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Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

European Technical Assessment ETA-17/0467 of 12/06/2017

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:	VELUX Modular Skylights type UNI HVC and HFC
Product family to which the above construction product belongs:	Self-supporting ridgelight
Manufacturer:	VELUX A/S Ådalsvej 99 DK-2970 Hørsholm Tel. +45 45 16 40 00 Internet www.velux.com
Manufacturing plant:	VELUX A/S
This European Technical Assessment contains:	26 pages including 6 Annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	EAD 220013-01-0401 - Self-supporting ridgelight, edition May 2017
This version replaces:	

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II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
The VELUX Modular Skylights type UNI HVC and HFC is a self-supporting ridgelight consisting of two roof windows (openable and/or fixed), each individually CE marked in accordance with EN 14351-1:2006+A2:2016. They are connected at the top by means of hardware.

The roof windows are supplied with the same frame width. Openable and fixed roof windows can be combined. The kits can be combined.

The kit does not contribute to the stiffness of the roof (racking resistance).

The angle between the two roof windows can vary between 70-130 degrees.

The profiles of the frame and casement are made from pultruded profiles consisting of 70% - 80% glass fibre and 30% - 20% polyurethane resin (by mass). The density is 1800 - 2200 kg/m3. The frame profiles of the fixed roof windows are identical. The frame profiles of the openable roof windows are identical as are the casement profiles.

Cross sections of the profiles are shown in Annex C.

The openable roof windows are power operated. The maximum opening is 321- 700 mm depending on the size. The surface of the profiles is treated with UV protecting coat.

Hardware (brackets and bearings) are made of steel EN 10149-2 S355MC and bolts are made of steel 8.8 in accordance with EN ISO 898-1:2013

The glazing is a double or triple insulating glass unit.

An example of the kit is shown in Annex B.

2 Specification of the intended use in accordance with the applicable EAD

The VELUX Modular Skylights type UNI HVC and HFC self-supporting ridgelight is intended to provide ventilation and/or weather protection and daylight luminance to any enclosed or partially enclosed building or space.

The static system of the self-supporting ridgelight is described in Annex A.

The calculated characteristic load bearing capacity of typical applications are given in Annex E without nationally determined partial safety factors and magnification and reduction factors (duration, aging/environment, temperature)

The provisions made in this European Technical Assessment are based on an assumed intended working life of the VELUX Modular Skylights type UNI HVC and HFC of 25 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability (BWR1)	
Load bearing capacity of the kit (except glazing)	See Annex D and E
Load bearing capacity of the glazing:	
- Resistance to wind load	See Annex F
- Resistance to snow and permanent load:	See Annex F
3.2 Safety in case of fire (BWR2)	
Reaction to fire (Hardware)	The components made from steel are classified as Euroclass A1 in accordance with Commission Delegated Regulation 2016/364 and EN 13501-1 and, and EC decision 96/603/EC, amended by EC Decision 2000/605/EC
Reaction to fire (Profiles)	See Annex F
External fire performance	See Annex F
3.3 Hygiene, health and the environment (BWR3)	
Content and emission and/or release of dangerous substances	The product does not contain/release dangerous substances specified in TR 034, dated March 2012 *)
Water tightness	See Annex F
3.4 Safety and accessibility (BWR4)	
Impact resistance	See Annex F
Load bearing capacity of safety devices	See Annex F
3.5 Protection against noise (BWR5)	
Acoustic performance	See Annex F
3.6 Energy economy and heat retention (BWR6)	
Thermal transmittance	See Annex F
Radiation properties	See Annex F
Air permeability	See Annex F
Durability	See Annex F

*) In addition to the specific clauses relating to dangerous substances contained in this European Technical Assessment, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Regulation, these requirements need also to be complied with, when and where they apply.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the decision 98/600/EC and 98/436/EC of the European Commission1, as amended, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 3.

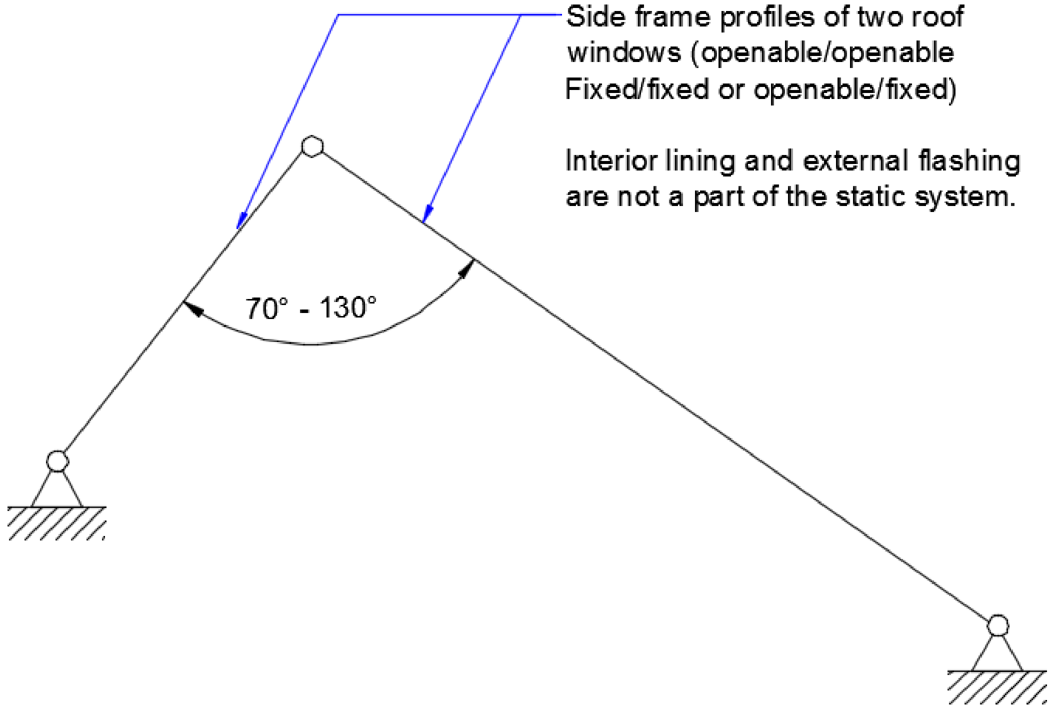
5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking

Issued in Copenhagen on 2017-06-12 by

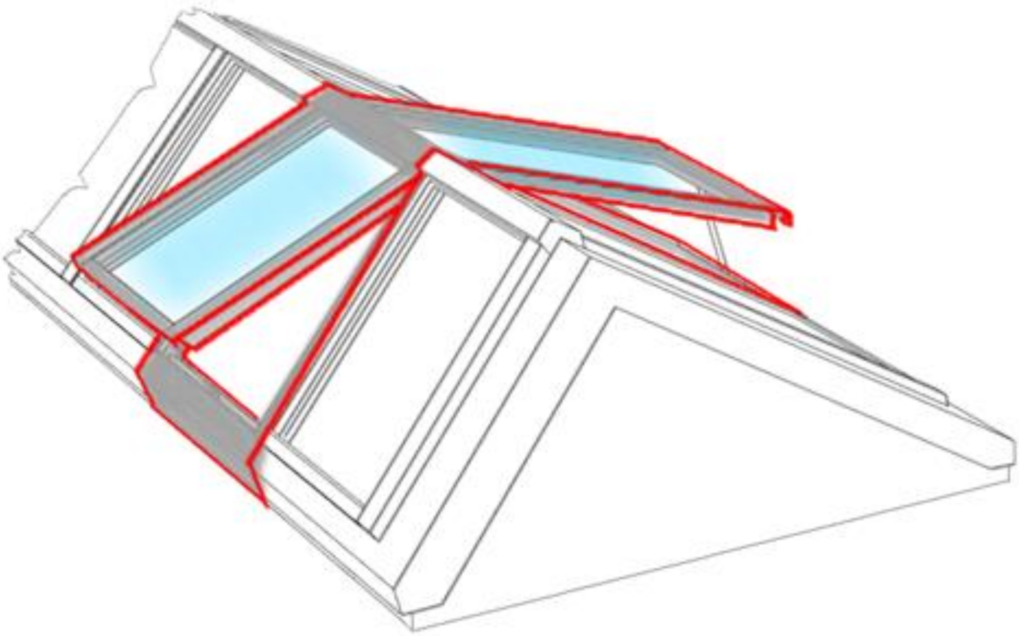
Thomas Bruun
Managing Director, ETA-Danmark

