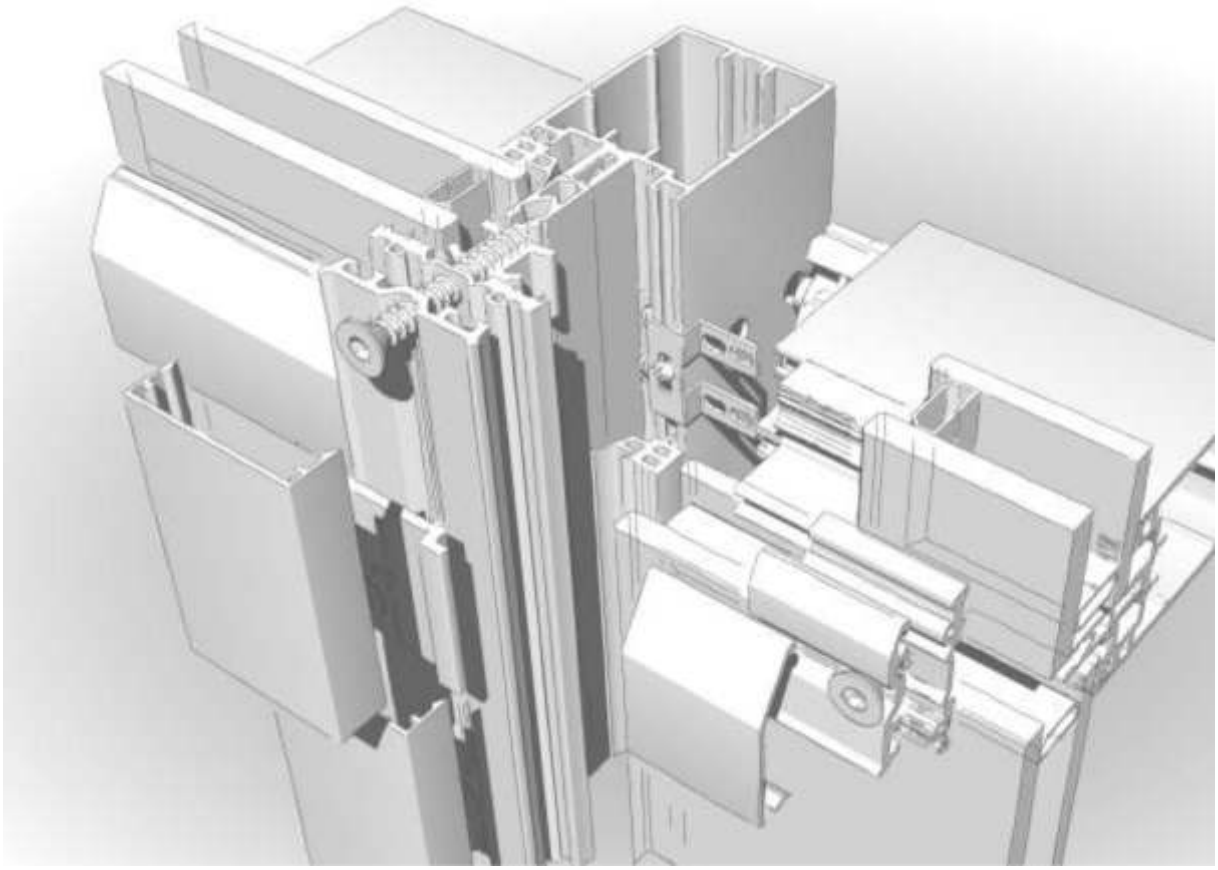

Table of Contents

1. General Information
- 1.1 System features 1.001
- 1.2 Aluminum as a fabrication material 1.003-1.005
- 1.3 Testing results 1.006-1.007
- 1.4 System concept 1.008-1.013
- 1.5 Basic profile overview 1.014-1.017

2. Profiles
- 2.1 Profile overview 2.002-2.005
- 2.2 Mullions / Transoms 2.006-2.010
- 2.3 Face Caps 2.011-2.012
- 2.4 Frames / Sashes 2.013-2.014
- 2.5 Various profiles 2.015-2.018

3. Section Details
- 3.1 Section overview 3.002
- 3.2 Typical sections 3.003-3.006
- 3.3 Door sections 3.007
- 3.4 Window sections 3.008-3.015
- 3.5 Corner sections 3.016-3.017
- 3.6 Curved wall sections 3.018-3.025
- 3.7 Transom details 3.026-3.031
- 3.7 Single glazing 3.032-3.033
- 3.7 Architectural details 3.034-3.038

4. Hardware
- 4.1 Accessories and gaskets 4.002-4.005
- 4.2 Glazing bridges 4.006
- 4.3 Transom cleats 4.007-4.009
- 4.4 Fittings 4.010-4.011
- 4.5 Mounting brackets 4.012-4.014
- 4.6 Spring cleats 4.015
- 4.7 Butyl tape, bolts, screws, etc... 4.016-4.019
- 4.8 Glazing table 4.020-4.022

Table of Contents

5. Manufacturing and Machining

5.1 Cutting list	5.002
5.2 T-cleat table	5.004-5.006
5.3 T-cleat for various angles	5.007-5.008
5.4 Manufacturing details	5.009-5.012
5.5 Ventilation and water evacuation	5.013-5.018
5.6 Glazing supports	5.019-5.020

6. Installation Guide

6.1 Introduction	6.002
6.2 Curtain wall	6.003-6.008
6.3 Priciples of weather tightness	6.009-6.015
6.4 Frames	6.016-6.023
6.5 Gaskets	6.024-6.028
6.6 Sealants	6.029-6.037
6.7 Finishes	6.038-6.041
6.8 Glass	6.042-6.051
6.9 Brackets and fixings	6.052-6.061

7. Building Physics

7.1 General remarks	7.002
7.2 Static load principles	7.002-7.006
7.3 Directives	7.006-7.007
7.4 Static pre-dimensioning	7.007-7.008
7.5 Examples	7.009
7.6 Required moment of inertia charts	7.010-7.013
7.7 Determining required moments	7.014-7.016
7.8 Examples	7.016-7.019
7.9 Required moments for roof loads	7.020-7.022
7.10 Examples	7.023
7.11 Wind load charts for mullions	7.024-7.035
7.12 Dead load charts for transoms	7.036-7.041
7.13 Static values for profiles	7.042-7.043
7.14 Standards and building requirements	7.044-7.045

8. Terminology for Curtain Walls 8.002-8.011

9. CE Marking for Curtain Walls 9.001-9.013

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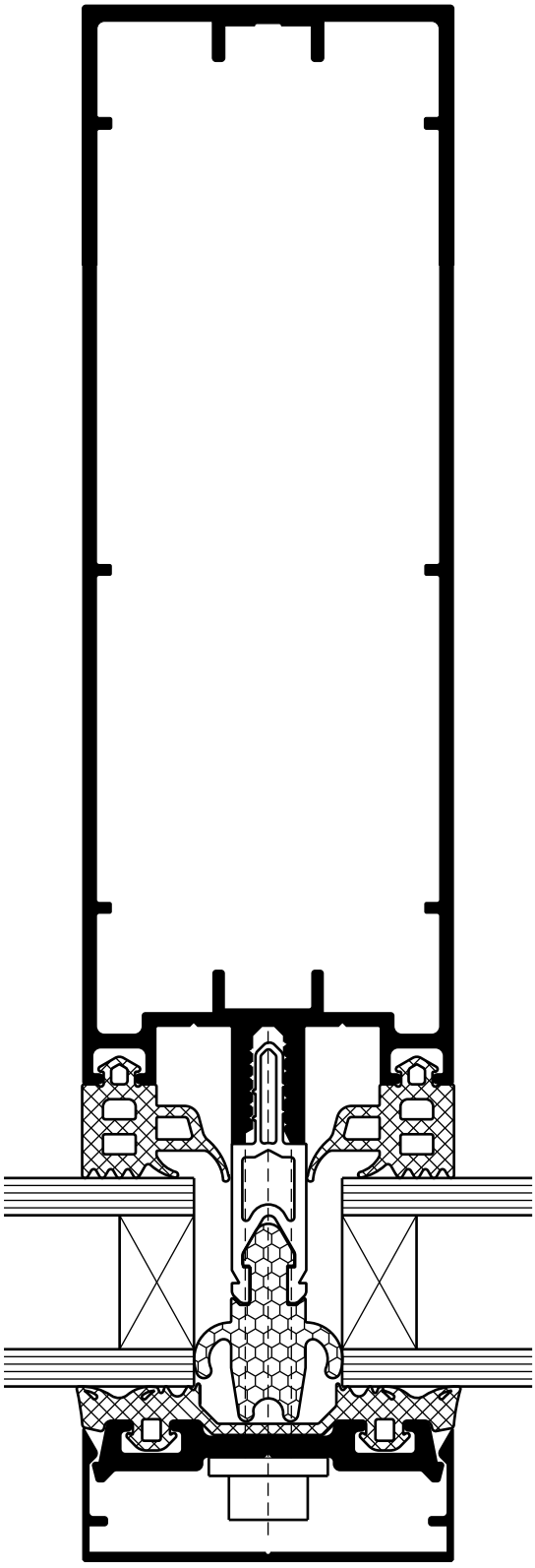
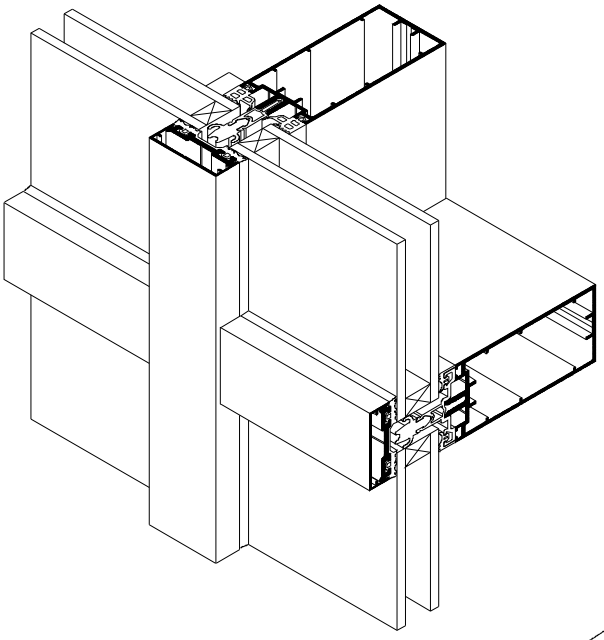


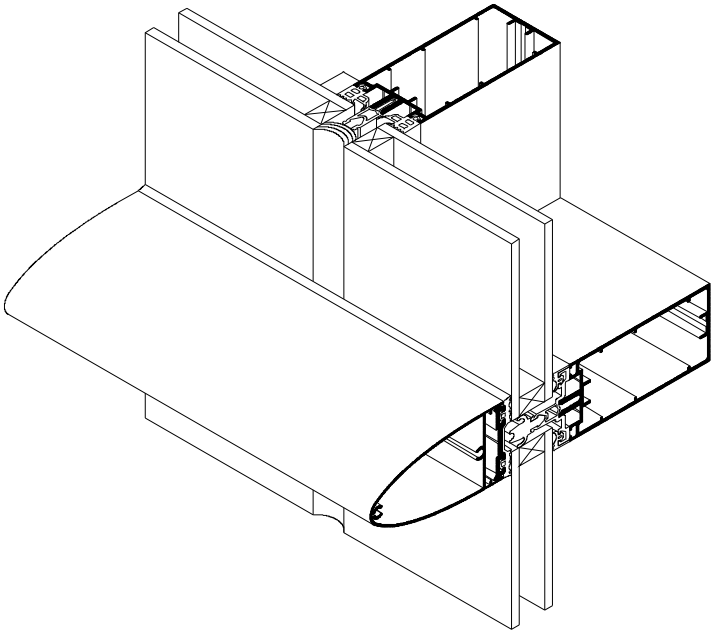
System Features

- Mullions and transoms are made with the same profiles with 50mm sightlines
- Special isolator, and EPDM gaskets for high thermal and sound insulation
- Concealed zone drainage-each pane acts as an individual self draining unit- for high weathertightness
- Glazing up to 40mm
- Comprehensive testing from recognized testing institutions contribute to the issuing of the CE mark
- Structural Silicon Glazing (SSG) is an option
- Incorporates the M5600 Solar Shading system
- Incorporates all vent systems including a concealed sash option
- High energy savings thanks to extremely low U_f values

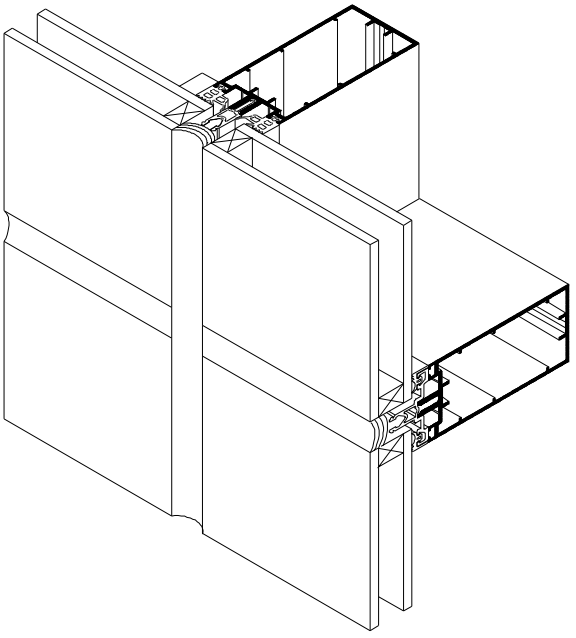
Standard curtain wall



Linear curtain wall



Structural curtain wall



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General Information

1. Aluminium as a fabrication material

Aluminium has the capability of being extruded into complex shapes to exact tolerances. Aluminium can be formed into literally thousands of unique profiles, each one able to meet a number of specific structural and aesthetic requirements. It is this capability to provide simple elegant solutions to extremely complex design problems that has led to aluminium's enduring appeal. Aluminium is chosen for outside use because it is a stable, corrosion-resistant and light weight metal. One of aluminium's primary appeals to a specifier is its exceptional strength to weight ratio. At 2.7g/cm2, aluminium is 66% lighter than steel. It is also far less susceptible to brittle fractures. Indeed, when aluminium and steel structures are compared, aluminium's greater modulus of elasticity means that weight ratios of 1:2 are easily attained. It can also be processed at high cutting speeds and welded connections are not necessary. These advantages help to reduce fabrication time. Alumil constructions are realized with aluminium profiles extruded in the alloy EN AW 6060 according to EN 755-1. The mechanical characteristics conform to the standard EN 755-2, with a modulus of elasticity of 70kN/mm^2.
The tolerances are based on EN 755-3.

2. Contact with other materials

2.1 Metals

When two metals of differing electro-negativity values come into contact in humid conditions, an electrical tension and oxidizing are experienced by the more electro-negative metal. Aluminium is electro-negative compared to most metals. Unprotected steel rusts and attacks aluminium. In order to avoid corrosion on aluminium, an insulating barrier should be placed between the two metals. Contact with stainless steel on the other hand has not been found to be harmful to aluminium to date. Contact with copper and its alloys is extremely harmful to aluminium. It is absolutely necessary to insulate these two metals. Lead is also more electro-positive than aluminium and should be insulated as well.

2.2 Timber

Most timbers have no harmful effects on aluminium. Some such as oak and walnut however, produce acids which attach and damage aluminium. These effects occur especially in humid conditions or when the timber is not sufficiently dry. Insulation is recommended by using a bituminous paint. When you treat timber against humidity and insects you should check that the chemical substances used in the treatment are not harmful to aluminium. Products containing copper salts, mercury salts, and fluoride compounds are very harmful to aluminium and should be avoided.

2.3 Lime/Cement

In humid conditions, lime or cement reacts with aluminium (even when anodized) revealing superficial white spots on the surface of the metal after cleaning. It is advisable to protect the aluminium during installation with ALUMIL protective foil.

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3. Surface treatment

The following colours are available:

Anodised finish:

Natural colour etched
Bronze colour
Special anodised colours

The anodising process is carried out according to the EWAA-EURAS regulations.

Painted finish:

White
Brown
RAL colours
Sable colours

The painting process is carried out in accordance to Qualicoat regulations.

4. Storage

To avoid superficial damage the following precautions should be taken:

4.1 Store the profiles in a dry area

4.2 Avoid any contact with steel by protecting the profiles with wrapping paper or plastic foil. In humid areas rust and steel burr can damage the surface finish.

4.3 Store the profiles horizontally in such a way as to eliminate the possibility of damaging or scratching the profiles while removing them.

4.4 Store the profiles in packed form.

5. Aluminium maintenance

Both anodised and painted aluminium should be cleaned on a regular basis. For rural areas that are not subjected to aggressive elements like air pollution or salty air, it is sufficient to clean the aluminium whenever you clean the glass. Lukewarm water should be with a non-aggressive, non-acetous detergent without ammonia for cleaning the aluminium. Then you should thoroughly rinse the aluminium with clear water and dry absorbing cloth. In urban areas or areas near to the sea, the aluminium should be cleaned more often and more thoroughly. Areas that are not exposed to rainfall should be cleaned more frequently than other surfaces. If water and mild detergents are not enough to clean the aluminium constructions there are detergents that have been specially developed for aluminium surfaces. These detergents contain light abrasive elements and can be used with a synthetic cleaning cloth. In all cases it is important to completely rinse surfaces with clear water and dry them thoroughly, especially the corners and the bottom profile. In order to protect and increase the life cycle of the aluminium, it may be treated with a very thin clear coat of water resistant film available from ALUMIL.

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1. Explanation of symbols:

(A) = Alignment corner	* = Not a stock item
(C) = Crimp cleat	(Sp) = Special
(N) = Nail cleat	= Saw
(S) = Spring cleat	= Milling bit
= Corner cleat, adjustable	= Rubber mallot
(T) = Transom cleat	= Drill Jig
= Transom, cleat adjustable	= Punching Tool
(I) = Couple Cleat	= Sealant
(Γ) = Reinforcing plate for corners	= Instant glue
(⊥) = Reinforcing plate for joints	= Sealing tape

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Type of test	Norm	Testing Institute	Test results
Air permeability	EN 12152	Ift-Rosenheim	AE
Weathertightness	EN 12154	Ift-Rosenheim	R7
Wind load resistance	EN 13116	Ift-Rosenheim	± 1500 Pa
Impact resistance / inside	prEN 14019	Ift-Rosenheim	I5
Impact resistance / outside	prEN 14019	Ift-Rosenheim	E5
Sound Insulation	EN ISO 717-1	Alumil lab	R_W = 44dB (R_{wglass} = 45dB) R_W = 49dB (R_{wglass} = 50dB) R_W = 37dB (R_{wglass} = 37dB)
Thermal Insulation	EN ISO 10077, T2	Alumil lab	U_f = 1,02 - 1,98 W/m^{2}K See following page

Note: Official test certificates may be sent upon request.

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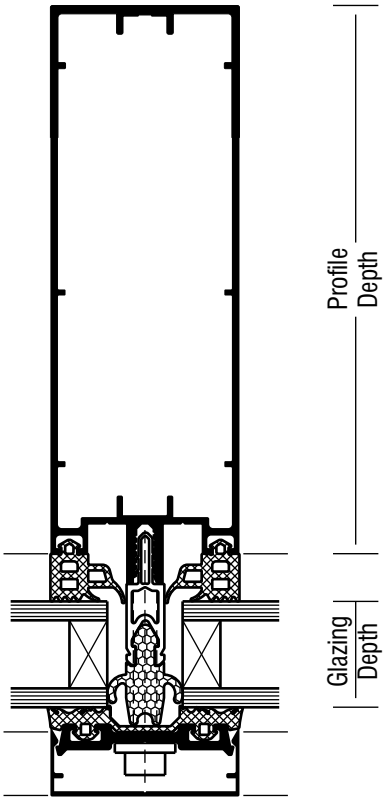
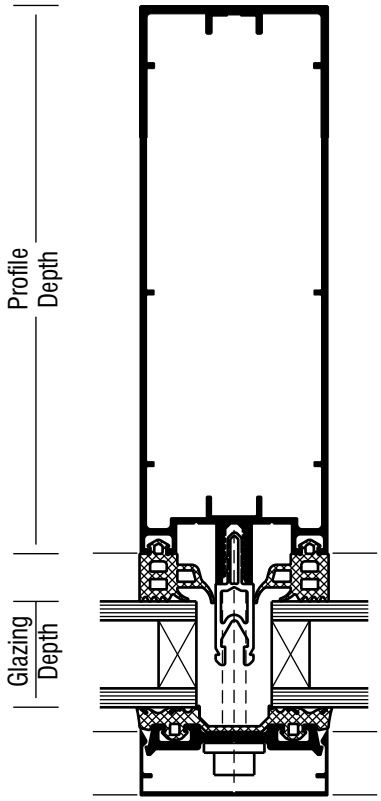
U_f value in W/m^{2}K in accordance to EN ISO 10077, T2

Profile Depth mm	M50 HI Glazing Depth mm					Profile Depth	M50 Glazing Depth mm				
	24-28	28-32	32-36	36-40	40-42		24-28	28-32	32-36	36-40	40-42
50	1,33	1,20	1,14	1,14	1,03	50	1,94	1,85	1,78	1,74	1,67
65	1,33	1,22	1,15	1,14	1,03	65	1,94	1,85	1,78	1,74	1,67
85	1,34	1,23	1,16	1,15	1,04	85	1,95	1,86	1,80	1,75	1,69
105	1,34	1,24	1,18	1,15	1,05	105	1,95	1,88	1,81	1,75	1,69
145	1,34	1,25	1,22	1,16	1,07	145	1,97	1,90	1,83	1,77	1,72
175	1,35	1,26	1,24	1,16	1,08	175	1,99	1,91	1,84	1,78	1,73

M50 HI



M50



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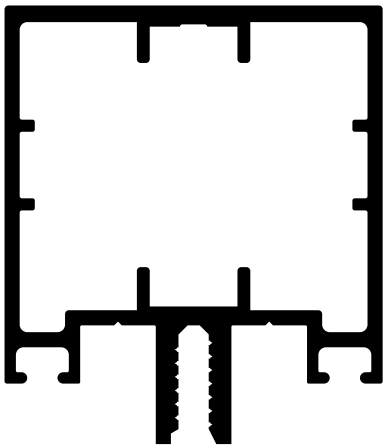
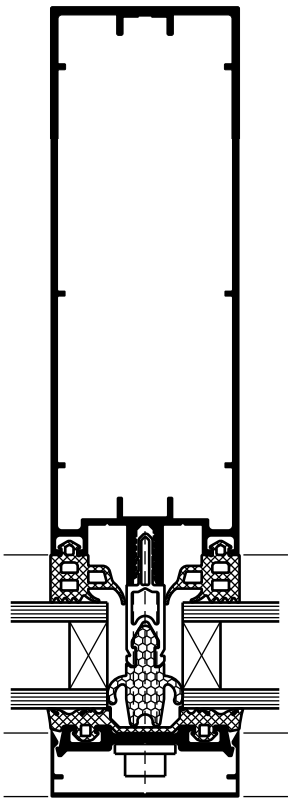
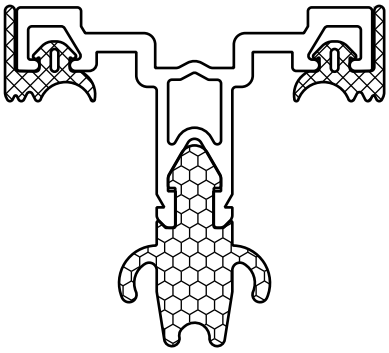


System Concept 1

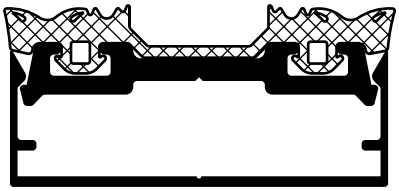
Mullions and transoms are assembled with blunt connections and square cuts





System Concept 2

Drainage profile with EPDM gaskets and isolator assembled with overlapping joints



System Concept 3

Pressure plate with inserted gasket and cover cap assembled with self-tapping screws

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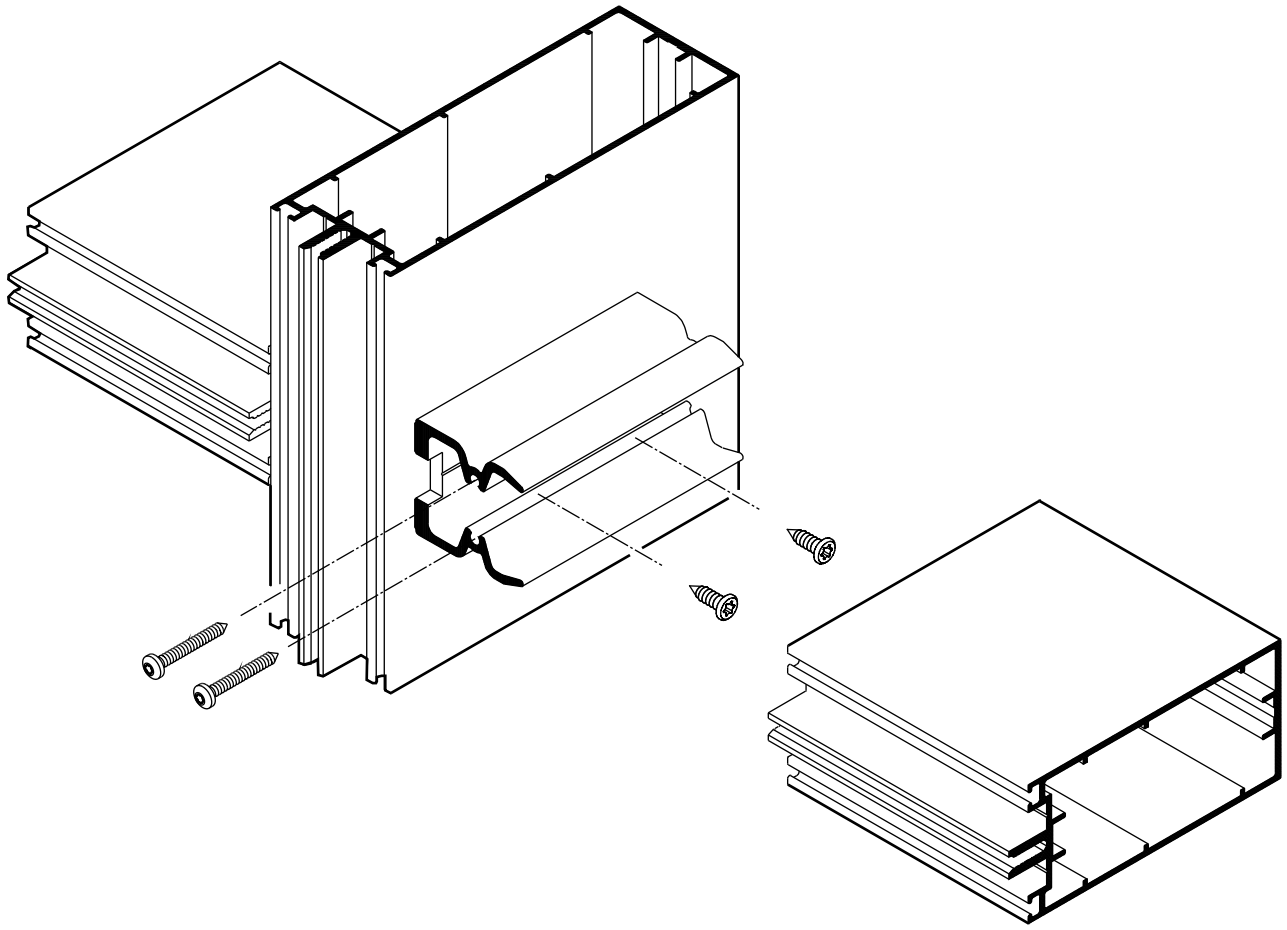
System Concept 1

Mullions and transoms are assembled
with blunt connections and square cuts



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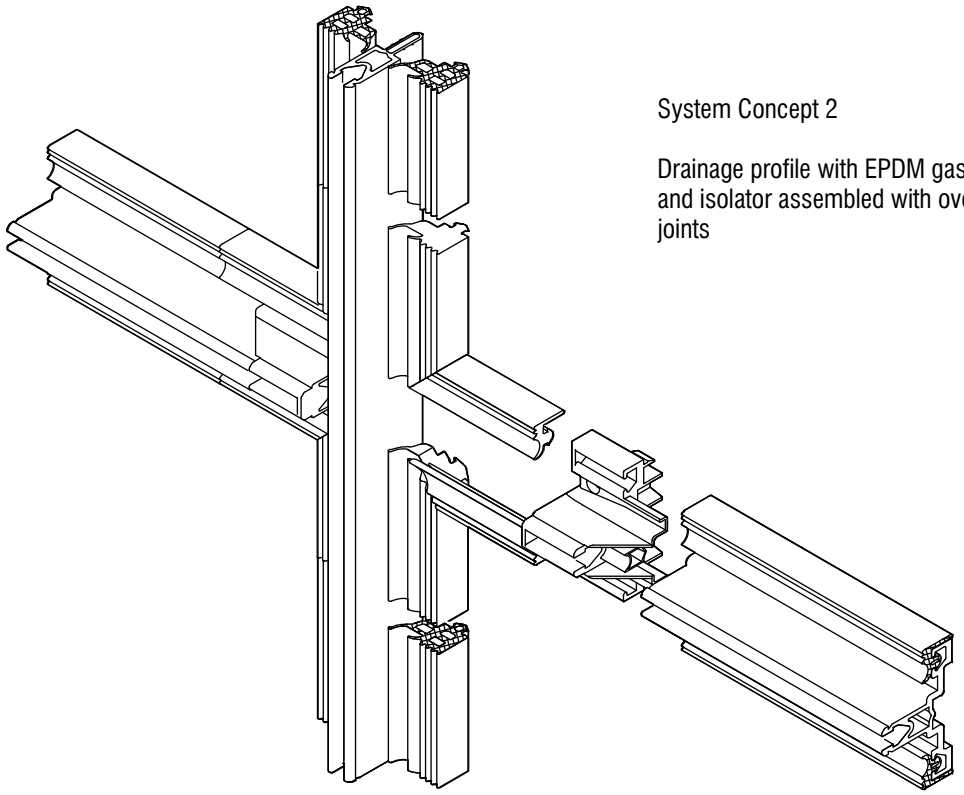
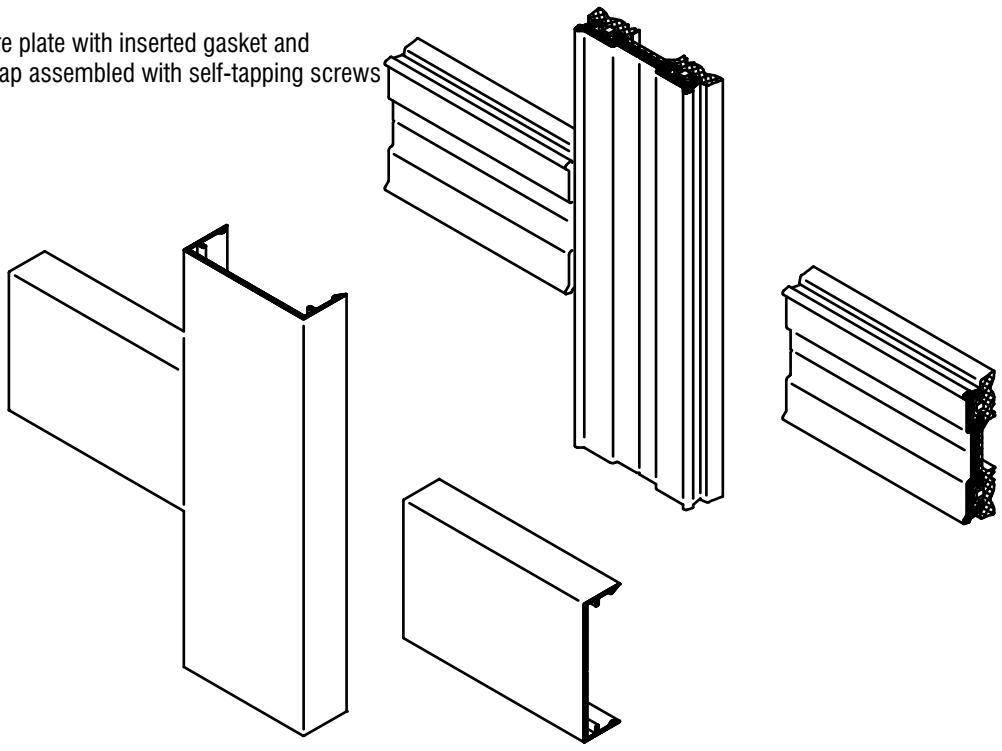


System Concept 2

Drainage profile with EPDM gaskets and isolator assembled with overlapping joints

System Concept 3

Pressure plate with inserted gasket and cover cap assembled with self-tapping screws



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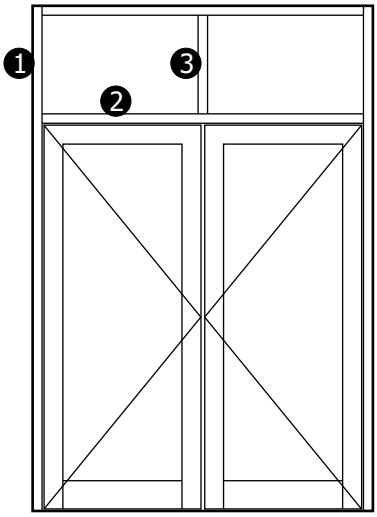
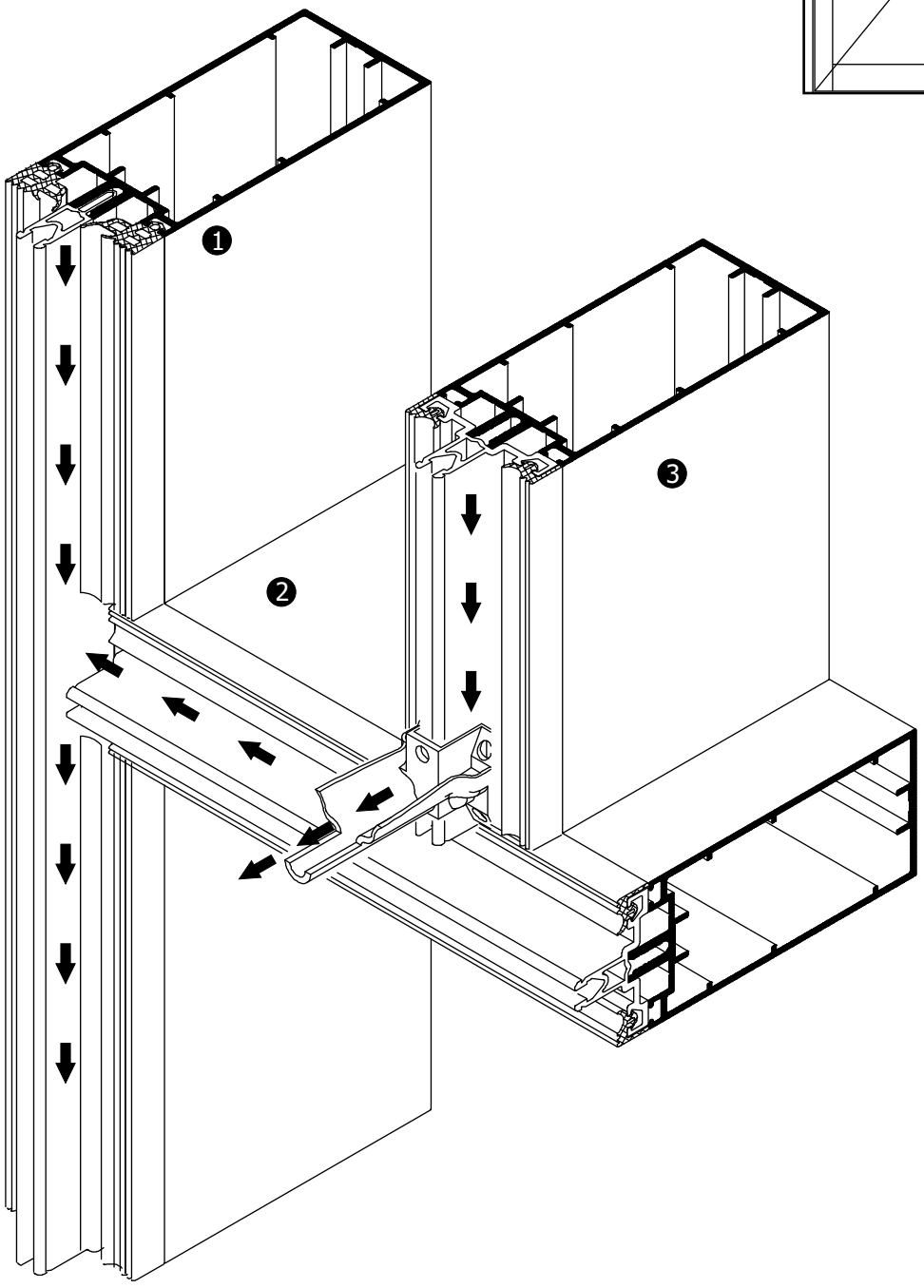
Drainage Concept

Drainage can be achieved on three levels, mullions, transoms, and short mullions. The same profiles and accessories are used to seal the joints in an overlapping method.





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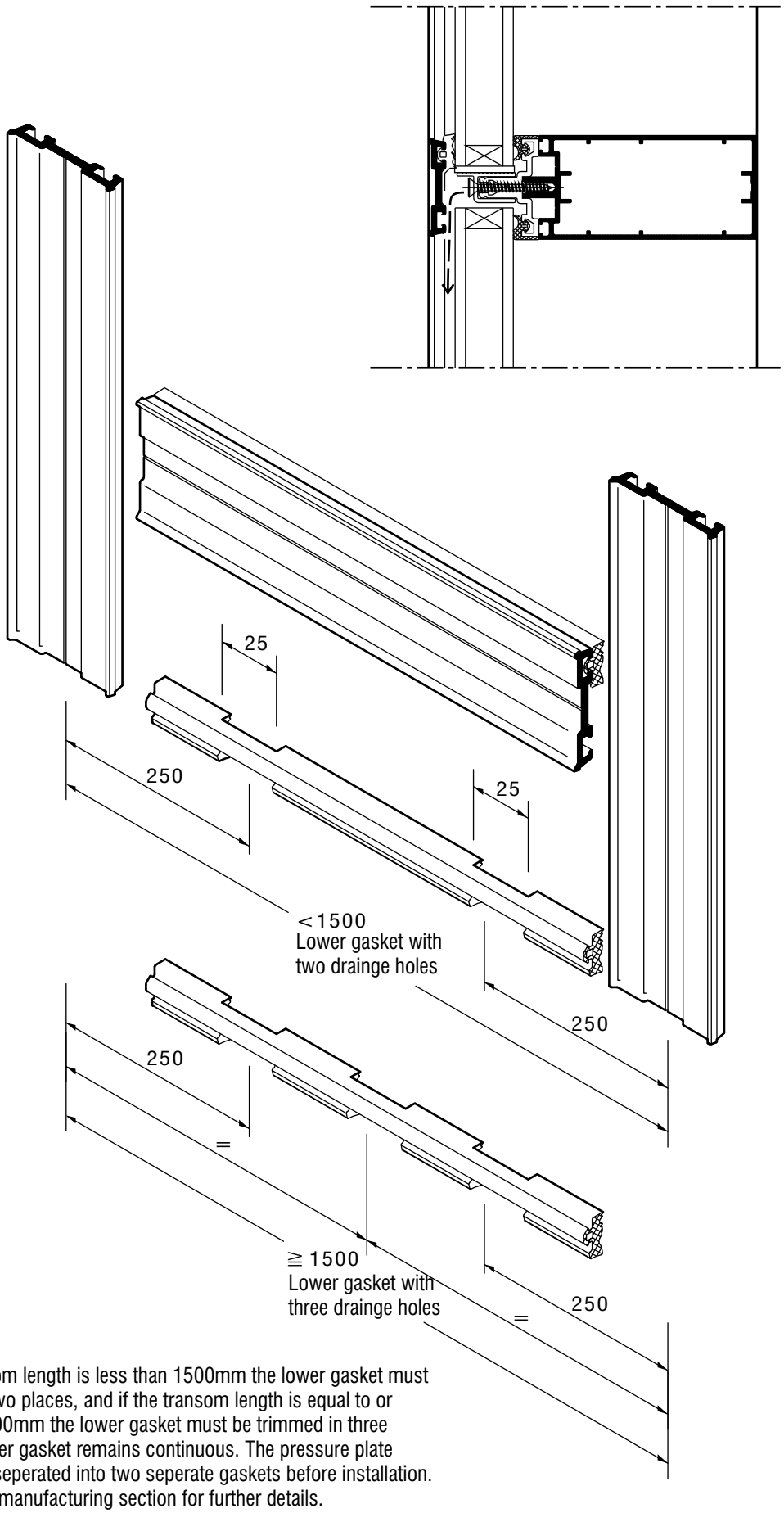

Note:
When the transom length is less than 1500mm the lower gasket must be trimmed in two places, and if the transom length is equal to or greater than 1500mm the lower gasket must be trimmed in three places. The upper gasket remains continuous. The pressure plate gasket may be seperated into two seperate gaskets before installation. See milling and manufacturing section for further details.

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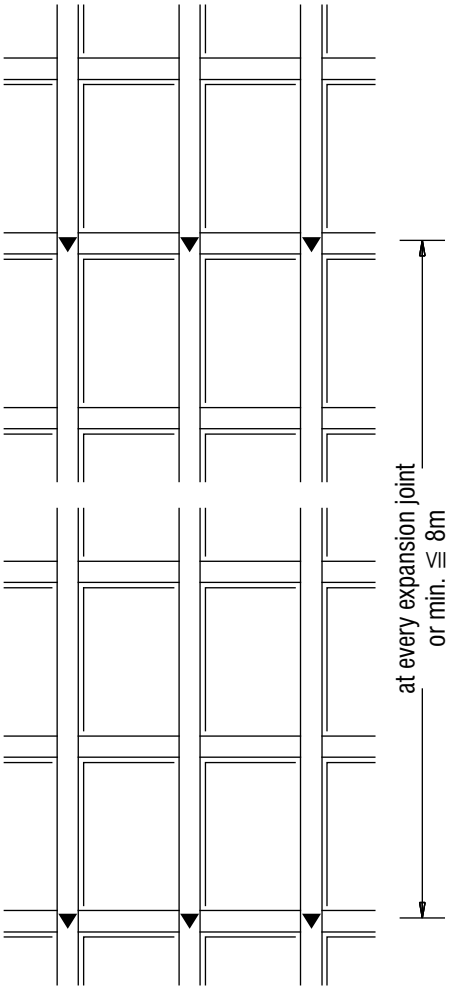
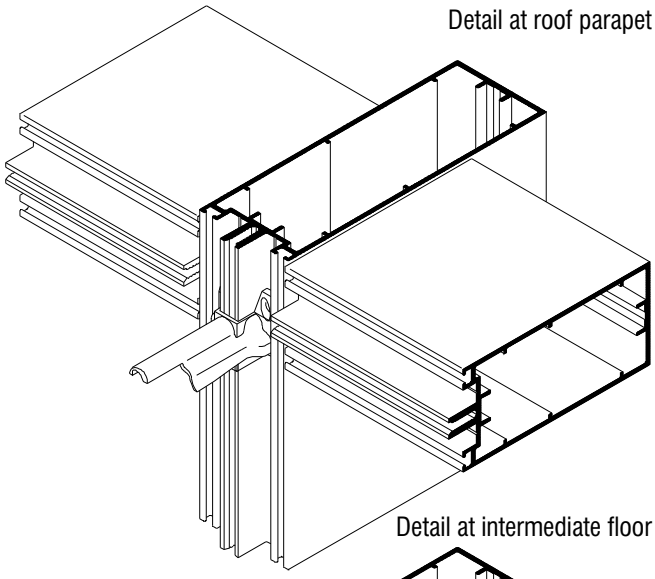
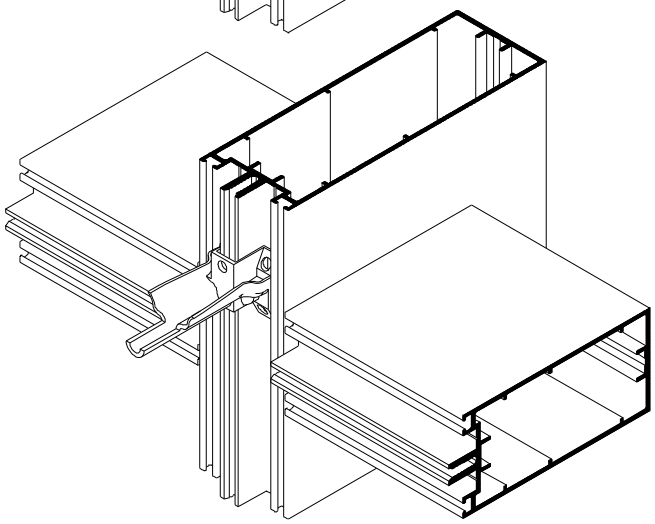
Drainage spout is installed on all mullions at every expansion joint or a minumum of 8 meters on center, starting from the ground level and ending at the roof parapet. Notice at the roof parapet the drainage spout is installed upside down in order to prevent moisture from entering into the building insulation.



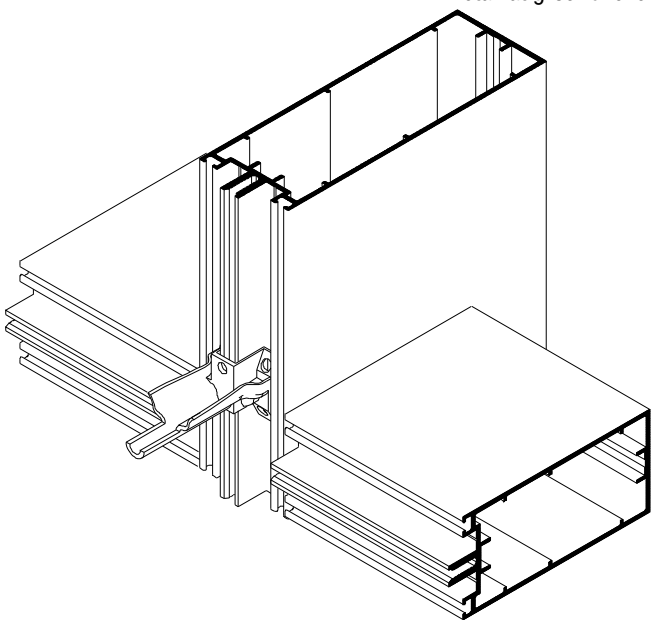
Detail at roof parapet



Detail at intermediate floor



Detail at ground level



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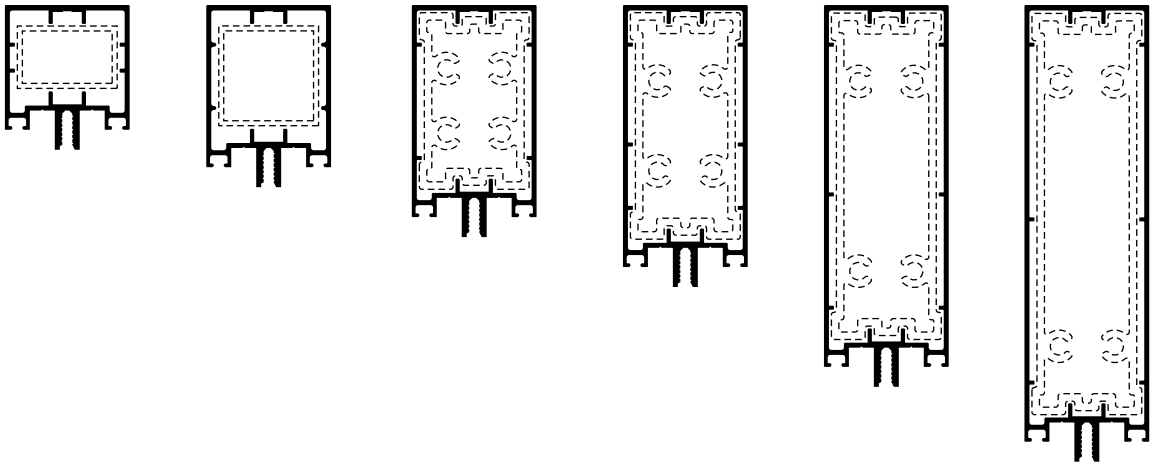
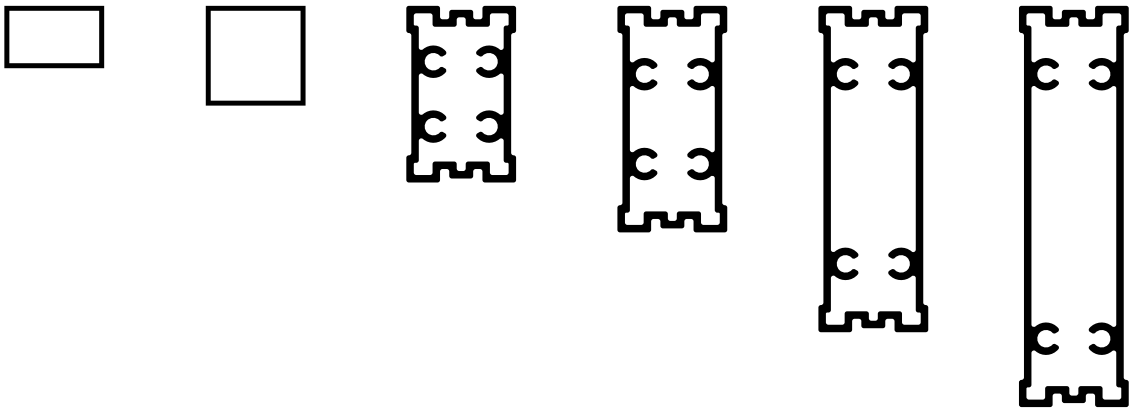
Mullions / Transoms

500003 500005 500007 500009 500011 500013



Profile Inserts

25x40x2 40x40x2 500084 500085 500064 500086



Note: The moment of inertia can be added together for profiles with profile inserts.

Code Number	Profile Depth mm	Bar Length m	Chemical Perimeter mm	Mechanical Perimeter mm	I_x cm^4	I_y cm^4	Profile Inserts Aluminum	Bar Length m	I_x cm^4	I_y cm^4
500003	50	6	227	150	20,81	16,69	25x40x2	6	2,43	5,17
500005	65	6	342	180	39,08	20,15	40x40x2	6	7,34	7,34
500007	85	6	382	220	74,52	24,76	500084	6	58,74	24,73
500009	105	6	422	260	124,17	29,70	500085	6	109,36	28,84
500011	145	6	502	340	272,45	38,87	500064	6	292,63	37,08
500013	175	6	562	400	433,10	45,78	500086	6	505,63	43,25

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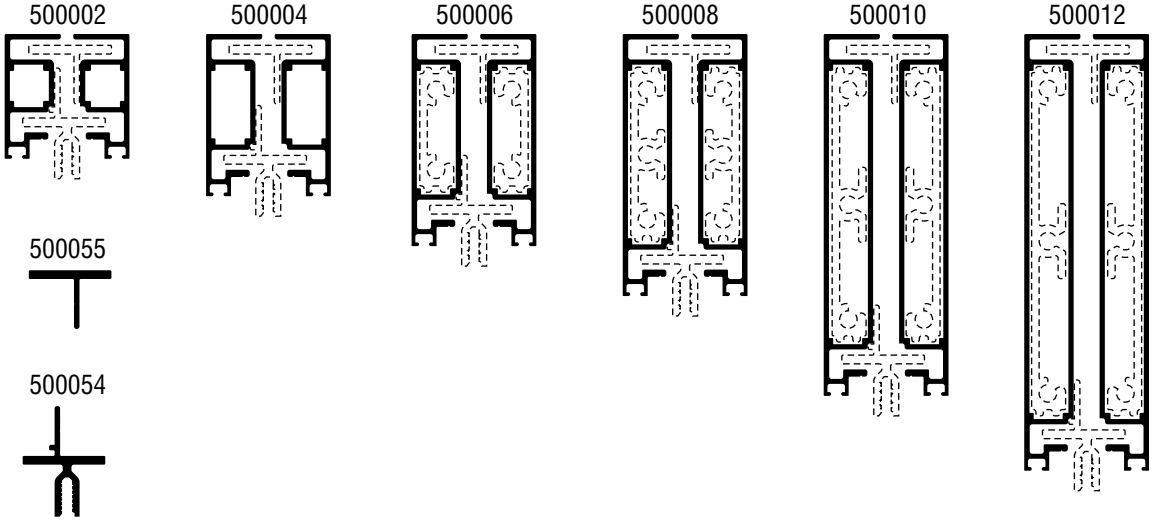
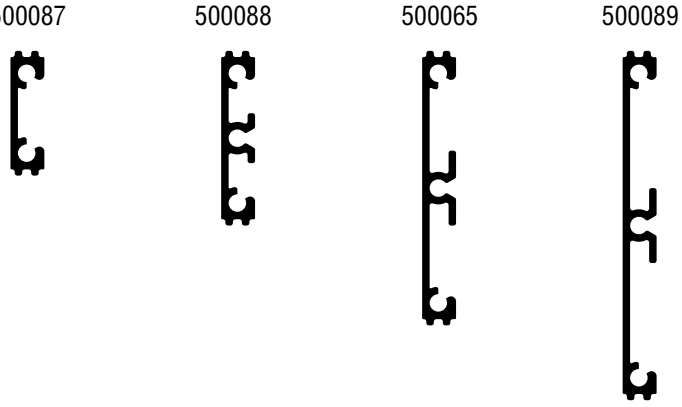
Half Mullions / Transoms



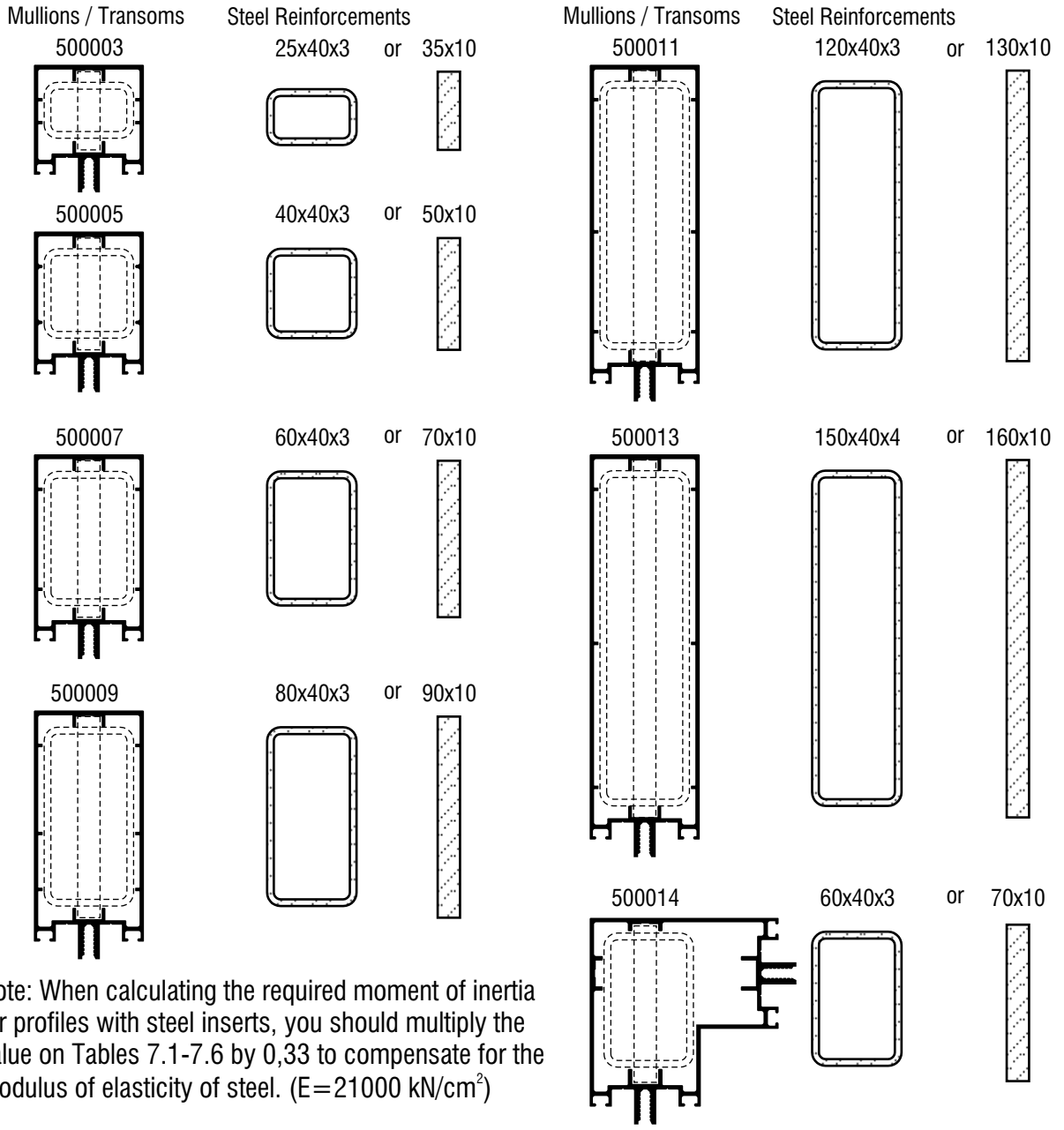
Profile Inserts



Note: The moment of inertia can be added together for profiles with profile inserts.

Code Number	Profile Depth mm	Bar Length m	Chemical Perimeter mm	Mechanical Perimeter mm	I_x cm^4	I_y cm^4	Profile Inserts Aluminum	Bar Length m	I_x cm^4	I_y cm^4
500002	50	6	226	73	7,57	1,54				
500004	65	6	256	88	16,14	2,05				
500006	85	6	296	108	34,57	2,72	500087	6	8,62	0,55
500008	105	6	336	128	62,54	3,39	500088	6	21,64	0,87
500010	145	6	416	168	153,85	4,72	500065	6	70,64	1,19
500012	175	6	476	198	259,88	5,72	500089	6	131,98	1,29

Basic profiles



Note: When calculating the required moment of inertia for profiles with steel inserts, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. (E=21000 kN/cm^2)

Code Number	Steel Tube	Mass kg/m	Area cm^2	I_x cm^4	I_y cm^4	Steel Flat bar	Mass kg/m	Area cm^2	I_x cm^4	I_y cm^4
500003	25x40x3	2,60	3,31	2,94	6,24	35x10	2,75	3,50	3,57	0,29
500005	40x40x3	3,30	4,21	9,32	9,32	50x10	3,93	5,00	10,42	0,41
500007 500014	60x40x3	4,25	5,41	25,40	13,40	70x10	5,50	7,00	28,58	0,58
500009	80x40x3	5,19	6,61	52,30	17,60	90x10	7,07	9,00	60,75	0,75
500011	120x40x3	7,07	9,01	148,00	25,80	130x10	10,21	13,00	183,08	1,08
500013	150x40x4	11,11	14,20	339,00	39,70	160x10	12,57	16,00	341,33	1,33

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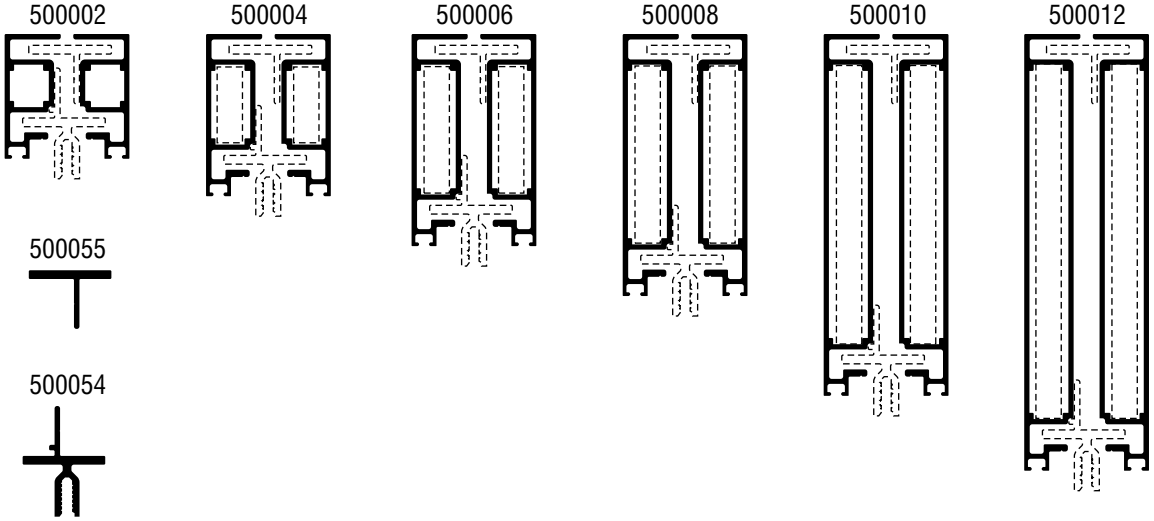
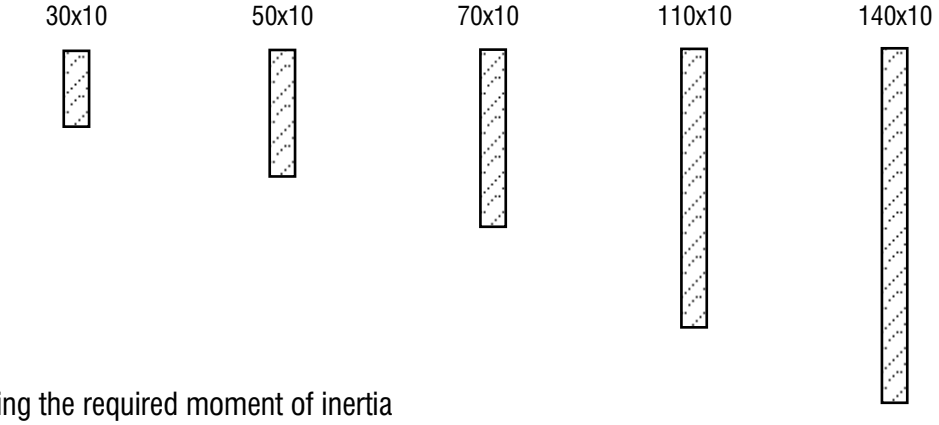
Half Mullions / Transoms



Profile Inserts



Note: When calculating the required moment of inertia for profiles with steel inserts, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. (E=21000 kN/cm^2)

Code Number	Steel Flat bar	Mass kg/m	Area cm^2	I_x cm^4	I_y cm^4					
500004	30x10	2,36	3,00	2,25	0,25					
500006	50x10	3,93	5,00	10,42	0,41					
500008	70x10	5,50	7,00	28,58	0,58					
500010	110x10	8,64	11,00	110,92	0,92					
500012	140x10	11,00	14,00	228,67	1,17					

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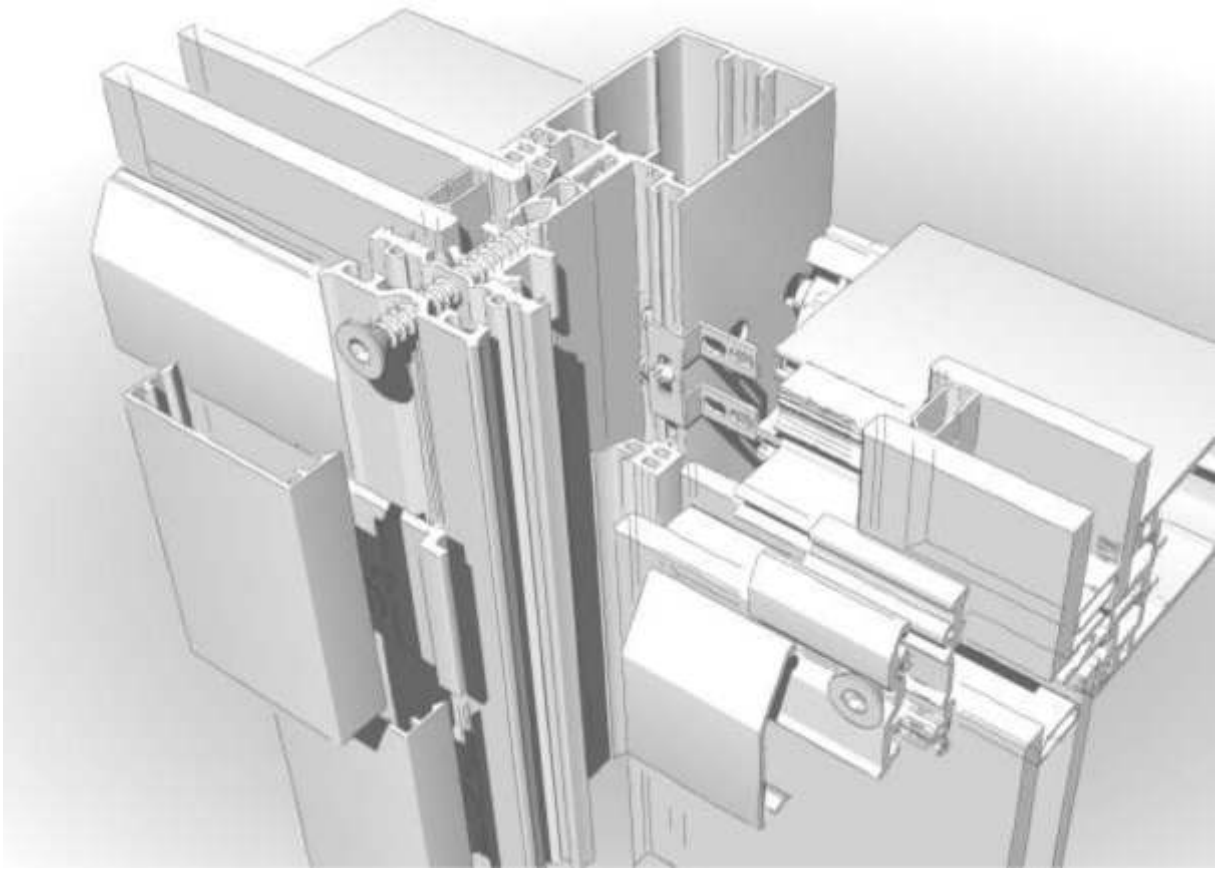

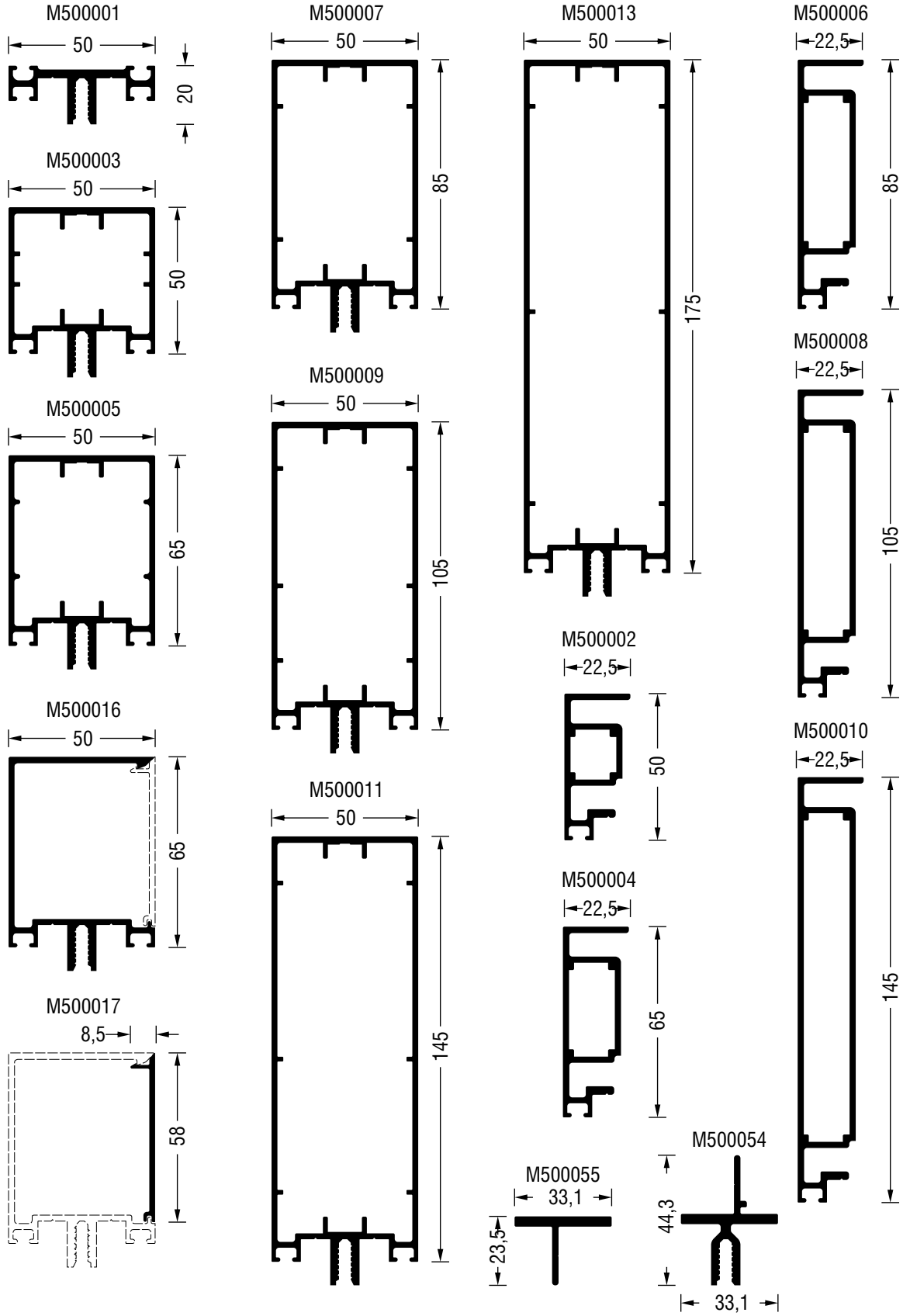

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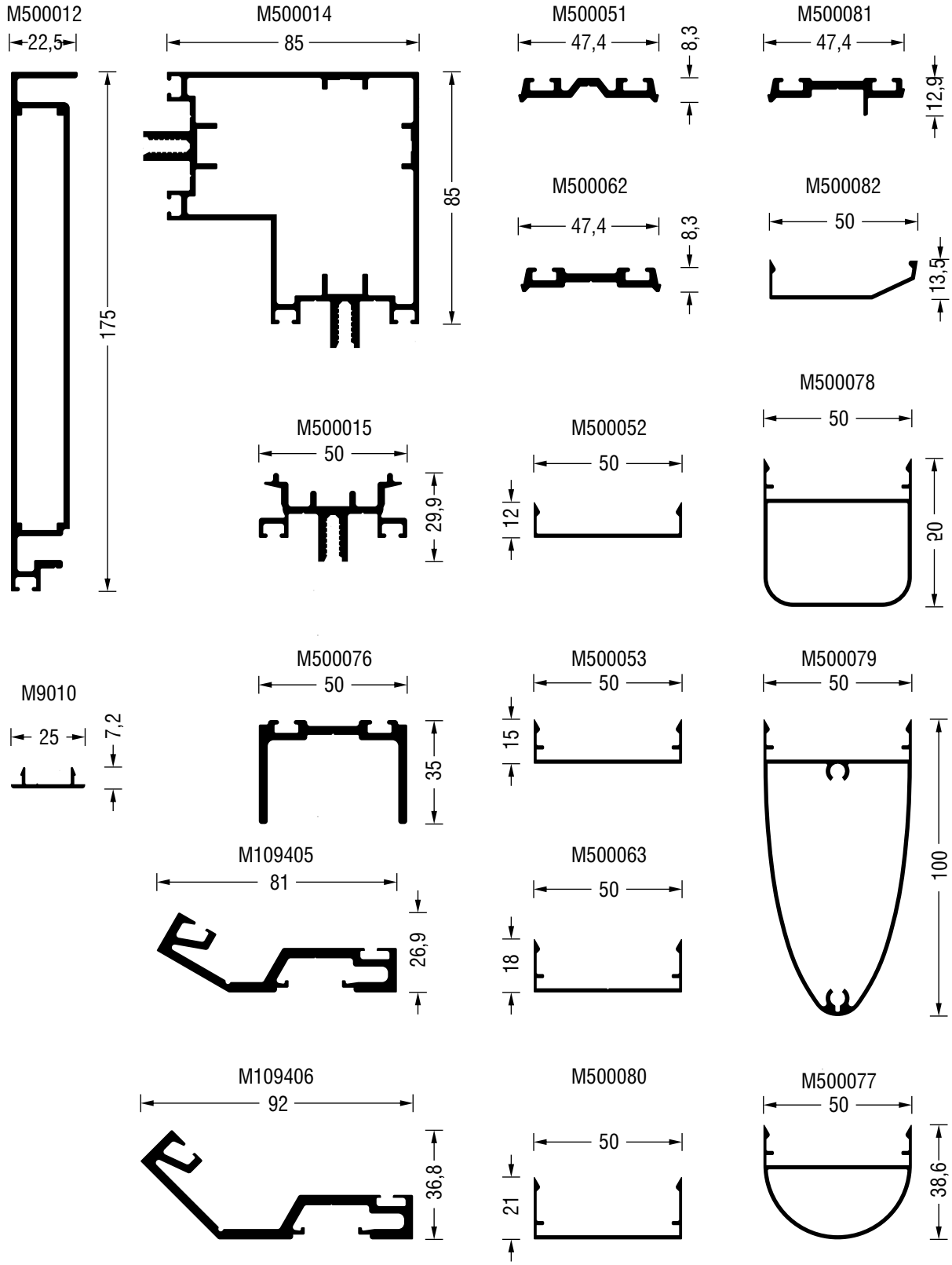

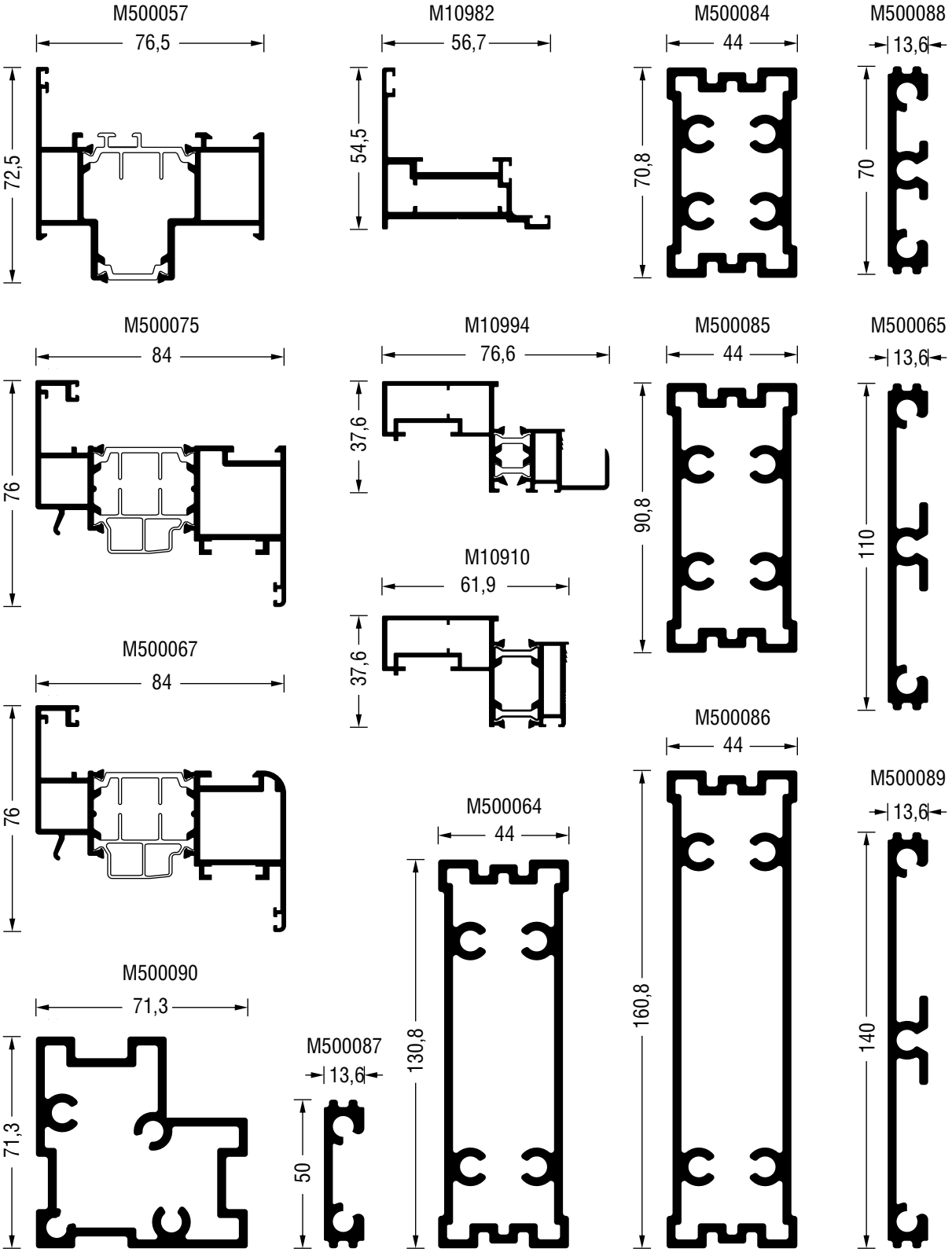

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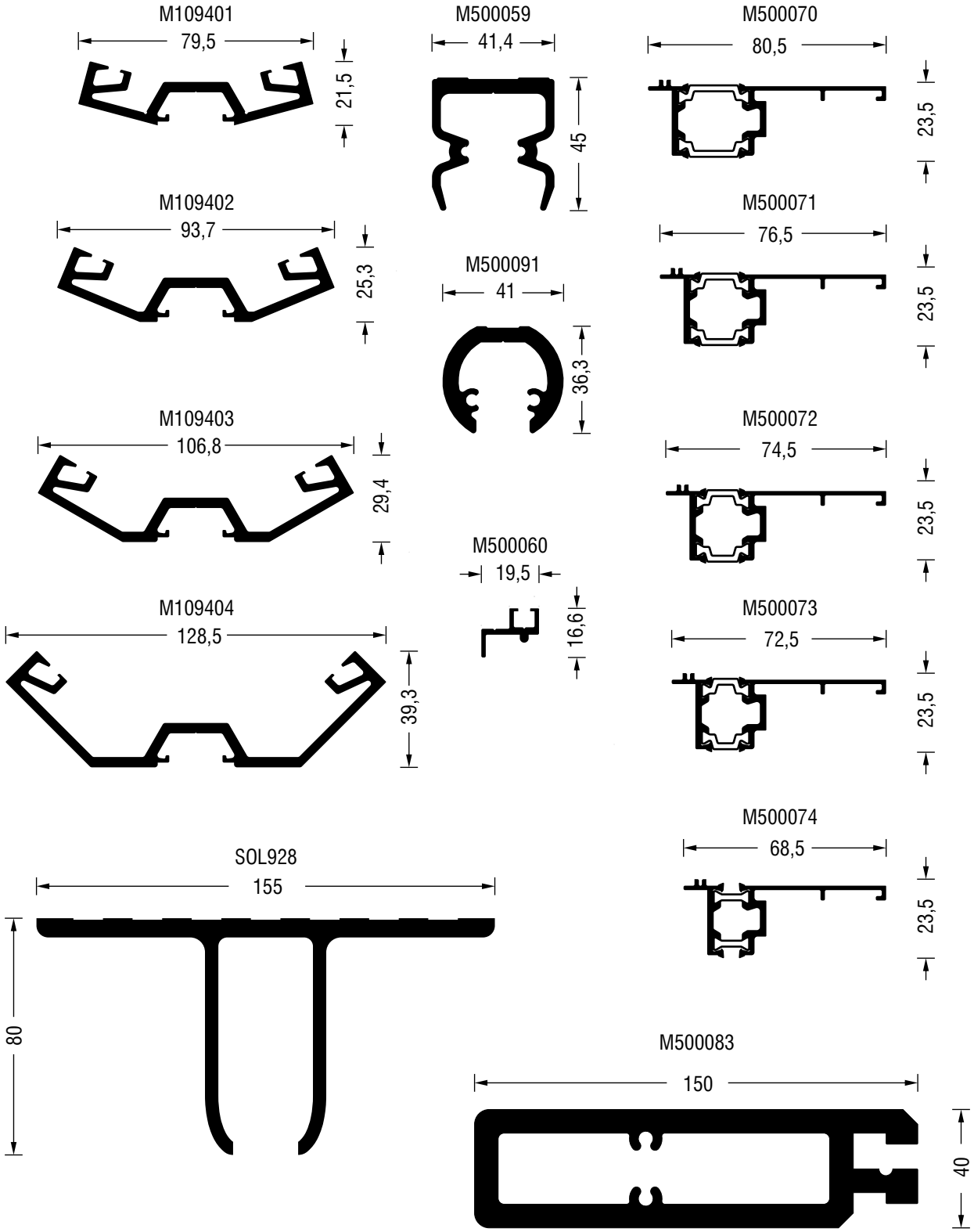

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M500001
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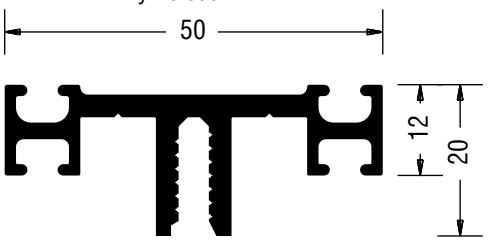
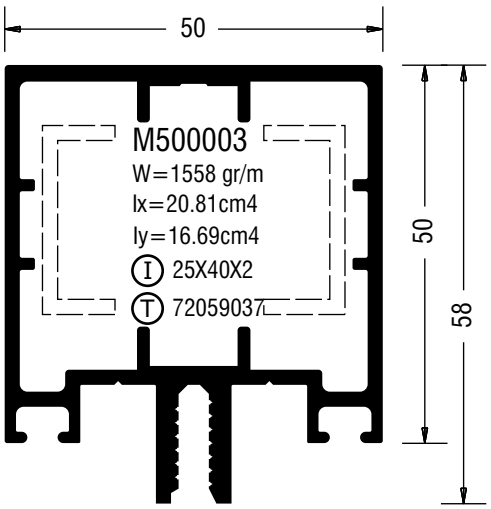
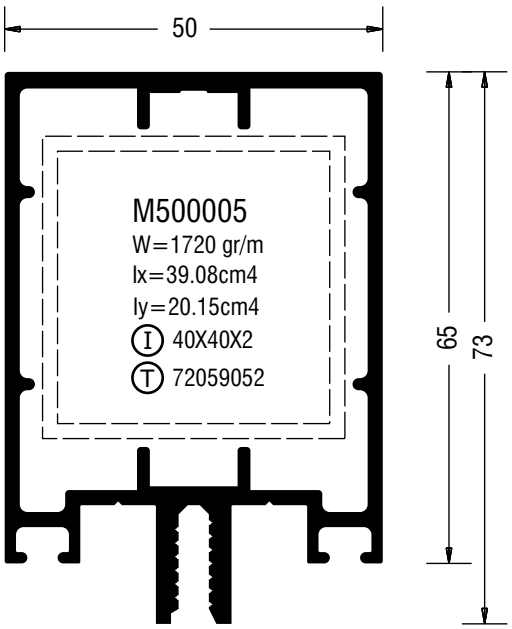
Ix=0.71cm4
Iy=5.89cm4







