text{Table 5}$$

2.3.1.2. Roofs art. 2.5.2

Wind load normal to the sidewall of the structure.

$$b_L := \min(\text{Length}, 2H) \quad b_L = 10.18 \text{ m}$$

$$b_W := \min(\text{Width}, 2H) \quad b_W = 10.18 \text{ m}$$

Table 10:

$$\begin{array}{c}
 A_o := \begin{pmatrix} -1.8 \\ -1.1 \\ -0.5 \\ 0.0 \\ 0.8 \\ 0.8 \end{pmatrix} \quad
 B_o := \begin{pmatrix} -1.2 \\ -0.8 \\ -0.5 \\ 0.0 \\ 0.8 \\ 0.8 \end{pmatrix} \quad
 C_o := \begin{pmatrix} -0.6 \\ -0.4 \\ -0.2 \\ 0.0 \\ 0.8 \\ 0.8 \end{pmatrix} \quad
 E := \begin{pmatrix} -0.9 \\ -1.3 \\ -0.9 \\ -0.4 \\ -0.8 \\ -0.9 \end{pmatrix} \quad
 F := \begin{pmatrix} -0.3 \\ -0.9 \\ -0.5 \\ -0.3 \\ -0.7 \\ -0.6 \end{pmatrix} \quad
 G := \begin{pmatrix} -0.4 \\ -0.5 \\ -0.5 \\ -0.3 \\ -0.6 \\ -0.8 \end{pmatrix} \\
 \\
 A_u := \begin{pmatrix} 0.0 \\ 0.2 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \end{pmatrix} \quad
 B_u := \begin{pmatrix} 0.0 \\ 0.2 \\ 0.5 \\ 0.6 \\ 0.8 \\ 0.8 \end{pmatrix} \quad
 C_u := \begin{pmatrix} 0.0 \\ 0.2 \\ 0.4 \\ 0.7 \\ 0.8 \\ 0.8 \end{pmatrix} \quad
 \alpha := \begin{pmatrix} 5\text{deg} \\ 15\text{deg} \\ 30\text{deg} \\ 45\text{deg} \\ 60\text{deg} \\ 75\text{deg} \end{pmatrix}
 \end{array}$$

$$C_{pe_rs_A_o} := \text{linterp}(\alpha, A_o, \alpha_{\text{roof}}) \quad C_{pe_rs_A_o} = -0.98$$

$$C_{pe_rs_A_u} := \text{linterp}(\alpha, A_u, \alpha_{\text{roof}}) \quad C_{pe_rs_A_u} = 0.32$$

$$C_{pe_rs_B_o} := \text{linterp}(\alpha, B_o, \alpha_{\text{roof}}) \quad C_{pe_rs_B_o} = -0.74$$

$$C_{pe_rs_B_u} := \text{linterp}(\alpha, B_u, \alpha_{\text{roof}}) \quad C_{pe_rs_B_u} = 0.26$$

$$C_{pe_rs_C_o} := \text{linterp}(\alpha, C_o, \alpha_{\text{roof}}) \quad C_{pe_rs_C_o} = -0.36$$

$$C_{pe_rs_C_u} := \text{linterp}(\alpha, C_u, \alpha_{\text{roof}}) \quad C_{pe_rs_C_u} = 0.24$$

$$C_{pe_rs_E} := \text{linterp}(\alpha, E, \alpha_{\text{roof}}) \quad C_{pe_rs_E} = -1.22$$

$$C_{pe_rs_F} := \text{linterp}(\alpha, F, \alpha_{\text{roof}}) \quad C_{pe_rs_F} = -0.82$$

$$C_{pe_rs_G} := \text{linterp}(\alpha, G, \alpha_{\text{roof}}) \quad C_{pe_rs_G} = -0.5$$

Wind load normal to the gablewall of the structure.

Table 10:

$$A := \begin{pmatrix} -2.0 \\ -1.6 \\ -1.2 \\ -1.2 \\ -1.2 \\ -1.2 \end{pmatrix} \quad B := \begin{pmatrix} -1.1 \\ -1.5 \\ -1.1 \\ -1.2 \\ -1.2 \\ -1.2 \end{pmatrix} \quad C := \begin{pmatrix} -0.6 \\ -0.6 \\ -0.6 \\ -0.6 \\ -0.7 \\ -1.15 \end{pmatrix} \quad D := \begin{pmatrix} -0.5 \\ -0.4 \\ -0.5 \\ -0.4 \\ -0.6 \\ -0.6 \end{pmatrix}$$

$$C_{pe_rg_A} := \text{linterp}(\alpha, A, \alpha_{roof}) \quad C_{pe_rg_A} = -1.52$$

$$C_{pe_rg_B} := \text{linterp}(\alpha, B, \alpha_{roof}) \quad C_{pe_rg_B} = -1.42$$

$$C_{pe_rg_C} := \text{linterp}(\alpha, C, \alpha_{roof}) \quad C_{pe_rg_C} = -0.6$$

$$C_{pe_rg_D} := \text{linterp}(\alpha, D, \alpha_{roof}) \quad C_{pe_rg_D} = -0.42$$

2.3.2. Internal wind pressure coefficients.

The wind also causes (table 16)

an underpressure: $C_{pi_u} := -0.3$

an overpressure: $C_{pi_o} := 0.0$

2.3.3. Global wind pressure.

Wind load normal to the sidewall of the structure.

Overpressure

$$q_{\text{sidewall_windw_overpress}} := C_{\text{pe_s_ww}} \cdot q_w - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{sidewall_windw_overpress}} = 0.355 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{sidewall_leew_overpress}} := C_{\text{pe_s_lw}} \cdot q_w - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{sidewall_leew_overpress}} = -0.258 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofA_side_overpress}} := C_{\text{pe_rs_A_o}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofA_side_overpress}} = -0.505 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofB_side_overpress}} := C_{\text{pe_rs_B_o}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofB_side_overpress}} = -0.381 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofC_side_overpress}} := C_{\text{pe_rs_C_o}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofC_side_overpress}} = -0.186 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofE_side_overpress}} := C_{\text{pe_rs_E}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofE_side_overpress}} = -0.629 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofF_side_overpress}} := C_{\text{pe_rs_F}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofF_side_overpress}} = -0.423 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofG_side_overpress}} := C_{\text{pe_rs_G}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofG_side_overpress}} = -0.258 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{gableA_overpress}} := C_{\text{pe_s_gA}} \cdot q_g - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{gableA_overpress}} = -0.711 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{gableB_overpress}} := C_{\text{pe_s_gB}} \cdot q_g - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{gableB_overpress}} = -0.437 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{gableC_overpress}} := C_{\text{pe_s_gC}} \cdot q_g - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{gableC_overpress}} = -0.273 \frac{\text{kN}}{\text{m}^2}$$

Underpressure

$q_{\text{sidewall_windw_underpress}} := C_{\text{pe_s_ww}} \cdot q_w - C_{\text{pi_u}} \cdot q_i$	$q_{\text{sidewall_windw_underpress}} = 0.496 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{sidewall_leew_underpress}} := C_{\text{pe_s_lw}} \cdot q_w - C_{\text{pi_u}} \cdot q_i$	$q_{\text{sidewall_leew_underpress}} = -0.117 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofA_side_underpress}} := C_{\text{pe_rs_A_u}} \cdot q_r - C_{\text{pi_u}} \cdot q_i$	$q_{\text{roofA_side_underpress}} = 0.306 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofB_side_underpress}} := C_{\text{pe_rs_B_u}} \cdot q_r - C_{\text{pi_u}} \cdot q_i$	$q_{\text{roofB_side_underpress}} = 0.275 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofC_side_underpress}} := C_{\text{pe_rs_C_u}} \cdot q_r - C_{\text{pi_u}} \cdot q_i$	$q_{\text{roofC_side_underpress}} = 0.264 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofE_side_underpress}} := C_{\text{pe_rs_E}} \cdot q_r - C_{\text{pi_u}} \cdot q_i$	$q_{\text{roofE_side_underpress}} = -0.488 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofF_side_underpress}} := C_{\text{pe_rs_F}} \cdot q_r - C_{\text{pi_u}} \cdot q_i$	$q_{\text{roofF_side_underpress}} = -0.282 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofG_side_underpress}} := C_{\text{pe_rs_G}} \cdot q_r - C_{\text{pi_u}} \cdot q_i$	$q_{\text{roofG_side_underpress}} = -0.117 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{gableA_underpress}} := C_{\text{pe_s_gA}} \cdot q_g - C_{\text{pi_u}} \cdot q_i$	$q_{\text{gableA_underpress}} = -0.57 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{gableB_underpress}} := C_{\text{pe_s_gB}} \cdot q_g - C_{\text{pi_u}} \cdot q_i$	$q_{\text{gableB_underpress}} = -0.297 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{gableC_underpress}} := C_{\text{pe_s_gC}} \cdot q_g - C_{\text{pi_u}} \cdot q_i$	$q_{\text{gableC_underpress}} = -0.133 \frac{\text{kN}}{\text{m}^2}$

