1. Static principles

1.1 General information

The present indications and tables are designed for the static pre-dimensioning of façade elements and have been compiled to the best of our knowledge.
They are based on the indicated dated standards. As standards are subject to continuous revision, the processor must always check their relevant validity. The processor himself is responsible for drawing up the static proof for the façade design which must be submitted to a recognised structural engineer or the responsible architect for testing and must be accepted by the client.

DIN 1055-4 “Effects on load-bearing structures - part 4: Wind loads” was completely revised and published in March 2005. It was integrated into the model list of acknowledged technical rules for works, version of September 2006, and is to be used from 1st January 2007. Due to formal reasons, however, it is unlikely that implementation will commence before April 2007.

The algorithm for calculating the wind loads significantly differs from the standard used so far (published in 1986-08) and will be explained in detail below.

1.2 Wind load

1.2.1 Wind load in accordance with DIN 1055-4:2005-03

The territory of the Federal Republic of Germany is subdivided into four wind zones with different average wind velocities v_{ref} and the pertaining velocity pressures q_{ref}.

Wind zone	v_{ref}	q_{ref}
WZ 1	22,5 m/s	0,32 kN/m²
WZ 2	25,0 m/s	0,39 kN/m²
WZ 3	27,5 m/s	0,47 kN/m²
WZ 4	30,0 m/s	0,56 kN/m²

Table 1: Wind zone map of Germany

The pressures q_{ref} stated in Table 1 apply to building sites up to a height of 800 m above sea level.
For building sites with a height H_s between 800 and 1100 m above sea level, the reference pressures q_{ref} must be increased by the factor $(0.2 + H_s/1000)$.
Special assessments are required for buildings located on ridges or peaks of low mountain ranges or at sites above 1100 m above sea level.

In addition, the velocity pressure depends on the roughness of the terrain and on its topology. In this context, the standard distinguishes between four different terrain categories:

			
Terrain category I	**Terrain category II**	**Terrain category III**	**Terrain category IV**
Open sea; lakes with an open area of at least 5 km in the wind direction; flat, even land without any obstacles	Terrain with hedges, individual homesteads, houses or trees, e.g. agricultural are	Suburbs, industrial or commercial areas; forests	Urban territories where at least 15 % of the area is covered with buildings with an average height exceeding 15 m

In general, the wind pressure (gust velocity pressure) q depending on building height z can be calculated by using q_{ref} from Table 1 as follows:

a. in the inland (mixed profile of terrain categories II and III)

$$q(z) = 1{,}5 \cdot q_{ref} \qquad \text{for } z \le 7 \text{ m}$$

$$q(z) = 1{,}7 \cdot q_{ref} \left(\frac{z}{10}\right)^{0{,}37} \qquad \text{for } 7 \text{ m} < z \le 50 \text{ m}$$

$$q(z) = 2{,}1 \cdot q_{ref} \left(\frac{z}{10}\right)^{0{,}24} \qquad \text{for } 50 \text{ m} < z \le 300 \text{ m}$$

b. in areas near the coast (up to 5 km inland) as well as on the islands in the Baltic Sea (mixed profile of terrain categories I and II)

$$q(z) = 1{,}8 \cdot q_{ref} \qquad \text{for } z \le 4 \text{ m}$$

$$q(z) = 2{,}3 \cdot q_{ref} \left(\frac{z}{10}\right)^{0{,}27} \qquad \text{for } 4 \text{ m} < z \le 50 \text{ m}$$

$$q(z) = 2{,}6 \cdot q_{ref} \left(\frac{z}{10}\right)^{0{,}19} \qquad \text{for } 50 \text{ m} < z \le 300 \text{ m}$$

c. on the North Sea islands (terrain category I)

$q(z) = 1{,}1$ kN/m² for $z \le 2$ m

$q(z) = 1{,}5 \cdot \left(\frac{z}{10}\right)^{0{,}19}$ kN/m² for 2 m < $z \le 300$ m

If the building is located on a topographically exposed site or if the site is located at extensive inland water surfaces, the wind load must be calculated separately in accordance with Appendix B of DIN 1055-5.

For buildings up to a building height of 25 m above ground level, the velocity pressure from Table 2 can be assumed for the wind zones in accordance with Table 1 in order to simplify calculation. The pressures apply constantly over the total height of the building.

Wind zone		Velocity pressure q in kN/m² for a building height h within the following limits:		
		h ≤ 10 m	**10 m < h ≤ 18 m**	**18 m < h ≤ 25 m**
1	Inland	0,50	0,65	0,75
2	Inland	0,65	0,80	0,90
	Coast [1] and islands in the Baltic Sea	0,85	1,00	1,10
3	Inland	0,80	0,95	1,10
	Coast [1] and islands in the Baltic Sea	1,05	1,20	1,30
4	Inland	0,95	1,15	1,30
	Coast [1] of North Sea and Baltic See and islands in the Baltic Sea	1,25	1,40	1,55
	North Sea islands	1,40	-	-

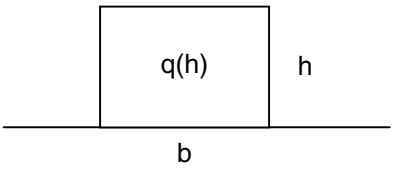
[1] Coastal area up to 5 km inland

Table 2: Simplified velocity pressures for buildings up to a height of 25 m

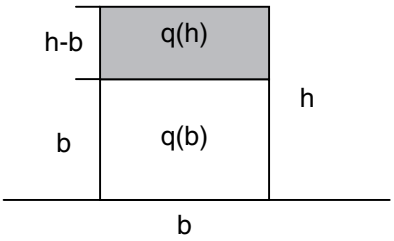
1.2.2 Aerodynamic coefficients

The external pressures on walls of buildings with a rectangular ground plan are staggered vertically as a function of the ratio of building height h to building width b:

a. **Building structure with h ≤ b**
The velocity pressure is assumed for the total façade area in building height h.

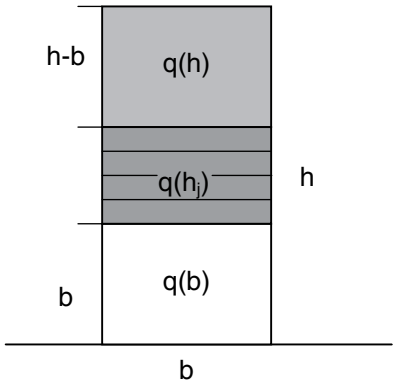


b. **Building structure with b < h ≤ 2b**
The building is subdivided into two strips: the lower one, from 0 to b, is loaded with the velocity pressure in height b over its total surface while the topmost strip, from b to h, is loaded with the velocity pressure in height h.