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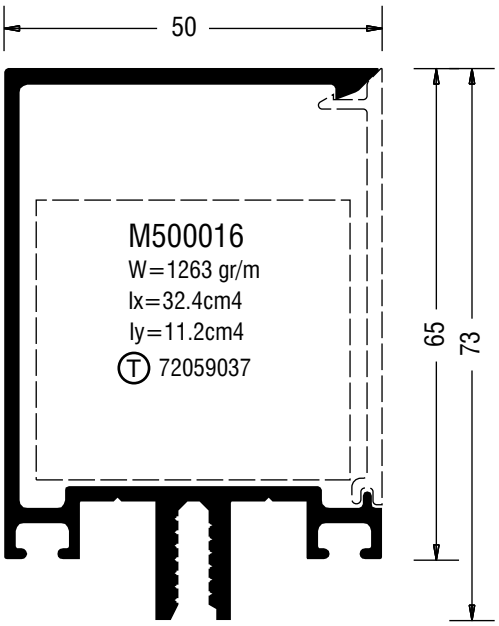

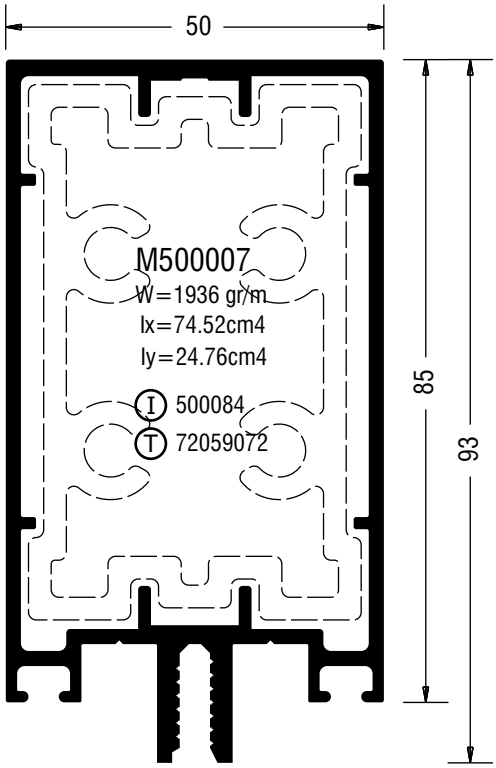

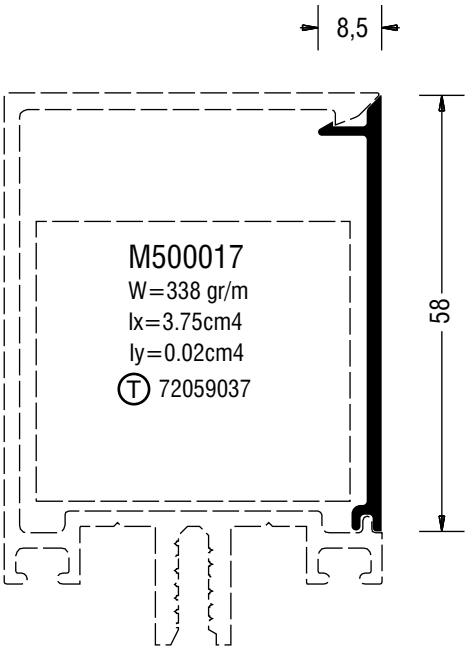

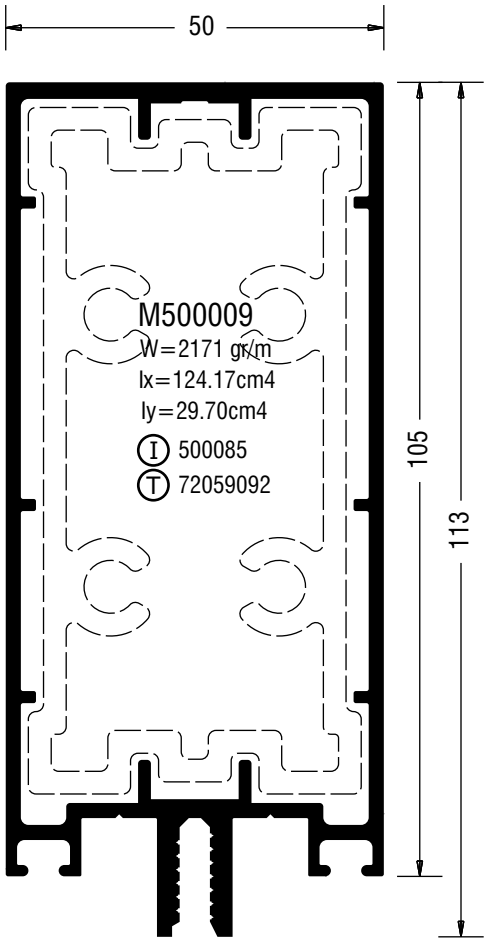

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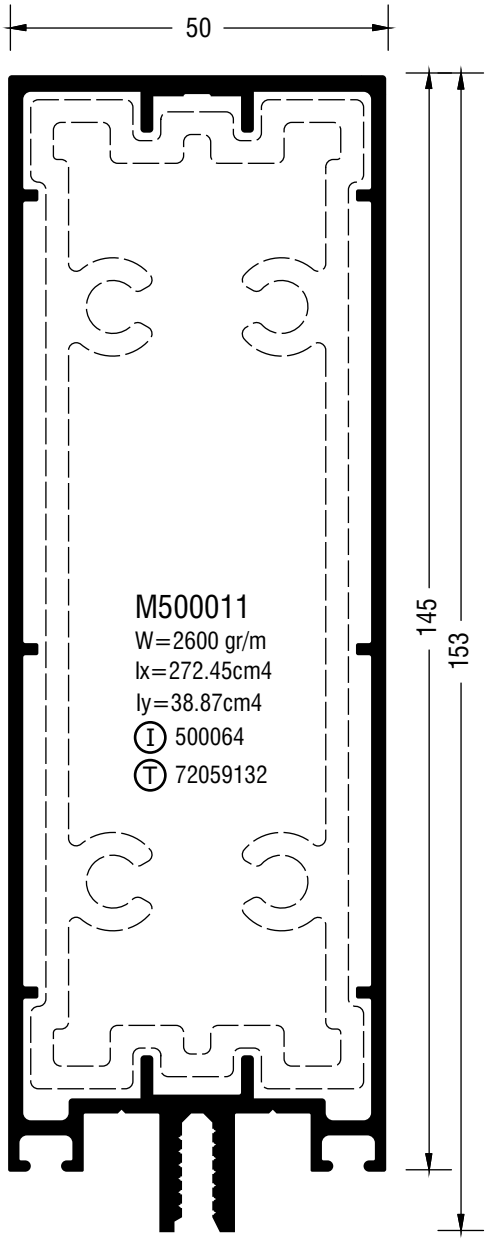

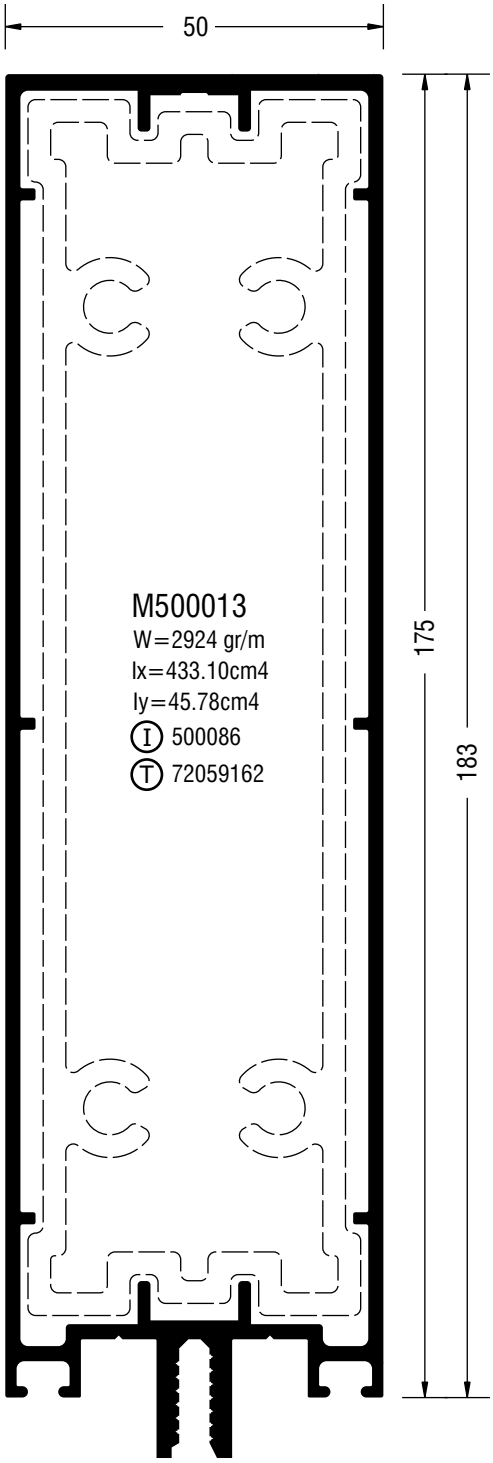

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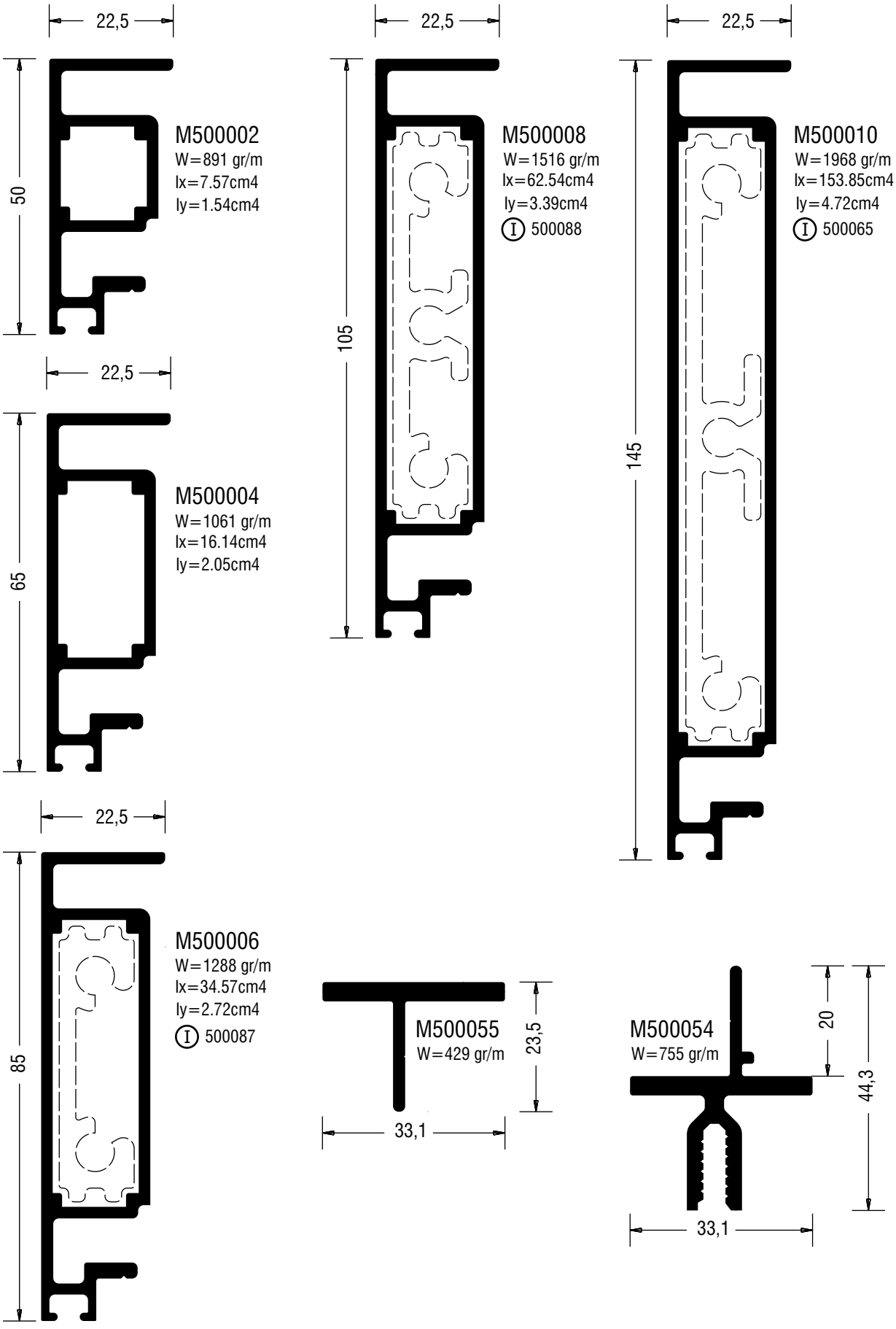

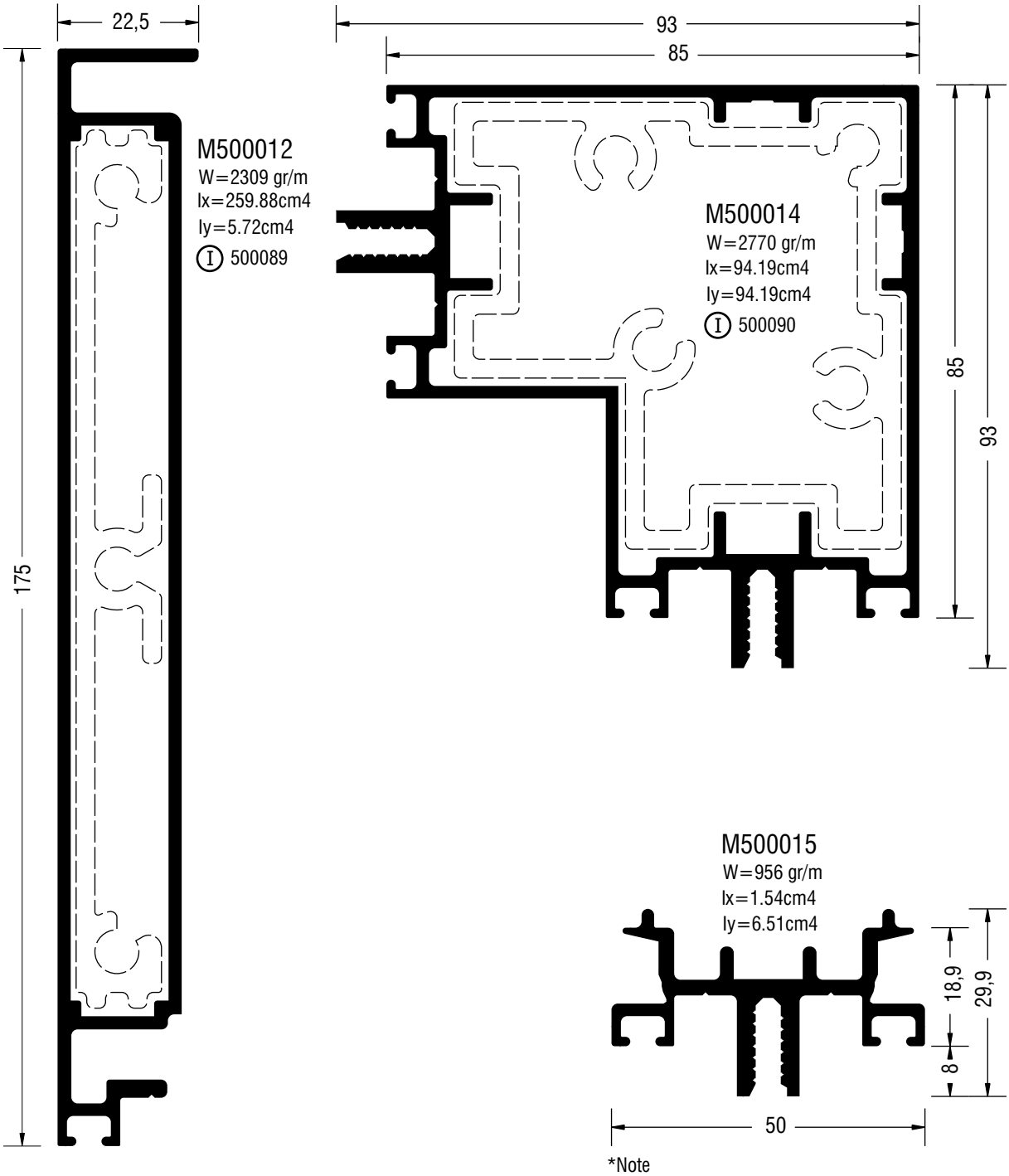

*Note
This profile must be bent to the required angle in the fabrication shop

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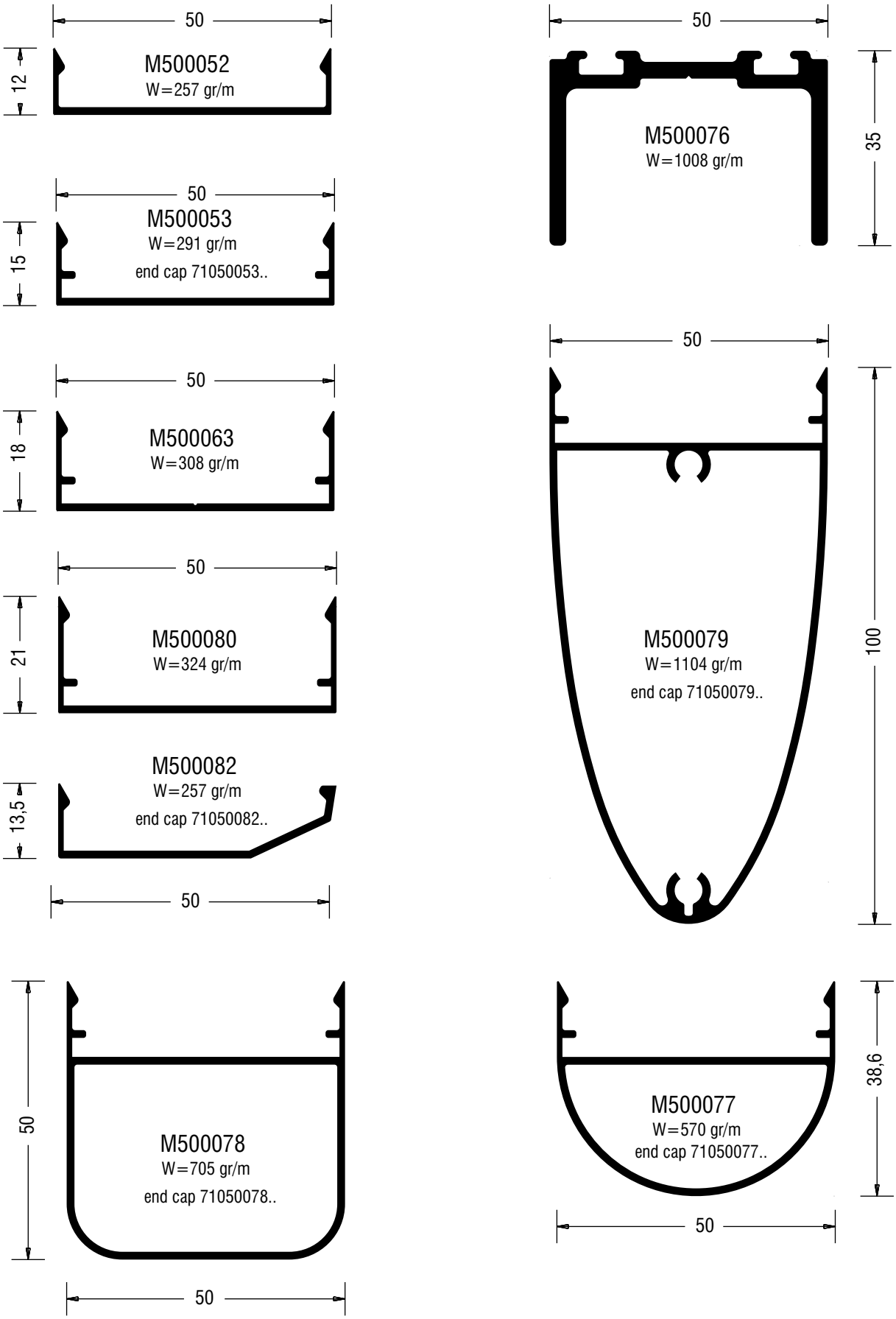
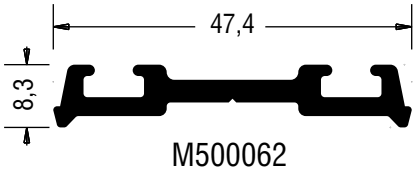
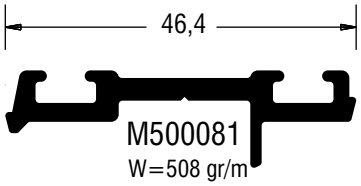


Pressure Plates

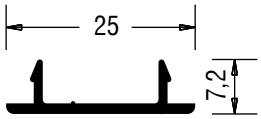
M500051
W=501 gr/m



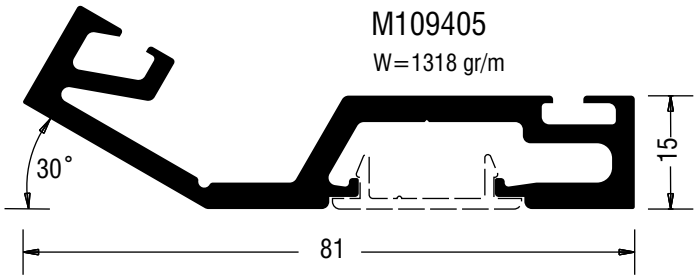
M500062
W=501 gr/m



M500081
W=508 gr/m



M9010
W=132 gr/m



M109405
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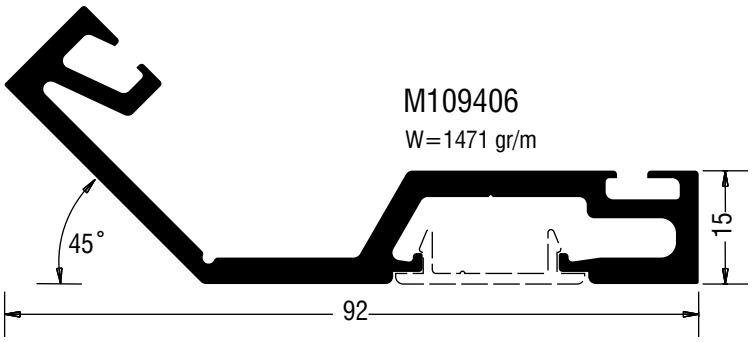

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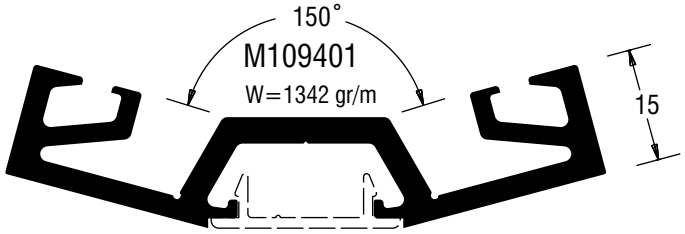

M109401
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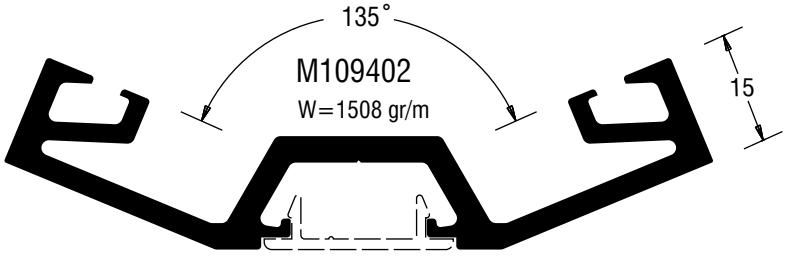
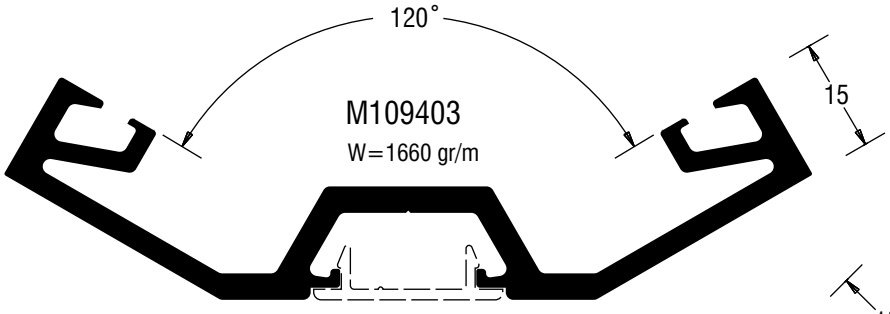


M109402
W=1508 gr/m



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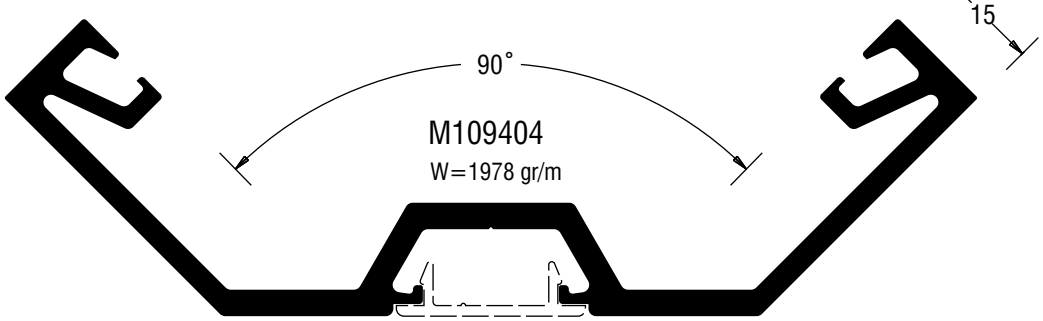
W=1660 gr/m



M109404
W=1978 gr/m

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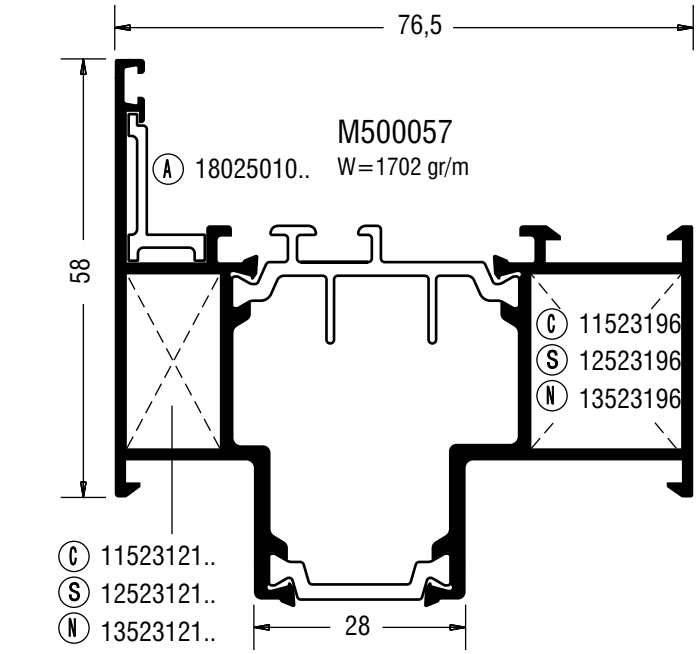

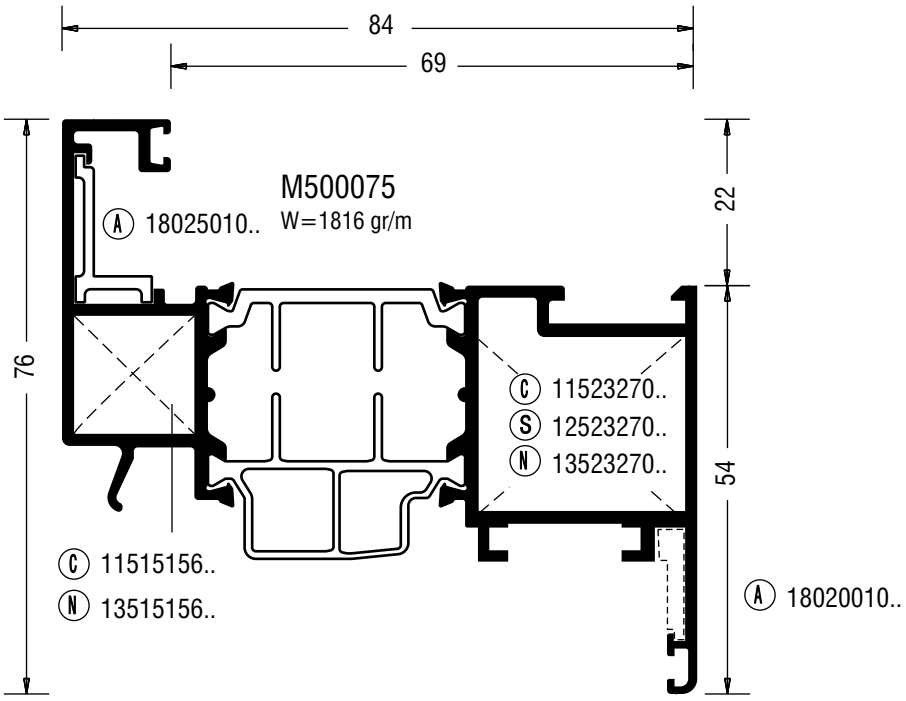

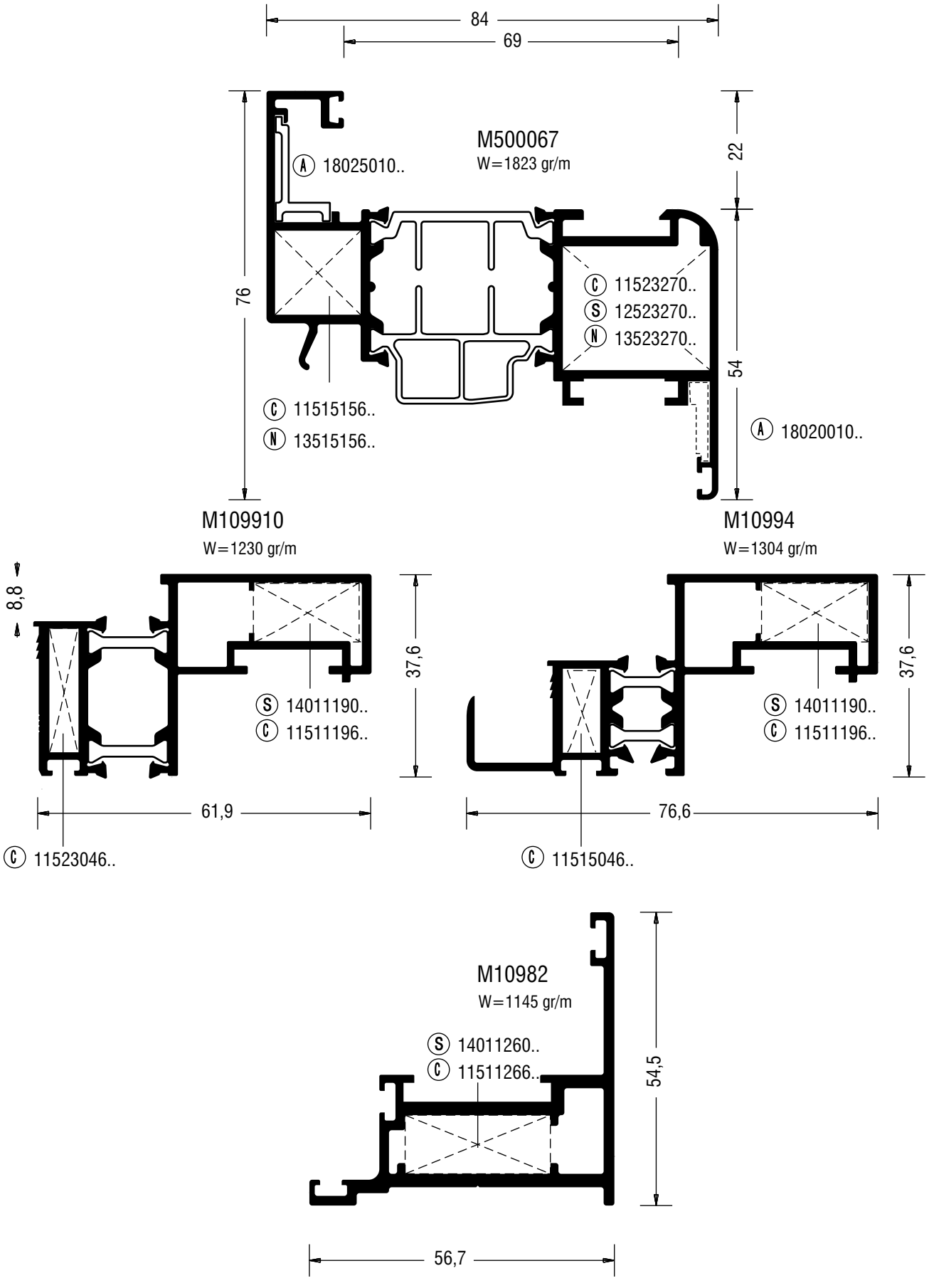

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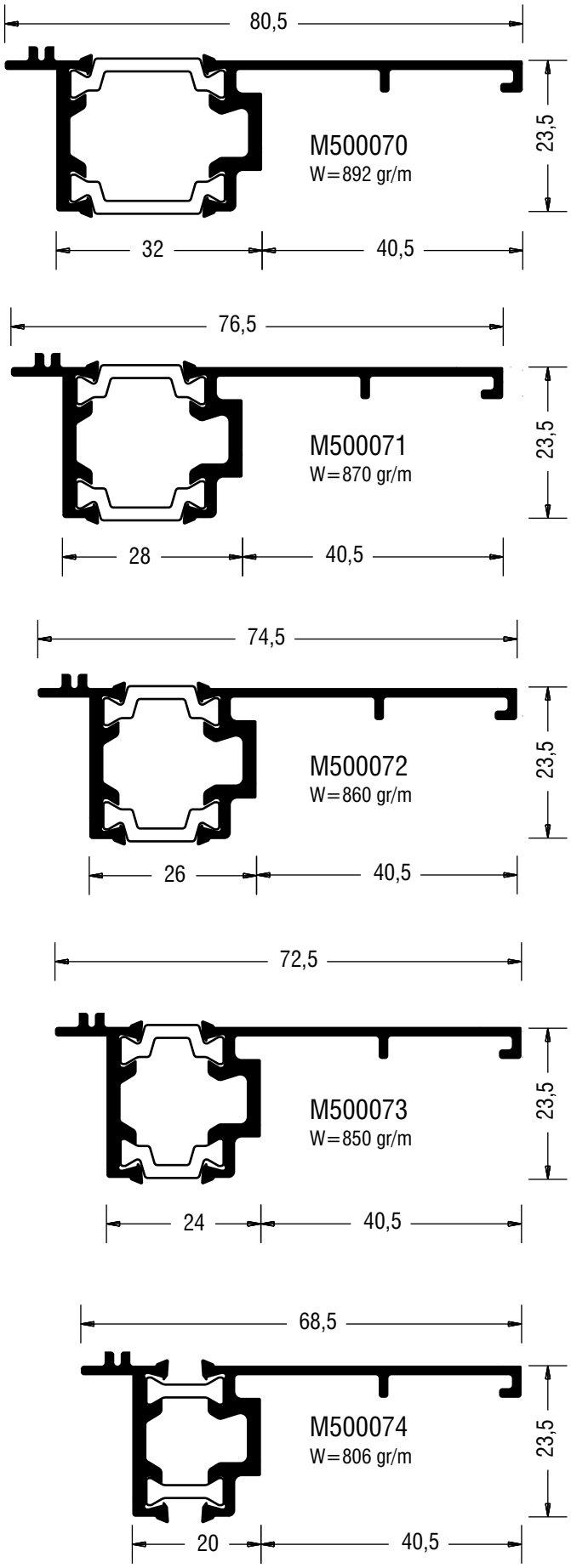

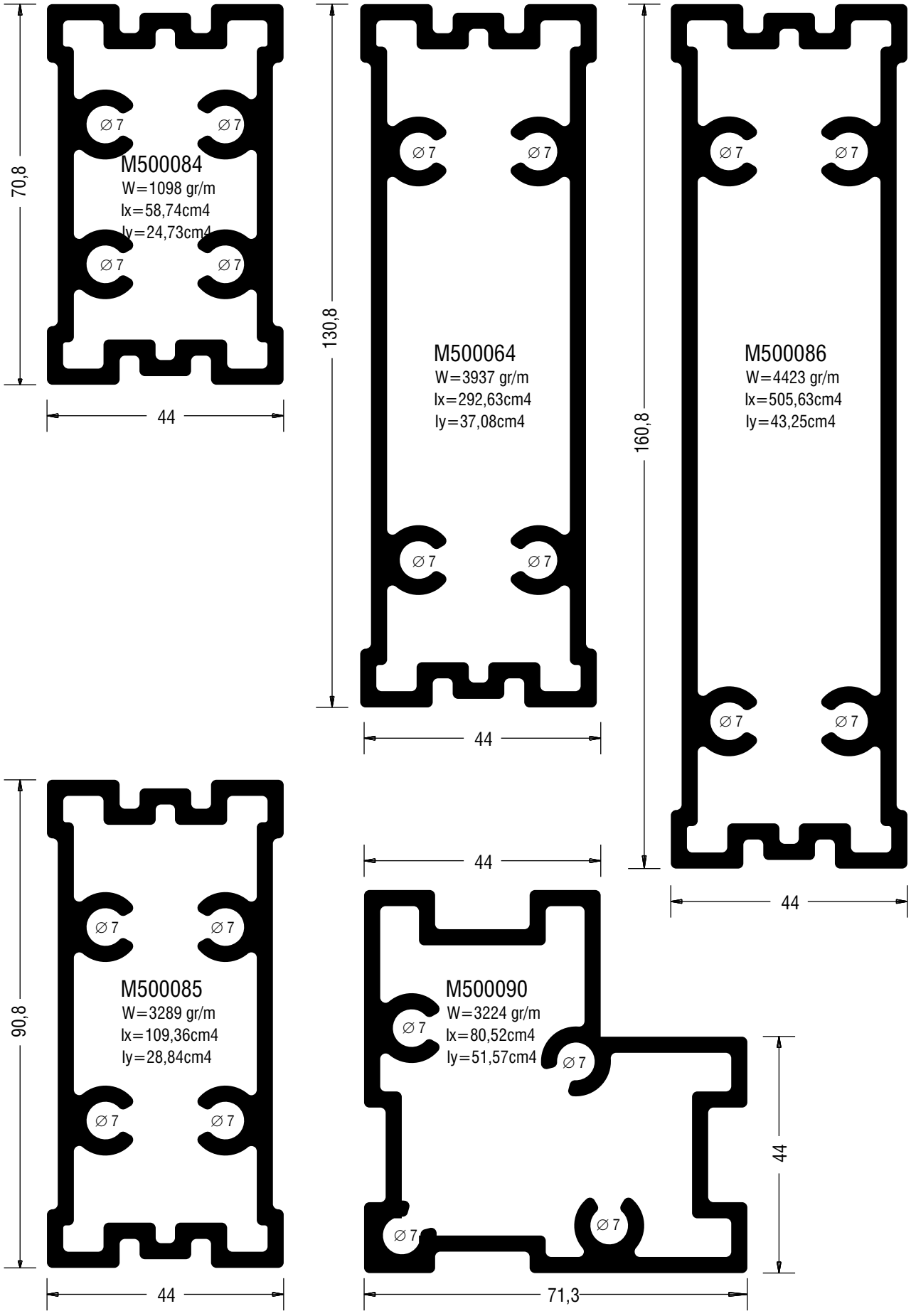

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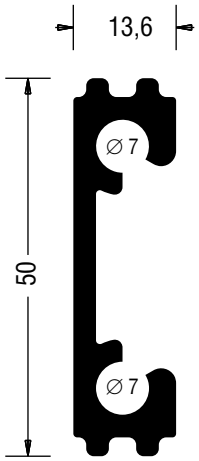
Iy=0,55cm4



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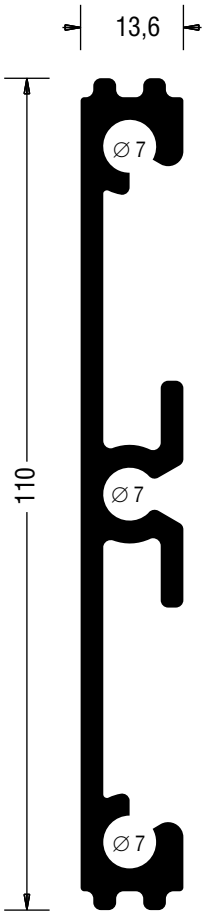
Iy=1,19cm4



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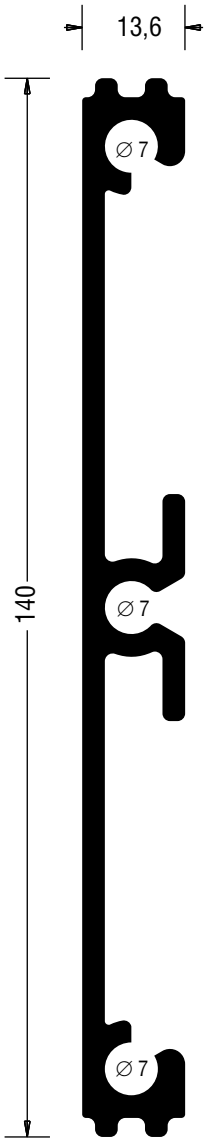
Ix=131,98cm4
Iy=1,29cm4



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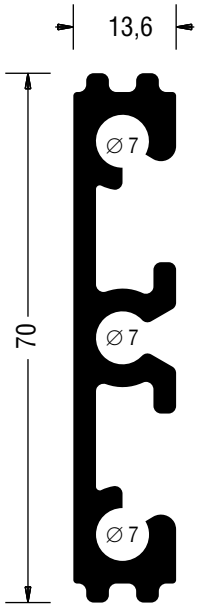
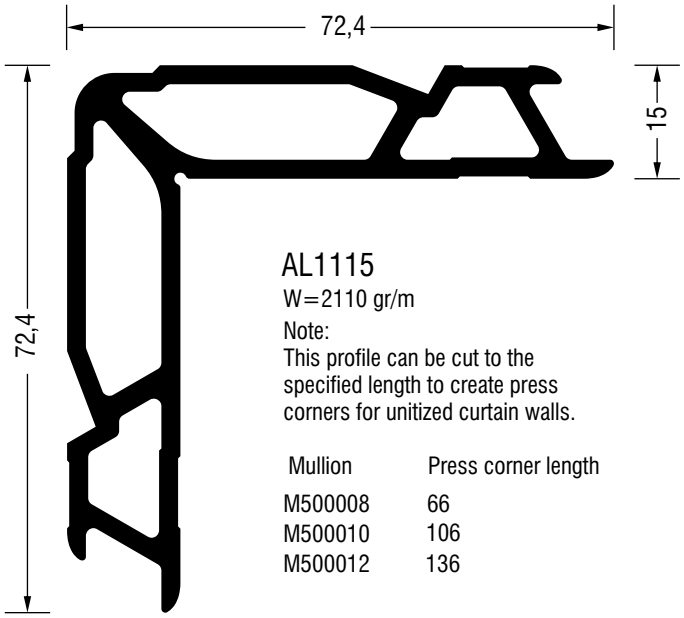
W=1237 gr/m
Ix=21,64cm4
Iy=0,86cm4



AL1115
W=2110 gr/m

Note:
This profile can be cut to the specified length to create press corners for unitized curtain walls.

Mullion	Press corner length
M500008	66
M500010	106
M500012	136



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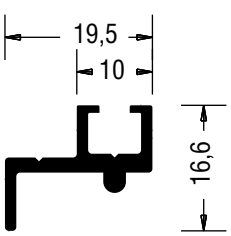

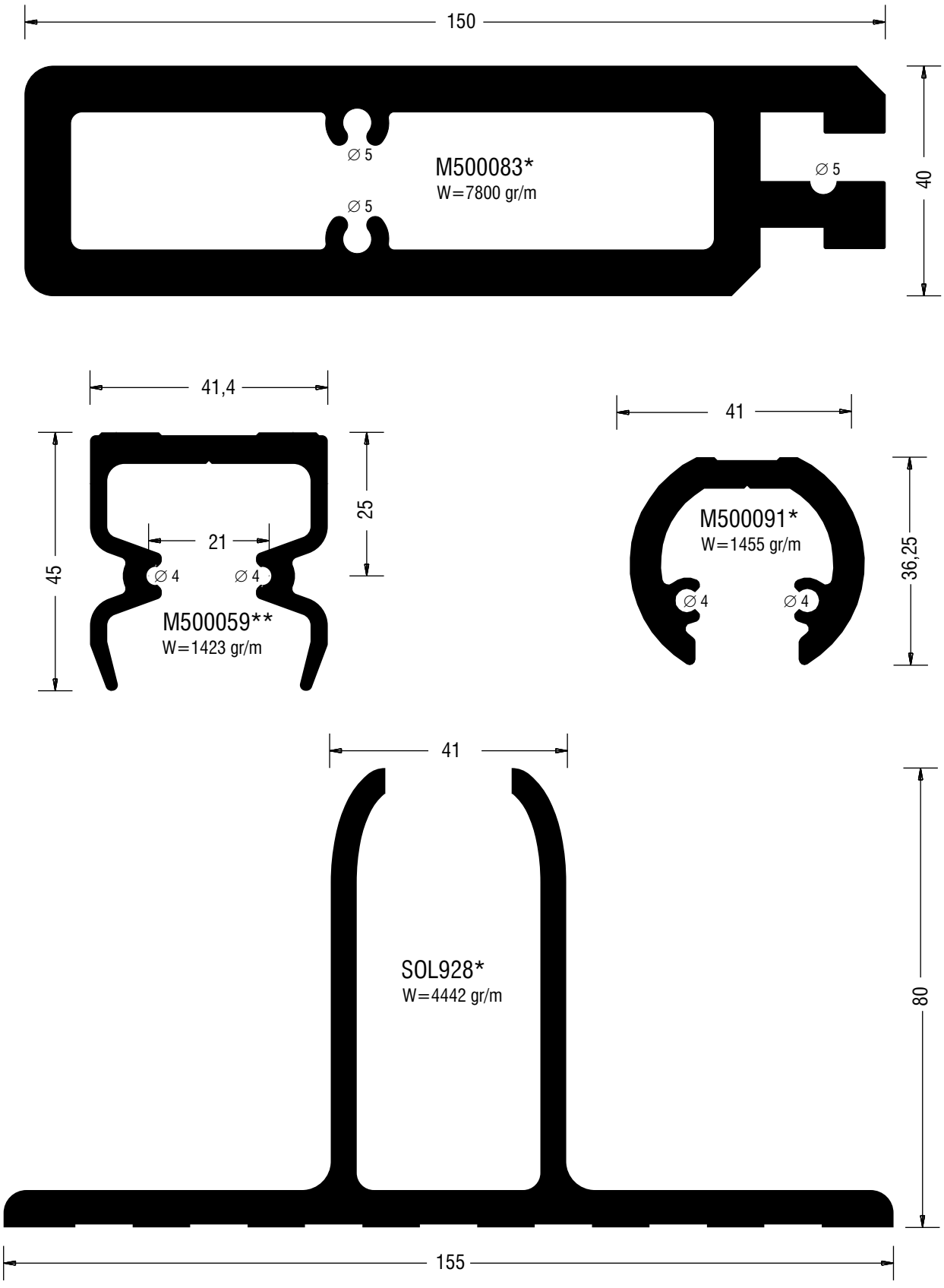

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*Note: These products have to be cut to the size in the work shop (see Milling and Manufacturing)
**Note: This product has to be cut to the size in the work shop when used as a T-Cleat for various angles (see Milling and Manufacturing)

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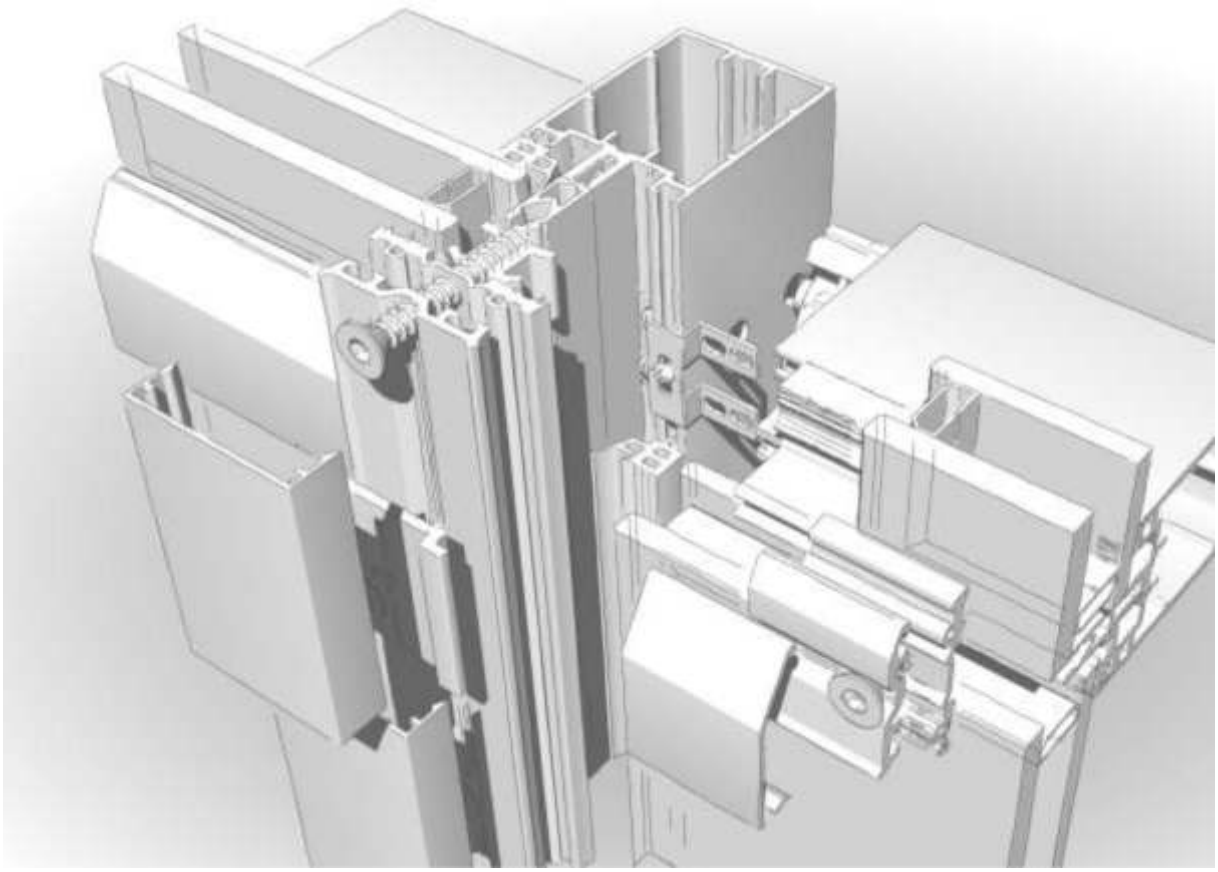

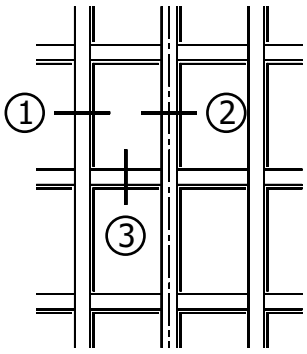

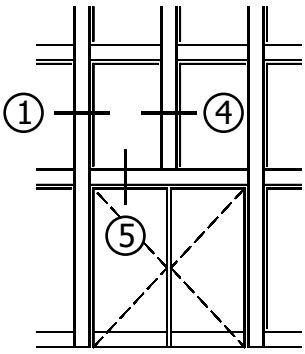

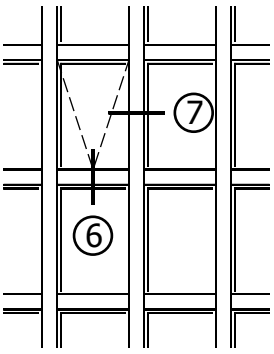

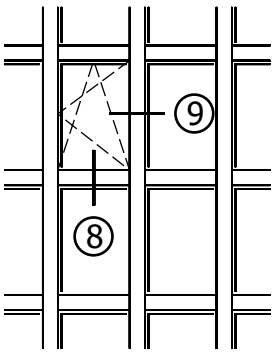

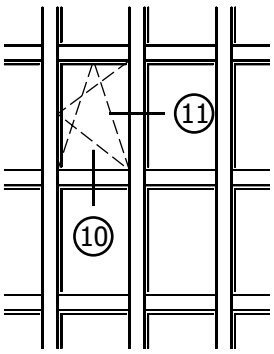

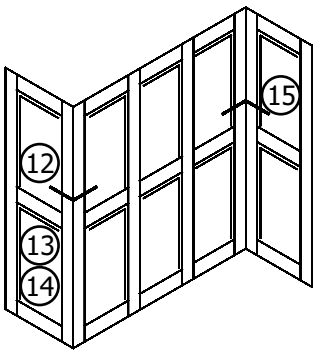

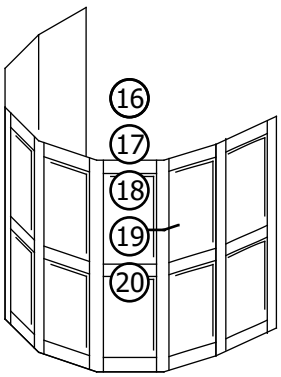

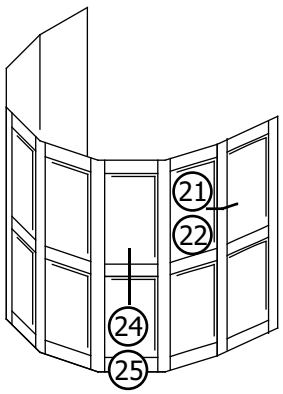

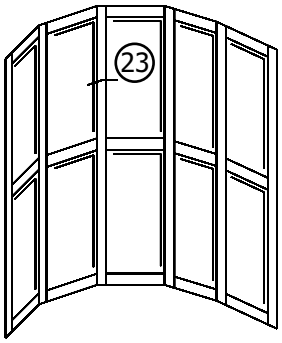

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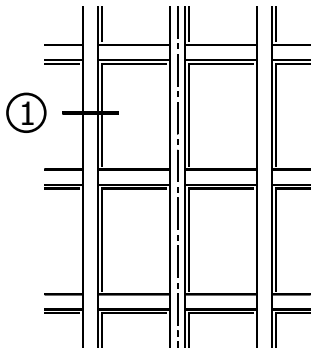
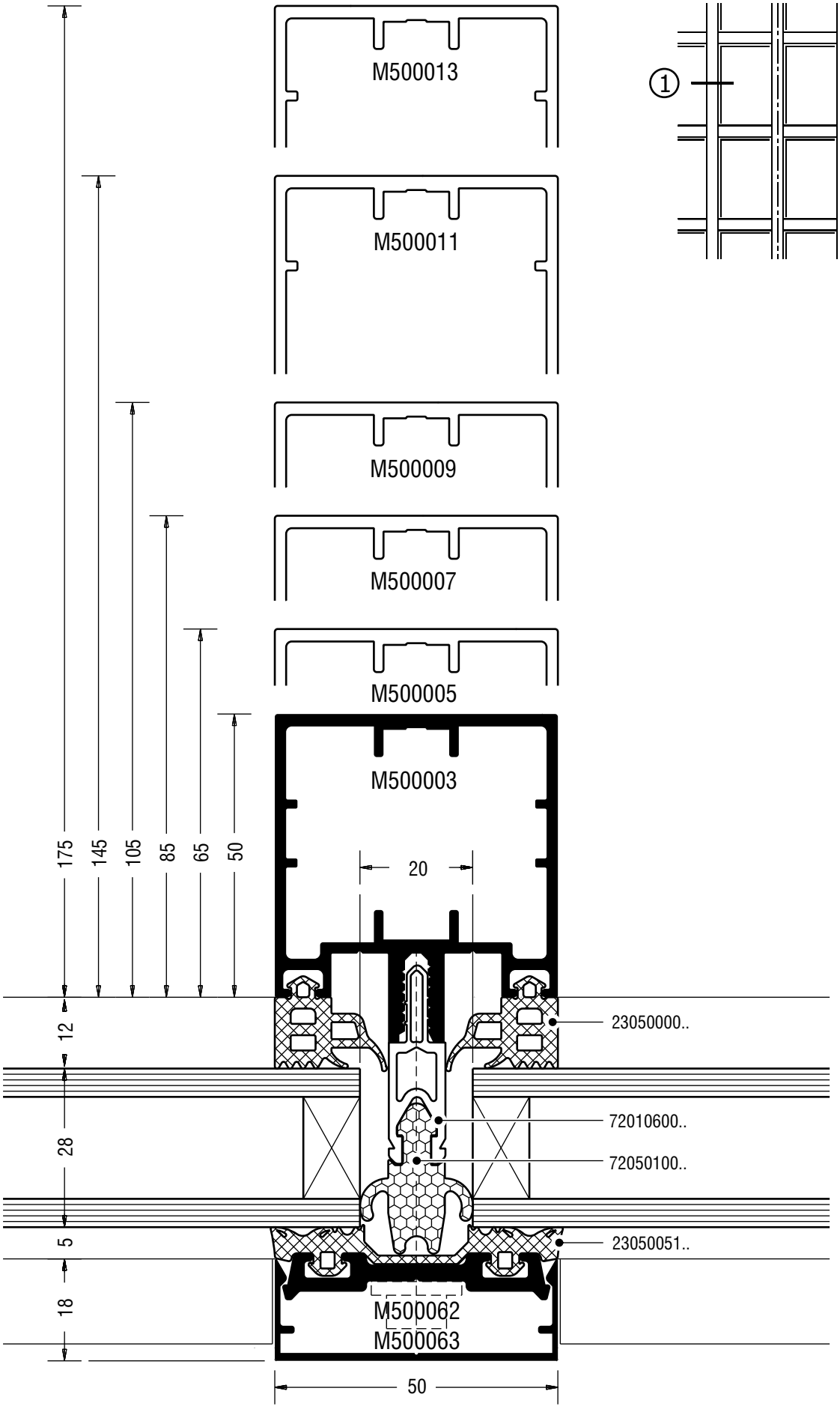
Typical sections through mullion-transom





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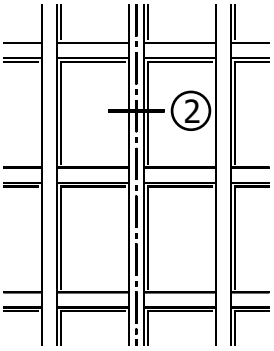
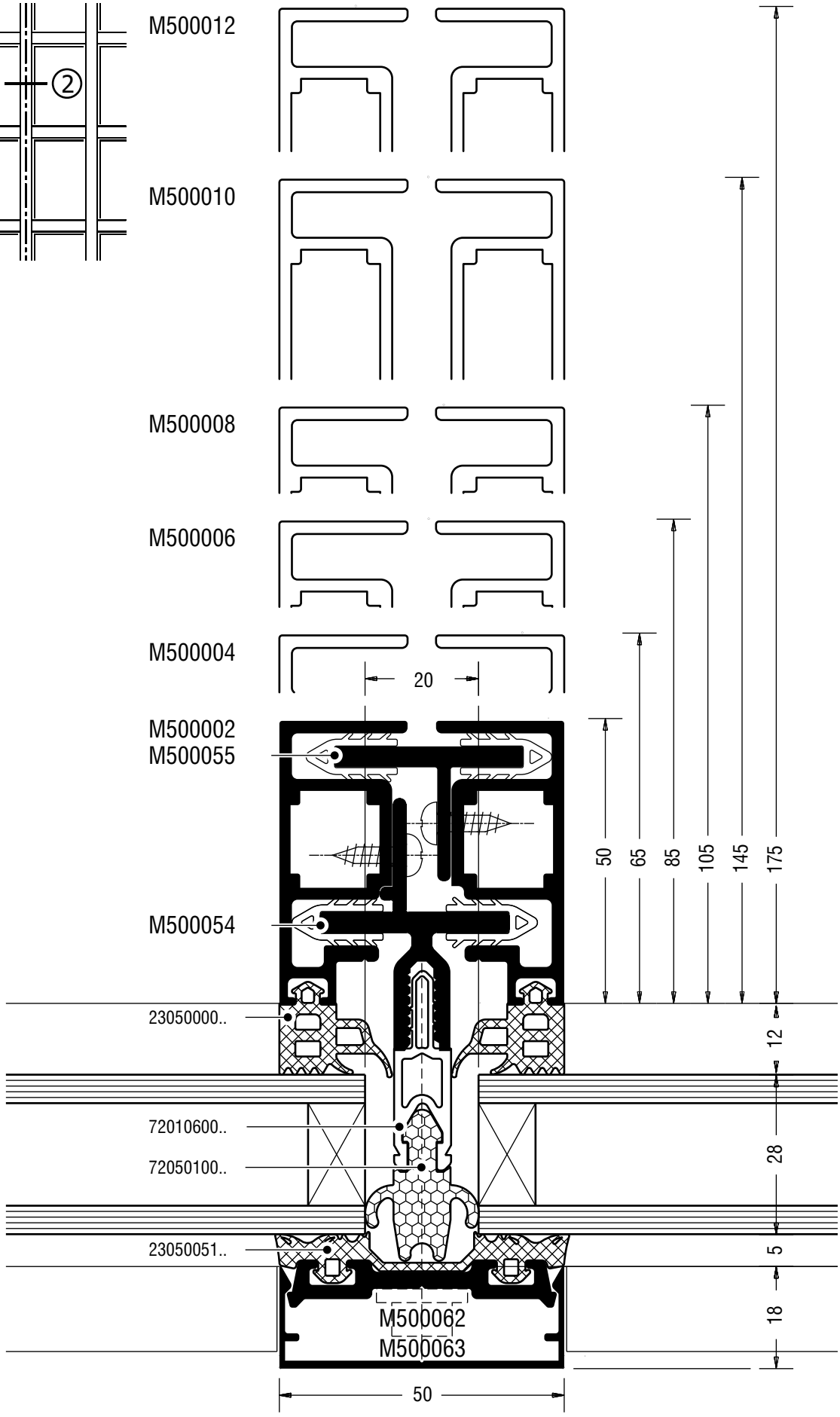
Typical section through mullion/ transom





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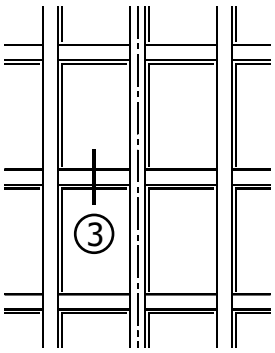
Typical sections through mullion-transom



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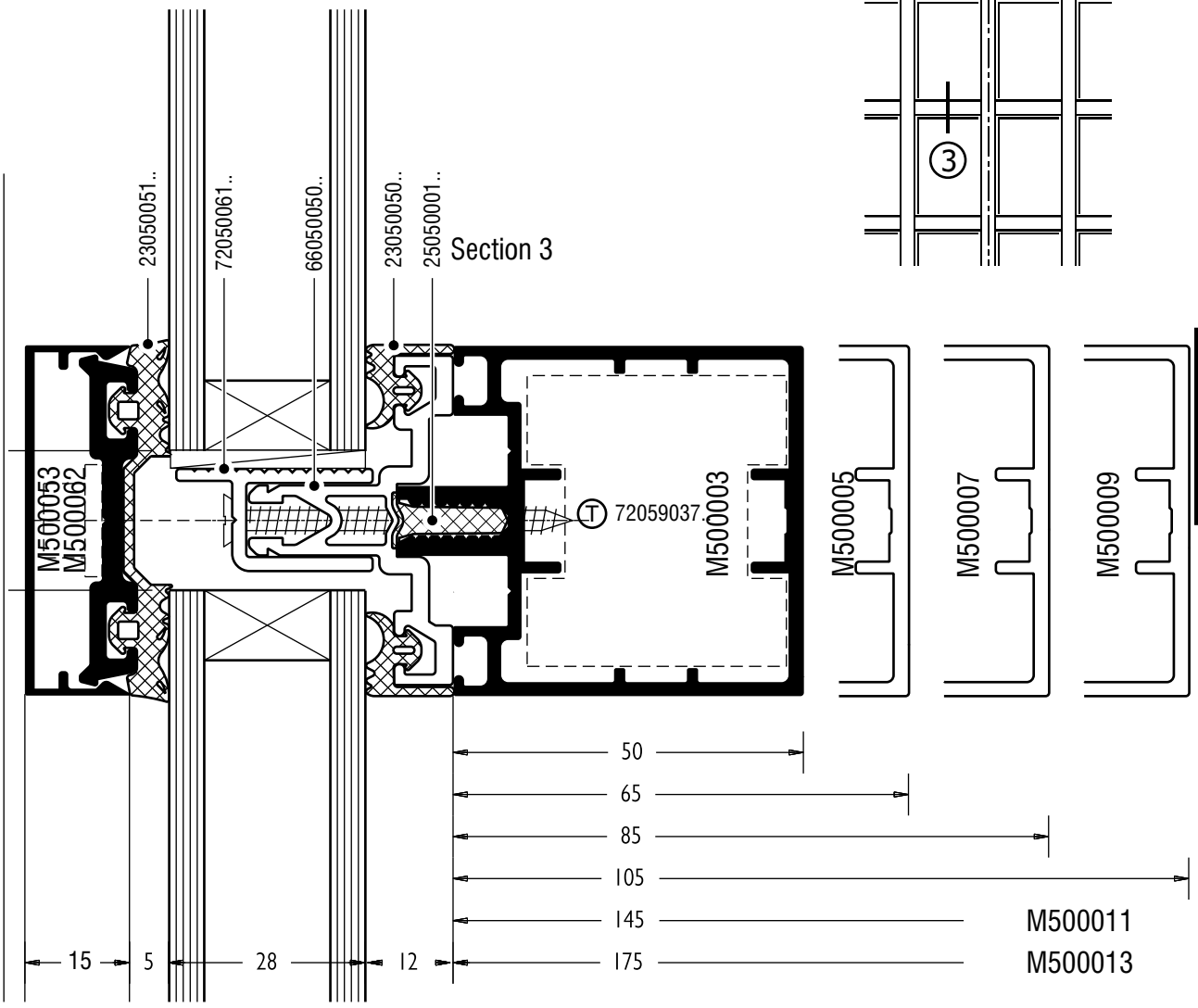

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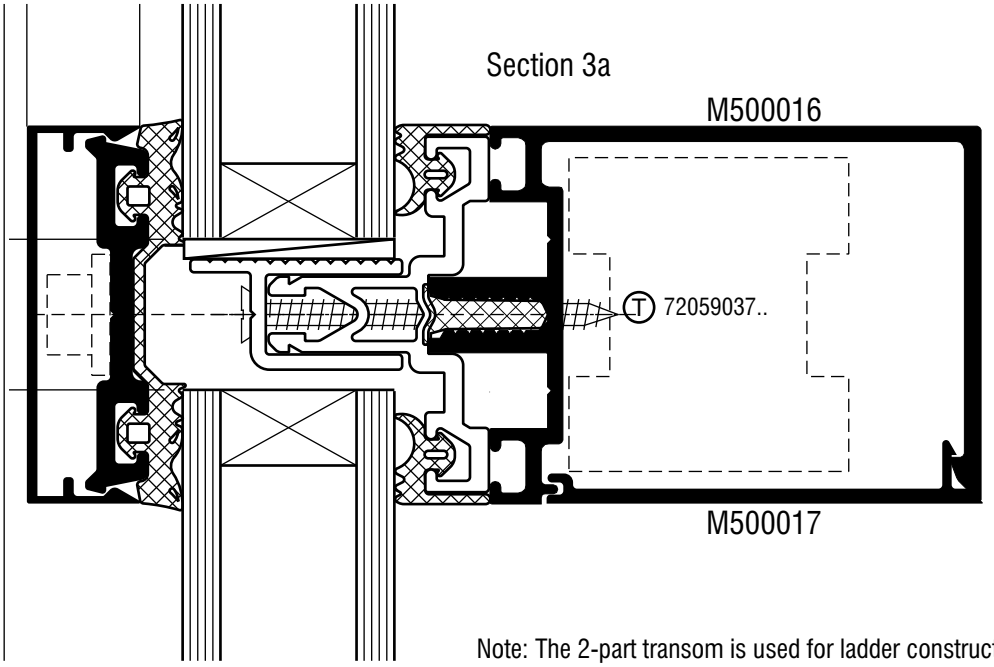

Note: The 2-part transom is used for ladder construction (see installation guide)

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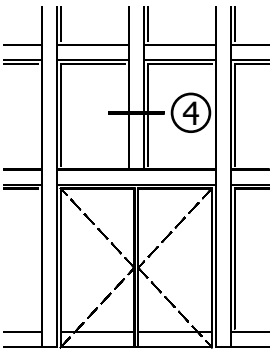
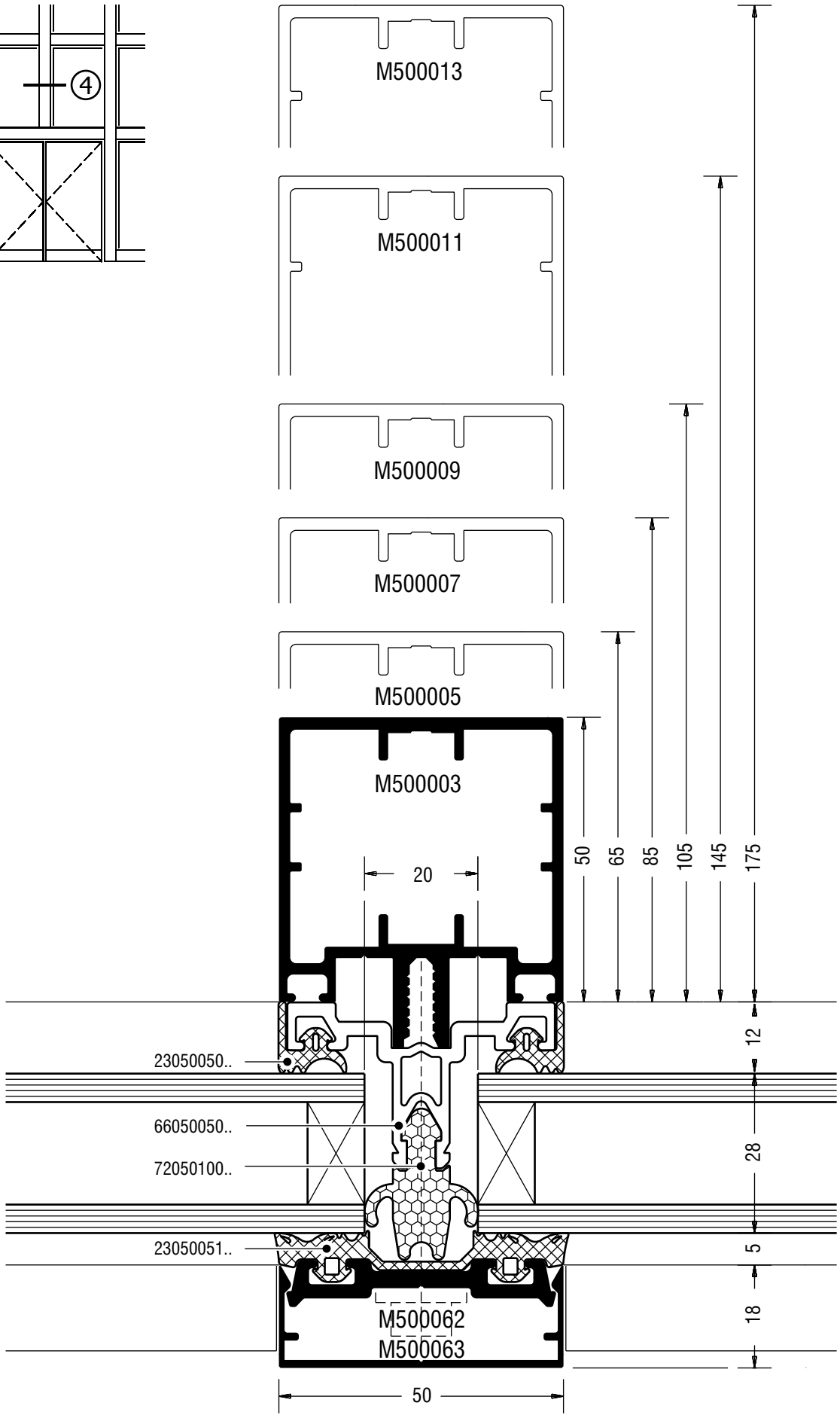
Typical section through mullion/ transom above entrance door





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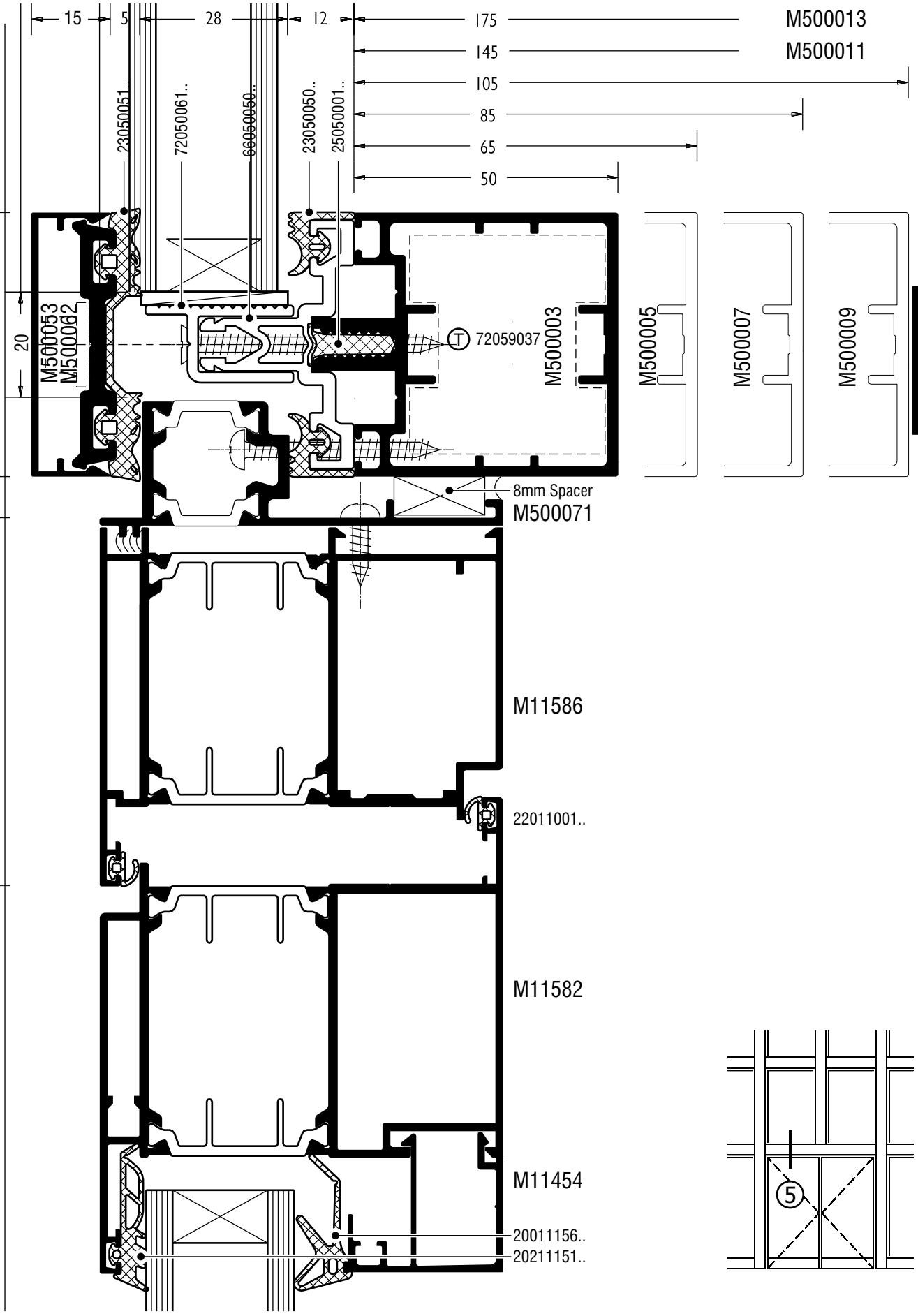

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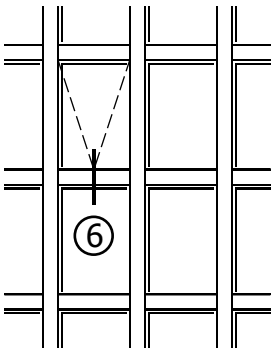
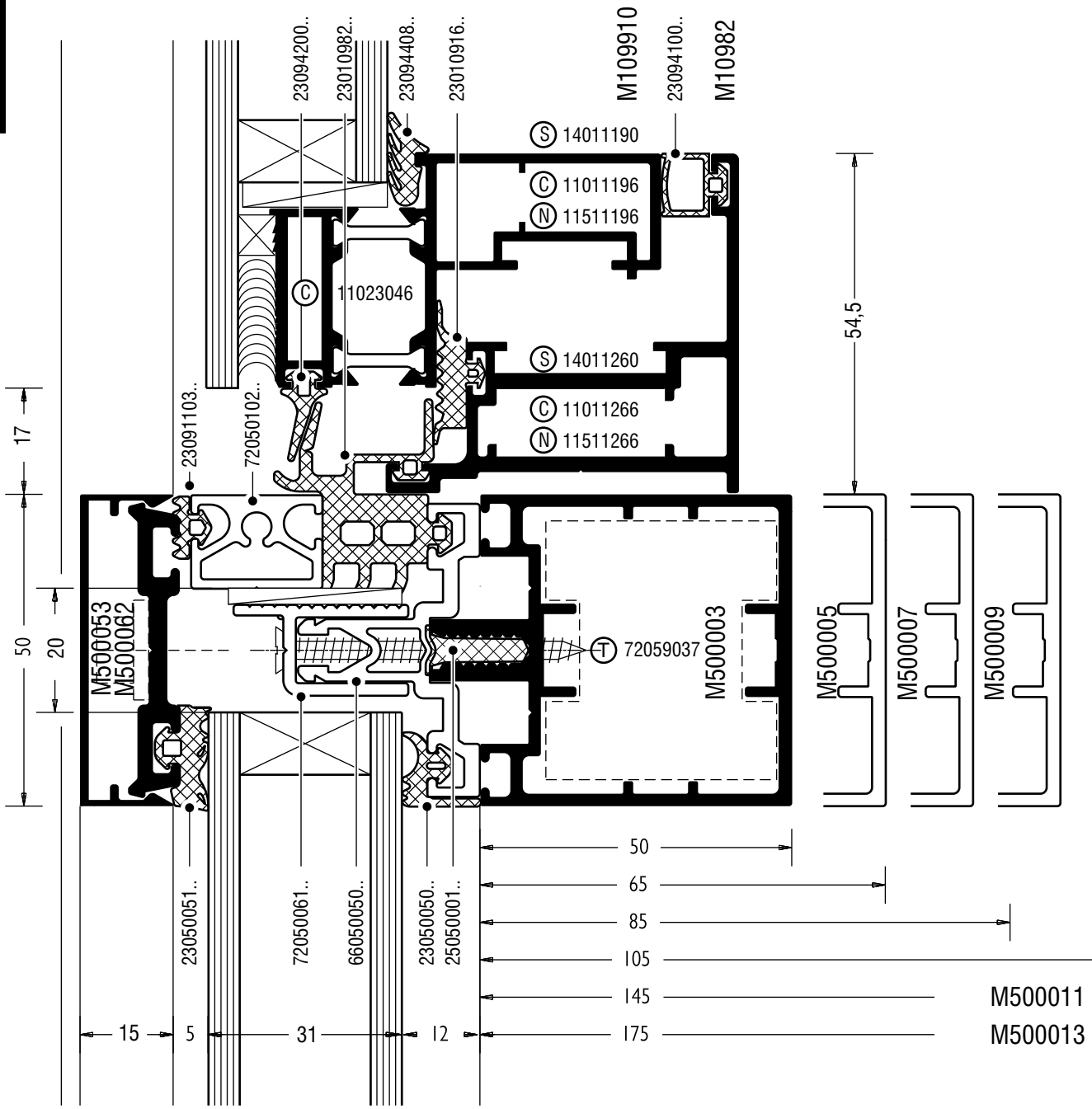
Section through top hung window