Wind load normal to the gablewall of the structure.Overpressure

$$q_{\text{sidewallA_overpress}} := C_{\text{pe_g_sA}} \cdot q_w - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{sidewallA_overpress}} = -0.671 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{sidewallB_overpress}} := C_{\text{pe_g_sB}} \cdot q_w - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{sidewallB_overpress}} = -0.413 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{sidewallC_overpress}} := C_{\text{pe_g_sC}} \cdot q_w - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{sidewallC_overpress}} = -0.258 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofA_overpress}} := C_{\text{pe_rg_A}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofA_overpress}} = -0.783 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofB_overpress}} := C_{\text{pe_rg_B}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofB_overpress}} = -0.732 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofC_overpress}} := C_{\text{pe_rg_C}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofC_overpress}} = -0.309 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{roofD_overpress}} := C_{\text{pe_rg_D}} \cdot q_r - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{roofD_overpress}} = -0.216 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{gable_windw_overpress}} := C_{\text{pe_g_ww}} \cdot q_g - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{gable_windw_overpress}} = 0.328 \frac{\text{kN}}{\text{m}^2}$$

$$q_{\text{gable_leew_overpress}} := C_{\text{pe_g_lw}} \cdot q_g - C_{\text{pi_o}} \cdot q_i$$

$$q_{\text{gable_leew_overpress}} = -0.273 \frac{\text{kN}}{\text{m}^2}$$

Underpressure

$q_{\text{sidewallA_underpress}} := C_{pe_g_sA} \cdot q_w - C_{pi_u} \cdot q_i$	$q_{\text{sidewallA_underpress}} = -0.53 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{sidewallB_underpress}} := C_{pe_g_sB} \cdot q_w - C_{pi_u} \cdot q_i$	$q_{\text{sidewallB_underpress}} = -0.272 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{sidewallC_underpress}} := C_{pe_g_sC} \cdot q_w - C_{pi_u} \cdot q_i$	$q_{\text{sidewallC_underpress}} = -0.117 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofA_underpress}} := C_{pe_rg_A} \cdot q_r - C_{pi_u} \cdot q_i$	$q_{\text{roofA_underpress}} = -0.643 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofB_underpress}} := C_{pe_rg_B} \cdot q_r - C_{pi_u} \cdot q_i$	$q_{\text{roofB_underpress}} = -0.591 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofC_underpress}} := C_{pe_rg_C} \cdot q_r - C_{pi_u} \cdot q_i$	$q_{\text{roofC_underpress}} = -0.168 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{roofD_underpress}} := C_{pe_rg_D} \cdot q_r - C_{pi_u} \cdot q_i$	$q_{\text{roofD_underpress}} = -0.076 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{gable_windw_underpress}} := C_{pe_g_ww} \cdot q_g - C_{pi_u} \cdot q_i$	$q_{\text{gable_windw_underpress}} = 0.469 \frac{\text{kN}}{\text{m}^2}$
$q_{\text{gable_leew_underpress}} := C_{pe_g_lw} \cdot q_g - C_{pi_u} \cdot q_i$	$q_{\text{gable_leew_underpress}} = -0.133 \frac{\text{kN}}{\text{m}^2}$

2.3.4. Total windload per arch (2nd arch = most loaded).

Wind load normal to the sidewall of the structure.

$$\frac{b}{2} = 5.09 \text{ m}$$

Overpressure

$$P_{\text{sidewall_windw_overpress}} := q_{\text{sidewall_windw_overpress}} \cdot \text{Span_distance} \quad P_{\text{sidewall_windw_overpress}} = 1.775 \frac{\text{kN}}{\text{m}}$$

$$P_{\text{sidewall_leew_overpress}} := q_{\text{sidewall_leew_overpress}} \cdot \text{Span_distance} \quad P_{\text{sidewall_leew_overpress}} = -1.291 \frac{\text{kN}}{\text{m}}$$

$$P_{\text{roof_low_windw_overpress}} := q_{\text{roofA_side_overpress}} \cdot \frac{\text{Span_distance}}{2} \dots \quad P_{\text{roof_low_windw_overpress}} = -2.216 \frac{\text{kN}}{\text{m}}$$

$$+ q_{\text{roofB_side_overpress}} \cdot \frac{\text{Span_distance}}{2}$$

$$P_{\text{roof_high_windw_overpress}} := q_{\text{roofC_side_overpress}} \cdot \text{Span_distance} \quad P_{\text{roof_high_windw_overpress}} = -0.928 \frac{\text{kN}}{\text{m}}$$

$$P_{\text{roof_high_leew_overpress}} := q_{\text{roofE_side_overpress}} \cdot \frac{\text{Span_distance}}{2} \dots \quad P_{\text{roof_high_leew_overpress}} = -2.629 \frac{\text{kN}}{\text{m}}$$

$$+ q_{\text{roofF_side_overpress}} \cdot \frac{\text{Span_distance}}{2}$$

$$P_{\text{roof_low_leew_overpress}} := q_{\text{roofG_side_overpress}} \cdot \text{Span_distance} \quad P_{\text{roof_low_leew_overpress}} = -1.289 \frac{\text{kN}}{\text{m}}$$

Underpressure

$$P_{\text{sidewall_windw_underpress}} := q_{\text{sidewall_windw_underpress}} \cdot \text{Span_distance} \quad P_{\text{sidewall_windw_underpress}} = 2.479 \frac{\text{kN}}{\text{m}}$$

$$P_{\text{sidewall_leew_underpress}} := q_{\text{sidewall_leew_underpress}} \cdot \text{Span_distance} \quad P_{\text{sidewall_leew_underpress}} = -0.587 \frac{\text{kN}}{\text{m}}$$

$$P_{\text{roof_low_windw_underpress}} := q_{\text{roofA_side_underpress}} \cdot \frac{\text{Span_distance}}{2} \dots \quad P_{\text{roof_low_windw_underpress}} = 1.451 \frac{\text{kN}}{\text{m}}$$

$$+ q_{\text{roofB_side_underpress}} \cdot \frac{\text{Span_distance}}{2}$$

$$P_{\text{roof_high_windw_underpress}} := q_{\text{roofC_side_underpress}} \cdot \text{Span_distance} \quad P_{\text{roof_high_windw_underpress}} = 1.322 \frac{\text{kN}}{\text{m}}$$

$$P_{\text{roof_high_leew_underpress}} := q_{\text{roofE_side_underpress}} \cdot \frac{\text{Span_distance}}{2} \dots \quad P_{\text{roof_high_leew_underpress}} = -1.925 \frac{\text{kN}}{\text{m}}$$

$$+ q_{\text{roofF_side_underpress}} \cdot \frac{\text{Span_distance}}{2}$$

$$P_{\text{roof_low_leew_underpress}} := q_{\text{roofG_side_underpress}} \cdot \text{Span_distance} \quad P_{\text{roof_low_leew_underpress}} = -0.585 \frac{\text{kN}}{\text{m}}$$

Wind load normal to the gablewall of the structure.

$$\begin{array}{lll}
 b = 10.18 \text{ m} & \text{zone}_{\text{wallA}} := b_{0.2} & \text{zone}_{\text{wallA}} = 2.036 \text{ m} \\
 b_{0.2} = 2.036 \text{ m} & \text{zone}_{\text{wallB}} := b - b_{0.2} & \text{zone}_{\text{wallB}} = 8.144 \text{ m} \\
 b_{10} = 1.018 \text{ m} & \text{zone}_{\text{roofAB}} := b_{10} & \text{zone}_{\text{roofAB}} = 1.018 \text{ m} \\
 & \text{zone}_{\text{roofC}} := \frac{b}{2} - b_{10} & \text{zone}_{\text{roofC}} = 4.072 \text{ m}
 \end{array}$$

Overpressure

$$P_{\text{sidewall_overpress}} := q_{\text{sidewallB_overpress}} \cdot \text{Span_distance}$$

$$P_{\text{sidewall_overpress}} = -2.065 \frac{\text{kN}}{\text{m}}$$

$$P_{\text{roofC_overpress}} := q_{\text{roofC_overpress}} \cdot \text{Span_distance}$$

$$P_{\text{roofC_overpress}} = -1.546 \frac{\text{kN}}{\text{m}}$$

Underpressure

$$P_{\text{sidewall_underpress}} := q_{\text{sidewallB_underpress}} \cdot \text{Span_distance}$$

$$P_{\text{sidewall_underpress}} = -1.361 \frac{\text{kN}}{\text{m}}$$

$$P_{\text{roofC_underpress}} := q_{\text{roofC_underpress}} \cdot \text{Span_distance}$$

$$P_{\text{roofC_underpress}} = -0.842 \frac{\text{kN}}{\text{m}}$$

3. Materials.

3.1. Properties.

$\gamma_M := 1.2$	partial safety factor
$\gamma_{Mb} := 1.2$	partial safety factor for bolts and pins
$\gamma_{Mr} := 1.2$	partial safety factor for rivets

3.2. Aluminium.

Quality = 6061 T6.

Yield stress	$R_{e_alu} := 240 \cdot \frac{N}{mm^2}$
Tensile strength	$R_{t_alu} := 260 \cdot \frac{N}{mm^2}$
Modulus of elasticity	$E_{alu} := 70000 \cdot \frac{N}{mm^2}$
Admissible stress	$\sigma_{adm_alu} := \frac{R_{e_alu}}{\gamma_M}$

3.3. Aluminium profile.

Aluminium hollow cross-section

	ALU 240/100/3	ALU 240+232
Wall thickness	$t_{\text{alu240}} := 3 \cdot \text{mm}$	$t_{\text{alu240232}} := 7.5 \cdot \text{mm}$
Depth of web element	$d_{\text{alu240}} := 168 \text{mm}$	$d_{\text{alu240232}} := 162 \text{mm}$
Width	$b := 100 \text{mm}$	$b := 100 \text{mm}$
Height	$h := 240 \text{mm}$	$h := 240 \text{mm}$
Section	$A_{\text{alu240}} := 2320 \cdot \text{mm}^2$	$A_{\text{alu240232}} := 4691 \cdot \text{mm}^2$
Moment of inertia in the y-direction	$I_{y_{\text{alu240}}} := 1.67 \cdot 10^7 \cdot \text{mm}^4$	$I_{y_{\text{alu240232}}} := 3.29 \cdot 10^7 \cdot \text{mm}^4$
Moment of inertia in the z-direction	$I_{z_{\text{alu240}}} := 3.90 \cdot 10^6 \cdot \text{mm}^4$	$I_{z_{\text{alu240232}}} := 6.59 \cdot 10^6 \cdot \text{mm}^4$
Height of the profile in y-direction	$y_{y_{\text{alu240}}} := 120 \cdot \text{mm}$	$y_{y_{\text{alu240232}}} := 120 \cdot \text{mm}$
Height of the profile in z-direction	$y_{z_{\text{alu240}}} := 50 \cdot \text{mm}$	$y_{z_{\text{alu240232}}} := 50 \cdot \text{mm}$
Elastic resistance in the y-direction	$W_{\text{ely}_{\text{alu240}}} := 1.40 \cdot 10^5 \cdot \text{mm}^3$	$W_{\text{ely}_{\text{alu240232}}} := 2.74 \cdot 10^5 \cdot \text{mm}^3$
Elastic resistance in the z-direction	$W_{\text{elz}_{\text{alu240}}} := 7.79 \cdot 10^4 \cdot \text{mm}^3$	$W_{\text{elz}_{\text{alu240232}}} := 1.32 \cdot 10^5 \cdot \text{mm}^3$
Plastic resistance in the y-direction	$W_{\text{ply}_{\text{alu240}}} := 1.79 \cdot 10^5 \cdot \text{mm}^3$	$W_{\text{ply}_{\text{alu240232}}} := 3.57 \cdot 10^5 \cdot \text{mm}^3$
Plastic resistance in the z-direction	$W_{\text{plz}_{\text{alu240}}} := 9.04 \cdot 10^4 \cdot \text{mm}^3$	$W_{\text{plz}_{\text{alu240232}}} := 1.63 \cdot 10^5 \cdot \text{mm}^3$