ANNEX A
The static system of the kit

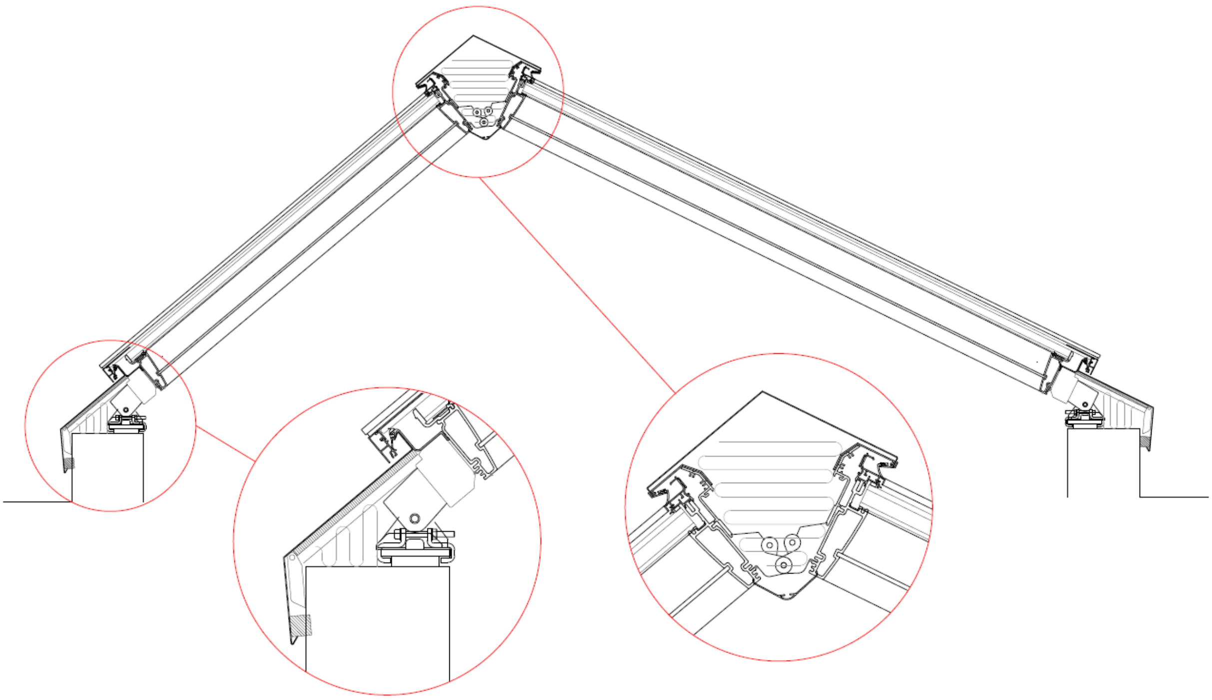


Annex B
Technical details of the product

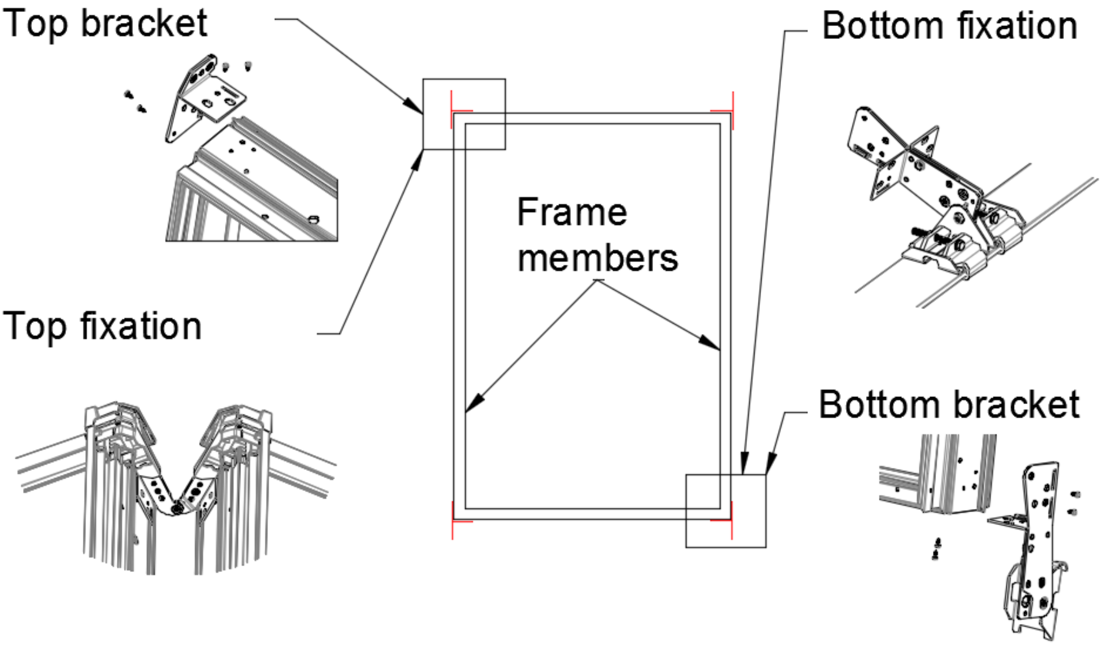
B.1 An example of the kit



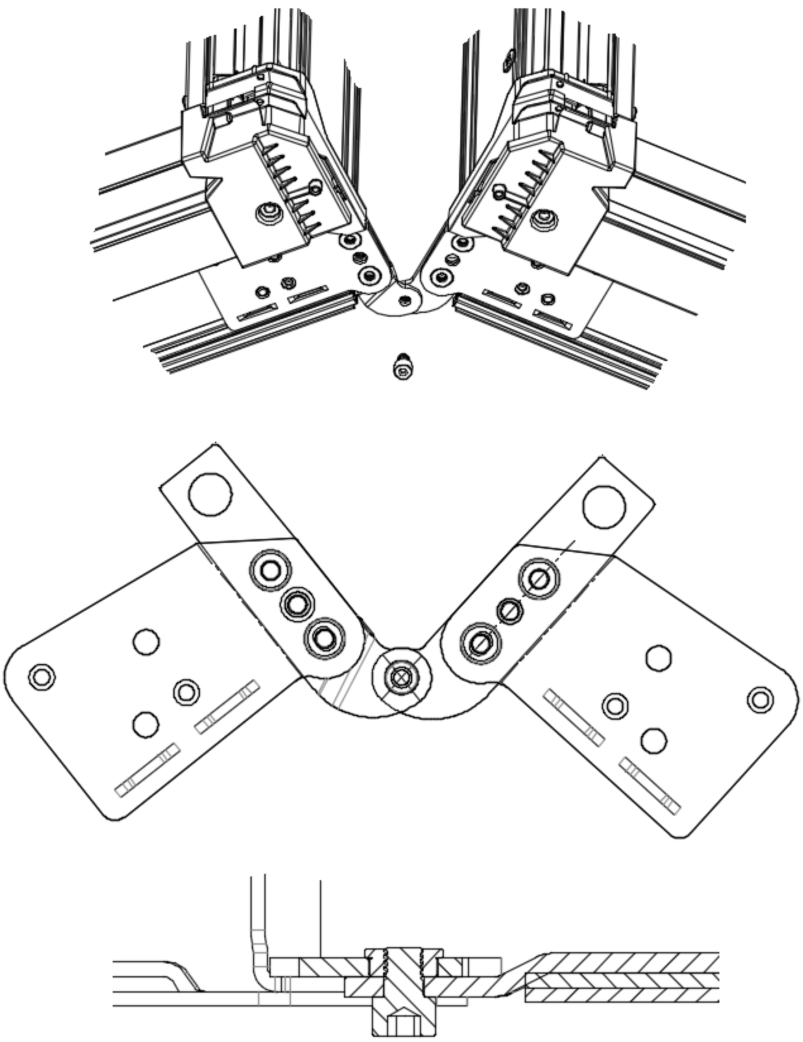
B.2 An example section of the kit



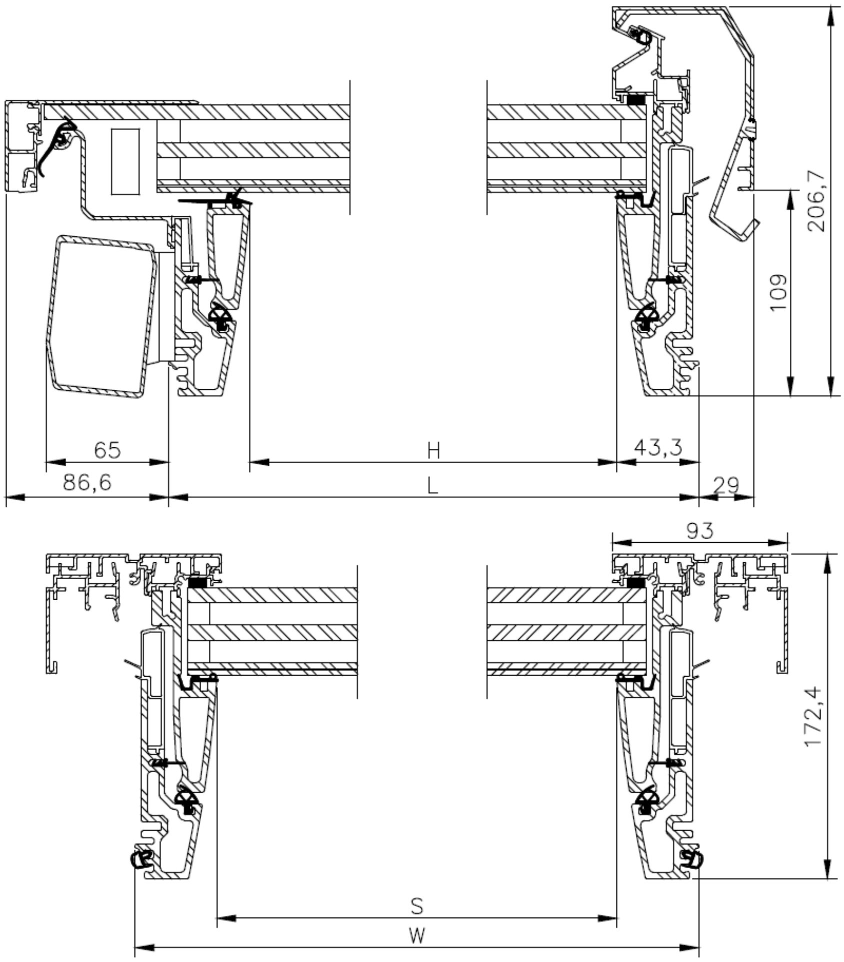
B.3 Overview of hardware



B.4 Top connection of the kit with the top bolt

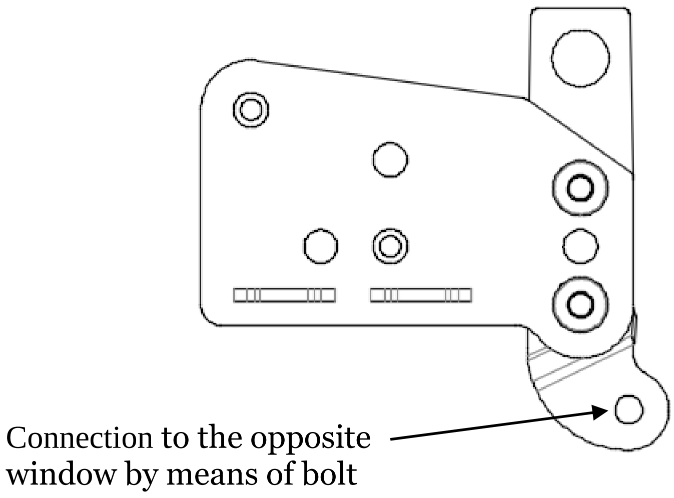


B.5 Cross sections and main dimensions (measures in mm)

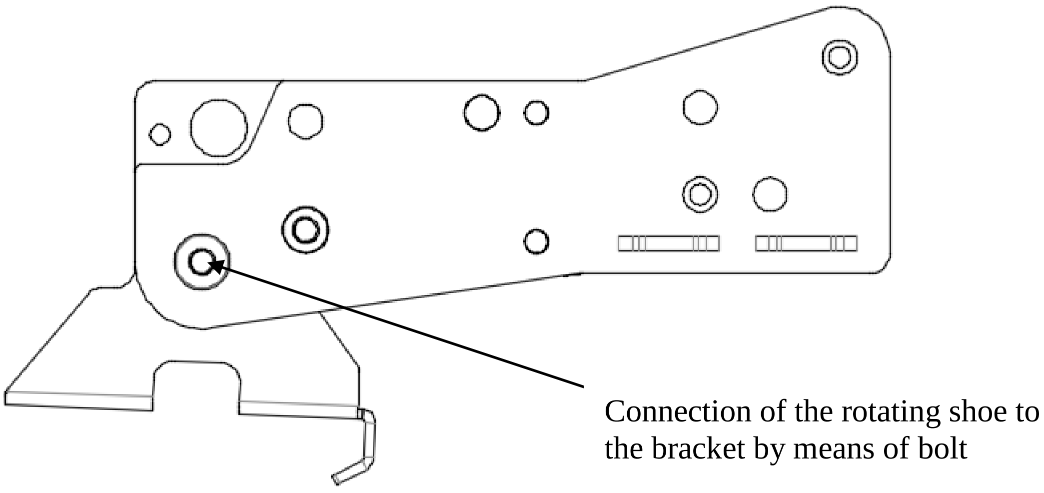


HVC dimensions		Frame outer dimension	Casement aperture
Size	Width	W	S (W-87)