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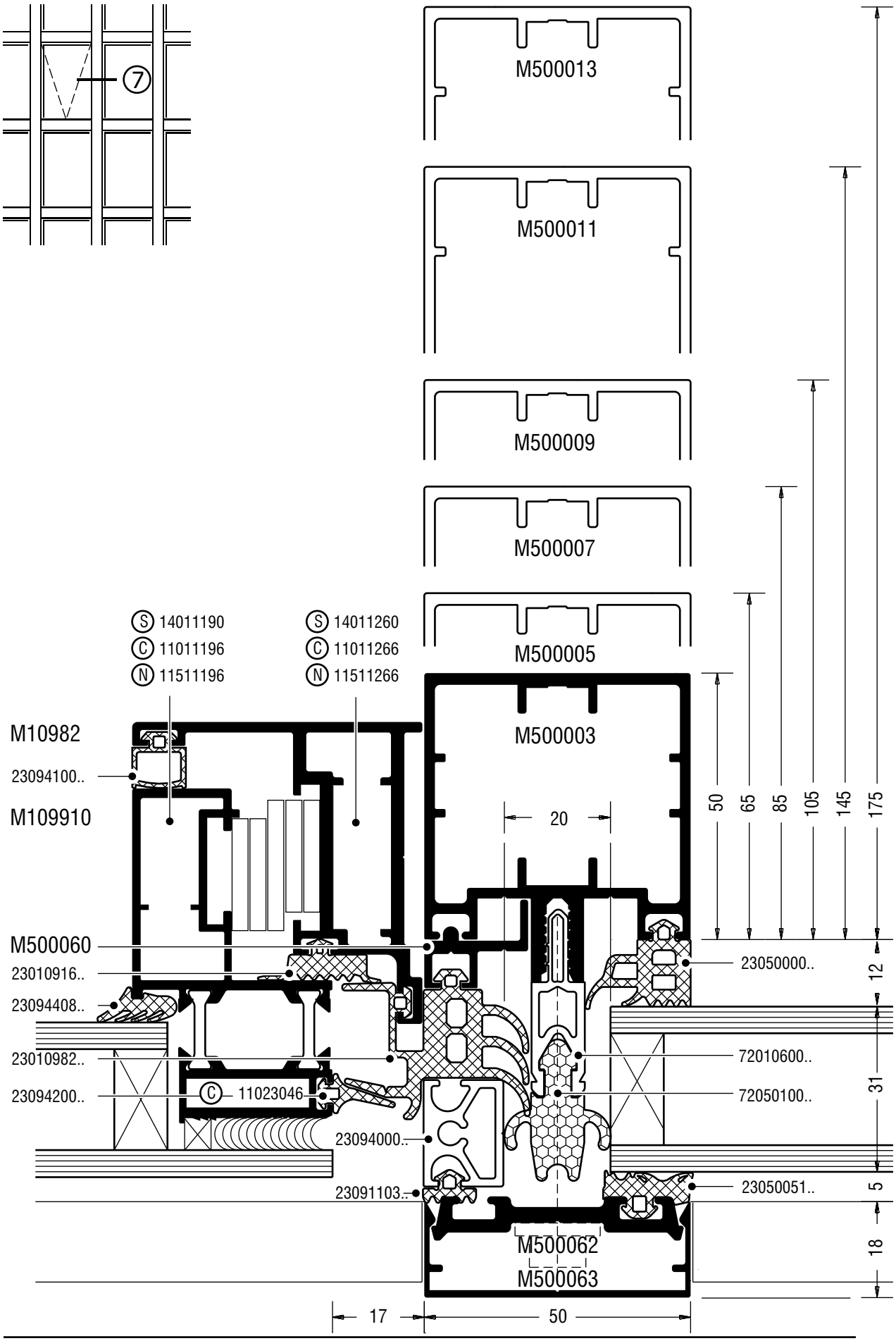

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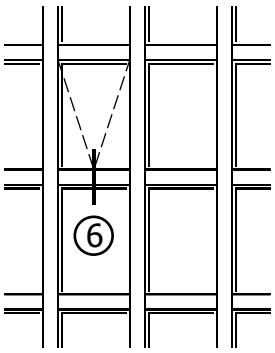
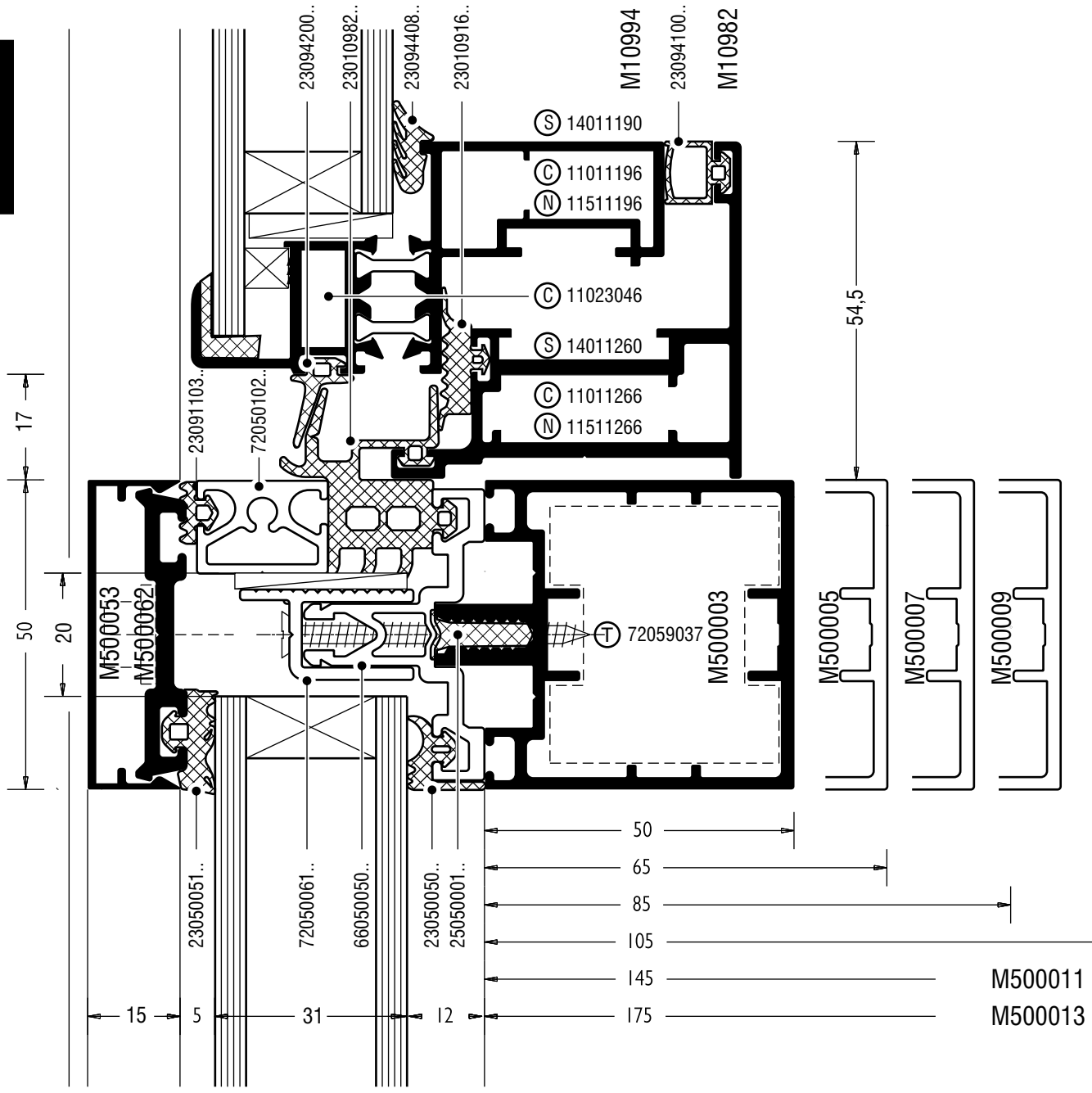
Section through top hung window





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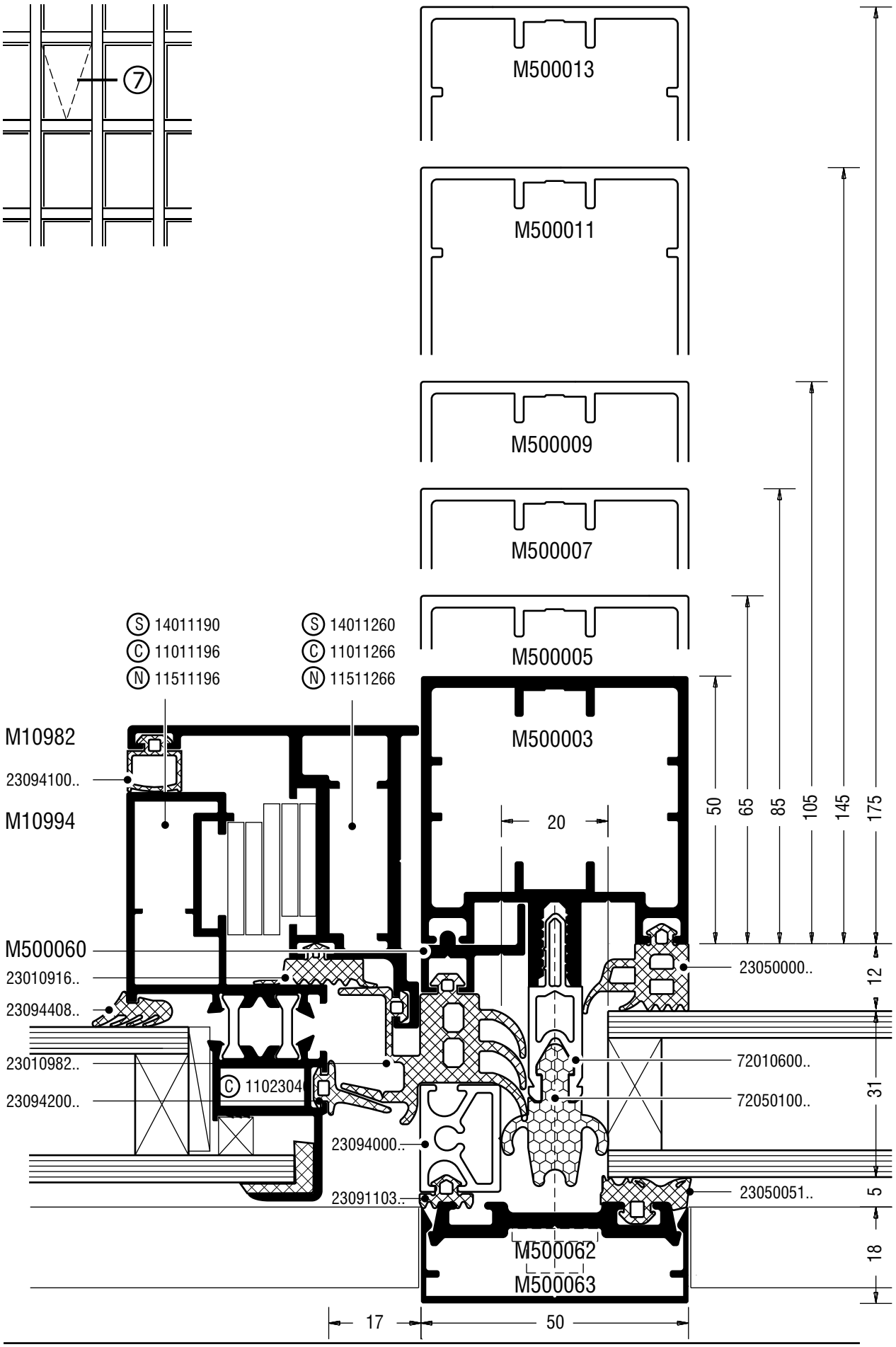

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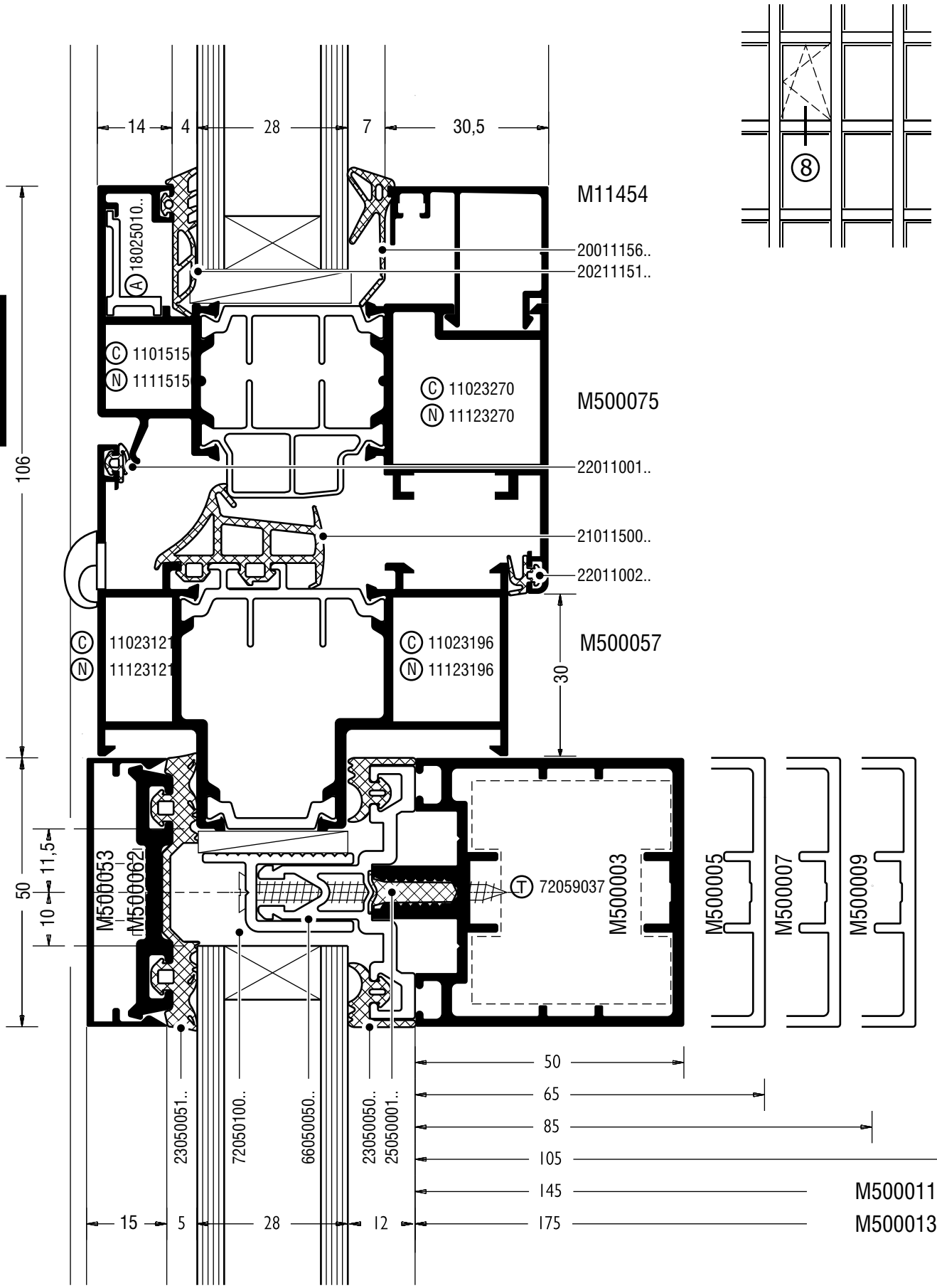
Section through tilt-turn window



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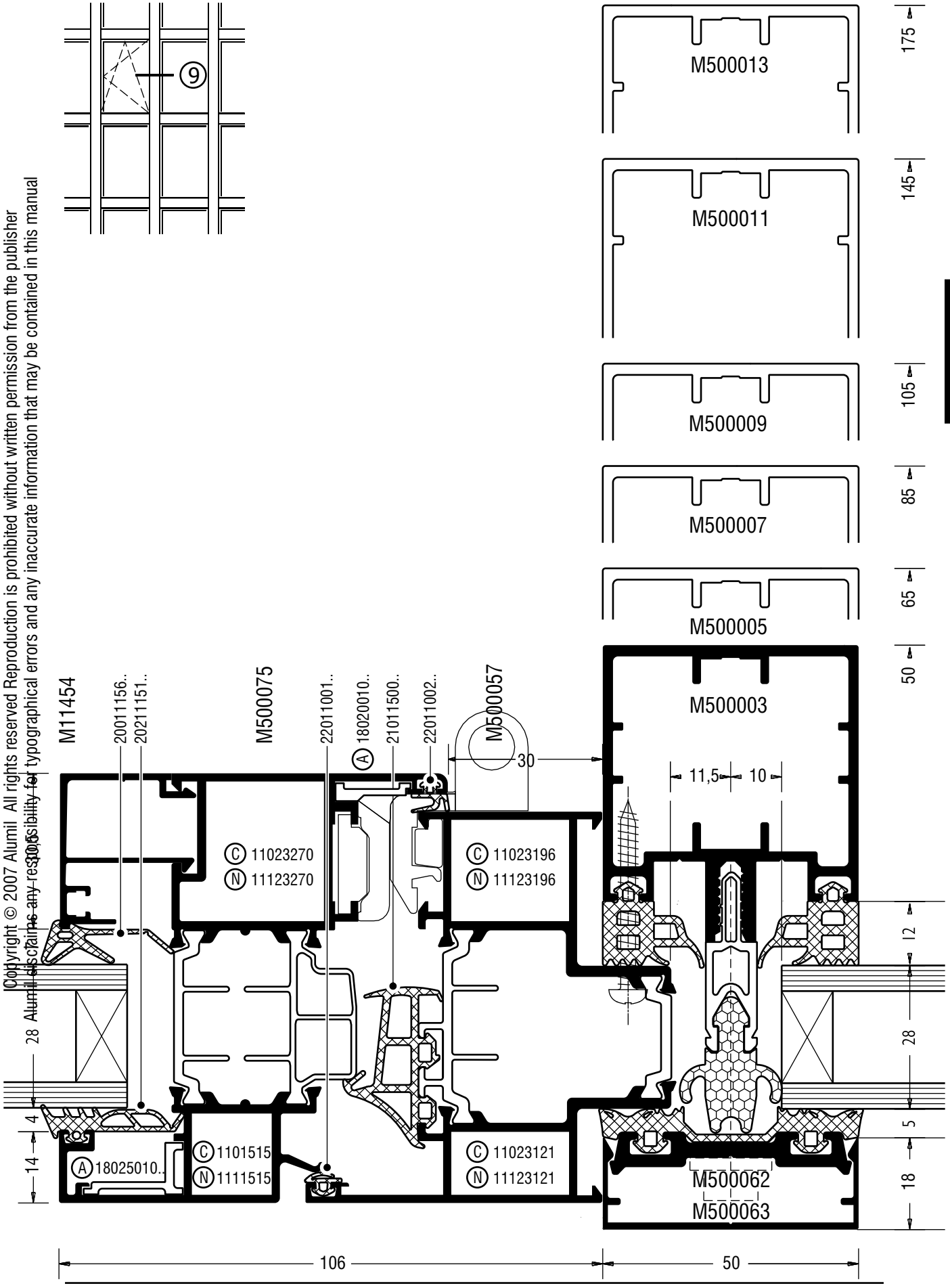
Typical sections through mullion-transom



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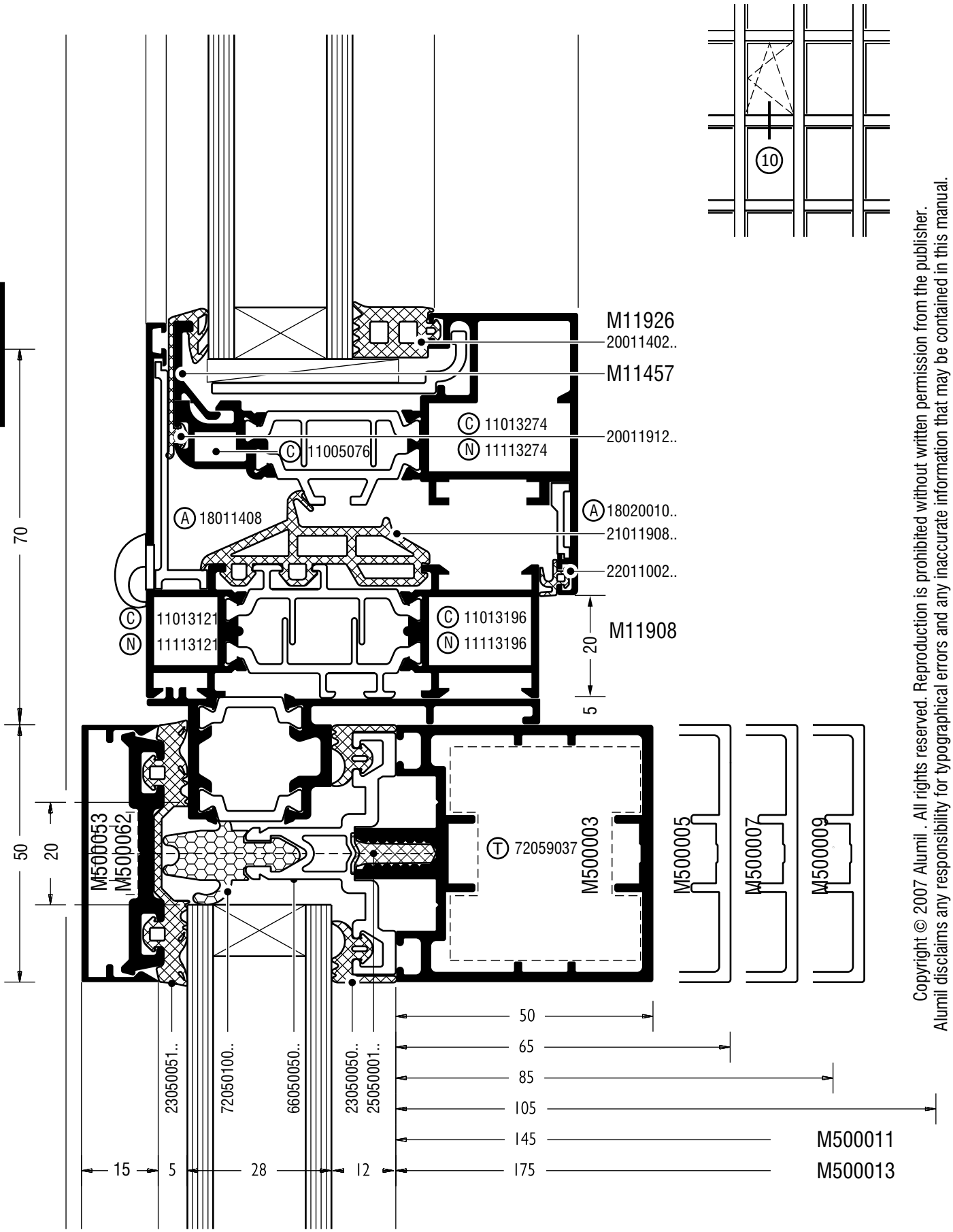
Section through integrated sash



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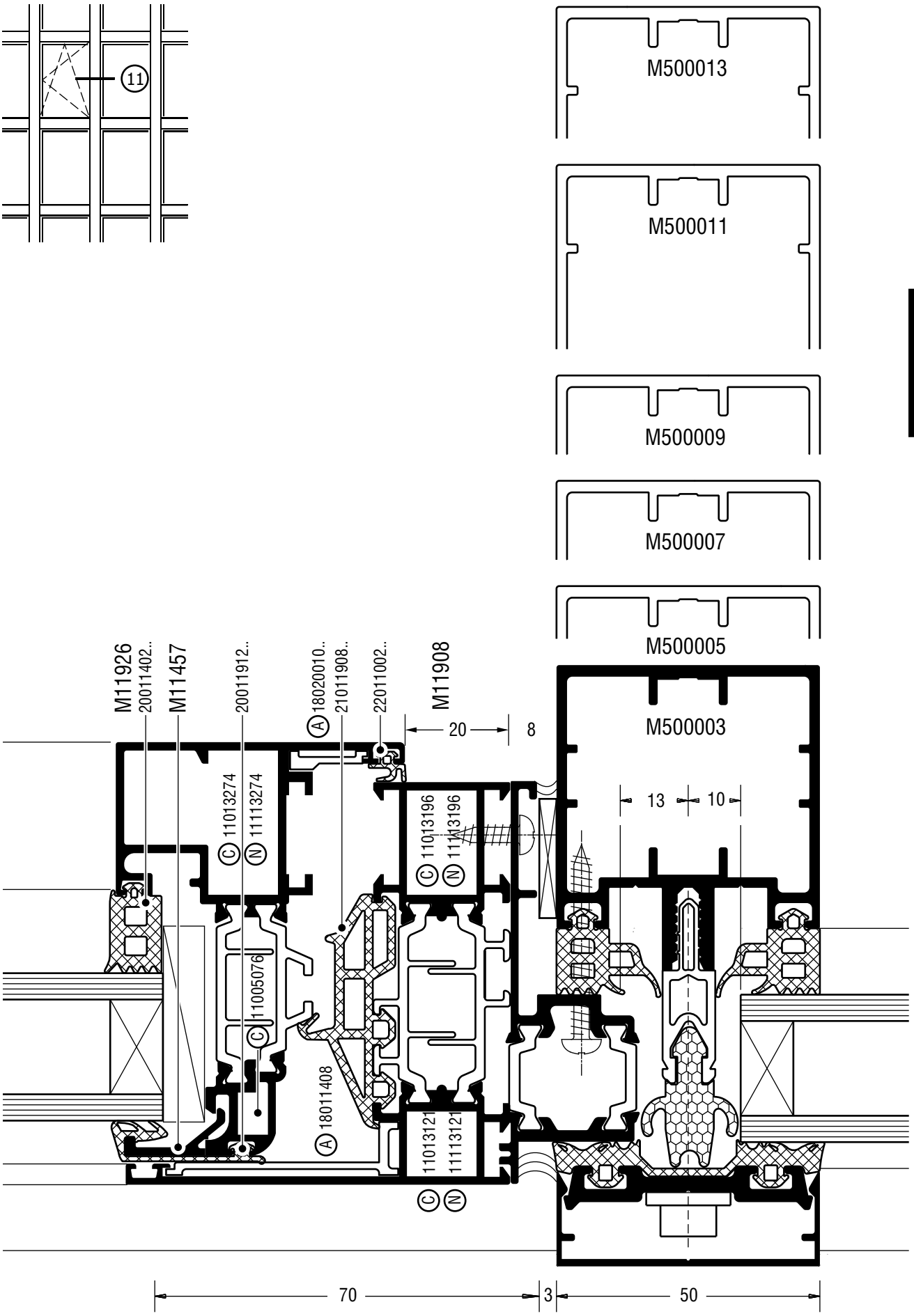

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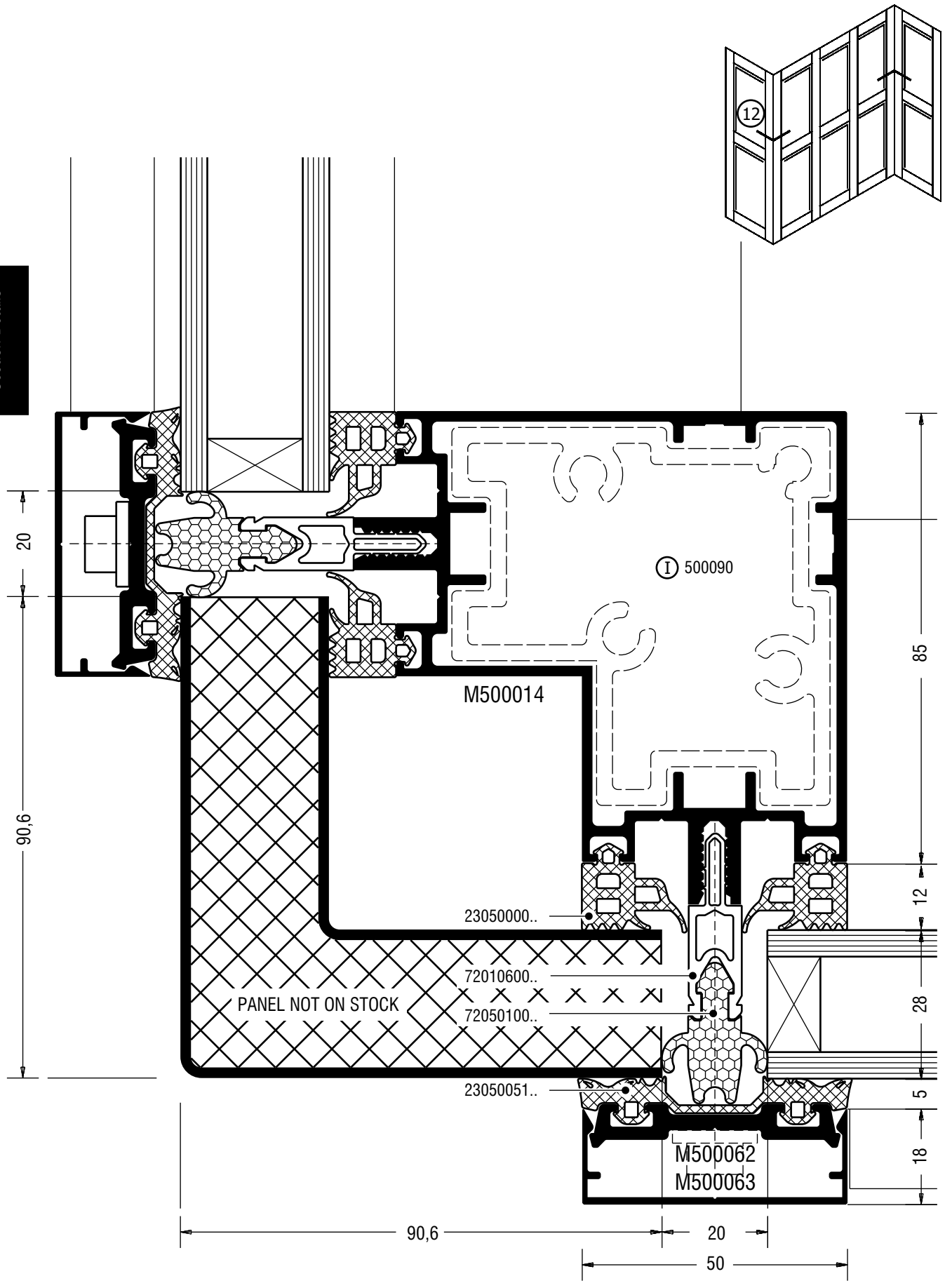
Section through mullion at exterior corner



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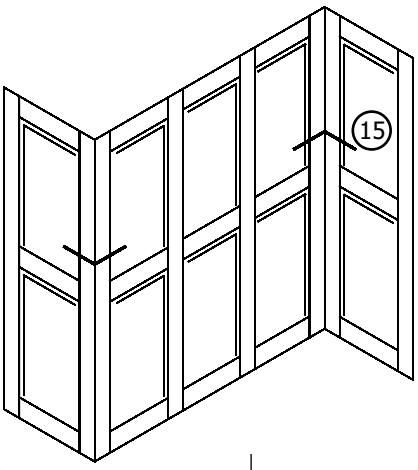
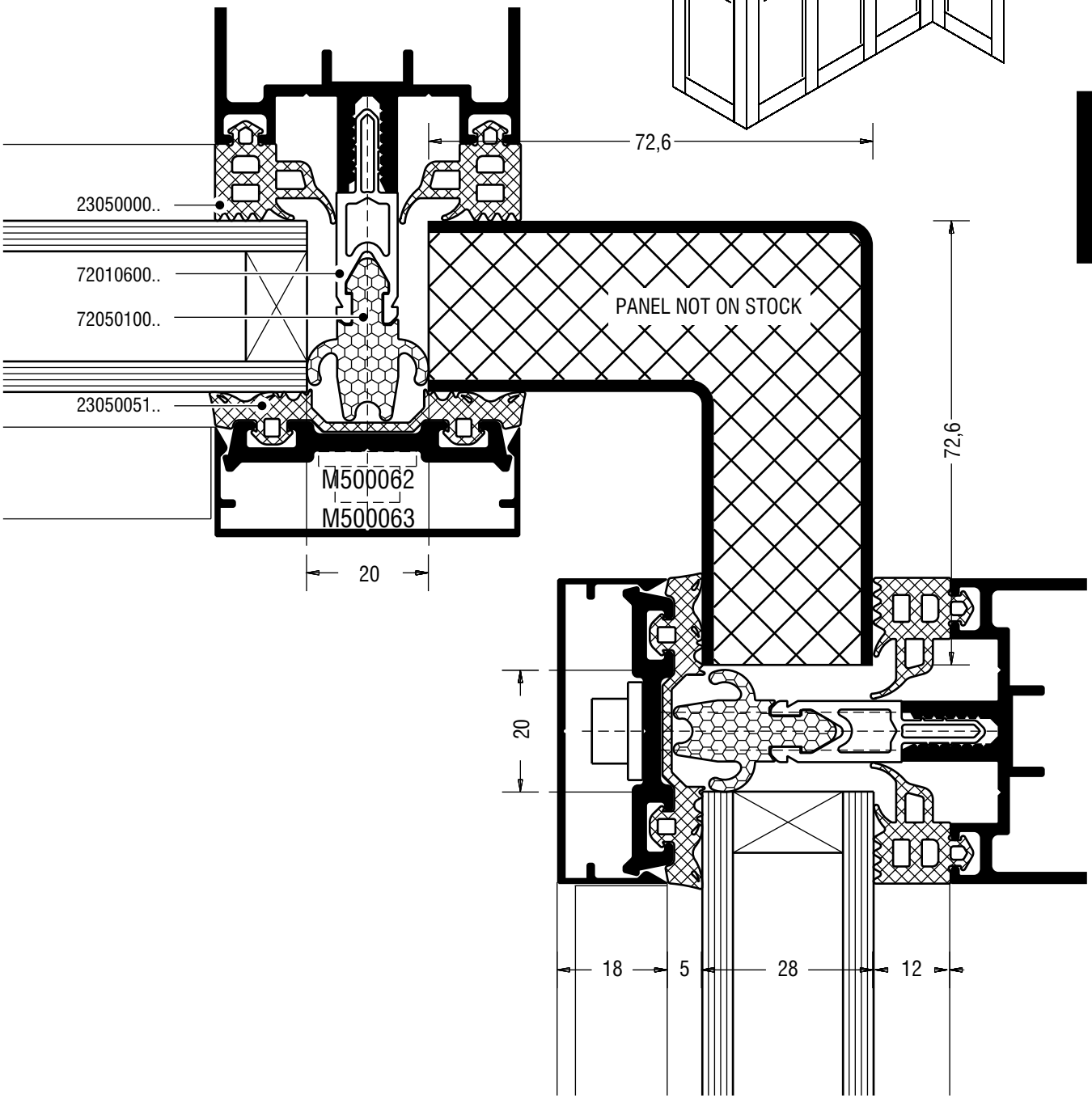
Section through mullion at interior corner





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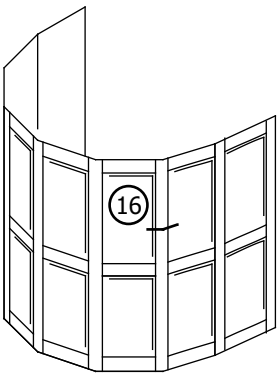
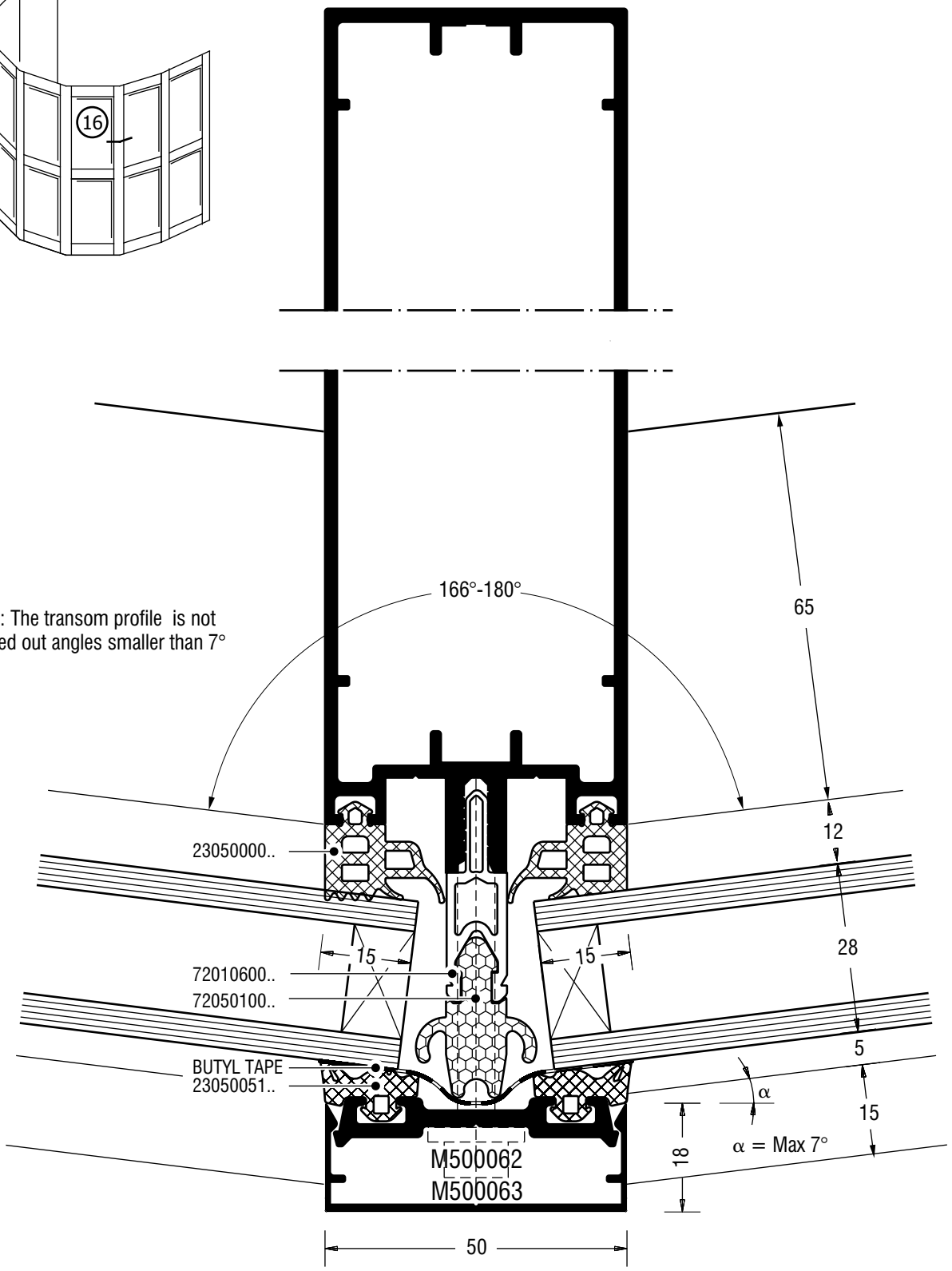
Section through mullion at 7˚ angle



*Note: The transom profile is not notched out angles smaller than 7°



*Note: Angles from 166-180 degrees can be made with the standard gaskets and profiles.

**Note: Butyl tape is required for all mullions on a curved or angled curtain wall. The tape should overlap the glazing panel a minimum of 12mm on each side. And a small strip of tape should be applied over the horizontal transoms at each intersection with an overlap of 25mm on each side of the mullion. See installation manual for further details.

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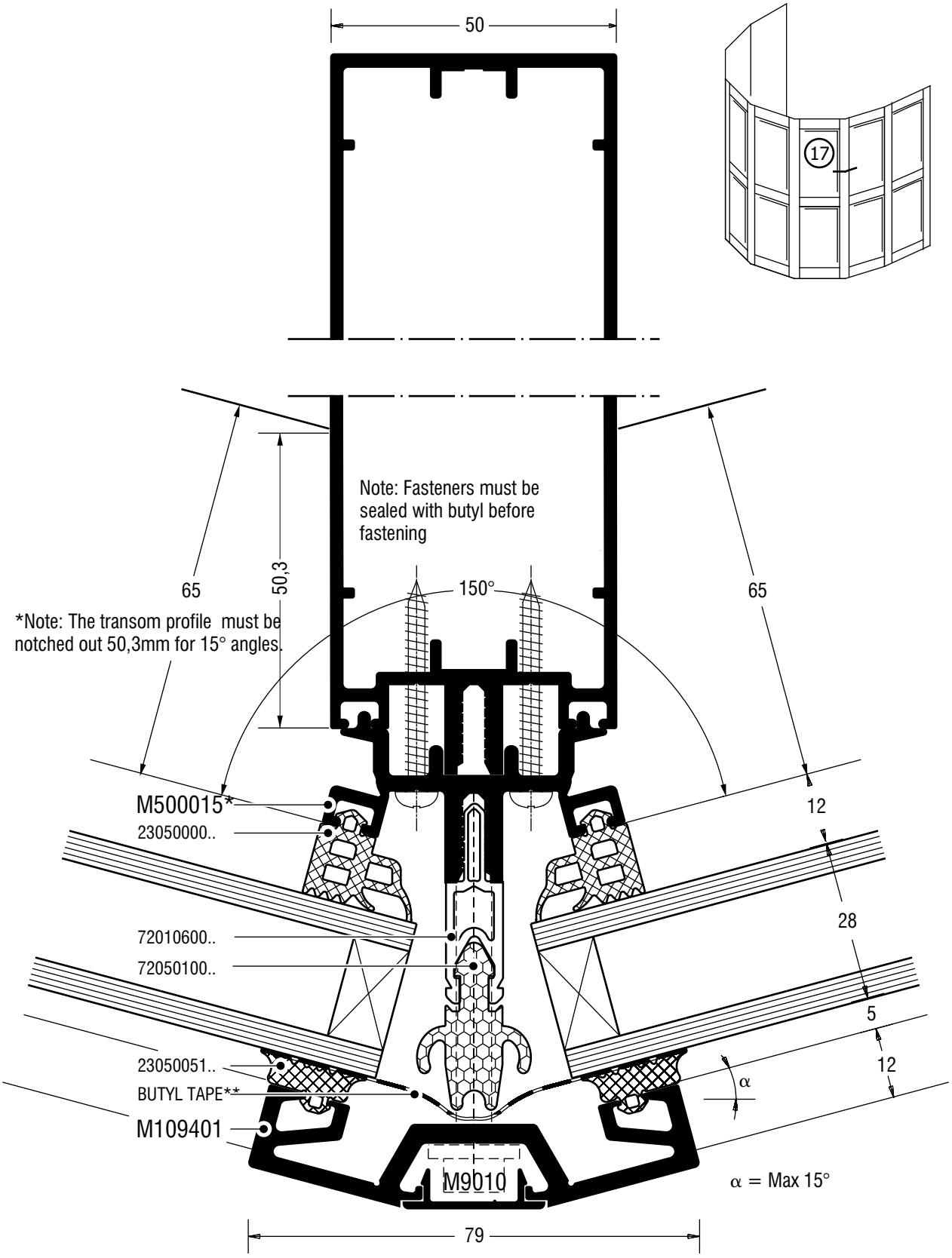
Section through mullion at 15° angle



*Note: The profile M500015 must be bent in the work shop to the correct angle.

**Note: Butyl tape is required for all mullions on a curved or angled curtain wall. The tape should overlap the glazing panel a minimum of 12mm on each side. And a small strip of tape should be applied over the horizontal transoms at each intersection with an overlap of 25mm on each side of the mullion. See installation manual for further details.

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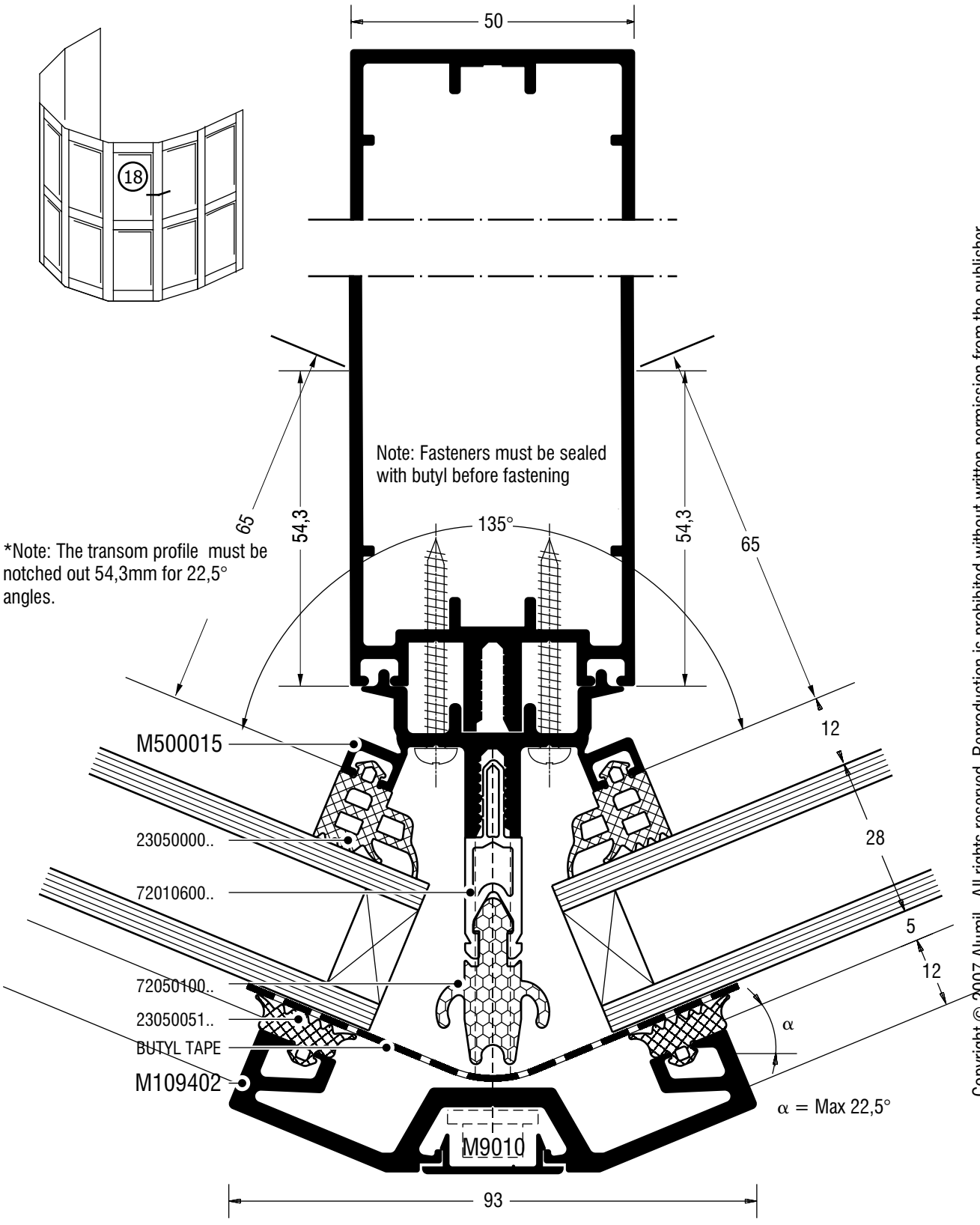
Section through mullion at 22,5˚ angle



*Note: The profile M500015 must be bent in the work shop to the correct angle.

**Note: Butyl tape is required for all mullions on a curved or angled curtain wall. The tape should overlap the glazing panel a minimum of 12mm on each side. And a small strip of tape should be applied over the horizontal transoms at each intersection with an overlap of 25mm on each side of the mullion. See installation manual for further details.

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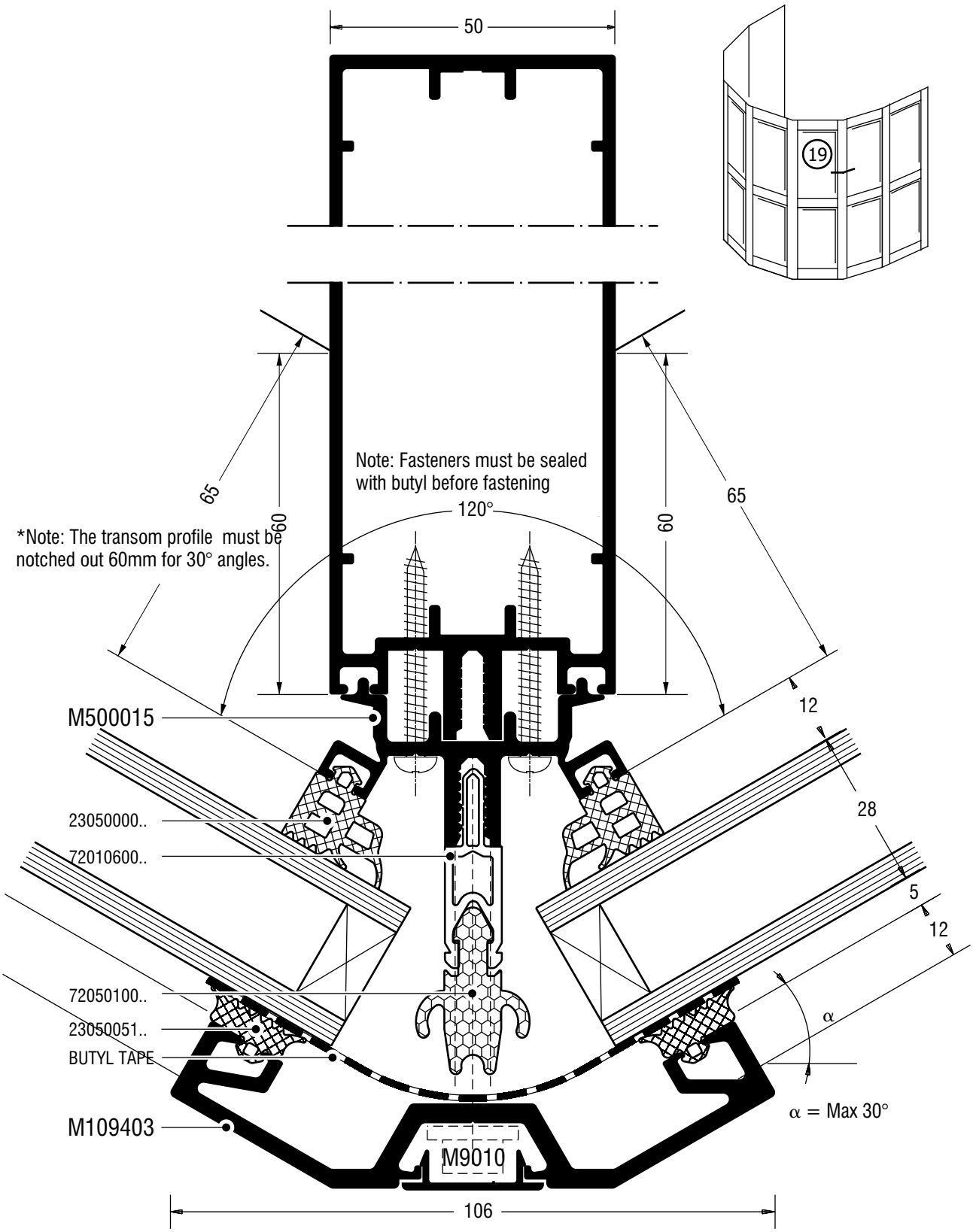
Section through mullion at 30° angle



*Note: The profile M500015 must be bent in the work shop to the correct angle.

**Note: Butyl tape is required for all mullions on a curved or angled curtain wall. The tape should overlap the glazing panel a minimum of 12mm on each side. And a small strip of tape should be applied over the horizontal transoms at each intersection with an overlap of 25mm on each side of the mullion. See installation manual for further details.

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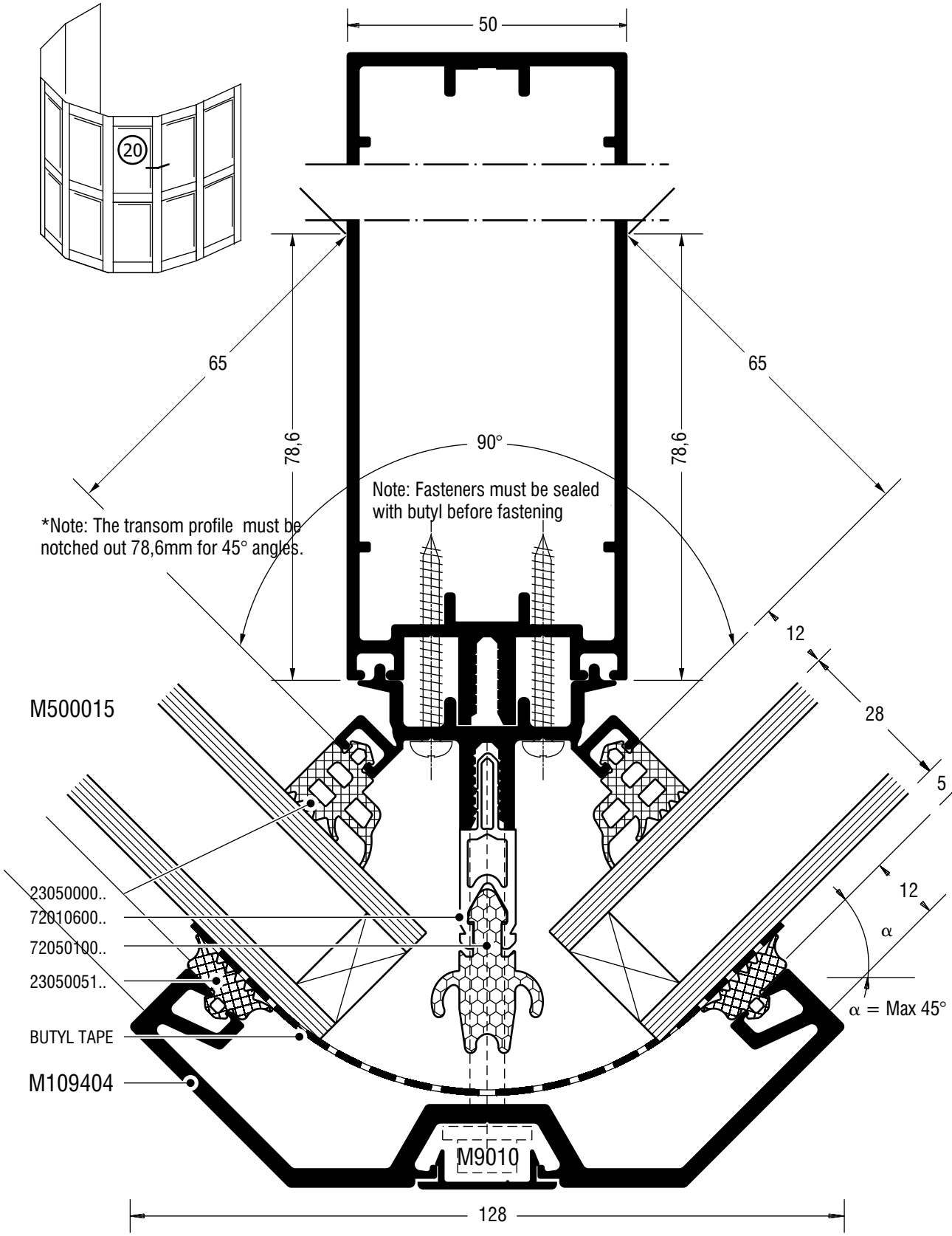
Section through mullion at 45˚ angle



*Note: The profile M500015 must be bent in the work shop to the correct angle.

**Note: Butyl tape is required for all mullions on a curved or angled curtain wall. The tape should overlap the glazing panel a minimum of 12mm on each side. And a small strip of tape should be applied over the horizontal transoms at each intersection with an overlap of 25mm on each side of the mullion. See installation manual for further details.

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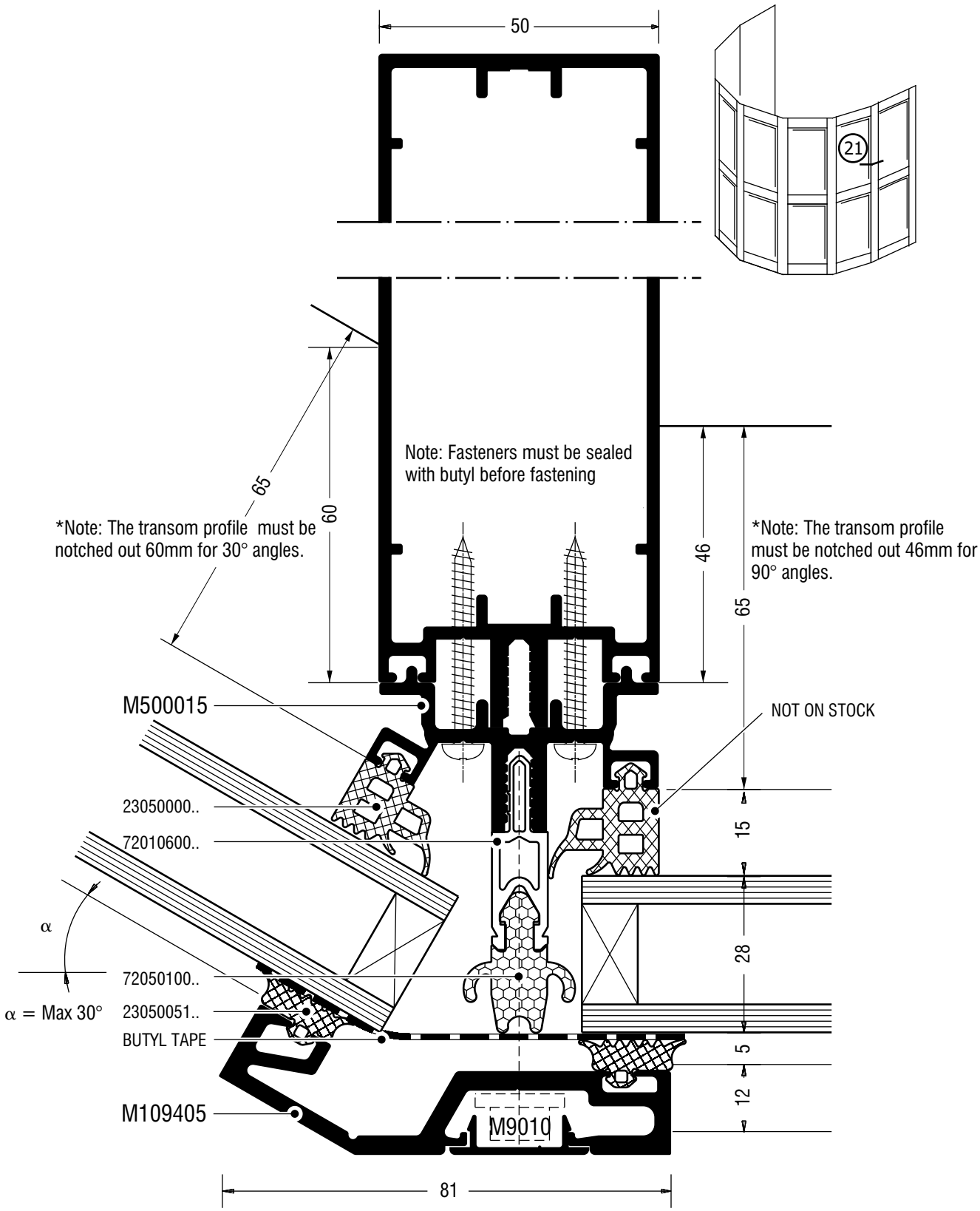
Section through mullion at 30° angle



*Note: The profile M500015 must be bent in the work shop to the correct angle.

**Note: Butyl tape is required for all mullions on a curved or angled curtain wall. The tape should overlap the glazing panel a minimum of 12mm on each side. And a small strip of tape should be applied over the horizontal transoms at each intersection with an overlap of 25mm on each side of the mullion. See installation manual for further details.

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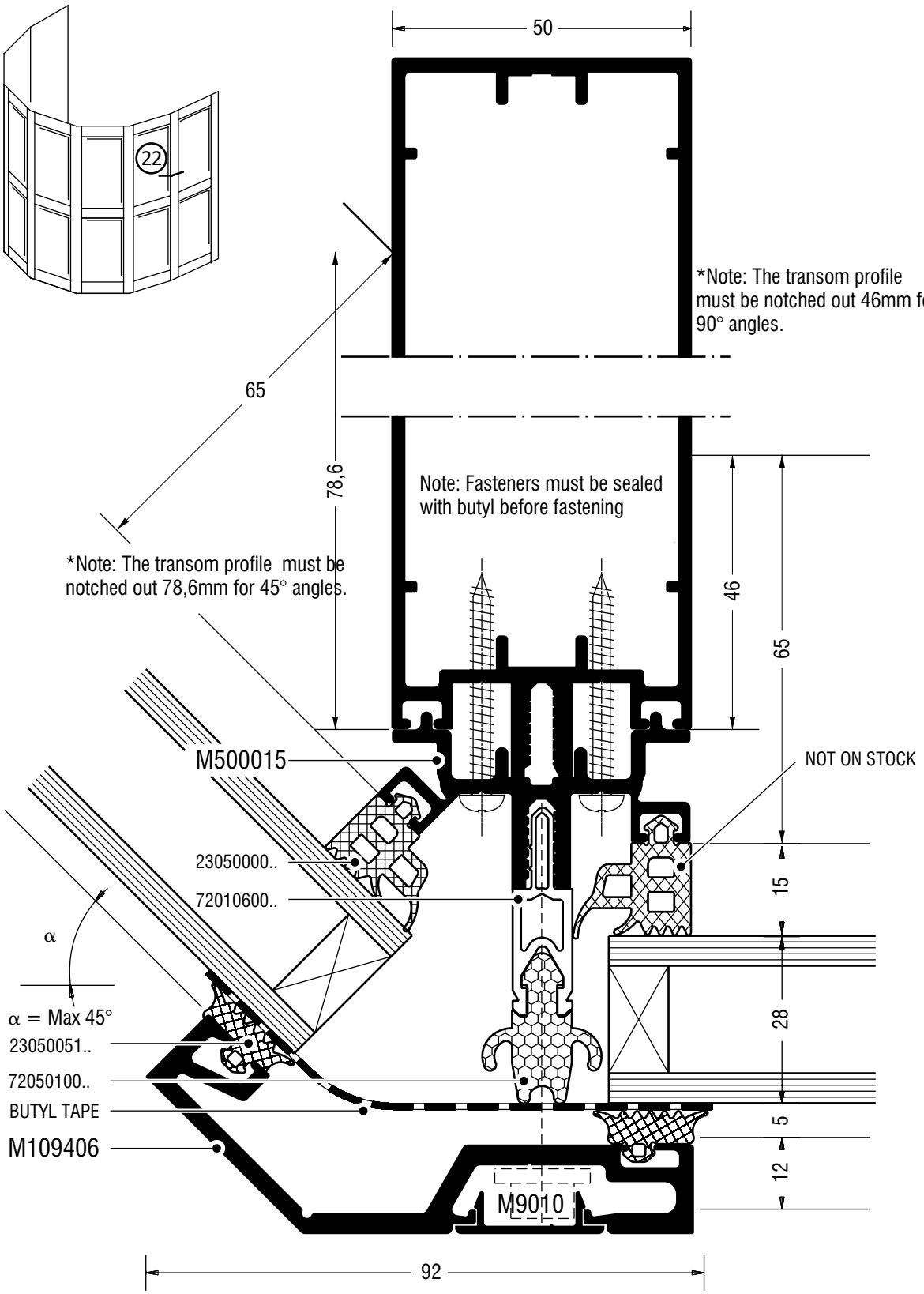
Section through mullion at 45˚ angle



*Note: The profile M500015 must be bent in the work shop to the correct angle.

**Note: Butyl tape is required for all mullions on a curved or angled curtain wall. The tape should overlap the glazing panel a minimum of 12mm on each side. And a small strip of tape should be applied over the horizontal transoms at each intersection with an overlap of 25mm on each side of the mullion. See installation manual for further details.

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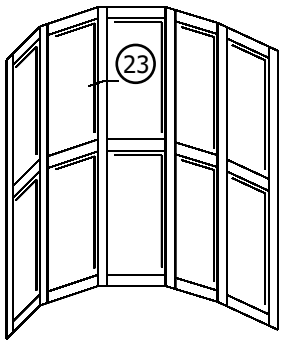
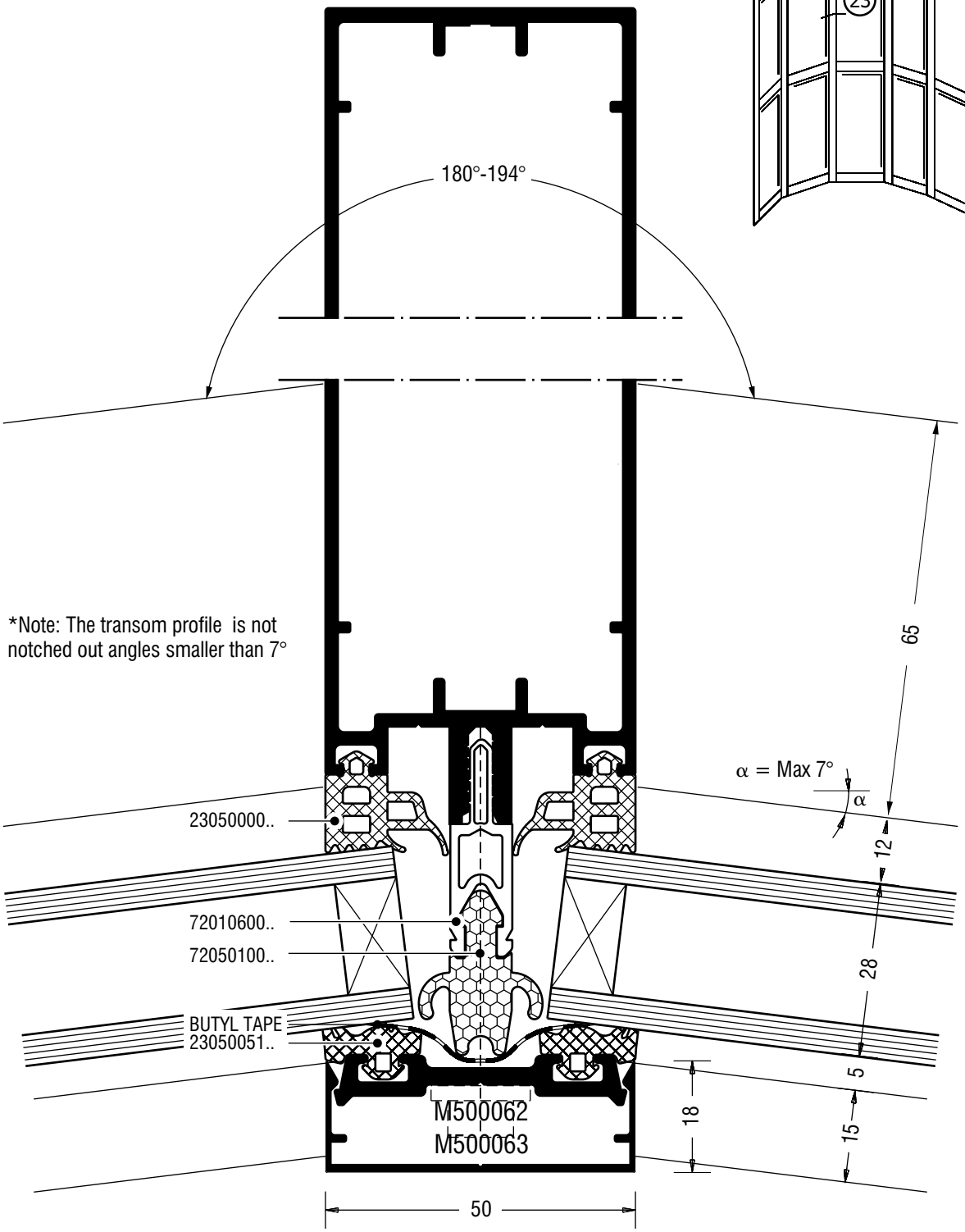
Section through mullion with interior angle 7°





*Note: Angles from 180-194 degrees can be made with the standard gaskets and profiles.

**Note: Butyl tape is required for all mullions on a curved or angled curtain wall. The tape should overlap the glazing panel a minimum of 12mm on each side. And a small strip of tape should be applied over the horizontal transoms at each intersection with an overlap of 25mm on each side of the mullion. See installation manual for further details.

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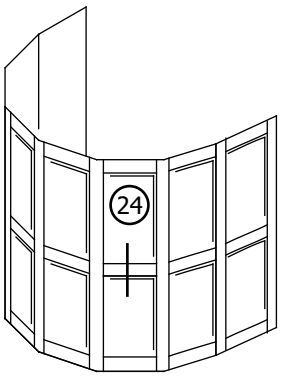
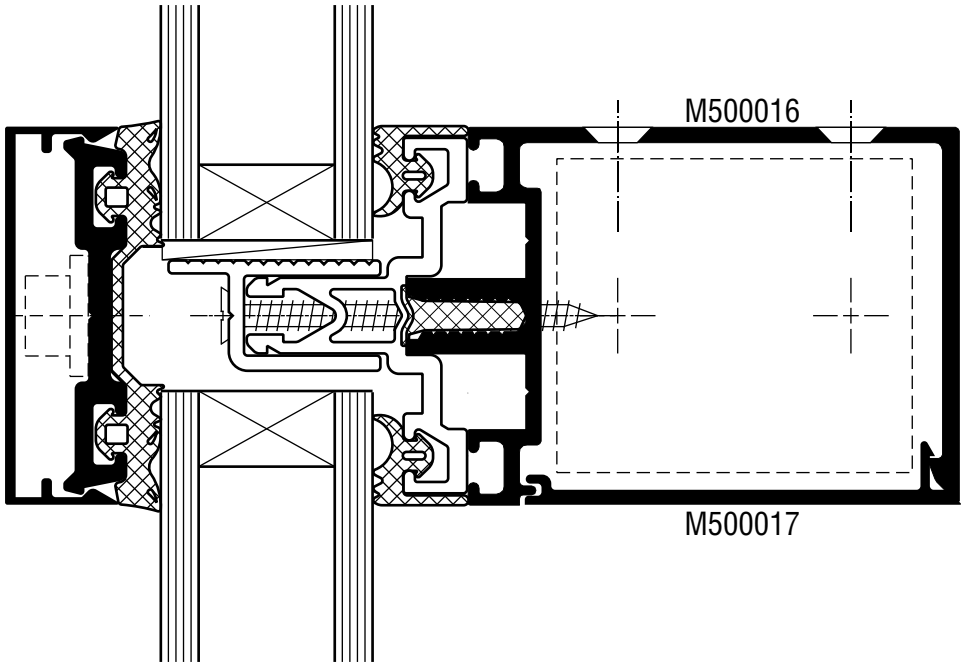
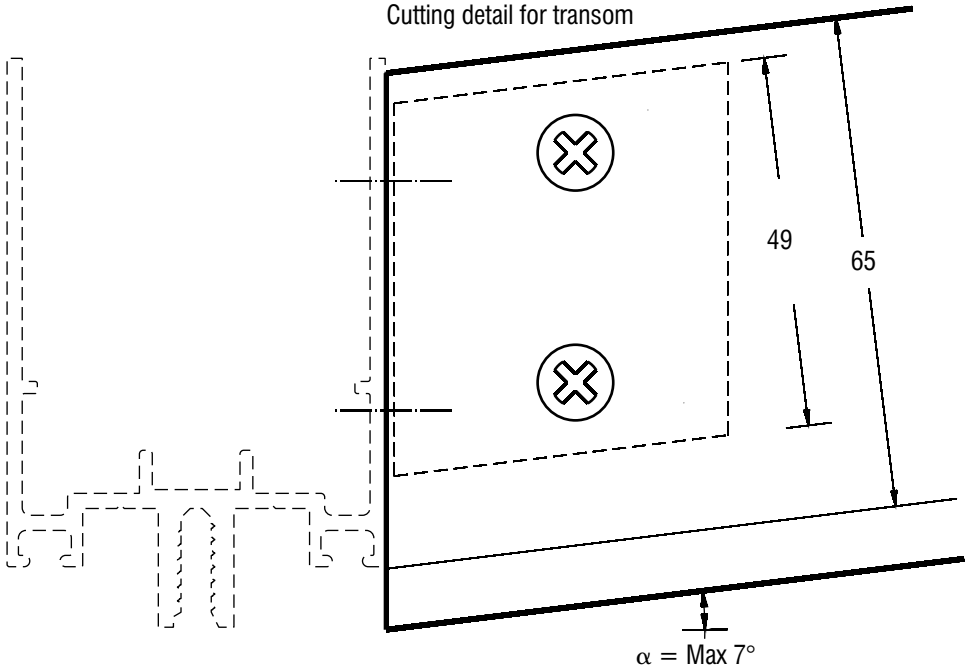
Section through transom at 7° angle





Cutting detail for transom



*Note: T-cleat must be cut at angle "α" and pre-drilled before assembly
It is recommended to use the 2 part transom for this construction

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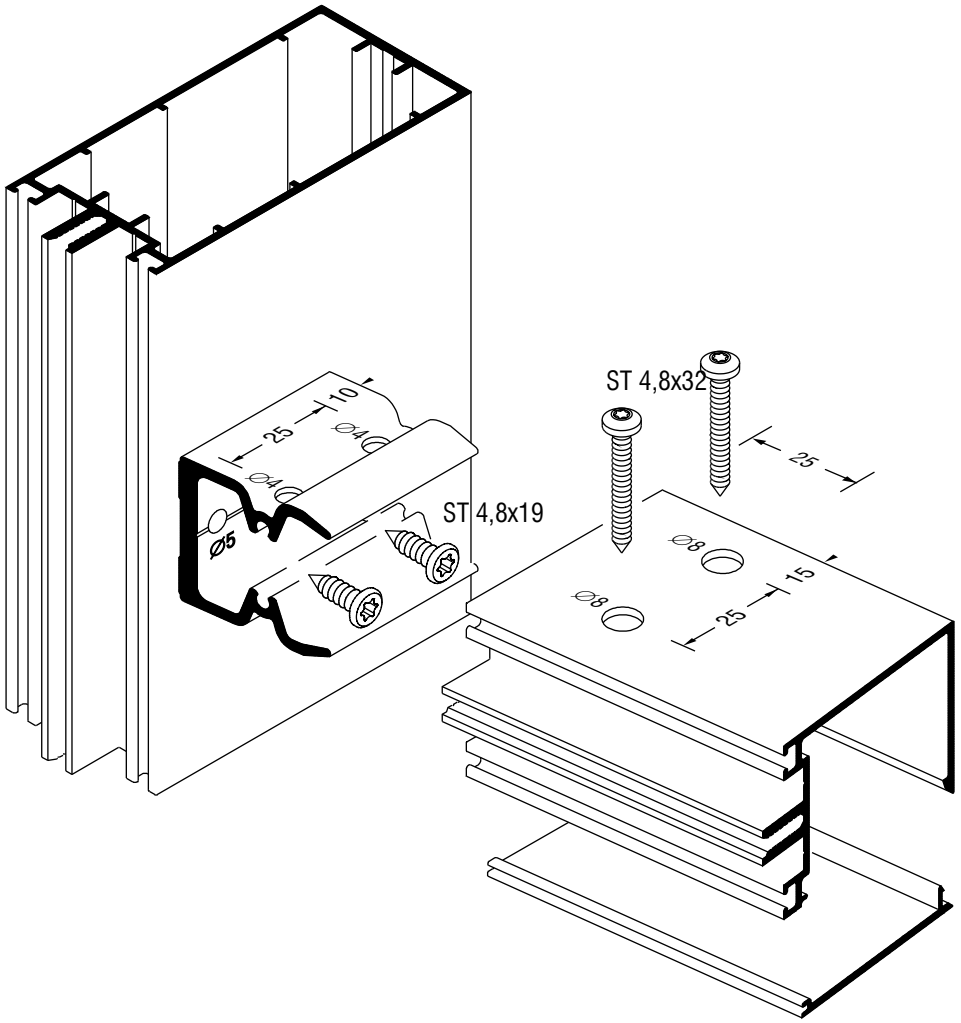
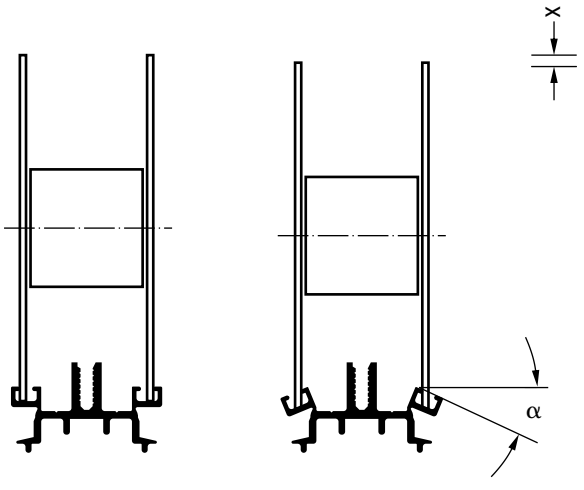


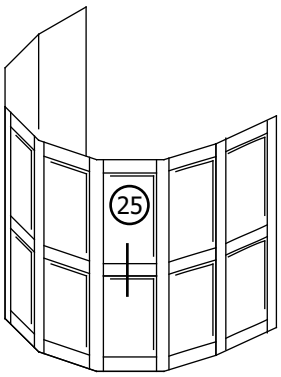
81050000 Bending machine for bending profile M500015

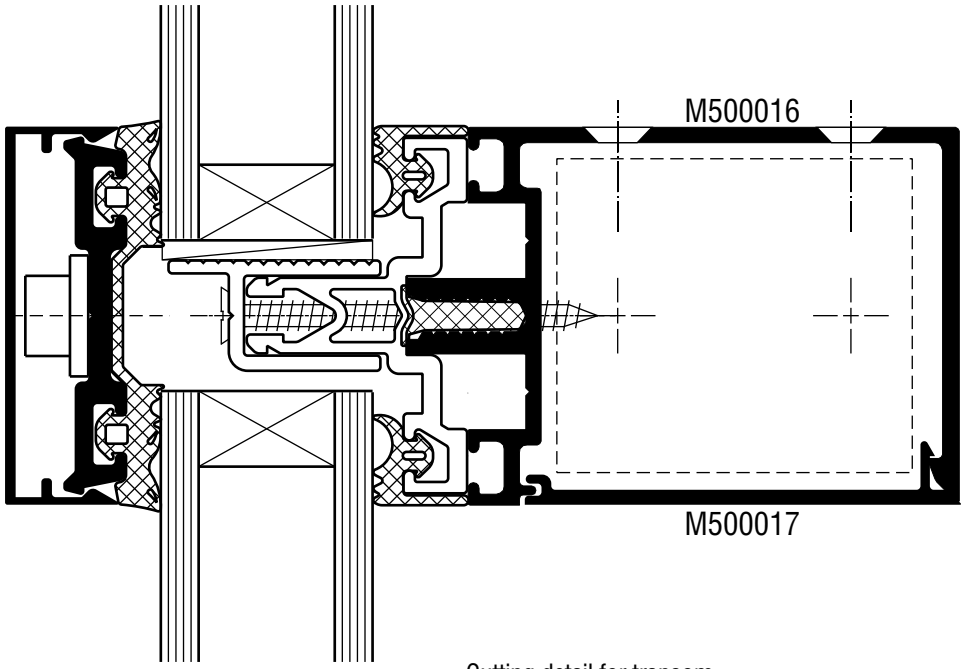


α = degrees to be bent
x = wheel adjustment in mm

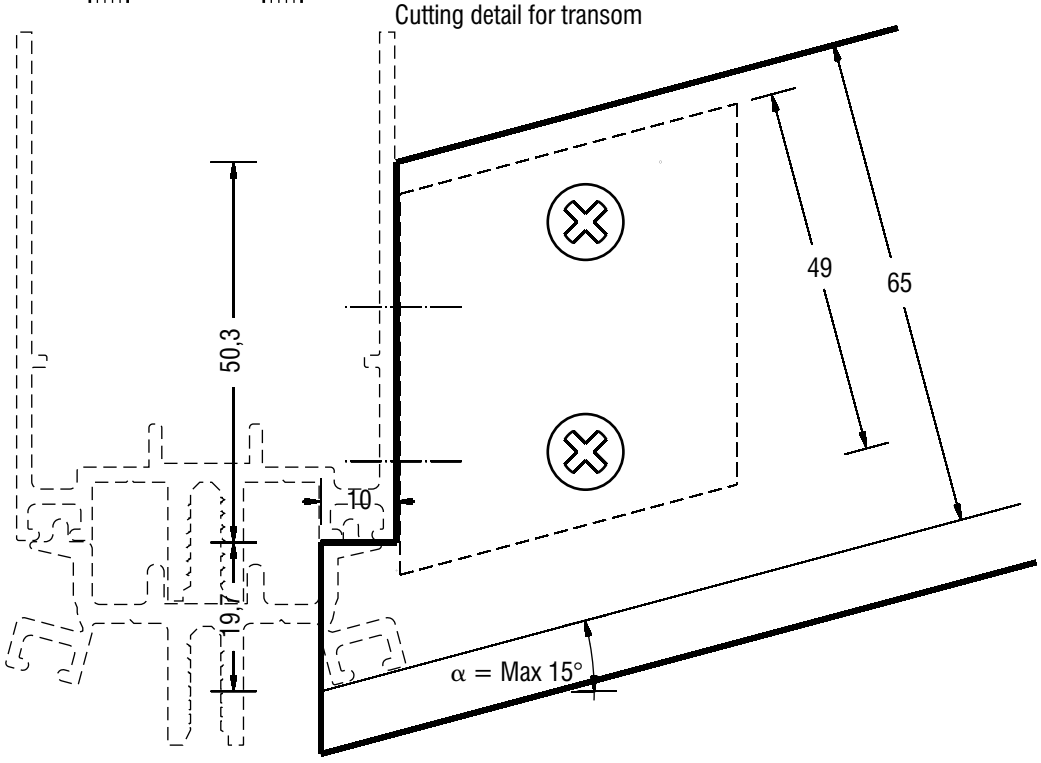
α	x
0	0
5	1
10	2
15	3
20	4
25	5
30	6
35	7
40	8
45	9

Section through transom at 7° angle





Cutting detail for transom



*Note: T-cleat must be cut at angle "α" and pre-drilled before assembly
It is recommended to use the 2 part transom for this construction

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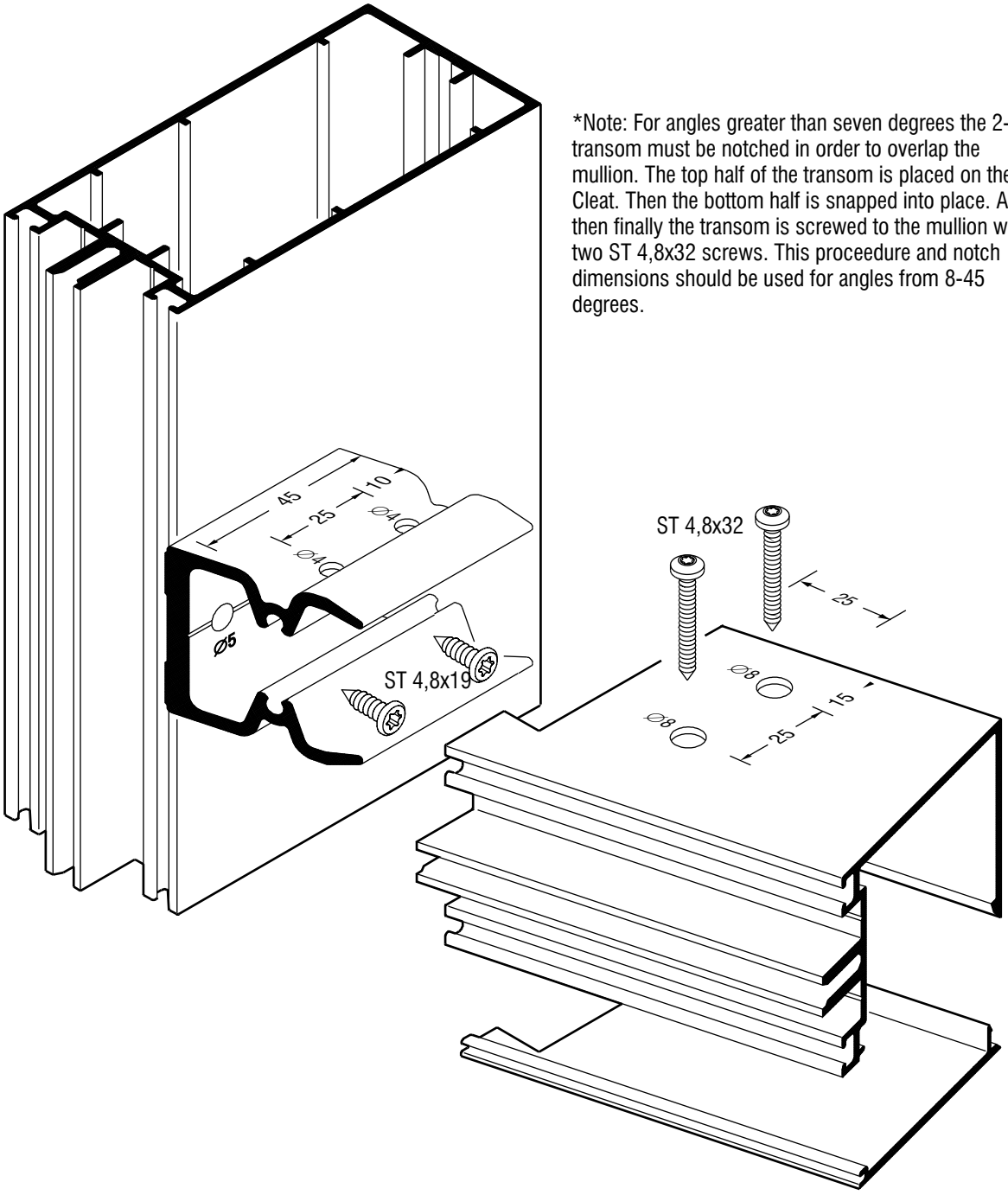
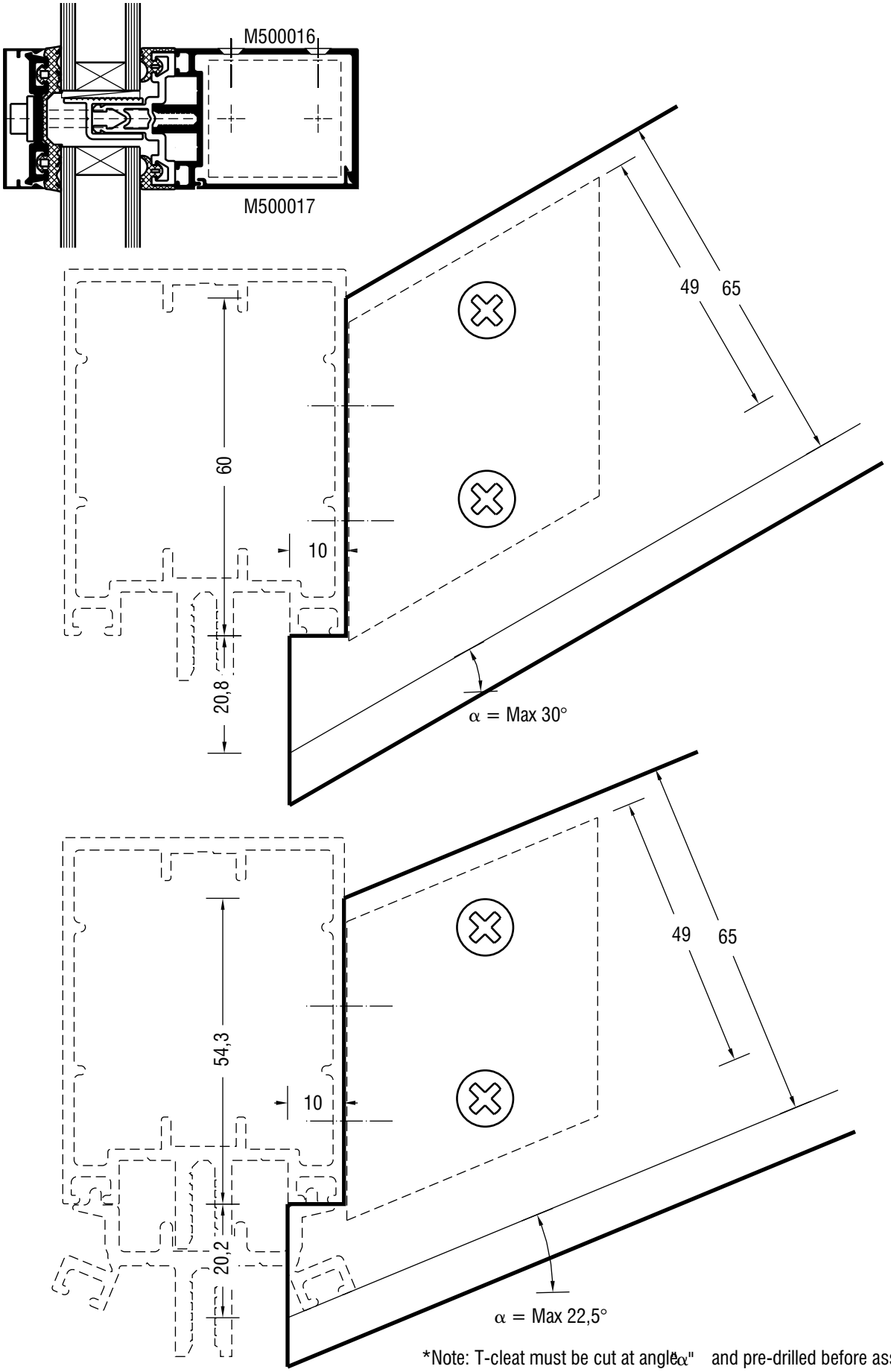


*Note: For angles greater than seven degrees the 2-part transom must be notched in order to overlap the mullion. The top half of the transom is placed on the T-Cleat. Then the bottom half is snapped into place. And then finally the transom is screwed to the mullion with two ST 4,8x32 screws. This proceedure and notch dimensions should be used for angles from 8-45 degrees.