$$t_{\text{alu}}(\text{profile}) := \begin{cases} t_{\text{alu240}} & \text{if profile} = 1 \\ t_{\text{alu240232}} & \text{if profile} = 2 \end{cases}$$

$$d_{\text{alu}}(\text{profile}) := \begin{cases} d_{\text{alu240}} & \text{if profile} = 1 \\ d_{\text{alu240232}} & \text{if profile} = 2 \end{cases}$$

$$A_{\text{alu}}(\text{profile}) := \begin{cases} A_{\text{alu240}} & \text{if profile} = 1 \\ A_{\text{alu240232}} & \text{if profile} = 2 \end{cases}$$

$$y_{y_alu}(\text{profile}) := \begin{cases} y_{y_alu240} & \text{if profile} = 1 \\ y_{y_alu240232} & \text{if profile} = 2 \end{cases}$$

$$y_{z_alu}(\text{profile}) := \begin{cases} y_{z_alu240} & \text{if profile} = 1 \\ y_{z_alu240232} & \text{if profile} = 2 \end{cases}$$

$$I_{y_alu}(\text{profile}) := \begin{cases} I_{y_alu240} & \text{if profile} = 1 \\ I_{y_alu240232} & \text{if profile} = 2 \end{cases}$$

$$I_{z_alu}(\text{profile}) := \begin{cases} I_{z_alu240} & \text{if profile} = 1 \\ I_{z_alu240232} & \text{if profile} = 2 \end{cases}$$

$$W_{\text{ply}}(\text{profile}) := \begin{cases} W_{\text{ply_alu240}} & \text{if profile} = 1 \\ W_{\text{ply_alu240232}} & \text{if profile} = 2 \end{cases}$$

$$W_{\text{plz}}(\text{profile}) := \begin{cases} W_{\text{plz_alu240}} & \text{if profile} = 1 \\ W_{\text{plz_alu240232}} & \text{if profile} = 2 \end{cases}$$

$$W_{\text{ely}}(\text{profile}) := \begin{cases} W_{\text{ely_alu240}} & \text{if profile} = 1 \\ W_{\text{ely_alu240232}} & \text{if profile} = 2 \end{cases}$$

$$W_{\text{elz}}(\text{profile}) := \begin{cases} W_{\text{elz_alu240}} & \text{if profile} = 1 \\ W_{\text{elz_alu240232}} & \text{if profile} = 2 \end{cases}$$

$$\text{prof}_{\text{control}}(\text{profile}) := \begin{cases} \text{"alu240/100"} & \text{if profile} = 1 \\ \text{"alu240+232"} & \text{if profile} = 2 \end{cases}$$

3.4. Stability formulas.

Bending and axiale compression

Profil classification

$$\beta(\text{profile}) := 0.40 \cdot \left(\frac{d_{\text{alu}}(\text{profile})}{t_{\text{alu}}(\text{profile})} \right) \quad \text{Slenderness parameter (art.5.4.3)}$$

$$\varepsilon := \sqrt{\frac{250 \cdot \frac{N}{\text{mm}^2}}{R_{e_alu}}} \quad \varepsilon = 1.021$$

$$\beta_1 := 11 \cdot \varepsilon \quad \beta_1 = 11.227 \quad \text{Table 5.1 (heat treated, unwelded)}$$

$$\beta_2 := 16 \cdot \varepsilon \quad \beta_2 = 16.33$$

$$\beta_3 := 22 \cdot \varepsilon \quad \beta_3 = 22.454$$

$$\text{classification}(\text{profile}) := \begin{cases} 1 & \text{if } \beta(\text{profile}) \leq \beta_1 \\ 2 & \text{if } \beta_1 < \beta(\text{profile}) \leq \beta_2 \\ 3 & \text{if } \beta_2 < \beta(\text{profile}) \leq \beta_3 \\ 4 & \text{if } \beta_3 < \beta(\text{profile}) \end{cases} \quad \langle 3.1 \rangle$$

Profile properties

Shape factor (table 5.3, no welding)

$$\alpha_y(\text{profile}) := \begin{cases} \frac{W_{\text{ply}}(\text{profile})}{W_{\text{ely}}(\text{profile})} & \text{if } \text{classification}(\text{profile}) = 1 \vee 2 \\ \left[1 + \frac{\beta_3 - \beta(\text{profile})}{\beta_3 - \beta_2} \cdot \left(\frac{W_{\text{ply}}(\text{profile})}{W_{\text{ely}}(\text{profile})} - 1 \right) \right] & \text{if } \text{classification}(\text{profile}) = 3 \end{cases} \quad \langle 3.2 \rangle \quad \text{form 5.15}$$

$$\alpha_z(\text{profile}) := \begin{cases} \min \left(1.25, \frac{W_{\text{plz}}(\text{profile})}{W_{\text{elz}}(\text{profile})} \right) & \text{if } \text{classification}(\text{profile}) = 1 \vee 2 \\ \min \left[1.25, 1 + \frac{\beta_3 - \beta(\text{profile})}{\beta_3 - \beta_2} \cdot \left(\frac{W_{\text{plz}}(\text{profile})}{W_{\text{elz}}(\text{profile})} - 1 \right) \right] & \text{if } \text{classification}(\text{profile}) = 3 \end{cases}$$

ENV 1999-1-1, art. 5.9.4(6): Profile capacity

$$N_{rd}(\text{profile}) := A_{\text{alu}}(\text{profile}) \cdot \frac{R_{e_alu}}{\gamma_M} \quad \langle 3.3 \rangle$$

$$M_{yrd}(\text{profile}) := \frac{\alpha_y(\text{profile}) \cdot W_{ely}(\text{profile}) \cdot R_{e_alu}}{\gamma_M}$$

$$M_{zrd}(\text{profile}) := \frac{\alpha_z(\text{profile}) \cdot W_{elz}(\text{profile}) \cdot R_{e_alu}}{\gamma_M}$$

Buckling control

Hollow cross sections (art. 5.9.4.2(4))

$$\psi_c := 0.8$$

$$\omega\omega := 1.0 \quad \omega\alpha := 1.0 \quad \text{for beams without localized welds}$$

Buckling stress (art. 5.8.4.1)

$$\alpha := 0.20 \quad \text{Values of imperfection factor (table 5.6, heat treated)}$$

$$\lambda\omega := 0.1 \quad \text{Values of imperfection factor (table 5.6, heat treated)}$$

$$\eta := 1.0$$

Slenderness :

$$\lambda_1 := \pi \cdot \sqrt{\frac{E_{\text{alu}}}{\eta \cdot R_{e_alu}}} \quad \lambda_1 = 53.653$$

$$\lambda_y(\text{profile}, k_y, L_y) := \frac{k_y \cdot L_y}{\sqrt{\frac{I_{y_alu}(\text{profile})}{A_{\text{alu}}(\text{profile})}}} \quad \lambda_z(\text{profile}, k_z, L_z) := \frac{k_z \cdot L_z}{\sqrt{\frac{I_{z_alu}(\text{profile})}{A_{\text{alu}}(\text{profile})}}} \quad \langle 3.4 \rangle$$

$$\lambda_{by}(\text{profile}, k_y, L_y) := \frac{\lambda_y(\text{profile}, k_y, L_y)}{\lambda_1} \quad \lambda_{bz}(\text{profile}, k_z, L_z) := \frac{\lambda_z(\text{profile}, k_z, L_z)}{\lambda_1} \quad \langle 3.5 \rangle$$

Reduction coefficients :

$$\phi_y(\text{profile}, k_y, L_y) := 0.5 \cdot \left[1 + \alpha \cdot (\lambda_{by}(\text{profile}, k_y, L_y) - \lambda\omega) + \lambda_{by}(\text{profile}, k_y, L_y)^2 \right] \quad \langle 3.6 \rangle$$

$$\phi_z(\text{profile}, k_z, L_z) := 0.5 \cdot \left[1 + \alpha \cdot (\lambda_{bz}(\text{profile}, k_z, L_z) - \lambda\omega) + \lambda_{bz}(\text{profile}, k_z, L_z)^2 \right]$$

$$\chi_y(\text{profile}, k_y, L_y) := \frac{1}{\phi_y(\text{profile}, k_y, L_y) + \sqrt{\phi_y(\text{profile}, k_y, L_y)^2 - \lambda_{by}(\text{profile}, k_y, L_y)^2}} \quad \text{form 5.33} \quad \langle 3.7 \rangle$$

$$\chi_z(\text{profile}, k_z, L_z) := \frac{1}{\phi_z(\text{profile}, k_z, L_z) + \sqrt{\phi_z(\text{profile}, k_z, L_z)^2 - \lambda_{bz}(\text{profile}, k_z, L_z)^2}} \quad \text{form 5.33}$$

$$\chi_{\min}(\text{profile}, k_y, k_z, L_y, L_z) := \min(\chi_y(\text{profile}, k_y, L_y), \chi_z(\text{profile}, k_z, L_z))$$

$$\text{buckling}(\text{profile}, k_y, k_z, L_y, L_z, N_{Ed}, M_{yEd}, M_{zEd}) := \left(\frac{N_{Ed}}{\chi_{\min}(\text{profile}, k_y, k_z, L_y, L_z) \cdot \omega \cdot N_{rd}(\text{profile})} \right)^{\psi_c} \dots \quad \text{form 5.46}$$

$$+ \left(\frac{1}{\omega} \right) \cdot \left[\left(\frac{M_{yEd}}{M_{yrd}(\text{profile})} \right)^{1.7} \dots \right]^{0.6} \quad \langle 3.8 \rangle$$

$$\left[+ \left(\frac{M_{zEd}}{M_{zrd}(\text{profile})} \right)^{1.7} \right]$$

Bending and axial tension

Hollow cross sections (art. 5.9.3.3(1))

$$\psi := 1.3$$

$$\omega = 1$$

$$\text{equation}(\text{profile}, N_{Ed}, M_{yEd}, M_{zEd}) := \left[\left(\frac{N_{Ed}}{\omega \cdot N_{rd}(\text{profile})} \right)^{\psi} \dots \right] \quad \text{form 5.43}$$

$$\left[+ \left[\left(\frac{M_{yEd}}{\omega \cdot M_{yrd}(\text{profile})} \right)^{1.7} + \left(\frac{M_{zEd}}{\omega \cdot M_{zrd}(\text{profile})} \right)^{1.7} \right]^{0.6} \right] \quad \langle 3.9 \rangle$$