067- - -		675	588
075- - -		750	663
080- - -		800	713
090- - -		900	813
100- - -		1000	913
Size		L	H (L-87)
- - -080	Height	800	713
- - -100		1000	913
- - -120		1200	1113
- - -140		1400	1313
- - -160		1600	1513
- - -180		1800	1713
- - -200		2000	1913
- - -220		2200	2113
- - -240		2400	2313

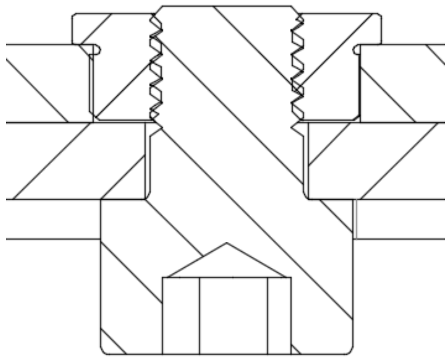
B.6 Top corner bracket



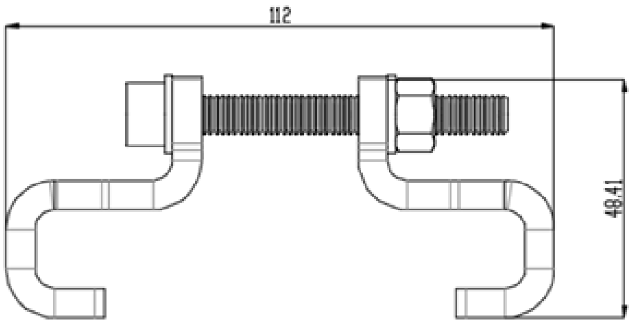
B.7 Bottom corner bracket with rotating shoe



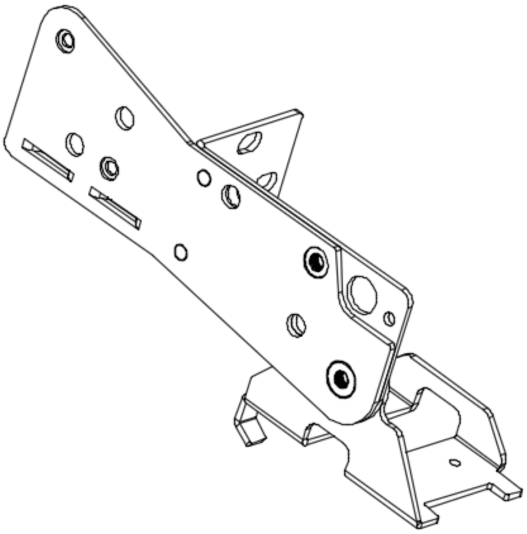
B.8 Bolt - Connection between the bottom bracket and rotating shoe and connection between the top brackets of opposite windows