Cutting details for trnsoms



*Note: T-cleat must be cut at angle "α" and pre-drilled before assembly
It is recommended to use the 2 part transom for this construction

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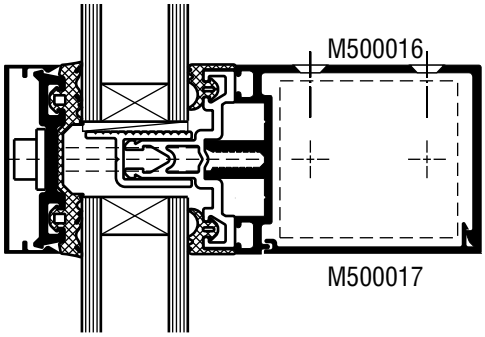

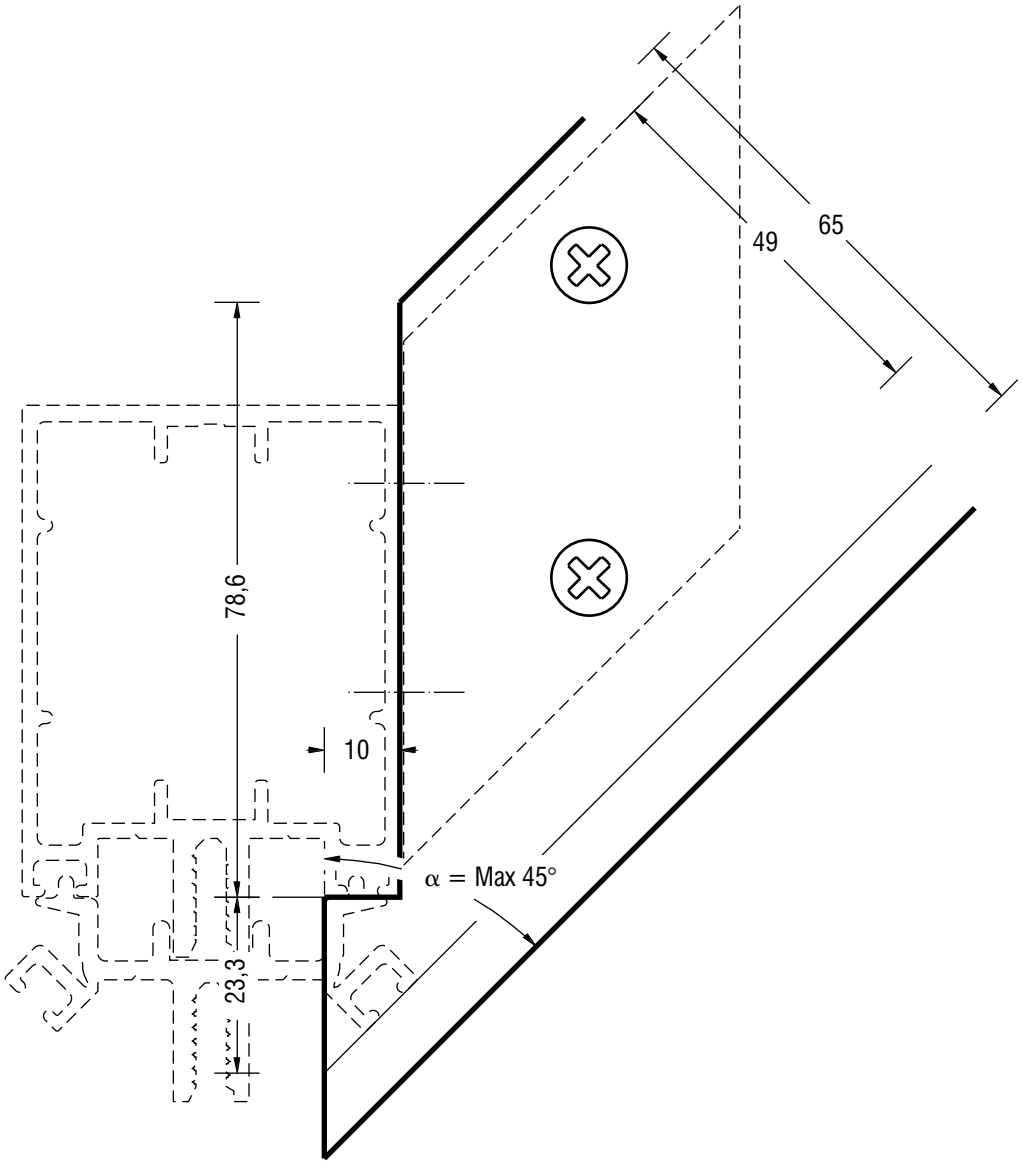

*Note: T-cleat must be cut at angle "α" and pre-drilled before assembly
It is recommended to use the 2 part transom for this construction

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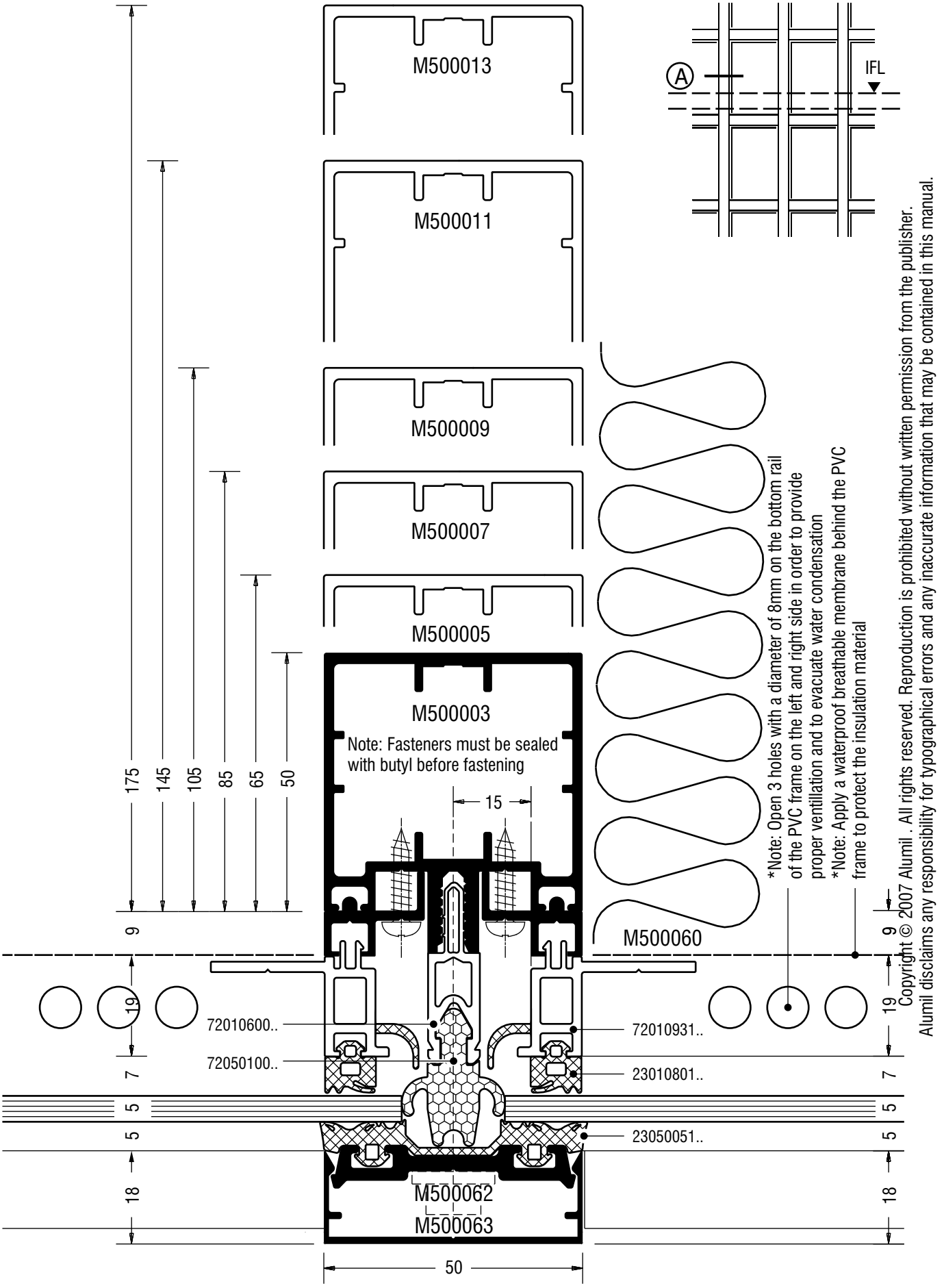
Section through single glazing at intermediate floor level (IFL)



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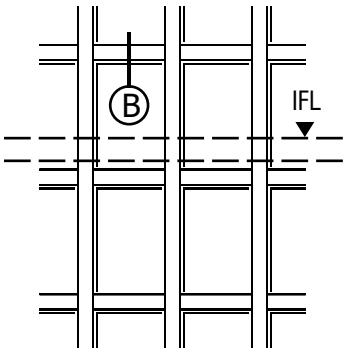
Section through single glazing at intermediate floor level (IFL)



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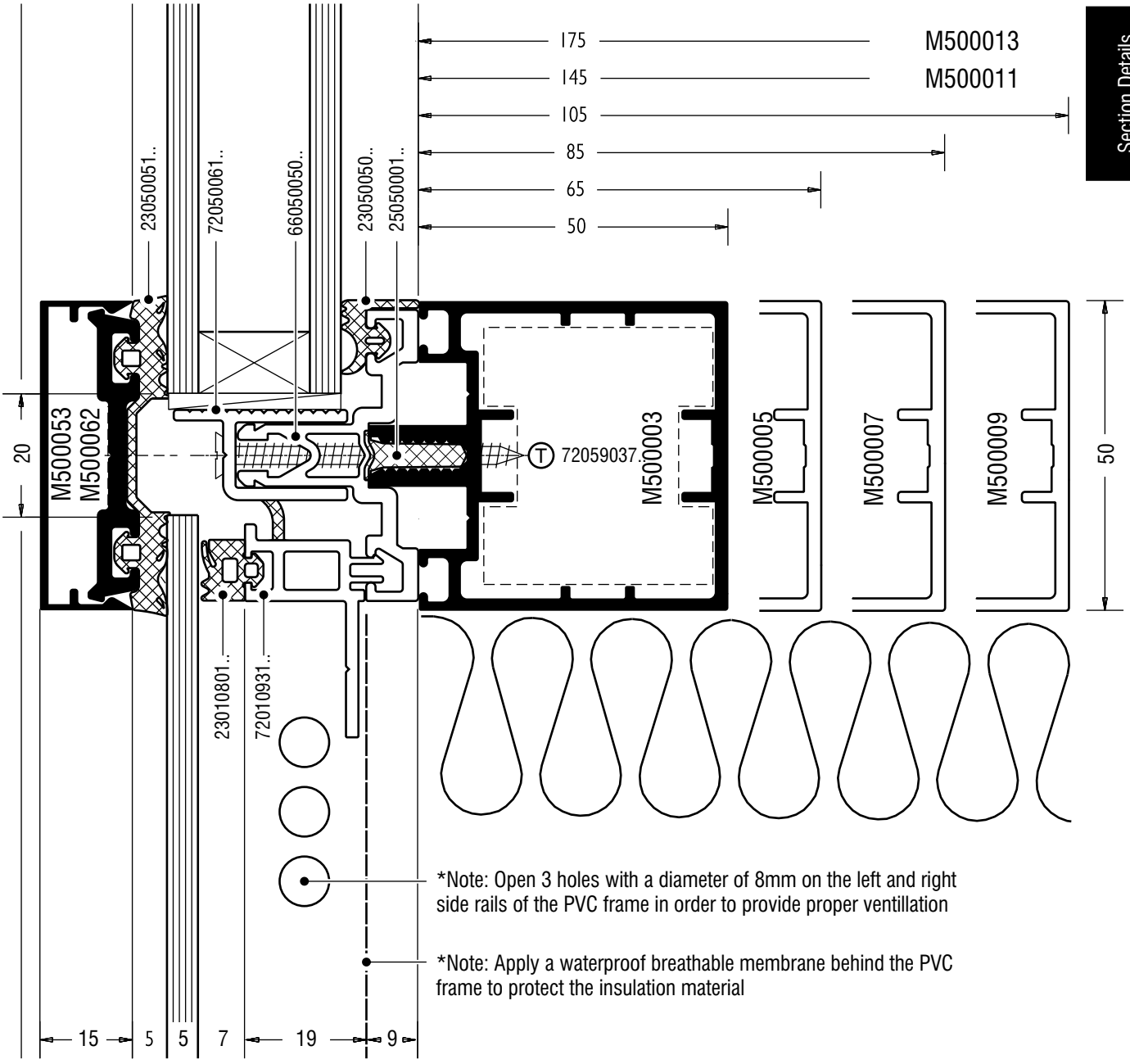
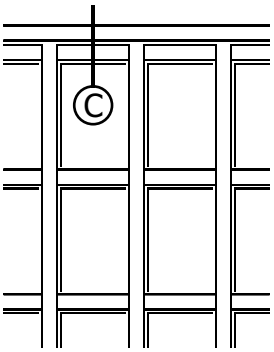
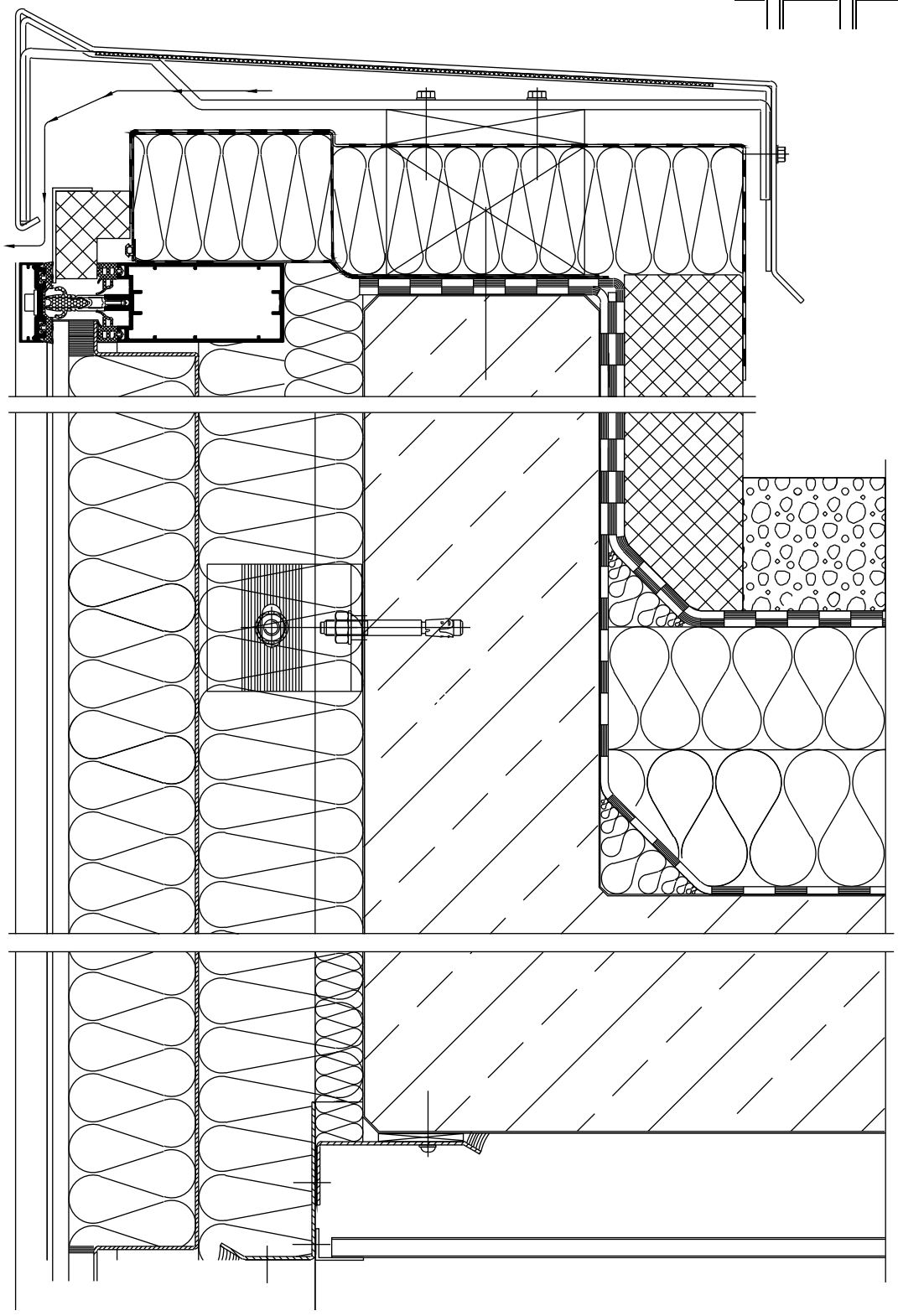


*Note: Open 3 holes with a diameter of 8mm on the left and right side rails of the PVC frame in order to provide proper ventillation

*Note: Apply a waterproof breathable membrane behind the PVC frame to protect the insulation material

Section through roof parapet with aluminum coping





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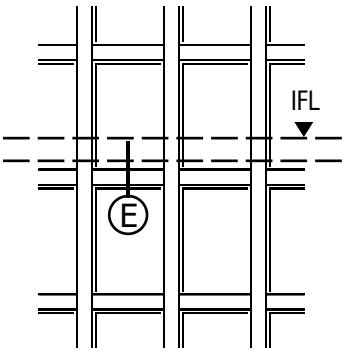
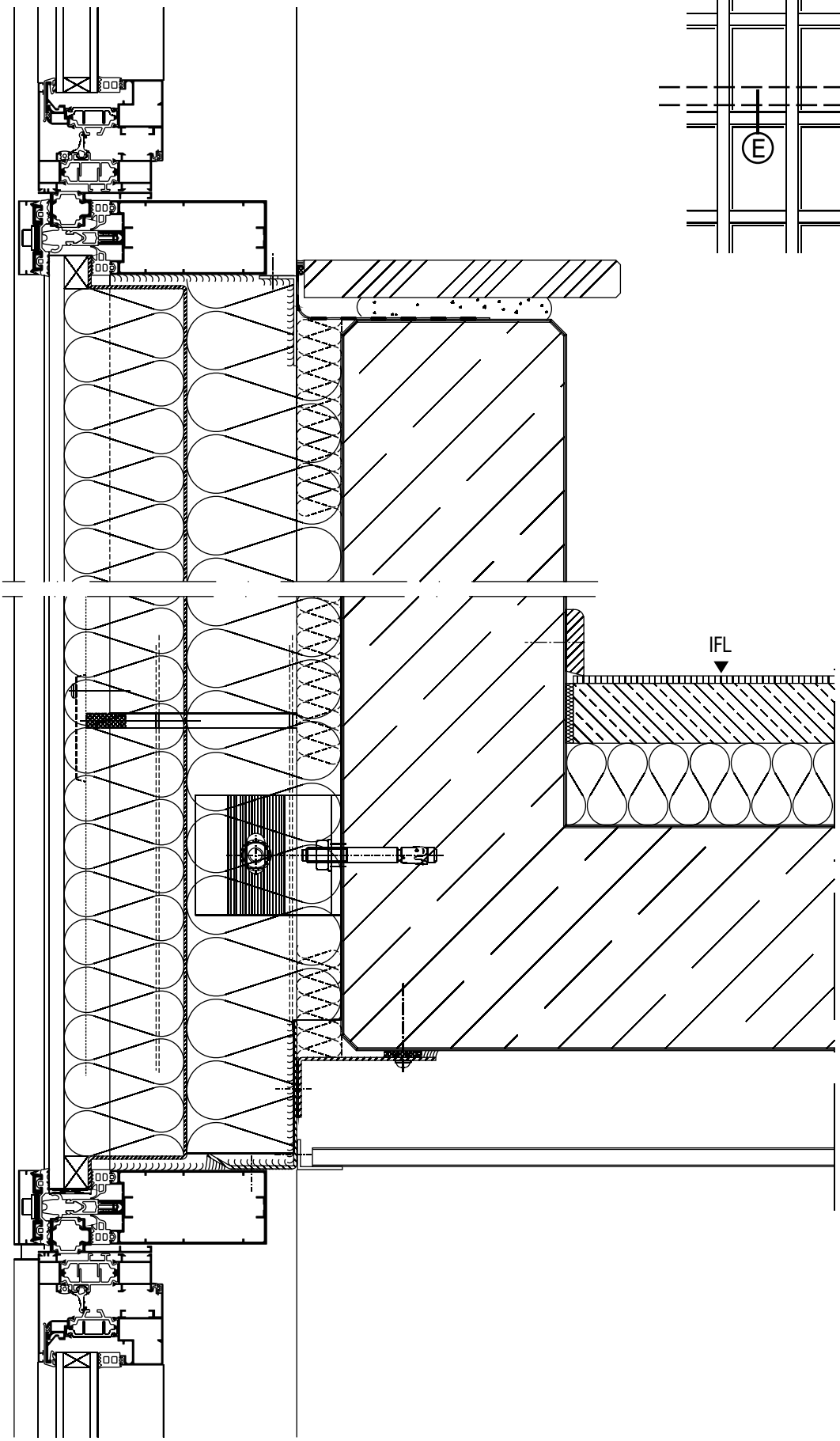
Section through single glazing at intermediate floor level (IFL)





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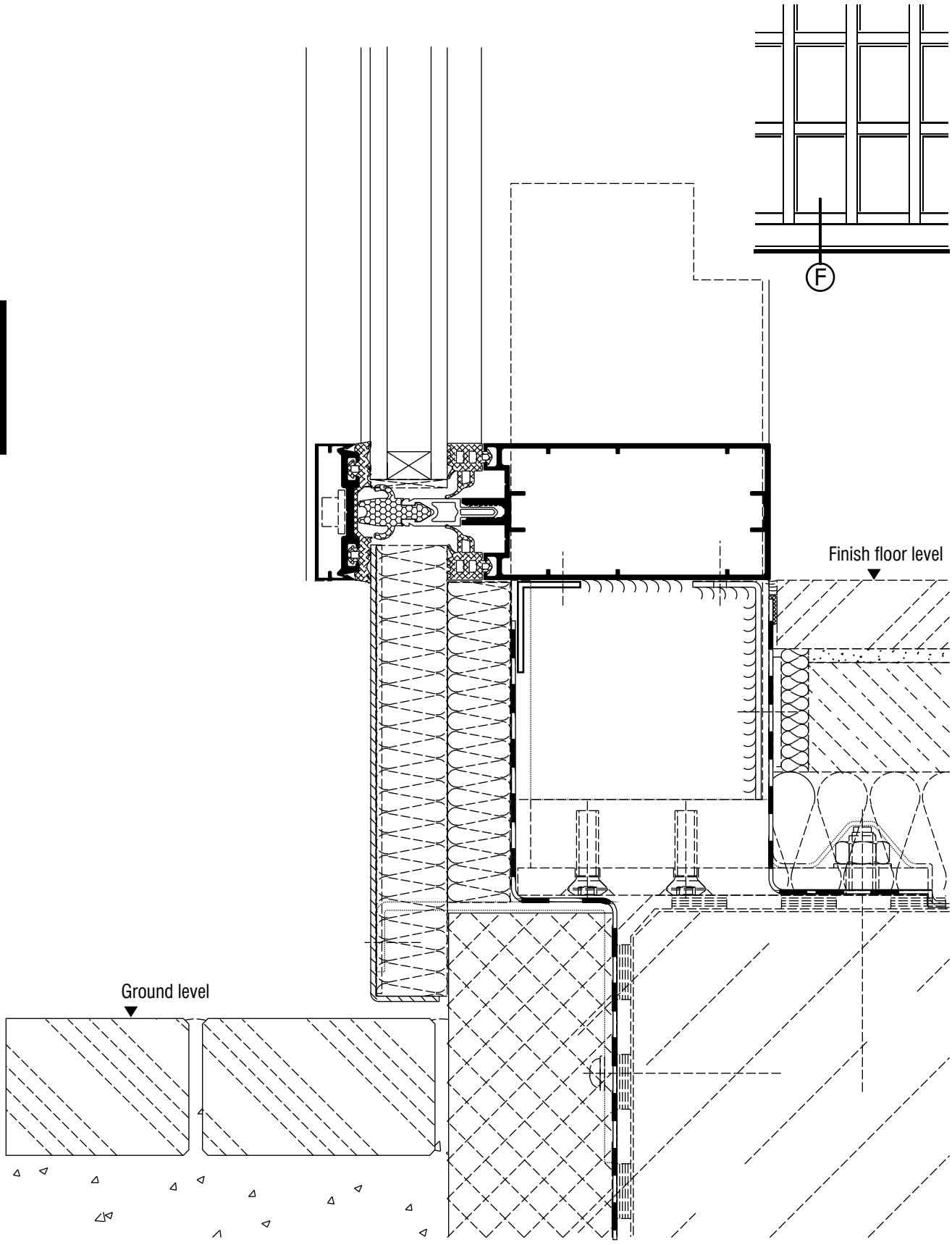
Section through ground level



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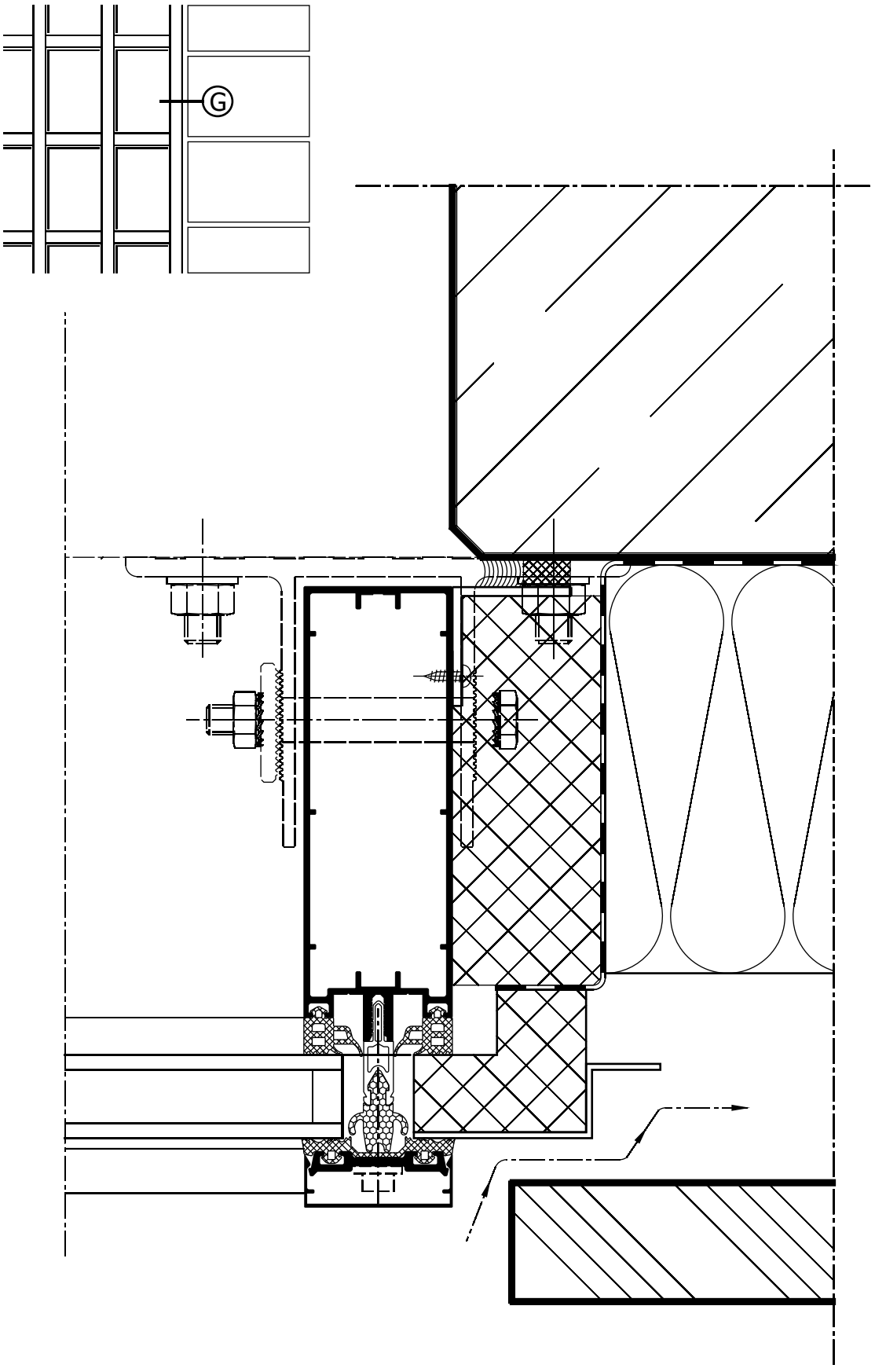
Section through jamb with ventilated facade



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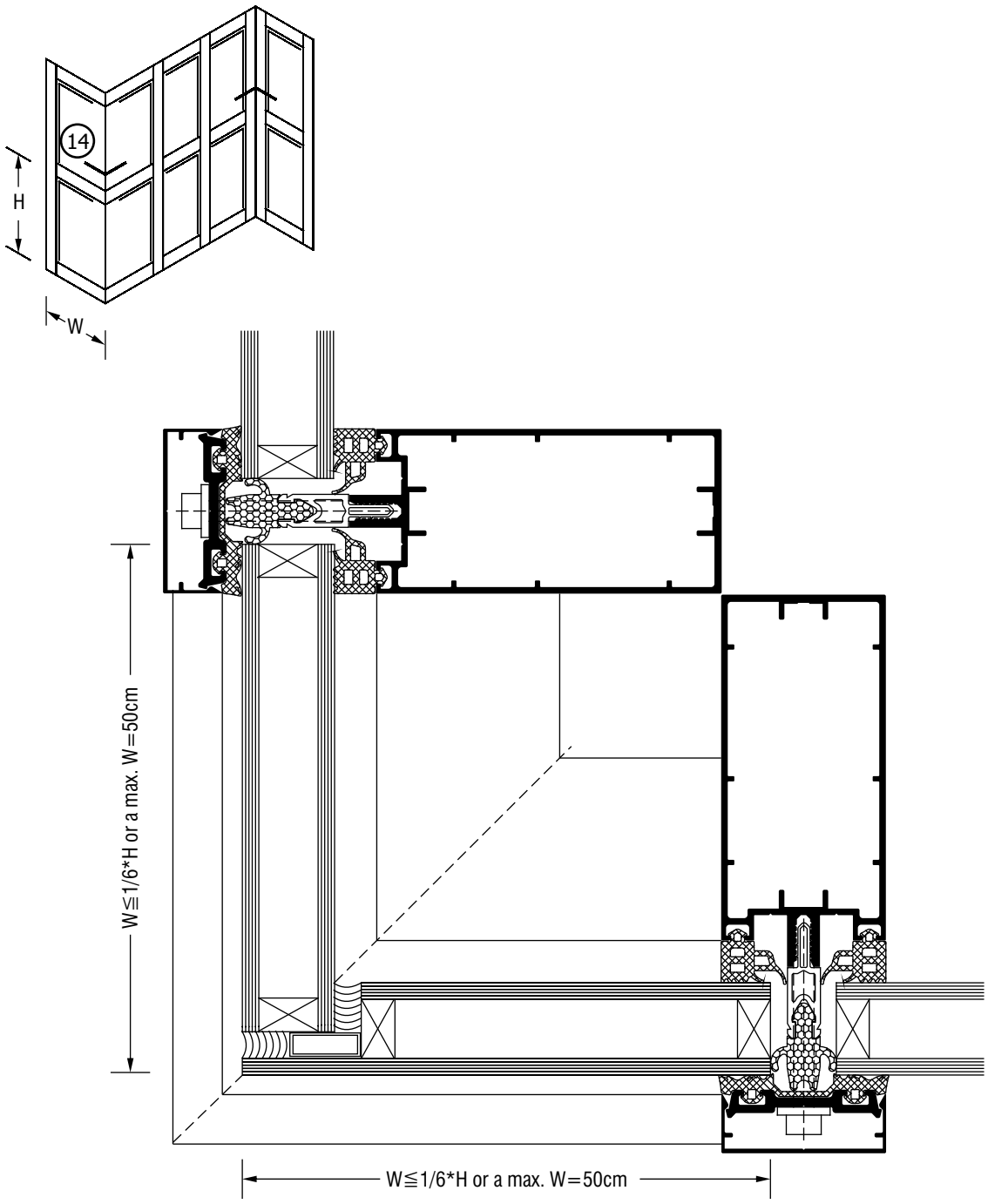
Section through mullion at exterior corner



*Note: The maximum glass height allowed is 300cm and the maximum glass width is 50cm. The glass width "W" should always be less than or equal to 1/6th of the glass height "H". Transoms should be assembled with mitred cuts and joined with the appropriate aluminum insert profile. Transoms must be screwed onto the mullions using transom cleats and screwed to each other with the insert profile. The transoms available for this construction are the M500007, M500009, M500011, and the M500013.

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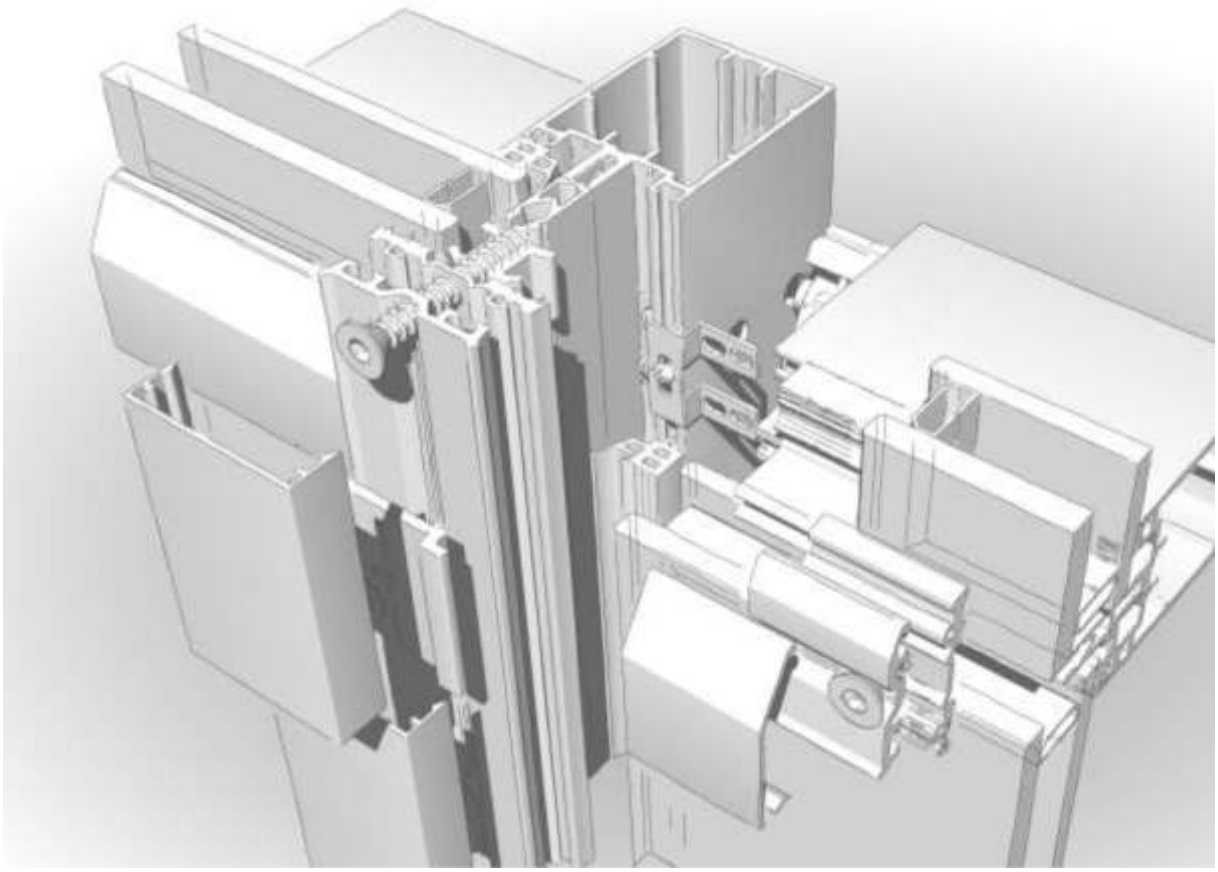

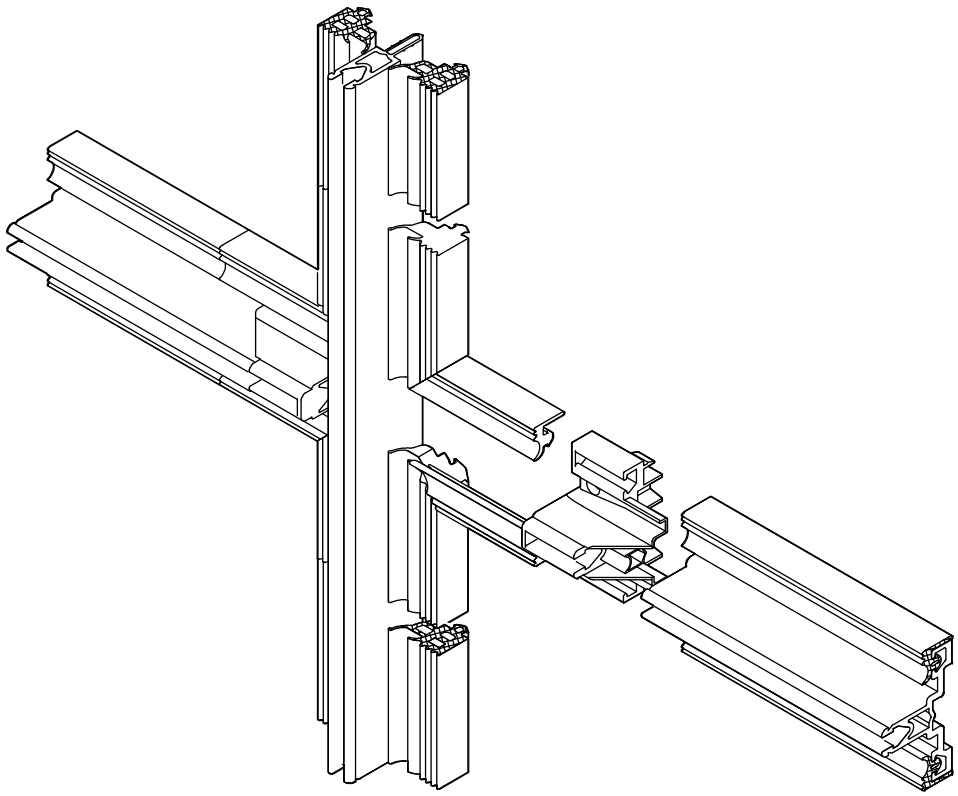

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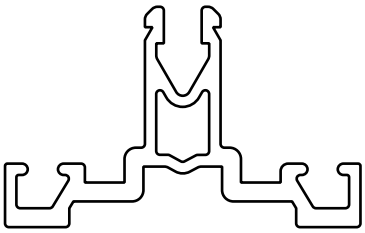
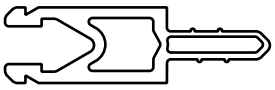
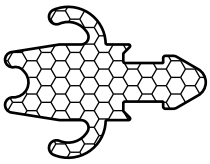
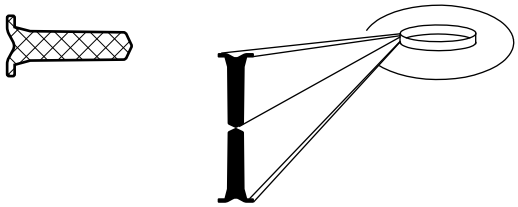
	660 50 050	Rebate isolator transom PVCu	10 x 3m	
	720 10 600	Rebate isolator mullion PVCu	10 x 3m	
	720 50 100	Isolator M50 HI Pex-Flex insulating foam (Polyurethane-cyclopentane foam) Thermal conductivity=0,029 W/mK	10 x 3m	
	250 50 001	Transom gasket EPDM	100m/coil	

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CODE	DESCRIPTION	QUANTITY	SIZE
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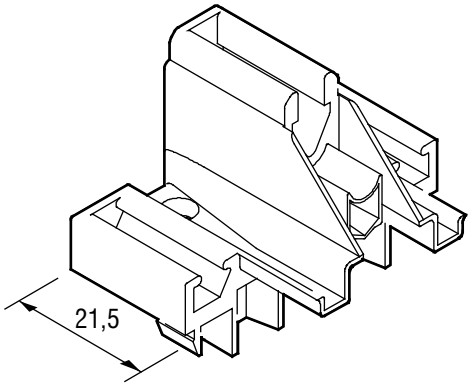
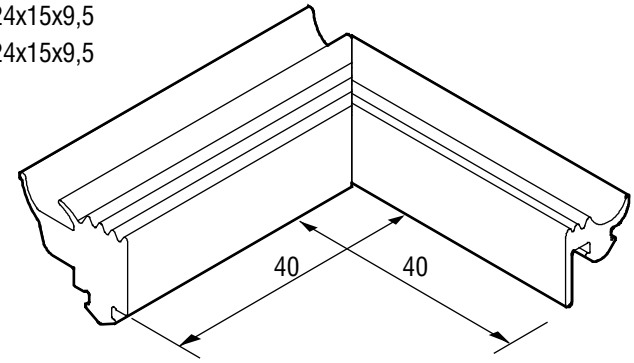
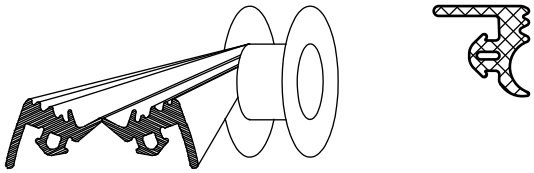


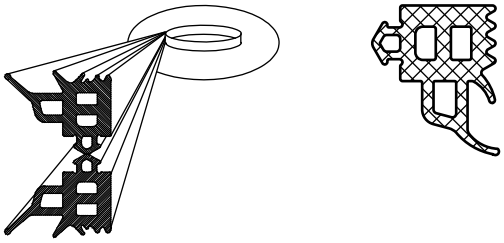
255 50 001	Vulcanized EPDM corner left	90 / box	24x15x9,5
255 50 002	Vulcanized EPDM corner right for gaskets 23050050 and 23050000	90 / box	24x15x9,5



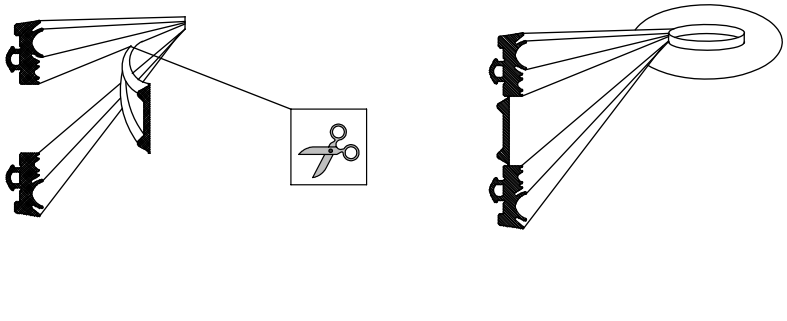
230 50 050	Glazing gasket transom EPDM	100m / coil	50x50x21



230 50 000	Glazing gasket mullion EPDM	120m / coil	77,5x58x20



230 50 051	Pressure plate gasket EPDM	90m / coil	77,5x58x20



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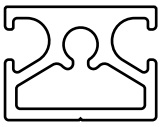
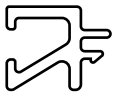
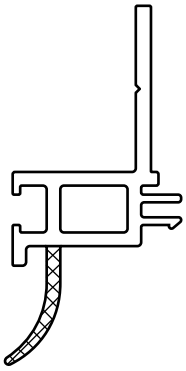
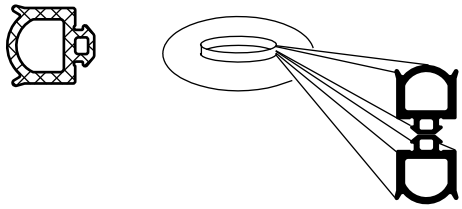
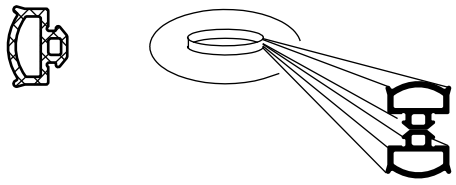
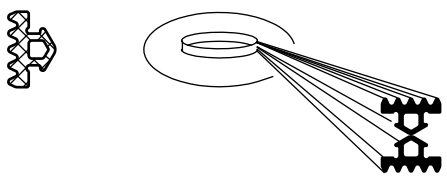
	720 50 102	Spacer for rebate PVCu	1	3m
	720 50 101	Spacer for rebate PVCu	1	3m
	720 10 931	Spacer for single glazing Co-extruded PVCu	1	3m
	230 94 100	Glazing gasket 8mm EPDM	100m/coil	
	230 94 000	Glazing gasket 4,5mm EPDM	100m/coil	
	230 91 103	Glazing gasket 3mm EPDM	100m/coil	

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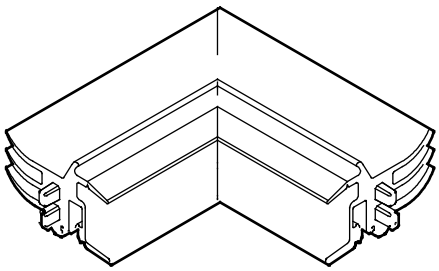
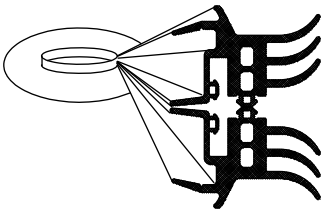
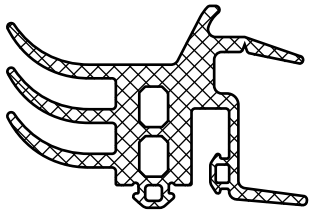
CODE	DESCRIPTION	QUANTITY	SIZE
255 10 982	Vulcanized EPDM corner for gasket 23010982	100 / box	

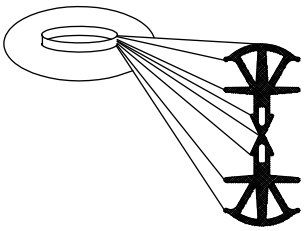


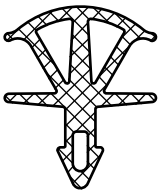
230 10 982	Frame gasket EPDM	80m / coil	



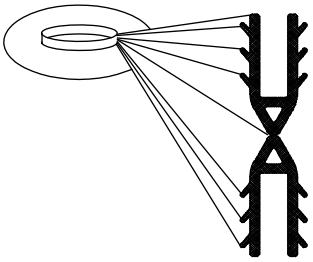


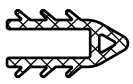
230 10 968	Structural glazing gasket EPDM	100m / coil	





230 00 959	Expansion gasket EPDM	100m / coil	





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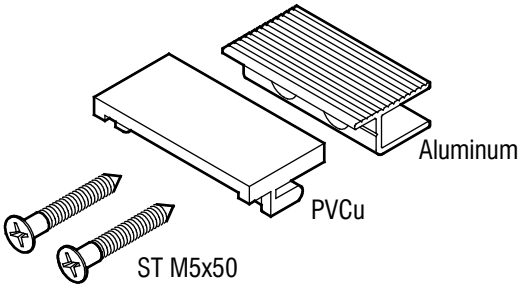
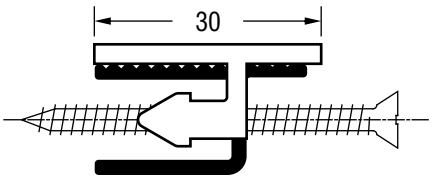
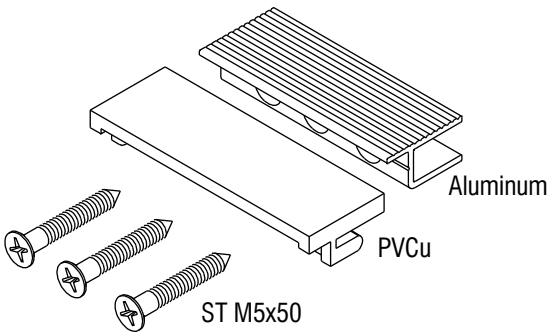
Hardware Accessories and Gaskets

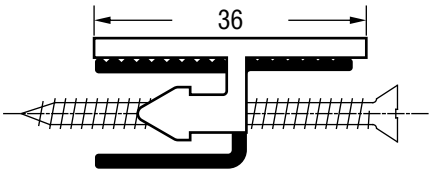
CODE	DESCRIPTION	QUANTITY	SIZE
720 50 061	Glazing support 24-30 Maximum load 180Kg with two supports	20 / box	



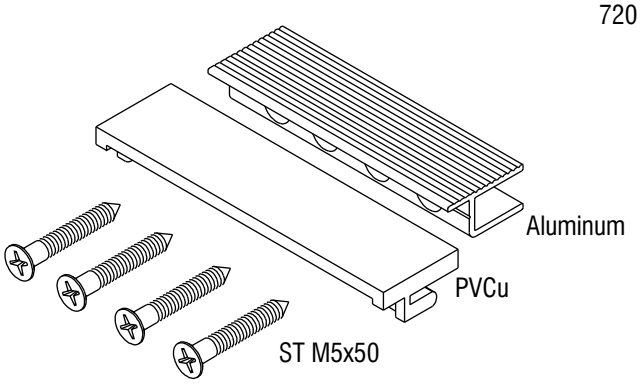


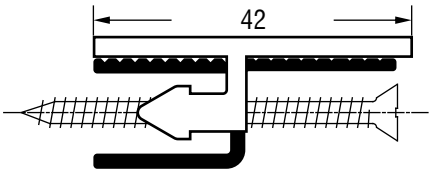
CODE	DESCRIPTION	QUANTITY	SIZE
720 50 062	Glazing support 30-36 Maximum load 270Kg with two supports	20 / box	





CODE	DESCRIPTION	QUANTITY	SIZE
720 50 063	Glazing support 36-42 Maximum load 360Kg with two supports	20 / box	





Note: Glazing supports must be securely fastened to the transoms. The ST M5x50 screws should penetrate the interior chamber of the transom. For additional support, profile inserts should be placed within the transoms and the glazing support should be fastened into the profile insert with ST M5x60 self-tapping screws. If a glazing panel is 30mm thick and has a weight of 360Kg, then four glazing supports (72050061) should be used. They should be placed in pairs at 100mm from the glass edge.

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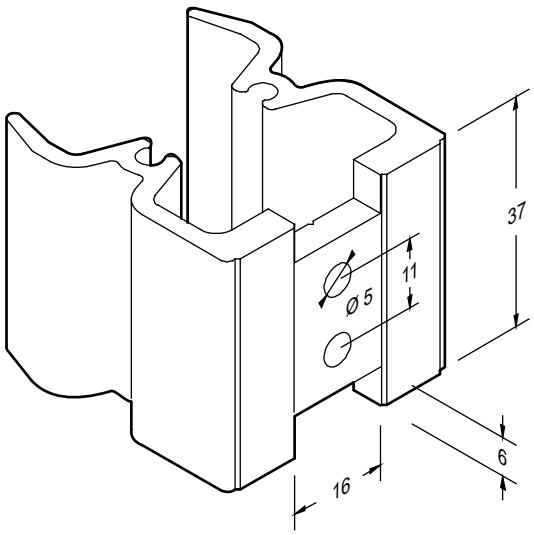
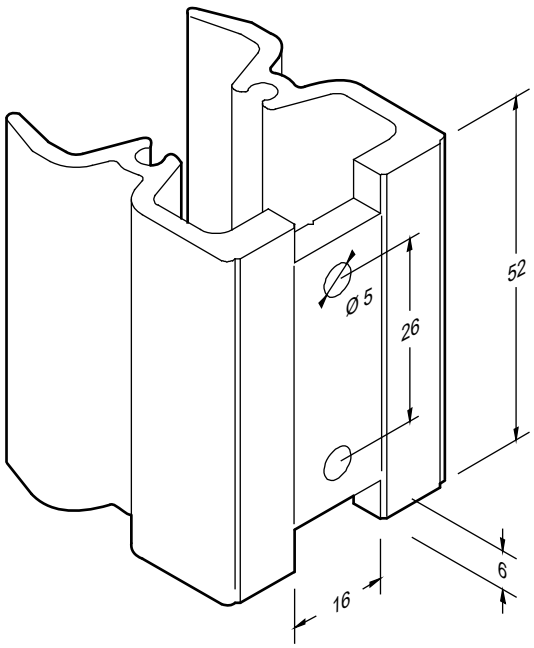
CODE	DESCRIPTION	QUANTITY	SIZE
720 59 037	Transom cleat for 500003 Aluminum	50 / box	



CODE	DESCRIPTION	QUANTITY	SIZE
720 59 052	Transom cleat for 500005 Aluminum	50 / box	



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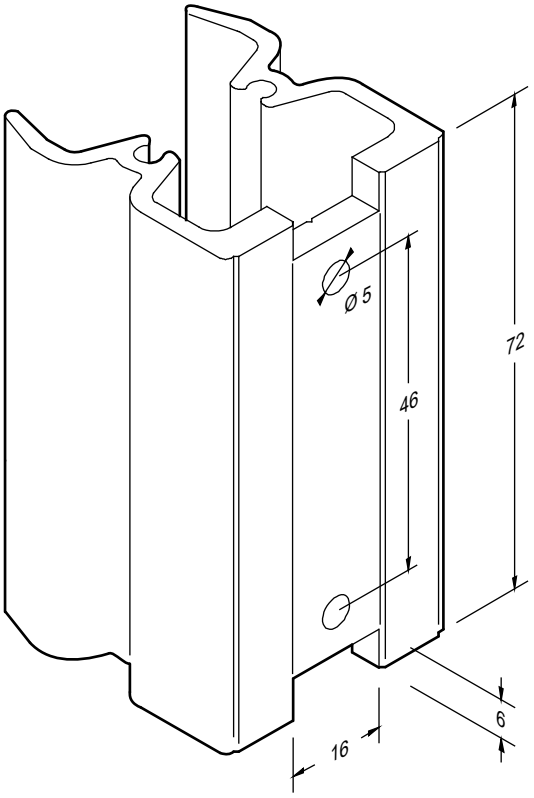
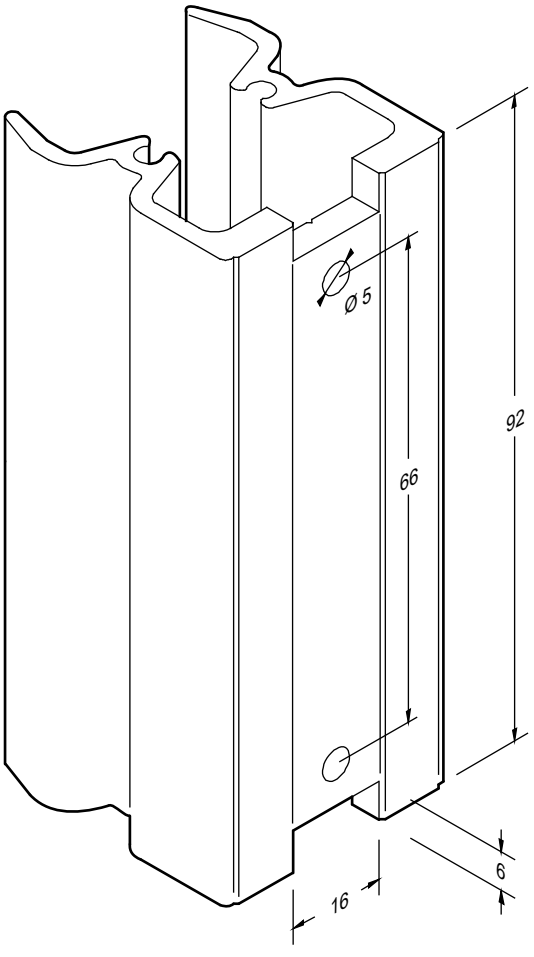
	CODE	DESCRIPTION	QUANTITY	SIZE
	720 59 072	Transom cleat for 500007 Aluminum	50 / box	

	CODE	DESCRIPTION	QUANTITY	SIZE
	720 59 092	Transom cleat for 500009 Aluminum	50 / box	

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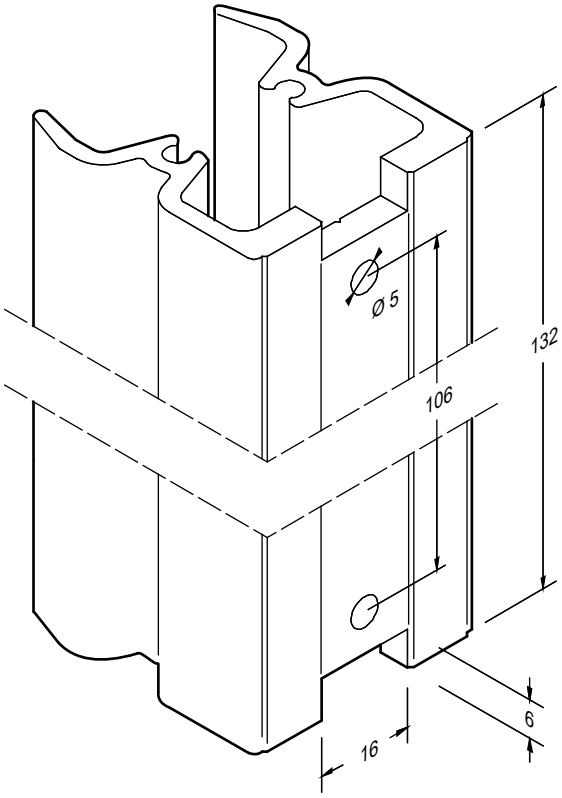
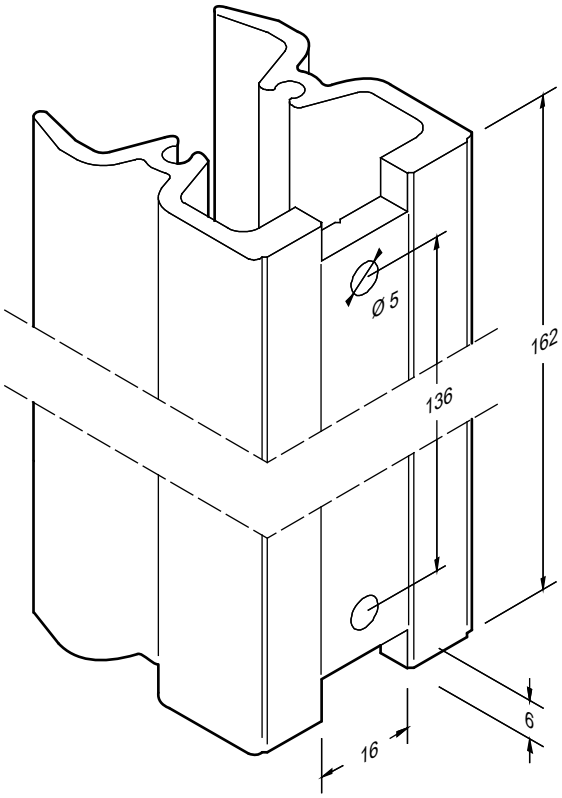
CODE	DESCRIPTION	QUANTITY	SIZE
720 59 132	Transom cleat for 500011 Aluminum	50 / box	



CODE	DESCRIPTION	QUANTITY	SIZE
720 59 162	Transom cleat for 500013 Aluminum	50 / box	



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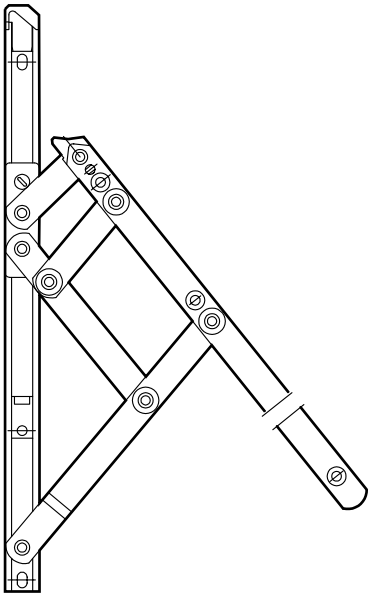
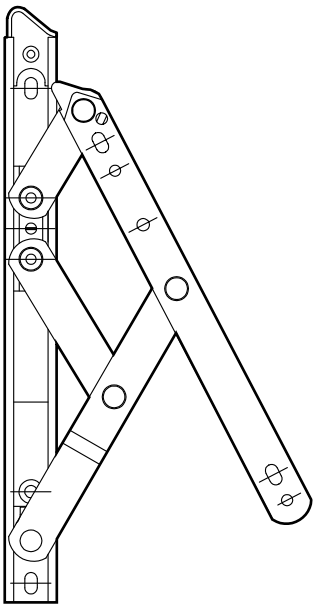
	CODE	DESCRIPTION	QUANTITY	SIZE
	720 92 001	Friction stay arm Stainless steel Max load 80Kg	5 pairs/box	
	720 92 002	Friction stay arm Stainless steel Max load 130Kg	5 pairs/box	

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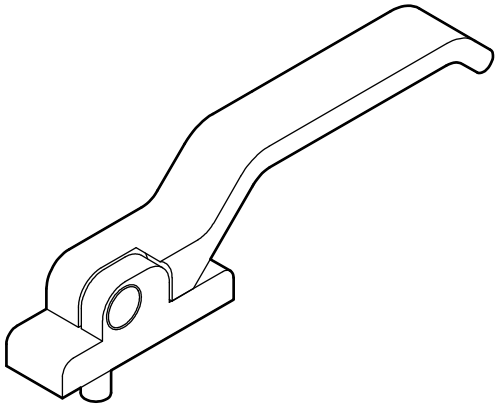
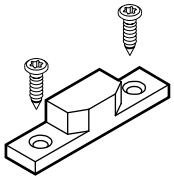
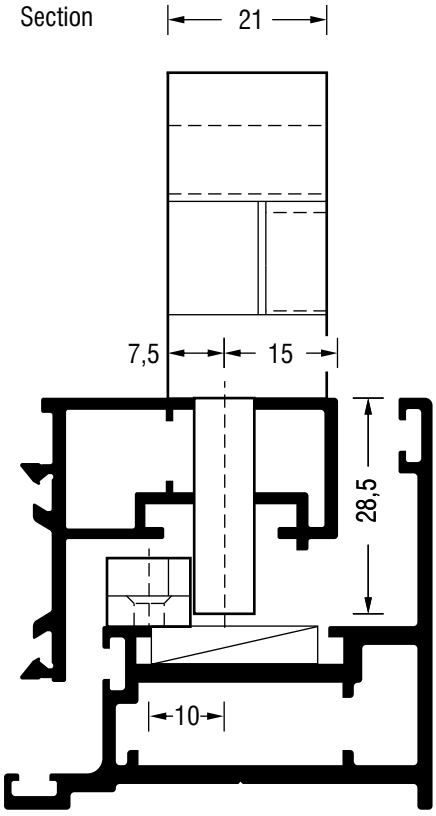
CODE	DESCRIPTION	QUANTITY	SIZE
720 93 002	Handle for top hung for right hand operation Aluminum	25/box	



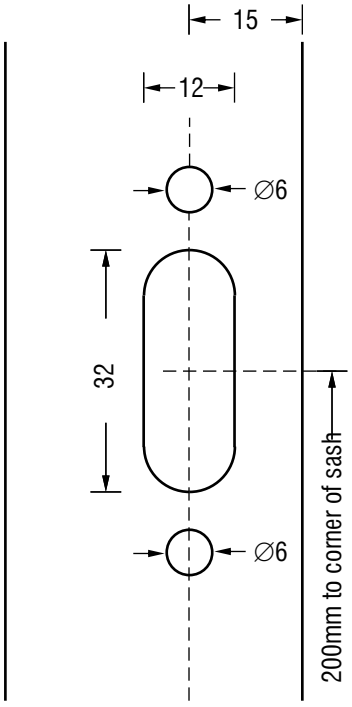
720 93 003	Lock point 9mm Aluminum	25/box	



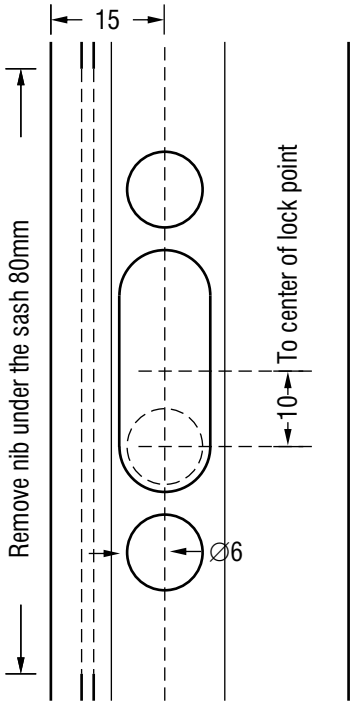
Section



Top view of sash



Bottom view of sash



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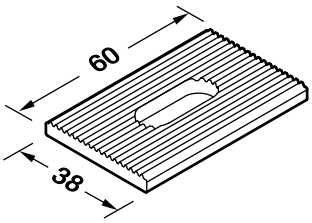
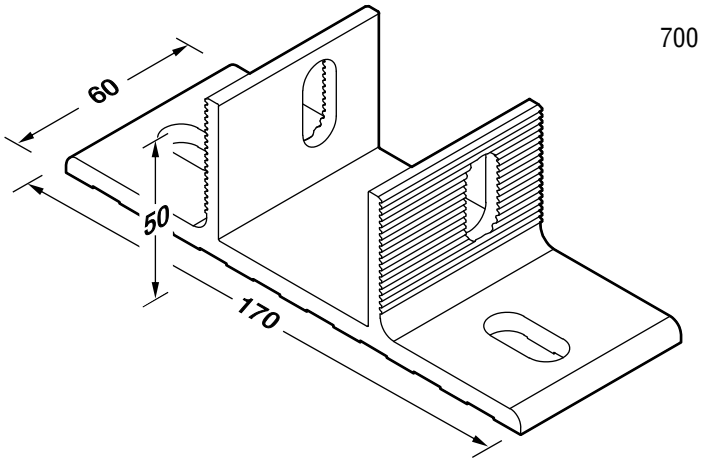
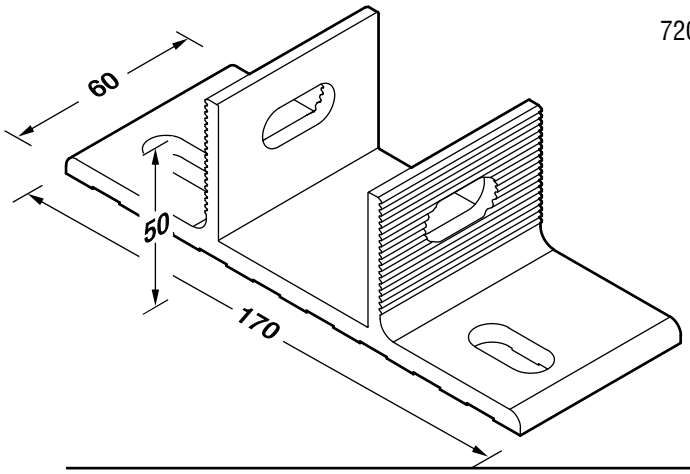
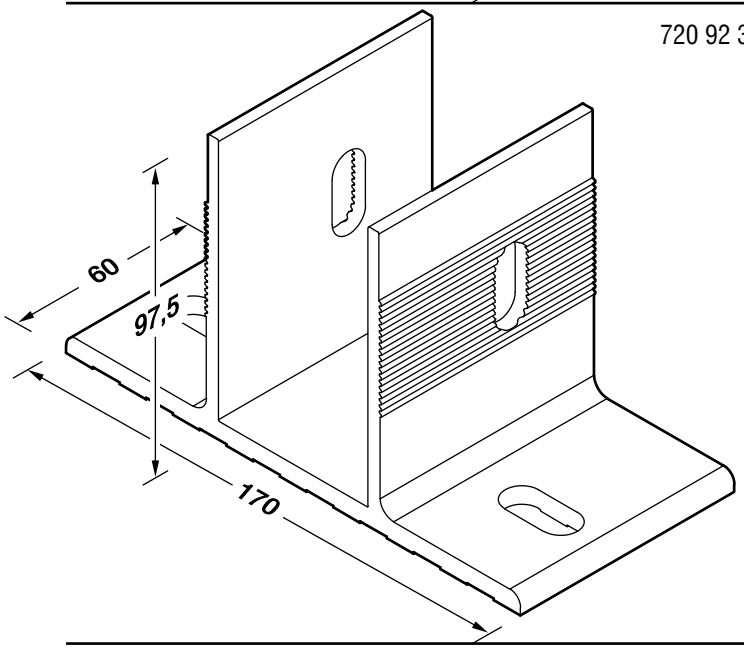
	CODE	DESCRIPTION	QUANTITY	SIZE
	700 92 100	Fastening plate Aluminum	500 / box	
	700 92 200	Mounting bracket Aluminum	80 / box	
	720 92 201	Mounting bracket Aluminum	80 / box	
	720 92 300	Mounting bracket Aluminum	42 / box	

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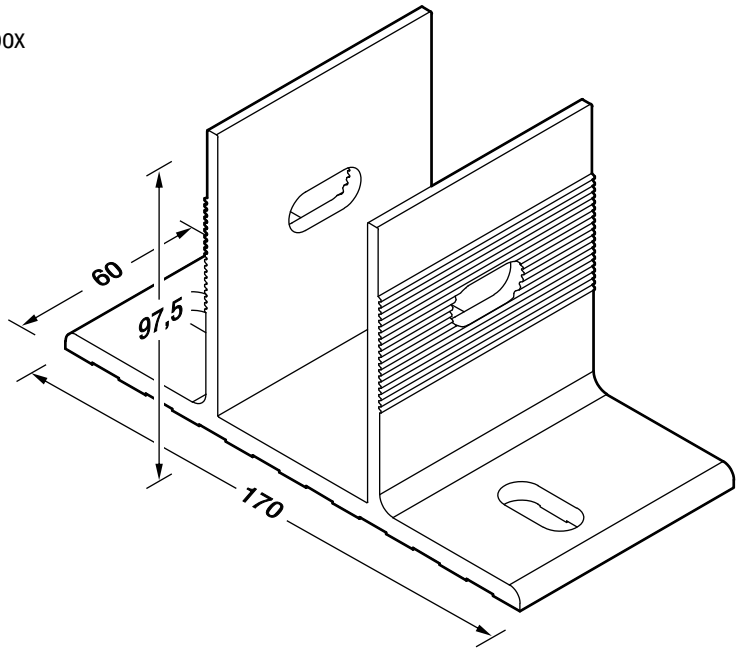
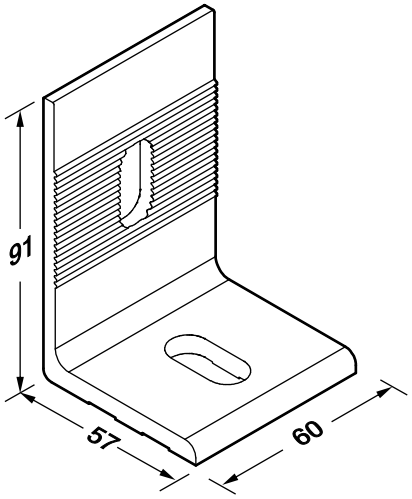
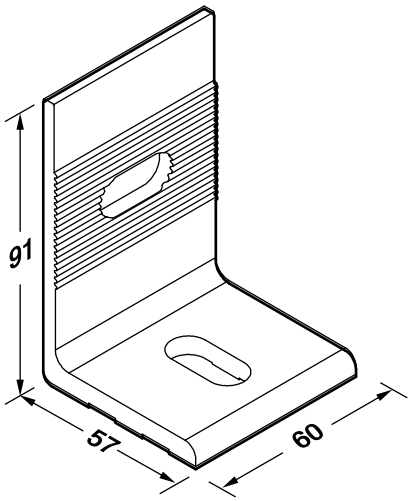
CODE	DESCRIPTION	QUANTITY	SIZE
720 92 301	Mounting bracket Aluminum	42 / box	
720 92 400	Mounting bracket Aluminum	140 / box	
720 92 401	Mounting bracket Aluminum	140 / box	

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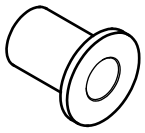
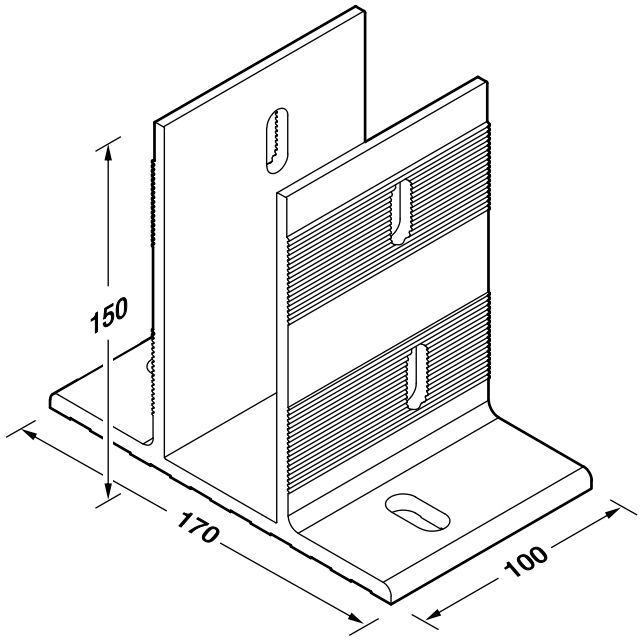
	CODE	DESCRIPTION	QUANTITY	SIZE
	700 50 004	Aluminum bushing	50 / box	

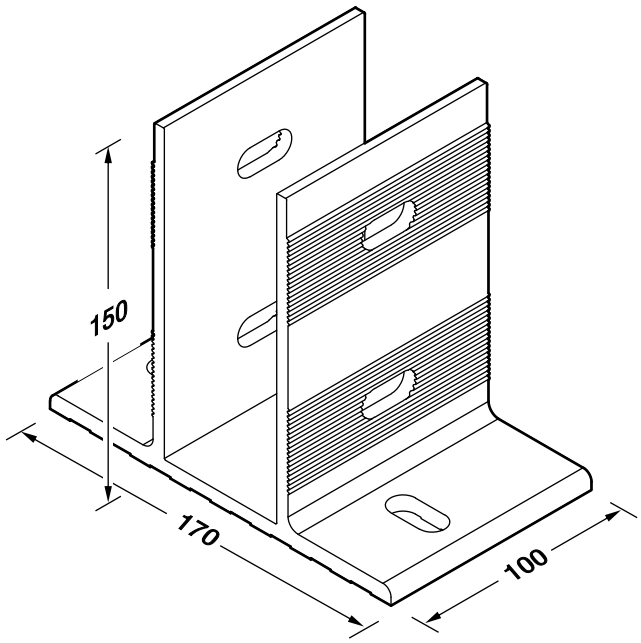


Note: The aluminum bushing is used to create a tight fit between the mounting bracket and the mullion. It should be inserted in mullion before fixating to the mounting bracket. See the installation guide for further details.