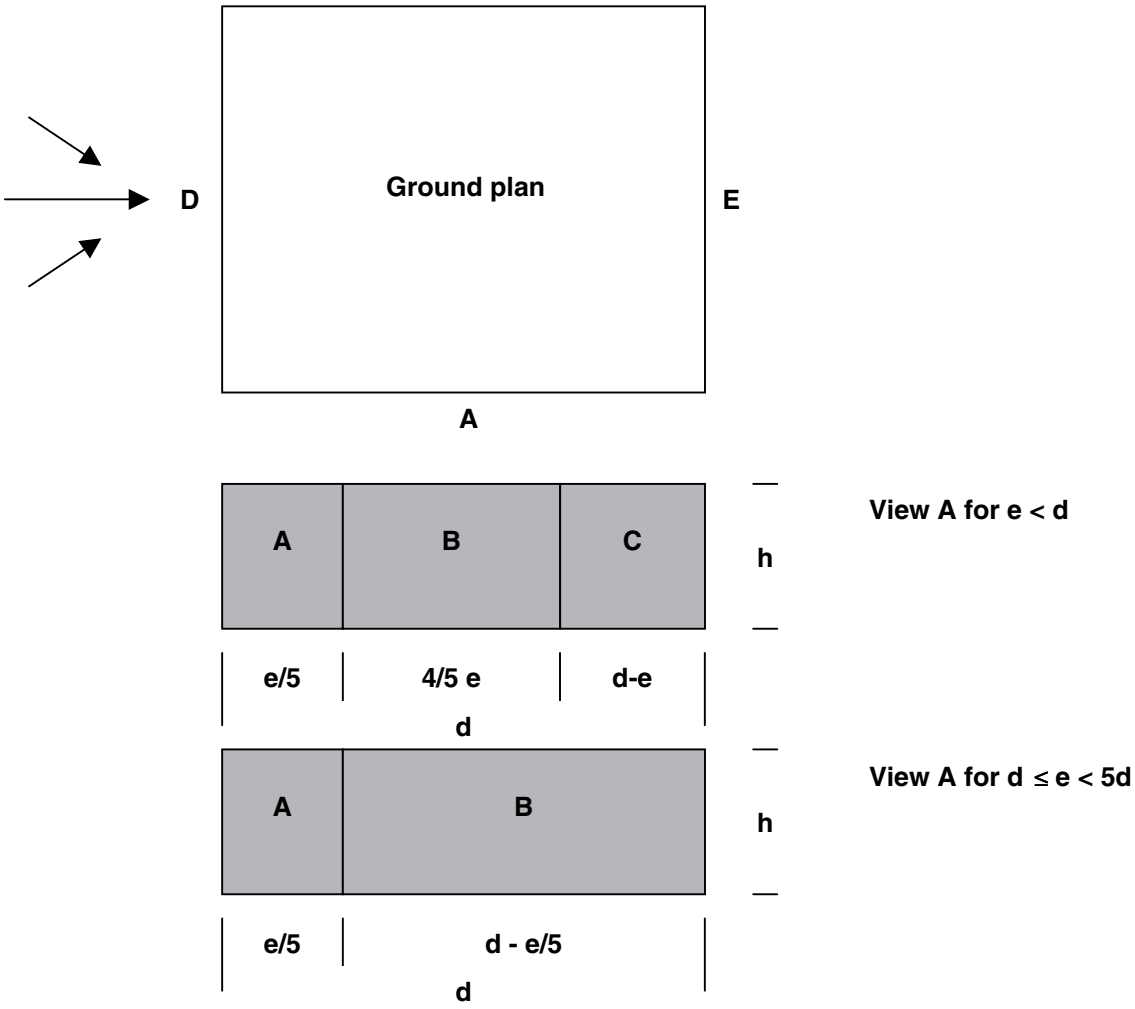


c. Building structure with h > 2b

The building is subdivided into three or more strips: the lower one, from 0 to b, is loaded with the velocity pressure in height b over its total surface while the upper strip, from h-b to h, is loaded with the velocity pressure in height h.
The intermediate area between b and h-b is subdivided into a suitable number of additional strips. The velocity pressure always refers to the upper edge of the strip.



Different coefficients c_{pe} are applied to the individual surfaces D, A and E depending on the direction of stream. The walls A which are parallel to the wind are subdivided into a maximum of three partial areas. The decisive value e is the smaller of the dimensions b or 2h.



If e > 5d for the elevation area A, the total façade area is assigned to A.

The external pressure coefficients for the windward side D, the lee side E as well as the partial areas of side A which is parallel to the wind (A, B, C) can be taken from Table 3. The values refer to façade areas > 10 m².

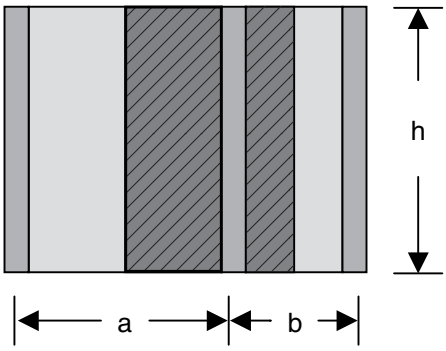
Area	A		B		C		D		E	
h/d	$C_{pe,1}$	$C_{pe,10}$	$C_{pe,1}$	$C_{pe,10}$	$C_{pe,1}$	$C_{pe,10}$	$C_{pe,1}$	$C_{pe,10}$	$C_{pe,1}$	$C_{pe,10}$
≥ 5	-1,7	-1,4	-1,1	-0,8	-0,7	-0,5	1,0	-0,8	-0,7	-0,5
1	-1,4	-1,2	-1,1	-0,8	-0,5	-0,5	1,0	-0,8	-0,5	-0,5
≤ 0,25	-1,4	-1,2	-1,1	-0,8	-0,5	-0,5	1,0	-0,7	-0,5	-0,3

Interim values may be interpolated linearly. For buildings with h/d > 5, the coefficient must be determined exactly (see DIN 1055-4).

1.2.3 Dimensioning of mullion-transom façades

As a general rule, the loading areas A applied to a mullion and/or transom are areas < 10 m². For axial dimensions a and b, it is calculated as follows:

$$A = h * (a/2 + b/2)$$



The external pressure coefficients c_{pe} for areas A between 1 m² and 10 m² may be interpolated in accordance with

$$c_{pe} = c_{pe,1} + (c_{pe,10} - c_{pe,1}) * \lg A$$

3. Directives

3.1 Directive governing profiles with a thermal barrier issued by the DIBT (German Institute for Building Technology)

The "Directive Governing the Verification of the Stability of Metal Profiles with Thermal Barriers"[1] governs the assessment by the building supervisory authority of thermally insulated and thermally separated aluminium profiles with regard to their long-term stability. It is intended in particular for structural engineers and the building supervisory authority.
Its validity is restricted to the main bearing members (supports, transoms etc.) of facades and window walls in accordance with DIN 18 056: 1966 – 06 with a width and/or height ≥ 2 m and a total area ≥ 9 m². It does not apply to components in up to two complete storeys and/or 8 m above height above ground or to floor-to-floor window elements at the back of terraces or balconies.

For profiles within the directive's scope, the system manufacturer must indicate the effective moments of inertia depending on the relevant distance between supports. As these take into account the influence of the composite parameters, this information always meets the directive's requirements. In accordance with the Conformity to Building and Construction Act[2] compliance with the directive is to be confirmed by a declaration of conformity by the system manufacturer on the basis of a general test certificate issued by the building supervisory authority.
Attention: With regard to static requirements must be pointed out that the indicated effective moments of inertia $I_{x,id}$ are based solely on a limitation of deflection of 1/300 of the distance between supports. This means that thermally separated aluminium profiles must conform to this limitation of deflection even if other regulations permit greater deflection (e.g. TRLV, see Chap. 3.2).

Pre-dimensioning by the metal window manufacturer is carried out as usual by means of the standard calculation method. In the directive's scope, the effective moments of inertia $I_{x,id}$ are used instead of the moments of inertia I_x depending on the distance between supports.

Verification by the structural engineer must be carried out in accordance with the "Draft directive for establishing and testing electronic stability verification". On request, the characteristics of the elastic composite established by an officially recognized authority will be made available by the system manufacturers to serve as dimensioning limits.

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1) The complete directive text has been published in the notifications of the German Institute for Building Technology no. 17 (1986), vol. 6, p. 197 ff.
2) The Conformity to Building and Construction Act applicable for the relevant case can be obtained from the publishers Ernst & Sohn, Bühringstraße 10, 13086 Berlin.

3.2 Technical regulations regarding the use of in-line bedded glazing (TRLV)[3]

The regulations of the German Institute for Building Technologies apply to glazing which is bedded continuously in-line on at least two opposite sides. They apply to both vertical and overhead glazing. In accordance with the Conformity to Building and Construction Law, metal constructors must confirm compliance with these technical regulations by means of a certificate of conformity.
Along with requirements with regard to the dimensioning of individual panes limiting values for the deflection of the supporting structure are indicated: the deflection of supporting profiles must not exceed 1/200 of the supported pane length, with the maximum value being 15 mm.
However, the glazing guidelines issued by the insulating glass manufacturer may restrict the maximum deflection still further (e.g. 1/300 of pane length, max. 8 mm).