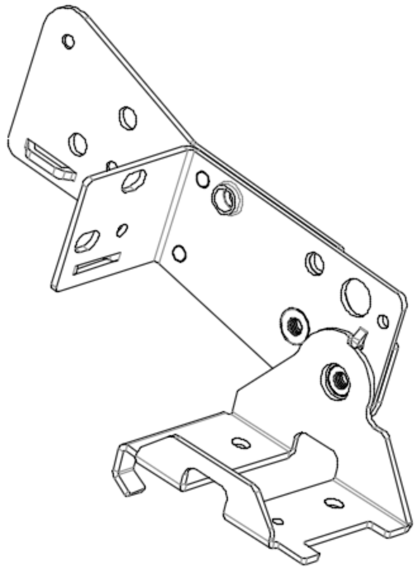


B.9 Mounting clamp (measures in mm)

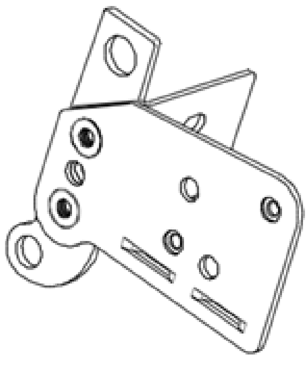


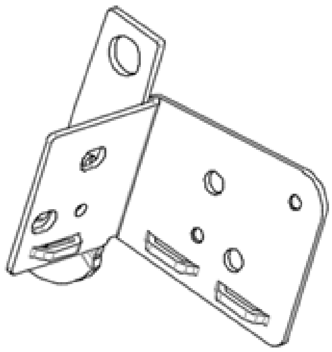
B.10 Bottom corner brackets with rotating shoe





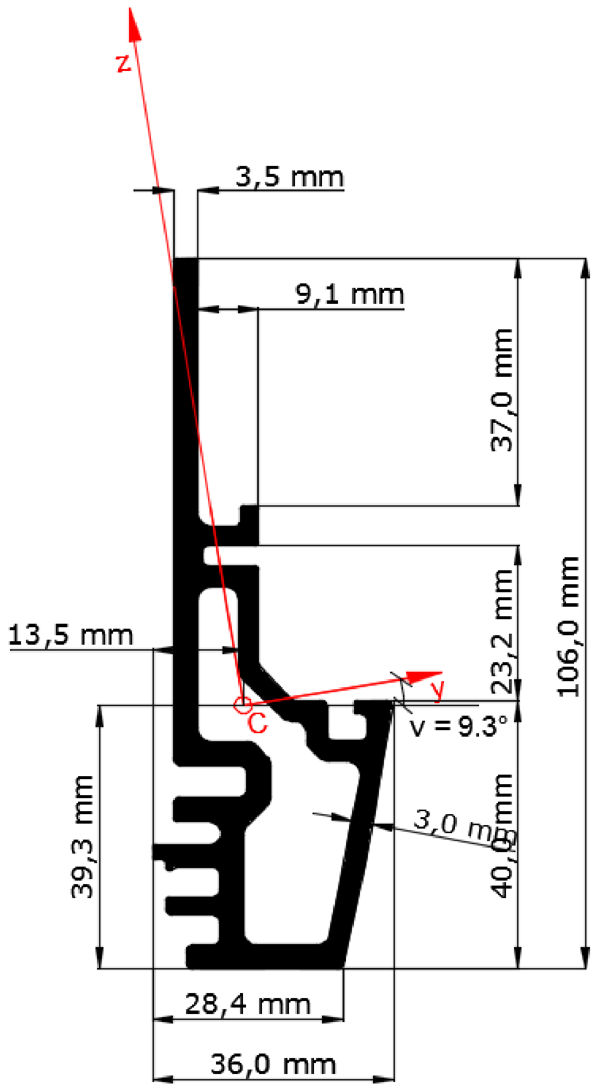
B.11 Top corner brackets





ANNEX C
Cross sections of the profiles

C.1 Openable window frame profile



Cross-sectional area:

$A = 867\ mm^2$

Section modulus:

$W_y = 9{,}93 \times 10^3\ mm^3$

$W_z = 2{,}76 \times 10^3\ mm^3$

Second moment of area:

$I_y = 0{,}669 \times 10^6\ mm^4$

$I_z = 0{,}0607 \times 10^6\ mm^4$

Angle of rotation for principle axis

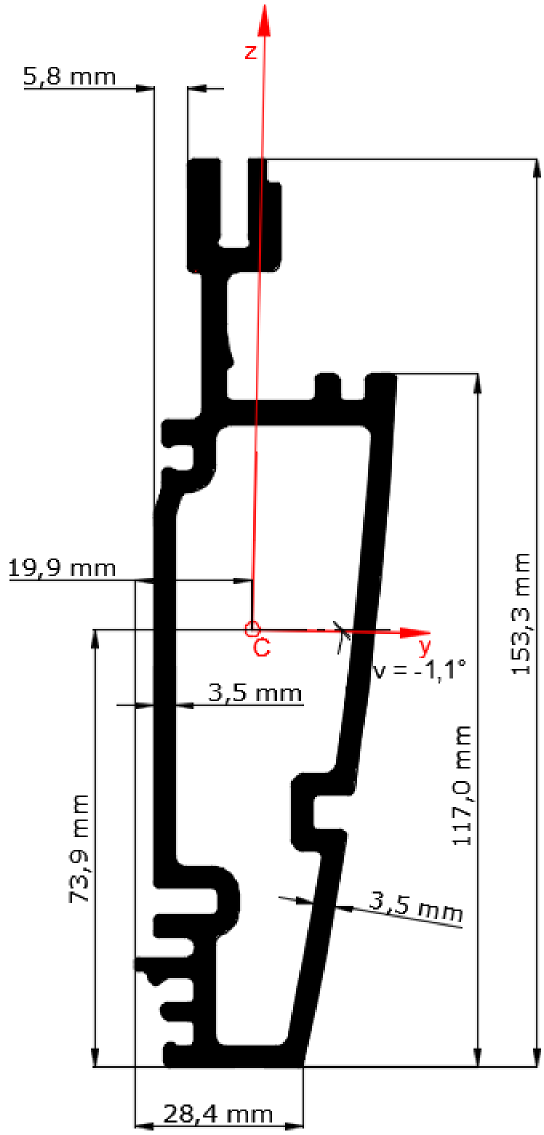
$v = 9{,}3°$

$A_{web} \approx 550\ mm^2$ (1)

Note:

(1) A_{web} is a conservative value of the web area used for calculations of the shear stresses in the profile.

C.2 Fixed window frame profile – 2-layer glazing



Cross-sectional area:

$A = 1502\ mm^2$

Section modulus:

$W_y = 40{,}9 \times 10^3\ mm^3$

$W_z = 10{,}0 \times 10^3\ mm^3$

Second moment of area:

$I_y = 3{,}25 \times 10^6\ mm^4$

$I_z = 0{,}234 \times 10^6\ mm^4$

Angle of rotation for principle axis

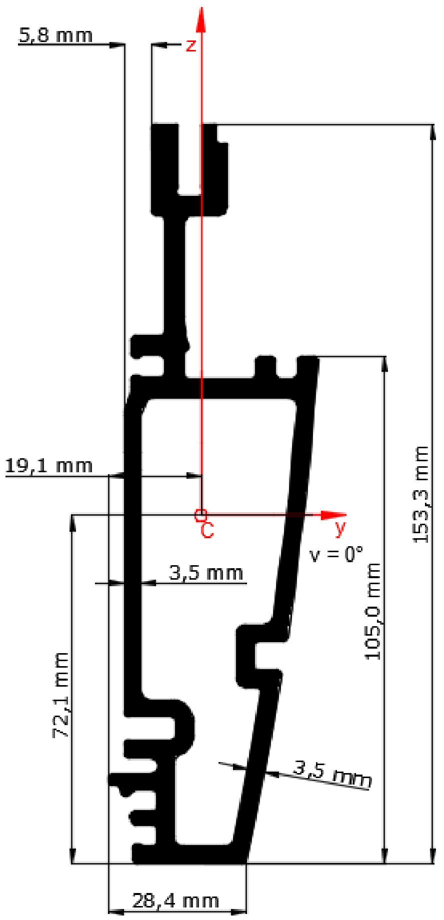
$v = -1{,}1°$

$A_{web} \approx 900\ mm^2$ (1)

Note:

(1) A_{web} is a conservative value of the web area used for calculations of the shear stresses in the profile.