	720 92 500	Mounting bracket Aluminum	30 / box	



	720 92 501	Mounting bracket Aluminum	30 / box	



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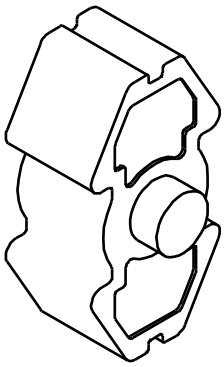
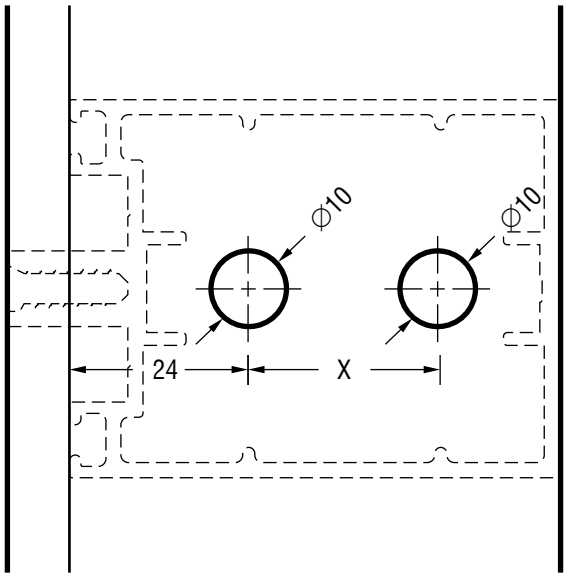
CODE	DESCRIPTION	QUANTITY	SIZE
720 50 000	Spring cleat Die-cast aluminum	100 / box	

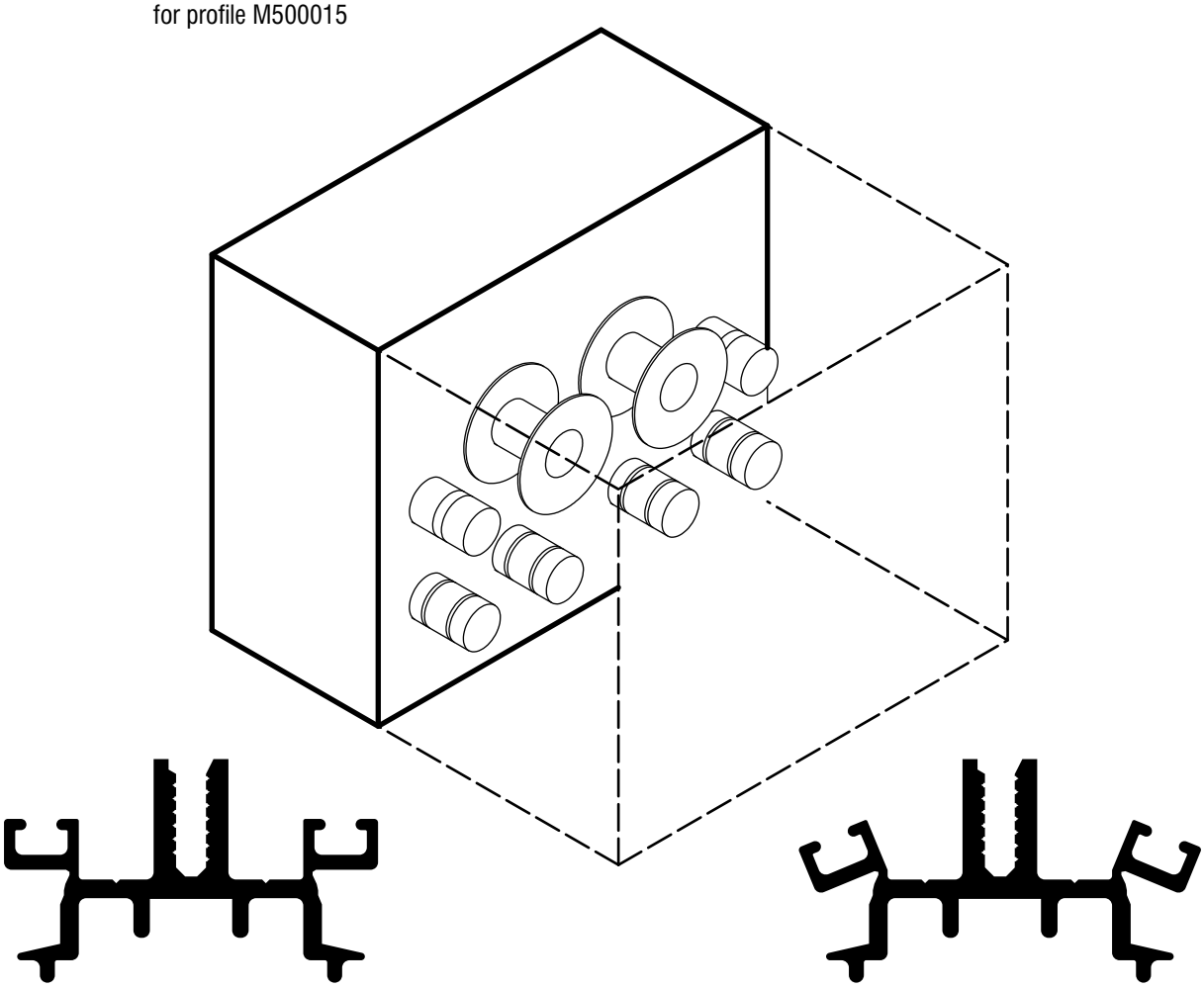


Profile	X
M500005	25
M500007	45
M500009	65
M500011	105
M500013	135

Note: This connection has been tested with loads exceeding 2000Kg. Test results can be delivered upon request.



810 50 000	Bending machine for profile M500015	1	



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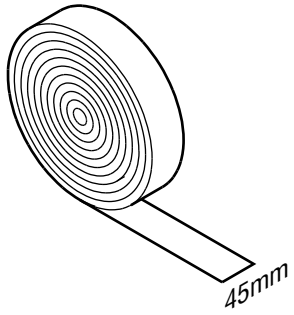
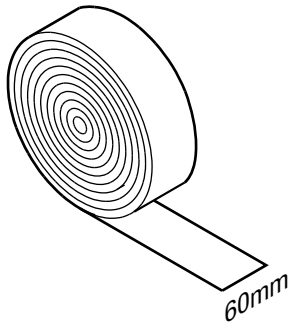
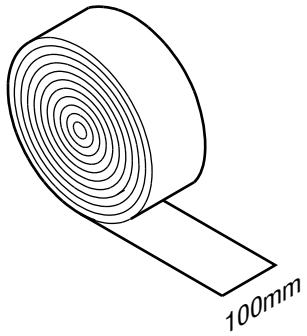
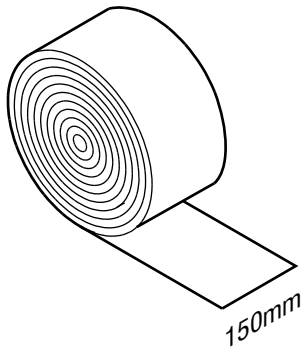
	CODE	DESCRIPTION	QUANTITY	SIZE
	720 90 045	Butyl tape 48mm	20m / coil	
	720 90 060	Butyl tape 60mm	20m / coil	
	720 90 100	Butyl tape 100mm	20m / coil	
	720 90 150	Butyl tape 150mm	20m / coil	

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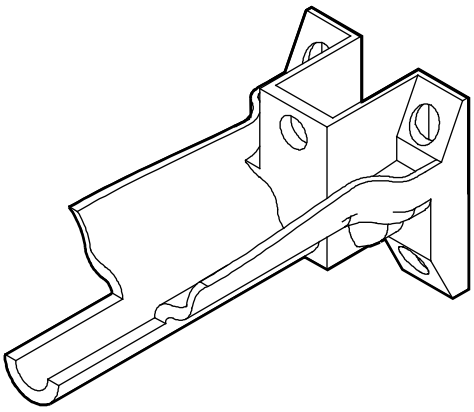
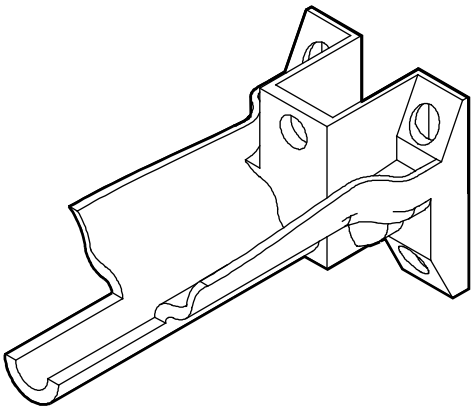
CODE	DESCRIPTION	QUANTITY	SIZE
710 50 001	Drainage spout EPDM 24-36mm	20 / box	



CODE	DESCRIPTION	QUANTITY	SIZE
710 50 001	Drainage spout EPDM 36-42mm	20 / box	



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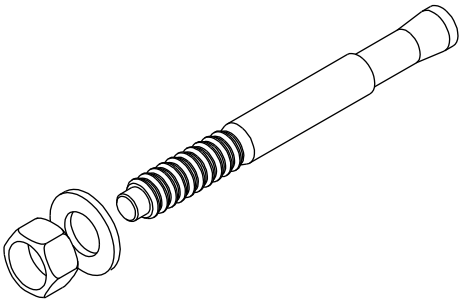
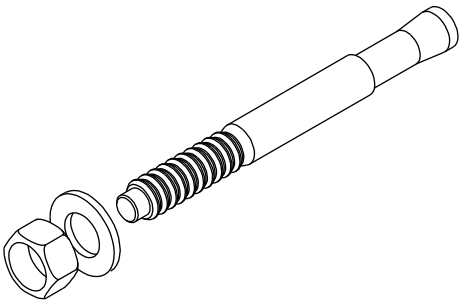
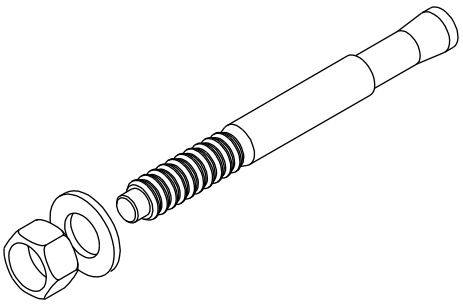
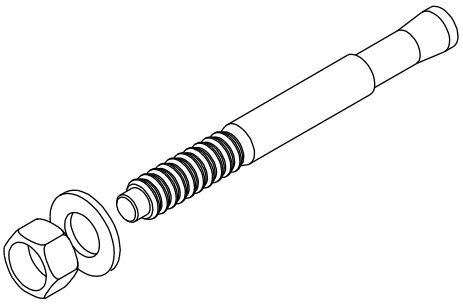
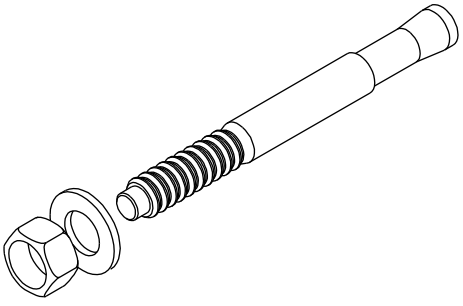
	CODE	DESCRIPTION	QUANTITY	SIZE
	76912080	Concrete anchor bolt 12x80 Stainless steel	20/box	
	76912100	Concrete anchor bolt 12x100 Stainless steel	20/box	
	76912120	Concrete anchor bolt 12x120 Stainless steel	20/box	
	76912150	Concrete anchor bolt 12x150 Stainless steel	20/box	
	76912180	Concrete anchor bolt 12x180 Stainless steel	20/box	

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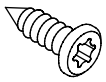
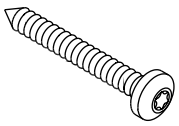
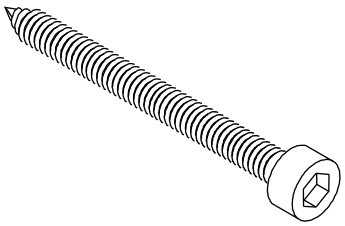
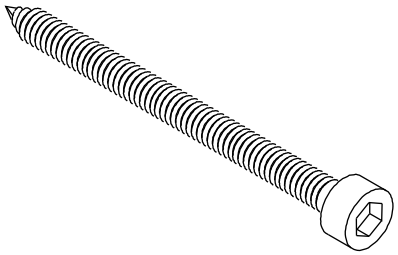
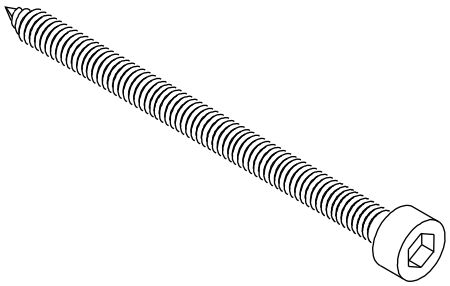
CODE	DESCRIPTION	QUANTITY	SIZE	
7623481901	ST 4,8mm X 19mm Flat head machine screw Stainless steel	500/box		
7623483201	ST 4,8mm X 32mm Pan head machine screw Stainless steel	100/box		
7629555501	ST M6 X 55mm Socket head cap screw Stainless steel	100/box		
7629556001	ST M6 X 60mm Socket head cap screw Stainless steel	100/box		
7629557001	ST M6 X 70mm Socket head cap screw Stainless steel	100/box		
7627551601	ST M6 washer with self-sealing rubber Stainless steel	100/box		

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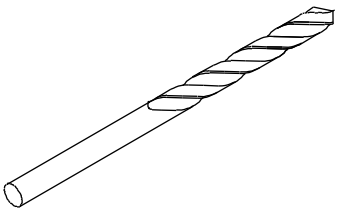
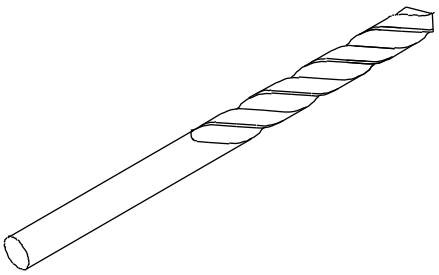
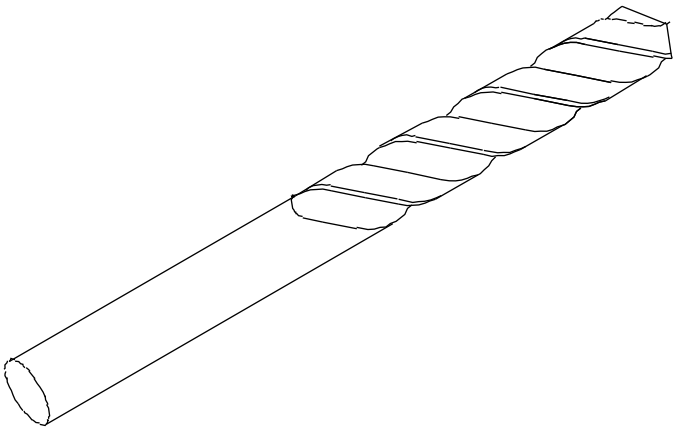
	CODE	DESCRIPTION	QUANTITY	SIZE
	759 03 502	Drill bit 3,5mm Stainless steel	150/box	
	759 05 002	Drill bit 5mm Stainless steel	150/box	
	759 10 002	Drill bit 10mm Stainless steel	150/box	

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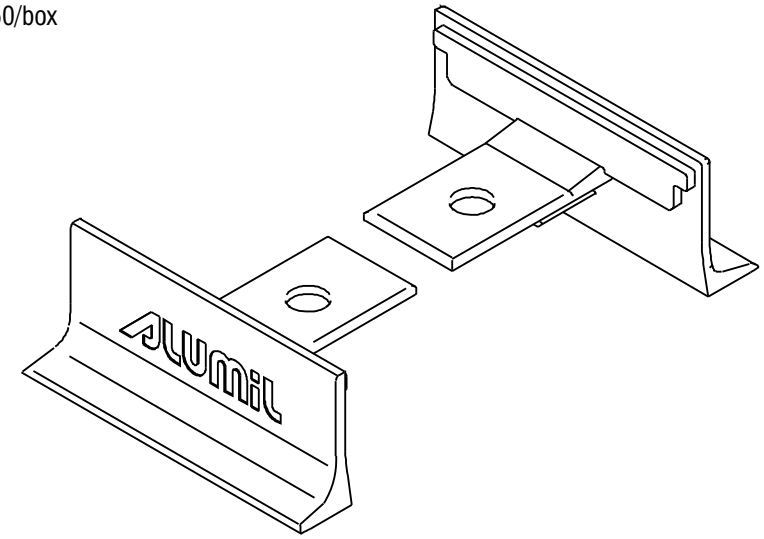
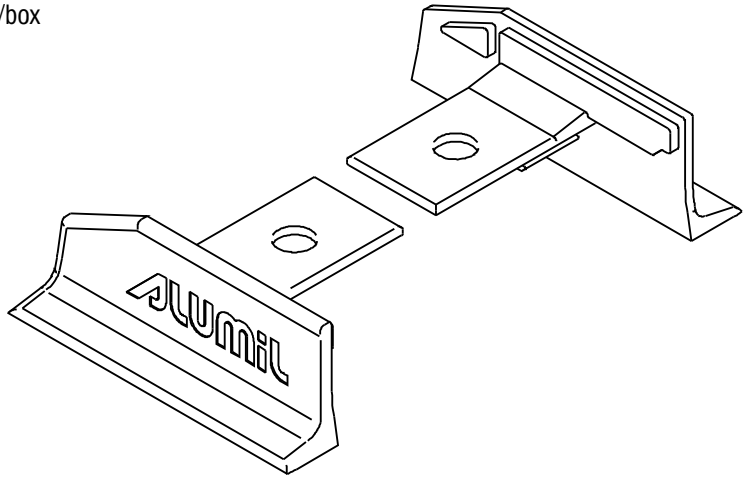
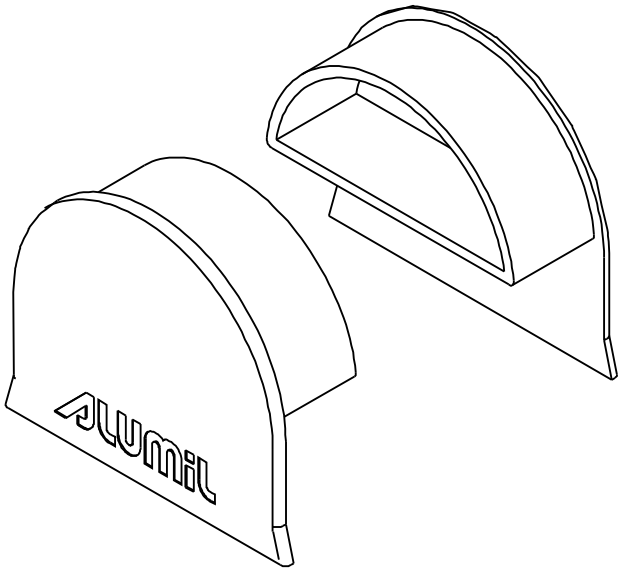
CODE	DESCRIPTION	QUANTITY	SIZE
710 50 053	End cover for M500053 EPDM	50/box	



710 50 082	End cover for M500082 EPDM	50/box	



710 50 077	End cover for M500077 PVCu	50/box	



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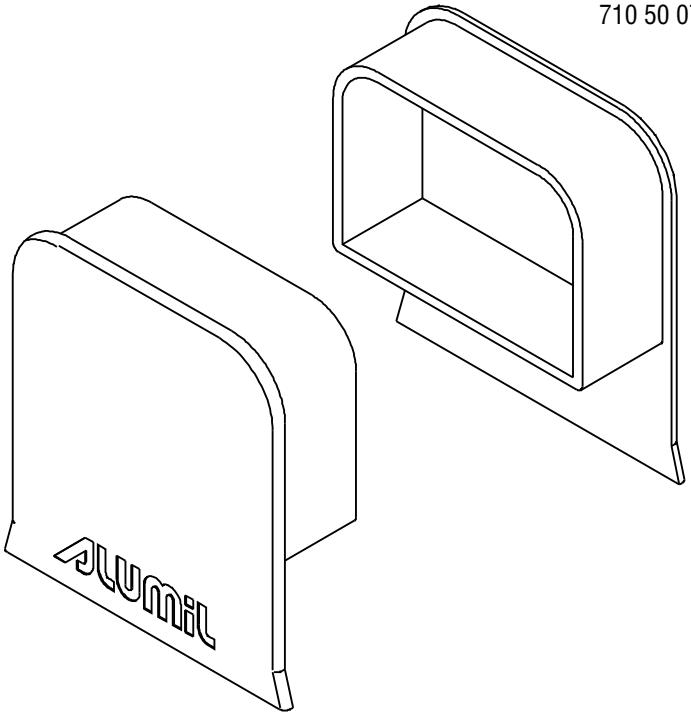
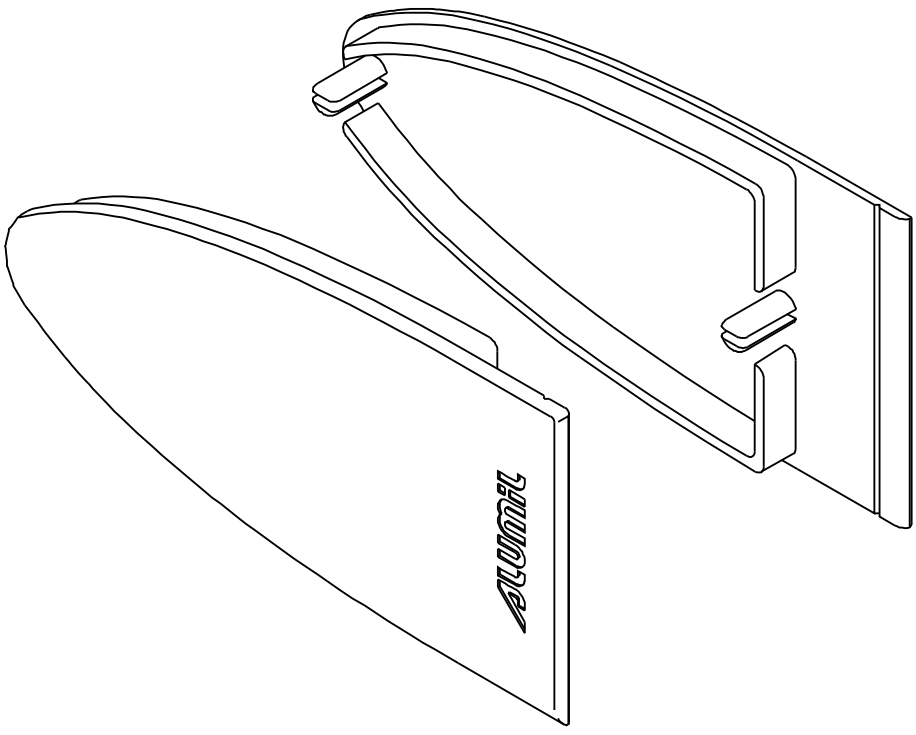
710 50 078	End cover for M500078 PVCu	50/box	



CODE	DESCRIPTION	QUANTITY	SIZE
710 50 079	End cover for M500079 PVCu	50/box	



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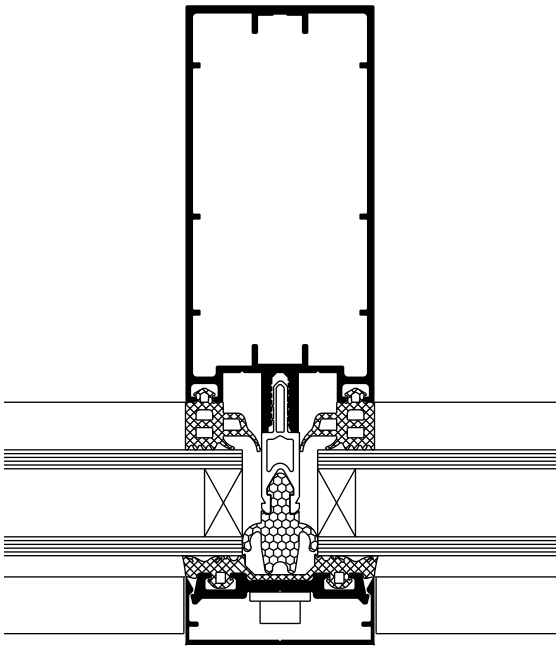

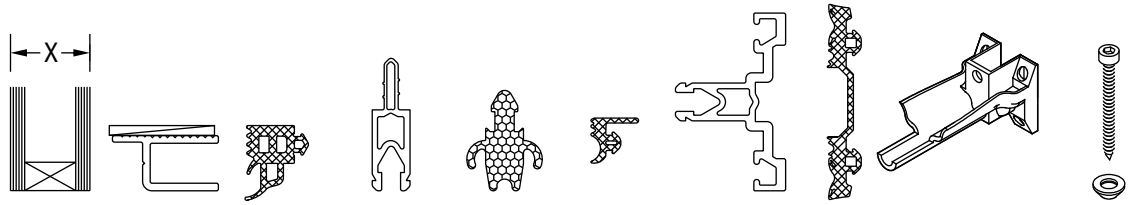

Glass Thickness	Glazing Bridge	Mullion Gasket	Mullion Isolator	Isolator M50 HI	Transom Gasket	Transom Isolator	Pressure Plate Gasket	Drainage Spout	Socket head cap screw
24-26	72050061	23050000	72010600	72050100	23050050	66050050	23050051	71050001	7629555501 7627551601
26-28	72050061	23050000	72010600	72050100	23050050	66050050	23050051	71050001	7629555501 7627551601
28-30	72050061	23050000	72010600	72050100	23050050	66050050	23050051	71050001	7629555501 7627551601
30-32	72050062	23050000	72010600	72050100	23050050	66050050	23050051	71050001	7629556001 7627551601
32-34	72050062	23050000	72010600	72050100	23050050	66050050	23050051	71050001	7629556001 7627551601
34-36	72050062	23050000	72010600	72050100	23050050	66050050	23050051	71050001	7629556001 7627551601
36-38	72050063	23050000	72010600	72050100	23050050	66050050	23050051	71050003	7629557001 7627551601
38-40	72050063	23050000	72010600	72050100	23050050	66050050	23050051	71050003	7629557001 7627551601
40-42	72050063	23050000	72010600	72050100	23050050	66050050	23050051	71050003	7629557001 7627551601

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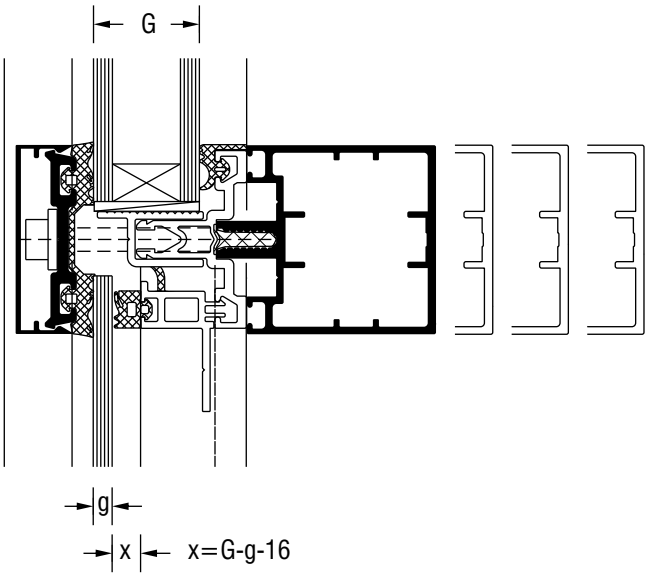
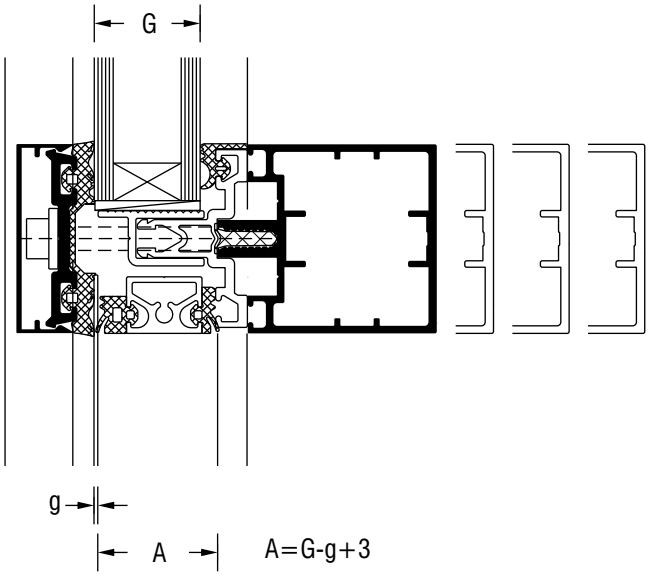


Gasket Dimension x(mm)	
2	23091103
3	23010911
4	23094000
6	23010801
8	23094100
12	23010910



Assembly Dimension A(mm)			
20		72050102	
22	23091103	72050102	
24	23091103	72050102	23091103
26	23010911	72050102	23010911
28	23094000	72050102	23094000
30	23094000	72050102	23010801
32	23010801	72050102	23010801
34	23010801	72050102	23094100
36	23094100	72050102	23094100

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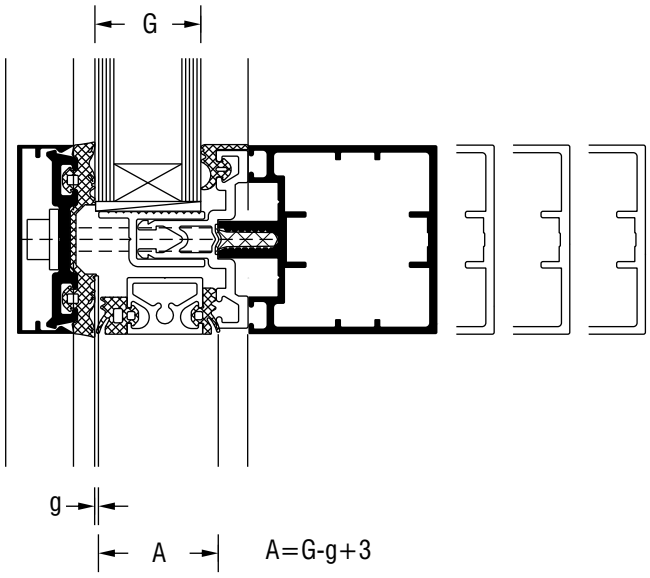

Gasket Dimension x(mm)	
2	23091103
3	23010911
4	23094000
6	23010801
8	23094100
12	23010910

Assembly Dimension A(mm)					
36	23010801	72050101	72050102		
38	23094100	72050101	72050102		
40		72050101	72050102	72050101	
42	23091103	72050101	72050102	72050101	
44	23094000	72050101	72050102	72050101	
46	23010911	72050101	72050102	72050101	23010911
48	23094000	72050101	72050102	72050101	23094000
50	23094000	72050101	72050102	72050101	23010801
52	23010801	72050101	72050102	72050101	23010801

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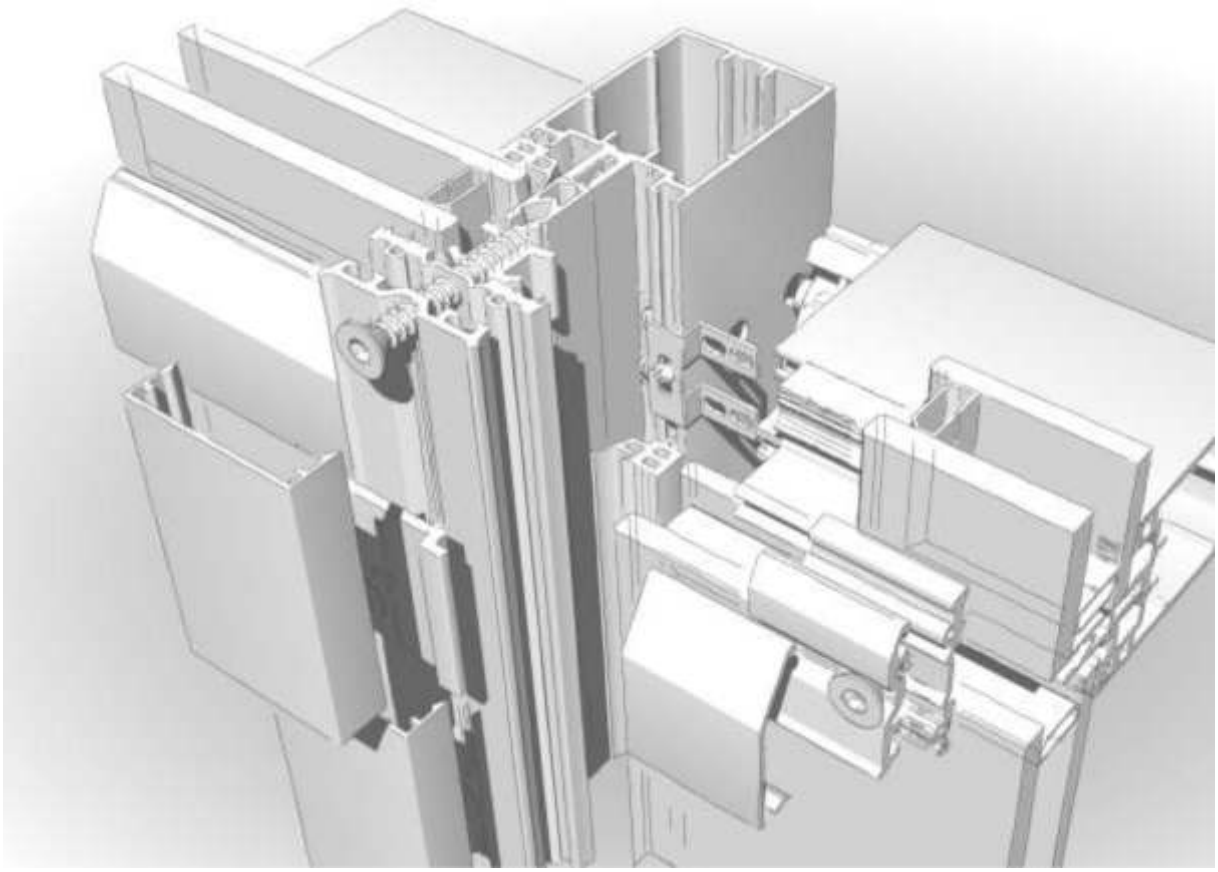

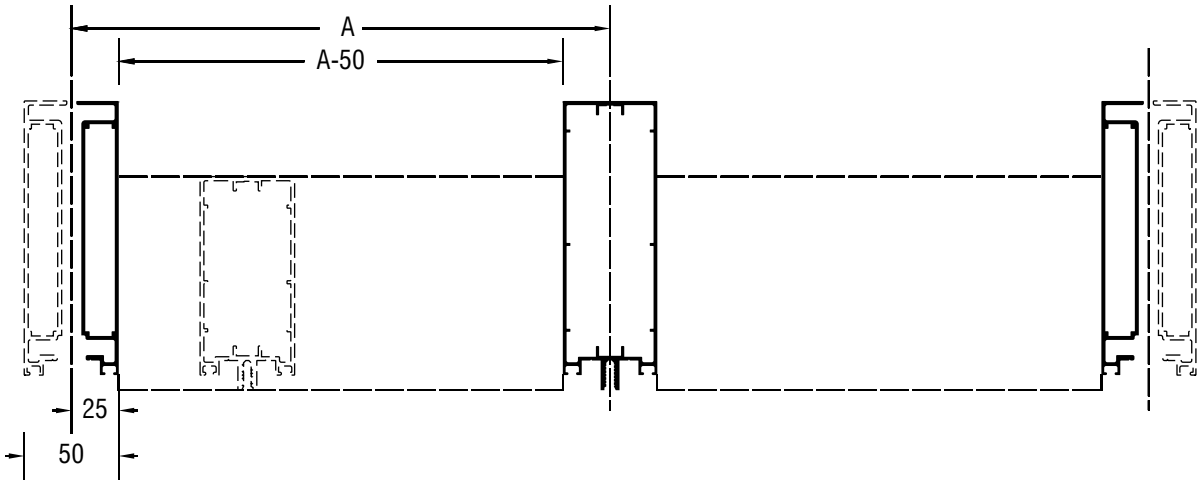

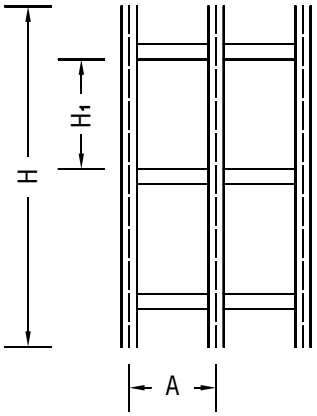

DESCRIPTION	CODE NR.	CUT	LENGTH	QUANTITY
Transom	500009		A-50	6
Half-Mullion	500010		H	2
Mullion	500011		H	1
Cover cap transom	500053		A-51	6
Pressure plate	500062		H	3
Pressure plate	500062		A-58	6
Cover cap mullion	500063		H	3
Gasket mullion	23050000		H_1-80	12
Pressure plate gasket	23050051		H	3
Pressure plate gasket	23050051		A-51	6
Gasket transom	23050050		A-130	6
Isolator transom	66050050		A-73	6
Isolator mullion	72010600		H	3
Isolator M50 HI	72050100		H	3
Isolator M50 HI	72050100		A-30	6

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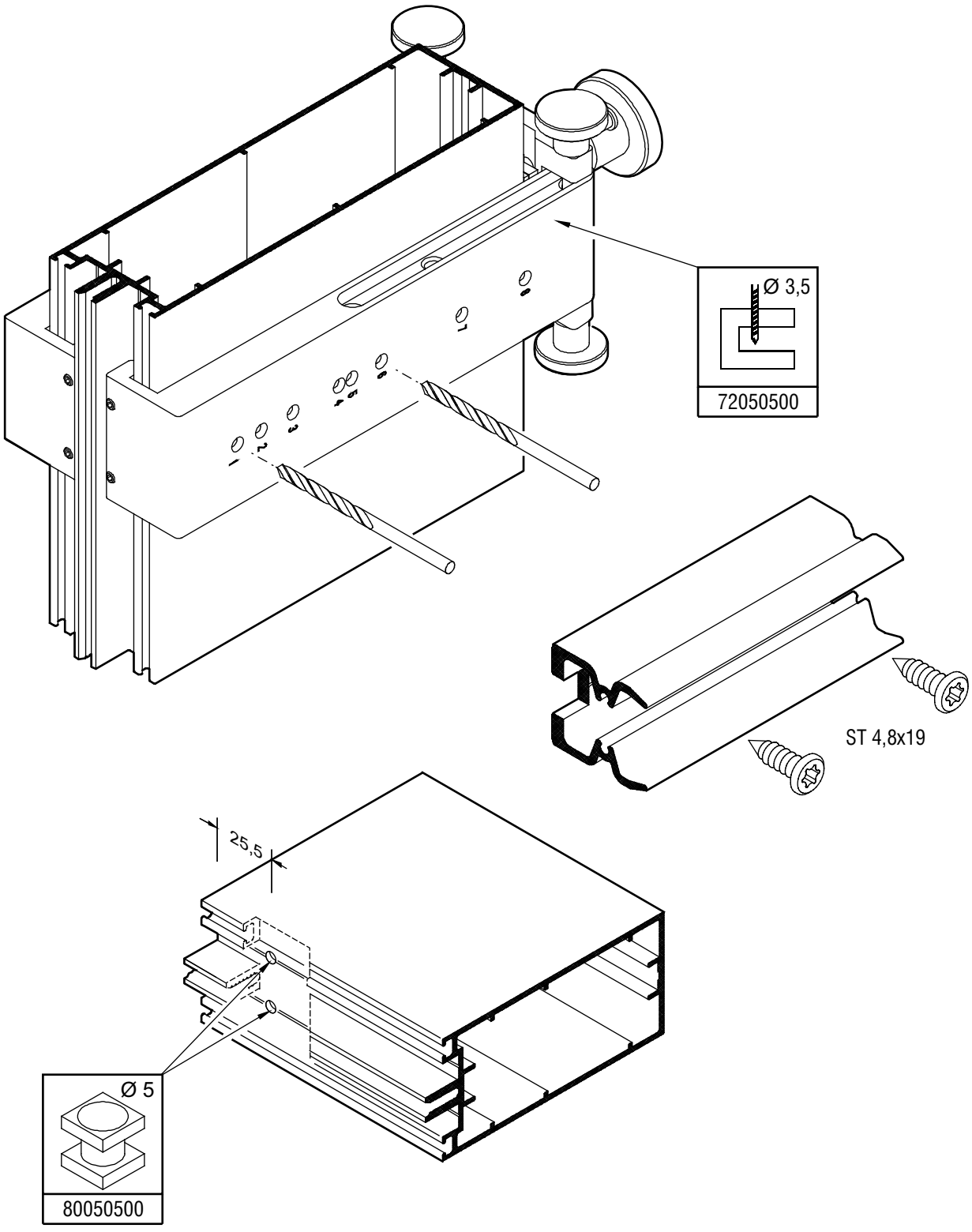

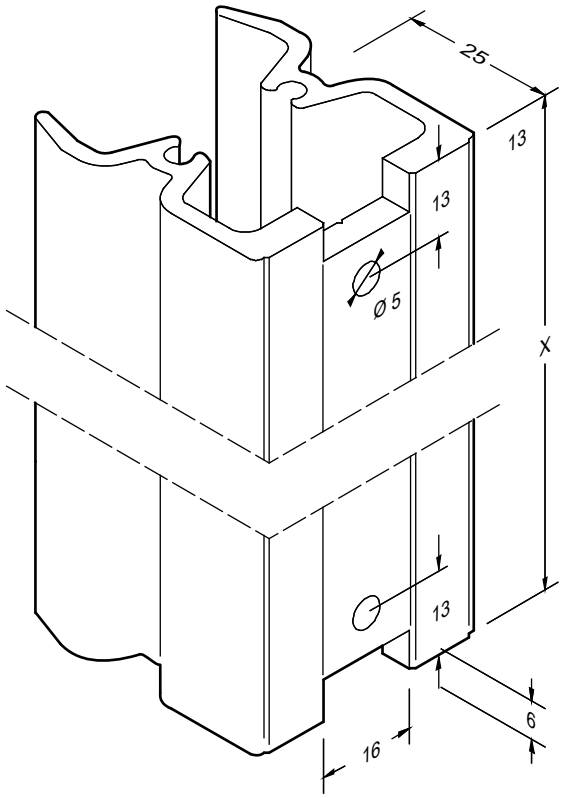

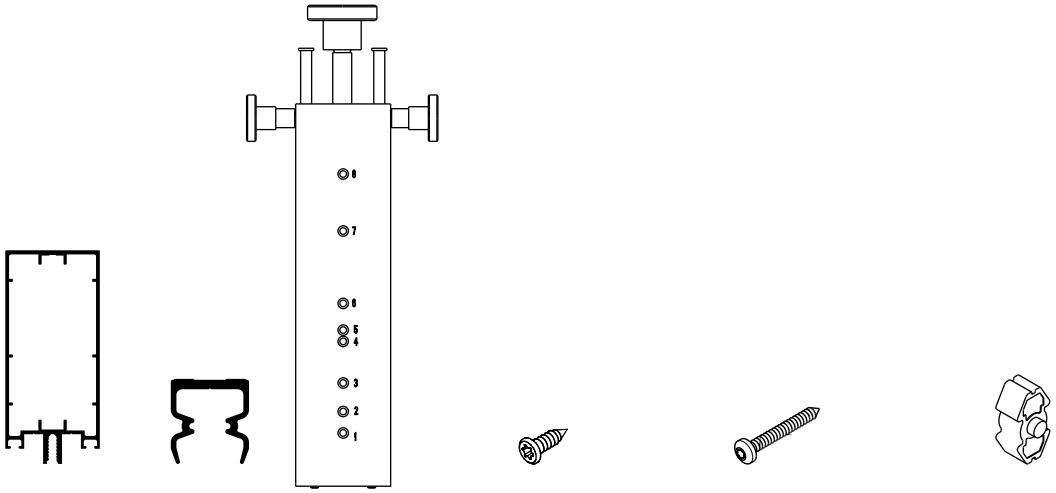

TRANSOM	T-CLEAT	JIG NR.	X	SCREWS	QTY	SCREWS	QTY	SPRING CLEAT	QTY
500003	72059037	1 + 2	37	ST 4,8X19	2	ST 4,8X32	2	72050000	2
500005	72059052	1 + 3	52	ST 4,8X19	2	ST 4,8X32	2	72050000	2
500007	72059072	1 + 4	72	ST 4,8X19	2	ST 4,8X32	2	72050000	2
500009	72059092	1 + 6	92	ST 4,8X19	2	ST 4,8X32	2	72050000	2
500011	72059132	1 + 7	132	ST 4,8X19	2	ST 4,8X38	2	72050000	2
500013	72059162	1 + 8	162	ST 4,8X19	2	ST 4,8X38	2	72050000	2

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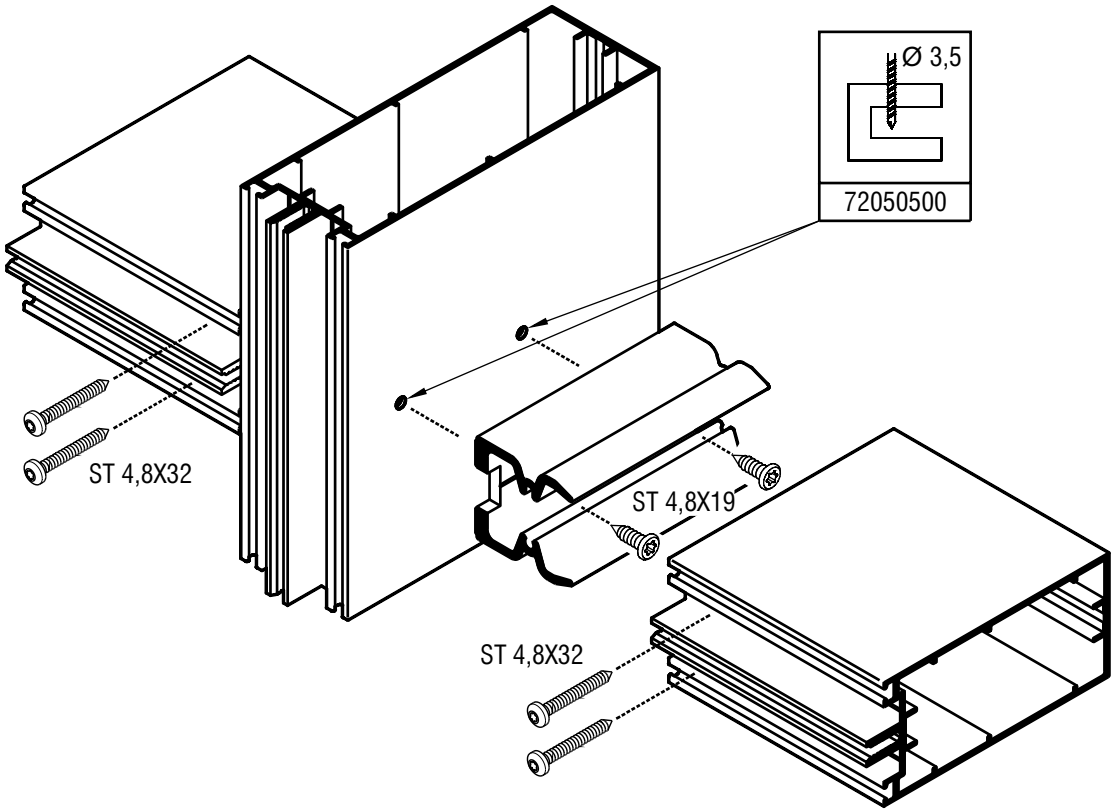
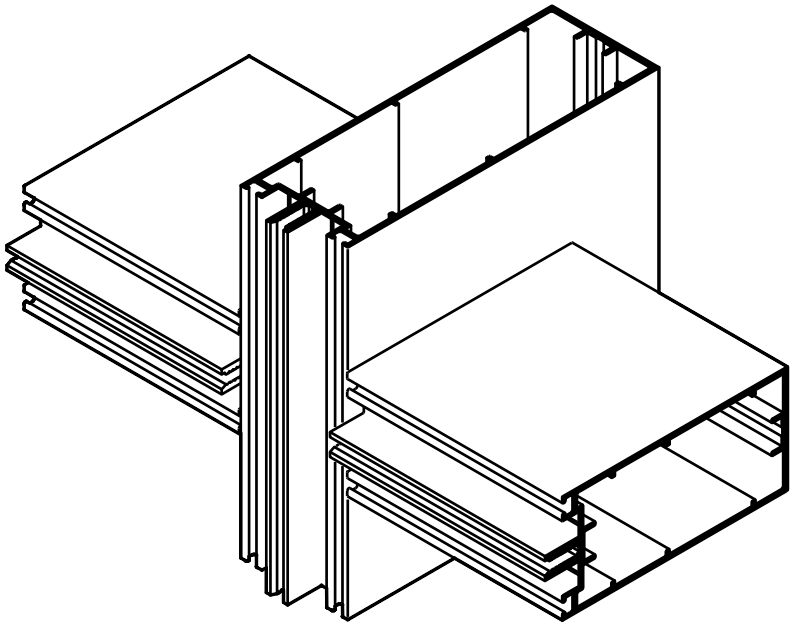
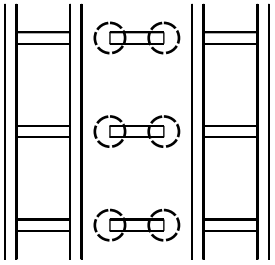
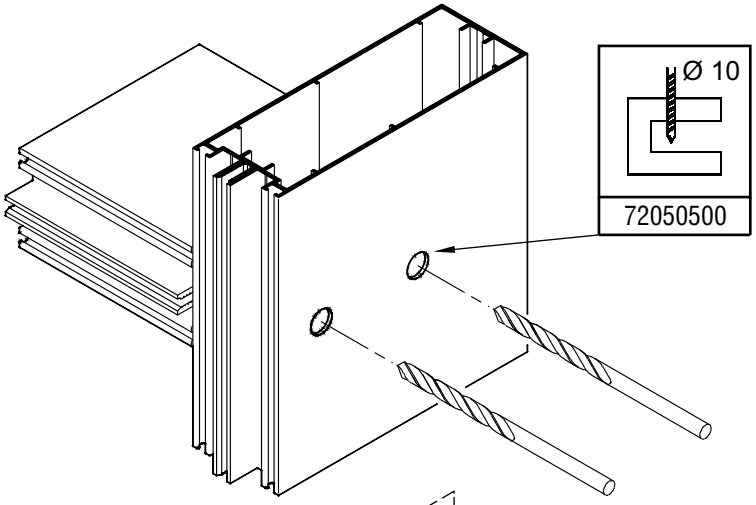




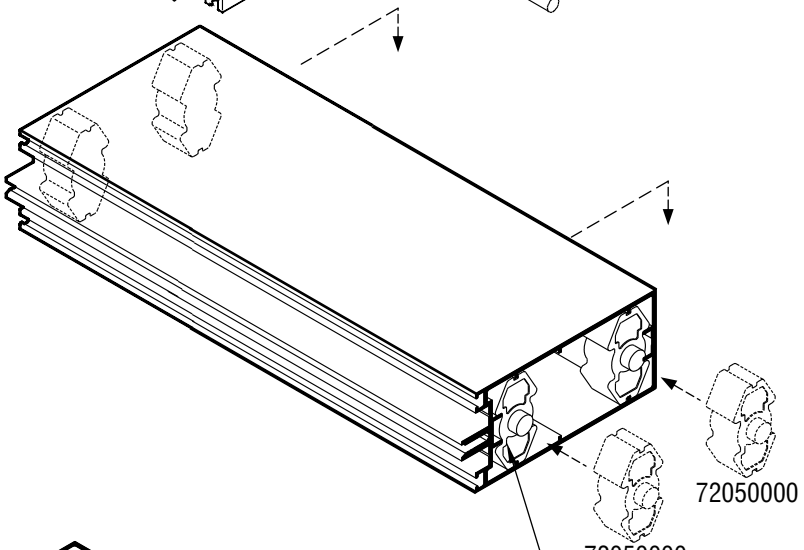
Note:
The T-cleats have been designed and tested to a maximum load of 1400Kg. This exceeds the maximum allowable deflection from the largest transom with a reinforcement profile. Therefore it is redudant to use more than two screws ST 4,8x19 in order to fasten the T-cleat to the mullion.

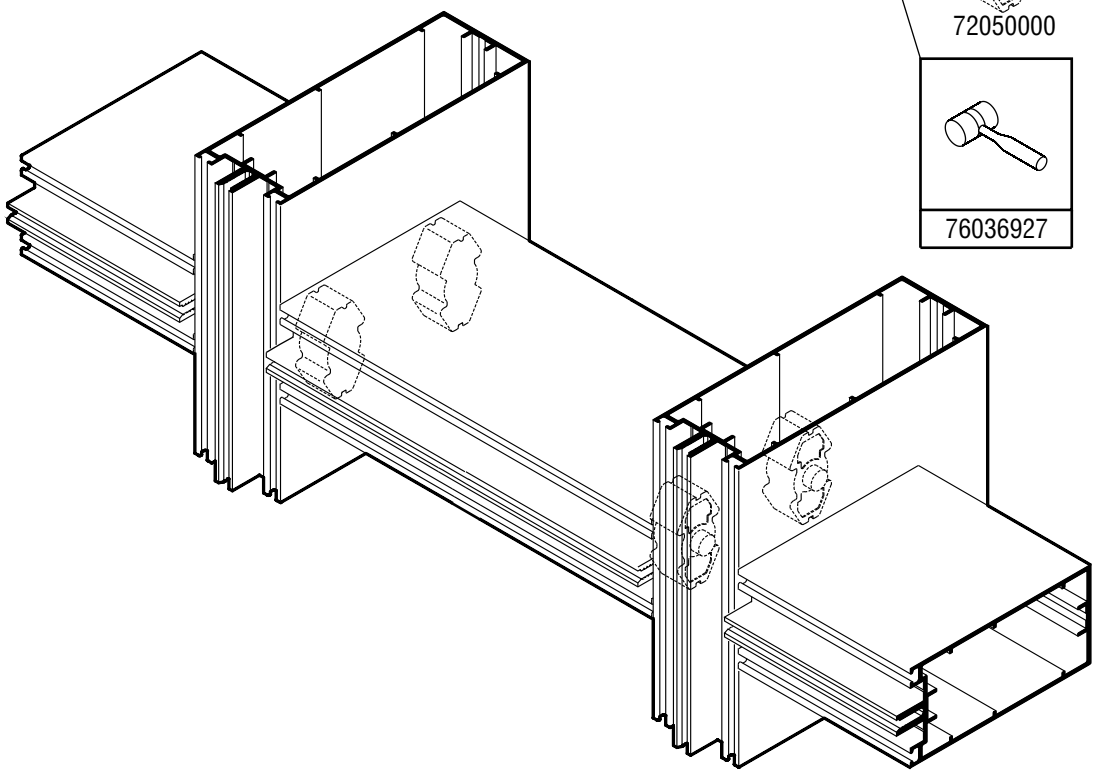
Mounting spring cleats for ladder construction





Note:
The spring cleats have been designed and tested to a maximum load of 2000Kg. This exceeds the maximum allowable deflection from the largest transom with a reinforcement profile. Therefore it is redudant to use more than two spring cleats in order to fasten the transom to the mullion.





Manufacturing and Machining

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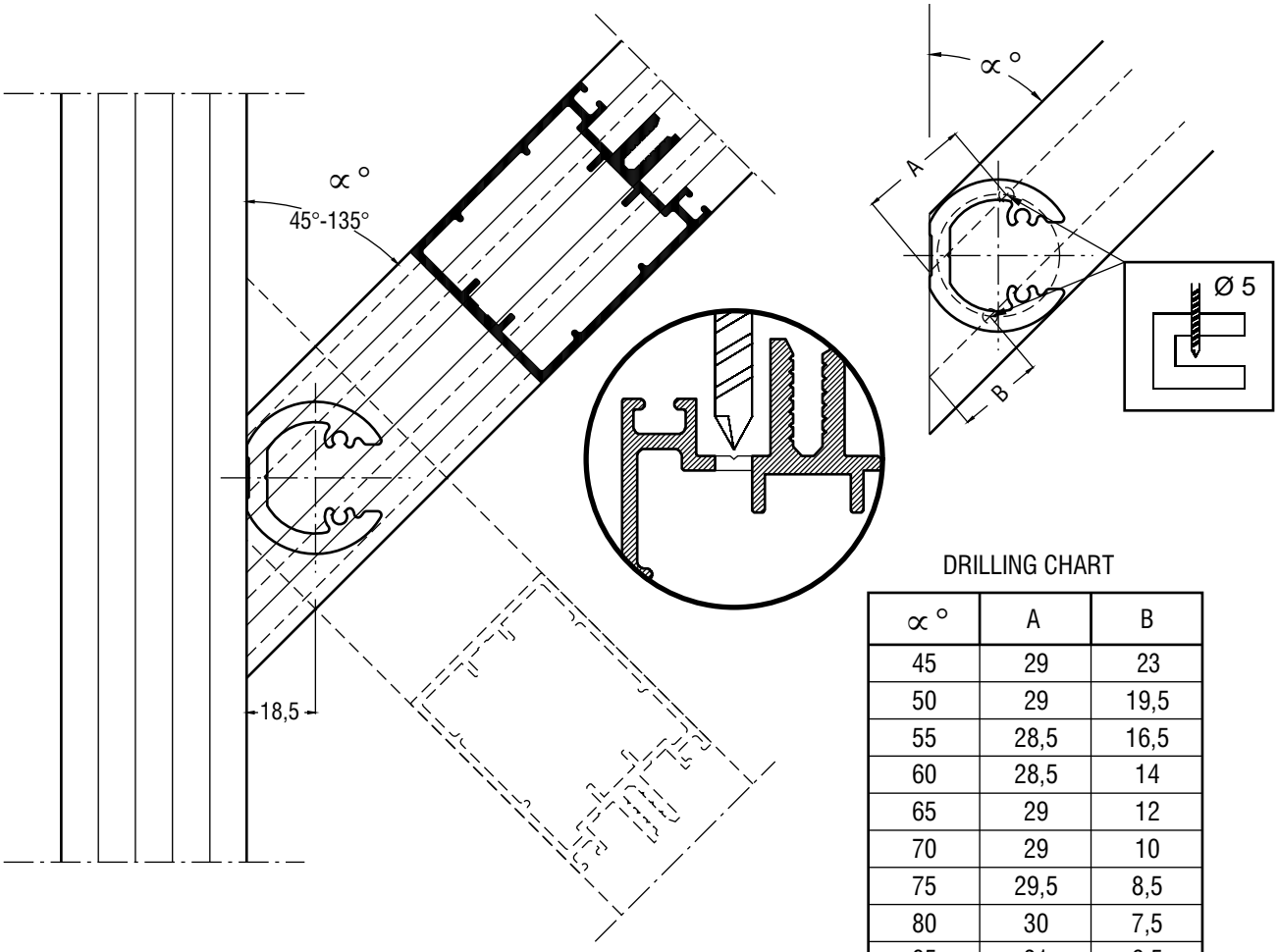
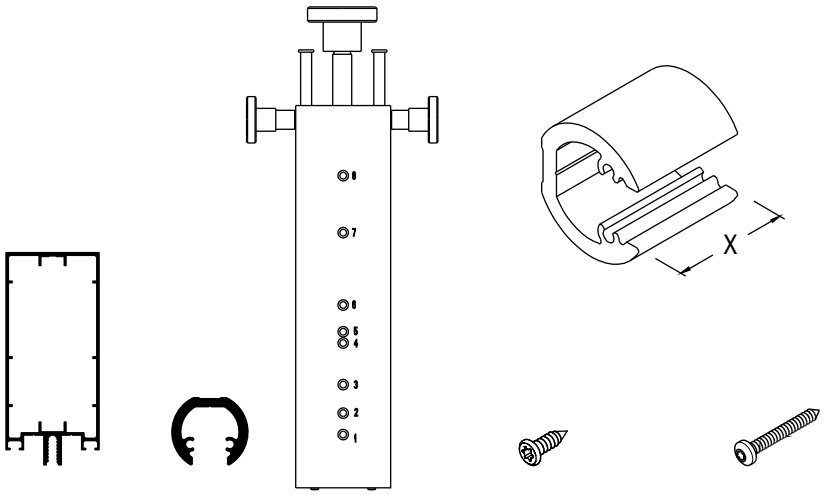


DRILLING CHART

∝ °	A	B
45	29	23
50	29	19,5
55	28,5	16,5
60	28,5	14
65	29	12
70	29	10
75	29,5	8,5
80	30	7,5
85	31	6,5
90	25	25
95	6,5	31
100	7,5	30
105	8,5	29,5
110	10	29
115	12	29
120	14	28,5
125	16,5	28,5
130	19,5	29
135	23	29



TRANSOM	T-CLEAT	JIG NR.	X	SCREWS	QTY	SCREWS	QTY
500003	500091	1 + 2	25	ST 4,8X19	2	ST 4,8X32	2
500005	500091	1 + 3	40	ST 4,8X19	2	ST 4,8X32	2
500007	500091	1 + 4	60	ST 4,8X19	2	ST 4,8X32	2
500009	500091	1 + 6	80	ST 4,8X19	2	ST 4,8X32	2
500011	500091	1 + 7	120	ST 4,8X19	2	ST 4,8X38	2
500013	500091	1 + 8	150	ST 4,8X19	2	ST 4,8X38	2

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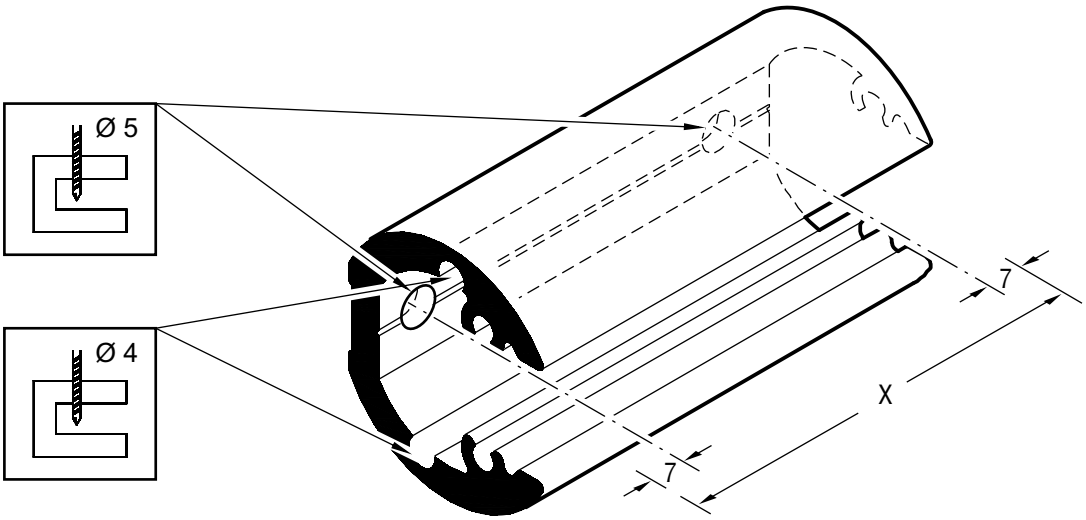

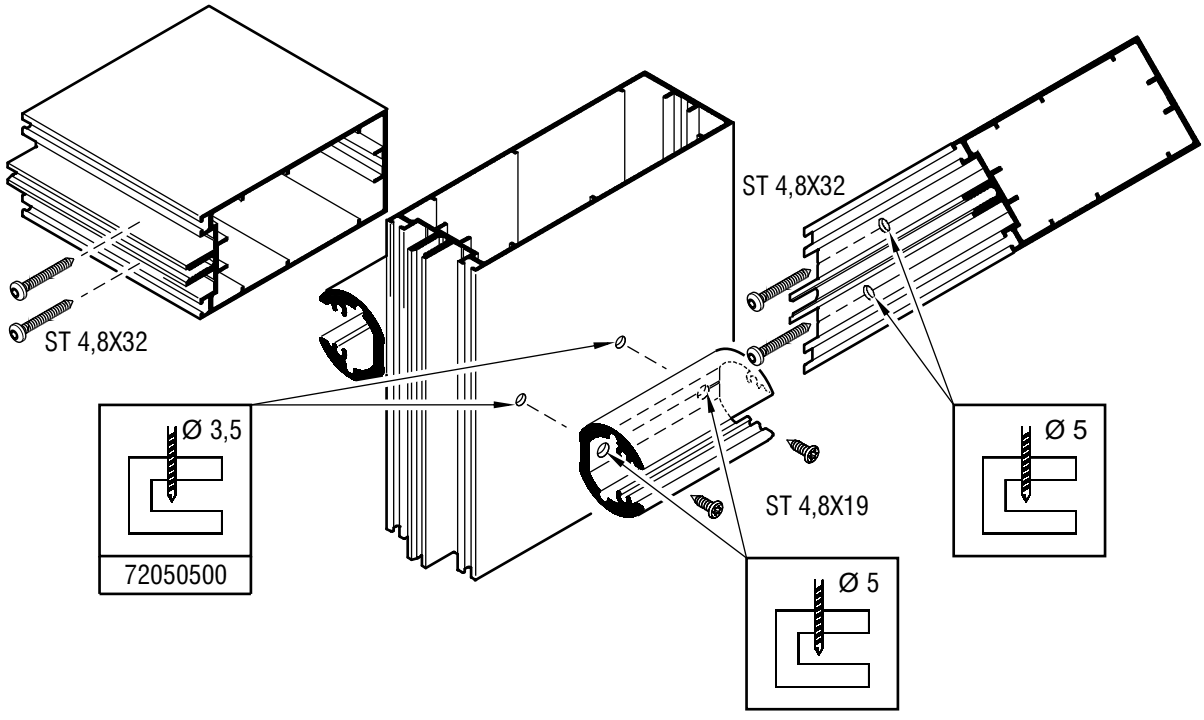

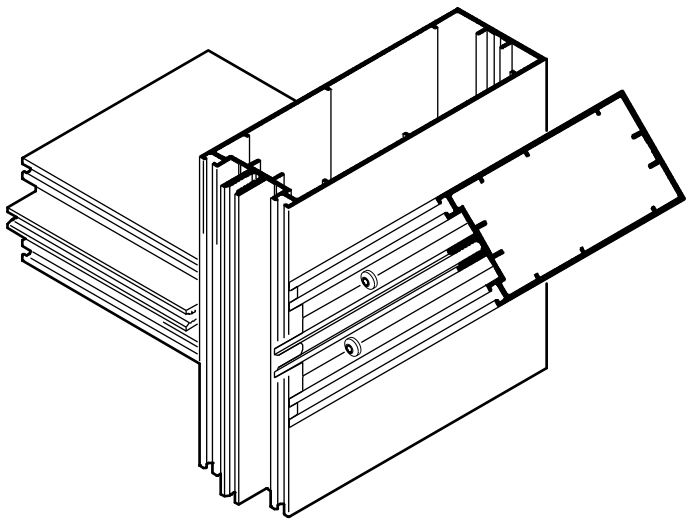

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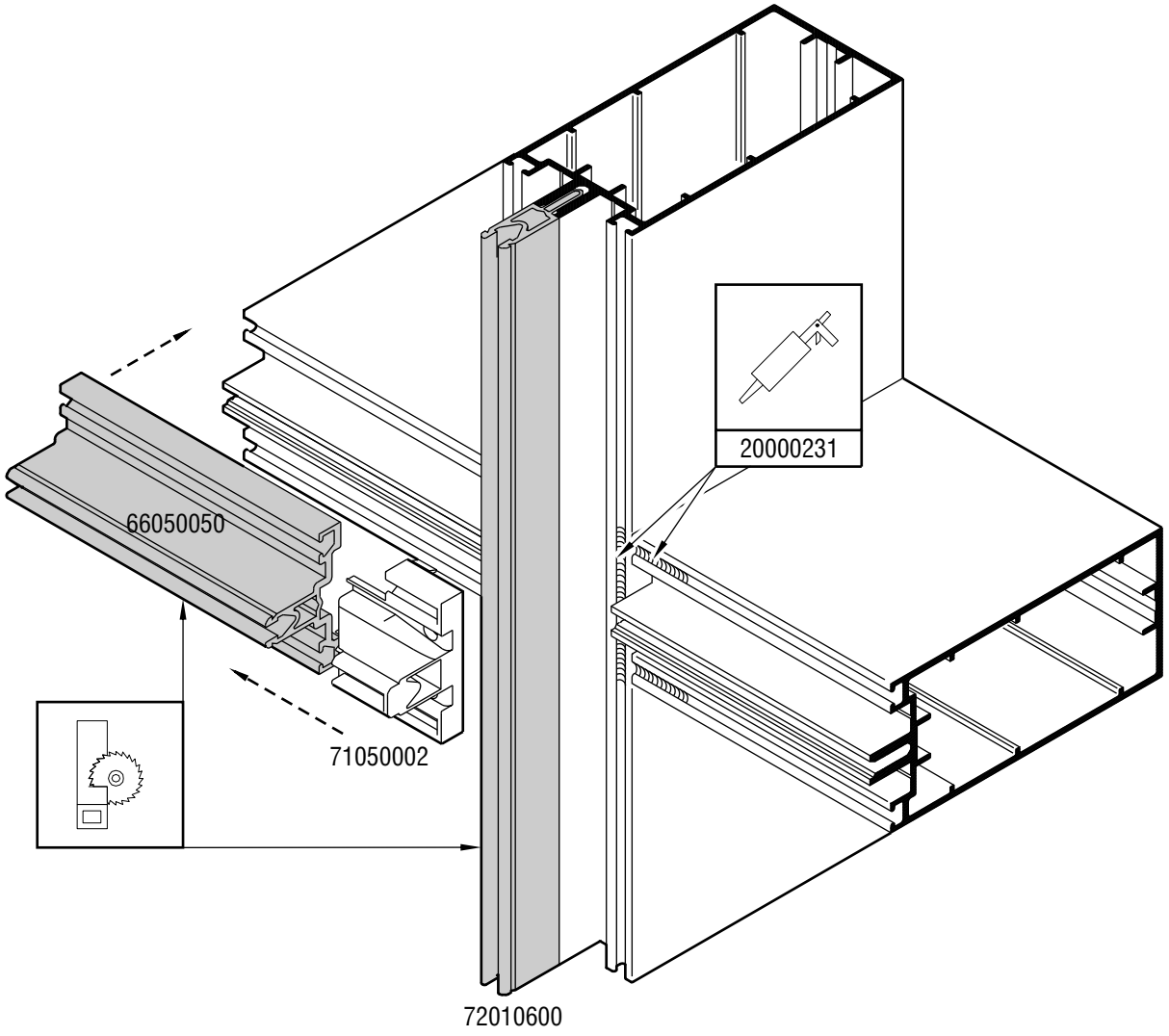

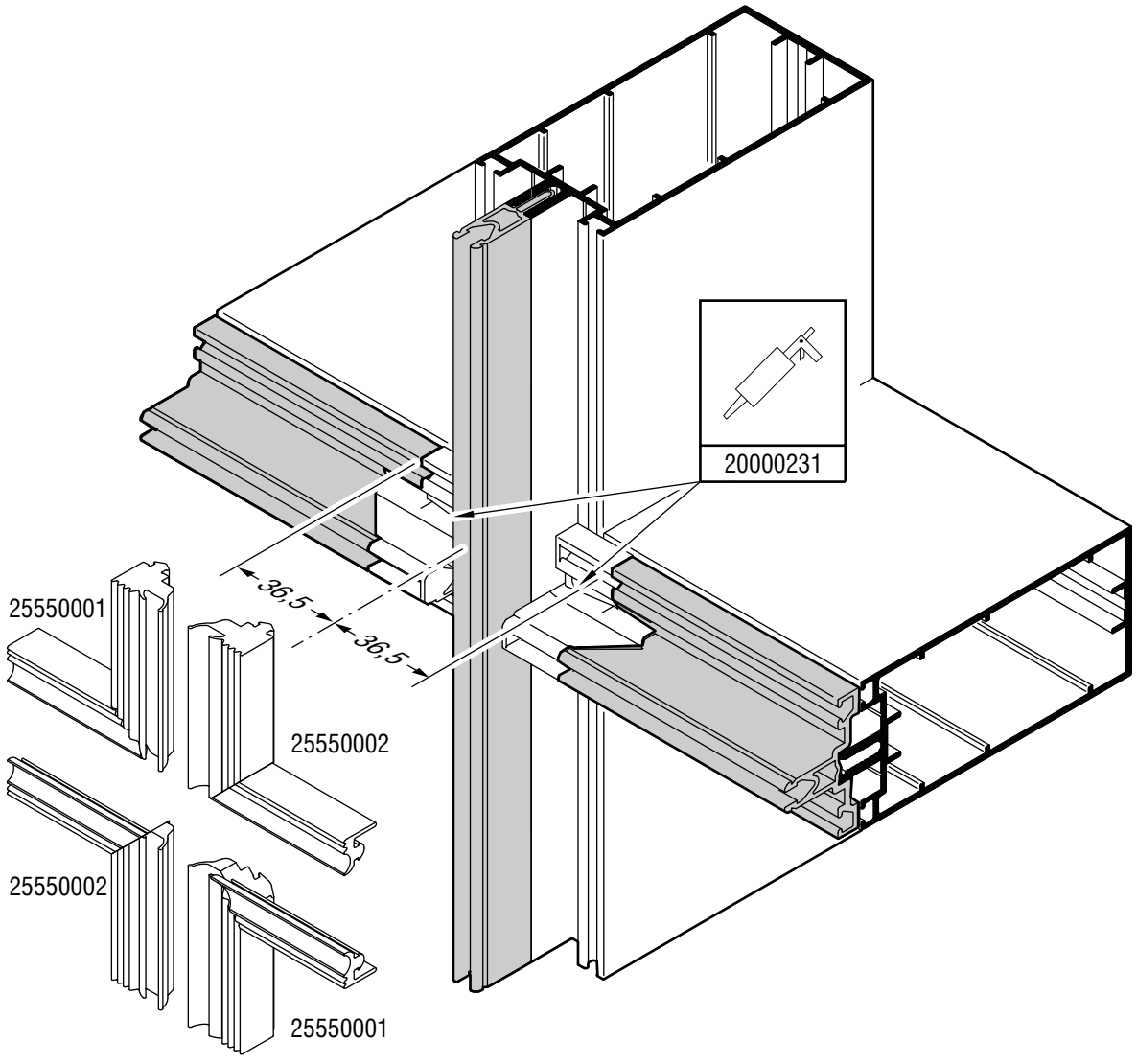

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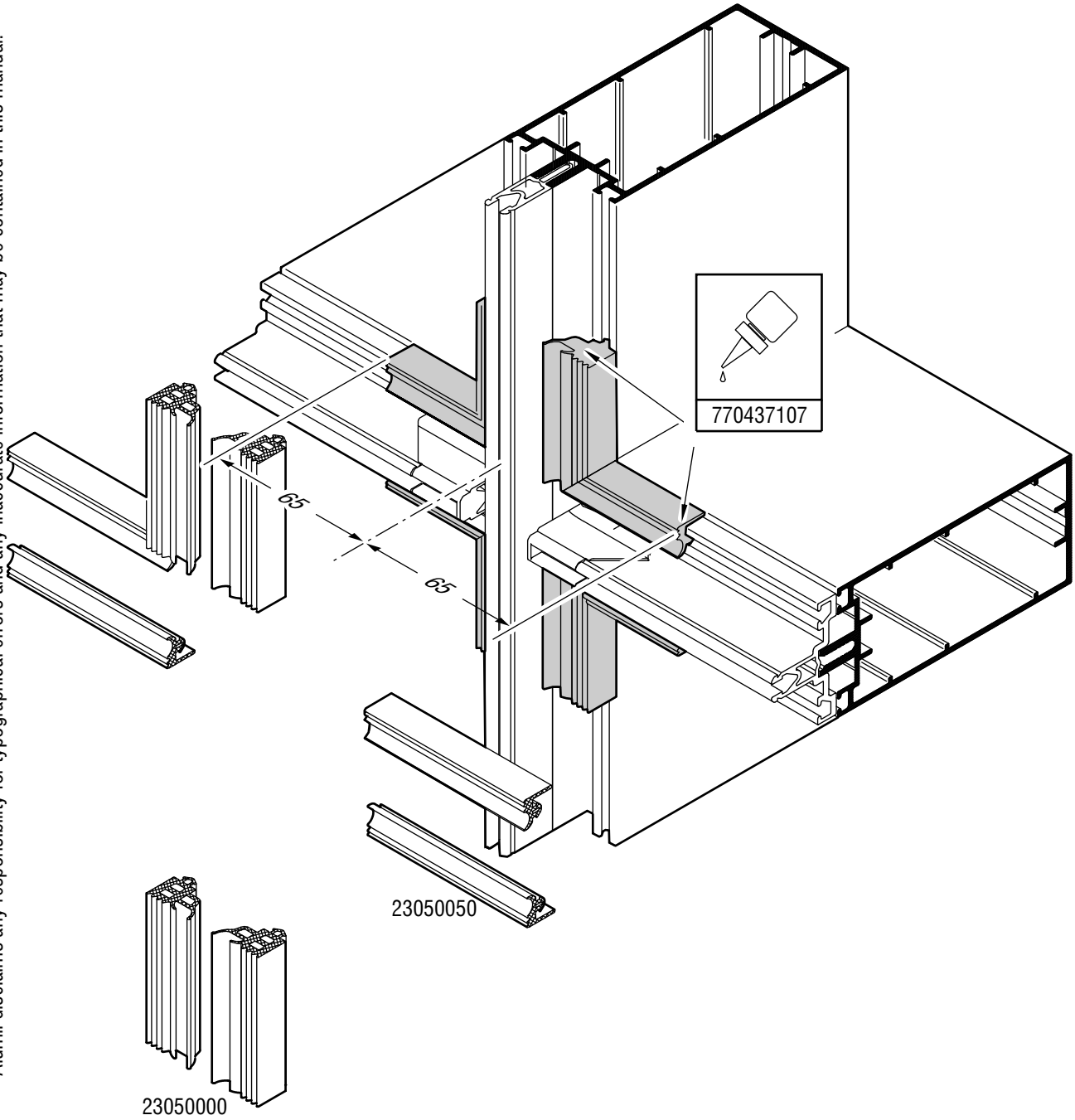

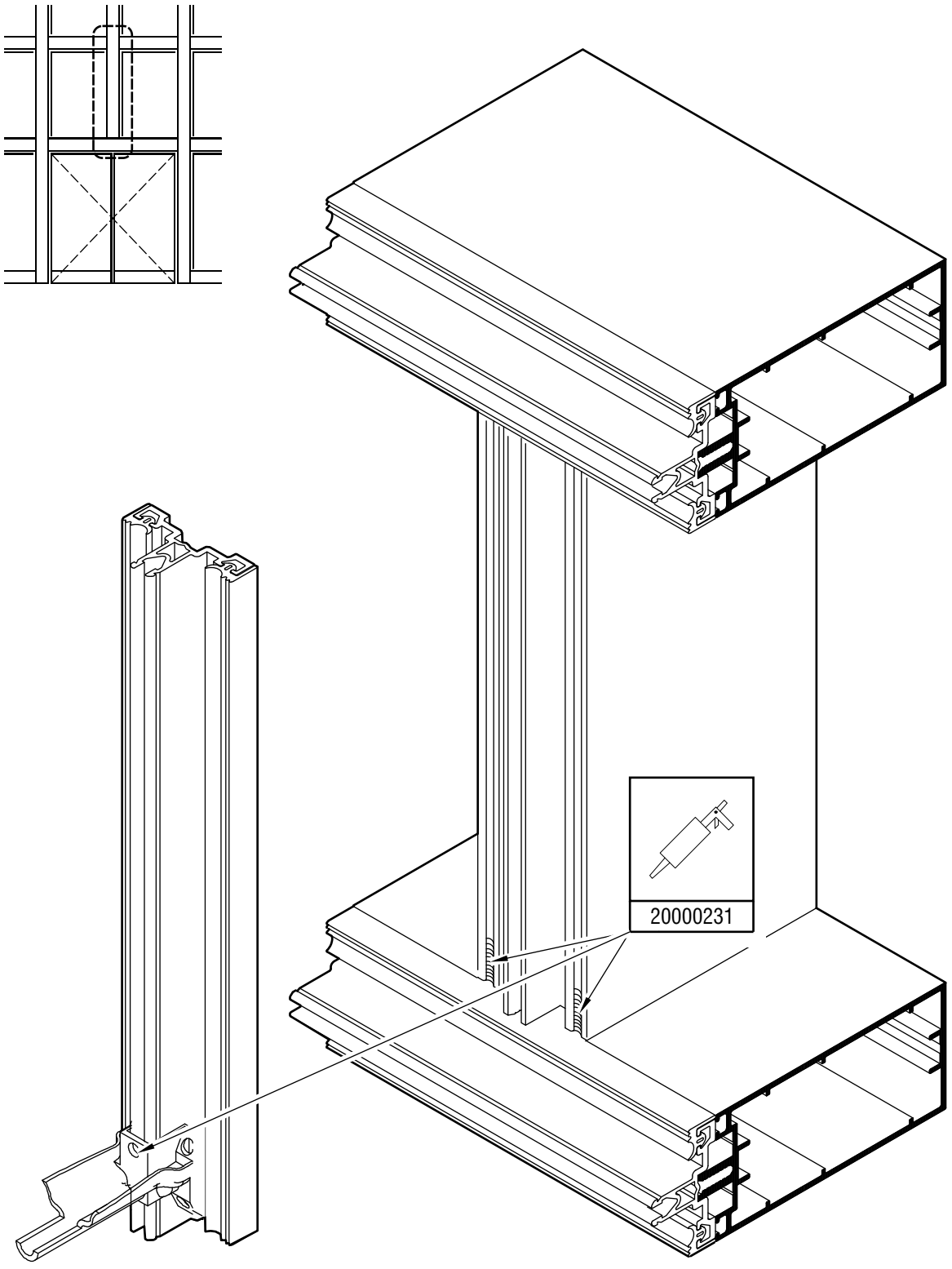

Note: This detail is for mullions that lie between transoms. This is common above an entrance door. The water drainage should be from mullion to transom and then to mullion.