3.3 Technical regulations regarding the use of crash-safe glazing (TRAV)[4]

The regulations of the German Institute for Building Technology apply to mechanically retained crash-safe glazing that secures a difference in altitude of more than 1 m. The static effects to be expected for the crash-safe glazing, such as wind load and beam load, are defined by DIN 1055. In case of insulating glass, climatic influences must be considered as well (see TRLV). In case of simultaneous wind load (w) and beam load (h), the least favourable of the two load combinations w + h/2 or h + w/2 may be taken as a reference load.
Mathematical proof of the bearing capacity is required for glazing and support construction.

3.4 Glazing guidelines - blocking

The glass loads are transmitted via setting blocks to the supporting construction. The number and position of the setting blocks depend on the type of glazing (opening sashes, fixed glazing). As a standard, the distance between the setting blocks and the glass corner is 100 mm. For fixed glazing and transoms with a wide span, it can be particularly advisable to shift the position of the setting blocks in the direction of the glass corner in order to limit transom deflection.
Because the glass breakage risk can be increased depending on the type of glass, it is absolutely necessary to co-ordinate measures of this kind beforehand with the glass manufacturer.

4. Static pre-dimensioning

4.1 Coordiante system

In contrast to the definition in DIN 1080 - 1, the following coordinate system is used in the present documents:

4.2 Determination of the required moment of inertia I_x

As with any other structural component of a building, glass-bearing aluminium constructions must be sufficiently dimensioned with regard to statics. For this purpose it must be ensured that the profiles used do not exceed the maximum permissible deformations in the case of wind load, or, where applicable, impact stress (beam load).

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3 The "Technical regulations regarding the use of in-line bedded glazing" have been published in the notifications of the DIBt 6/1998 and can be obtained from the publishers Ernst & Sohn, Bühringstraße 10, 13086. The complete text, with extensive explanations, can also be found in: i.f.t Rosenheim (ed.); i.f.t forum 1/00 Linienförmig gelagerte Verglasungen [In-line bedded glazing]; Rosenheim 1999.

4 The "Technical regulations regarding the use of crash-safe glazing – draft of March 2001" have been published in the notification of the DIBt of 3/2001 which can be obtained from the publishers Ernst & Sohn, Bühringstraße 10, 13086.

Table 1: Maximum deflection $f_{perm.}$ in dependence on the distance between supports l

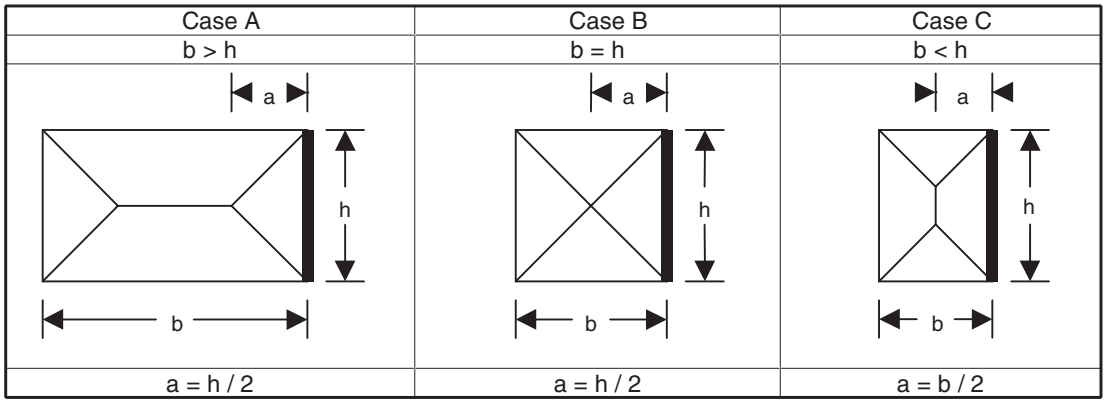
Application	Type of profile	Max. deflection
Vertical	Profiles made entirely of aluminium	f ≤ l/200, max 15 mm
	Thermally separated profiles	f ≤ l/300, max 15 mm
Overhead (inclination > 10° with regard to vertical line)	Profiles made entirely of aluminium	f ≤ l/200, max 15 mm
	Thermally separated profiles	f ≤ l/300, max 15 mm

*) only range of pane edge

With window elements (single cavity windows), only self-supporting transom profiles require static verification. Dimensioning of profiles joined to the brickwork is not necessary.

Loads acting on large areas of an external element (e.g. wind load) are subdivided into trapezoid and/or triangular loads and assigned individually to horizontal or vertical bearing members (cf. Fig. 1).

Figure 1: Subdivision into trapezoid and/or triangular loads (a = load width, referring to the vertical bearing member)



The resulting load widths a enable the required moment of inertia I_x to be derived from Table 2 or 3 respectively. If the bearing member is subjected to load from two sides, I_x must be defined individually for each load width a and both I_x values must be added.

The moments of inertia I_x in the tables on page 12 – 15 are standardized to a velocity pressure q = 1.0 kN/m². Depending on the wind zone and the building height (see Table 2), the calculated required moment of inertia must be multiplied by the velocity pressure q.

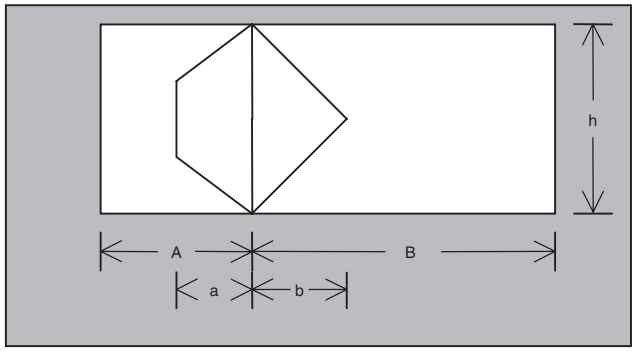
4.3 Example of a calculation for thermally separated aluminium profile

Mullion pre-dimensioning

Wind zone 2, Inland
10-18 m above ground

$q = 0{,}80\ kN/m^2$

Pane width	A	120 cm
Pane width	B	320 cm
Pane height	h	300 cm
Load width (Case C)	a	60 cm
Load width (Case A)	b	150 cm



Required I_x in accordance with Table 2:

$I_{x,a}$	=	84,7 cm^4
$I_{x,b}$	=	144,6 cm^4
$I_{x,total}$	=	229,3 cm^4

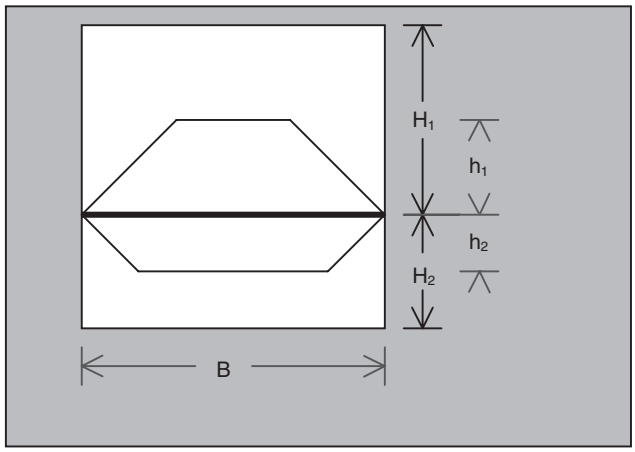
$I_{x,erf} = q \cdot I_{x,\,total} = 0{,}8 \cdot 229{,}3\ cm^4 =$ **183,5 cm^4**