Stress

$$\sigma_s(\text{profile}, N_{Ed}, M_{yEd}, M_{zEd}) := \frac{N_{Ed}}{A_{\text{alu}}(\text{profile})} + \frac{M_{yEd} \cdot y_{y_alu}(\text{profile})}{I_{y_alu}(\text{profile})} + \frac{M_{zEd} \cdot y_{z_alu}(\text{profile})}{I_{z_alu}(\text{profile})} \quad \langle 3.10 \rangle$$

4. Control of the main profiles.

4.1. Foot : alu240

$k_y := 1.0$ $k_z := 1.0$ buckling factor

$L_y := 2.65\text{m}$ Buckling length of the foot profile in the strong direction

$L_z := 2.65\text{m}$ Buckling length of the foot profile in the weak direction

profile := 1

prof_control(profile) = "alu240/100"

classification(profile) = 3 <3.1>

Shape factor :

$\alpha_{y_prof} = 1.002$ $\alpha_{z_prof} = 1.001$ <3.2>

Profile capacity :

$N_{rd_prof} = 464\text{ kN}$

$M_{yrd_prof} = 28.068\text{ kN}\cdot\text{m}$ <3.3>

$M_{zrd_prof} = 15.602\text{ kN}\cdot\text{m}$

Slenderness :

$\lambda_{y_prof} = 31.234$ $\lambda_{z_prof} = 64.633$ <3.4>

$\lambda_{by_prof} = 0.582$ $\lambda_{bz_prof} = 1.205$ <3.5>

Reduction coefficient for buckling :

$\phi_{y_prof} = 0.718$ $\phi_{z_prof} = 1.336$ <3.6>

$\chi_{y_prof} = 0.879$ $\chi_{z_prof} = 0.522$ <3.7>

4.1.1 Bending and axial compression (art. 5.9.4)

4.1.1.1 Maximum moment

$$M_y := 10.4 \cdot \text{kN} \cdot \text{m}$$

{comb. 9, member 1, x=1.344m}

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 11.5 \cdot \text{kN}$$

normal force / compression

Buckling control

$$\text{buckling}_{\text{control_unity}} = 0.451$$

<3.8>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{buckling}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 79.687 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.398$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.1.1.2 Maximum normal force

$$M_y := 10.6 \cdot \text{kN} \cdot \text{m}$$

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 11.7 \cdot \text{kN}$$

{comb. 9, member 15, x = 1.344 m}

Buckling control

$$\text{buckling}_{\text{control_unity}} = 0.459$$

<3.8>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{buckling}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 81.211 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.406$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.1.2 Bending and axial traction (art. 5.9.3.3)

4.1.2.1 Maximum moment

$$M_y := 13.5 \cdot \text{kN} \cdot \text{m}$$

{comb. 2, member 1, x = 1.344m}

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 10.7 \cdot \text{kN}$$

normal force / traction

Unity control

$$\text{bending_traction}_{\text{control_unity}} = 0.481$$

<3.9>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{bending_traction}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 101.618 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.508$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.1.2.2 Maximum normal force

$$M_y := 6.2 \cdot \text{kN} \cdot \text{m}$$

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 12.0 \cdot \text{kN}$$

{comb. 4, member 15, x=1.344m}

Unity control

$$\text{bending_traction}_{\text{control_unity}} = 0.223 \quad \langle 3.9 \rangle$$

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{bending_traction}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 49.723 \frac{\text{N}}{\text{mm}^2} \quad \langle 3.10 \rangle$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.249$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.2. Foot : alu240+232

$k_y := 1.0$ $k_z := 1.0$ buckling factor

$L_y := 2.65\text{m}$ Buckling length of the foot profile in the strong direction

$L_z := 2.65\text{m}$ Buckling length of the foot profile in the weak direction

profile := 2

prof_control(profile) = "alu240+232"

classification(profile) = 1 <3.1>

Shape factor :

$\alpha_{y_prof} = 1.303$ $\alpha_{z_prof} = 1.235$ <3.2>

Profile capacity :

$N_{rd_prof} = 938.2\text{kN}$

$M_{yrd_prof} = 71.4\text{kN}\cdot\text{m}$ <3.3>

$M_{zrd_prof} = 32.6\text{kN}\cdot\text{m}$

Slenderness :

$\lambda_{y_prof} = 31.643$ $\lambda_{z_prof} = 70.703$ <3.4>

$\lambda_{by_prof} = 0.59$ $\lambda_{bz_prof} = 1.318$ <3.5>

Reduction coefficient for buckling :

$\phi_{y_prof} = 0.723$ $\phi_{z_prof} = 1.49$ <3.6>

$\chi_{y_prof} = 0.876$ $\chi_{z_prof} = 0.458$ <3.7>

4.2.1 Bending and axial compression (art. 5.9.4)

4.2.1.1 Maximum moment

$$M_y := 20.6 \cdot \text{kN} \cdot \text{m}$$

{comb. 9, member 16, x=1.305m}

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 11.7 \cdot \text{kN}$$

normal force / compression

Buckling control

$$\text{buckling}_{\text{control_unity}} = 0.337$$

<3.8>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{buckling}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 77.631 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.388$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.2.1.2 Maximum normal force

$$M_y := 20.6 \cdot \text{kN} \cdot \text{m}$$

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 11.7 \cdot \text{kN}$$

{comb. 9, member 16, x = 1.305m}

Buckling control

$$\text{buckling}_{\text{control_unity}} = 0.337$$

<3.8>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{buckling}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 77.631 \frac{\text{N}}{\text{mm}^2}$$

<3.10>

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.388$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.2.2 Bending and axial traction (art. 5.9.3.3)

4.2.2.1 Maximum moment

$$M_y := 23.1 \cdot \text{kN} \cdot \text{m}$$

{comb. 2, member 2, x = 1.305m}

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 10.7 \cdot \text{kN}$$

normal force / traction

Unity control

$$\text{bending_traction}_{\text{control_unity}} = 0.319$$

<3.9>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{bending_traction}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 86.536 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.433$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.2.2.2 Maximum normal force

$$M_y := 7.3 \cdot \text{kN} \cdot \text{m}$$

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 12.0 \cdot \text{kN}$$

{comb. 4, member 16, x=1.305m}

Unity control

$$\text{bending_traction}_{\text{control_unity}} = 0.101 \quad <3.9>$$

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{bending_traction}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 29.184 \frac{\text{N}}{\text{mm}^2} \quad <3.10>$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.146$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.3. Roof : alu240+232

$k_y := 1.0$ $k_z := 1.0$ buckling factor

$L_y := 7.88\text{m}$ Buckling length of the roof profile in the strong direction

$L_z := 2.63\text{m}$ Buckling length of the roof profile in the weak direction (= purlin distance)

profile := 2

prof_control(profile) = "alu240+232"

classification(profile) = 1 <3.1>

Shape factor :

$\alpha_{y_prof} = 1.303$ $\alpha_{z_prof} = 1.235$ <3.2>

Profile capacity :

$N_{rd_prof} = 938.2\text{kN}$

$M_{yrd_prof} = 71.4\text{kN}\cdot\text{m}$ <3.3>

$M_{zrd_prof} = 32.6\text{kN}\cdot\text{m}$

Slenderness :

$\lambda_{y_prof} = 94.094$ $\lambda_{z_prof} = 70.169$ <3.4>

$\lambda_{by_prof} = 1.754$ $\lambda_{bz_prof} = 1.308$ <3.5>

Reduction coefficient for buckling :

$\phi_{y_prof} = 2.203$ $\phi_{z_prof} = 1.476$ <3.6>

$\chi_{y_prof} = 0.283$ $\chi_{z_prof} = 0.463$ <3.7>

4.3.1 Bending and axial compression (art. 5.9.4)

4.3.1.1 Maximum moment

$$M_y := 21.8 \cdot \text{kN} \cdot \text{m}$$

{comb. 7, member 14, x=1.19m}

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 7.7 \cdot \text{kN}$$

normal force / compression

Buckling control

$$\text{buckling}_{\text{control_unity}} = 0.357$$

<3.8>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{buckling}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 81.155 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.406$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.3.1.2 Maximum normal force

$$M_y := 20.6 \cdot \text{kN} \cdot \text{m}$$

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 10.7 \cdot \text{kN}$$

{comb. 9, member 14, x = 1.19m}

Buckling control

$$\text{buckling}_{\text{control_unity}} = 0.358$$

<3.8>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{buckling}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 77.418 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.387$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.3.2 Bending and axial traction (art. 5.9.3.3)

4.3.2.1 Maximum moment

$$M_y := 23.1 \cdot \text{kN} \cdot \text{m}$$

{comb. 2, member 3, x = 0.0m}

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 9.1 \cdot \text{kN}$$

normal force / traction

Unity control

$$\text{bending_traction}_{\text{control_unity}} = 0.319$$

<3.9>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{bending_traction}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 86.195 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.431$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.3.2.2 Maximum normal force

$$M_y := 7.7 \cdot \text{kN} \cdot \text{m}$$

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 13.1 \cdot \text{kN}$$

{comb. 4, member 3, x=1.19m}

Unity control

$$\text{bending_traction}_{\text{control_unity}} = 0.107 \quad \langle 3.9 \rangle$$

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{bending_traction}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 30.878 \frac{\text{N}}{\text{mm}^2} \quad \langle 3.10 \rangle$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.154$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.4. Roof : alu240

$k_y := 1.0$ $k_z := 1.0$ buckling factor

$L_y := 7.88\text{m}$ Buckling length of the roof profile in the strong direction

$L_z := 2.63\text{m}$ Buckling length of the roof profile in the weak direction (= purlin distance)

profile := 1

prof_control(profile) = "alu240/100"

classification(profile) = 3 <3.1>

Shape factor :

$\alpha_{y_prof} = 1.002$ $\alpha_{z_prof} = 1.001$ <3.2>

Profile capacity :

$N_{rd_prof} = 464\text{ kN}$

$M_{yrd_prof} = 28.068\text{ kN}\cdot\text{m}$ <3.3>

$M_{zrd_prof} = 15.602\text{ kN}\cdot\text{m}$

Slenderness :

$\lambda_{y_prof} = 92.878$ $\lambda_{z_prof} = 64.146$ <3.4>

$\lambda_{by_prof} = 1.731$ $\lambda_{bz_prof} = 1.196$ <3.5>

Reduction coefficient for buckling :