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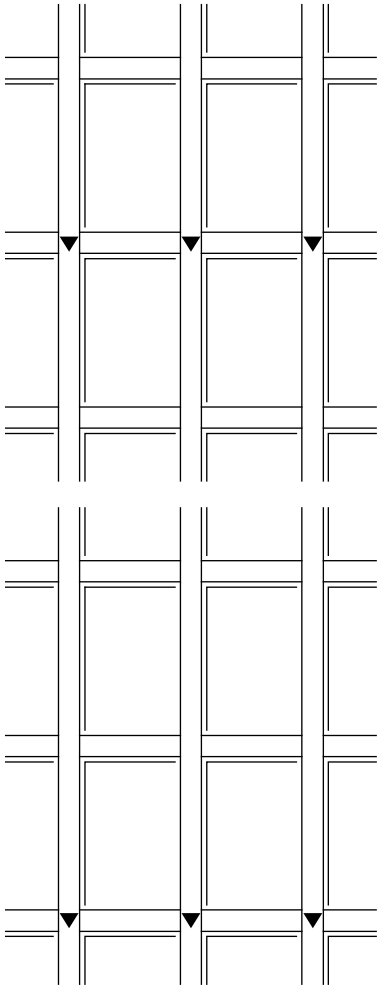
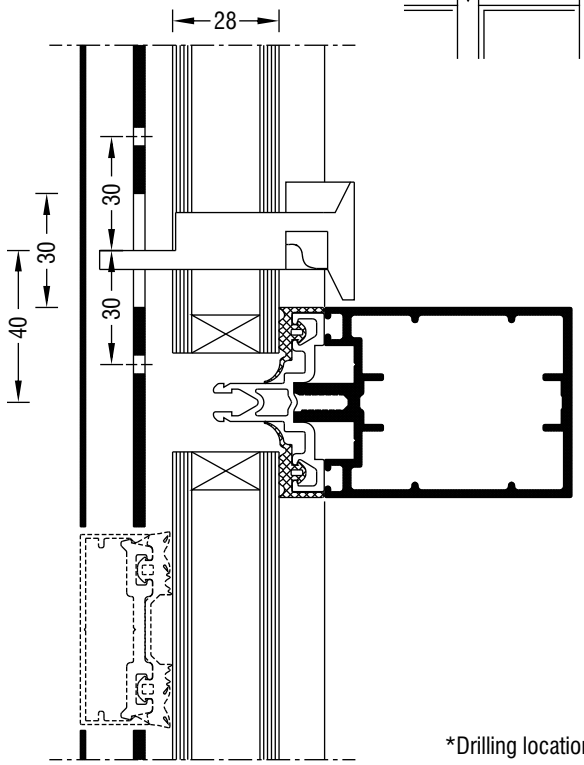
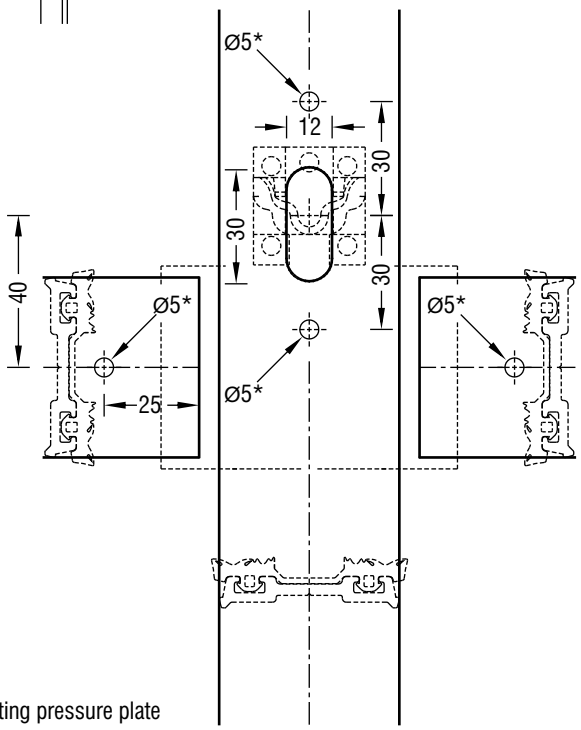
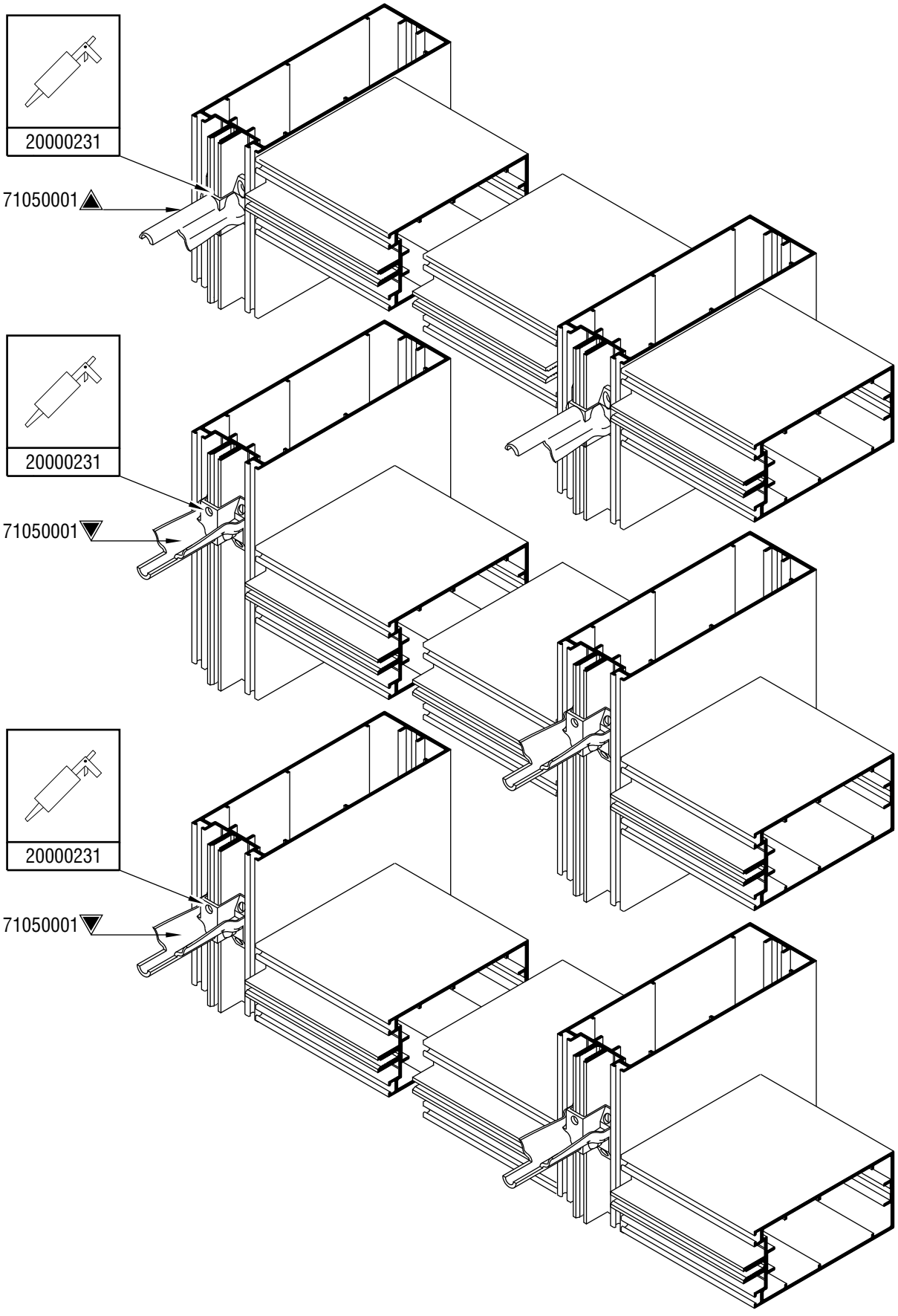


Drainage spout placed at every column and spaced at every expansion joint or a minimum of eight meter intervals





*Drilling location for fixating pressure plate



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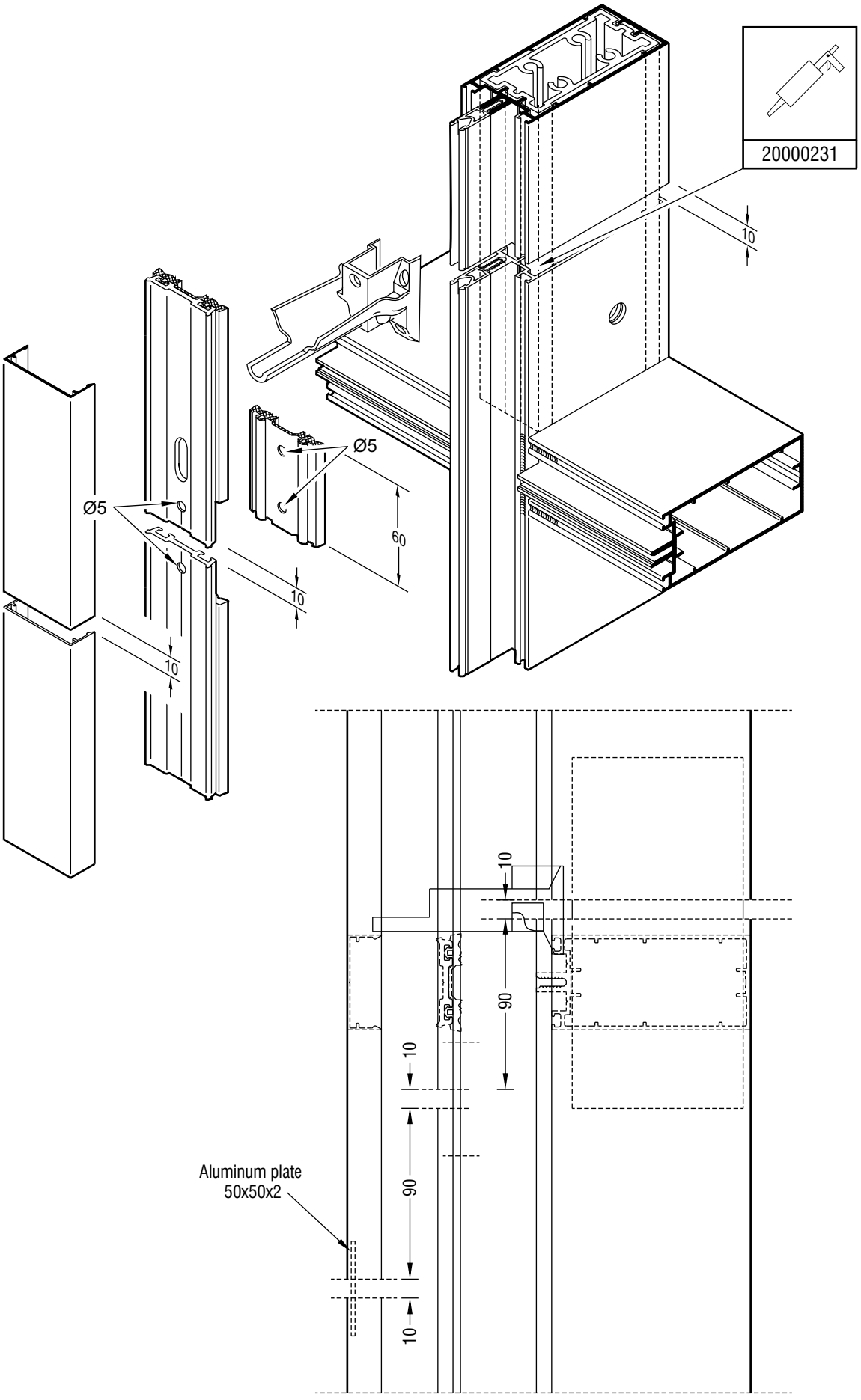

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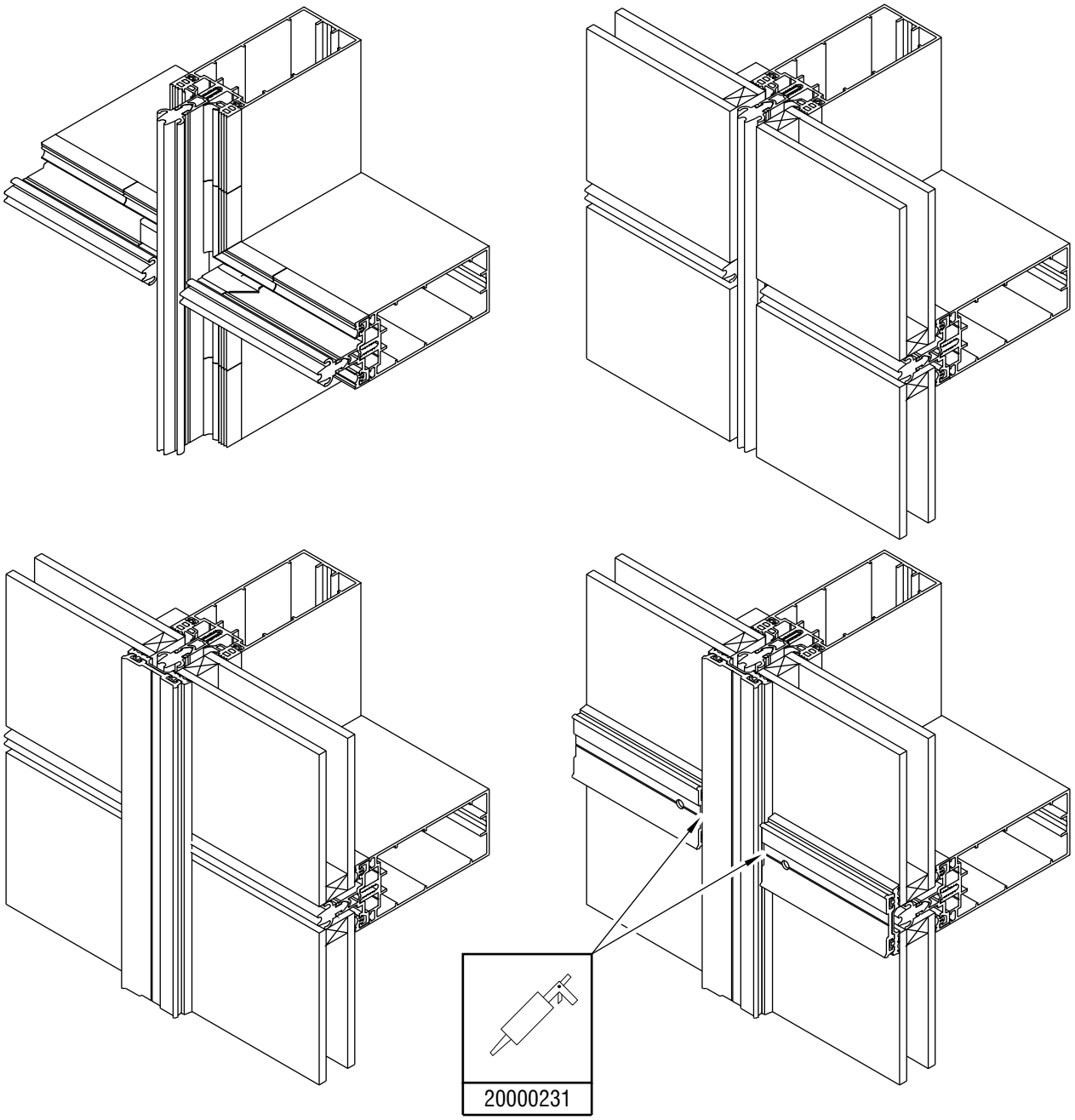
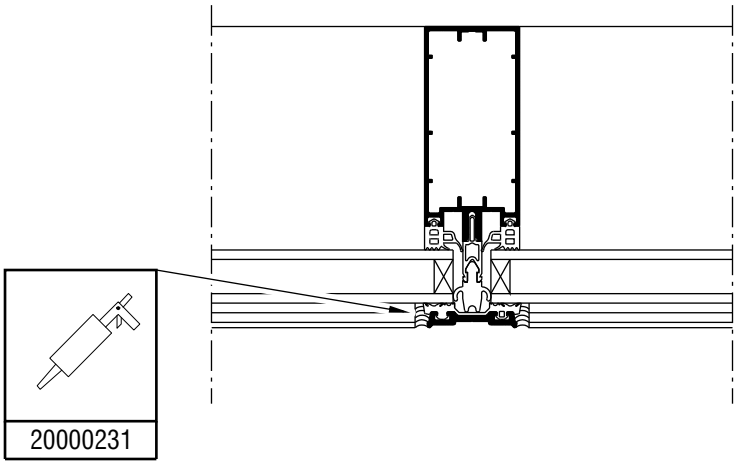
Sequence of assembly variant 1





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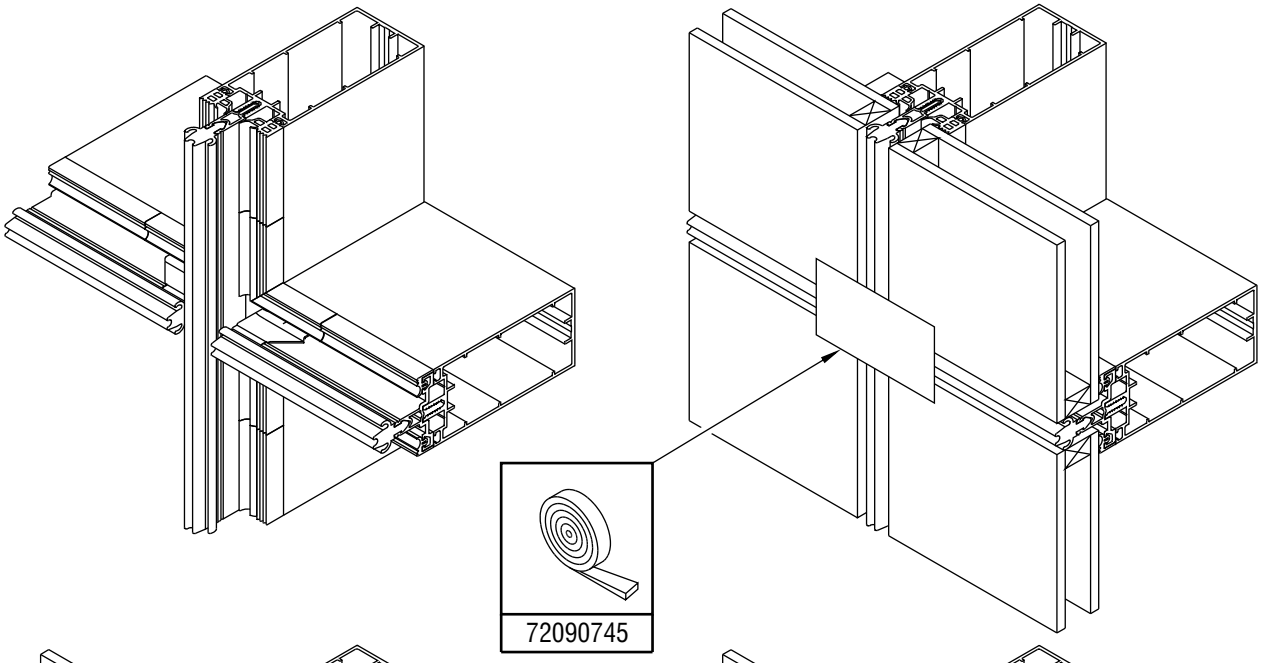

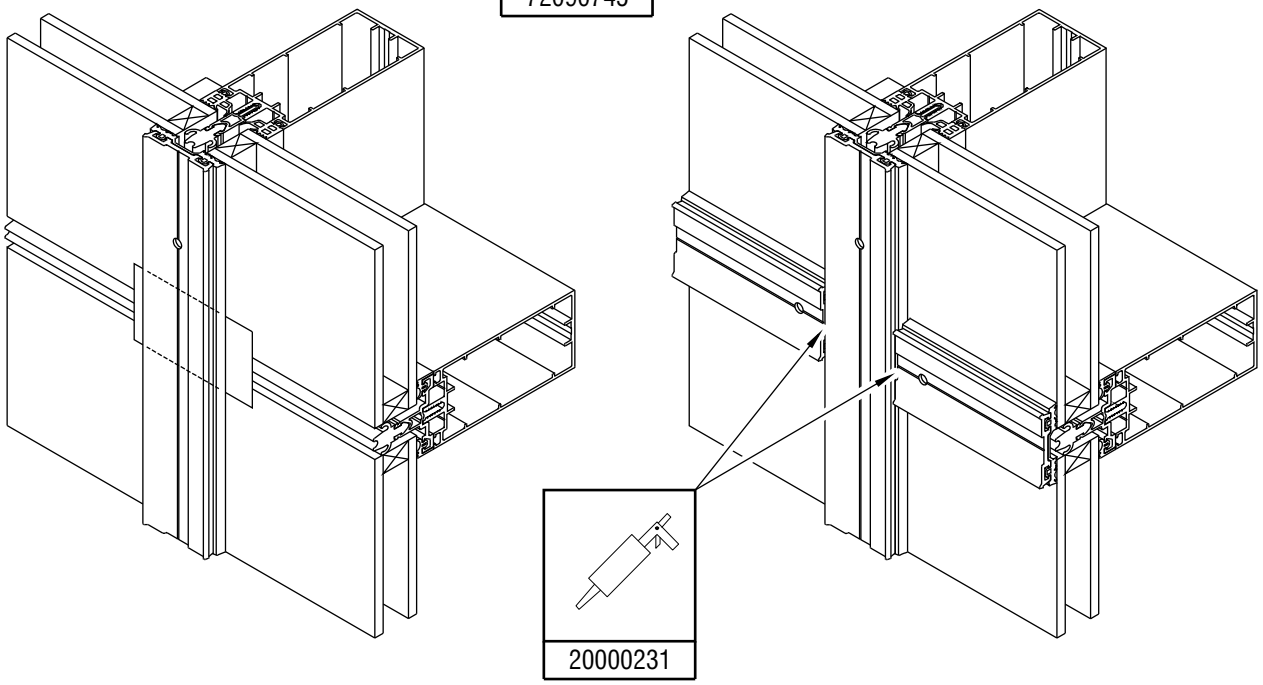

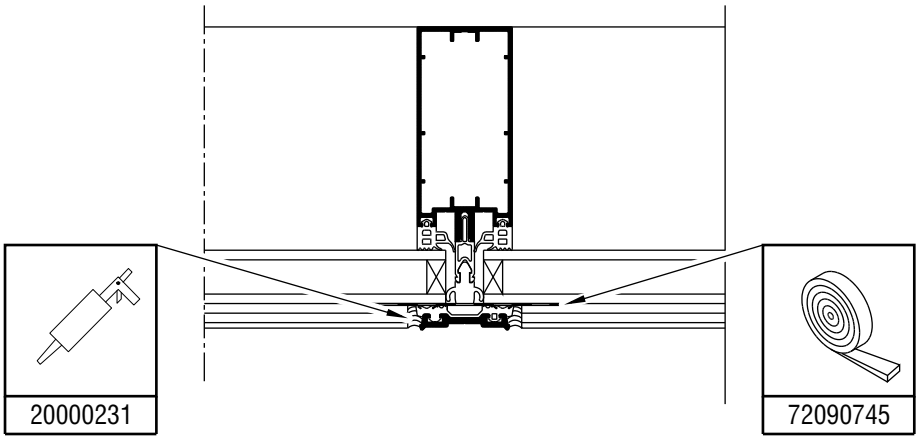

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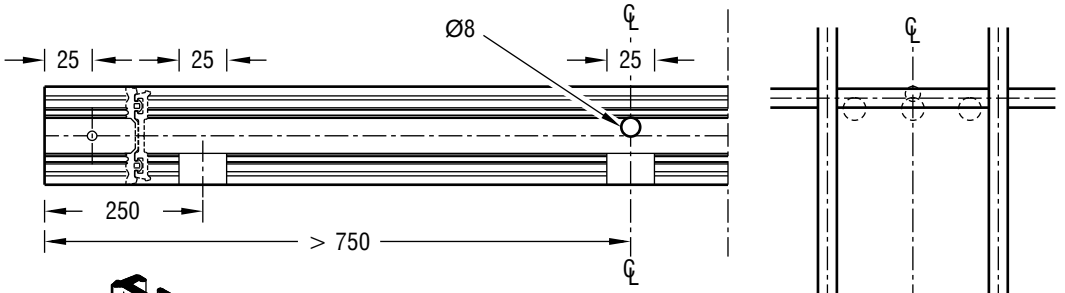
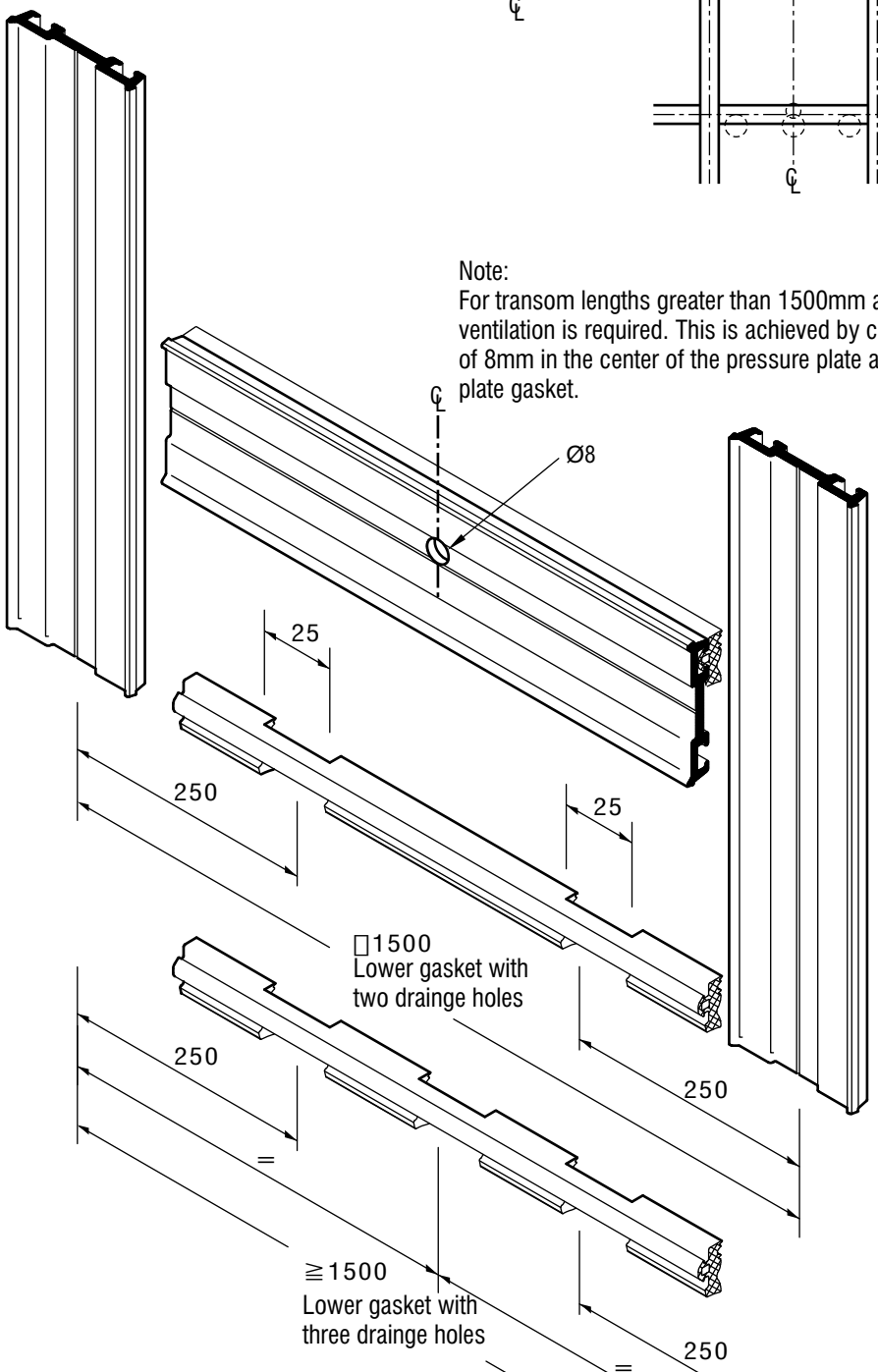
Ventilation details



Note:
For transom lengths greater than 1500mm additional air ventilation is required. This is achieved by creating a hole of 8mm in the center of the pressure plate and the pressure plate gasket.



Note:
When the transom length is less than 1500mm the lower gasket must be trimmed in two places, and if the transom length is equal to or greater than 1500mm the lower gasket must be trimmed in three places. The upper gasket remains continuous. The pressure plate gasket may be seperated into two seperate gaskets before installation.

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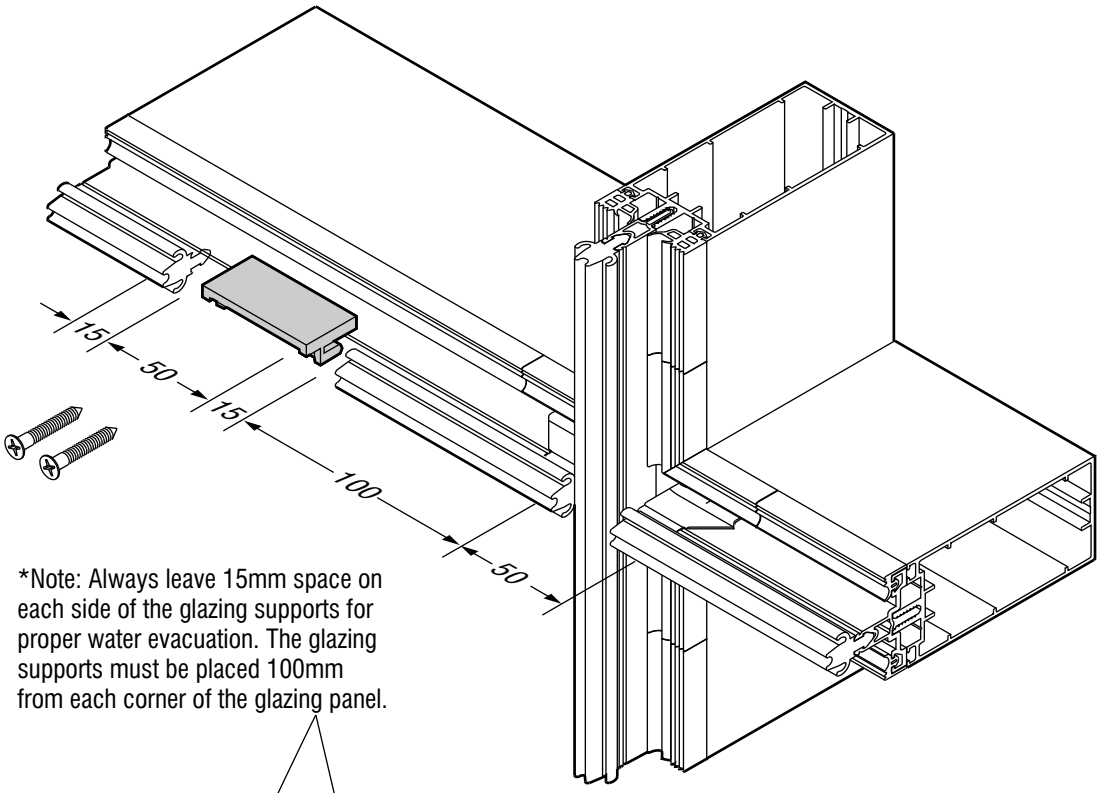
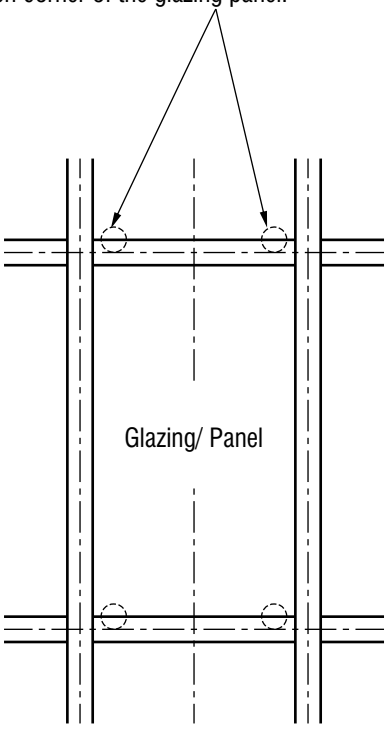
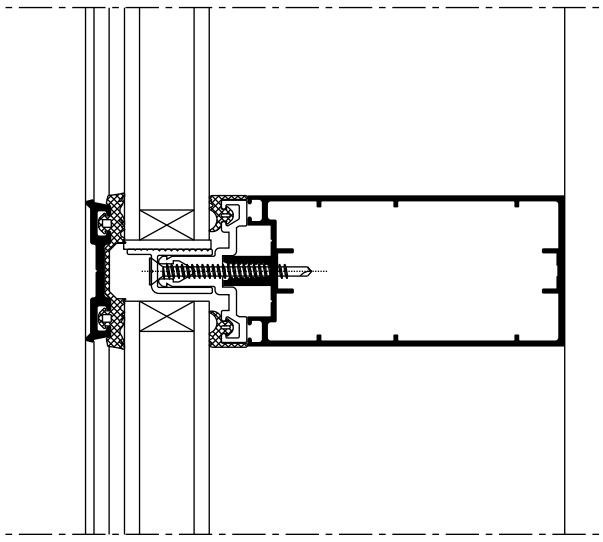
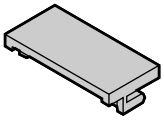


*Note: Always leave 15mm space on each side of the glazing supports for proper water evacuation. The glazing supports must be placed 100mm from each corner of the glazing panel.



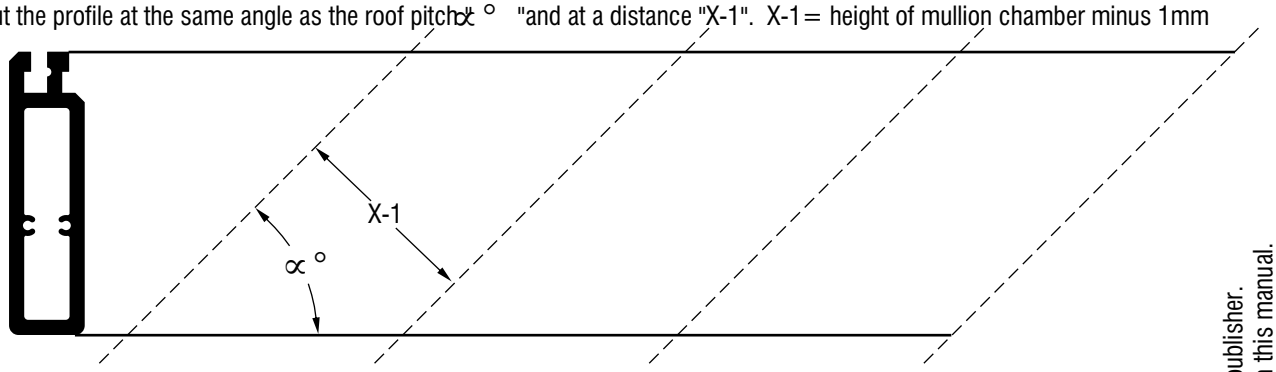




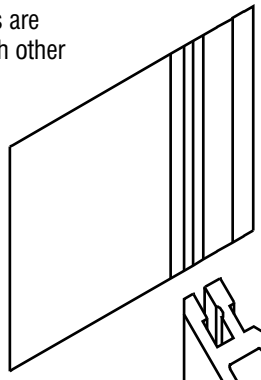
720 50 061	Maximum glazing weight = 180Kg
720 50 062	Maximum glazing weight = 270Kg
720 50 063	Maximum glazing weight = 360Kg

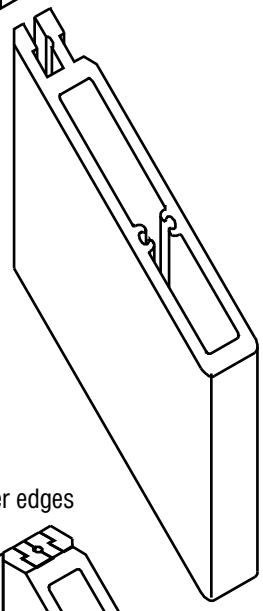
Mullion cleats for various angles

Cut the profile at the same angle as the roof pitch "∝ °" and at a distance "X-1". X-1 = height of mullion chamber minus 1mm

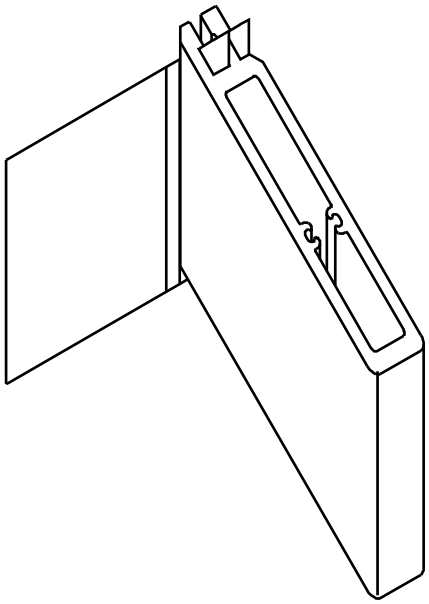


Flip the parts around so the legs are facing each other

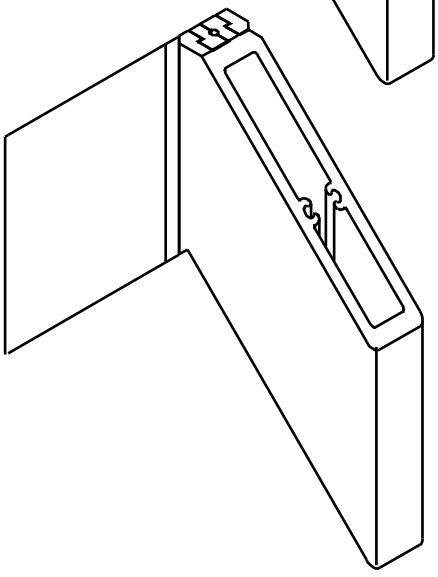




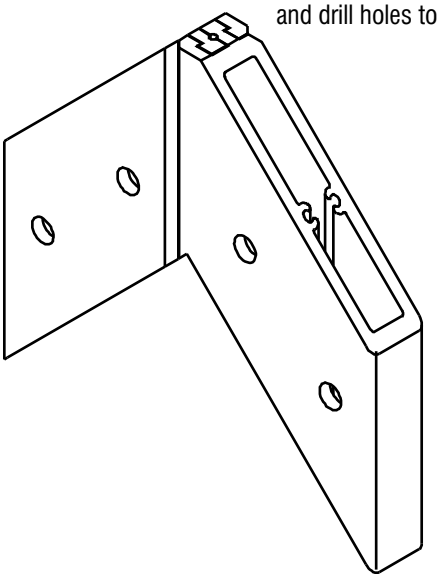
Slide the parts together and align them at the bottom edge



Remove top corner edges



Screw pieces together with a ST 4,8x19 and drill holes to receive the bolts



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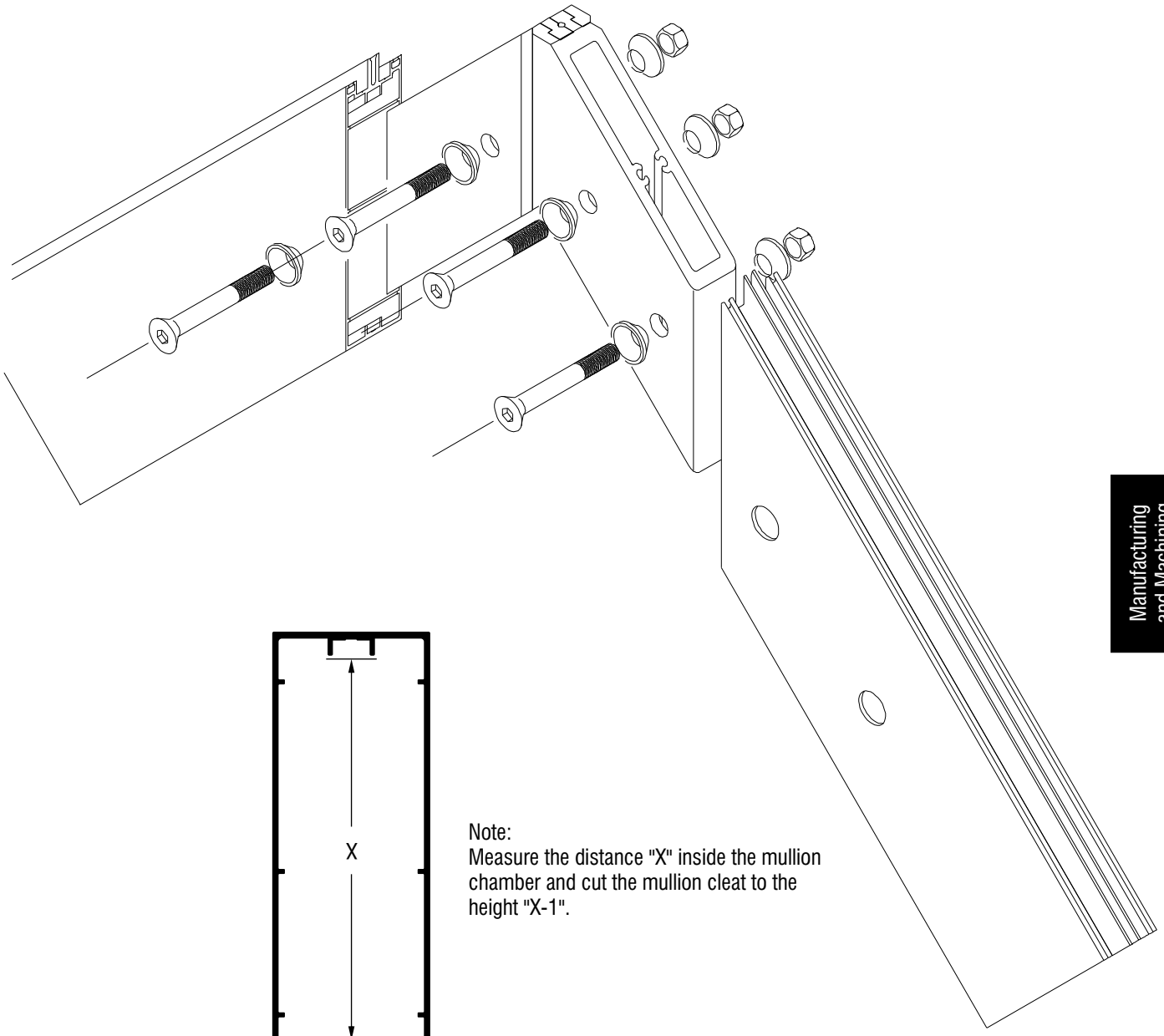
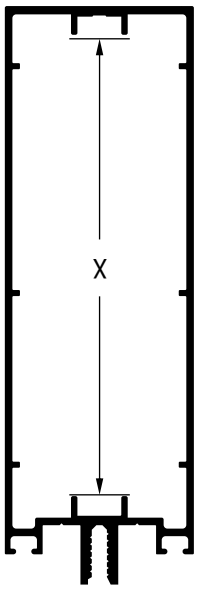
Mullion cleats for various angles

Assemble the pre-drilled mullions to the mullion cleats with stainless steel bolts.





Note:
Measure the distance "X" inside the mullion chamber and cut the mullion cleat to the height "X-1".

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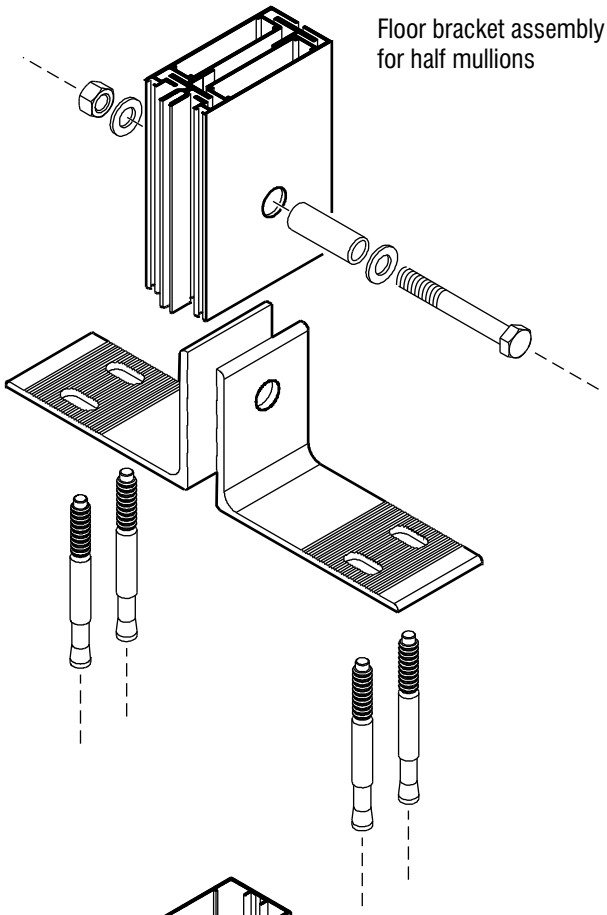
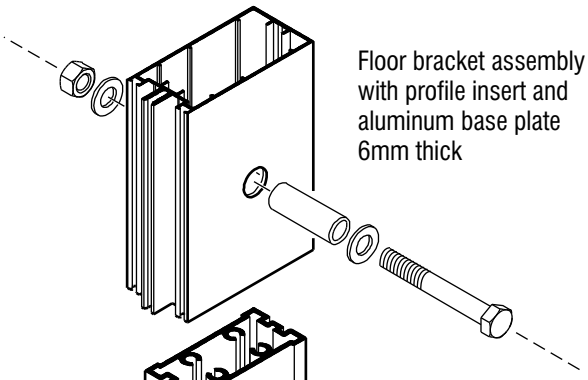
Floor brackets

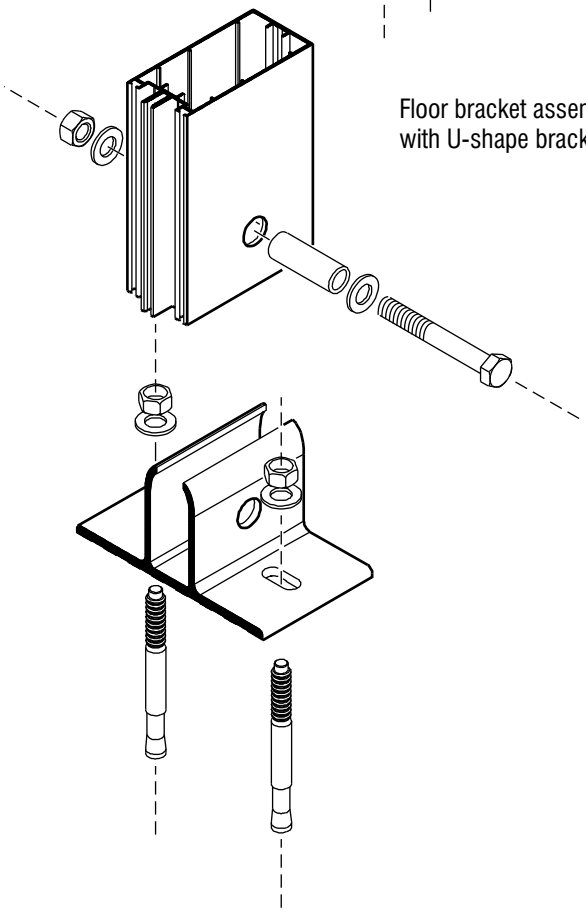


Floor bracket assembly
for half mullions

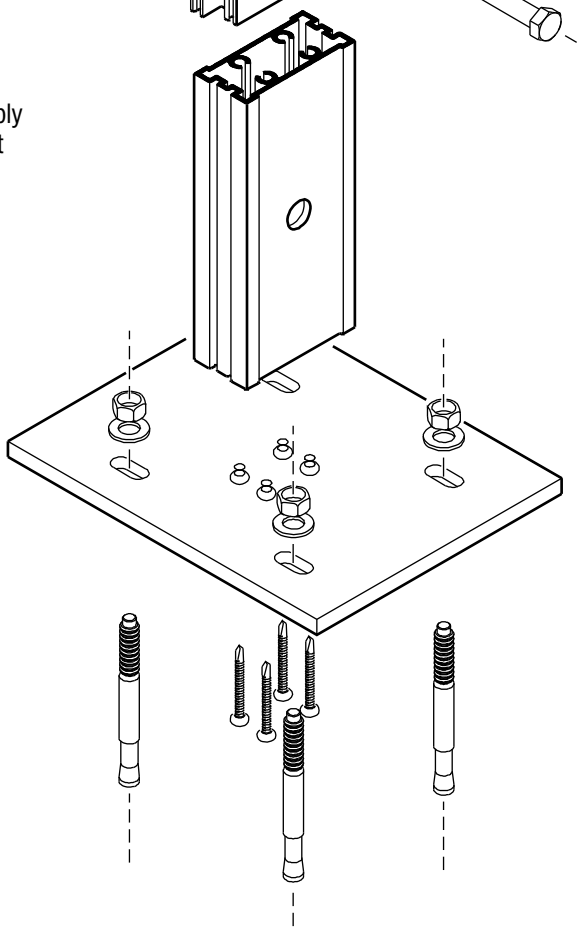
Note:
The dimensions of the base plate depend on the mullion to be used. See the following pages for base plate templates.



Floor bracket assembly
with profile insert and
aluminum base plate
6mm thick



Floor bracket assembly
with U-shape bracket



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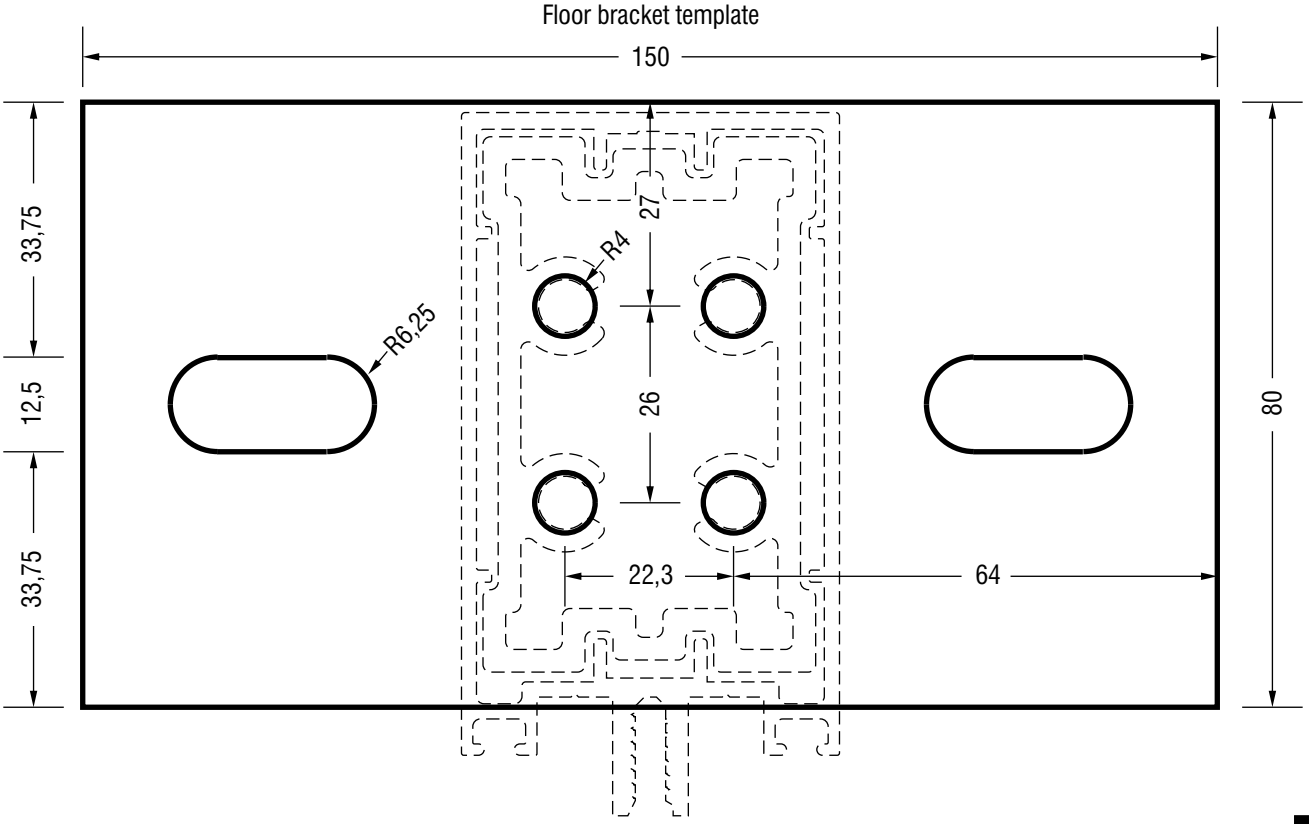
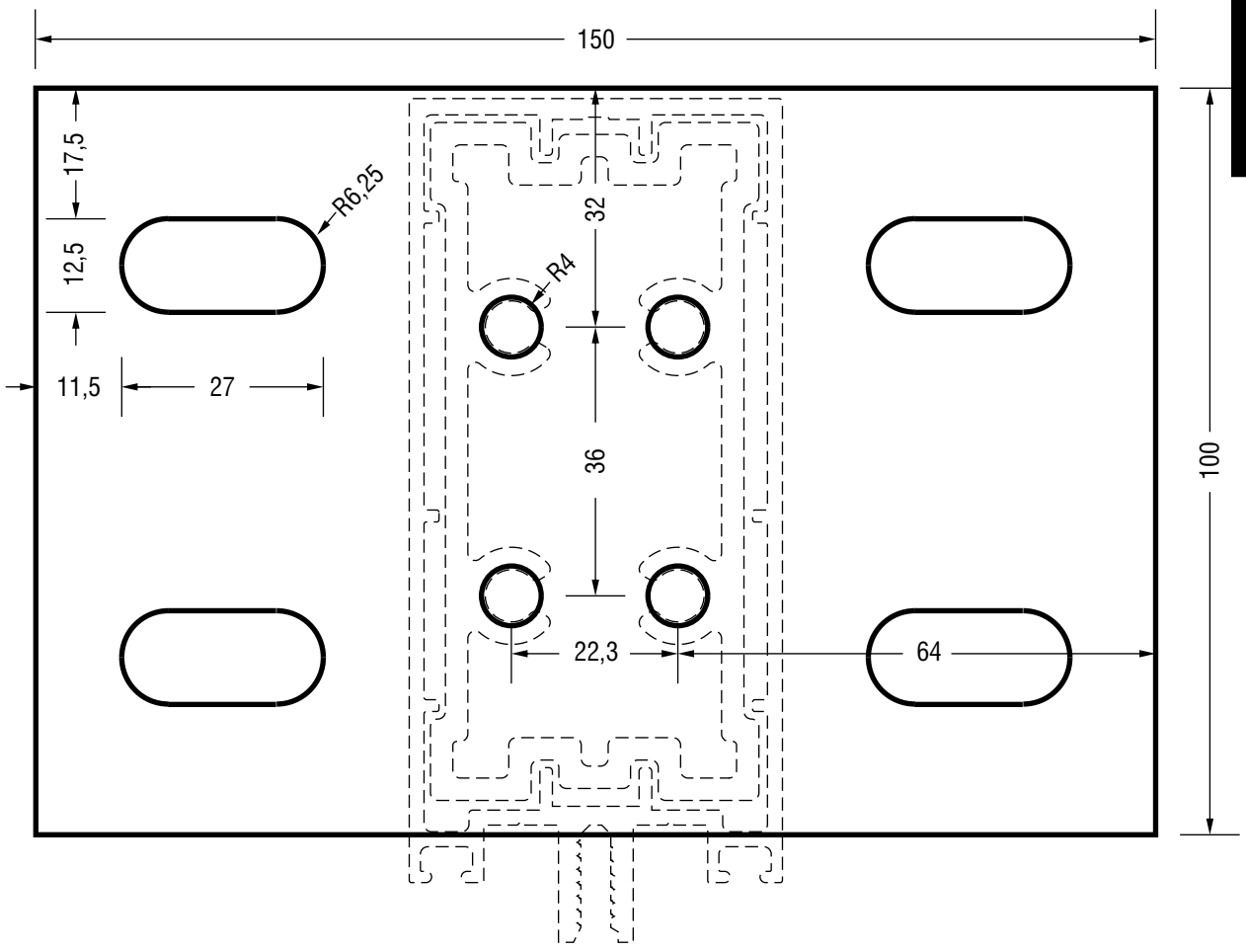
Floor bracket template

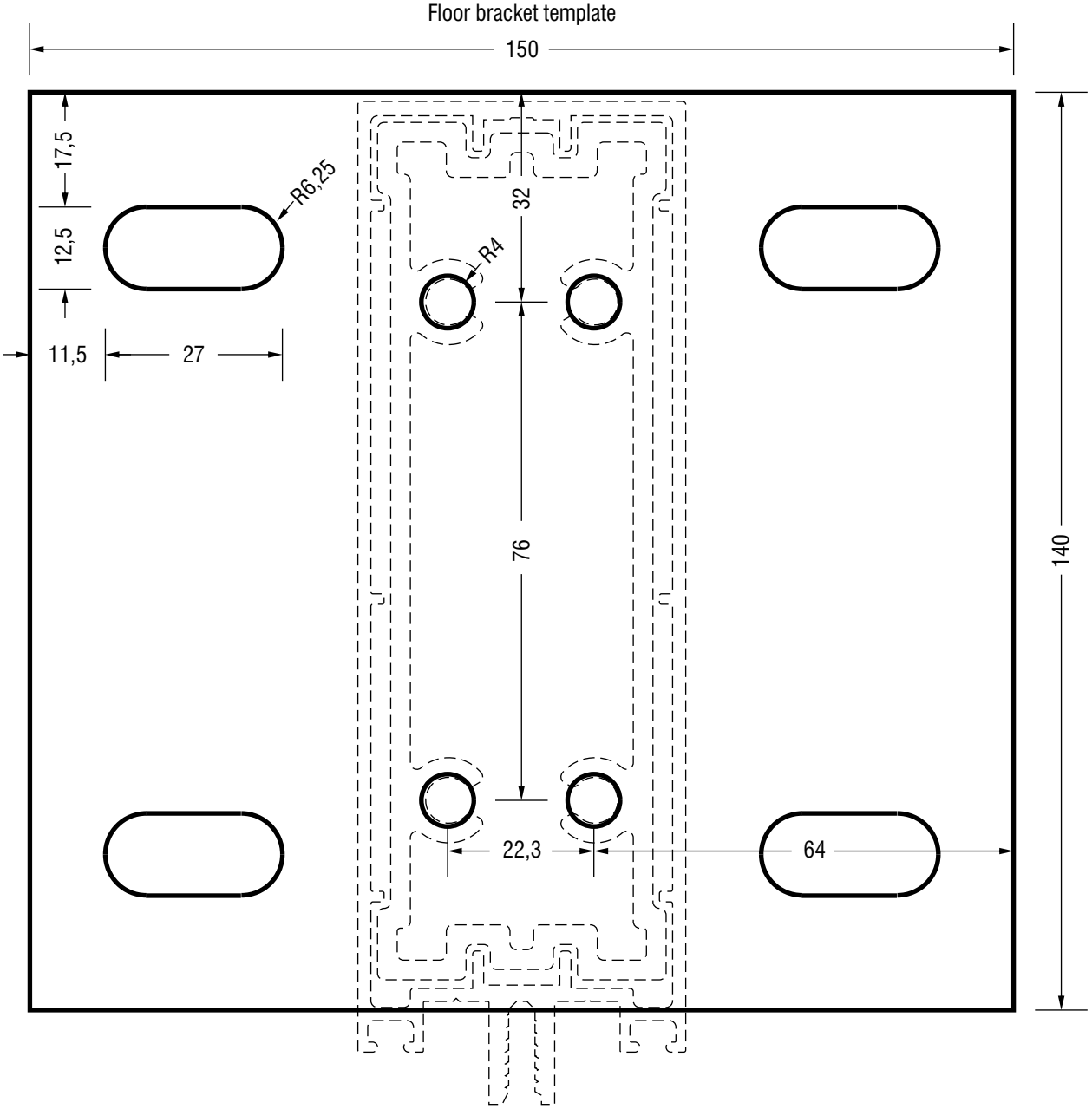




Floor bracket base is made from a 6mm aluminum sheet

Floor brackets

Floor bracket template



Floor bracket base is made from a 6mm aluminum sheet

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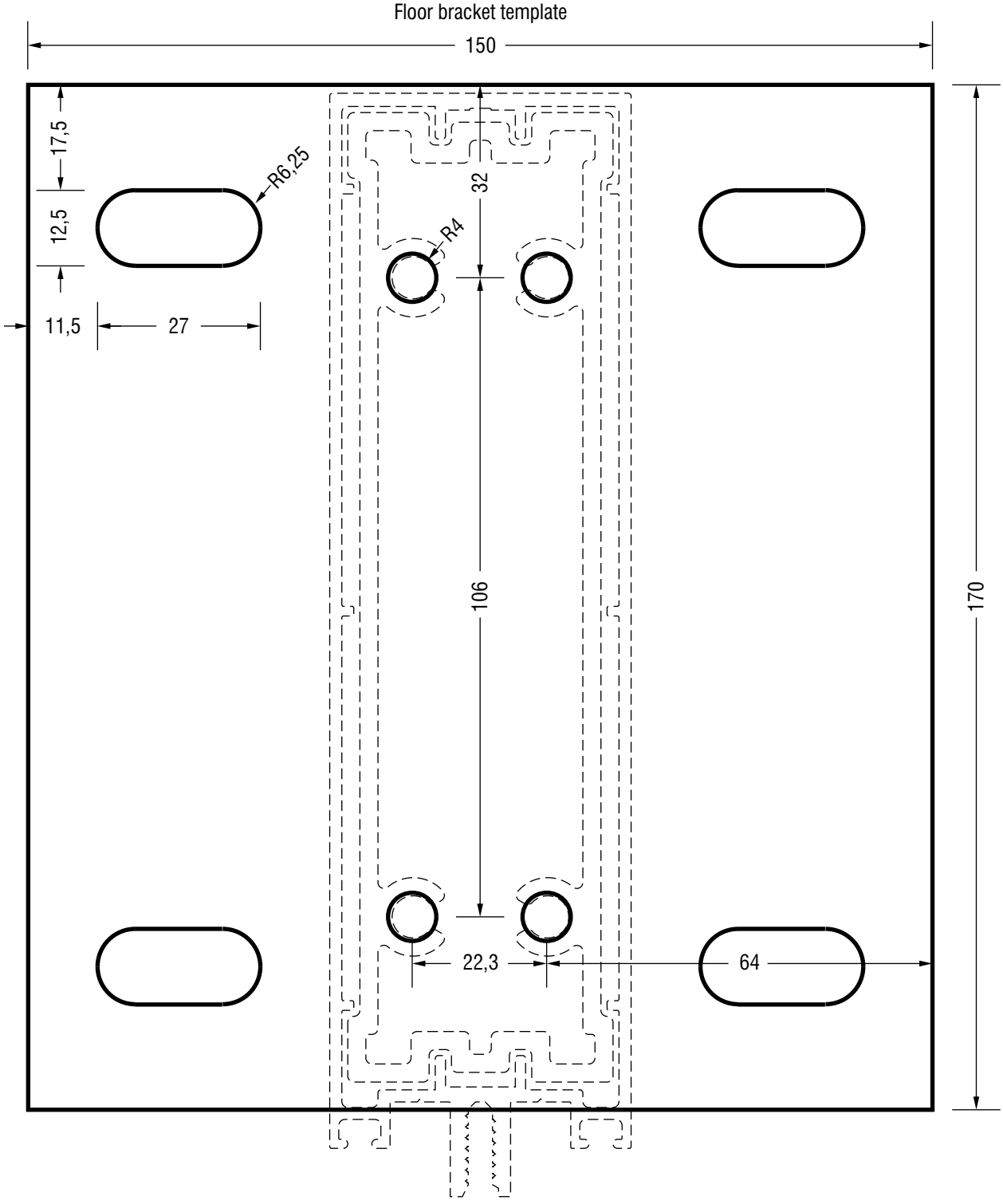
Floor bracket template



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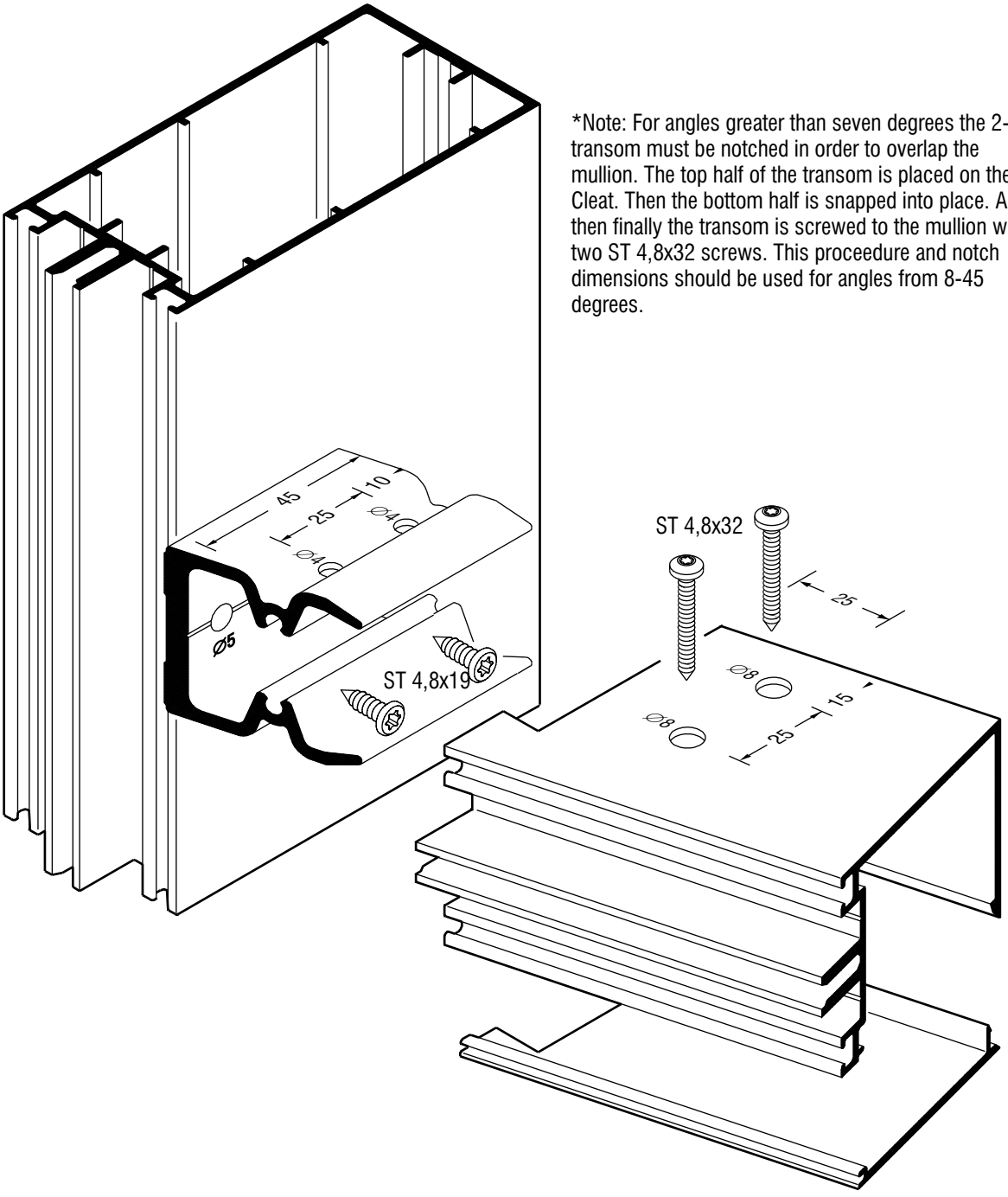
Floor bracket base is made from a 6mm aluminum sheet



*Note: For angles greater than seven degrees the 2-part transom must be notched in order to overlap the mullion. The top half of the transom is placed on the T-Cleat. Then the bottom half is snapped into place. And then finally the transom is screwed to the mullion with two ST 4,8x32 screws. This proceedure and notch dimensions should be used for angles from 8-45 degrees.

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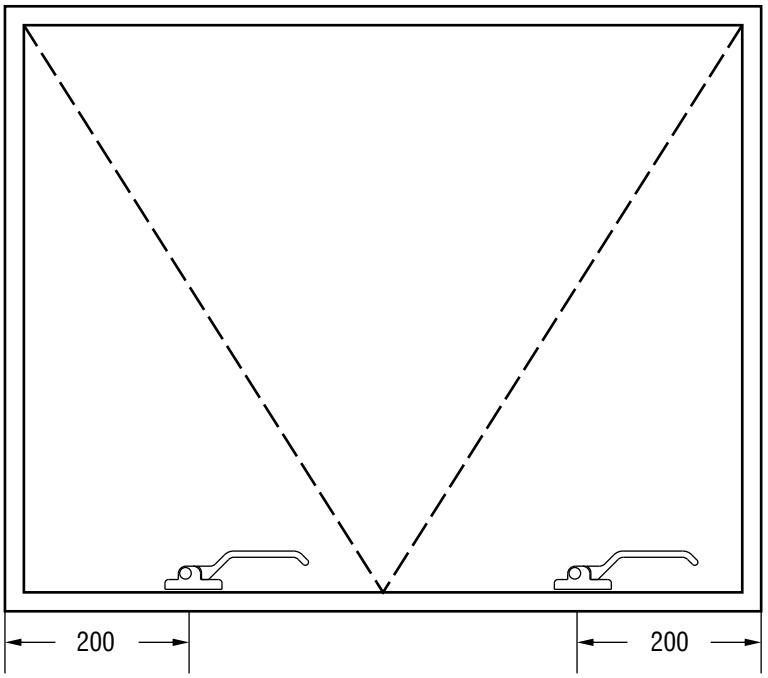
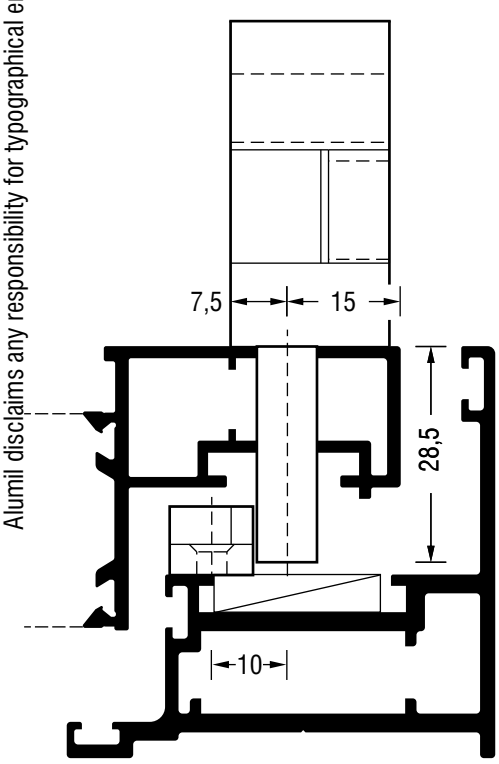
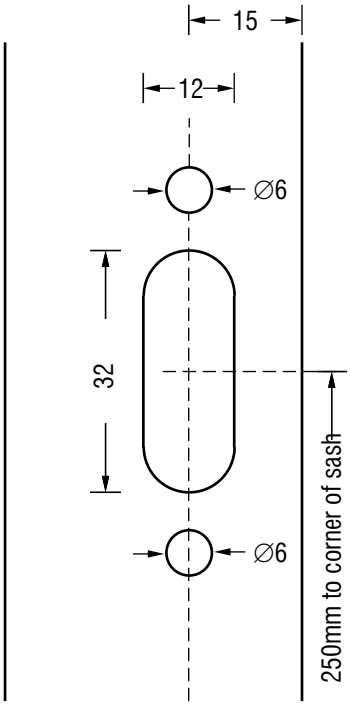


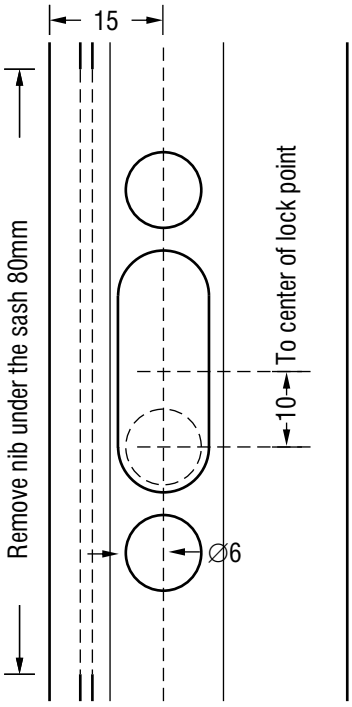
Section



Top view of sash



Bottom view of sash



Manufacturing and Machining

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Introduction

The installation of curtain walls is one of the most complex activities on the building site. This fabrication manual will try to demystify the process and explain in detail the complexities of properly installing a curtain wall. All of the major components of curtain walling are included such as: frames, gaskets, sealants, finishes, glass, and fixings, and explanations are given about the proper installation process. The critical areas are covered in more detail, and special attention is given to prevent water leakage. The documentation should be considered a guide and is not a substitute for care and diligence. It should not be considered a replacement for proper training. The information contained in this manual is based on many years of experience and the successful certification from highly recognized international testing institutes.

Contents

1. The curtain wall
2. Priciples of weather tightness
3. Frames
4. Gaskets
5. Sealants
6. Finishes
7. Glass
8. Brackets and fixings

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The curtain wall

The main functions of the curtain wall are to repel the weather conditions, provide natural daylight, insulation, security, and low maintenance costs. A curtain wall system can only achieve this when it is properly designed, planned, and installed. This guide will give you advice on the correct installation process and the components that make up the faηade.

Curtain walls are made up of many elements. These components are factory made to high precision and quality. Each piece is individually designed and may be combined to create infinite forms of faηade construction. It is up to the faηade engineer and installer to detail and fit the components on each individual project. Each element of the faηade serves a particular purpose and may not be eliminated for any reason. Window and door openings are selected to provide ventilation, ease of cleaning, ease of operation, appearance, fire evacuation, resistance to burglary and blast. Many types of glass are available to meet many different building requirements. Glass can provide, insulation, security, resistance to fire, resistance to blast, sound insulation, glare reduction, tinting, and self-cleaning. Infill panels are selected for their appearance, strength, fire rating, and ease of installation.

The faηade can be designed in many different configurations; stick frame curtain wall, frame panel curtain wall, unitized curtain wall, panelized curtain wall, rain screen, bolted glass, structural glazed curtain wall, semi-structural glazed curtain wall, and profiled metal cladding.

Stick frame curtain walling is a system of site assembled framing members, mullions and transoms (Figure 6.1.1-4). Glazing and infill panels are fixed to the framing grid clamping them in a glazing rebate with pressure plates. Panels may also be fitted as rain screen, structural silicone glazing or bolted structural glazing. Stick frame curtain walls are usually built from standard systems but they always require special detailing at adjoining building elements (roof, structure, floor, etc…). Stick frame curtain walls can be customized to receive exterior blinds and “brise soleil”.

Frame panel curtain walling is made of prefabricated panels, made of one glazing bay in width and height. The panels is framed, glazed, and sealed at the manufacturing plant. Then it is hung on to a stick frame curtain wall and fixed with screws. This system combines the advantages of a stick frame system with a unitized system.

Unitized curtain walling is made with prefabricated panels, typically one glazing bay in width and one or two storeys high(Figure 6.1.5-8). Otherwise known as ladder construction, these curtain walls are usually made with a stick frame system and some special accessories(Figure 6.1.9-14). Sealing the joints between elements depends on good craftsmanship and an understanding of the joint behavior.

Panelized curtain walling may be constructed as large panels, several bays in width and one storey in height. They are extremely heavy and must be assembled with cranes. Components are fitted onto the panels much like the other facades, however they require very large fixings and anchors to hold them to the building. Special attention should be given to the seals between panel units.

Rain-screen is a panel construction with a ventilated cavity between panels and an inner air barrier. Rain-screen is either built by mounting support rails and panels and on an inner wall of concrete, brick, or masonry blocks (cladding) or is an integral part of a curtain wall system. The panels may be of any material including metal, aluminum composite, glass, stone, and ceramics.

Bolted glass assemblies are either bolted directly to a supporting frame or glazing panels are bolted together to form a structural glass assembly. The installation of these curtain walls is not covered in this manual.

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The curtain wall

Structural glazed curtain walling is a curtain wall that uses structural grade silicone to hold the glazing panels to the supporting frame. These systems can be made with both stick frame and frame panel curtain walls. The exterior elevation provides an uninterrupted glass fanade with out face caps and operating windows that are completely integrated. This system requires a special knowledge and technique of applying structural silicone.

Semi-structural glazed curtain walling is similar to the structural glazed curtain wall, but it does not require structural grade silicone to hold the glazing panels to the supporting frame. These systems can be made with both stick frame and frame panel curtain walls. Each glazing panel has a small visible frame that creates a unique pattern in the fanade with operating windows that are completely integrated. This system delivers a structural glazed appearance with the safety of a typical stick frame curtain wall.

Profiled metal cladding usually spans between sheeting rails or purlins supported by the structural frame. It may be used in one or two basic forms: single skin and double skin insulated. The second form is used for cladding climatized habitable buildings. The installation of windows and doors requires attention to weather proofing and sealing complex joints and shapes.

All fanade components will eventually deteriorate in time. This results from weathering, abrasion, staining, and mechanical usage. The life span of a curtain wall can be increased if each component is installed correctly and inferior products are not used. In general curtain walls are designed to have a life span of 20 years or more. The primary framing members may last from 40-60 years while hardware components may last 20 years before needing replacement. Poor installation can reduce the life span of components to less than fifty percent. Inconsistent workmanship can cause premature failure of a curtain wall as well as inferior products. Medium and high rise building have a much larger repair and life cycle costs than any short term gain from using inferior materials or modifying design requirements to simplify the installation process.

A wide variety of components and wall elements are brought together in different combinations every day in to create a unique building fanade. Components are designed by manufacturers to create a number of construction forms, but the interface between different manufactures' components is the responsibility of a specialist contractor. Particular problems occur when two contractors meet at an interface and design responsibility is shared. Changes and substitutions made on the job site require special designs for new and unforeseen interface detailing.