Transom pre-dimensioning

Wind zone 2, Inland
10-18 m above ground

$q = 0{,}80\ kN/m^2$

Pane width	B	200 cm
Pane height	H_1	200 cm
Pane height	H_2	100 cm
Load width (Case C)	h_1	100 cm
Load width (Case C)	h_2	50cm



Required I_x in accordance with Table 2:

$I_{x,1}$	=	28,6 cm^4
$I_{x,2}$	=	20,1 cm^4
$I_{x,total}$	=	48,7 cm^4

$I_{x,erf} = F_w \cdot I_{x,total} = 0{,}8 \cdot 48{,}7\ cm^4 =$ **39,0 cm^4**

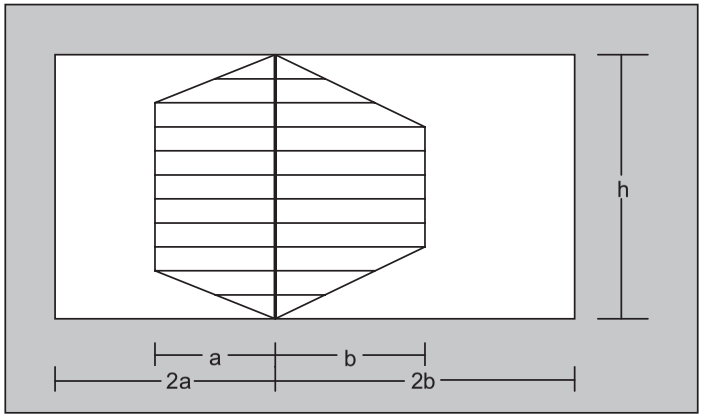
Determination of required moments of inertia I_x (cm⁴)

Modulus of elasticity aluminium 7000 kN/cm²

Deflection **f = l/200, max. 15 mm**
Wind load **1.0** kN/m²

Profiles made entirely of aluminium • Trapezoidar distributed load

h [cm]	Load width a or b respectively [cm]																			
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
100	0,7	1,0	1,1	1,2																
110	0,9	1,3	1,6	1,7																
120	1,2	1,7	2,1	2,4	2,5															
130	1,6	2,2	2,8	3,2	3,4															
140	2,0	2,8	3,6	4,1	4,5	4,6														
150	2,4	3,5	4,5	5,2	5,7	6,0														
160	3,0	4,3	5,5	6,5	7,2	7,7	7,8													
170	3,6	5,2	6,7	7,9	8,9	9,6	9,9													
180	4,3	6,2	8,0	9,6	10,8	11,7	12,3	12,5												
190	5,0	7,4	9,5	11,4	13,0	14,2	15,0	15,5												
200	5,9	8,6	11,2	13,4	15,4	17,0	18,1	18,8	19,0											
210	6,8	10,0	13,0	15,7	18,1	20,0	21,5	22,6	23,1											
220	7,8	11,5	15,0	18,2	21,0	23,4	25,3	26,7	27,6	27,9										
230	8,9	13,2	17,2	21,0	24,3	27,2	29,5	31,4	32,6	33,2										
240	10,2	15,0	19,7	24,0	27,8	31,3	34,2	36,5	38,1	39,2	39,5									
250	11,5	17,0	22,3	27,2	31,7	35,7	39,2	42,0	44,2	45,7	46,4									
260	13,0	19,2	25,2	30,8	36,0	40,6	44,7	48,1	50,8	52,8	54,0	54,4								
270	14,5	21,5	28,3	34,6	40,5	45,9	50,6	54,7	58,0	60,6	62,3	63,2								
280	16,2	24,1	31,6	38,8	45,5	51,6	57,1	61,9	65,9	69,0	71,3	72,7	73,2							
290	18,0	26,8	35,2	43,2	50,8	57,7	64,0	69,6	74,3	78,2	81,1	83,1	84,1							
300	19,9	29,7	39,0	48,0	56,5	64,3	71,5	77,9	83,4	88,0	91,7	94,3	95,9	96,4						
310	22,8	33,8	44,6	54,9	64,7	73,8	82,1	89,6	96,3	101,9	106,5	109,9	112,3	113,5						
320	25,8	38,5	50,7	62,5	73,7	84,2	93,9	102,7	110,5	117,3	122,9	127,4	130,6	132,5	133,2					
330	29,2	43,5	57,5	70,9	83,6	95,7	106,8	117,1	126,3	134,3	141,1	146,7	150,9	153,7	155,1					
340	33,0	49,1	64,8	80,0	94,5	108,3	121,1	132,9	143,6	153,0	161,2	168,0	173,3	177,2	179,5	180,3				
350	37,0	55,2	72,9	90,0	106,5	122,1	136,7	150,2	162,6	173,6	183,3	191,5	198,1	203,1	206,5	208,2				
360	41,5	61,8	81,7	101,0	119,5	137,1	153,7	169,2	183,4	196,2	207,5	217,2	225,3	231,7	236,3	239,0	239,9			
370	46,3	69,0	91,2	112,8	133,6	153,5	172,3	189,8	206,0	220,8	233,9	245,4	255,1	263,0	268,9	272,9	274,9			
380	51,5	76,8	101,6	125,7	149,0	171,3	192,4	212,3	230,7	247,6	262,8	276,1	287,7	297,2	304,7	310,1	313,3	314,4		
390	57,1	85,3	112,8	139,7	165,7	190,6	214,3	236,7	257,5	276,7	294,1	309,6	323,1	334,5	343,7	350,7	355,4	357,7		
400	63,2	94,4	125,0	154,8	183,7	211,5	238,0	263,0	286,5	308,2	328,1	345,9	361,6	375,1	386,2	395,0	401,3	405,1	406,3	
450	101,4	151,5	200,8	249,3	296,5	342,3	386,5	428,8	469,1	507,2	542,8	575,7	605,9	633,2	657,4	678,3	696,0	710,2	721,0	728,2
500	154,6	231,2	306,9	381,3	454,4	525,7	594,9	661,9	726,2	787,8	846,3	901,5	953,2	1001,2	1045,2	1085,2	1120,8	1152,0	1178,7	1200,6
550	226,5	338,8	450,1	559,9	667,9	773,9	877,3	978,0	1075,5	1169,6	1260,0	1346,3	1428,2	1505,6	1578,1	1645,5	1707,5	1764,0	1814,7	1859,5
600	320,9	480,2	638,3	794,7	948,9	1100,6	1249,4	1394,8	1536,5	1674,1	1807,1	1935,3	2058,3	2175,7	2287,2	2392,5	2491,3	2583,3	2668,3	2745,9
650	442,1	661,8	880,1	1096,4	1310,1	1520,9	1728,2	1931,6	2130,6	2324,7	2513,5	2696,5	2873,3	3043,5	3206,7	3362,6	3510,6	3650,5	3782,0	3904,7
700	594,7	890,6	1184,8	1476,6	1765,5	2051,0	2332,4	2609,3	2881,0	3147,0	3406,9	3660,0	3905,9	4144,0	4374,0	4595,2	4807,4	5009,9	5202,5	5384,6
750	783,8	1174,1	1562,3	1947,9	2330,2	2708,4	3082,1	3450,4	3812,9	4168,8	4517,5	4858,5	5191,2	5514,9	5829,1	6133,2	6426,7	6709,1	6979,9	7238,6
800	1014,9	1520,4	2023,6	2523,8	3020,3	3512,1	3998,7	4479,3	4953,2	5419,6	5877,8	6327,1	6766,9	7196,5	7615,2	8022,3	8417,3	8799,5	9168,3	9523,1



h = Distance between supports in cm
a = Load width in cm
b = Load width in cm

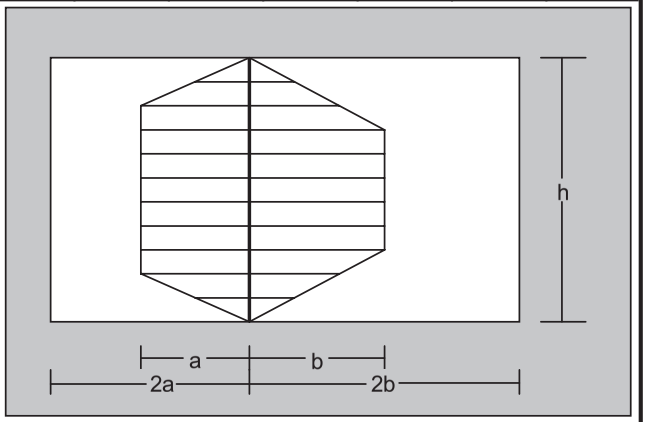
Determination of required moments of inertia I_x (cm⁴)