C.3 Fixed window frame profile – 3-layer glazing



Cross-sectional area:
$A = 1467\ mm^2$

Section modulus:
$W_y = 38{,}1 \times 10^3\ mm^3$
$W_z = 8{,}74 \times 10^3\ mm^3$

Second moment of area:
$I_y = 3{,}10 \times 10^6\ mm^4$
$I_z = 0{,}212 \times 10^6\ mm^4$

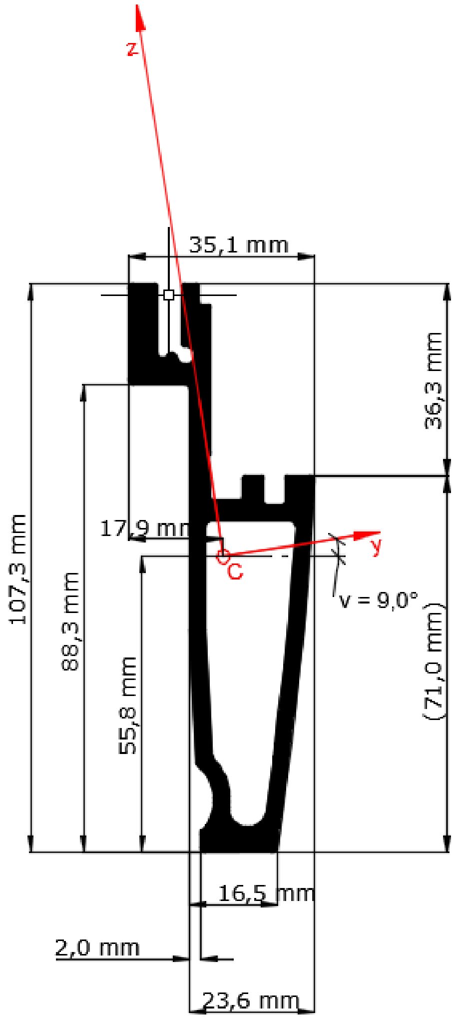
Angle of rotation for principle axis
$v = 0{,}0°$

$A_{web} \approx 900\ mm^2$ (1)

Note:

(1) A_{web} is a conservative value of the web area used for calculations of the shear

C.4 Openable window casement profile – 2-layer glazing



Cross-sectional area:
$A = 857\ \text{mm}^2$

Section modulus:
$W_y = 16{,}4 \times 10^3\ \text{mm}^3$
$W_z = 2{,}82 \times 10^3\ \text{mm}^3$

Second moment of area:
$I_y = 0{,}930 \times 10^6\ \text{mm}^4$
$I_z = 0{,}0543 \times 10^6\ \text{mm}^4$

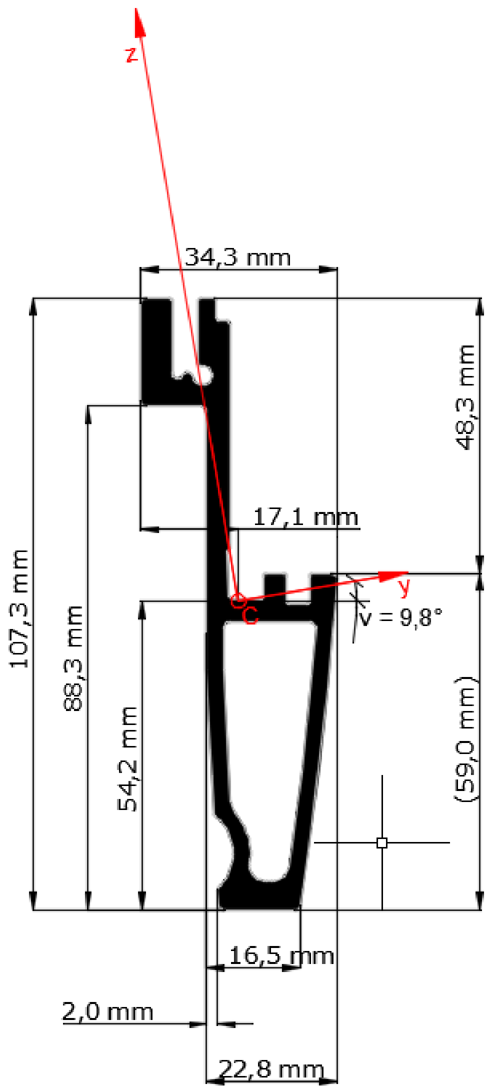
Angle of rotation for principle axis
$v = 9{,}0°$

$A_{web} \approx 600\ \text{mm}^2$ (1)

Note:

(1) A_{web} is a conservative value of the web area used for calculations of the shear stresses in the profile.

C.5 Openable window casement profile – 3-layer glazing



Cross-sectional area:

A = 826 mm^2

Section modulus:

W_y = 16,7 × 10^3 mm^3

W_z = 2,25 × 10^3 mm^3

Second moment of area:

I_y = 0,922 × 10^6 mm^4

I_z = 0,0398 × 10^6 mm^4

Angle of rotation for principle axis

v = 9,8°

A_{web} ≈ 550 mm^2 (1)

Note:

(1) A_{web} is a conservative value of the web area used for calculations of the shear stresses in the profile.

ANNEX D
Test results

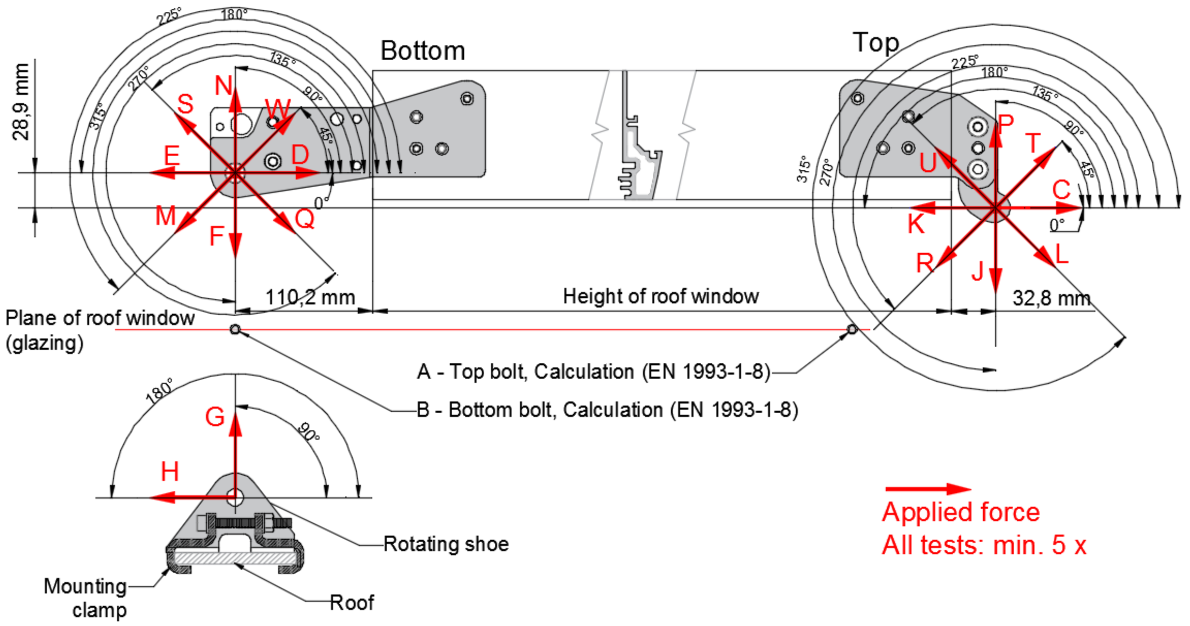
D.1 Small scale test results

Small-scale tests		Value	Unit
a)	Density of the frame profiles – EN ISO 1183-1 (Method A-immersion)	2,076	g/cm^3
b)	Glass % of the frame profiles – EN ISO 1172 (Method B)	74,2	%
c)	Thermal expansion coefficients of the profiles (axial and transverse) – ISO 11359-2	Axial: $6{,}7 \times 10^{-6}$ Transverse: $38{,}3 \times 10^{-6}$	K^{-1}