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Individual assembly

Figure 6.1.1
Align and anchor support brackets to building structure

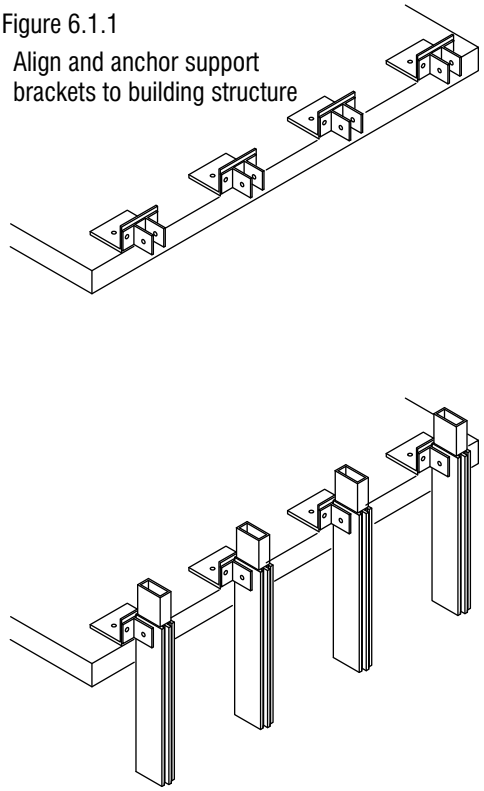


Figure 6.1.2
Install mullion elements to support brackets

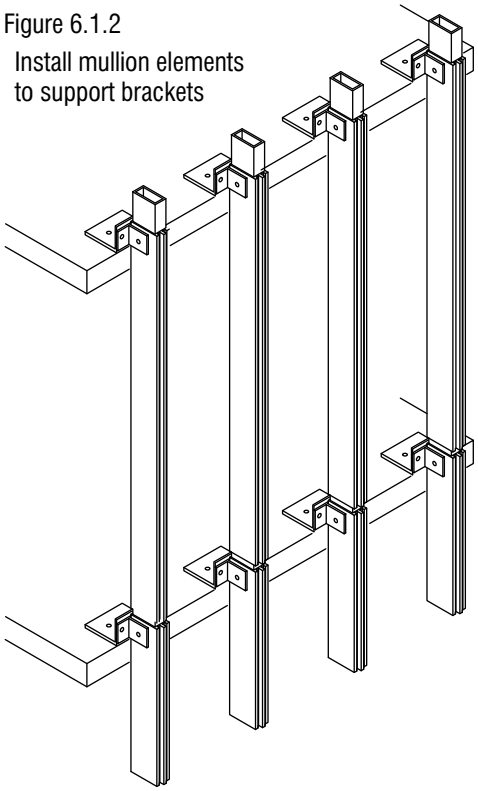


Figure 6.1.3
Install transoms between mullion elements with spring cleats or special transoms

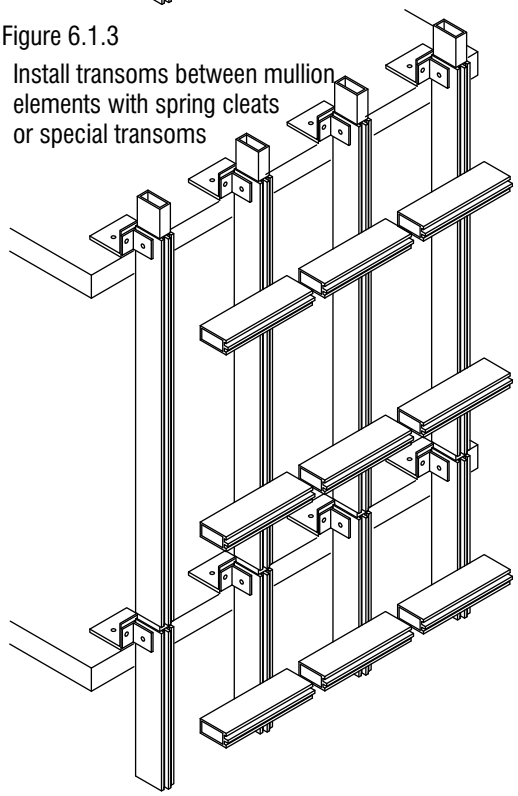
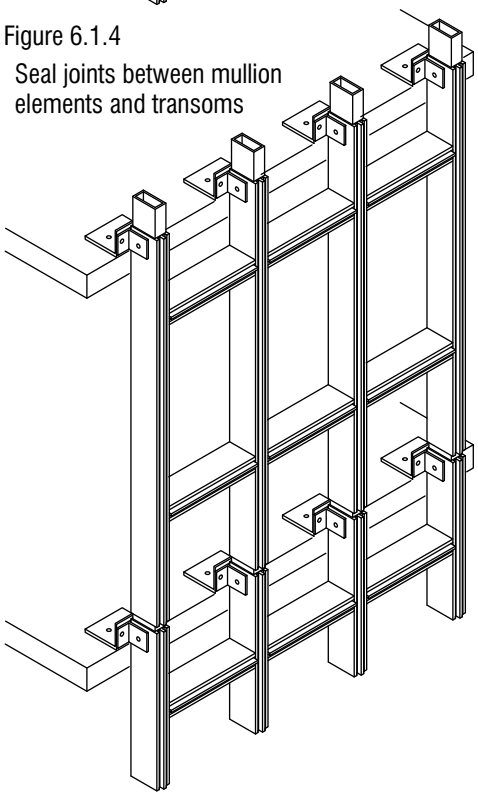


Figure 6.1.4
Seal joints between mullion elements and transoms



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Ladder type construction

Figure 6.1.5
Align and anchor support brackets to building structure

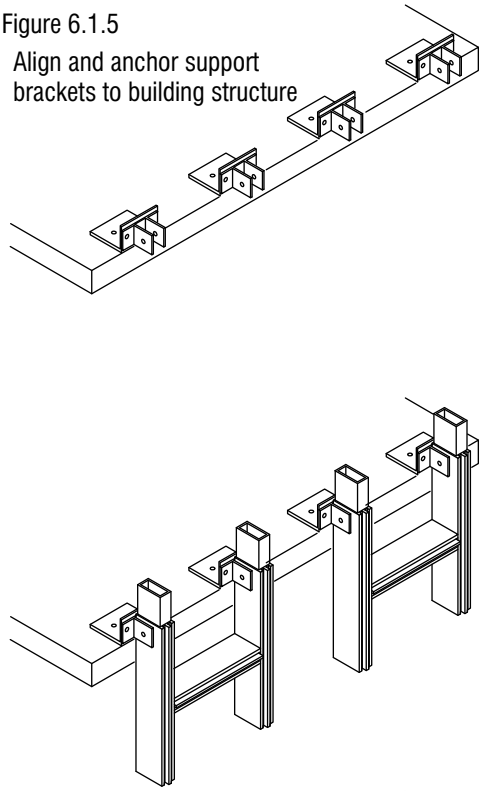


Figure 6.1.6
Install ladder elements to support brackets

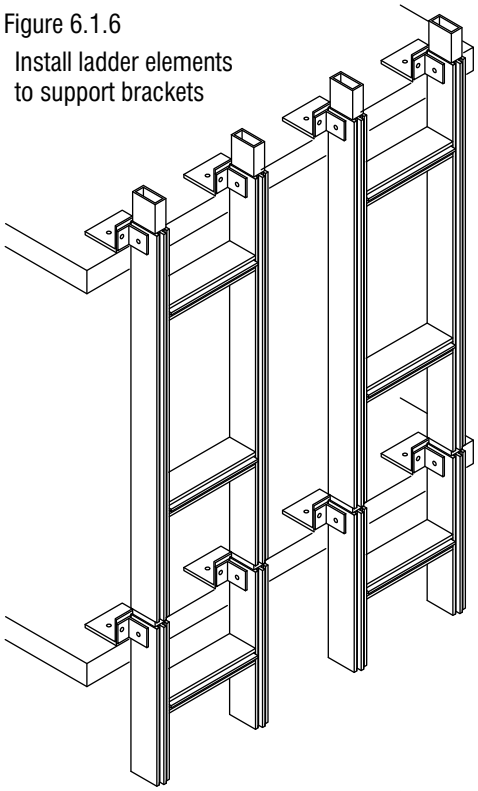


Figure 6.1.7
Install transoms between ladder elements with spring cleats or special transoms

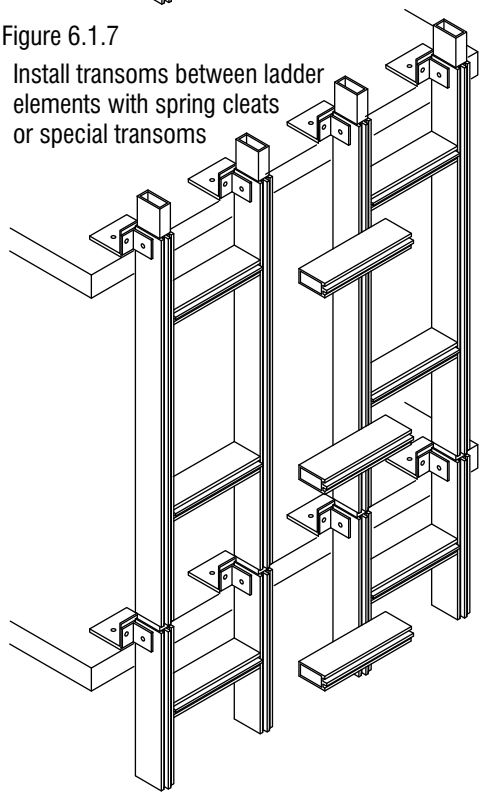
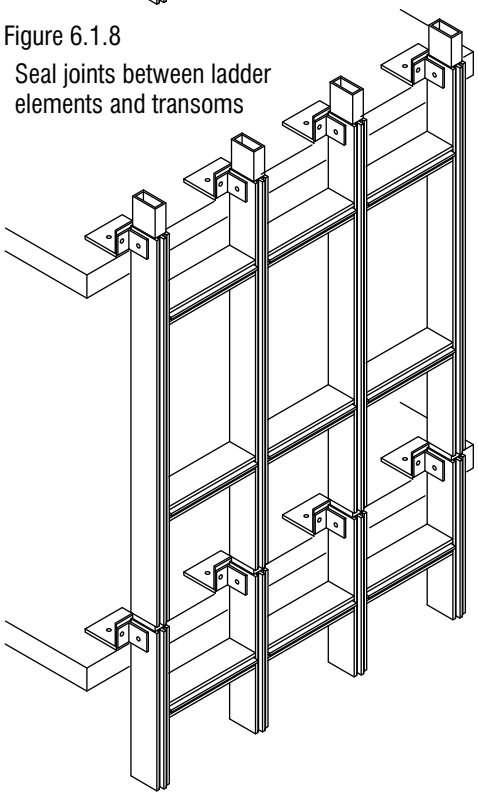


Figure 6.1.8
Seal joints between ladder elements and transoms



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Unitized type construction variant 1

Figure 6.1.9
Align and anchor support brackets to building structure

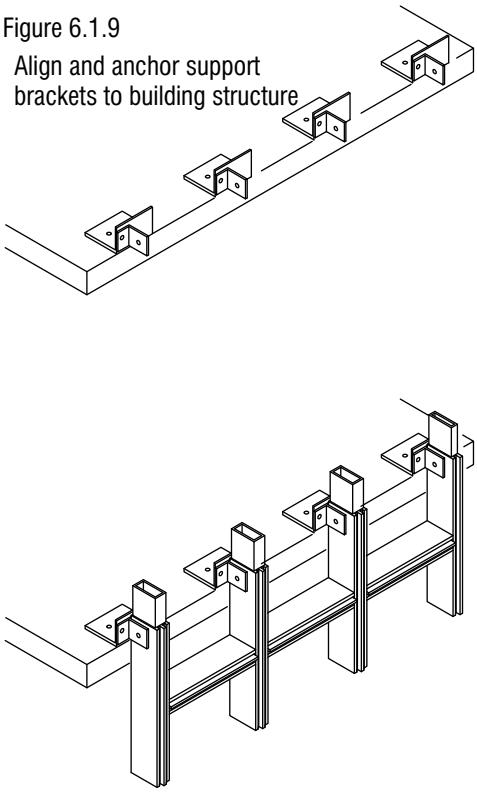


Figure 6.1.10
Install unitzed elements to support brackets

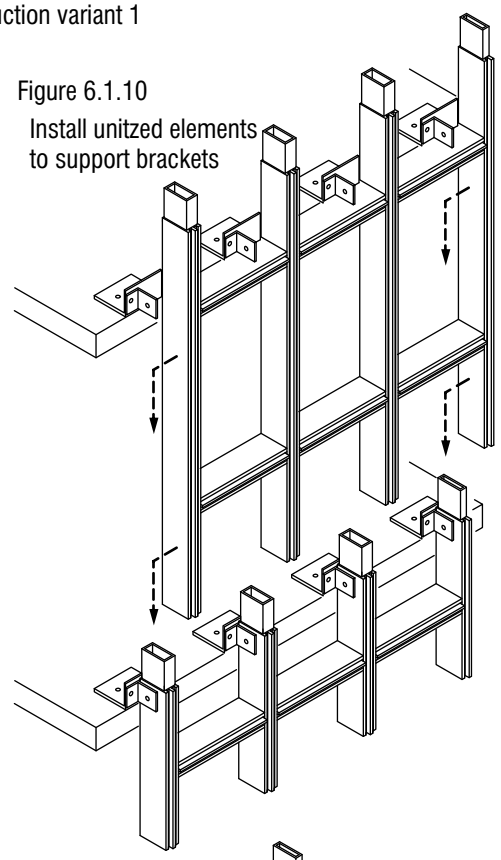
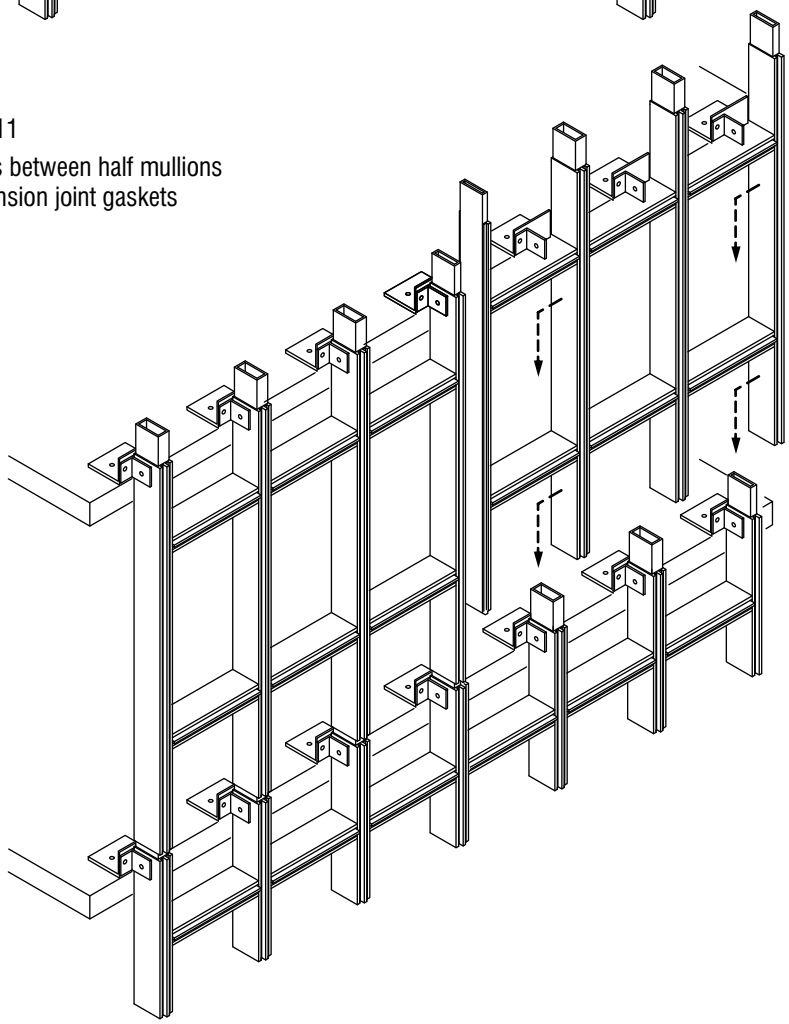


Figure 6.1.11
Seal joints between half mullions with expansion joint gaskets



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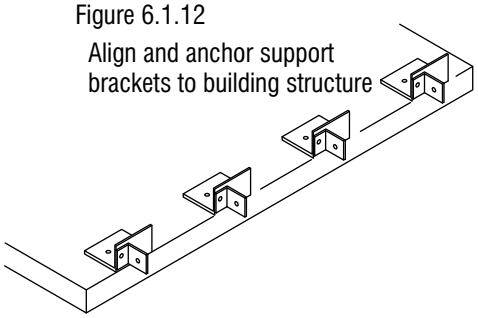
Unitized type construction variant 11

Figure 6.1.12
Align and anchor support brackets to building structure



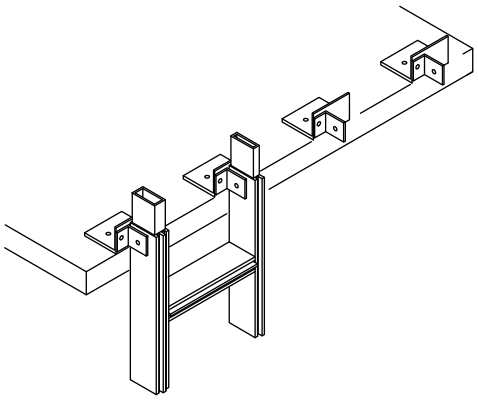
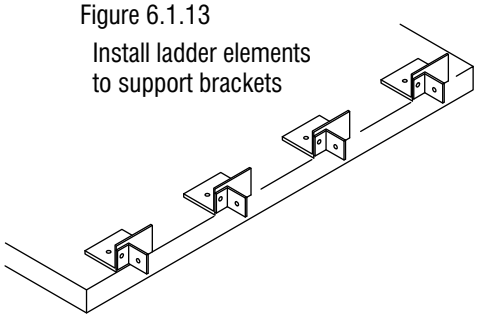


Figure 6.1.13
Install ladder elements to support brackets



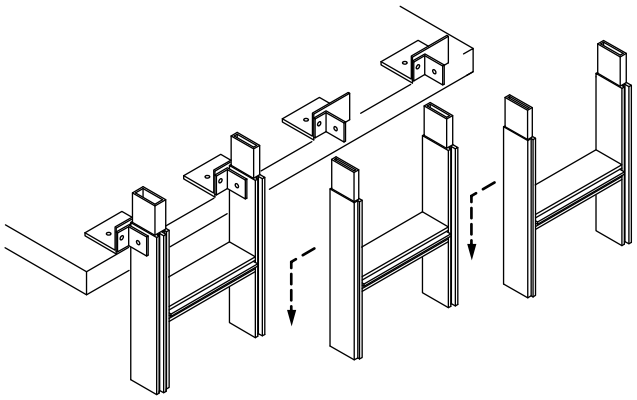
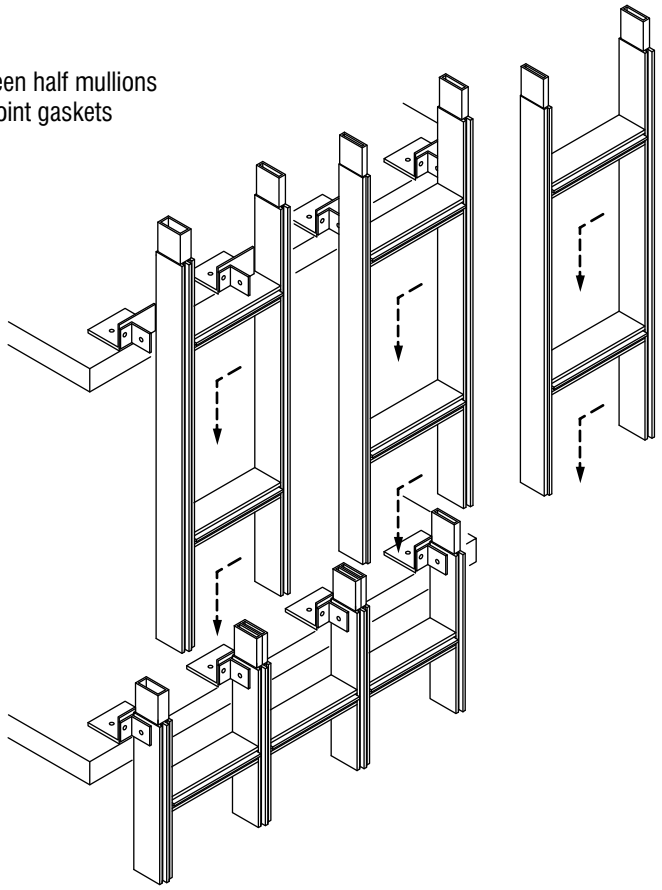


Figure 6.1.14
Seal joints between half mullions with expansion joint gaskets



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Principles of weather tightness

It is important that a faηade keeps out the rain and the wind. Walls are designed to resist wind loading according to a particular site and wall height, and provide water protection according to the corresponding wind load. Walls are designed to have a minimum amount of air leakage. The allowable amount is determined by the specifier and depends on the use for which the building is designed. Excess air leakage can increase the heating costs of a building and may even lose sound insulation.

Water should not penetrate and reach the inner surface of the wall. It is also unacceptable for water to penetrate partly through the wall, because water may cause damage to other building materials such as thermal insulation. A wall may be designed to allow water to enter into the wall and then be drained to the outside. Water management rather than water tightness is the secret to constructing a good curtain wall.

Water can penetrate a wall or component in six basic ways:
Gravity
Wind pressure
Air borne
Kinetic energy
Surface tension
Capillary action

Incorrect installation can allow water to enter by any these means even if the curtain wall is designed to prevent water penetration. Failure to overlap components such as flashing, poorly fitted gaskets and sealing joints will all create openings that will allow water to flow into the wall under gravity. If drainage paths are blocked water will pond and overflow into the wall by the effect of gravity. Failure to seal openings with proper gaskets and sealants leaves areas through which wind can force water through the openings. Failure to install air seals correctly allows air pressure to force water into wall openings. Removal of drips and nibs under a component can allow water to attach to a surface and run into the wall under surface tension.

Gravity is the most serious cause of water leakage followed by the effects of wind pressure. Both can allow large volumes of water to flow into the curtain wall. The other causes of leakage allow only minor amounts of water to flow into the wall. The risk of leakage is greatest at places on the wall where there is a large amount of water or air pressure. Water is driven across the faηade by wind. It gathers at the mullions and runs down to the corner of each frame bay.

Wind passing over a building moves around and over the building. This kind of wind movement leaves more intense rain on the edges of the building. Wind moving upwards on the wall can drive rain up the wall especially on medium to high rise buildings. Drainage openings should be designed to cope for this. Water may leak past gaskets and seals at the head of a frame if the joints are not correctly sealed. Never assume that a joint is in a protected position and is not necessary to seal. The use of picture frame gaskets eliminate the need to make mitered or blunt joints with gaskets on site.

Walls have to be sealed from air leakage and water penetration, in many systems the air seal and water barrier are separated. The outer wall barrier, or rain screen, prevents the majority of water from entering the wall. A cavity in the wall intercepts small amounts of water that penetrate the outer barrier. The inner air seal is behind the cavity and is required to achieve low levels of air leakage. The water barrier is the primary defense against water leakage and should be constructed with care. Any amount of water that enters the cavity should be evacuated to the outer face of the wall. The outer layer may be aluminum and glass, but these principals are also true for brick and terracotta facades.

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Principles of weather tightness

With the exception of front sealed construction (structural glazing), all framing members and cavities behind rain screens should be designed to be drained. This means that water passing the outer seal has to drain out through drainage openings to the outer face. Drainage may occur through open joints between panels or through drainage paths in the framing members.

Window frames are normally drained through holes in the outer face of the frames, and an opening sash should have drainage holes in the lower edges. This system drains water from the glazing cavity to the cavity of the frame below. Then the water is evacuated to the outer face of the frame.

Stick frame curtain wall systems may be drained in the same way as a window system. Each glazing rebate can be drained to the outer face through holes in the pressure plate and face cap or simply by removing portions of the outer glazing gasket. Another alternative to this system is to drain the water along the transoms and into the mullions. This process is limiting and water should be drained from the mullions through water spouts every eight meters in height. It is extremely important that drainage channels are not blocked as the curtain wall is being installed. Badly placed glazing blocks, sealants made in the wrong places, debris left in the glazing rebate, and inadequate draining holes may prohibit the proper drainage flow.

Water will not flow freely through very small openings due to the effect of surface tension. Drainage holes should be a minimum of 8mm in diameter or 25mm x 6mm. Holes must clear from burrs and debris in order to drain properly. Glazing blocks should bridge the drainage channel in the glazing rebate unless drainage holes are provided between all glazing blocks. Water will not drain for long distances along horizontal frames, particularly if they deflect under dead load. Many designs specify a minimum distance between drainage holes.

Drained rain screens and glazing frames have drainage holes at the bottom of each cavity to allow the water to evacuate. Holes should also be provided at the top of the cavity (pressure plate) in order to provide the proper ventilation of the cavity. This allows air to travel freely through the cavity to remove any excess water vapor. Holes for ventilation may be smaller than drainage holes; however they are normally made the same size as drainage holes and placed in symmetrical positions in order to avoid mistakes during the assembly process. Draining over the glazing panel may cause unsightly streaks, although this can be avoided by covering the lower glazing panel with a protective barrier.

Pressure equalized windows and curtain walls are designed with holes and cavities large enough to allow the air pressure with in the cavity to nearly balance the wind pressure on the outside. This helps to prevent water from entering the cavity due to the vacuum effect. For a rain screen the drainage and ventilation holes may be larger than the holes needed for a drained and ventilated system. Pressure equalized window frames do not always need large drainage holes. It is not obvious whether a system is pressure equalized or drained and ventilated, so special attention should always be given to the manufacturers' specifications. Unless a seal is shown it should be assumed that drainage and ventilation holes are necessary to prevent water penetration into the wall. If a glazing rebate is vented into the cavity of an opening sash and fixed frame the drainage holes in the sash should be smaller than the drainage holes in the frame. This insures the proper depressurization of the two different cavities.

Windows are tested according to the EN 12207 for air permeability and the EN 12208 for water tightness. This test only proves the effectiveness of the window unit and its internal seals. The joint between the window and the surrounding wall is equally important if the wall is to function correctly. The window should be sealed to the surrounding wall either with a wet applied sealant, a sealant impregnated sponge, or in the case of a window in a curtain wall, an EPDM gasket. Seals should always be made with craftsmanship. It should always be assumed that some water may penetrate the outer seal, and provisions must be made to drain this water to the outer face. An effective air seal should be made at the inner face. Special attention should be given to the sill detail. The sill should be sealed to the surrounding surfaces and to the window unit without blocking any draining channels or holes.

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Principles of weather tightness

Sills are not tested according to EN 12208 and usually very according to the individual project.

Curtain walls are tested according to the EN 12152 for air permeability and the EN 12154 for water tightness. A representative sample of a curtain wall is tested including the flashings and typical interfaces with adjacent elements of the building envelope. Flashings and interfaces must be constructed in accordance with the tested and approved drawings. The installer should be alert to any possible leakage paths. If there is any doubt about the detailing of the interfaces the curtain wall designer should be consulted before work continues. The wall should be constructed on site to match exactly the wall tested. The installer should be notified of any modifications or non-standard details. Systems may change according to the individual contract and the installer should not assume that he is completely familiar with the system.

Rain screen performance depends on the rain screen panels and all the components in the cavity. Design drawings and test reports should show details of the framing members, number and location of fixations, and size and position of all openings, dimension of cavities, internal flashing and gutters, cavity closers and fire barriers. Excess water may pass the rain screen if; drainage and ventilation openings are the wrong size, cavity closers are omitted or improperly made, baffles are omitted from joints, or the cavity is too wide. Water will fail to drain from the cavity if; drainage holes are too small, drainage paths are blocked with debris, the cavity is blocked with insulation material, internal flashings and gutters are incorrectly made or missing, or the drainage of components (windows, doors, etc…) are not linked to the drainage system of the rain screen

Site testing should be carried out during construction to check for good workmanship and consistent performance. Testing may also be made after construction to determine the cause of a leakage problem. The hose pipe test is used for routine site testing for water penetration. The site test is described in EN 13051. Testing should be made with a standard nozzle, standard water pressure and motion of the nozzle. The test was developed for testing sealed joints, but it may be modified for open joints by varying the nozzle pressure and not the motion of the nozzle.

Air leakage can lead to excessive heating bills, inability to heat a building, and uncomfortable draughts. Allowable air leakage rates are described in EN 12152. High rates of air leakage are a sign of poor installation. Walls that leak too much air are also likely to leak water, because poor air seals impair the pressure equalization process. High rates of air leakage are associated with unintentional openings in the air barrier, and these openings will impair the acoustic properties of the curtain wall. The main causes of unintentional air leaks are; incorrectly fitted air seal gaskets, failure to seal windows and other elements to the air barrier of the surrounding wall, and opening windows and doors that are not correctly adjusted and do not seat correctly.

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Figure 6.2.1
Potential water entry points
in a typical curtain wall

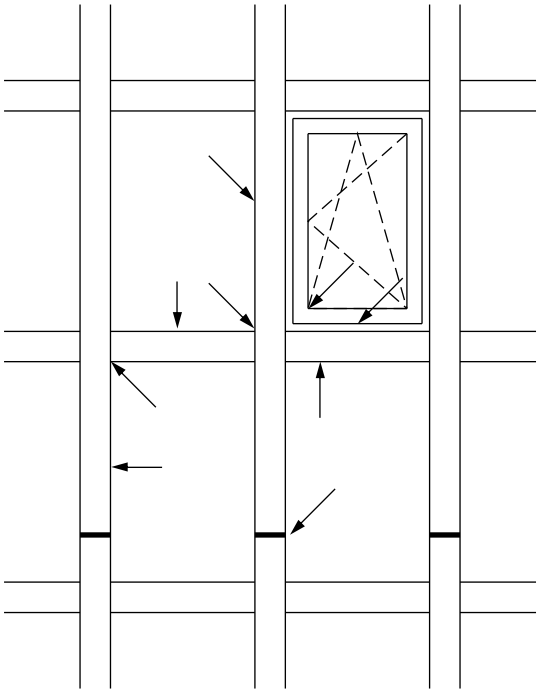

Figure 6.2.2
Properly seal all joints according
to the instruction manual

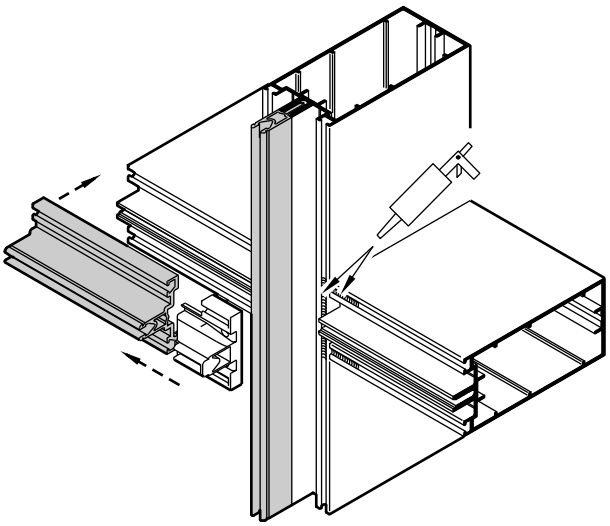

Figure 6.2.3
Use EPDM vulcanized corners
as specified in the instruction manual

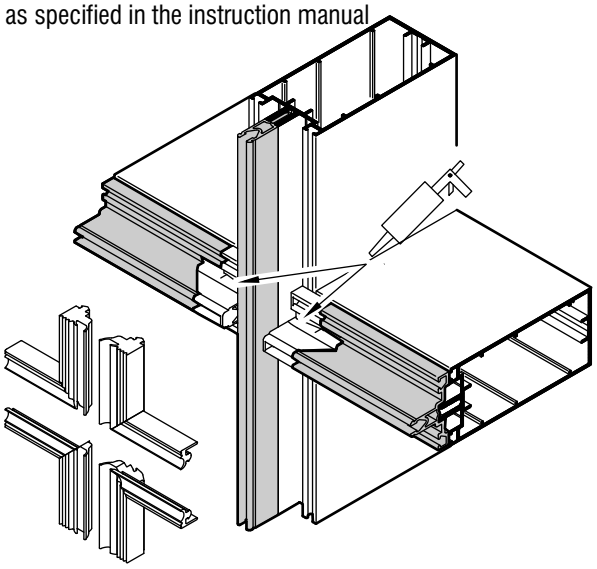

Figure 6.2.4
Use butyl/EPDM adhesive for sealing
joints between EPDM gaskets

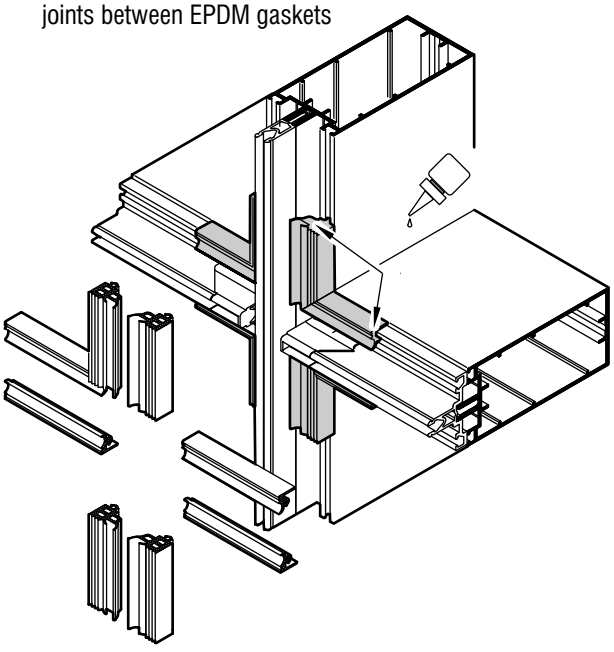

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Figure 6.2.5

Use overlapping procedure at expansion joints and use expandable foam tape to seal large openings

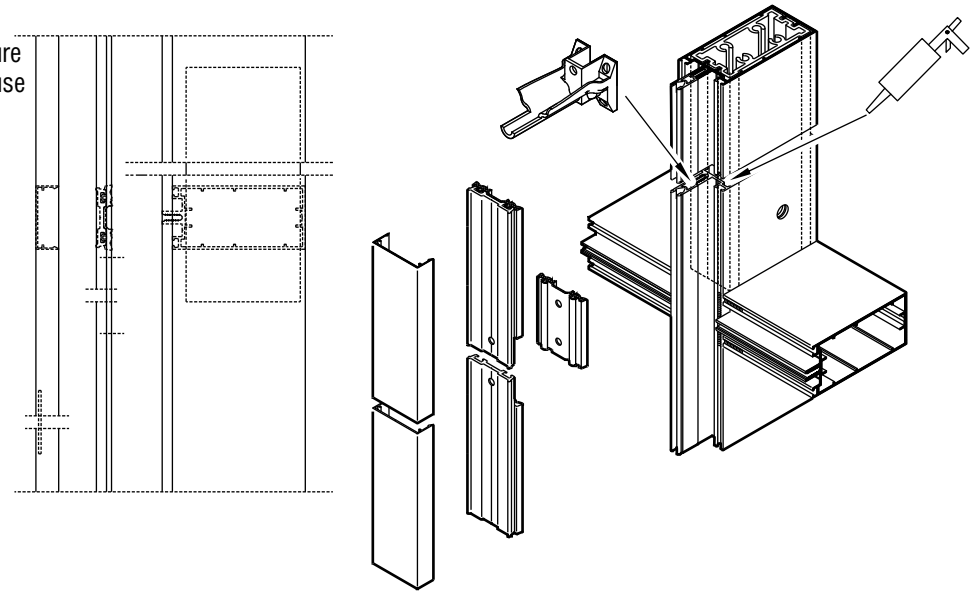

Figure 6.2.6

Drainage spouts are necessary for the proper drainage and ventilation required for curtain walling

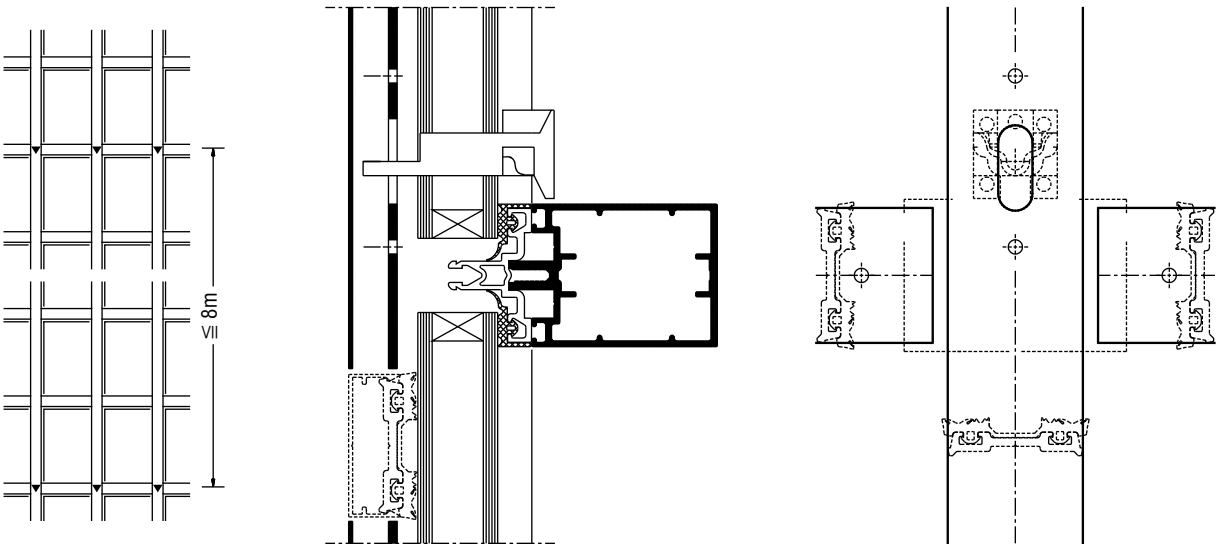

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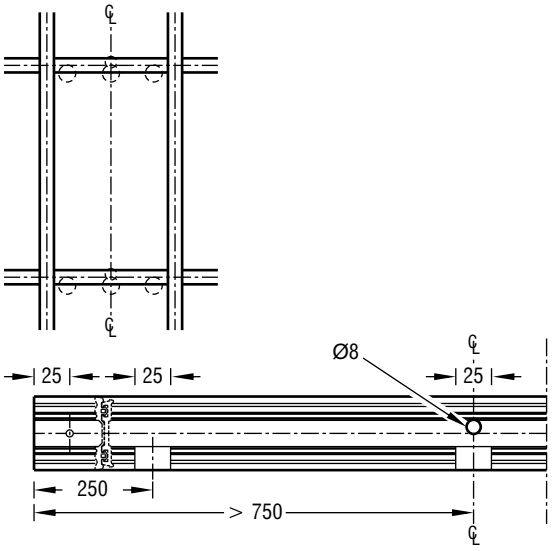
Figure 6.2.7

Drainage spouts are necessary for the proper drainage and ventilation required for curtain walling



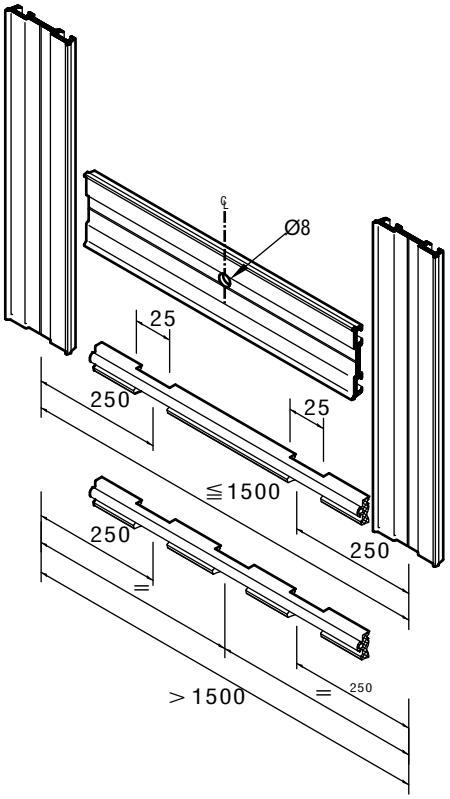
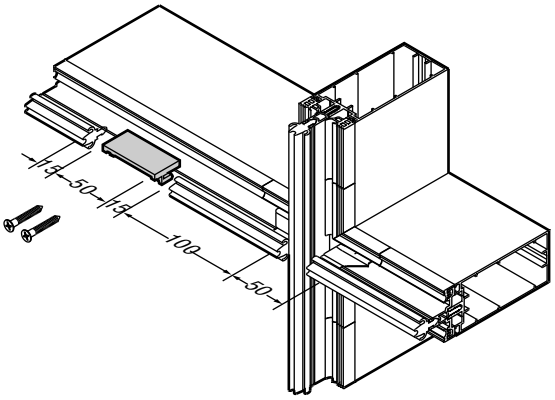
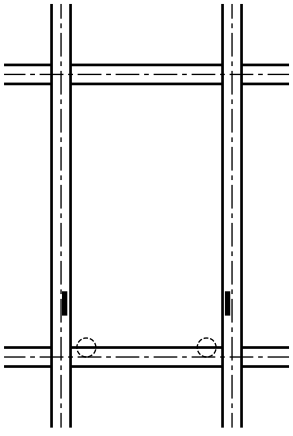


Figure 6.2.8

Glazing bridges and glazing blocks should be placed properly and should not block the flow of water egress





Glazing bridges
Glazing blocks

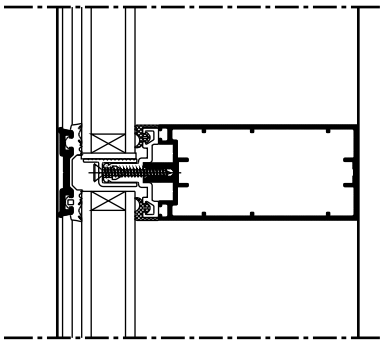


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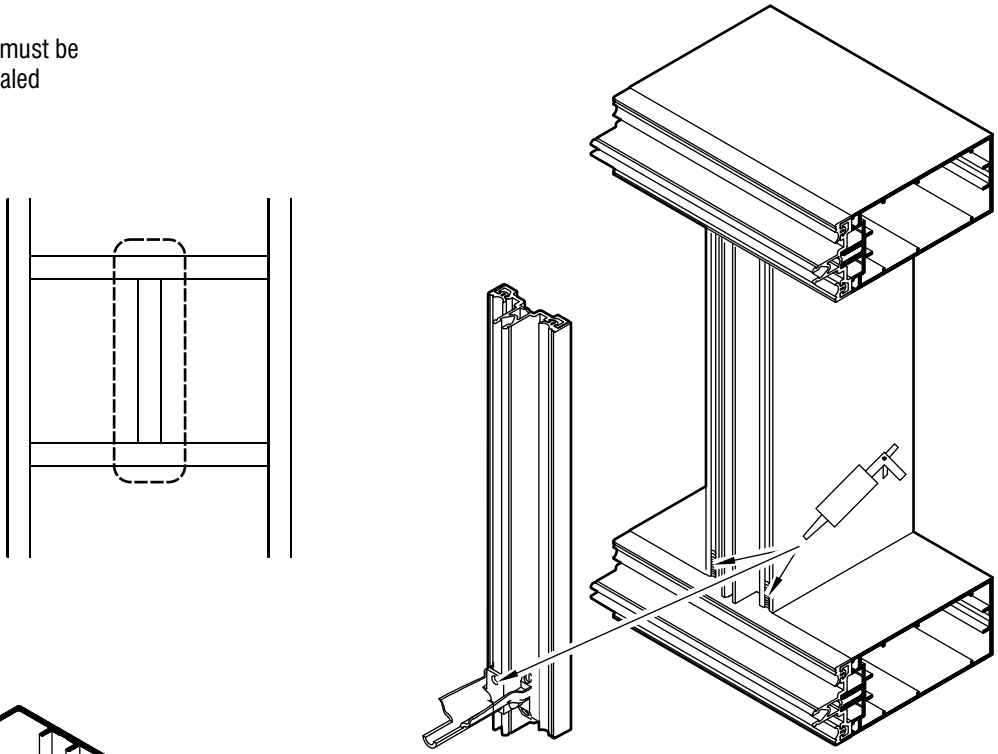
Figure 6.2.7
Intermediate mullions must be properly milled and sealed



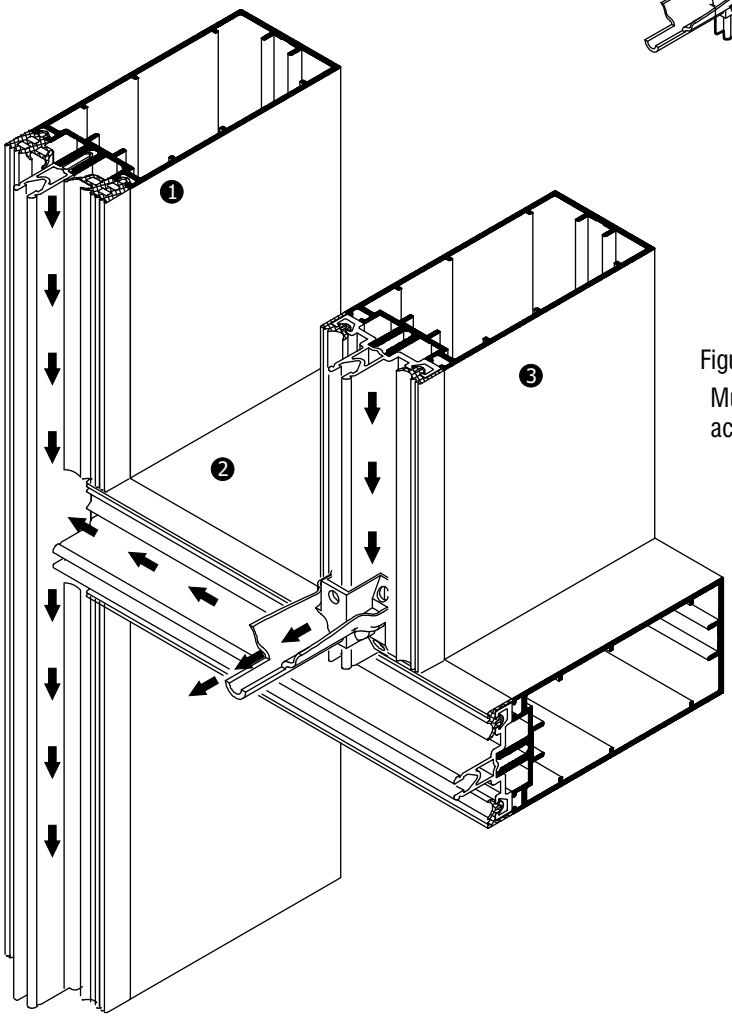


Figure 6.2.7
Mullion drainage can be achieved on three levels

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Frames

Frames may be used for windows, glazing screens, and curtain walls. In all cases the frame is composed of a series of profiles assembled to form the structure that supports the glazing or infill panels. For windows assembly of the frame and glazing installation is done before delivery is made to the site, whereas for glazing screens and curtain walls most of the assembly work will be done on site.

Framing materials are selected largely on the basis if individual or corporate preference. They are chosen because of the specifier's familiarity with the material or for "green issues". Each material offers different benefits and this may also determine the choice of material. The principal materials used in curtain walling are aluminum, timber, steel, PVCu, and composites.

Aluminum has been used as a framing material for more than fifty years. Aluminum does not suffer badly from corrosion and is easy to form and finish allowing many different design possibilities. Aluminum can be used as hollow sections and is relatively flexible in bending and torsion. Aluminum is light weight and is easy to handle for on site construction as well as prefabricated modules. Aluminum is not flammable and does not propagate a flame. Profile shapes can be designed to receive any kind of hardware. Drained and ventilated or pressure equalized windows and walls can utilize the complex geometrical shapes that are only possible with aluminum extrusion.

However aluminum is a good conductor of heat, and in order to meet the requirements for low thermal transmission aluminum profiles must be thermally broken with either polyamide bars or resin elements between the inside and outside aluminum sections. The latest proposals for improving the performance of aluminum windows will require an improved thermal break system.

Aluminum is the most common frame material for stick frame curtain walls, glazing screens and store fronts. It is also the most commonly used framing system for rain screens.

Timber has been used as a traditional framing material. Because timber is a living organism it suffers wood decay and possible deterioration. Therefore special treatments along with good design and workmanship must be combined in order to have an acceptable life span. Also regular maintenance is necessary in order to maintain the desired performance and appearance of the wood. Timber may be produced with a drained glazing cavity, but many systems are not drained and rely entirely upon the outer glazing seal for weather performance. Combining an aluminum profile system with a timber structure is a good solution for the drainage problem. Timber is used as a solid section and is a stiff material. It resists bending and torsion and can readily receive window hardware.

Steel was introduced as an alternative to timber for window frames. Originally hot formed sections were used but today mainly cold-formed sections are used for window and door frames. Steel windows are galvanized and powder coated and may be double glazed. The hardware is usually an integral part of the window. Steel windows use slender sections that are robust and secure, and are particularly suited for fire resistant doors and glazing screens.

PVCu is a flexible material that is internally reinforced with steel or aluminum to give it the required strength and stiffness. Like aluminum it is easily formed to produce a wide variety of shapes. When first introduced to the industry the finish was white, but now colored material, foil finishes, and special paints can be used to create a variety of finishes. PVCu systems are dependant upon their reinforcements for strength and all hardware must be assembled to the reinforcement profiles. PVCu is now used for glazing screens and low rise curtain walling. The structural members are aluminum profiles with PVCu cladding.

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Frames

The use of composite frames allows the designer to use the advantages of different materials for the inner and outer parts of the frame. Some of the possible combinations are; aluminum-PVCu, aluminum-timber, aluminum-stainless steel and aluminum-bronze. Composite frames are used to improve thermal performance, reduce condensation, provide a durable exterior surface and give different appearances to the inner and outer surface.

There are many window types available on the market today. Some of these are based on traditional designs, while others use the most modern materials and hardware to engineer new window types. The most common window types are; fixed light, side hung vent, projected side hung, top hung vent, projected top hung, tilt and turn, vertical slider (single- hung, double-hung), horizontal slider, horizontal pivot, vertical pivot, lift and slide, tilt and slide, and folding doors. Drawing notations are used according to ISO 128-1:2003 in which the arrow drawn on the infill panel is pointing away from the hinges. A solid line represents a window opening inside and a dotted line represents a window opening outside.

The types of frame used on any particular contract will depend on a number of factors.
These include; maintenance, safety, ventilation, local traditions, size of opening, infill material, appearance, and costs. Windows that can be cleaned from the inside of the building may be preferred where it is possible to use a large proportion of opening windows. Framing materials that require little maintenance are also preferred. Windows have to be safe in use. They may have to meet any of these needs:
- be safe to clean and maintain
- provide a fire escape route
- prevent people from falling out
- not obstruct paths and passages when open

Windows of different types give different ventilation patterns in a building. The size of the opening sash will determine its weight and the hardware to be used. Windows will often be selected to match those on nearby buildings. For refurbishment they are normally chosen to follow the style of earlier windows. On listed buildings and in conservation areas it may be a requirement that particular windows are used. The size of window opening will depend among other things on the lighting requirements, view, allowable heat loss and appearance of the window. Framing materials may be selected on the basis of cost, durability, strength, appearance. Increasingly whole life costs and environmental issues are being taken into account. The glazing or infill material may affect the choice of framing material. The frame has to support the weight of the glazing and accept glazing units of the required thickness.
This probably has the greatest influence on the selection of framing materials. Both the available finishes and the slenderness of the frame are factors. Window frame construction is governed firstly by the type of framing material and secondly by the style of the window. The following are typical cross sections through window frames:

Timber

There are no timber systems but there have been standardised designs. Timber is machined to a profile from hard or softwood and joined by tenon joints and finger joints to produce glazing frames. Today timber windows are available factory-painted and glazed.

Steel

Hot rolled sections have traditionally been used to make window and door frames. They are of welded construction and are robust but the range of sections available is limited.
Cold-formed sections are available as proprietary systems Figure 3.4. The corners are normally cleated rather than welded. Care should be taken that frames are not racked or otherwise distorted during installation as the corner joints may be damaged.

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Frames

Aluminium
Aluminium can be extruded in an infinite number of complex shapes and to very close tolerances. Window and wall framing systems consist of a number of profiles to facilitate extrusion and assembly. Aluminium profiles are formed into frames by the use of mechanical joints. Window frames comprise a main framing member that provides the strength and stiffness and an extruded glazing bead that generally clips into place to retain the glazing in a drained glazing rebate. Aluminium frames are thermally broken to make them more energy efficient and reduce the risk of condensation forming.

PVCu
PVCu framing members are formed into window frames either by heat welding the members at mitred joints or by mechanical joints. Heat welded joints are more common and provide a clean seal that keeps water out of the frame. Window frames comprise a main framing member that provides the strength and stiffness and an extruded glazing bead that generally clips into place to retain the glazing in a drained rebate. Many window suppliers are now able to supply an additional outer frame of galvanised steel. This can be built into a new wall allowing the window to be fitted sometime after the bricklaying has been completed.

Composite
Frame construction depends largely on the material of the main or central element. For instance a timber window is made and then clad with plastic or metal. The jointing technology has to take account of the materials to be joined and the presence of different materials and is generally more complex than for non-composite frames.

Doors
Doors are constructed from all of the framing materials. In general doors are made from larger sections. This is due to their size but also due to the robustness requirements, particularly for commercial buildings. The most commonly used framing materials are aluminium, hardwood and PVCu.

Tolerances
Overall tolerances for windows and doors are set out in the European Standards for each framing material. Tolerances are defined in terms of height, width and difference between diagonals (or squareness). They are (in mm):

Material	Width	Height	Diagonal
Timber	± 2mm	± 2mm	3,5mm*
Steel	± 1,5mm	± 1,5mm	4mm
Aluminium	± 1,5mm	± 1,5mm	4mm
PVCu	± 3mm	± 3mm	4mm

*The diagonal dimension depends on the size of the window.

Particular manufacturers will be able to make windows to greater accuracy. However they may not be able to do so for very large windows. The tolerance achieved with a composite frame should be the greater of the above when considering both materials. The squareness of a fixed frame may change if it is fixed incorrectly to the wall. That of an opening frame may change as it is glazed. Squareness should be checked before and after installation. The rigidity of a window frame depends on the presence of the glazing and the positioning of the
glazing blocks. The use of factory glazed windows can overcome this problem. However care is still required with the frames of doors and opening lights.

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Frames

Curtain wall sections
Stick system curtain walls comprise mullion (vertical) and transom (horizontal) framing members. Curtain wall frames act structurally to resist wind loading and to carry the weight of the wall. The profile comprises an outer section that serves to hold the infill material in place, prevent water penetration and form an air seal. The inner section comprises a hollow structural box the depth of which determines the strength and stiffness of the section.
Most curtain walls are constructed from aluminium profiles. Some walls are constructed as
an assembly of windows with PVCu frames. These are supported in a structural frame the mullions and transoms of which are aluminium sections sheathed with PVCu. Stick curtain wall members are delivered to site machined and cut to length. A high degree of accuracy is required in cutting to length. Slight variations in the length of members will result in the erected frames being out of square or distorted, whereas if all the elements are consistently over or under size the frame can be erected square, but the final bay may have to be manufactured specially to fit the remaining gap. The tolerance for these elements should be agreed at the design stage. Framing members may be pre-assembled as ladder frames or unitised walling.

Framing members may be designed to retain the infill panels in a number of ways:

Pressure cap
The most common means of retaining glazing in a curtain wall frame is by using a pressure plate which secures the glass in the glazing rebate around the full perimeter of the glazing unit. Pressure caps are secured in position by screws which must be either tightened to a required torque or to a stop where the pressure cap makes contact with the frame.

Structural silicone glazing
Structural silicone provides a means of retaining glass without the need for external components. It is therefore possible to obtain a smooth faηade. It is important that the structural silicone should be applied under controlled conditions in a factory. This should ensure a clean environment and controlled curing times. To achieve this the structural silicone is normally used to attach the glazing to a carrier frame that is then fixed to the curtain wall frame using mechanical fixings.

Bolted connections
Bolted connections have been developed as an alternative means of achieving a smooth faηade. Bolted connections can be used with glazing units and single glass.

Rain screen frames and rails
Rain screen is a layered form of construction comprising an outer cladding or rain screen, a cavity and a backing wall. Rain screens may be constructed in various ways. Panels may be supported by a masonry or concrete backing wall via brackets or timber battens. Alternatively the rain screen panels may be supported by rails spanning between floors or a frame consisting of vertical and horizontal members. The frame may be of similar proportions to a curtain wall frame and span from floor to floor as a self contained, integral, rain screen. Alternatively sections of lighter weight may be used attached to a background wall for support. Frame members are made from aluminium profiles or cold formed steel sections. The tolerances on components are similar to those achievable for curtain walls.

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Figure 6.3.1
Aluminum curtain walling frame

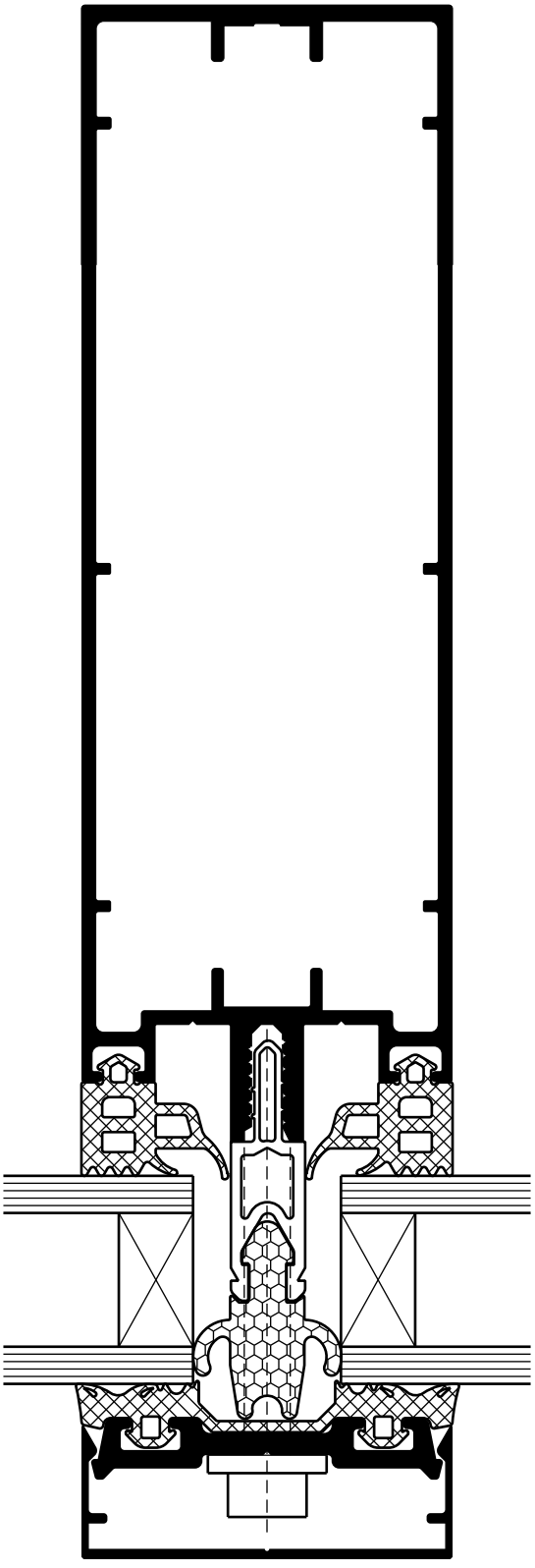

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Figure 6.3.2
Aluminum with wood structure
curtain walling frame

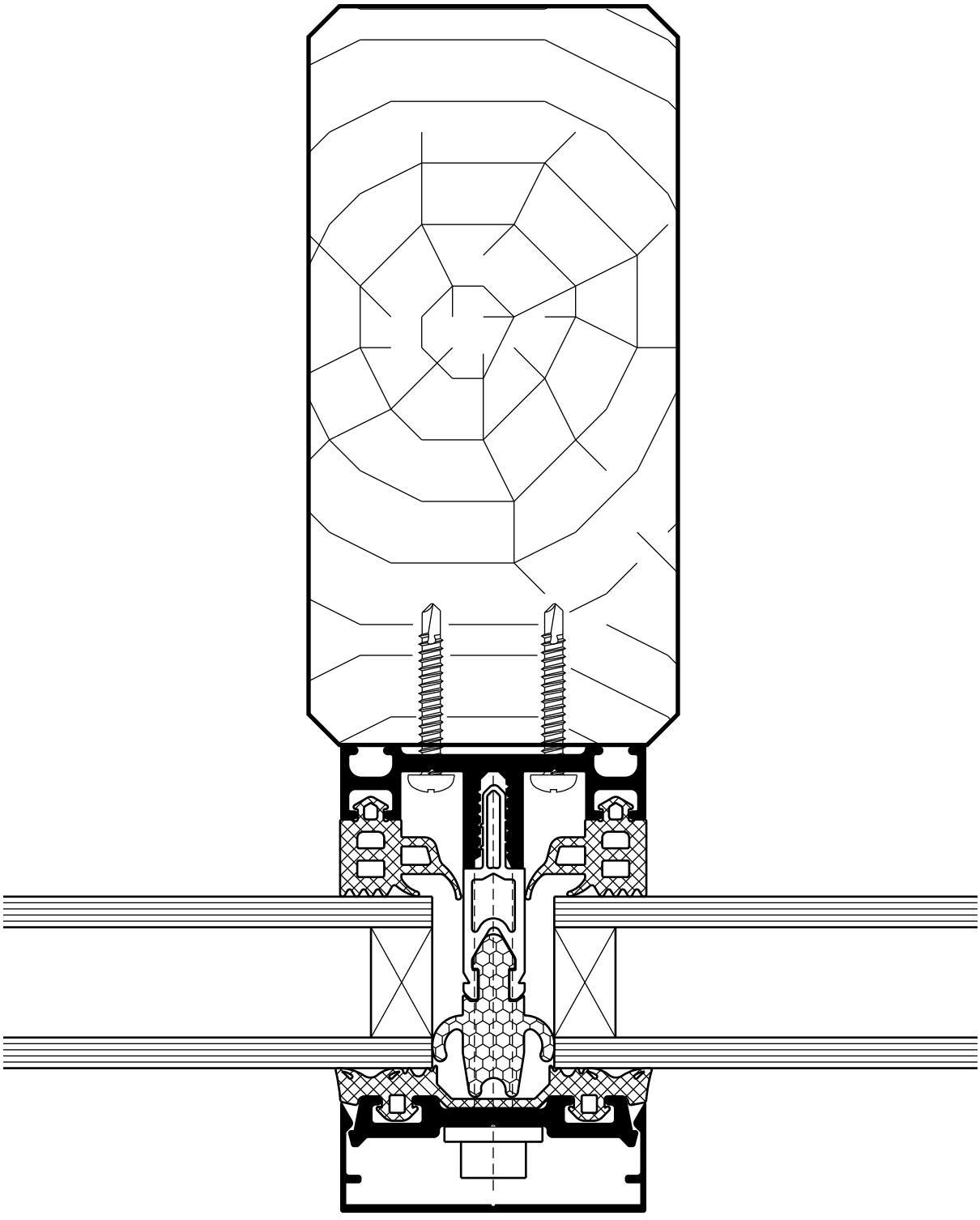

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Figure 6.3.3
Aluminum with steel structure
curtain walling frame

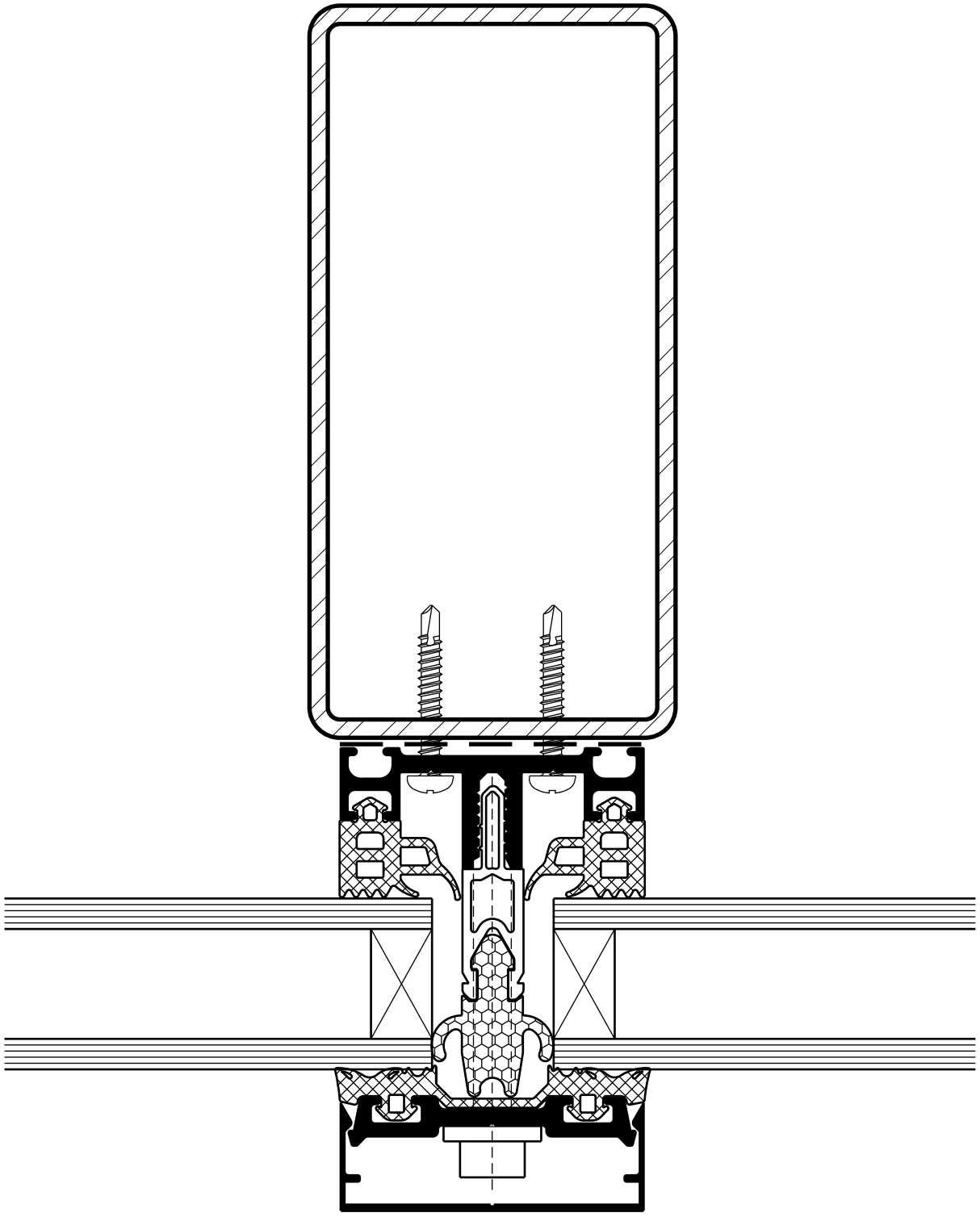

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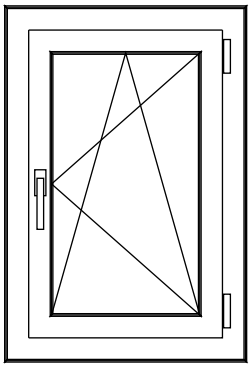
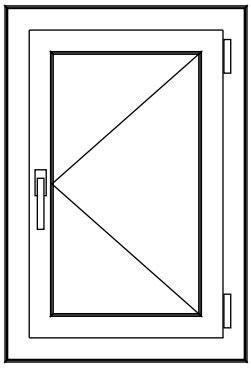
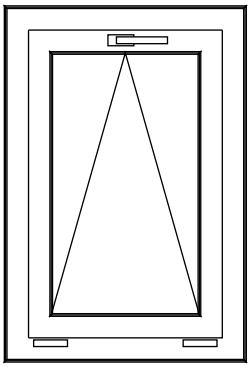
Figure 6.3.4
Standard window types



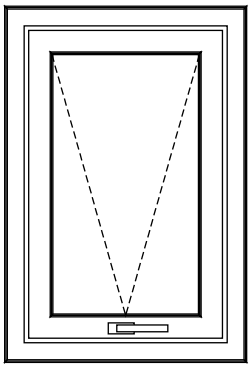
Tilt and turn



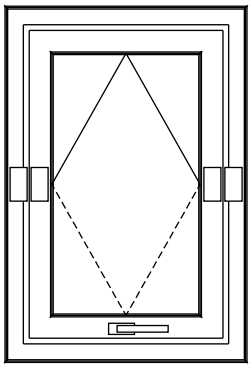
Side hung



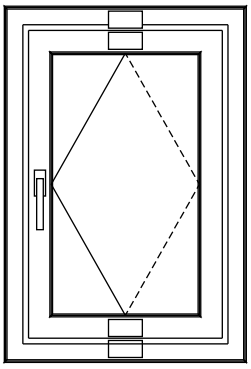
Bottom hung



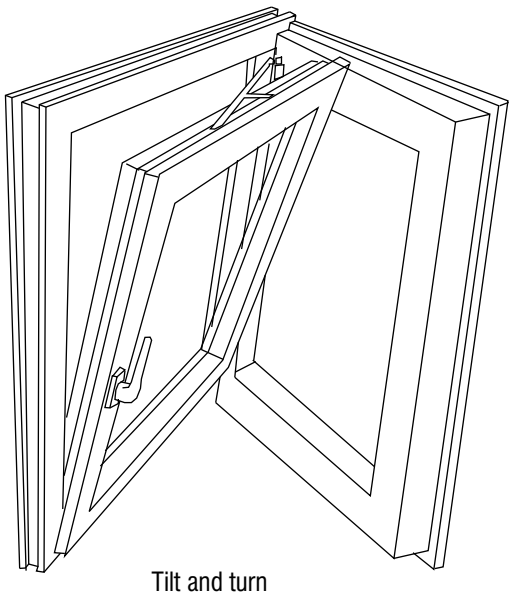
Top hung



Horizontal Pivot



Vertical Pivot



Tilt and turn

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Gaskets

Function

Glazing gaskets are required to:
- Limit air leakage and water penetration
- Allow relative movement
- Distribute and absorb loads
- Accommodate tolerances

Materials

There is a very wide choice of gasket materials available to the designer. Materials are selected for their ability to:
- Retain their shape
- Resist weathering
- Work at extremes of temperature
- Resist tearing

Cost is also of course a consideration when selecting a suitable gasket material.
Materials used to make gaskets can be grouped into families but within each family a wide range of performance can be achieved. It is wrong to assume that all gasket materials are the same because they are in the same family. Gaskets from one supplier should not be replaced with those from another without considering the performance requirements given above.

The most commonly used gasket materials can be grouped into the following families:

EPDM

Shape retention	Good
Low temperatures	Good
Tear resistance	Good
Weathering	Good
Cost	Average

Neoprene

Shape retention	Average
Low temperatures	Average
Tear resistance	Very good
Weathering	Average
Cost	Average

Silicone

Shape retention	Good
Low temperatures	Very good
Tear resistance	Poor
Weathering	Very good
Cost	Expensive

Butyl

Shape retention	Poor
Low temperatures	Good
Tear resistance	Average
Weathering	Very good
Cost	Expensive

Thermos-plastic rubbers

Shape retention	Poor
Low temperatures	Poor
Tear resistance	Poor
Weathering	Poor
Cost	Average

Hypalon

Shape retention	Average
Low temperatures	Average
Tear resistance	Good
Weathering	Good
Cost	Good

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Gaskets

Types
Gaskets are made in a range of shapes and sizes and can be categorised in several ways as follows:

Type of seal
A weatherstrip is a gasket whose primary purpose is to prevent water entering a joint and which will normally be located on the exposed side of the joint. A draught strip is primarily intended to prevent the passage of air through the joint and is normally located at the back of the joint.

Method of fixing
Three methods of locating gaskets are employed:
- Push-in gaskets are designed to be fitted into a groove in the mounting surface, prior to the formation of the joint.
- Drive-in or wedge gaskets are designed to be forced into the gap between the mounting surface and contact surface, usually as the last stage in sealing the joint. A drive-in gasket can usually be removed by pulling it from the joint, although it may be manufactured with a rigid strip that makes this difficult.
- Slide-in gaskets are designed to slide into a groove on the mounting surface, but must be installed from the end of the groove. A slide-in gasket can usually only be removed by sliding it out from the end of the groove.
- Slide in gaskets can only be installed as single lengths and corner joints have to be made after installation. Factory made joints perform better than site made joints.

Principle of operation
Most gaskets form a seal as a result of compression of the bulk material but some gaskets form a seal by deflection, either of a cantilevered arm or a hollow tube and others work by wiping contact with minimal deflection. To seal effectively a gasket must remain in compression however the compression of the gasket will cause forces to be exerted on the contact surfaces of the joint. The joint must therefore be designed to ensure that when the joint is at its widest there is sufficient compression in the gasket to create an effective seal. However the gasket must also be capable of being compressed sufficiently to fit when the joint is at its narrowest in such a way that the forces on the contact surfaces do not damage the joint components or prevent movement. Where a single gasket cannot accommodate the full range of possible joint widths due to manufacturing and erection tolerances, it may be necessary to have a range of gaskets available. The installer can then select the appropriate gasket by measuring the width of the joint gap. The force exerted by a gasket in compression will gradually decrease over a period of time due to the effects of creep and stress relaxation. There will also be a reduction in recovery of compression when the load is removed.

Corners
Gaskets are either injection moulded or extruded. Most glazing gaskets and other gaskets used in the facade are extruded as continuous lengths. At corners the gasket has to be cut and joined. The practice of bending the gasket around the corner is generally unacceptable as the cross section of the gasket distorts locally to the corner.
The following options are available for making corner joints:
- Cut extrusions to length and glue
- Cut extrusions to length and heat weld
- Cut extrusions to length and site vulcanise
- Mould corners and bond to extrusions
- Mould corners onto extrusions

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Gaskets

All of these methods will produce a single gasket that forms a continuous seal around the infill panel or glazing. This is recommended for the inner (air) seal of a curtain wall. For window glazing and for the outer (water) seal of a curtain wall it may be acceptable to mitre the corners of the gasket and make an unsealed butt joint at each corner.

Installation

It does not matter how much effort is expended in designing the perfect joint and the perfect gasket if it is then installed by an untrained workforce with little appreciation of the performance requirements of a sealed joint.
Basic good practice includes:
- Careful handling of the gaskets to avoid damage
- Cleaning of joint surfaces including removal of burrs. Lubricants may be used to ease fitting of gaskets but must be compatible with the gaskets and adjacent materials.
- Leaving gaskets unpacked in a warm environment to relax and recover their natural shape prior to installation is also recommended although this may leave the gaskets prone to damage.
- The gasket should be inspected before installation and discarded if visible defects such as cuts and abrasions are found.

Temperature may affect the flexibility of the gasket and width of the joint. Generally it is not recommended that gaskets are installed at temperatures below 5˚C and even at this temperature the joint may have opened up due to thermal contraction of the components, leading to the risk of crushing the seal at higher summer-time temperatures. The correct gasket should be used. The size of gasket to be used depends on the frame dimensions and thickness of the glazing unit or infill panel. Different sizes of gasket may be available to accommodate different glazing types and tolerances. Gaskets that are undersize and easy to insert will not be compressed and form a proper seal throughout the life of the wall. Gaskets that are too tight and are forced into position may crush the edge of the infill. Gaskets that are stretched as they are fitted will return to their original length after installation leaving gaps at any butt joints. Gaskets should be cut slightly over size and compressed lengthways as they are fitted. Fitting commences from the ends followed by the middle, Figure 4.3. Gaskets are available with co-extruded cords that prevent stretching of the gasket. Gaskets should not be twisted or folded during fitting. Most glazing systems are designed to be dry glazed using only gaskets. However some systems require the use of a sealant with the gasket. This need arises with special systems such as blast resistant glazing. This should be done in accordance with the system designer's recommendations. The arbitrary use of sealants in combination with gaskets should not be allowed. Like sealants, gaskets are a target for cost cutting. A fabricator will buy cheaper gaskets from another supplier just to save a few pence on the cost of each metre length, without any form of guarantee that the new gaskets will perform satisfactorily. The cost of even a small amount of water leakage, in terms of problem rectification/damage repair never justifies the initial cost saving, but the capital cost saving is made by the fabricator, who rarely sees the clients' costs of repair.

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Figure 7.4.1

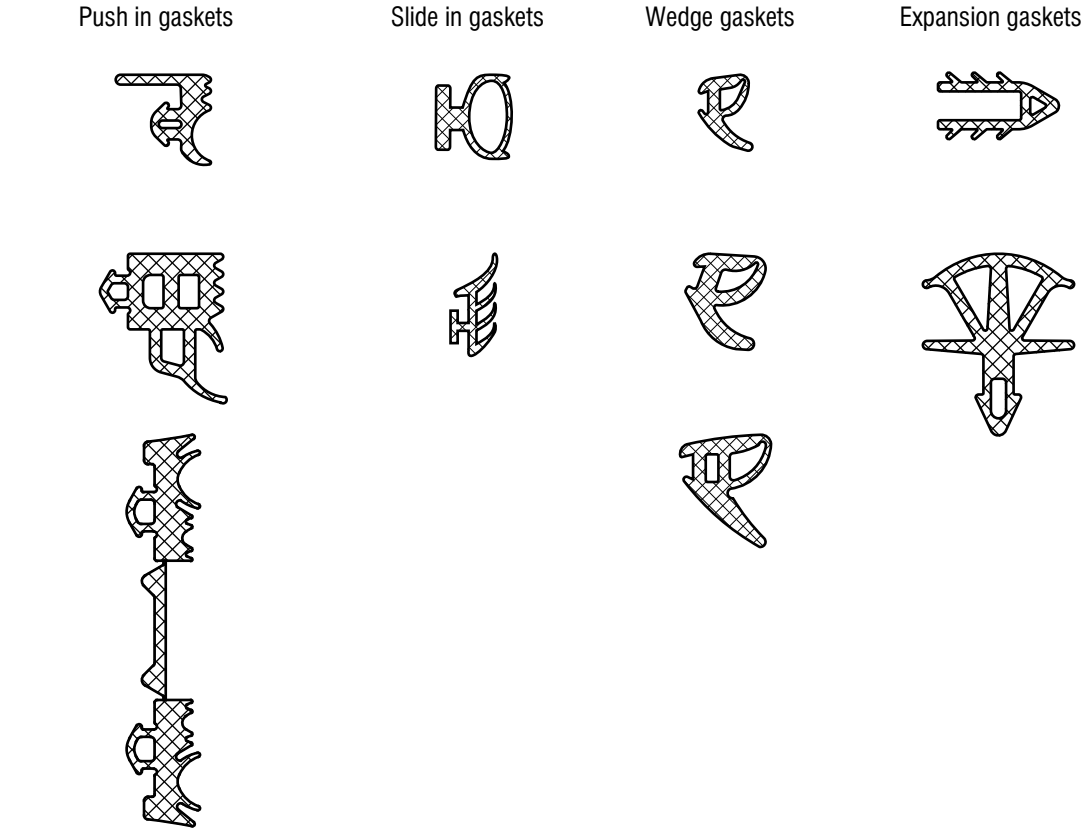

Figure 7.4.2

Vulcanized EPDM corners

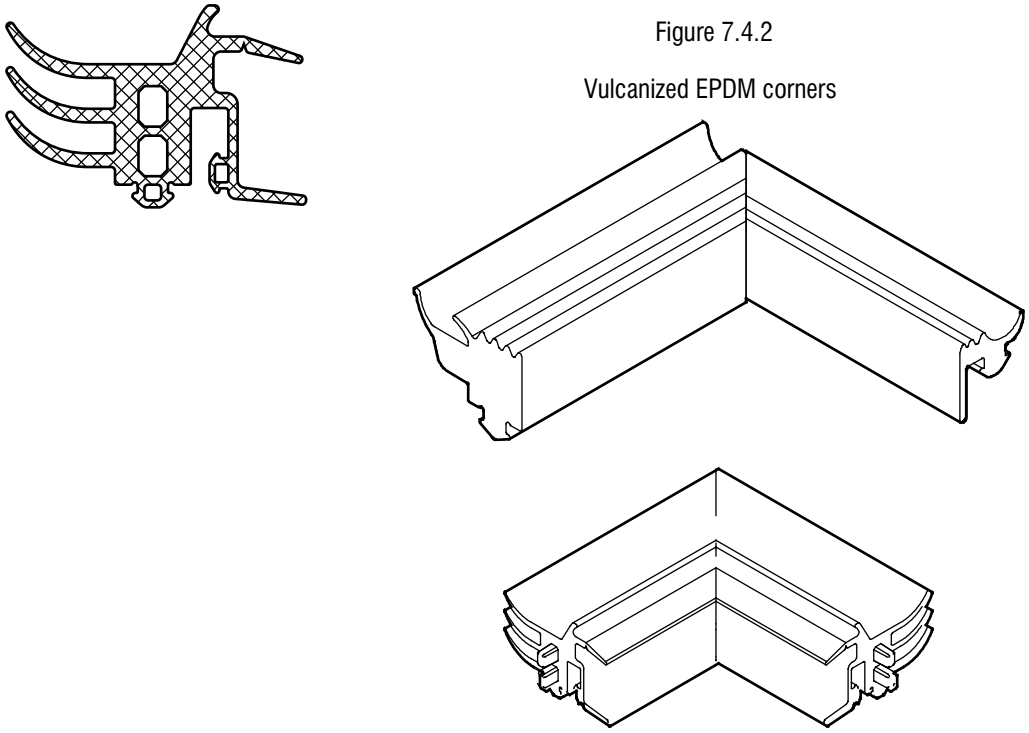

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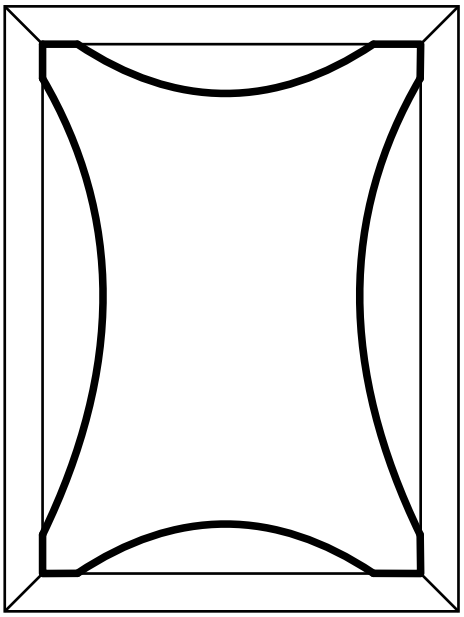
Figure 7.4.3

Procedure for fitting a wedge gasket

Step 1



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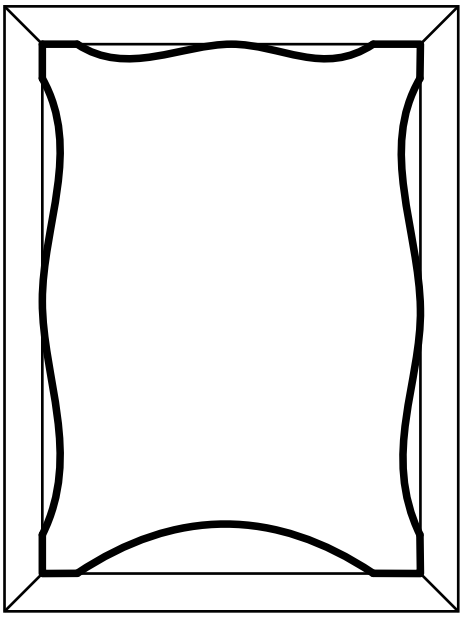

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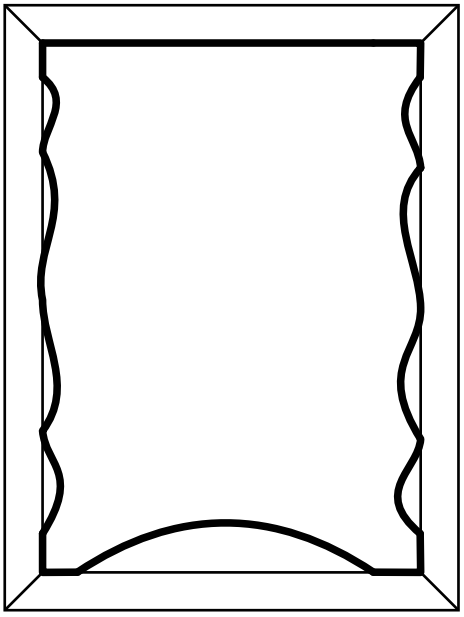
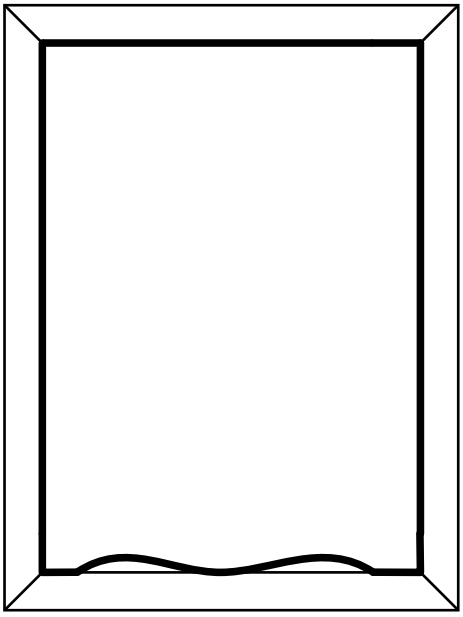


Step 4



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Sealants

Function
Sealants are used to make water seals, air seals, and combined seals or to protect an internal seal. They have to adhere to the materials they connect, resist tearing and be durable. In movement joints they should not stress adjacent materials. Many sealants are likely to have a shorter useful life than the design life of the building unless they are protected and provision should be made for replacing the sealants within the joints, or over sealing.

Sealant systems
Sealants used in modern façade construction are wet applied materials based on synthetic polymers which cure to form flexible solids. Oil based mastics which gradually harden with time are not generally suitable for use in these applications. Sealants should be used as part of a system comprising sealant, cleaner, primer, and backer rod.

Sealant
There is a large range of wet applied sealants. Supplied in tubes or tins, they are either one or two part materials. One-part materials avoid the need for site mixing but generally take longer to cure as they cure from the surface.

Cleaners
Cleaners are used to prepare surfaces before a primer or sealant is used. They are used to degrease the surface and are normally solvent based. Some cleaners are not suitable for use with all materials, particularly plastics. Cleaners should be chosen to be compatible with both the sealant material and the substrate. Cleaners should be tested on a small area of substrate before being used more widely.

Primers
Primers are used to prepare the surfaces the sealant has to bond to. They may seal the surface to prevent penetration of the sealant and improve bond or they may promote a chemical bond between the sealant and substrate material. Primers used to seal porous materials serve to reduce seepage of the sealant into the substrate and possible staining of surfaces adjacent to the joint.

Backer rods
Backer rods are used with wet applied sealants to control the joint shape and to limit the waste of sealant material in joints that are too deep.