Modulus of elasticity aluminium 7000 kN/cm²

Deflection **f = l/300, max. 15 mm**
Wind load **1.0** kN/m²

Thermally separated profiles • Trapezoidar distributed load

h [cm]	Load width a or b respectively [cm]																			
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
100	1,0	1,4	1,7	1,8																
110	1,4	2,0	2,4	2,6																
120	1,8	2,6	3,2	3,6	3,7															
130	2,4	3,4	4,2	4,8	5,1															
140	3,0	4,3	5,4	6,2	6,7	6,9														
150	3,7	5,3	6,7	7,8	8,6	9,0														
160	4,5	6,5	8,3	9,7	10,8	11,5	11,7													
170	5,4	7,8	10,0	11,9	13,3	14,3	14,9													
180	6,4	9,3	12,0	14,3	16,2	17,6	18,5	18,7												
190	7,5	11,0	14,2	17,1	19,4	21,3	22,6	23,2												
200	8,8	12,9	16,7	20,1	23,1	25,4	27,2	28,2	28,6											
210	10,2	15,0	19,5	23,5	27,1	30,0	32,3	33,8	34,6											
220	11,7	17,3	22,5	27,3	31,5	35,1	38,0	40,1	41,4	41,8										
230	13,4	19,8	25,9	31,4	36,4	40,7	44,3	47,1	48,9	49,9										
240	15,3	22,6	29,5	35,9	41,8	46,9	51,2	54,7	57,2	58,7	59,2									
250	17,3	25,6	33,5	40,9	47,6	53,6	58,8	63,0	66,3	68,5	69,6									
260	19,4	28,8	37,8	46,2	53,9	60,9	67,0	72,2	76,2	79,2	81,0	81,6								
270	21,8	32,3	42,4	51,9	60,8	68,8	76,0	82,1	87,1	90,9	93,4	94,7								
280	24,3	36,1	47,4	58,2	68,2	77,4	85,6	92,8	98,8	103,5	107,0	109,1	109,8							
290	27,0	40,1	52,8	64,9	76,2	86,6	96,0	104,3	111,4	117,2	121,6	124,6	126,1							
300	29,9	44,5	58,6	72,0	84,7	96,5	107,2	116,8	125,1	132,0	137,5	141,4	143,8	144,6						
310	33,0	49,1	64,7	79,7	93,9	107,1	119,2	130,1	139,7	147,9	154,5	159,6	163,0	164,7						
320	36,3	54,1	71,3	87,9	103,6	118,4	132,0	144,4	155,4	164,9	172,8	179,1	183,6	186,3	187,2					
330	39,9	59,4	78,3	96,6	114,0	130,5	145,7	159,6	172,2	183,1	192,4	200,0	205,7	209,6	211,5					
340	43,6	65,0	85,8	105,9	125,1	143,3	160,3	175,9	190,0	202,5	213,4	222,3	229,4	234,5	237,6	238,6				
350	47,6	70,9	93,7	115,8	136,9	156,9	175,7	193,2	209,0	223,2	235,6	246,2	254,7	261,2	265,5	267,7				
360	51,8	77,2	102,1	126,2	149,3	171,4	192,2	211,5	229,2	245,2	259,4	271,5	281,6	289,6	295,3	298,8	299,9			
370	56,3	83,9	111,0	137,2	162,5	186,7	209,5	230,9	250,6	268,5	284,5	298,5	310,3	319,8	327,1	331,9	334,4			
380	61,0	90,9	120,3	148,9	176,5	202,9	227,9	251,4	273,2	293,2	311,2	327,0	340,6	351,9	360,8	367,2	371,1	372,3		
390	65,9	98,4	130,2	161,2	191,2	219,9	247,3	273,1	297,1	319,3	339,3	357,2	372,8	386,0	396,6	404,7	410,1	412,8		
400	71,1	106,2	140,6	174,1	206,6	237,9	267,7	295,9	322,3	346,8	369,1	389,1	406,8	422,0	434,5	444,4	451,4	455,7	457,1	
450	101,4	151,5	200,8	249,3	296,5	342,3	386,5	428,8	469,1	507,2	542,8	575,7	605,9	633,2	657,4	678,3	696,0	710,2	721,0	728,2
500	154,6	231,2	306,9	381,3	454,4	525,7	594,9	661,9	726,2	787,8	846,3	901,5	953,2	1001,2	1045,2	1085,2	1120,8	1152,0	1178,7	1200,6
550	226,5	338,8	450,1	559,9	667,9	773,9	877,3	978,0	1075,5	1169,6	1260,0	1346,3	1428,2	1505,6	1578,1	1645,5	1707,5	1764,0	1814,7	1859,5
600	320,9	480,2	638,3	794,7	948,9	1100,6	1249,4	1394,8	1536,5	1674,1	1807,1	1935,3	2058,3	2175,7	2287,2	2392,5	2491,3	2583,3	2668,3	2745,9
650	442,1	661,8	880,1	1096,4	1310,1	1520,9	1728,2	1931,6	2130,6	2324,7	2513,5	2696,5	2873,3	3043,5	3206,7	3362,6	3510,6	3650,5	3782,0	3904,7
700	594,7	890,6	1184,8	1476,6	1765,5	2051,0	2332,4	2609,3	2881,0	3147,0	3406,9	3660,0	3905,9	4144,0	4374,0	4595,2	4807,4	5009,9	5202,5	5384,6
750	783,8	1174,1	1562,3	1947,9	2330,2	2708,4	3082,1	3450,4	3812,9	4168,8	4517,5	4858,5	5191,2	5514,9	5829,1	6133,2	6426,7	6709,1	6979,9	7238,6
800	1014,9	1520,4	2023,6	2523,8	3020,3	3512,1	3998,7	4479,3	4953,2	5419,6	5877,8	6327,1	6766,9	7196,5	7615,2	8022,3	8417,3	8799,5	9168,3	9523,1



h = Distance between supports in cm
a = Load width in cm
b = Load width in cm

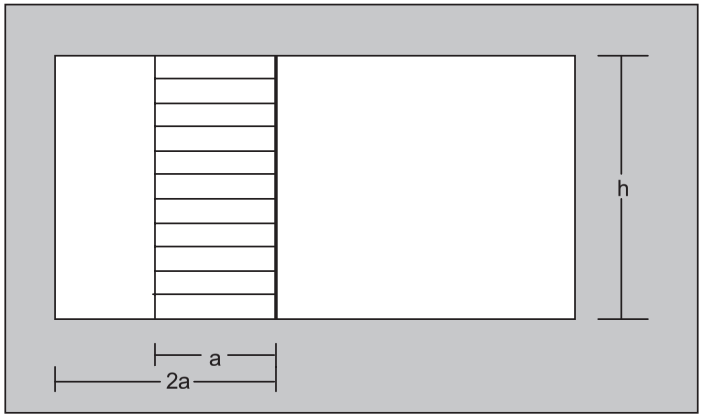
Determination of required moments of inertia I_x (cm⁴)