Small-scale tests (characteristic values)		Value	Unit
d)	Tensile strength (parallel to the glass fibre) – EN ISO 527-5	832,9	MPa
e)	Compression strength (parallel to the glass fibre) – EN ISO 14126 (Sample specimen type B1, loading fixture method; type 2- end loading)	465	MPa
f)	Bending strength (parallel to the glass fibre) – EN ISO 14125 (Method A)	1257	MPa
g)	E- modulus / flexural modus (parallel to the glass fibre) – EN ISO 14125 (Method A) (1)	39,5	GPa
h)	G-modulus – EN ISO 14129 (2)	3,1	GPa
i)	Shear strength – EN ISO 14130	53,8	MPa

Notes:
(1) Mean value, confidence level 75%, unknown standard deviation: 41,6 GPa. (See ISO 16269-6:2014)
(2) Mean value, confidence level 75%, unknown standard deviation: 3,4 GPa. (See ISO 16269-6:2014)

D.2 Hardware connection (test and calculation results)

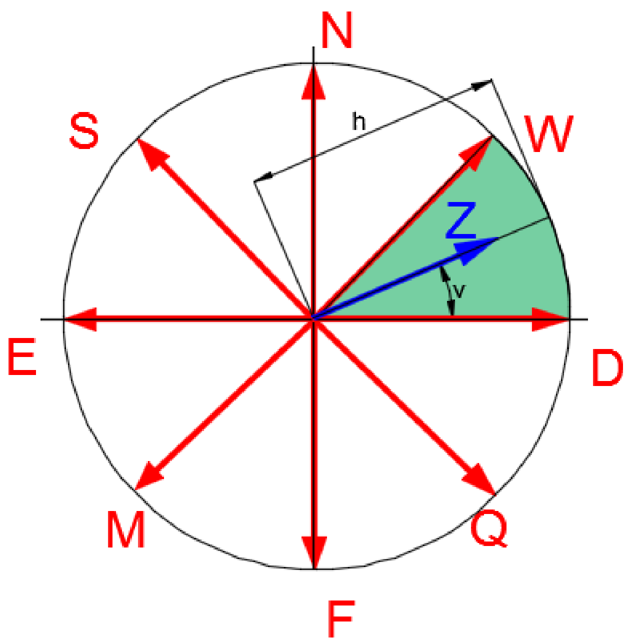


	Element/Connection	Value (kN)
A	Top bolt connection (calculated minimum)	13,5 (4)
B	Bottom bolt connection (calculated minimum)	17,6 (4)
G	Rotating shoe/mounting clamp/roof connection in 90°	20,3
H	Rotating shoe/mounting clamp/roof connection in 180°	28,2

	Element/Connection	**Value (kN)** (3)			
		Product variant			
		HFC 100240 00**10**	HVC 100240 00**10**	HFC 100240 00**16T**	HVC 100240 00**16T**
C	Top corner bracket/frame connection in 0°	9,9	10,6	8,8	10,6
D	Bottom corner bracket/frame connection in 0°	9,5	7,5	10,9	7,5
E	Bottom corner bracket/frame connection in 180°	22,7	12,8	15,2	12,8
F	Bottom corner bracket/frame connection in 270°	3,9	2,0	4,3	2,1
J	Top corner bracket/frame connection in 270°	3,9	2,0	4,3	2,1
K	Top corner bracket/frame connection in 180°	9,5	9,7	8,4	9,7
L	Top corner bracket/frame connection in 315°	6,2	3,4	6,0	3,5
M	Bottom corner bracket/frame connection in 225°	6,2	3,4	6,0	3,5
N	Bottom corner bracket/frame connection in 90°	6,0	6,0	6,3	5,7
P	Top corner bracket/frame connection in 90°	6,0	6,0	6,3	5,7
Q	Bottom corner bracket/frame connection in 315°	5,4	3,0	5,0	3,6
R	Top corner bracket/frame connection in 225°	5,4	3,0	5,0	3,6
S	Bottom corner bracket/frame connection in 135°	7,8	8,2	8,1	7,5
T	Top corner bracket/frame connection in 45°	7,8	8,2	8,1	7,5
U	Top corner bracket/frame connection in 135°	8,7	9,3	8,6	9,0
W	Bottom corner bracket/frame connection in 45°	8,7	9,3	8,6	9,0

(3) Without influence caused by nationally determined magnification and reduction factors (duration, aging/environment, temperature, i.e. $C_t = C_u = C_Q = 1$ and $K_t = K_u = K_Q = 1$, see ETAG 010, 6.3.1.2)
(4) Strength of the bottom and top bolt themselves: 17,6 kN

D.3 Strength of hardware connection in other directions than tested (principle)



Z: Result of a structural calculations [kN]

v : Result of a structural calculations [angle to the roof window]

h: Result of a linear interpolation [kN]

$$h = (D * (45° - v°) + W * v°) / 45°$$

Requirement: $h \geq Z$

ANNEX E

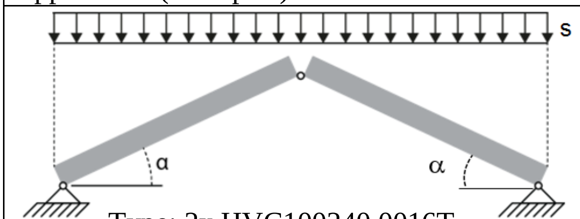
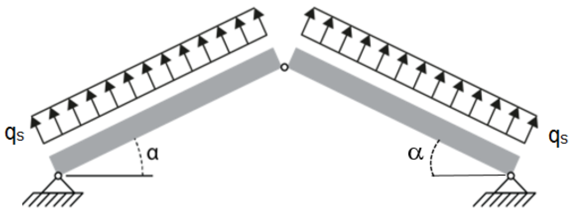
Calculated characteristic load bearing capacity (q) without influence caused by nationally determined partial safety factors, magnification, and reduction factors (duration, aging/environment, temperature)

Notes:

(1) $g_{MR} = 1$, $g_{MC} = 1$, $C_t = C_u = C_\theta = 1{,}0$ and $K_t = K_u = K_\theta = 1{,}0$ (see ETAG 010, 6.3.1.1 and 6.3.1.2)
$g_{G,sup} = 1$, $g_{G,inf} = 1$ (see EN 1990:2007)

(2) The load bearing capacity of the glazing shall be determined in accordance to EAD DP 14-22-0013-04.01, 2.2.2, 2.2.3

E.1 Typical applications

Application (examples)	α°	s/q_s [kN/m^2] (without self-weight) ULS	SLS 1/300	SLS 1/150
 Type: 2x HVC100240 0016T (1000mm x 2400mm) Glazing: 22 mm glass in total	25°	3,8	1,5	3,8
	30°	4,6	1,6	4,0
	35°	5,3	1,7	4,2
	40°	6,1	1,9	4,6
 (1000mm x 2400mm) Glazing: 14 mm glass in total	25°	4,8	1,9	3,4
	30°	5,0	1,9	3,3
	35°	4,9	1,9	3,3
	40°	4,5	1,9	3,3

The self-weight (including hardware, lining, cladding and flashing) of the fixed window (G_f and g_f) and the openable window (G_v and g_v) shall be calculated as follows:

$G_f = (W-12) * (L-96) * t*25*10^{-9}+2(W+L) *57*10^{-6}$ [kN]

$g_f = G_f /(W*L)* 10^6$ [kN/m^2]

and

$G_v = (W-12) * (L-96) * t*25 * 10^{-9}+2(W+L) * 96 * 10^{-6}$ [kN]

$g_v = G_v /(W*L)* 10^6$ [kN/m^2]

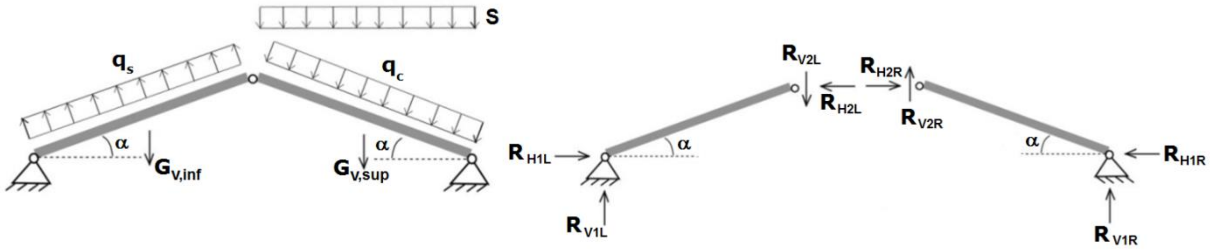
where;

W = Width of the window in mm
L = Height of the window in mm
t = Total thickness of glass in mm

E.2 Calculation example

Asymmetric load

To demonstrate the calculation procedure, a VELUX modular skylight self-supporting ridgelight application under asymmetric wind and snow load is examined.
Geometry and roof window variant is the same as in the wind load example in Annex E.1:
2 x HVC1002400 0010 (1000mm x 2400mm). Glazing: 14mm glass in total.
The pitch is $\alpha = 25°$.