$\phi_{y_prof} = 2.161$ $\phi_{z_prof} = 1.324$ <3.6>

$\chi_{y_prof} = 0.289$ $\chi_{z_prof} = 0.528$ <3.7>

4.4.1 Bending and axial compression (art. 5.9.4)

4.4.1.1 Maximum moment

$$M_y := 20.9 \cdot \text{kN} \cdot \text{m}$$

{comb. 7, member 13, x=0.964m}

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 7.6 \cdot \text{kN}$$

normal force / compression

Buckling control

$$\text{buckling}_{\text{control_unity}} = 0.841$$

<3.8>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{buckling}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 153.456 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.767$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.4.1.2 Maximum normal force

$$M_y := 11.6 \text{ kN}\cdot\text{m}$$

$$M_z := 0.0 \text{ kN}\cdot\text{m}$$

$$N_v := 10.2 \text{ kN}$$

{comb. 9, member 13, x = 0.964m}

Buckling control

$$\text{buckling}_{\text{control_unity}} = 0.533$$

<3.8>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{buckling}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 87.75 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.439$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.4.2 Bending and axial traction (art. 5.9.3.3)

4.4.2.1 Maximum moment

$$M_y := 7.6 \cdot \text{kN} \cdot \text{m}$$

{comb. 4, member 13, x = 0.964m}

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 13.1 \cdot \text{kN}$$

normal force / traction

Unity control

$$\text{bending_traction}_{\text{control_unity}} = 0.273$$

<3.9>

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{bending_traction}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 60.257 \frac{\text{N}}{\text{mm}^2} \quad \text{<3.10>}$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.301$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

4.4.2.2 Maximum normal force

$$M_y := 1.5 \cdot \text{kN} \cdot \text{m}$$

$$M_z := 0.0 \cdot \text{kN} \cdot \text{m}$$

$$N_v := 13.5 \cdot \text{kN}$$

{comb. 4, member 8, x=2.143m}

Unity control

$$\text{bending_traction}_{\text{control_unity}} = 0.06 \quad \langle 3.9 \rangle$$

$$\text{control} := \begin{cases} \text{"OK"} & \text{if } \text{bending_traction}_{\text{control_unity}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{control} = \text{"OK"}$$

Stress control

$$\sigma_{\text{control}} = 16.597 \frac{\text{N}}{\text{mm}^2} \quad \langle 3.10 \rangle$$

$$\frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} = 0.083$$

$$\text{stress} := \begin{cases} \text{"OK"} & \text{if } \frac{\sigma_{\text{control}}}{\sigma_{\text{adm_alu}}} \leq 1.0 \\ \text{"NOK"} & \text{otherwise} \end{cases}$$

$$\text{stress} = \text{"OK"}$$

5. Conclusion.

The relocatable Alu 15m structure, manufactured by EFS N.V., Veldeman Tent Technology in Bree Belgium complies with the stiputations of the British Standard 6399, under the following conditions:

- basic windspeed = **25m/s**
- effective windspeed = **31m/s**
- ground snowload = **20kg/m²**
- the structure is good anchored to the ground and is completely closed.

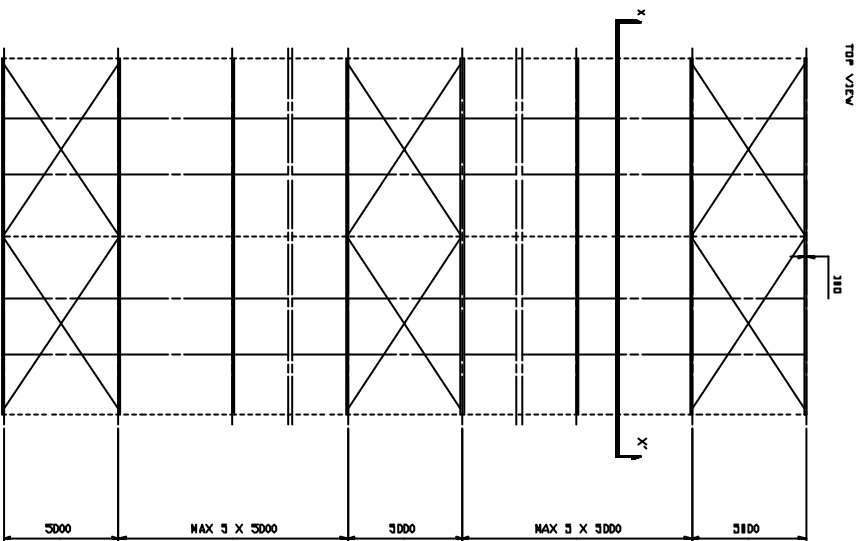
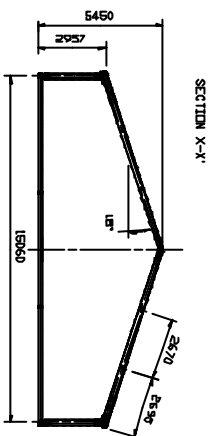
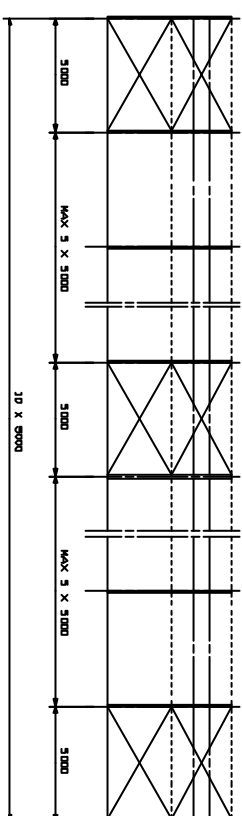
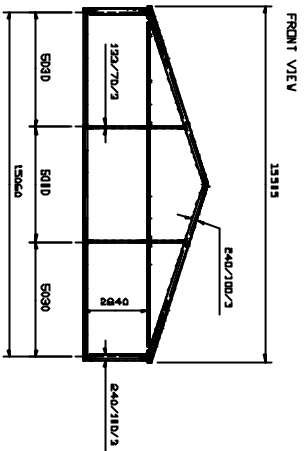
The relocatable Alu 12m structure, manufactured by EFS N.V., complies consequently with the stipulations of the BS 6399, because the same profiles bear the same loads on a smaller span.




Bree, April 6, 2006

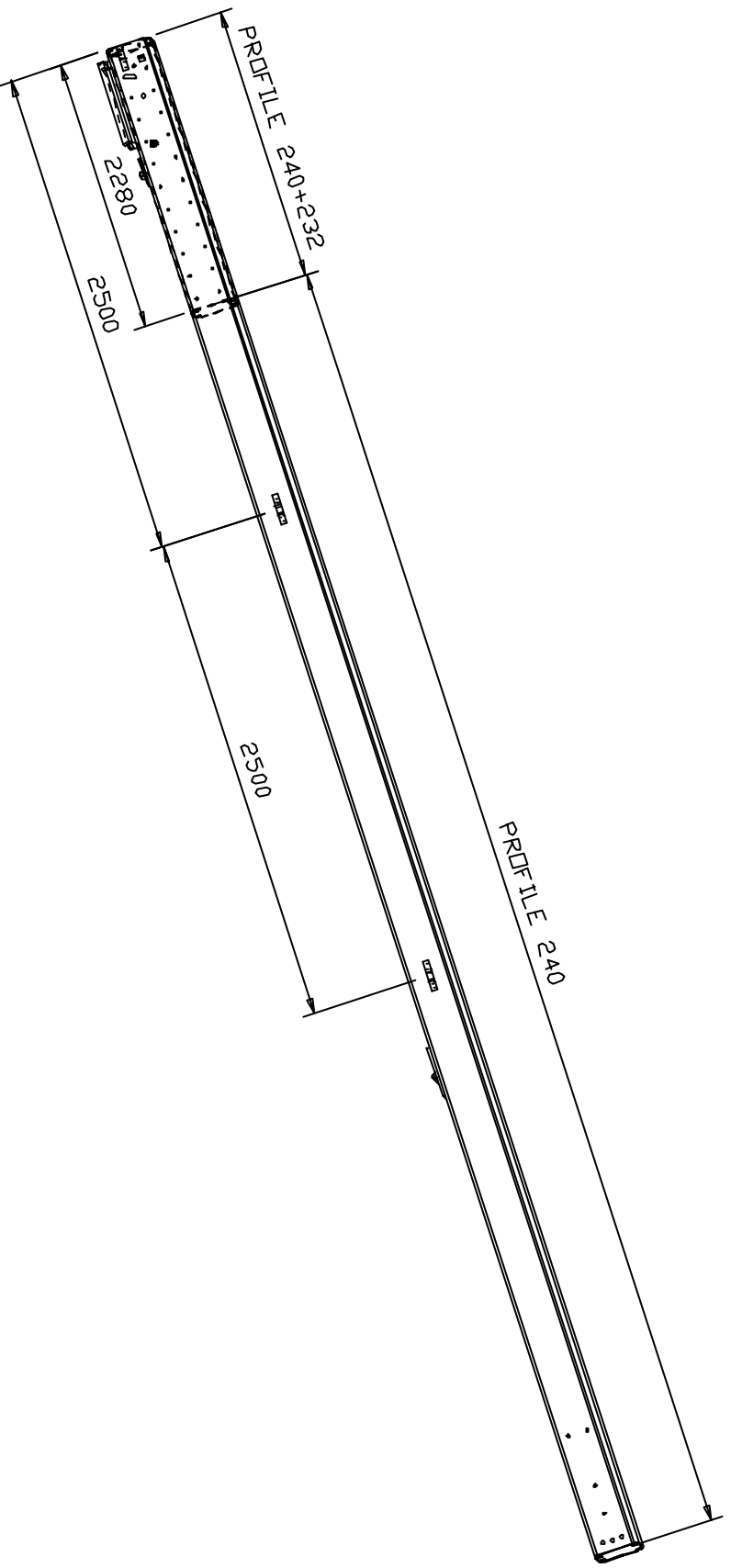
for EFS nv,
Veldeman Tent Technology


ENCLOSURE 1 :

Drawings of the ALU structure 15m




 PT. SANGREKA KAWAN TINT TEMPERALY		DENGERA VELOSIAN NAY-GA RUMAH SANGREKA KAWAN JALAN SANGREKA KAWAN NO. 100 50000	
TEMPORARY TENTCONSTRUCTION ALUS/2/8			
GENERAL VIEW			
PERIOD 03/01/20		ALU 13H	BALISE01
SKALA 1:100		ALU 13H	BALISE01