Modulus of elasticity aluminium 7000 kN/cm²

Deflection **f = l/200, max. 15 mm**
Wind load **1.0** kN/m²

Profiles made entirely of aluminium • Uniformly distributed load

h [cm]	Load width a or b respectively [cm]																			
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
100	0,7	1,1	1,5	1,9																
110	1,0	1,5	2,0	2,5																
120	1,3	1,9	2,6	3,2	3,9															
130	1,6	2,5	3,3	4,1	4,9															
140	2,0	3,1	4,1	5,1	6,1	7,1														
150	2,5	3,8	5,0	6,3	7,5	8,8														
160	3,0	4,6	6,1	7,6	9,1	10,7	12,2													
170	3,7	5,5	7,3	9,1	11,0	12,8	14,6													
180	4,3	6,5	8,7	10,8	13,0	15,2	17,4	19,5												
190	5,1	7,7	10,2	12,8	15,3	17,9	20,4	23,0												
200	6,0	8,9	11,9	14,9	17,9	20,8	23,8	26,8	29,8											
210	6,9	10,3	13,8	17,2	20,7	24,1	27,6	31,0	34,5											
220	7,9	11,9	15,8	19,8	23,8	27,7	31,7	35,7	39,6	43,6										
230	9,1	13,6	18,1	22,6	27,2	31,7	36,2	40,7	45,3	49,8										
240	10,3	15,4	20,6	25,7	30,9	36,0	41,1	46,3	51,4	56,6	61,7									
250	11,6	17,4	23,3	29,1	34,9	40,7	46,5	52,3	58,1	63,9	69,8									
260	13,1	19,6	26,2	32,7	39,2	45,8	52,3	58,8	65,4	71,9	78,5	85,0								
270	14,6	22,0	29,3	36,6	43,9	51,3	58,6	65,9	73,2	80,5	87,9	95,2								
280	16,3	24,5	32,7	40,8	49,0	57,2	65,3	73,5	81,7	89,8	98,0	106,2	114,3							
290	18,1	27,2	36,3	45,4	54,4	63,5	72,6	81,7	90,7	99,8	108,9	118,0	127,0							
300	20,1	30,1	40,2	50,2	60,3	70,3	80,4	90,4	100,4	110,5	120,5	130,6	140,6	150,7						
310	22,9	34,4	45,8	57,3	68,7	80,2	91,6	103,1	114,5	126,0	137,4	148,9	160,3	171,8						
320	26,0	39,0	52,0	65,0	78,0	91,0	104,0	117,0	130,0	143,0	156,0	169,0	182,0	195,0	208,1					
330	29,4	44,1	58,8	73,5	88,2	102,9	117,7	132,4	147,1	161,8	176,5	191,2	205,9	220,6	235,3					
340	33,1	49,7	66,3	82,9	99,4	116,0	132,6	149,1	165,7	182,3	198,9	215,4	232,0	248,6	265,1	281,7				
350	37,2	55,8	74,4	93,0	111,7	130,3	148,9	167,5	186,1	204,7	223,3	241,9	260,5	279,1	297,7	316,4				
360	41,7	62,5	83,3	104,1	125,0	145,8	166,6	187,5	208,3	229,1	249,9	270,8	291,6	312,4	333,3	354,1	374,9			
370	46,5	69,7	93,0	116,2	139,4	162,7	185,9	209,2	232,4	255,7	278,9	302,1	325,4	348,6	371,9	395,1	418,3			
380	51,7	77,6	103,4	129,3	155,1	181,0	206,9	232,7	258,6	284,4	310,3	336,1	362,0	387,9	413,7	439,6	465,4	491,3		
390	57,4	86,1	114,8	143,4	172,1	200,8	229,5	258,2	286,9	315,6	344,3	373,0	401,6	430,3	459,0	487,7	516,4	545,1		
400	63,5	95,2	127,0	158,7	190,5	222,2	254,0	285,7	317,5	349,2	381,0	412,7	444,4	476,2	507,9	539,7	571,4	603,2	634,9	
450	101,7	152,6	203,4	254,3	305,1	356,0	406,8	457,7	508,5	559,4	610,2	661,1	711,9	762,8	813,6	864,5	915,3	966,2	1017,0	1067,9
500	155,0	232,5	310,0	387,5	465,0	542,5	620,0	697,5	775,0	852,6	930,1	1007,6	1085,1	1162,6	1240,1	1317,6	1395,1	1472,6	1550,1	1627,6
550	227,0	340,4	453,9	567,4	680,9	794,3	907,8	1021,3	1134,8	1248,2	1361,7	1475,2	1588,7	1702,1	1815,6	1929,1	2042,6	2156,0	2269,5	2383,0
600	321,4	482,1	642,9	803,6	964,3	1125,0	1285,7	1446,4	1607,1	1767,9	1928,6	2089,3	2250,0	2410,7	2571,4	2732,1	2892,9	3053,6	3214,3	3375,0
650	442,7	664,1	885,4	1106,8	1328,2	1549,5	1770,9	1992,3	2213,6	2435,0	2656,3	2877,7	3099,1	3320,4	3541,8	3763,2	3984,5	4205,9	4427,2	4648,6
700	595,5	893,2	1191,0	1488,7	1786,5	2084,2	2381,9	2679,7	2977,4	3275,2	3572,9	3870,7	4168,4	4466,1	4763,9	5061,6	5359,4	5657,1	5954,9	6252,6
750	784,7	1177,1	1569,5	1961,8	2354,2	2746,6	3139,0	3531,3	3923,7	4316,1	4708,4	5100,8	5493,2	5885,5	6277,9	6670,3	7062,6	7455,0	7847,4	8239,7
800	1015,9	1523,8	2031,7	2539,7	3047,6	3555,6	4063,5	4571,4	5079,4	5587,3	6095,2	6603,2	7111,1	7619,0	8127,0	8634,9	9142,9	9650,8	10158,7	10666,7



h = Distance between supports in cm
a = Load width in cm

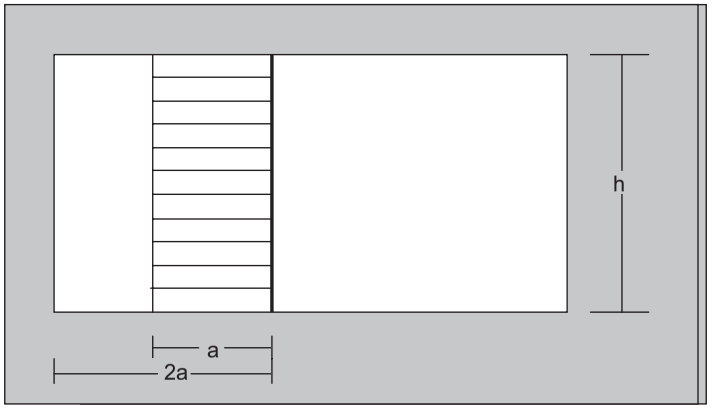
Determination of required moments of inertia I_x (cm⁴)