Corrections in height and angle

Because of the brackets, it is necessary to correct the calculation angle and the profile height. On the Figure in Annex D.2 the ΔL_1 = 110,2 mm and ΔL_2 = 43,7 mm for the brackets can be found. ΔL_2 can be transformed into a parallel part ΔL_{2ll} = 32,8 mm and a perpendicular part $\Delta L_{2\perp}$ = 28,9 mm.
ΔL_1 and ΔL_2 are constants no matter the height L or angle α of the glazing.

The corrected height can thereby be found:

$$L_{cor} = \sqrt{(L + \Delta L_1 + \Delta L_{2ll})^2 + (L_{2\perp})^2} = \sqrt{(2400mm + 110{,}2mm + 32{,}8mm)^2 + (28{,}9mm)^2} = 2543mm$$

The corrected angle is found:

$$\Delta\alpha = \sin^{-1}\left(\frac{\Delta L_2}{L + \Delta L_1 + \Delta L_{2ll}}\right) = \sin^{-1}\left(\frac{28{,}9mm}{2400mm + 110{,}2mm + 32{,}8mm}\right) = 0{,}65^o$$

$$\alpha_{cor} = \alpha - \Delta\alpha = 25^o - 0{,}7^o = 24{,}3^o$$

For deflection calculations of an upwards load for an openable window, only the casement will deflect. Therefore, only the height of the casement profile and correct angle hereof should be used for the deflections calculations. From the Figure below $\Delta L_{1,up,dfl}$ = -9,7 mm, $\Delta L_{2ll,up,dfl}$ = 23,5 mm and $\Delta L_{2\perp,up,dfl}$ = 24 mm are found.

The corrected height $L_{cor,up,dfl}$ can thereby by found:

$$L_{cor,up,dfl} = \sqrt{\left(L + \Delta L_{1,up,dfl} + \Delta L_{2ll,up,dfl}\right)^2 + \left(L_{2,up,dfl}\right)^2}$$

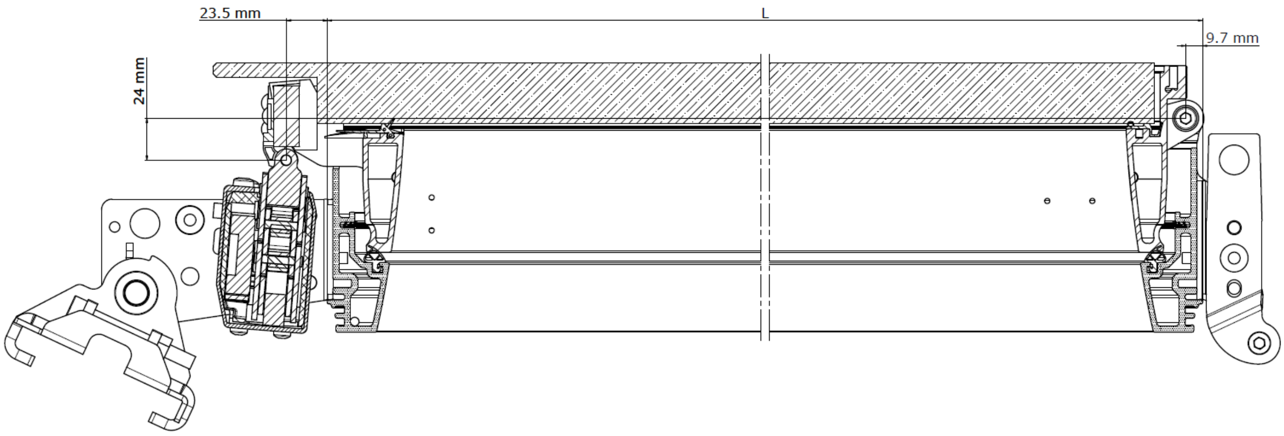
$$= \sqrt{(2400mm - 9{,}7mm + 23{,}5mm)^2 + (24mm)^2} = 2414mm$$

The corrected angle is found:

$$\Delta\alpha_{up,dfl} = \sin^{-1}\left(\frac{\Delta L_{2,up,dfl}}{L + \Delta L_{1,up,dfl} + \Delta L_{2ll,up,dfl}}\right)$$

$$= \sin^{-1}\left(\frac{24mm}{2400mm - 9{,}7mm + 23{,}5mm}\right) = 0{,}57^o$$

$$\alpha_{cor,up,dfl} = \alpha + \Delta\alpha = 25^o + 0{,}6^o = 25{,}6^o$$



$\Delta L_{1,up,dfl}$ = -9,7 mm, $\Delta L_{2II,up,dfl}$ = 23,5 mm and $\Delta L_{2\perp,up,dfl}$ = 24 mm. All these measurements are constants.

Loads
Self-weight on each side frame/casement:

$$G_v = \frac{1}{2} \cdot \left((W-12) \cdot (L-96) \cdot t \cdot 25 \cdot 10^{-9} + 2 \cdot (W+L) \cdot 96 \cdot 10^{-6}\right)$$

$$= \frac{1}{2} \cdot \left((1000-12) \cdot (2400-96) \cdot 14 \cdot 25 \cdot 10^{-9} + 2 \cdot (1000+2400) \cdot 96 \cdot 10^{-6}\right) = 0.72kN$$

In this example, the wind peak velocity pressure is set to 0,8kN/m^2 and the shape factor is set to 0,5 for wind pressure (q_c) and -0,5 for wind suction (q_s). Hence, the load is

$$q_c = q_s = 0{,}8kN/m^2 \cdot 0{,}5 \cdot 0{,}5m = 0{,}2kN/m\text{, } \textit{on each side frame/casement}$$

The wind load is split into a vertical and a horizontal component, using the original angle α. Using the corrected height, L_{cor} to find the equivalent concentrated load.

$$Q_{sH} = Q_{cH} = q_c \cdot L_{cor} \cdot \sin(\alpha) = 0{,}2kN/m \cdot 2{,}543m \cdot \sin(25^o) = 0{,}21kN \textit{ on each side frame/casement}$$

$$Q_{sV} = Q_{cV} = q_c \cdot L_{cor} \cdot \cos(\alpha) = 0{,}2kN/m \cdot 2{,}543m \cdot \cos(25^o) = 0{,}46kN \textit{ on each side frame/casement}$$

For the snow load (s) in this example the two C factors (according to EN 1991-1-3) are set to 1,0, the shape factor μ_2 set to 0,8 and the characteristic value of snow load on the ground s_k=1,0kN/m^2, given the snow load s:

$$s = \mu_2 \cdot C_e \cdot C_t \cdot S_k = 0{,}8 \cdot 1{,}0 \cdot 1{,}0 \cdot 1{,}0kN/m^2 = 0{,}8kN/m^2 \rightarrow 0{,}4kN/m\text{, } \textit{on each side frame/casement}$$

The snow load is only vertical, and the corrected height L_{cor} is used to find the equivalent concentrated load.

$$S_V = s \cdot \cos(\alpha) \cdot L_{cor} = 0{,}4kN/m \cdot \cos(25^o) \cdot 2{,}543m = 0{,}92kN$$

Reactions in brackets
The corrected height L_{cor} and angle α_{cor} are used in the static system to determine the reactions. These calculations are not presented here.
Reactions are calculated separately for each load type and are found in Table E.2.1. For the Characteristic load combination, the three load types are simply added together:

$$\textit{Characteristic load combination}: 1{,}0 \cdot G_v + 1{,}0 \cdot q + 1{,}0 \cdot S$$

Table E.2.1, Horizontal and vertical reactions of the brackets

Load type	R_{H1L} [kN]	R_{V1L} [kN]	R_{H2L} [kN]	R_{V2L} [kN]	R_{H2R} [kN]	R_{V2R} [kN]	R_{H1R} [kN]	R_{V1R} [kN]
G_V	0,80	0,72	0,80	0,00	0,80	0,00	0,80	0,72
Q_s and Q_c	0,21	-0,18	0,00	0,28	0,00	0,28	-0,21	0,18
S	0,51	0,23	0,51	0,23	0,51	0,23	0,51	0,69
Characteristic combi.	1,52	0,77	1,31	0,51	1,31	0,51	1,10	1,59

The resulting bracket forces and utilization hereof are found in Table E.2.2 for the characteristic load combination. The bearing resistances of the brackets in the resulting angle are found by linear interpolation between the two neighbouring bearing resistances, see Annex D.2 and D.3.