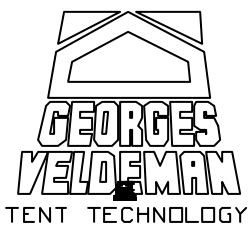
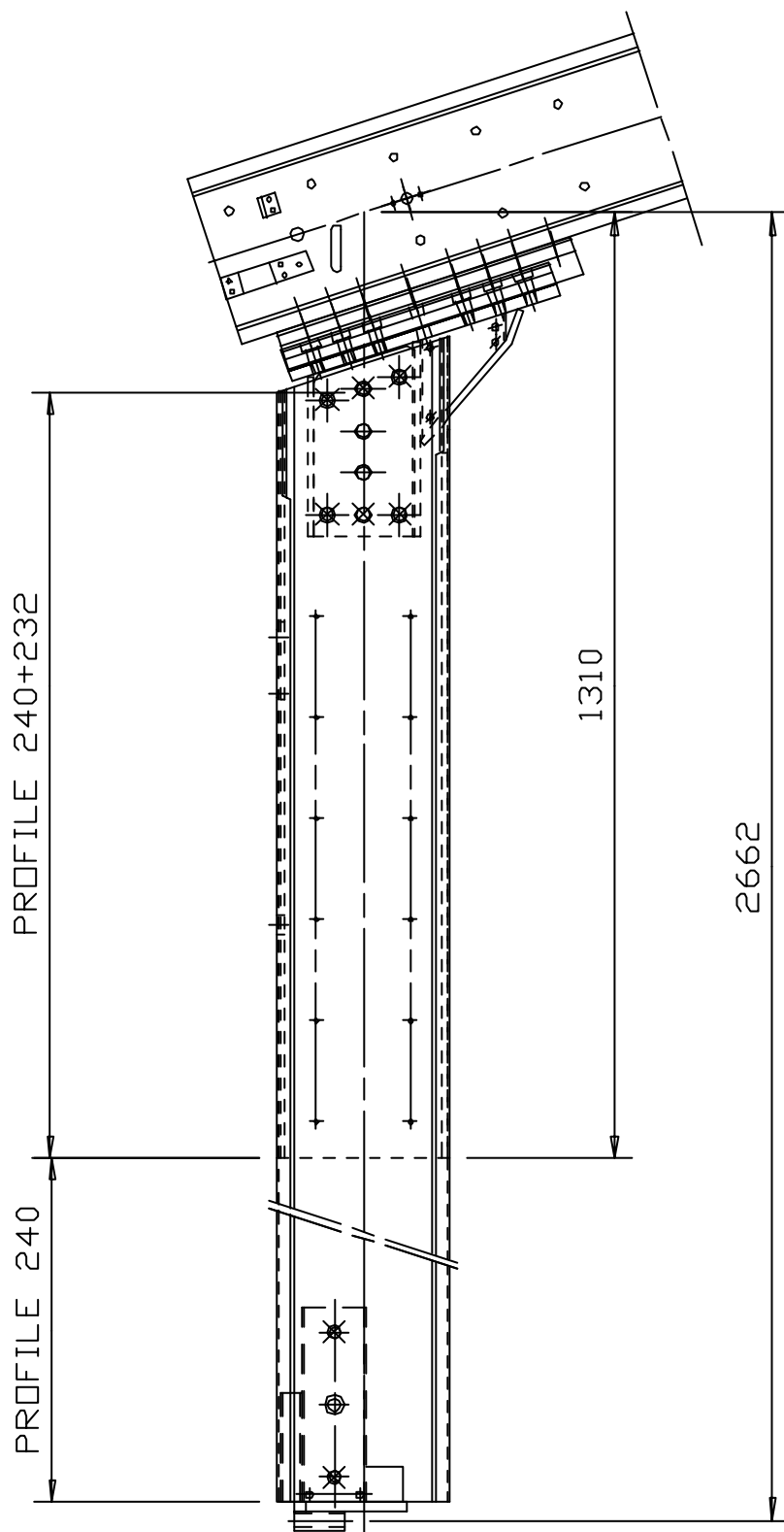



GEORGES
VELDEMAN
 TENT TECHNOLOGY

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 Industriëlezone "Vorstert", P.831
 B-3360 BREE (BELGIUM)
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 Fax: (089) 473777

ROOF TRUSS

PROJEKTION		
MASSSTAB	A4	
DATUM	08/07/05	
	eb	
KODENR.	BAL15E02	ALU 15M



GEORGES VELDEMAN N.V.-S.A.

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 Telex : 39 246 gvelde b
 Fax : (011) 47.37.77

FOOT TRUSS

PROJECTIE		
SCHAAL		A4
DATUM	08/07/05	EB

ALU 15M

BAL20E03

ENCLOSURE 2 :

**Print out of calculation results of
the Alu 15m structure
by program ESA PRIMA WIN (release 3.50.63).**

ESA-Prima Win release 3.50.63

Project : Alu 15m (+ Alu 12m) BS6399
Author : EFS nv.

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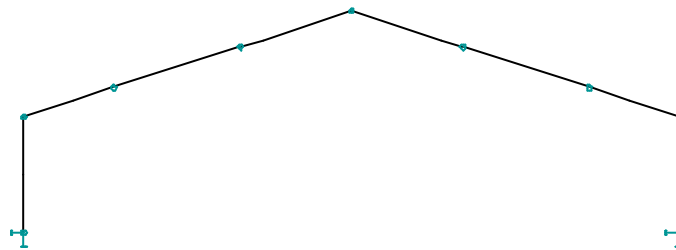
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Basic data**Type of structure : Frame XYZ**

Number of nodes:	17
Number of members:	16
Number of 1D macros:	4
Number of bound. lines:	0
Number of 2D macros:	0
Number of profiles :	7
Number of cases:	13
Number of materials:	2

Material

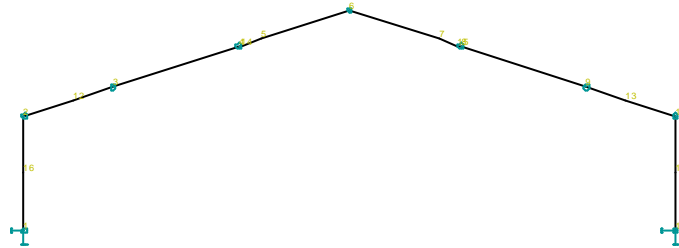
Name:		
6061 T6		
	E modulus	71000.00 MPa
	Poisson coeff.	0.30
	Density	0.000 kg/mm ³
	Extensibility	2.4e-005 mm/mm.K
6x37 +1TWK		
	Ultimate strength	1770.000 MPa
	Yield design	664.000 MPa
	E modulus	80000.00 MPa
	Poisson coeff.	0.30
	Density	0.000 kg/mm ³
	Extensibility	1.2e-005 mm/mm.K

List of material**Group of members :****1/16**

no.	Name:	quality	unit weight kg/mm	length mm	weight kg
1	ALU 240 (General)	6061 T6	0.01	17384.38	108.90
2	ALU240/232 (General)	6061 T6	0.01	3685.00	46.17

The total weight of the structure: 155.06 kg

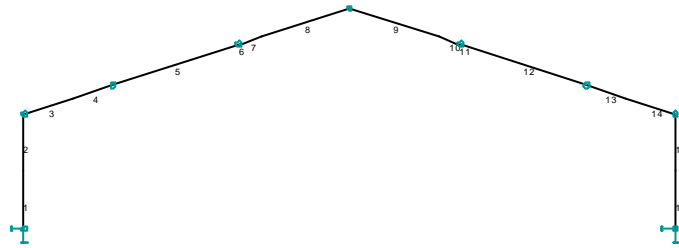
Surface for painting:
 mm²



Nodes

Nodes

node	X mm	Y mm	Z mm
1	0	0	0
2	0	0	2649
3	2048	0	3315
4	4948	0	4258
5	5462	0	4423
6	7500	0	5085
7	9538	0	4423
8	10052	0	4258
9	12952	0	3315
10	15000	0	2649
11	15000	0	0
12	1132	0	3017
13	13868	0	3017
14	5000	0	4274
15	10000	0	4274
16	0	0	1344
17	15000	0	1344



Members

Members

macro	memb	node 1	node 2	length mm	Rx deg	profile	quality
1	1	1	16	1344	0.00	1 - ALU 240 (General)	6061 T6
	2	16	2	1305	0.00	2 - ALU240/232 (General)	6061 T6
2	3	2	12	1190	0.00	2 - ALU240/232 (General)	6061 T6
	4	12	3	964	0.00	1 - ALU 240 (General)	6061 T6
	5	3	4	3049	0.00	1 - ALU 240 (General)	6061 T6
	6	4	14	55	0.00	1 - ALU 240 (General)	6061 T6
	7	14	5	485	0.00	1 - ALU 240 (General)	6061 T6
	8	5	6	2143	0.00	1 - ALU 240 (General)	6061 T6
3	9	6	7	2143	0.00	1 - ALU 240 (General)	6061 T6
	10	7	15	485	0.00	1 - ALU 240 (General)	6061 T6
	11	15	8	55	0.00	1 - ALU 240 (General)	6061 T6
	12	8	9	3049	0.00	1 - ALU 240 (General)	6061 T6
	13	9	13	964	0.00	1 - ALU 240 (General)	6061 T6
	14	13	10	1190	0.00	2 - ALU240/232 (General)	6061 T6
4	15	11	17	1344	0.00	1 - ALU 240 (General)	6061 T6
	16	17	10	1305	0.00	1 - ALU 240 (General)	6061 T6

Profiles



ALU 240 (General)

Profile no. 1 - ALU 240 (General)
 Material : 19 - 6061 T6

A:	2.319993e+003 mm ²		
Ay/A:	1.000	Az/A:	1.000
Iy:	1.675432e+007 mm ⁴	Iz:	3.895877e+006 mm ⁴
Iyz:	3.870310e+000 mm ⁴	It:	2.065020e+007 mm ⁴
Iw:	0.000000e+000 mm ⁶		
Wely:	1.396194e+005 mm ³	Welz:	7.791748e+004 mm ³
Wply:	1.788524e+005 mm ³	Wplz:	9.035651e+004 mm ³
cy:	50.00 mm	cz:	120.00 mm
iy:	84.98 mm	iz:	40.98 mm
dy:	0.00 mm	dz:	0.00 mm
Outline :		0.00 mm	

Type for check: Untypical section



ALU240/232 (General)

Profile no. 2 - ALU240/232 (General)
 Material : 19 - 6061 T6

1	- 6061 T6
2	- 6061 T6

A:	4.690648e+003 mm ²		
Ay/A:	1.000	Az/A:	1.000
Iy:	3.291946e+007 mm ⁴	Iz:	6.585148e+006 mm ⁴
Iyz:	-1.390684e+001 mm ⁴	It:	3.950460e+007 mm ⁴

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A:	4.690648e+003 mm ²		
Iw:	0.000000e+000 mm ⁶		
Wely:	2.743242e+005 mm ³	Welz:	1.317015e+005 mm ³
Wply:	3.570655e+005 mm ³	Wplz:	1.628792e+005 mm ³
cy:	50.00 mm	cz:	120.00 mm
iy:	83.77 mm	iz:	37.47 mm
dy:	0.00 mm	dz:	0.00 mm
Outline :		0.00 mm	

Type for check: Untypical section

Supports

support	node	type	Size mm
1	1	XYZ	0.00
2	2	Y	0.00
3	3	Y	0.00
4	4	Y	0.00
5	6	Y	0.00
6	8	Y	0.00
7	9	Y	0.00
8	10	Y	0.00
9	11	XYZ	0.00

Loadcases

Case	Name:	Description
1	self weight	Self weight. Direction -Z
2	dead load - connections	Permanent - Loads
3	dead load - fabric	Permanent - Loads
4	dead load - purlins	Permanent - Loads
5	dead load - sum	Permanent Summational load case 2. dead load - connections, 1.00 3. dead load - fabric, 1.00 4. dead load - purlins, 1.00
6	wind side over	Variable - wind Excl.
7	wind side under	Variable - wind Excl.
8	wind gable over	Variable - wind Excl.
9	wind gable under	Variable - wind Excl.
10	dead load - extra point load	Permanent - Loads
11	snow load - case 1	Variable - snow Excl.