Modulus of elasticity aluminium 7000 kN/cm²

Deflection **f = l/300, max. 15 mm**
Wind load **1.0** kN/m²

Thermally separated profiles • Uniformly distributed load

h [cm]	Load width a or b respectively [cm]																			
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
100	1,1	1,7	2,2	2,8																
110	1,5	2,2	3,0	3,7																
120	1,9	2,9	3,9	4,8	5,8															
130	2,5	3,7	4,9	6,1	7,4															
140	3,1	4,6	6,1	7,7	9,2	10,7														
150	3,8	5,7	7,5	9,4	11,3	13,2														
160	4,6	6,9	9,1	11,4	13,7	16,0	18,3													
170	5,5	8,2	11,0	13,7	16,4	19,2	21,9													
180	6,5	9,8	13,0	16,3	19,5	22,8	26,0	29,3												
190	7,7	11,5	15,3	19,1	23,0	26,8	30,6	34,4												
200	8,9	13,4	17,9	22,3	26,8	31,3	35,7	40,2	44,6											
210	10,3	15,5	20,7	25,8	31,0	36,2	41,3	46,5	51,7											
220	11,9	17,8	23,8	29,7	35,7	41,6	47,5	53,5	59,4	65,4										
230	13,6	20,4	27,2	33,9	40,7	47,5	54,3	61,1	67,9	74,7										
240	15,4	23,1	30,9	38,6	46,3	54,0	61,7	69,4	77,1	84,9	92,6									
250	17,4	26,2	34,9	43,6	52,3	61,0	69,8	78,5	87,2	95,9	104,6									
260	19,6	29,4	39,2	49,0	58,8	68,7	78,5	88,3	98,1	107,9	117,7	127,5								
270	22,0	33,0	43,9	54,9	65,9	76,9	87,9	98,9	109,8	120,8	131,8	142,8								
280	24,5	36,8	49,0	61,3	73,5	85,8	98,0	110,3	122,5	134,8	147,0	159,3	171,5							
290	27,2	40,8	54,4	68,0	81,7	95,3	108,9	122,5	136,1	149,7	163,3	176,9	190,5							
300	30,1	45,2	60,3	75,3	90,4	105,5	120,5	135,6	150,7	165,7	180,8	195,9	210,9	226,0						
310	33,2	49,9	66,5	83,1	99,7	116,4	133,0	149,6	166,2	182,9	199,5	216,1	232,7	249,4						
320	36,6	54,9	73,1	91,4	109,7	128,0	146,3	164,6	182,9	201,1	219,4	237,7	256,0	274,3	292,6					
330	40,1	60,2	80,2	100,3	120,3	140,4	160,4	180,5	200,5	220,6	240,6	260,7	280,8	300,8	320,9					
340	43,9	65,8	87,7	109,7	131,6	153,5	175,5	197,4	219,3	241,3	263,2	285,1	307,1	329,0	350,9	372,9				
350	47,9	71,8	95,7	119,6	143,6	167,5	191,4	215,3	239,3	263,2	287,1	311,0	335,0	358,9	382,8	406,7				
360	52,1	78,1	104,1	130,2	156,2	182,3	208,3	234,3	260,4	286,4	312,4	338,5	364,5	390,5	416,6	442,6	468,6			
370	56,5	84,8	113,1	141,3	169,6	197,9	226,1	254,4	282,7	310,9	339,2	367,5	395,7	424,0	452,3	480,5	508,8			
380	61,2	91,9	122,5	153,1	183,7	214,3	245,0	275,6	306,2	336,8	367,4	398,1	428,7	459,3	489,9	520,5	551,2	581,8		
390	66,2	99,3	132,4	165,5	198,6	231,7	264,8	297,9	331,0	364,1	397,2	430,3	463,4	496,5	529,6	562,7	595,8	628,9		
400	71,4	107,1	142,9	178,6	214,3	250,0	285,7	321,4	357,1	392,9	428,6	464,3	500,0	535,7	571,4	607,1	642,9	678,6	714,3	
450	101,7	152,6	203,4	254,3	305,1	356,0	406,8	457,7	508,5	559,4	610,2	661,1	711,9	762,8	813,6	864,5	915,3	966,2	1017,0	1067,9
500	155,0	232,5	310,0	387,5	465,0	542,5	620,0	697,5	775,0	852,6	930,1	1007,6	1085,1	1162,6	1240,1	1317,6	1395,1	1472,6	1550,1	1627,6
550	227,0	340,4	453,9	567,4	680,9	794,3	907,8	1021,3	1134,8	1248,2	1361,7	1475,2	1588,7	1702,1	1815,6	1929,1	2042,6	2156,0	2269,5	2383,0
600	321,4	482,1	642,9	803,6	964,3	1125,0	1285,7	1446,4	1607,1	1767,9	1928,6	2089,3	2250,0	2410,7	2571,4	2732,1	2892,9	3053,6	3214,3	3375,0
650	442,7	664,1	885,4	1106,8	1328,2	1549,5	1770,9	1992,3	2213,6	2435,0	2656,3	2877,7	3099,1	3320,4	3541,8	3763,2	3984,5	4205,9	4427,2	4648,6
700	595,5	893,2	1191,0	1488,7	1786,5	2084,2	2381,9	2679,7	2977,4	3275,2	3572,9	3870,7	4168,4	4466,1	4763,9	5061,6	5359,4	5657,1	5954,9	6252,6
750	784,7	1177,1	1569,5	1961,8	2354,2	2746,6	3139,0	3531,3	3923,7	4316,1	4708,4	5100,8	5493,2	5885,5	6277,9	6670,3	7062,6	7455,0	7847,4	8239,7
800	1015,9	1523,8	2031,7	2539,7	3047,6	3555,6	4063,5	4571,4	5079,4	5587,3	6095,2	6603,2	7111,1	7619,0	8127,0	8634,9	9142,9	9650,8	10158,7	10666,7



h = Distance between supports in cm
a = Load width in cm

4.4 Determination of required moments of inertia based on transom deflection

The maximum transom deflection is limited to 3 mm.
Deflection is calculated using equation (1) which does not consider the transom's dead weight.

$$I_{y,\,req} = \frac{\frac{G}{2} \cdot a \cdot (3l^2 - 4a^2)}{24 \cdot E \cdot f} \quad (1)$$

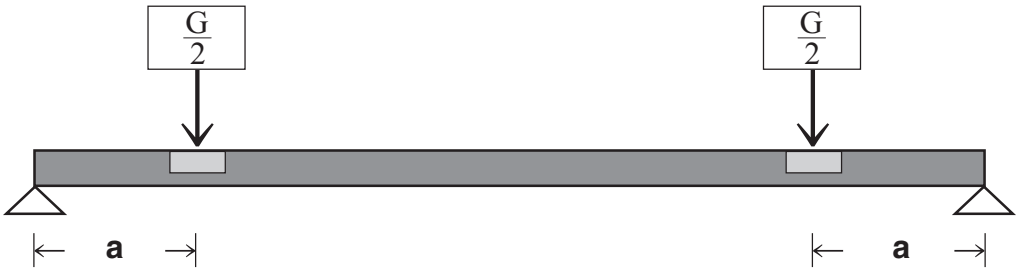
G	Force of insert element
a	Distance between centre of setting block and transom edge
I	Transom length
E	Modulus of elasticity aluminium (7000 kN/cm²)
f	Transom deflection (max. 3 mm in accordance with pr EN 13830)

The equation can be resolved as follows

$$\frac{I_{y,\,req}}{G} = \frac{a \cdot (3l^2 - 4a^2)}{2 \cdot 24 \cdot E \cdot f} \quad (2)$$

The illustration below shows the equation for three variants:

a = 150 mm	corresponds to 100 mm distance between the setting block and the glass corner, in accordance with standard glazing guidelines
a = 120 mm	70 mm distance between setting block and glass corner
a = 100 mm	50 mm distance between setting block and glass corner



**If the distance between the setting block and the glass corner is less than 100 mm, blocking requires individual authorization by the glazing industry.
However, the consent of the glass manufacturer must be obtained in any case.**