Table E.2.2, Brackets forces (resultants) and utilization for the characteristic load combination

	R_{1L}	R_{2L}	R_{2R}	R_{1R}
Bracket reaction force, k [kN]	1,69	1,40	1,40	1,93
Angle according to Annex D2 [º]	2,0	176,4	133,6	30,6
Bearing resistance, k [kN]	7,58	9,67	9,20	8,72
Utilization [%]	22	14	15	22

Bending in frame and casement profile

The line load from self-weight perpendicular to the roof window is denoted g_p and perpendicular line load from the snow pressure is denoted s_p. The corrected height is applied but the original angle is used:

$$g_p = \frac{G_V \cdot cos(\alpha)}{L_{cor}} = \frac{0{,}72 \ \cdot cos(25)}{2{,}543} = 0{,}26kN/m\,,\ \ on\ each\ side\ frame/casement$$

$$q_c = 0{,}20kN/m\ on\ each\ Helo\ beam$$

$$s_p = 0{,}40kN/m \cdot \cos(\alpha) = 0{,}40kN/m \cdot \cos(25) = 0{,}36kN/m\,,\ \ on\ each\ side\ frame/casement$$

$$M = \frac{1}{8} \cdot \left(g_p + q_c + s_p\right) \cdot L_{cor}^2 = \frac{1}{8} \cdot (0{,}26 + 0{,}20 + 0{,}36)kN/m \cdot (2{,}543m)^2 = 0{,}66kNm$$

$$M_{frame} = M \cdot \ \frac{I_{frame}}{I_{frame}+I_{casement}} \ = \ 0{,}66kNm \cdot \ \frac{0{,}669}{0{,}669+0{,}930} \ = 0{,}28kNm$$

$$\sigma_{frame} \approx \frac{M_{frame}}{W_{y,frame}} = \frac{0{,}28 \cdot 10^6 Nmm}{9{,}93 \cdot 10^3 mm^3} = 28{,}1N/mm^2 \quad \ll \ 1257N/mm^2$$

$$M_{casement} = M \cdot \ \frac{I_{casement}}{I_{frame}+I_{casement}} \ = \ 0{,}66kNm \cdot \ \frac{0{,}930}{0{,}669+0{,}930} \ = 0{,}38kNm$$

$$\sigma_{frame} \approx \frac{M_{frame}}{W_{y,frame}} = \frac{0{,}38 \cdot 10^6 Nmm}{16{,}4 \cdot 10^3 mm^3} = 23{,}2N/mm^2 \quad \ll \ 1257N/mm^2$$

Here, the characteristic bending strength is taken from Annex D.1. Second moment of area and section modulus are taken from Annex C.1 and C.4. The rotation of the main axis is ignored, as it has little influence on the result, and the resulting stress is much lower than the bending strength.

Shear force in frame profile

The shear force is generally taken in combination by the frame and casement profile, but near the ends of the roof window, the entire shear force is taken by the frame profile. The original angle is used. Largest shear force is in the right roof window in this example:

$$V_{frame} = R_{V1R} \cdot cos(\alpha) - R_{H1R} \cdot sin(\alpha)$$

$$= 1{,}59kN \cdot cos(25) - 1{,}10kN \cdot sin(25)$$

$$= 0{,}98kN$$

$$\tau_{frame} = \frac{V_{frame}}{A_{web}} \approx \frac{0{,}98 \cdot 10^3 N}{550mm^2} = 1{,}8N/mm^2 \quad \ll \quad 53{,}8N/mm^2$$

Here, the characteristic shear strength is taken from Annex D.1 and A_{web} from Annex C1.

Deflection

Deflection of the roof window at mid height, perpendicular to the corrected roof window angle for the left side:

$$g_{p,cor} = \frac{G_V \cdot cos(\alpha_{cor})}{L_{cor}} = \frac{0{,}72 \ \cdot cos(24{,}3)}{2{,}543} = 0{,}26kN/m\,, \quad on\ each\ side\ frame/casement$$

$$q_{s,cor} = 0{,}20kN/m \cdot \cos(-\Delta\alpha) = 0{,}2kN/m \cdot \cos(0{,}7) = 0{,}20kN/m\,, \quad on\ each\ side\ frame/casement$$

$$u = \frac{5}{384} \cdot \frac{(g_{p,cor} - q_{s,cor}) \ \cdot L_{cor}^4}{E \cdot (I_{frame} + I_{casement})} = \frac{5}{384} \cdot \frac{(0{,}26 - 0{,}20)N/mm \ \cdot (2543mm)^4}{41600N/mm^2 \cdot (0{,}669 \cdot 10^6 mm^4 + 0{,}930 \cdot 10^6 mm^4)} = 0{,}5\ mm < \frac{L}{150} = 16\ mm$$

E is the E-modulus mean value, taken from Annex D.1 note 1.

Deflection of the roof window at mid height, perpendicular to the corrected roof window angle for the right side:

$$g_{p,cor} = \frac{G_V \cdot cos(\alpha_{cor})}{L_{cor}} = \frac{0{,}72 \ \cdot cos(24{,}3)}{2{,}543} = 0{,}26kN/m\,, \quad on\ each\ side\ frame/casement$$

$$q_{c,cor} = 0{,}20kN/m \cdot \cos(-\Delta\alpha) = 0{,}2kN/m \cdot \cos(0{,}7) = 0{,}20kN/m\,, \quad on\ each\ side\ frame/casement$$

$$s_{p,cor} = 0{,}40kN/m \cdot \cos(\alpha_{cor}) = 0{,}40kN/m \cdot \cos(24{,}3) = 0{,}36kN/m\,, \quad on\ each\ side\ frame/casement$$

$$u = \frac{5}{384} \cdot \frac{(g_{p,cor} + q_{c,cor} + s_{p,cor}) \ \cdot L_{cor}^4}{E \cdot (I_{frame} + I_{casement})} = \frac{5}{384} \cdot \frac{(0{,}26 + 0{,}20 + 0{,}36)N/mm \ \cdot (2543mm)^4}{41600N/mm^2 \cdot (0{,}669 \cdot 10^6 mm^4 + 0{,}930 \cdot 10^6 mm^4)} = 6{,}7mm < \frac{L}{150} = 16\ mm$$

E is the E-modulus mean value, taken from Annex D.1 note 1.

ANNEX F
Assessment of characteristics

Characteristic	Performance	Reference EAD 220013-01-04.01
3.1 Load bearing capacity of the glazing (BWR1)		
- Resistance to wind load	See the CE marking of window	2.2.2
- Resistance to snow and permanent load	See the CE marking of window	2.2.3
3.2 Safety in case of fire (BWR2)		
- Reaction to fire (Hardware)	See the CE marking of window	2.2.4
- Reaction to fire (Profiles)	See the CE marking of window	2.2.4
- External fire performance	See the CE marking of window	2.2.5
3.3 Hygiene, health and the environment (BWR3)		
- Watertightness	See the CE marking of window	2.2.7
3.4 Safety and accessibility (BWR4)		
- Impact resistance	See the CE marking of window	2.2.8
- Load bearing capacity of safety devices	See the CE marking of window	2.2.9
3.5 Protection against noise (BWR5)		
- Acoustic performance	See the CE marking of window	2.2.10
3.6 Energy economy and heat retention (BWR65)		
- Thermal transmittance	See the CE marking of window	2.2.11
- Solar factor	See the CE marking of window	2.2.12
- Light transmittance	See the CE marking of window	2.2.12
- Air permeability	See the CE marking of window	2.2.13
Durability		2.2.14