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Case	Name:	Description
12	snow load - case 2	Variable - snow Excl.
13	snow load - case 3	Variable - snow Excl.

Variable loads group

Name:		Description
snow	Excl.	BS - load type I - imposed load
wind	Excl.	BS - load type W - wind load

Loadcase no. 2 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
2	0.00	0.00	-0.18	0.00	0.00	0.00
6	0.00	0.00	-0.22	0.00	0.00	0.00
10	0.00	0.00	-0.18	0.00	0.00	0.00

Loadcase no. 4 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
2	0.00	0.00	-0.22	0.00	0.00	0.00
3	0.00	0.00	-0.09	0.00	0.00	0.00
4	0.00	0.00	-0.09	0.00	0.00	0.00
6	0.00	0.00	-0.22	0.00	0.00	0.00
8	0.00	0.00	-0.09	0.00	0.00	0.00
9	0.00	0.00	-0.09	0.00	0.00	0.00
10	0.00	0.00	-0.22	0.00	0.00	0.00

Loadcase no. 5 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
2	0.00	0.00	-0.18	0.00	0.00	0.00
6	0.00	0.00	-0.22	0.00	0.00	0.00
10	0.00	0.00	-0.18	0.00	0.00	0.00
2	0.00	0.00	-0.22	0.00	0.00	0.00
3	0.00	0.00	-0.09	0.00	0.00	0.00
4	0.00	0.00	-0.09	0.00	0.00	0.00
6	0.00	0.00	-0.22	0.00	0.00	0.00
8	0.00	0.00	-0.09	0.00	0.00	0.00

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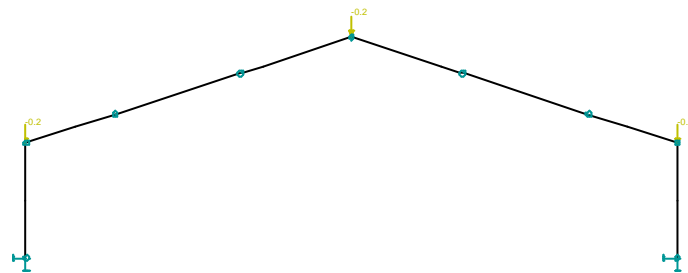
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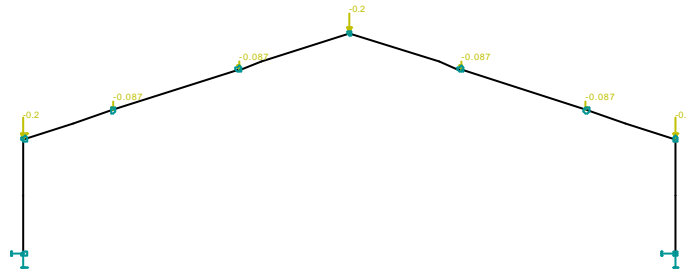
node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
9	0.00	0.00	-0.09	0.00	0.00	0.00
10	0.00	0.00	-0.22	0.00	0.00	0.00

Loadcase no. 10 - nodal loads

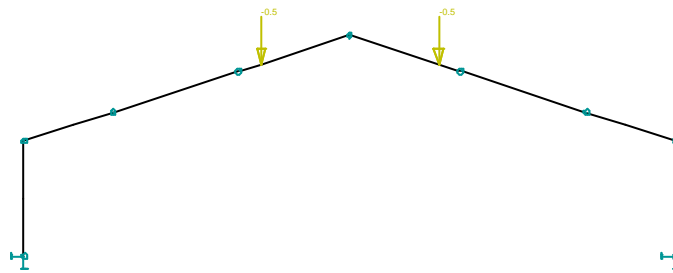
node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
5	0.00	0.00	-0.50	0.00	0.00	0.00
7	0.00	0.00	-0.50	0.00	0.00	0.00



Nodal loads.Loadcases - 2



Nodal loads.Loadcases - 4



Nodal loads.Loadcases - 10

Loadcase no. 3 - distributed loads

macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
2	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.03 -0.03
3	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.03 -0.03

Loadcase no. 5 - distributed loads

macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
2	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.03 -0.03
3	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.03 -0.03

Loadcase no. 6 - distributed loads

macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
1	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	-1.78 -1.78
2	force kN/m	0.00 rel 0.13	0.00	0.00	loc len	0.00 0.00	0.00 0.00	2.22 2.22
	force kN/m	0.13 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	0.93 0.93
3	force kN/m	0.00 rel 0.13	0.00	0.00	loc len	0.00 0.00	0.00 0.00	2.63 2.63
	force kN/m	0.13 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	1.29 1.29
4	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	-1.29 -1.29

Loadcase no. 7 - distributed loads

macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
1	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	-2.48 -2.48
2	force kN/m	0.00 rel 0.13	0.00	0.00	loc len	0.00 0.00	0.00 0.00	-1.45 -1.45
	force kN/m	0.13 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	-1.32 -1.32

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macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
3	force kN/m	0.00 rel 0.13	0.00	0.00	loc len	0.00 0.00	0.00 0.00	1.93 1.93
	force kN/m	0.13 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	0.58 0.58
4	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	-0.59 -0.59

Loadcase no. 8 - distributed loads

macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
1	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	2.06 2.06
2	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	1.55 1.55
3	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	1.55 1.55
4	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	-2.06 -2.06

Loadcase no. 9 - distributed loads

macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
1	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	1.36 1.36
2	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	0.84 0.84
3	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	0.84 0.84
4	force kN/m	0.00 rel 1.00	0.00	0.00	loc len	0.00 0.00	0.00 0.00	-1.36 -1.36

Loadcase no. 10 - distributed loads

macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
2	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.03 -0.03
3	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.03 -0.03

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Date : April 2006**Loadcase no. 11 - distributed loads**

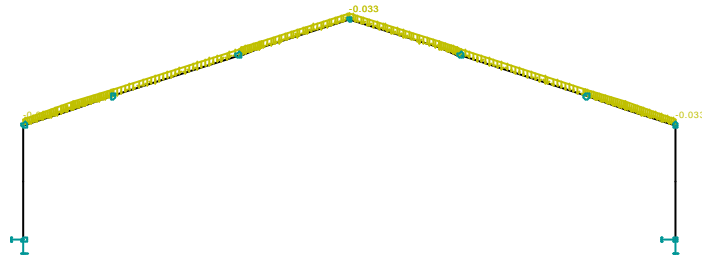
macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
2	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.80 -0.80
3	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.80 -0.80

Loadcase no. 12 - distributed loads

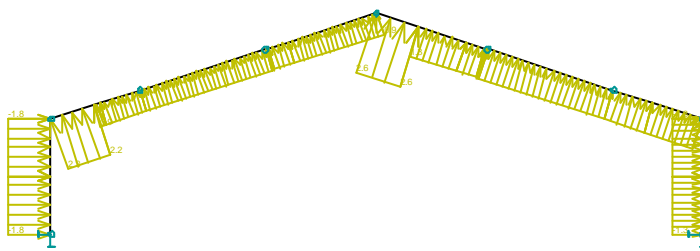
macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
2	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.80 -0.80
3	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.86 -0.86

Loadcase no. 13 - distributed loads

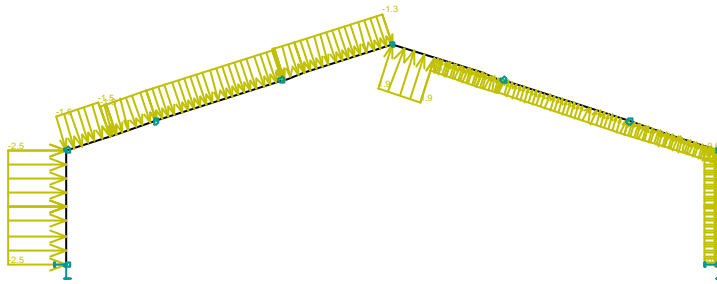
macro	type	dx mm	exY mm	exZ mm		X beg end	Y beg end	Z beg end
3	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-0.40 -0.40