Diagram 1

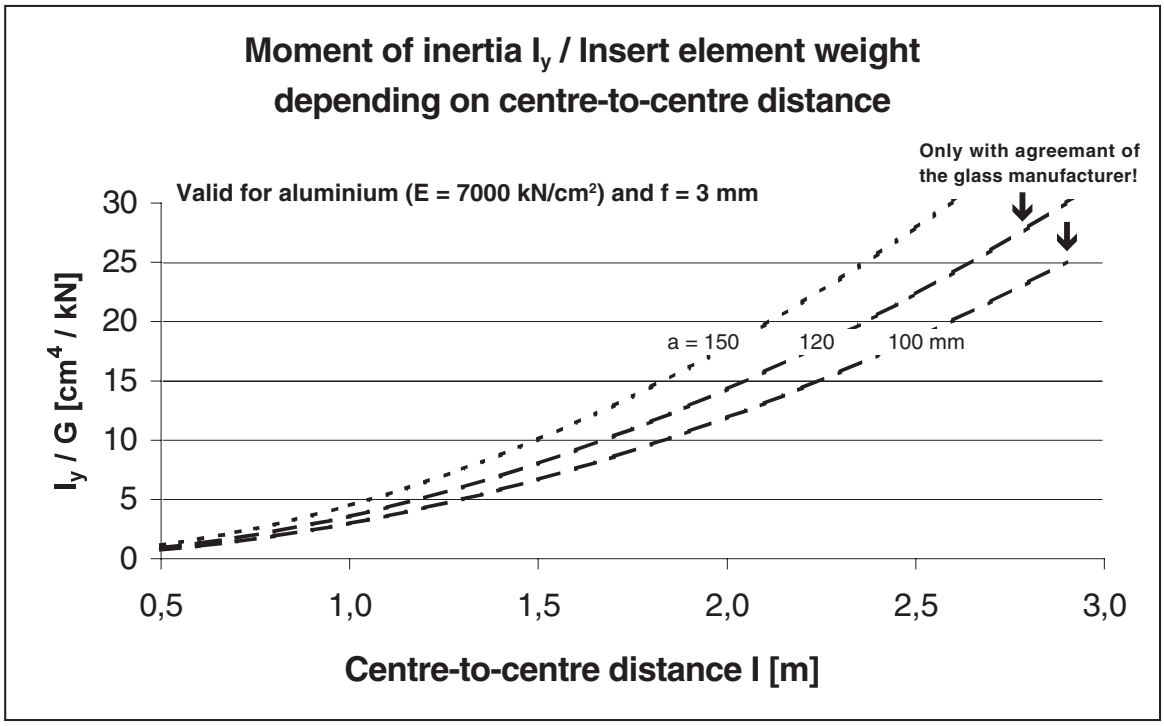


Diagram 1 enable the following values to be determined:

1. Required: permissible centre-to-centre distance
Given: moment of inertia and insert element weight

$$\text{Adm. transom length [m]} = \text{Reading value}\left(\frac{I_{y\,ex.}\ [cm^4]}{G_{ex.}\ [kN]}\right)$$

2. Required: permissible insert element weight
Given: moment of inertia and centre-to-centre distance

$$G_{perm.}\,[kN] = \frac{I_{y\,ex.}\ [cm^4]}{\text{Reading value}\left(\frac{l}{G}\right)}$$

$I_{y\,ex.}$ Existing moment of inertia of transom

$I_{y\,req.}$ Required moment of inertia of transom

$G_{ex.}$ Existing insert element weight

$G_{perm.}$ Permitted insert element weight

3. Required: permissible moment of inertia
Given: insert element weight and centre-to-centre distance

$$I_{y\,req.}\,[cm^4] = \text{Reading value}\left(\frac{l}{G}\right)\cdot G_{ex.}\,[kN]$$

4.5 Load table for glass retainers and T-brackets VF50RR

Tables 4.5.1 to 4.5.3 are valid for wind loads up to 1.1 kN/m² and a mullion centre-to-centre distance up to 3 m. The indicated unit area up up to 4 m² and up to 6 m² equals horizontal axis x vertical axis.
Transom deflection is not taken into consideration but is determined in diagram 1 under 3.4
The required moments of inertia for the system profiles can be derived from Table 1 under 3.3

4.5.1 Load table for glass retainers and standard T-brackets VF50RR

			Transom 519351		Transom 519352		Transom 519353		Transom 519354/55/56	
			Max. insert element weight [kN]		Max. insert element weight [kN]		Max. insert element weight [kN]		Max. insert element weight [kN]	
Glass retainer		Insert element [mm]	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²
Standard	911810	20 to 28	2.18	1.93	2.77	2.45	3.21	2.83	3.47	3.06
	911811	30 to 38	1.96	1.74	2.55	2.25	2.60	2.60	2.60	2.60
	911898	40 to 48	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Reinforced	912727	20 to 28	Not required	Not required	Not required	Not required	Not required	Not required	Not required	Not required
	912728	30 to 38	Not required	Not required	Not required	Not required	3.00	2.66	3.00	2.90
	912729	40 to 48	1.79	1.58	2.37	2.09	2.40	2.40	2.40	2.40

4.5.2 Load table for glass retainers and T-brackets with spring pin VF50RR

			Transom 519351		Transom 519352		Transom 519353		Transom 519354/55/56	
			Max. insert element weight [kN]		Max. insert element weight [kN]		Max. insert element weight [kN]		Max. insert element weight [kN]	
Glass retainer		Insert element [mm]	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²
Standard	911810	20 to 28	1.00	1.00	1.00	1.00	3.21	2.83	3.21	2.83
	911811	30 to 38	1.00	1.00	1.00	1.00	2.60	2.60	2.60	2.60
	911898	40 to 48	1.00	1.00	1.00	1.00	1.30	1.30	1.30	1.30
Reinforced	912727	20 to 28	Not required	Not required	Not required	Not required	Not required	Not required	Not required	Not required
	912728	30 to 38	Not required	Not required	Not required	Not required	3.00	2.66	3.00	2.90
	912729	40 to 48	Not required	Not required	Not required	Not required	2.40	2.40	2.40	2.40

4.5.3 Load table for glass retainers and polygonal T-bracket with at least 2 pins VF50RR

The increased wind loads in the corner area must be noted! The indicated values refer to the load acting on a straight vertical facade. Diminution factors are to be included in accordance with DIN 1055.

			Transom 519351		Transom 519352		Transom 519353		Transom 519354/55/56	
			Max. insert element weight [kN]		Max. insert element weight [kN]		Max. insert element weight [kN]		Max. insert element weight [kN]	
Glass retainer		Insert element [mm]	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²	Unit area up to 4 m²	Unit area up to 6 m²
Standard	911810	20 to 28	2.18	1.93	2.18	1.93	3.21	2.83	3.21	2.83
	911811	30 to 38	1.96	1.74	1.96	1.74	2.60	2.60	2.60	2.60
	911898	40 to 48	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Reinforced	912727	20 to 28	Not required	Not required	Not required	Not required	Not required	Not required	Not required	Not required
	912728	30 to 38	Not required	Not required	Not required	Not required	3,00	2,66	3,00	2,66
	912729	40 to 48	1,79	1,58	1,79	1,58	2,40	2,40	2,40	2,40

Not required means that the T-bracket will carry less load than the reinforced glass retainer, thus a reinforced glass retainer does not permit higher loads.

4.5.4 Load table for glass retainers and T-brackets on sloping roofs VF50RR

This table is valid for an installation angle of between 7° and 80° with regard to the horizontal line and a snow load s = 0.75 kN/m²
The indicated unit areas equal horizontal axis x vertical axis.
Transom deflection is not taken into account!
Determine the required moments of inertia for the system profiles e.g. by means of pre-dimensioning a three-hinged frame!

			Transom 519351	Transom 519352	Transom 519353	Transom 519354/55/56
			Max. insert element weight [kN]	Max. insert element weight [kN]	Max. insert element weight [kN]	Max. insert element weight [kN]
Glass retainer		Filling [mm]	Unit area up to 2.00 m²	Unit area up to 2.25 m²	Unit area up to 2.50 m²	Unit area up to 2.75 m²
Standard	912862	20 to 28	2.18	2.77	2.77	3.47
	912863	30 to 38	1.96	2.55	2.55	2.60
	912864	40 to 48	1.30	1.30	1.30	1.30