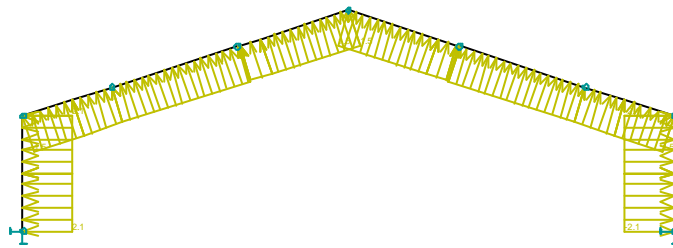
Distributed loads.Loadcases - 3



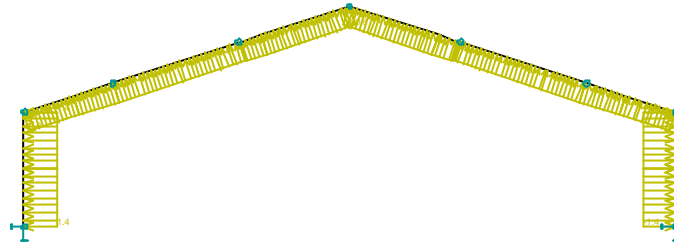
Distributed loads.Loadcases - 6



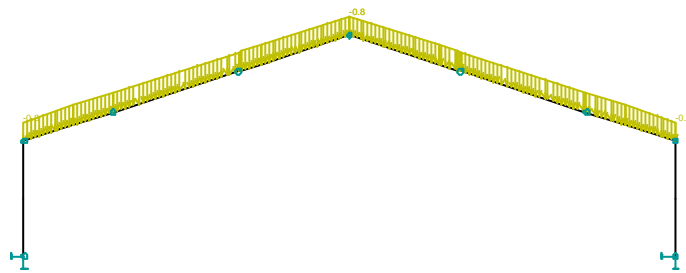
Distributed loads.Loadcases - 7



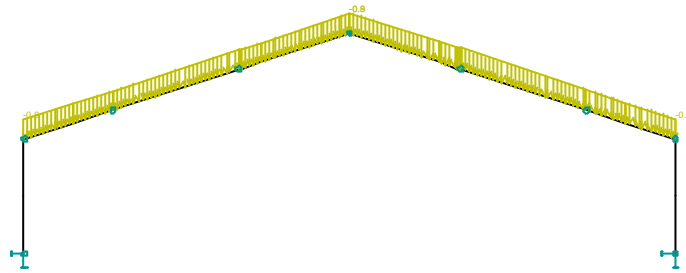
Distributed loads.Loadcases - 8



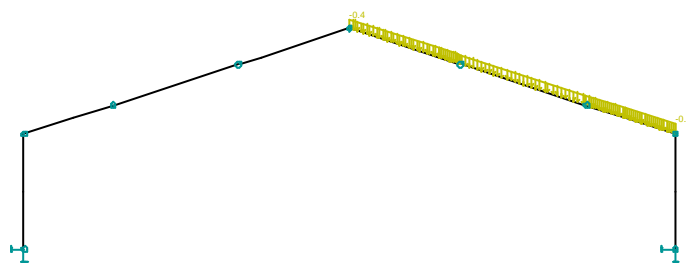
Distributed loads.Loadcases - 9



Distributed loads.Loadcases - 11



Distributed loads.Loadcases - 12



Distributed loads.Loadcases - 13

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Combi	Norm	Case	coeff
1.	User-ultimate	1 self weight	1.20
		5 dead load - sum	1.20
		10 dead load - extra point load	1.20
2.		1 self weight	1.20
		5 dead load - sum	1.20
		10 dead load - extra point load	1.20
		6 wind side over	1.20
		7 wind side under	1.20
		8 wind gable over	1.20
3.		9 wind gable under	1.20
		1 self weight	1.20
		5 dead load - sum	1.20
		10 dead load - extra point load	1.20
		11 snow load - case 1	1.33
		12 snow load - case 2	1.33
4.		13 snow load - case 3	1.33
		1 self weight	0.80
		5 dead load - sum	0.80
5.		10 dead load - extra point load	0.80
		1 self weight	0.80
		5 dead load - sum	0.80
6.		10 dead load - extra point load	0.80
		6 wind side over	1.20
		7 wind side under	1.20
		8 wind gable over	1.20
		9 wind gable under	1.20
		1 self weight	0.80
		5 dead load - sum	0.80
		10 dead load - extra point load	0.80
		11 snow load - case 1	1.33
		12 snow load - case 2	1.33
		13 snow load - case 3	1.33

Basic rules for generation of ultimate load combinations:

- 1 : 1.20*LC1 / 1.20*LC5 / 1.20*LC10
2 : 1.20*LC1 / 1.20*LC5 / 1.20*LC10 / 1.20*LC6 / 1.20*LC7 / 1.20*LC8 / 1.20*LC9
3 : 1.20*LC1 / 1.20*LC5 / 1.20*LC10 / 1.33*LC11 / 1.33*LC12 / 1.33*LC13
4 : 0.80*LC1 / 0.80*LC5 / 0.80*LC10
5 : 0.80*LC1 / 0.80*LC5 / 0.80*LC10 / 1.20*LC6 / 1.20*LC7 / 1.20*LC8 / 1.20*LC9
6 : 0.80*LC1 / 0.80*LC5 / 0.80*LC10 / 1.33*LC11 / 1.33*LC12 / 1.33*LC13

List of extreme ultimate load combinations

- 1/ 1 : +1.20*LC1+1.20*LC5+1.20*LC10

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- 2/ 5 : +0.80*LC1+0.80*LC5+1.20*LC6+0.80*LC10
- 3/ 5 : +0.80*LC1+0.80*LC5+1.20*LC7+0.80*LC10
- 4/ 5 : +0.80*LC1+0.80*LC5+1.20*LC8+0.80*LC10
- 5/ 6 : +0.80*LC1+0.80*LC5+0.80*LC10+1.33*LC13
- 6/ 2 : +1.20*LC1+1.20*LC5+1.20*LC6+1.20*LC10
- 7/ 2 : +1.20*LC1+1.20*LC5+1.20*LC7+1.20*LC10
- 8/ 2 : +1.20*LC1+1.20*LC5+1.20*LC8+1.20*LC10
- 9/ 3 : +1.20*LC1+1.20*LC5+1.20*LC10+1.33*LC12
- 10/ 3 : +1.20*LC1+1.20*LC5+1.20*LC10+1.33*LC13

Nonlinear combination

Combi	Group of init. deformations	dx mm/m	dy mm/m	Group of init. curvatures	Case	coeff
C 1	0	0.00	0.00	0	1 self weight	1.20
	0	0.00	0.00	0	5 dead load - sum	1.20
	0	0.00	0.00	0	10 dead load - extra point load	1.20
C 2	0	0.00	0.00	0	1 self weight	0.80
	0	0.00	0.00	0	5 dead load - sum	0.80
	0	0.00	0.00	0	6 wind side over	1.20
	0	0.00	0.00	0	10 dead load - extra point load	0.80
C 3	0	0.00	0.00	0	1 self weight	0.80
	0	0.00	0.00	0	5 dead load - sum	0.80
	0	0.00	0.00	0	7 wind side under	1.20
	0	0.00	0.00	0	10 dead load - extra point load	0.80
C 4	0	0.00	0.00	0	1 self weight	0.80
	0	0.00	0.00	0	5 dead load - sum	0.80
	0	0.00	0.00	0	8 wind gable over	1.20
	0	0.00	0.00	0	10 dead load - extra point load	0.80
C 5	0	0.00	0.00	0	1 self weight	0.80
	0	0.00	0.00	0	5 dead load - sum	0.80
	0	0.00	0.00	0	10 dead load - extra point load	0.80
	0	0.00	0.00	0	13 snow load - case 3	1.33
C 6	0	0.00	0.00	0	1 self weight	1.20
	0	0.00	0.00	0	5 dead load - sum	1.20
	0	0.00	0.00	0	6 wind side over	1.20
	0	0.00	0.00	0	10 dead load - extra point load	1.20
C 7	0	0.00	0.00	0	1 self weight	1.20
	0	0.00	0.00	0	5 dead load - sum	1.20
	0	0.00	0.00	0	7 wind side under	1.20
	0	0.00	0.00	0	10 dead load - extra point load	1.20
C 8	0	0.00	0.00	0	1 self weight	1.20
	0	0.00	0.00	0	5 dead load - sum	1.20
	0	0.00	0.00	0	8 wind gable over	1.20
	0	0.00	0.00	0	10 dead load - extra point load	1.20
C 9	0	0.00	0.00	0	1 self weight	1.20
	0	0.00	0.00	0	5 dead load - sum	1.20

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Combi	Group of init. deformations	dx mm/m	dy mm/m	Group of init. curvatures	Case	coeff
	0	0.00	0.00	0	10 dead load - extra point load	1.20
	0	0.00	0.00	0	12 snow load - case 2	1.33
C 10	0	0.00	0.00	0	1 self weight	1.20
	0	0.00	0.00	0	5 dead load - sum	1.20
	0	0.00	0.00	0	10 dead load - extra point load	1.20
	0	0.00	0.00	0	13 snow load - case 3	1.33

Internal forces: foot alu240

Group of member(s) :1,15

Group of nonlinear combination(s):1/10

memb	cr.nr	non. c.	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
15	1	4	1344.0	12.0	0.0	-6.3	0.0	-6.2	0.0
		9	0.0	-11.8	0.0	7.9	0.0	0.0	0.0
1		2	1344.0	10.7	0.0	8.7	0.0	13.5	0.0
		9		-11.5	-0.0	-7.7	0.0	-10.4	-0.0

Internal forces: foot alu240+232

Group of member(s) :2,16

Group of nonlinear combination(s):1/10

memb	cr.nr	non. c.	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
16	1	4	163.1	12.0	-0.0	-6.7	0.0	-7.3	-0.0
		9	1305.0	-11.7	0.0	7.6	0.0	20.6	0.0
2	2	2		10.7	0.0	6.0	0.0	23.1	0.0
		9		-11.4	-0.0	-7.6	0.0	-20.5	-0.0

Internal forces: roof alu240+232

Group of member(s) :3,14

Group of nonlinear combination(s):1/10

memb	cr.nr	non. c.	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
3	2	4	1190.0	13.1	0.0	-6.6	0.0	7.7	0.0
14		9		-10.7	-0.0	-8.4	0.0	-20.6	-0.0
3		2	0.0	9.1	0.0	-8.6	0.0	23.1	0.0
14		7	1190.0	-7.7	-0.0	-0.4	0.0	-21.8	-0.0

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Internal forces: roof alu240

Group of member(s) : 4/5,7/10,12/13

Group of nonlinear combination(s) : 1/10

memb	cr.nr	non. c.	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
8	1	4	2142.8	13.5	0.0	4.6	0.0	1.5	0.0
13		9	963.6	-10.2	0.0	-6.9	0.0	-11.6	0.0
5		7	1284.0	-2.8	0.0	-0.1	0.0	19.3	0.0
13			963.6	-7.6	0.0	-1.1	0.0	-20.9	0.0

Reactions in support(s) - nodal values. Global extreme

Nonlinear calculation, local nonlinearities, II. order

Group of node(s) : 1/17

Group of nonlinear combination(s) : 1/10

support	node	non. c.	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	1	9	7.6	0.0	11.7	0.0	0.0	0.0
		2	-11.8	0.0	-10.3	0.0	0.0	0.0
9	11	9	-7.6	0.0	11.9	0.0	0.0	0.0
		4	3.1	0.0	-11.9	0.0	0.0	0.0