Sealing strips
An alternative to wet applied sealants is to use sealing strips. Sealing strips are flexible materials which are pre-formed in a range of sizes and sections and mainly rely on compression although some adhesion to a joint face may take place. They may be considered as a special type of gasket and are of two basic types:

Mastic strips, usually manufactured from relatively soft, tacky synthetic rubber to which an easily removed backing paper is applied; and,

Cellular strips, usually based on a synthetic polymer, which may also be edge-coated with an adhesive layer. They may be composed of closed cell material or open cell material impregnated with a sealant. They are supplied pre-compressed to about 20% of their normal thickness and expand after placing. They can either be inserted in a preformed joint or fixed to one side of the joint before placing the component forming the other side of the joint.

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Sealants

Types of joint
Joints are made to join together elements of the building and may be used for two purposes:

Fixed joints
These occur where materials are joined because maximum panel or unit size requires the use of more than one element. Joints also occur where different materials or components meet.
At a fixed joint the adjacent components are fastened together to prevent movement between them. The joint then has a constant size and shape and the sealant does not have to move. For fixed joints the materials used are selected to be durable and to bond to the substrates.

Movement joints
These joints are provided to allow the building and the cladding to move. Movement occurs because of temperature change, wind loading and imposed loading amongst other things. Movement joints are made at the natural joints in the building where there would otherwise be fixed joints. The shape and size of a movement joint will change daily and over longer periods of time. A sealant that can move in the required way is chosen for a movement joint and there is a wide range of performance available. Sealants also have to be durable and bond to the substrates. In a movement joint the stretching of the sealant will make greater demand on the bond to the substrate.

Joint size
The exact size of a movement joint gap is important to its short and long term performance. If the width of a movement joint is made only half of the intended size then the forces within it will be double those intended and failure is almost inevitable. All joint designs should specify a minimum joint gap size to be achieved on site.

Joint shape
There are three basic shapes of sealant joint:

Butt joint
This shape of joint occurs when two thick panels are joined edge to edge or where thinner panels are required to have a flush face. Thin panels should be formed with a return that gives an adequate bond area for the sealant. It is important, particularly for a movement joint, which the sealant material can stretch across its full width. A backer rod or release tape is used at the back of the joint to prevent adhesion of the sealant at the back of the joint. If the sealant is not free to move then it will tear early in its life. It is important to control the depth of sealant within the joint. Too deep a sealant will cause high stresses and tear the sealant or adjacent material. It will also be wasteful of material. Too little sealant will not create a robust joint.

Lap joint
This shape of joint is most commonly used for fixed joints although it can be designed to move. It is important that the gap achieved on site is not less than that intended, particularly for a movement joint. Otherwise the sealant will be overstressed leading to tearing or unsealing. Backer rods should be used to control the size of the sealant bead within the joint to avoid the wasteful use of material and to provide a robust joint.

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Sealants

Fillet joint
This shape of joint is frequently used when components are neither lapped nor positioned to give a flush face. This is the joint commonly used to seal windows recessed in openings.
The joint should be constructed to give an adequate contact area between the sealant and the substrates. This should be not less than 6mm onto a non-porous surface and 10mm onto a porous surface. A fillet joint made in front of two components that are very close together will tear and a minimum gap of 5mm should be allowed. Joints between windows and walls are not designed as movement joints but are not perfectly fixed and so some movement will occur. Backer rods should be used to prevent the wasteful use of material and so that the joint can be properly tooled to form a good bond.

Materials
Sealants are commonly classified by their base materials:
- Silicones
- Polysulfide
- Polyurethanes
- Acrylics

However the performance of a sealant is not only governed by the base material but also by additives such as plasticizers, retarders and fillers. The preferred practice adopted by recent European Standards is to specify sealants by performance. The following classification system is given in EN ISO 11600:

Sealant type
Sealants may be classed as type G which are suitable for use in glazing and type F which are suitable for use in building joints other than glazing.

Sealant class
Four classes are given relating to the amount of movement the sealant can accommodate. The classes are 7.5, 12.5, 20 and 25 which give the allowable movement as a percentage of the unstressed width. Sealants can accept this movement in both compression and tension. Although a class 25 sealant can accommodate more movement than a lower class sealant it would only be suitable for use in place of a lower class sealant if all the other properties of the sealant are also acceptable. Some sealant specifications give movement accommodation as the total movement expressed as a percentage of the minimum joint width (the joint width when the sealant is fully compressed). This will give values about twice those given using the EN ISO 11600 definition. When selecting sealants for movement joints it is important to check the basis on which the movement characteristics sealant are given.

Sub-classes
Sub-classes relate to the elastic properties of the sealant.
Class 20 and 25 sealants are elastic and may be designated LM for low modulus or HM for high modulus.
Class 7.5 sealants are plastic
Class 12.5 sealants may be designated P for plastic or E for elastic
Test criteria are given in British Standards to establish compliance of the sealants with this classification system. This classification system gives a starting point for the specification and selection of sealants however other properties which must be considered include:
- Life expectancy
- Colour
- Compatibility with substrate
- Adhesion to substrate
- Stress relaxation

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Sealants

It follows that sealants should not be casually chosen or substituted at site. It will always be possible to buy a cheaper sealant but it will probably not be suitable.

Storage and use
A successful sealant joint requires correct installation procedures. All materials making up the sealant system must be compatible and should preferably come from the same supplier. The materials making up the sealant system must also be compatible with the substrate. Materials must be used in accordance with the manufacturer's instructions. The provision of detailed site specific method statements ensures that the applicator is aware of the correct procedures and allows co-ordination of sealant application with other work on site. Aspects to be included in the method statement are described below.

Storage
Sealants and associated materials including primers and cleaners may contain hazardous materials and require appropriate storage conditions. Materials may also require protection against frost and excessive heat or humidity during storage. Storage procedures should also ensure that materials are used before their expiry dates.

Inspection
Before sealant application commences joints should be inspected to ensure that their dimensions are within permitted limits and that the adjacent materials are of suitable quality. The inspections should be carried out in sufficient time to allow remedial work to be carried out where necessary.

Weather
Temperature will affect the properties of the sealant and the opening of joints. In cold conditions the sealant will be more viscous and take longer to cure whereas in hot conditions it will be less viscous and have a shorter working life. Sealant application is normally limited to temperatures between 5˚C and 40˚C. These temperatures apply to the surfaces to be sealed not the ambient air temperature. Frost may persist on shaded surfaces after the air temperature has risen to 5˚C and surfaces subject to direct sunlight may reach temperatures as high as 80˚C. It is also necessary to consider likely temperature changes during the curing period of the sealant as excessive movement during this period may cause the joint to move while it is curing and pucker the cured surface of the joint. Sealants should be applied in dry conditions although some primers are tolerant of damp surfaces. Wet surfaces can arise due to condensation in cold weather as well as rain. For this reason sealants should only be applied when surface temperatures are at least 5˚C and rising.

Cleaning
Cleaning of the joint surfaces is always necessary. The cleaning methods to be used vary according to the type and condition of the surfaces. Physical removal of dirt may require use of a dry brush, compressed air, wire brush or abrasive pads. The method chosen must ensure that the surface is not damaged. Removal of grease may require use of a solvent. The solvent must be compatible with the substrate, primer and sealant and must be clean. Cloths used for application should also be clean and lint free. The use of a white or light coloured cloth is preferable so that soiling is evident. One cloth should be used to apply the cleaner and a second to wipe it off.

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Sealants

Masking
Masking tape is useful on substrate surfaces where removal of excess sealant is difficult and may also be used to improve the appearance of the finished joint by giving a clean edge. Tape should be applied prior to application of primer and the tape should not touch surfaces cleaned for sealant application. Tape must be removed immediately after sealant application and tooling.

Priming
The need for a primer will depend on the substrate and sealant to be used. Non-porous surfaces usually use a silane type primer which must be applied sparingly using a cloth. Resin type primers are normally used for porous surfaces and may be applied by brush or cloth.
Primer should only be applied to the sides of the joint to which the sealant is required to adhere. Care should be taken to avoid contamination of the primer both before application and between application of primer and sealant. The primer must normally dry or cure before application of the sealant but if left too long may cease to be effective.

Back up material
Closed cell polyethylene or polyurethane foams supplied in rods, hoses, or flat sheets, which may be cut to form rectangular sections, are commonly used as back up materials to control the depth of the joint. The back up material may have a surface skin which prevents adhesion of the sealant. If this is only present on one surface care is required to ensure that the material is inserted the right way round. If the back up material does not have a surface skin a bond breaker tape is required. Polyethylene and PTFE are commonly used for bond breaker tape. The back up material may be applied before or after priming. In the former case care is required to ensure the primer is not removed or damaged during installation of the back up material and in the latter care is required to avoid application of the primer to the back up material. Foam back up material should be compressed by 25% to 50% when installed to ensure that it is held securely in place during sealant application. The backer rod must be placed carefully to avoid distortion or twisting and it must be at the correct depth as it controls the depth of the sealant. If the backer rod is damaged during installation gases can be released and as a precaution a period of 30 minutes should be left between installation of the backer rod and application of sealant to allow gasses to disperse. If severe damage to the backer rod occurs replacement is necessary.

Mixing
Two part sealants require mixing. Mixing is normally carried out using a paddle in a low speed drill. Mixing needs to be thorough, indicated by a uniform colour, but if too vigorous air can be trapped in the sealant. Curing of the sealant will commence as soon as it is mixed hence it should be mixed in quantities which can be used within the pot life.

Sealant application
Sealant is normally applied from a hand operated gun. The nozzle should suit the width of joint and the rate of extrusion and movement of the gun should be such that the joint is filled with sealant in a single pass. For very wide joints it may be necessary to use several passes of the sealant gun building up from the back corners of the joint.

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Sealants

Tooling
Tooling removes voids, improves adhesion by compacting the sealant against the sides of the joint and gives a neat finish. A slightly concave surface reduces movement stresses but over tooling can leave the sealant too thin at the centre. Tooling must be carried out before the surface forms a skin which may be damaged. The available time for tooling varies from a few minutes to several hours depending on the type of sealant and ambient conditions. Tooling is usually carried out using a wooden or metal spatula which may be wetted with water or a dilute detergent solution. Water should be used sparingly and applied to the tool rather than the joint. Excess water should be shaken from the tool.

Protection
During the curing cycle dirt may adhere to the tacky surface of the sealant and become embedded. The sealant should therefore be protected from dirt and debris. The sealant may also require protection against inclement weather. However sealants may require the presence of air, moisture or UV to aid curing and protection should not interfere with the curing process.

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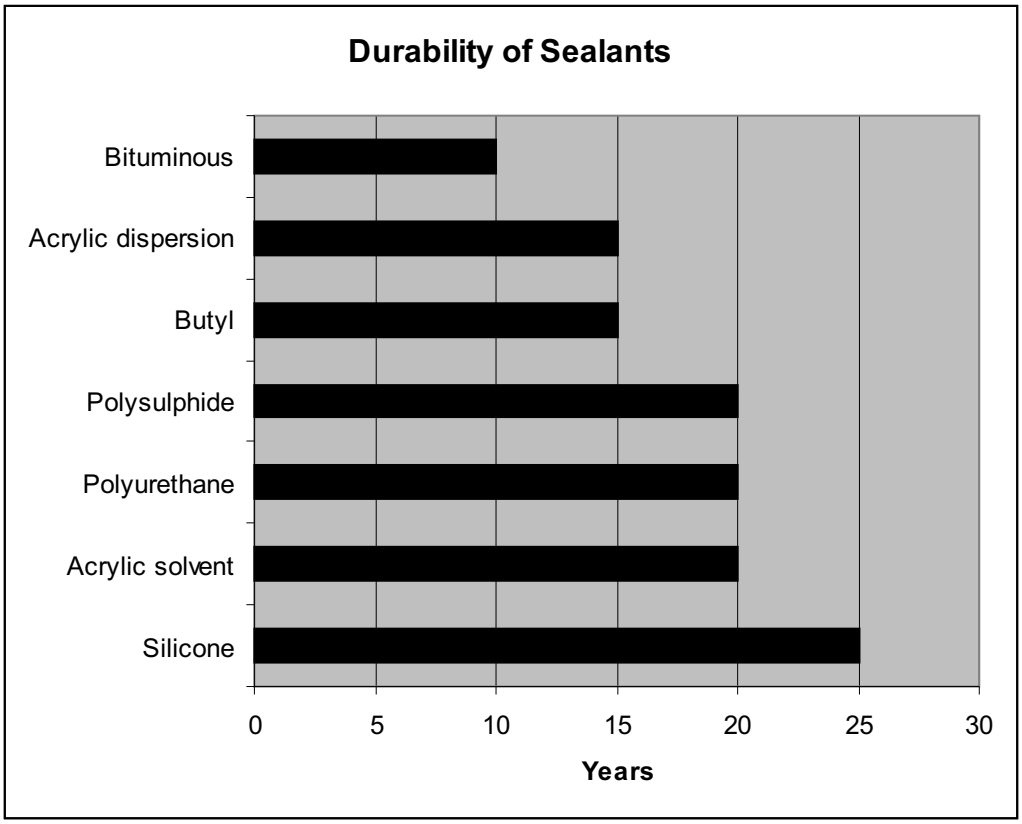

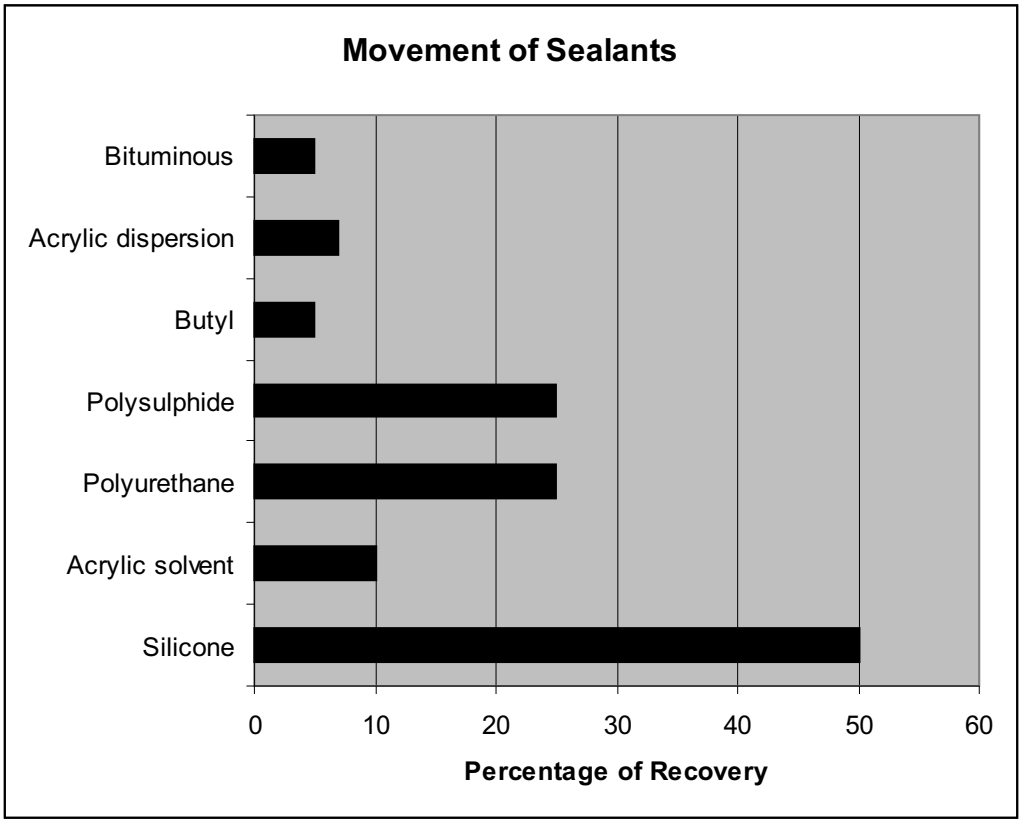

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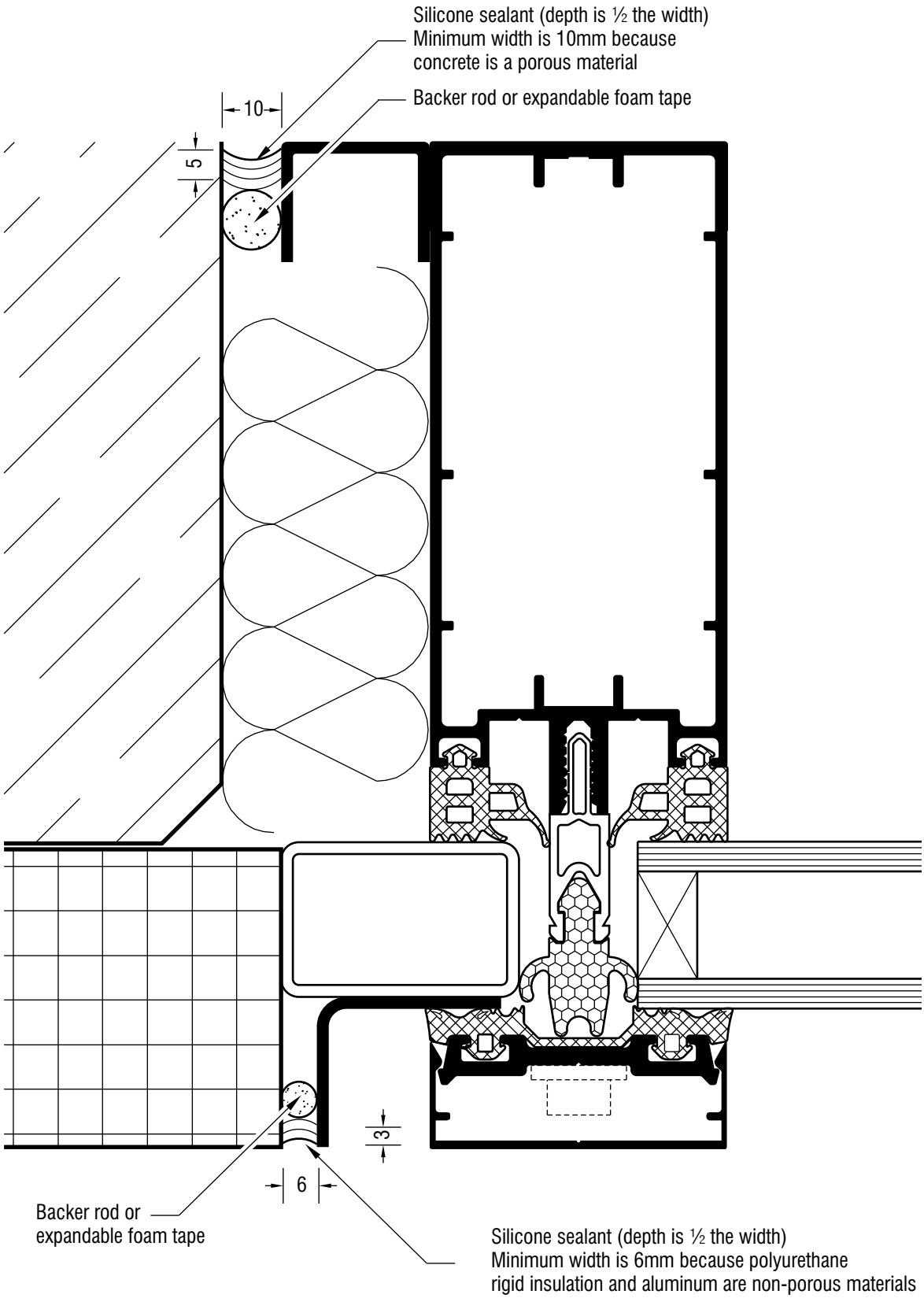

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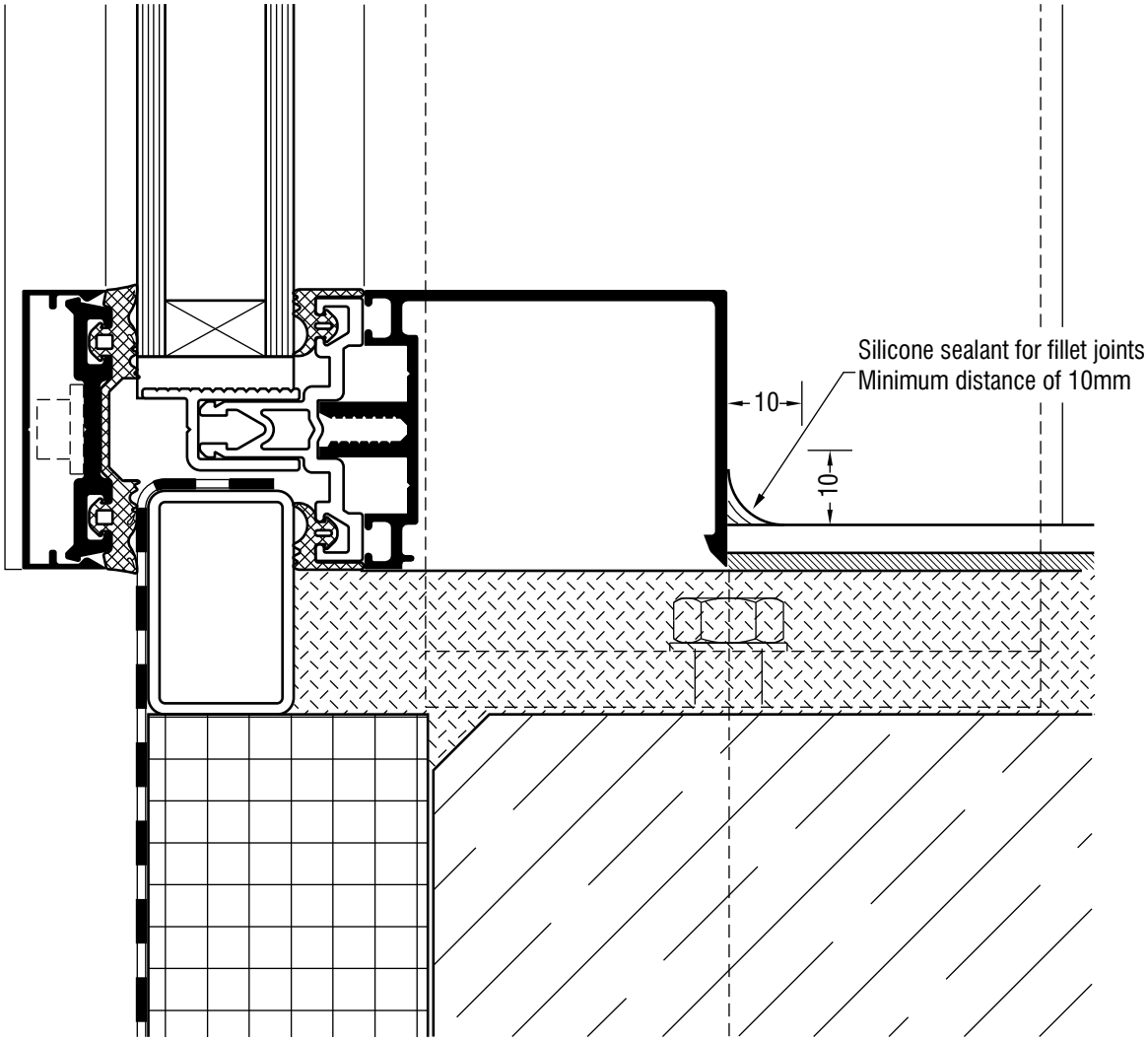

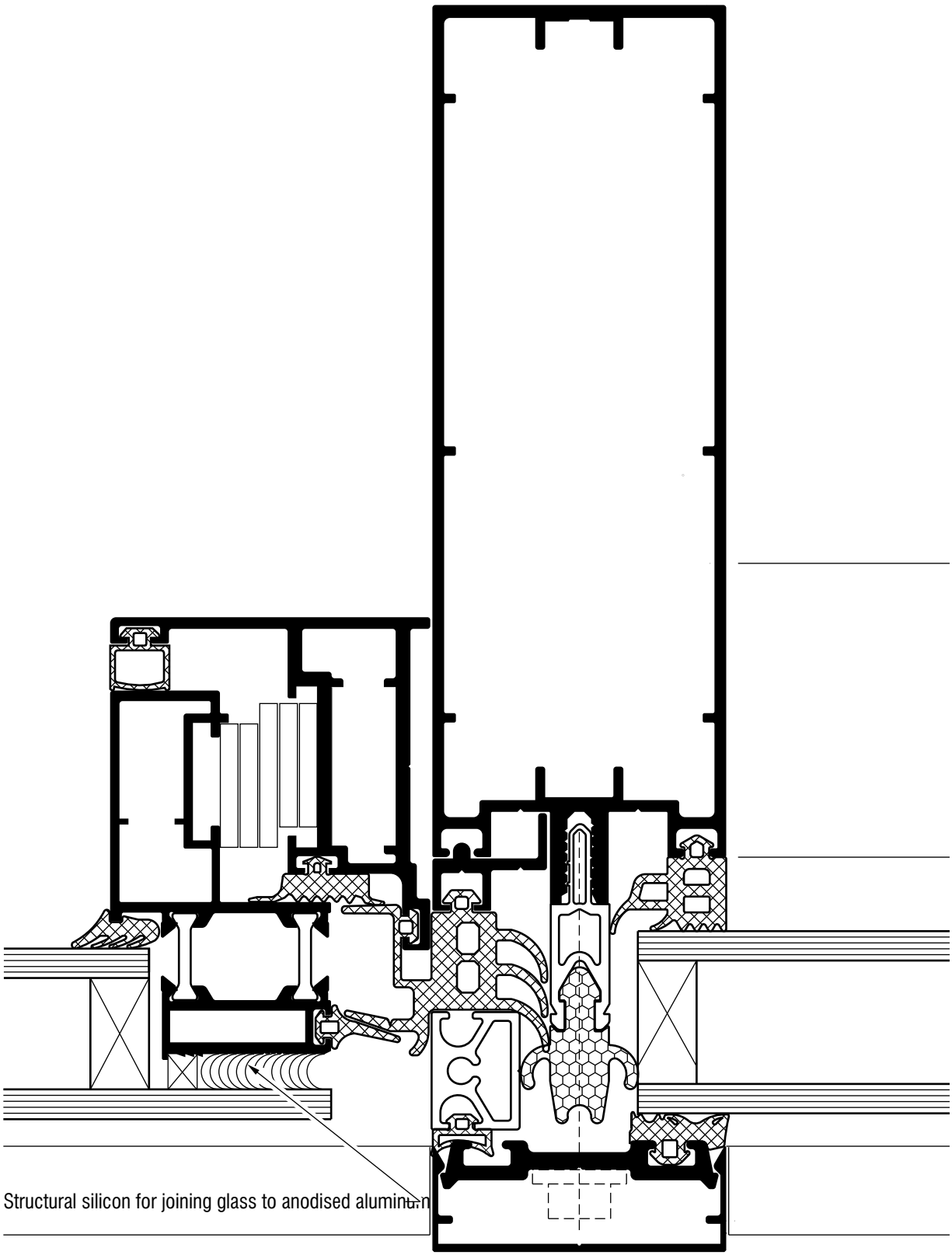

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Finishes

Function
Many facade materials have to be finished or coated to protect them from the environment and give the required appearance. The quality of the finish may be the greatest factor affecting the useful life of the wall and is likely to be a contentious issue if the appearance is not acceptable to the client. Materials may rot, corrode and suffer other forms of degradation in the presence of moisture, UV light, salt laden air and air borne pollutants. The materials most in need of protection from these atmospheric conditions are metals and timber. Plastics and other materials may be painted for reasons of appearance.

Aluminium

Mill finish
Aluminium may be left uncoated as 'mill finish' aluminium. In this form the surface oxidises to form a stable coat. However the oxide coating appears as a slightly white bloom that may not be visually acceptable. Although the oxide coating is stable it will penetrate under adjacent paint and powder finishes allowing them to blister and separate.

Coatings
Coated aluminium is a durable material and a useful life of 25 years or more can be achieved. The quality of the paint or powder finish depends on the materials used and the cleaning and pre-treatment of the aluminium prior to painting. Paints and powder coatings are applied to closely controlled thicknesses in the range 40-100 microns. The coating is then oven baked to achieve a uniform and durable surface. Finished aluminium is a quality product that cannot easily be repaired on site. It should be treated with care and protected as necessary during construction.

The commonly used coatings are:
- Polyester powder coating
- PVDF (Polyvinylidene Fluoride)
- Wet applied paints

Anodising
Aluminium may be anodised to form a hard resistant oxide coating. This coating is integral with the aluminium but should be treated with the same care as painted and powder coated surfaces. Anodised aluminium may be coloured or clear. Clear finishes are used to give corrosion protection and should be treated with the same care as coloured surfaces.

Cut edges
Aluminium is often finished in lengths prior to cutting and fabrication. Cut edges can be the starting point for corrosion and some contracts do not allow the use of pre-finished (post-cut) aluminium. The risk of corrosion occurring at cut edges depends on the quality of cutting, standard of pre-treatment and coating. The use of hand held saws and drills is unlikely to give a satisfactory edge quality. Factory machining uses separate drills and blades for working aluminium and steel.

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Finishes

Protection
All significant surfaces should be protected from abrasion, scuffing and other damage during transportation and installation. Protective tapes are used on coated aluminium surfaces but they are no substitute for careful handling. Additional methods such as protective boards may be used to protect against damage by following trades. Only low tack tapes should be used as agreed by the manufacturer. Tapes should not be left in place for more than six months or difficulty may be experienced in removing them. Tapes should be removed by peeling. If this is difficult a soft tool should be used. Sharp blades and solvents should not be used. Products such as windows may be protected during transport to site by using bubble wrap, shrink wrap or card. Tape should still be applied to protect significant surfaces during and after installation. Mortar drops and similar alkaline materials are particularly damaging to coatings and paint finishes which should be appropriately protected.

Remedial work
Site repairs to finishes should be agreed with the Client's agent. It is seldom possible to achieve a repair that looks good and the Architect may ask that the component be replaced. This decision must depend on the extent of damage and any disruption that may arise. Repairs to coated surfaces should be carried out in accordance with the suppliers instructions. This often requires the use of specialist paint contractors.

Steel
All steel has to be finished to protect it from corrosion. Steel may be coated in the same way as aluminium but these finish coats are applied over a protective treatment. For use in facades steel sections are hot-dip galvanised, or equivalent. This is done after machining to avoid edge corrosion. Paint or powder coat is then applied to give the required appearance. Galvanising deposits a zinc layer on the steel, which protects the steel by forming a barrier between the environment and the steel surface. The zinc layer will corrode unless protected by a coating but corrodes more slowly than steel. Zinc also provides protection to the steel by corroding preferentially to the steel at breaks in the zinc layer. This process is a form of cathodic protection but is only effective when a sufficient area of the zinc is exposed.
Where there is a paint finish on the zinc surface, protection only occurs at small scratches. Larger areas of damage to the galvanising should be made good with zinc paint. Protection of finishes and repair of any damage should be dealt with in the same way as damage to finishes on aluminium. Steel may also be plastic coated. This finish is used for metal coil that is subsequently formed into profiled metal sheets or flat cladding panels. The plastic coating is applied at the steel mill before the metal is shaped and cut and no attention is given to machine cut edges. Holes and cut edges made with hand held tools will not have such clean cut edges and may be sites for early corrosion.

Timber
Timber is treated and then finished to prevent the onset of rot and provide a good appearance. The finishes most commonly used are paints and micro-porous stains. Timber windows are often pre-finished at the factory but may be supplied primed for painting on site.
Exposure of untreated timber to sunlight will adversely affect the durability of paint finishes hence untreated timber should be painted, or at least primed, as soon as possible. Most timber finishes can be repaired by site painting but it is difficult to conceal heavy damage to stained timber. Timber frames should be treated with the same care as other finished materials.

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Finishes

Plastics
Many plastic components are made from self-coloured plastic, predominantly white although brown and other colours are available. These plastics cannot be refinished. They should be protected and treated with care. Components may be coloured by co-extruding a coloured outer layer of the required colour. Damage to this layer may allow the base material colour to show. Low tack protective tapes should be used on all significant surfaces even if they are only self coloured plastic surfaces. Tapes should be peelable and used in accordance with the manufacturers instructions. Plastics are easily damaged by solvents and some adhesives.
Plastics can be finished by painting or applying foil to the surface. Adhesive foil is commonly used to achieve a wood grain effect on domestic windows. Repairs to painted and foiled surfaces are difficult to achieve with any degree of success and the manufacturer should be consulted before any remedial work is started.

Appearance
Finishes determine the appearance of the completed building and this is a subjective issue. It is little wonder that the appearance of finishes is so often questioned.

Appearance depends on:
- Colour match
- Level of gloss
- Texture

On larger contracts it is common practice to make samples showing the acceptable colour range and level of gloss. All oven baked finishes will suffer some orange peeling and this texture is to be expected. Samples will show the acceptable limits of this texturing. In some cases an independent inspector will be employed to acceptance test the finishes. In either case it is advisable to gain acceptance for the finishes before they are delivered to site or at least as the components are installed. When inspecting finishes for appearance they should be viewed from a distance of one metre using normal, corrected vision in diffuse daylight.

Cleaning
Protective tape and other protective measures should be left in place as long as possible. If tape is removed for inspection it should be replaced, if necessary with new tape of the same type. On completion surfaces should be cleaned down using water containing a mild detergent. Neither abrasives or solvents should be used on any finished surfaces.

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Glass

Types
Glass is available in many types, thicknesses, patterns and finishes. The glass is selected for reasons of safety, appearance and the way it controls the internal environment of the building.

Glass may be grouped into categories by considering:
- Strength and safety
- Appearance
- Environmental control

Strength and safety
Glass in a building will be subject to mechanical loads in the form of wind load and impact. It may also be subject to stresses due to environmental conditions such as temperature changes. The strength properties of glass can be varied by increasing the thickness, heat treatment and combining the glass with other materials to form composites. The strength of glass must be sufficient to resist the loads it is likely to be exposed to. Safety of glass is related to its strength but also takes into account the risk of injury from the failed glass.

Annealed glass
Annealed glass is the basic form of glass produced in float glass plants. It has no special properties of strength or safety and on breaking it forms large shards with sharp edges.

Heat strengthened glass
Annealed glass may be strengthened by controlled heating and cooling. **Heat strengthened glass is not a safety glass** but is roughly twice as strong as annealed glass. When broken it behaves like annealed glass and breaks into large shards with sharp edges.

Wired glass
Wired glass fractures in the same way as annealed glass but remains in place with the shards held together by the wire mesh. Wired glass is not stronger than annealed glass before failure. After failure the strength of the pane will depend on the thickness of the wires. Wired glass is available as ordinary wired glass and safety wired glass which contains stronger wires.

Toughened glass
Annealed glass is toughened by heating it to 650˚C and rapidly cooling the surfaces. This compresses the surfaces and increases the strength of the glass. Toughened glass is roughly five times as strong as annealed glass. An important property of toughened glass is the way in which it breaks. Any cracking of the glass leads to a rapid release of the surface compression and toughened glass always breaks into small pieces of glass. Toughened glass complying with EN 12600 is a safety glass. Toughened safety glass should be CE-marked and installed with the CE mark visible. Toughened glass cannot be cut or drilled after toughening and must therefore be cut to size before toughening.

Heat soaked toughened glass
Toughened glass may fail due to the presence of nickel sulfide crystals in the glass. To reduce the risk of nickel sulfide failure, the glass may be subjected to a process known as heat soaking. To be effective the heat soaking process must be strictly controlled.

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Glass

Laminated glass
Annealed, heat strengthened or toughened glass can be laminated in any combination to make a safety or security glass. Two or more pieces of glass are laminated together to give the required properties. The glass may be laminated as a sandwich with a layer(s) of polyvinyl butyral (PVB) between the sheets of glass. Glass can also be laminated by pouring a resin between two sheets of glass. PVB laminates are best suited to flat glass while poured resins are best suited for curved glass. Laminated glass is not as strong as a single pane of glass of the same type and thickness but after failure the broken pieces of glass will be held together by the interlayer. The performance of a laminated glass depends on the type of interlayer used. Some are designed to resist penetration and others solely as safety glasses.

Tempered glass
Tempering is the American term for strengthening and toughening. Tempered glass is roughly equivalent to heat strengthened glass and is not a safety glass. Only fully tempered glass has similar properties to toughened glass. Fully tempered glass used as a safety glass should conform to EN 12600.

Plastics
Polycarbonates are sometimes used as glazing materials. They are used for safety glazing as they are less prone to breakage. Plastics are more flexible than glass of the same thickness. They may be sprung out of a glazing frame and are not always suitable as security glazing. Plastics are less scratch resistant than glass.

Appearance
Patterned
Glass may be patterned by rolling a relief onto one surface while it is still hot and soft. This is done to obscure vision or to change the appearance of the facade. Patterned glass has the same strength and safety characteristics as annealed glass and is not normally a safety glass however it is possible to toughen patterned glass. Some patterned glasses - those that do not have deeply embossed surfaces - may also be laminated.

Printed
It is possible to print patterns on to glass. This may be done to make people aware of the glass for safety reasons. In this case the patterning has to be in the correct position. Note that company logos and other signage may be used for this safety purpose.

Fritted and etched
The surface of glass may be etched or otherwise altered to achieve the same effect as printing. Again this may be done for safety reasons.

Environmental control
Environmental control glasses are used to limit the heat and light passing through a window.

Tinted
Glass may be tinted to reduce light transmission and prevent glare within a building.

Coated
Glasses are coated to change the properties of the glazing. Coatings are used to reflect light and/or heat. Increasing the amount of reflected light may be required for aesthetic reasons (giving a mirror effect) or to restrict the view into the building. Reflection of heat may be required to reduce solar gain or to retain heat within the building. The type of coating will differ depending on its purpose. Low emissive (low-E) coatings are among the most widely used and are provided to reflect heat from inside the building back to the inside and therefore reduce heat loss. They do not reflect solar radiation in the same way due to the different wavelength. They are not visible to the eye.

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Glass

Printed
Patterns may be printed or etched onto the surface of the glass to obscure vision or prevent glare.

Double and multiple glazing
Glass is frequently used as insulated glazing units (double glazing). This is normally done to reduce heat loss from the building but it can also help to reduce noise levels inside a building. In some cases triple glazing is used to reduce noise levels or further reduce heat loss.
Insulated glazing units may be made using any of the glasses described above and different glasses may be used for the inner and outer panes. The panes are separated by a spacer bar. The units may be constructed with a primary airtight seal between the spacer bar and the glass and a secondary structural seal outside the spacer bar holding the glass panes together. Alternatively a single structural and air tight seal may be used.

Gas filled
Insulated glazing units may be gas filled to reduce energy loss through the window. Any units that are broken or damaged should be replaced with equivalent units.

Safety glazing and fire rated glazing
The Building Regulations make specific requirements for the use of safety glazing and fire rated glazing under certain circumstances. The design of the facade will have taken account of these requirements. It is essential that safety glazing and fire rated glazing are installed as specified.

Safety glazing
Glass in critical locations (adjacent to doorways and pedestrian areas and in windows with low sills) has to comply with Building Regulations. The glass has either to break in a safe manner or resist impact. It is normal to use toughened, laminated or wired glass in these locations. Plain annealed glass may be used provided no single pane exceeds 0.5 m2 in area, the smaller dimension is no more than 250mm and the thickness is not less than 6 mm.
Substitution with glass of different performance in a critical zone may be unsafe and should only be approved by the specifier.

Fire rated glazing systems
Fire rated glazing systems will have been tested to show that they can resist fire for the required period of time. The performance of a fire rated screen depends on the exact replication of the test sample on every contract. No substitution of any framing, glazing or other components is permitted. Alumil maintains a register of trained installers and approved specialist contractors.

CDM Regulations
The Construction, Design and Management Regulations require all people involved in the construction of a building to ensure that it is safe during construction and use. Glass is a potentially hazardous material and care will be required to ensure the safety of the workforce, occupants of the completed building and any future maintenance workers.

Terminology
The following terms are related to glazing.
_ Sight size
_ Pane size
_ Tight size
_ Edge clearance
_ Rebate depth
_ Edge cover
_ Back clearance

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Glass

Condition
The performance of glass is highly dependent on its condition. The use of damaged glass or insulated glazing units will impair the performance of the facade.
Glass should be inspected for:

Size
Glass that is undersize will not have sufficient cover in the glazing rebate. This can lead to an inadequate seal at the gasket and in the extreme loss of glass retention. Glass that is oversized will reduce the clearance between the glass and frame which will limit the accommodation of relative movement of the glass and frame. If thinner glazing blocks are used to accommodate oversized glazing panels, the rebate in the lower frame may not be large enough to have proper water egress. This may lead to the breakdown of seals of glazing units. Ultimately the glass may not fit into the frame if it is too large.

Surface defects
Surface defects are uncommon with float glass. However when they do occur they are clearly visible. Surface defects are an obvious source of irritation to the client. It is good practice to check all glass for surface defects at the time of installation. It is far easier to replace glass at this stage while the access scaffold is still in place. Toughened glass may have a slightly rippled surface as a result of the toughening process. This is generally accepted but if particularly bad it may be unacceptable and the glass may have to be replaced. If the cavity of an insulated glazing unit is at a different pressure to the surrounding air, the glass will dish and give distorted reflections. Pressure differences can be caused by sealing the units at too high a temperature or at a different altitude from the site. This results in dishing of the glass as the cavity volume changes. Visual effects can be quite pronounced and unacceptable.
Changes in weather conditions will have a smaller effect that is normally acceptable.

Edge defects
Edge defects include:
- Feathering where the edge of the glass is not exactly square to the face and may not be plane
- Venting where the edge of the glass is clearly chipped to leave sharp edges around a depression

Feathering of the edge is acceptable up to a point. Venting is never acceptable. Edge defects cause stress concentrations which weaken the glass if it is subject to load. Thermal fracture of glass takes place if there is a large temperature difference between different parts of the glass. This can occur when most of the glass is heated by solar radiation but the edge is kept cool by shadows or the insulation of the frame. Stress concentrations at edge defects increase the risk of thermal cracking. An edge tape may be used but this is not recommended as it provides little protection, hides edge damage, prevents inspection of the seal(s) and can even trap moisture causing breakdown of the seal.

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Glass

Laminated glass
Laminated glass should be visually and optically acceptable. There should be no damage to the edge of any sheet of glass in the laminate.

Edge seals
Sealed units are made with either single or double edge seals to comply with EN 1279.
Double edge seals are used to give a longer life to the unit. Any units replaced on site due to breakage or the presence of defects should be replaced with units of the same construction.
Edge seals should be free of any visible air bubbles.

Identification
Identification of glass on site can present difficulty if it is part of a glazing unit, has invisible coatings or particular strength properties. The main methods of identifying glass are:

Visual inspection with a gauge card held against the surface will identify the glass thickness using the reflection from the back face of the glass. A reflected flame will appear differently on coated surfaces.

Marking of glazing units at the time of manufacture assists identification. Labels should show: type of glass, size, manufacturer, glazing position and orientation. Toughened safety glass should be CE-marked according to EN 12150. Glazing units must be CE-marked according to the appropriate European standard.

Gauges or meters may be used to determine glass thickness. Several commercial systems are available.

DSR (differential surface refractometer) equipment can be used to determine the surface stresses in glass and the degree of toughening. This equipment is expensive and is unlikely to be available on site.

Ultrasonic test equipment can be used to identify laminated glasses. These also sound differently when tapped.

Suitable methods of identification:

Glass types	**Methods**
Clear float	Visual or meter
Patterned	Visual
Wired	Visual
Tinted	Visual
Coated	Visual or meter
Heat-strengthened	DSR
Toughened	Mark, DSR or polarised light
Bent	Visual
Laminated	Mark, ultrasonic
Glazing unit	Mark on spacer
Printed	Visual
Off-line coated	Visual, meter, reflections

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Glass

Glass installation
The following standards apply to glass installation:

EN 1279 Parts 1, 2, 3, 4, 5 and 6 Glass in building: Insulating Glass Units
EN ISO 9001 Quality management systems - Requirements
EN 13830 Curtain walling - Product standards

Glazing materials should be installed in accordance with the manufacturer's instructions.
EN 1279 gives general guidance applicable to most windows. Where manufacturer's instructions differ from EN 1279 the manufacturer's instructions should be followed.

Positioning
It is important that glazing units are correctly positioned. Units that include safety glass should be used in the correct openings and not swapped with non safe units. Units that have different glasses for the inner and outer panes should be positioned with the correct face outermost. This may be required for reasons of safety, appearance or the effectiveness of energy efficient glazing. Each glazing unit will contain two or more pieces of glass that will be of slightly different size due to manufacturing tolerances. Good quality glazing units are constructed with all glass aligned on two edges of the unit that are labelled 'bottom'. Glass should be installed with the correct edge resting on the glazing blocks so that all sheets of glass are equally supported.

Glazing blocks and spacers
Glazing blocks are used to support the glass and must support both panes of a glazing unit. They prevent glass to frame contact and centralise the glazing in the frame. Glazing blocks should support the glazing clear of any water that enters the glazing rebate. Glazing blocks should not block any drainage paths. Some systems require glazing blocks that bridge the drainage channel. Use of sealant to locate setting and location blocks may also block drainage paths.

Glazing blocks may be made from the following materials:

- Neoprene with Shore Hardness 80 to 90
- Plasticized PVC with softness of 35 to 45
- Extruded non-plasticized PVC

Hammered lead is sometimes used in non-drained systems and sealed hardwood may be encountered in some windows but should not be used in curtain walls. Location blocks are used to prevent lateral movement of the glazing and give rigidity to opening lights and factory glazed products. They are made from the same materials as glazing blocks. Distance pieces are used to maintain the distance between the glass and the frame when using wet applied sealants. They are made from the same materials as glazing blocks.

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Glass

Glass and frame support
The glazing material stiffens the frame of opening lights and doors and prevents them distorting or sagging in use. The glazing block positions are selected to correctly stiffen the frames as well as support the glass. For windows that pivot on a horizontal axis the glazing blocks at the top of the frame also support the glass. The recommended positions for glazing blocks for windows are shown here but the manufacturer's instructions should also be read.
Glazing blocks should be at least 30mm and no more than 100mm from the corner of the glazing frame. Curtain walling and glazing screens have to move to accommodate movement of the primary structure. Location blocks in curtain walling should be placed near the bottom of the glass to prevent lateral movement of the glass but allow racking of the frame.

Edge clearance
Glass should be fitted into the frame with adequate edge clearance.
This is necessary so that:
- The glass and frame can move without stressing the glass
- Water entering the frame can drain freely

Minimum edge clearances for glass are:
- 3mm for glass sizes up to 2m
- 5mm for glass sizes over 2m
- 6mm for all drained systems

Minimum edge clearances for plastic glazing materials are:
- 3mm for plastic sizes up to 1m
- 5mm for plastic sizes between 1 and 2m
- 7mm for plastic sizes between 2 and 3m

Drainage
Drain holes in the bottom or face of the frame must not be blocked by glazing blocks, burrs or sealants.

Storage and Handling
Glass weight
Typical glazing units are heavy and larger units require special consideration. It is always preferable to glaze windows at the factory. However for larger windows the completed weight is too great to be lifted manually and these windows have to be site glazed. Some windows have to be deglazed for fixing into the opening.

Glass weighs 2.5kg/m2/mm. Weights of typical glass products are shown below:

6mm glass	15 kg/m2
6 - 12 - 6 glazing unit	30 kg/m2
7.3 - 12 - 6 laminated glazing unit	32.5 kg/m2
15mm glass	37.5 kg/m2

Consideration should be given to mechanical handling and lifting of larger glazing units and complete glazed windows.

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Glass

Glass storage
Glass should be stored:
- In a dry covered area
- Out of direct sunlight
- Stood on edge
- Protected from impact
- Protected from dirt

Glass should be stored on site in a protected location where it will not be damaged and does not become marked or unduly dirty. If glazing seals become wet, particularly if water becomes trapped behind edge tapes, the seals will start to break down. If water is trapped between two pieces of glass for too long then the glass surfaces may be permanently marked. If glass is stored in direct sunlight then heat passes into the stack and cannot escape. The glass within the stack can become very hot causing fracture. Glass should be stored stood on edge and inclined against a rest to prevent it from falling. With glazing units both edges should be supported to reduce the risk of edge damage. A suitable arrangement is shown below.

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Figure 7.1.1
Setting the glazing blocks

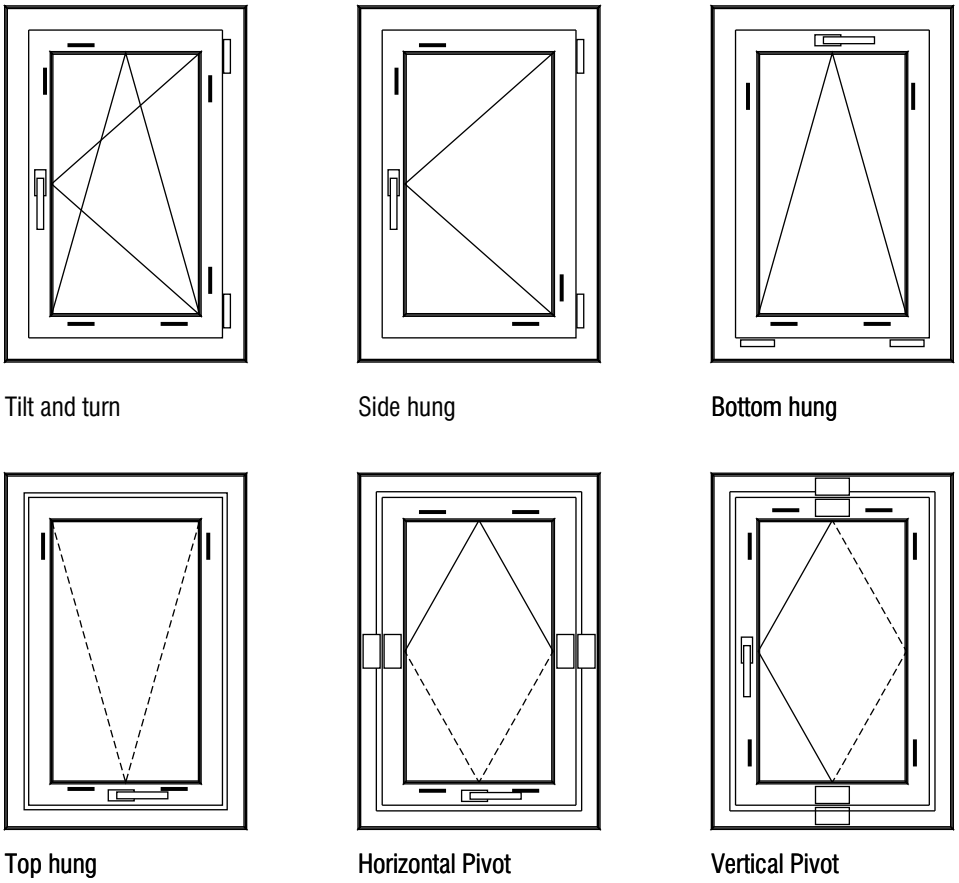

Figure 7.1.2
Setting the glazing blocks for fixed glazing spandrels in typical curtain walls

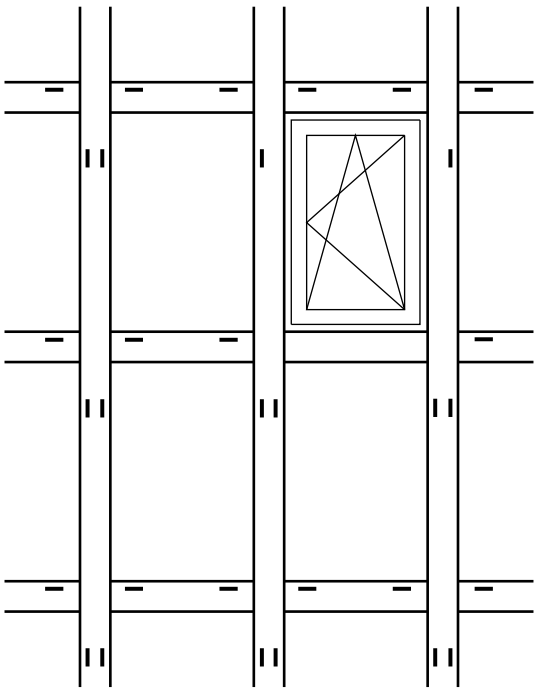

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Figure 7.2.1
Setting the glazing blocks

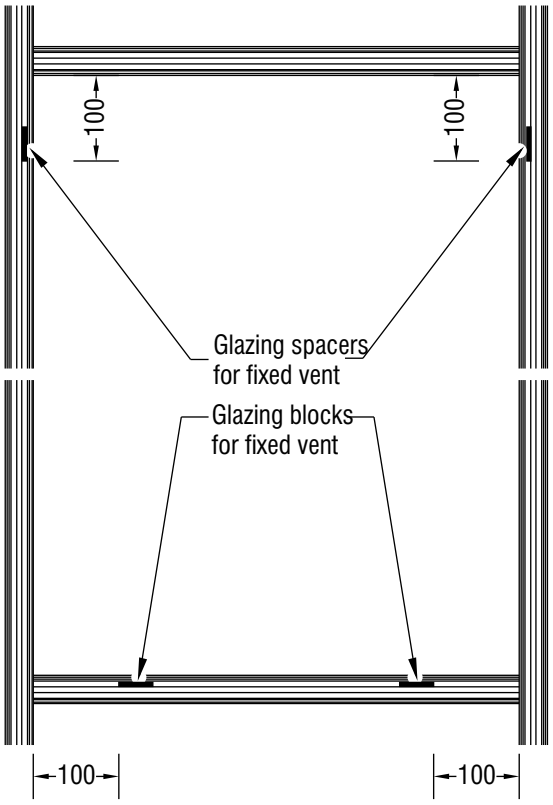


Figure 7.2.2
Use glass holders to support glazing
before installing pressure plates

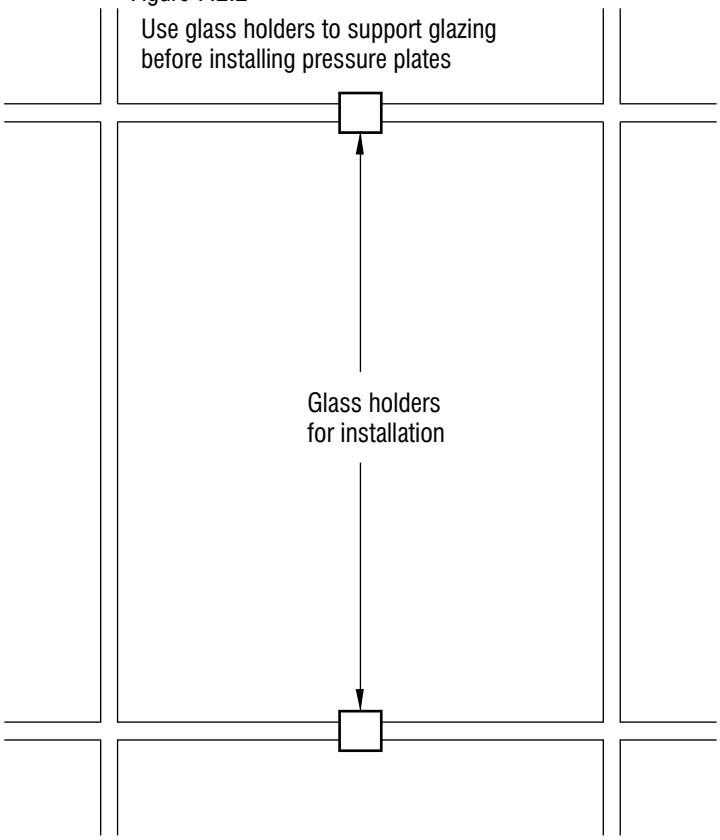


Figure 7.2.3
Glazing block detail

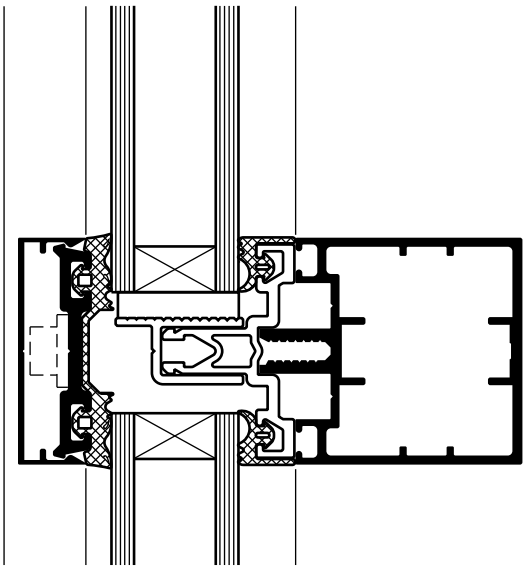
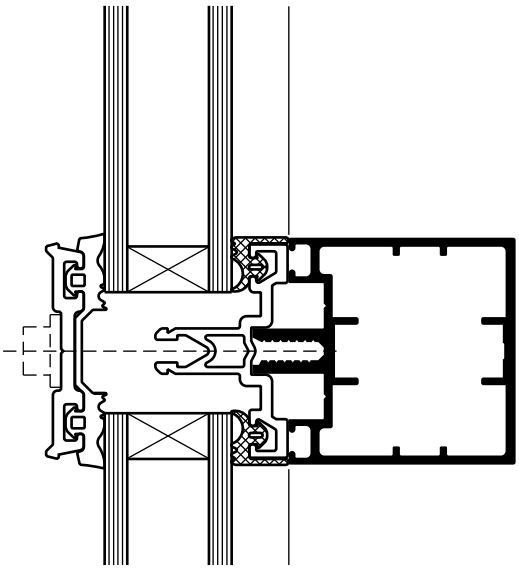


Figure 7.2.4
Glass holders can be made from
the pressure plates and gaskets



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Bracket and fixings

Function
Brackets and fixings are used to attach curtain walling and windows to the supporting structure. Windows are normally located within the supporting wall so that vertical loads are transferred to the structure by bearing at the window sill. Fixings are required to hold the frame securely in position and resist horizontal loads. Fixings may pass directly through the frame into the supporting structure. Alternatively a strap or lug may be attached to the frame and fixings pass through the strap into the supporting structure, Figure 8.1. The use of lugs or straps is essential for factory glazed windows. When through fixing care is needed to avoid crushing or distortion of the frame. Curtain walling is normally positioned in front of the supporting structure and brackets are required to connect the curtain wall to the structure. Fixings are then required to attach the brackets to the structure.

Performance of Brackets
Brackets are required to perform a number of functions as described below.

Loads
Vertical forces due to dead loads and horizontal forces due to live loads are transferred to the structure by the brackets. To transfer these loads two types of connection are required:
a) Support brackets are required to carry dead loads and these will prevent vertical movement of the mullion relative to the supporting structure. Only one support bracket is necessary for each length of mullion and provision of additional supports is undesirable as movement will be restricted (see below).
b) Restraint connections are required at both top and bottom of mullions to resist wind loads.
Two possible bracket arrangements for a single storey height mullion are shown in Figure 8.2. The top hung arrangement is more common but the bottom supported arrangement may be used, particularly for low rise construction. Where mullions span more than one storey restraint connections are usually provided at the intermediate floors.

Adjustment
All brackets should provide adjustment in three directions to overcome dimensional variations.

Means of adjustment include:

- Slotted holes for fixings
These may need to be combined with serrated surfaces to prevent further movement after adjustment or low friction surfaces to permit movement by sliding after installation;

- Site-drilling or welding after positioning of components. This may be used for final fixing after initial fixing with slotted holes. It is likely to be less successful for fixings into concrete as the required hole positions may coincide with reinforcement;

- Shims, packing pieces or washers
If excessive thicknesses are used nuts may not engage fully with bolt threads and bending stresses may be induced in bolts. Packing pieces may also reduce the contact area between components increasing stresses and inducing additional bending

- Sliding connections;

- Channel fixings - Comments for slotted holes apply:

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Bracket and fixings

Movements
Design of brackets needs to take account of movements of the curtain wall and structure to avoid:
- Imposing loads on the curtain wall for which it has not been designed
- Breakdown of seals due to large movements being transferred from the frame to the curtain wall. For stick curtain walls, vertical movements are usually accommodated in the splices between mullions which allow the sections of mullion to slide vertically but transfer horizontal load. Movements which cause shear of the curtain wall can usually be accommodated by rotation of the mullion/transom joints provided there is sufficient clearance between the frame and the infill. Although vertical movements will normally be greater than horizontal movements, horizontal movements must also be considered. All brackets should allow the required amount of movement after fixing. Movement accommodation should not be sacrificed to achieve fit of incorrectly sized elements and components.

Resistance to corrosion
Two forms of corrosion warrant consideration:
- General corrosion of individual components including brackets, fixing bolts and curtain walling
- Bi-metallic corrosion resulting from contact between components made from different metals.

Requirements for corrosion resistance also apply to fixings and are described in the materials section below.

Feasibility
Cladding is often erected at height in inclement conditions. Connection details should therefore be simple to construct, to improve safety and reduce the risk of poor workmanship.
Brackets which are capable of being lined and levelled in advance of cladding erection can produce overall cost benefits.

Fixings
Fixings are required to attach curtain wall brackets and windows to the structure. A wide variety of proprietary fixings is available. The selection of suitable fixings for a particular application depends on a number of requirements including the magnitude of the loads to be carried, the nature of the loads (shear, tension or compression), thickness of the fixture (including provision for packing or shims), the substrate and the required life of the fixing. Substitution of a specified fixing by an alternative type requires a reappraisal of all these factors. The load which fixings are required to carry varies greatly. Window frames will normally be secured with a number of fixings at intervals around the perimeter, Figure 8.3, giving fairly small loads at each fixing. A fixing for a curtain wall bracket will carry the total wind load for a larger area of cladding, Figure 8.4. The curtain wall fixing will also have to carry the dead load. The load from the curtain wall bracket may be carried by one or two fixings giving little scope for load redistribution in the event of failure whereas failure of a single window fixing may be accommodated
with little difficulty.

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Bracket and fixings

The performance of curtain wall fixings is therefore more critical to the safety of the installation. Fixings may be required to connect to steel, concrete or masonry. Brackets for curtain walling are commonly fixed to concrete floor slabs but can be fixed to the structural steel frame. Window frames are commonly fixed to masonry but may be fixed to concrete.

Steel
Fixings to steelwork are normally bolts which may connect directly to structural steel sections or to cleats welded to the sections. Any welding should normally be carried out by the steelwork fabricator prior to delivery to site.

Concrete
Fixings to concrete may be cast-in place or post installed. Cast-in place fixings are positioned in the formwork prior to casting the concrete and usually take the form of channels with T-head bolts or internally threaded sockets, Figure 8.5. There are three forms of post-installed fixings related to their method of load transfer as follows:

- Expansion anchors in which a metal cone is drawn into a metal sleeve or shield causing friction against the sides of the hole, Figure 8.6. In torque controlled fixings the expansion occurs as the fixing is tightened. In displacement controlled fixings the sleeve is forced over the cone using a hammer and a separate operation is required to connect the fixture to the installed fixing.

- Undercut anchors in which the end of the hole is enlarged allowing the end of the anchor to expand without inducing stress in the substrate, Figure 8.7. Mechanical interlock then provides resistance to pullout.

- Bonded anchors in which the anchor is held in the hole by resin which may either be introduced in the form of a glass capsule or may be injected from a cartridge, Figure 8.8. Resin anchors transfer the load over the whole of the bonded length giving lower contact stresses than other types of fixing. The performance of fixings in concrete depends on the strength of the concrete and density of aggregate. The choice of appropriate fixings will also take account of the practical problems of either securing the fixings to the formwork or alternatively drilling holes in the hardened concrete.

Masonry
Masonry can be a difficult material to fix into due to the wide range of strength of masonry materials, the presence of voids within the masonry units and the presence of mortar joints. Fixings should normally be located within the masonry unit rather than the mortar joint. Fixings for use in masonry include expansion anchors, bonded anchors, screws and specialist fixings designed for use in low strength materials, particularly aerated concrete Some expansion anchors with metal sleeves and cones are suitable for use in masonry but similar anchors with plastic sleeves and plastic wall plugs are also available. These may be standard wall plugs were the plug is embedded fully within the masonry and expands when a conventional screw is inserted, Figure 8.9, or frame fixings where the plug extends through the fixture into the masonry and may be expanded by a screw or nail, Figure 8.10. When perforated masonry units are used it may be necessary to use longer fixings which will pass
through several webs of material to provide a secure fixing. Bonded fixings may be used in solid masonry in the same way as they are used in concrete. However where hollow masonry units are used it may be necessary to use a net sleeve to contain the injected resin, Figure 8.11. Screws which will cut their own thread in predrilled holes in masonry materials are available, Figure 8.12.

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Bracket and fixings

Specialist fixings for use in aerated concrete include plastic plugs with fins which are hammered into predrilled holes, Figure 8.13, and anchors which are grouted into an enlarged hole using a cement grout, Figure 8.14.

Materials

Brackets may be manufactured for a particular installation requiring the specifier to select the appropriate material. Brackets may be made of aluminium, steel or stainless steel. In most cases proprietary fixings will be used and the choice of material depends on what is available. Fixings are commonly available in stainless steel or zinc plated and passivated steel. Most stainless steel fixings are available in grade 1.4401(316) but some are also available in other grades. Fixings may also be available in hot dip galvanised steel and unprotected carbon steel. Aluminium and stainless steel are durable in most conditions but stainless steel is available in different grades and an appropriate grade should be selected. Carbon steel components require protection which is commonly provided by galvanising or zinc plating. Galvanising gives greater protection than zinc plating but is less durable than stainless steel.
Aluminium, zinc coated steel and stainless steel are generally compatible in situations which are likely to occur in practice. Although there is an increased risk of corrosion of aluminium when it is in contact with stainless steel the risk depends on the relative areas of the materials. Stainless steel fixings for aluminium components are therefore acceptable whereas aluminium fixings for stainless steel are not. The specifier should have taken into account the durability of the materials used and the specified material and finish must not be changed without his agreement.

Installation

General

- Before installation all fixings should be checked to ensure that they are of the specified type, size and material. Fixings must be installed in accordance with the manufacturer's instructions.

- Setting out is required before fixings can be installed. Setting out should be related to the site datum rather than local features such as the slab edge or nearby column.

- The correct equipment is required. Some fixings require special tools supplied by the fixing manufacturer and may not operate correctly it alternative tools are used.

Cast in fixings in concrete

- Fixings should be securely fixed in place before placing the concrete
- The concrete should be allowed to cure before applying load to the fixings

Post drilled fixings

- Drill hole to correct diameter. Drills become worn with use and need to be replaced at intervals. Percussive drilling is normally required for concrete but when drilling into weak materials rotary drilling may be required to prevent enlargement of the hole.

- In all cases the hole must be deep enough to allow the fixing to be inserted to its full depth.
For some fixings a greater depth of hole will not affect the fixing performance. However, for some types of fixing, for example bonded fixings with resin capsules and some displacement controlled expansion anchors, an overlong fixing hole may prevent the correct operation of the fixing.

- Ensure holes are square to the surface.

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Bracket and fixings

-Ensure minimum edge distance and spacing is provided. Reducing the edge distance and spacing reduces the strength of the fixing.

- Ensure reinforcing steel is avoided and agree procedures to be adopted where holes conflict with reinforcement. Reinforcement should only be cut with the agreement of the structural engineer and when the cut reinforcement will not affect the operation of the fixing.

- Where holes are aborted, due to hitting reinforcement or for any other reason, procedures for filling aborted holes and minimum spacing for replacement holes must be agreed.

- Clean hole thoroughly: blowing is usually sufficient for mechanical anchors, brushing is required for bonded anchors.

- For bonded fixings ensure temperature and moisture conditions are suitable and allow resin to cure before applying load.

- Position fixing correctly.

- Tighten to specified torque using calibrated torque spanner. If too low a torque is used the anchor may not clamp the fixture securely when subject to tensile load and expansion anchors may not give the required pullout strength. Too high a torque may damage the fixing material or may break the bond of resin anchors.

- Fixings should be marked for example by spraying with paint to indicate that the correct torque has been applied.

Packing and shims

- Shims should be made of material with suitable strength and durability. Plastic shims may be used when fixing window frames but metal shims should be used when fixing brackets. When metal shims are used the metal must be of sufficient inherent durability for the exposure conditions and be compatible with other metals with which it may come in contact.

- Shims should be of sufficient size to prevent concentrated loads.

- Use of shims will lead to increased bending stresses in fixings subject to shear load. The maximum thickness of shims should be specified and not exceeded.

Slotted holes

- Where slotted holes are used to provide adjustment it is important to use washers which are sufficiently thick to bridge the slot without deformation.

- Where slotted holes are used to provide adjustment but additional movement is to be prevented during the service life a means of locking the fixing is required. Friction under the clamping action of the fixing is not sufficient.

- This is usually achieved by the use of serrated surfaces. The pitch of the serrations must be selected to give sufficiently fine adjustment.

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Bracket and fixings

Testing

- In most cases proprietary fixings can be used in situations covered by the manufacturer's test data however occasionally testing may be required to check the suitability of fixings. This is most likely to occur when fixing to an existing structure and the properties of the substrate are unknown.

- To check the quality of installation a proportion of the installed fixings may be tested. The test load must be sufficiently high to give a meaningful test but not so high that correctly installed fixings are damaged. Testing is more likely to be required for curtain wall fixings than for window fixings.

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Figure 8.1.1
Assembly of support bracket
to the top of the slab

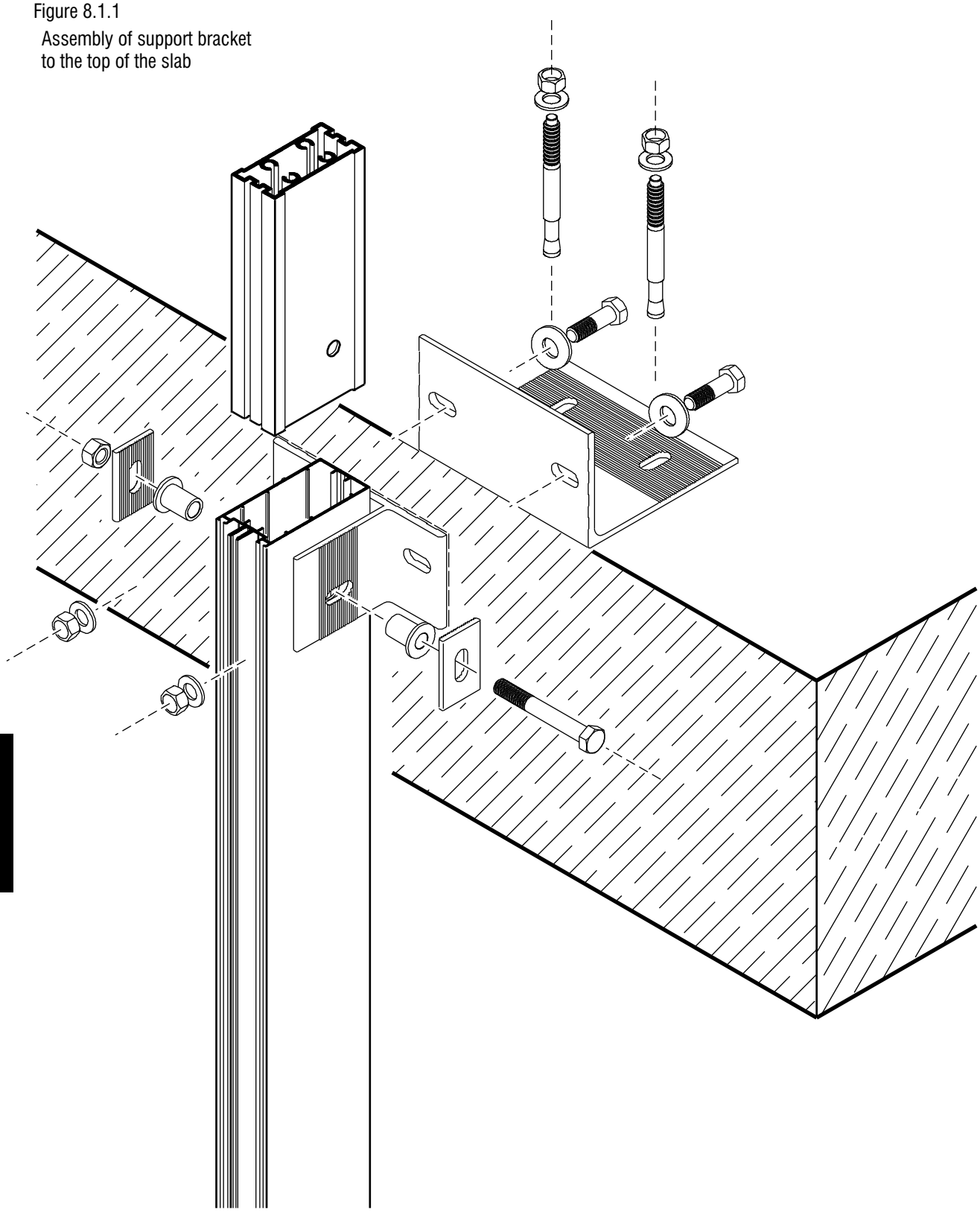

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Figure 8.2.1
Assembly of support bracket to concrete floor with stainless steel expansion bolts

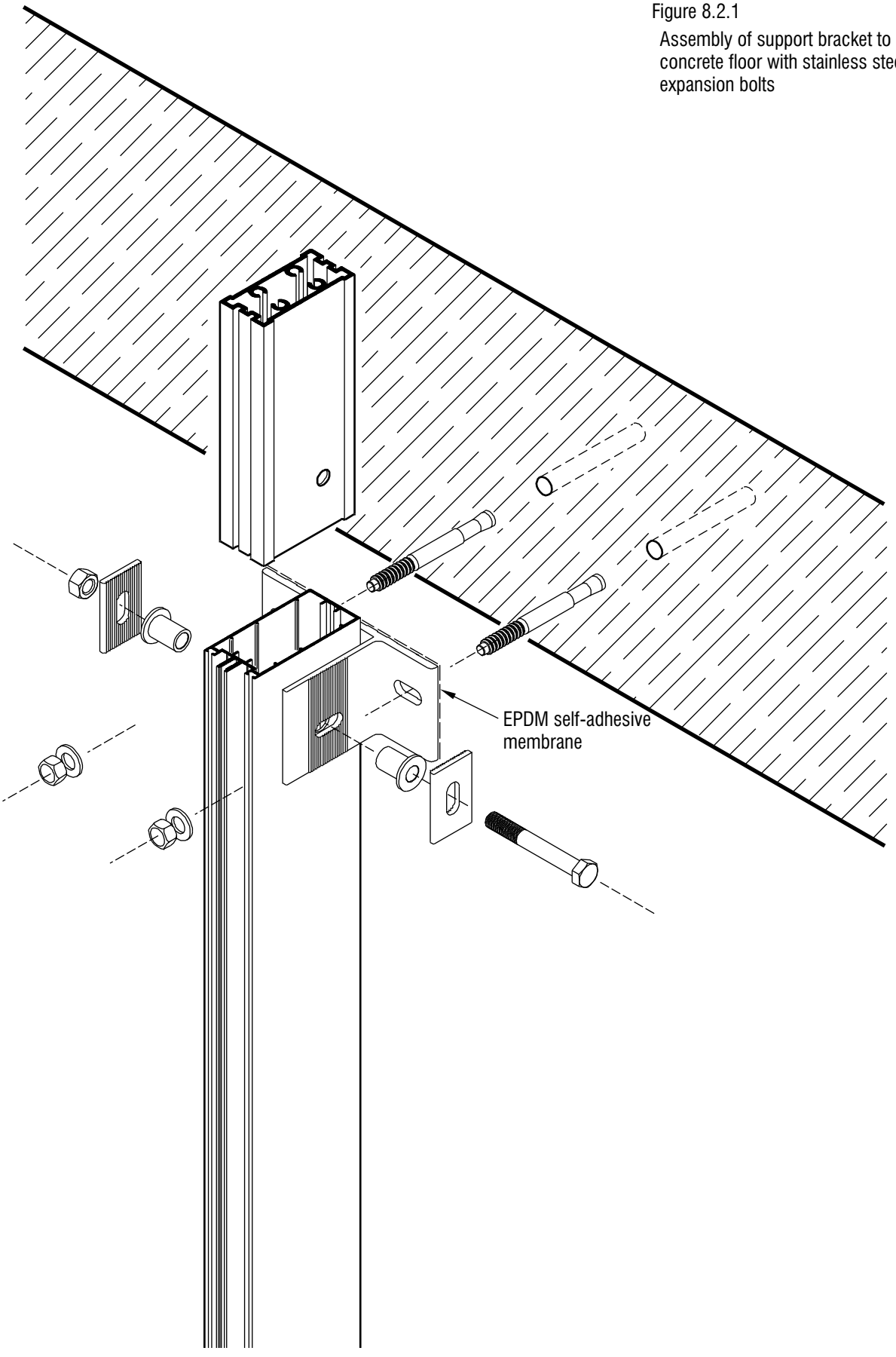

Figure 8.3.1
Assembly of support bracket to aluminum channel embedded into the concrete

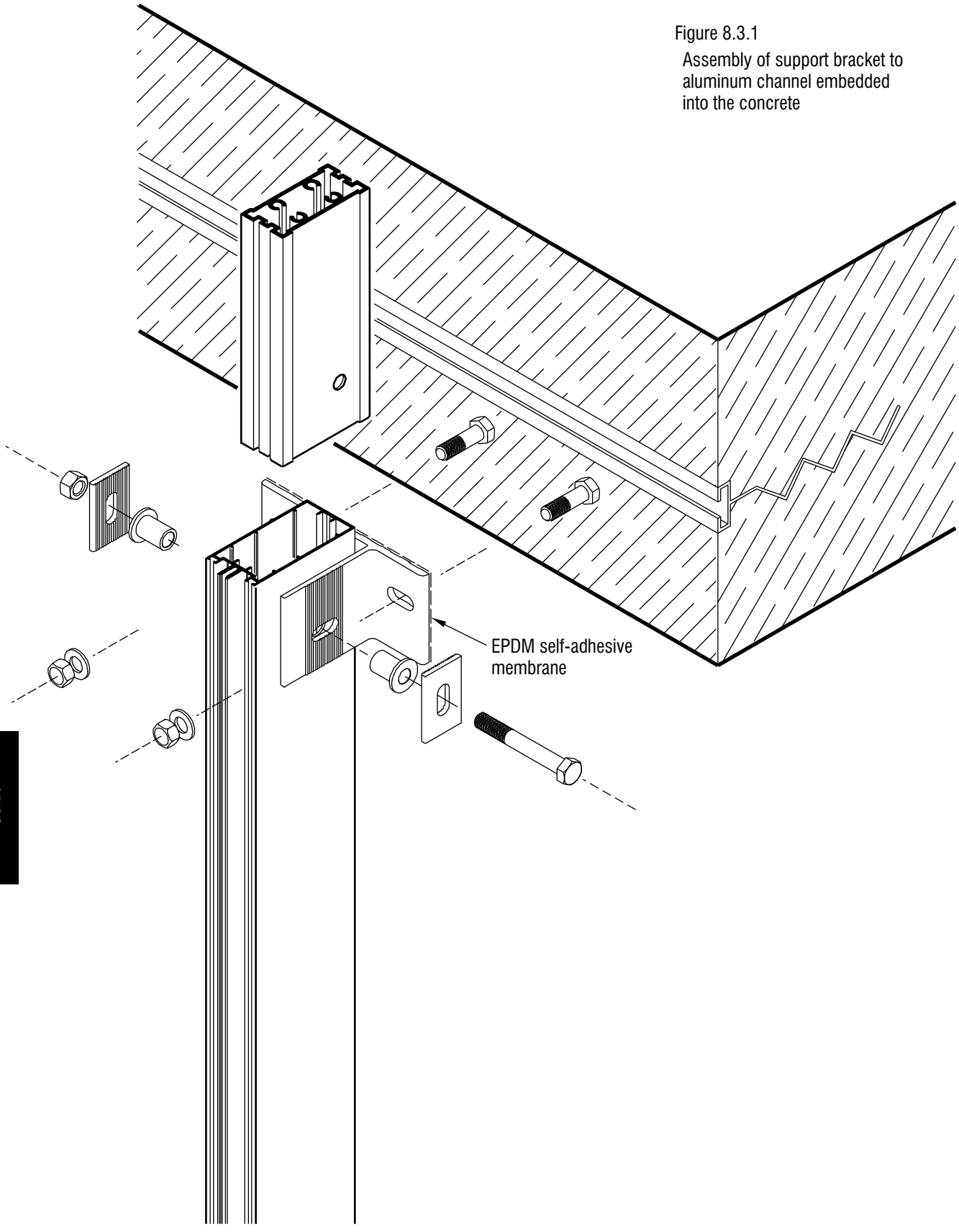

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Figure 8.4.1
Floor bracket assembly
for half mullions

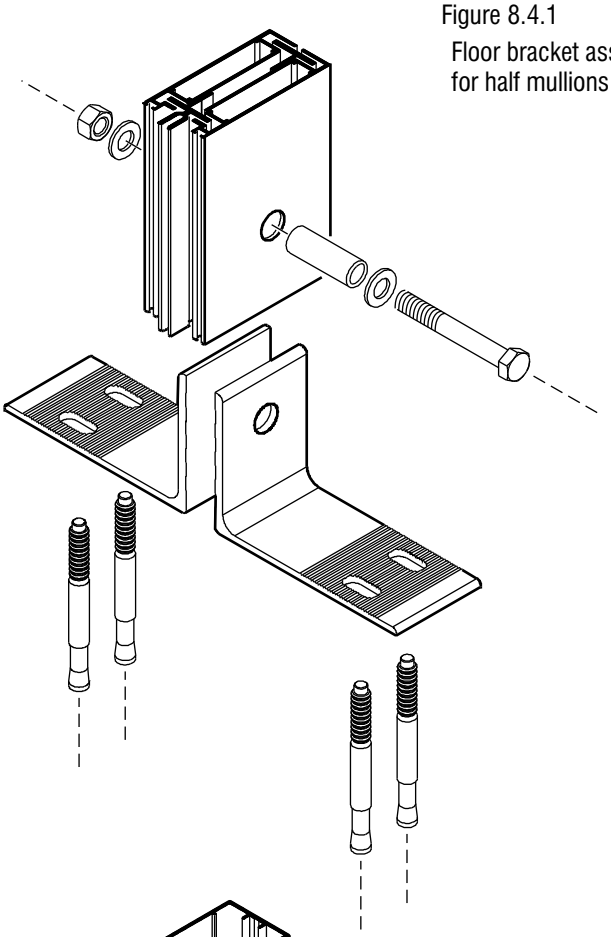


Figure 8.4.2
Floor bracket assembly
with profile insert and
aluminum base plate

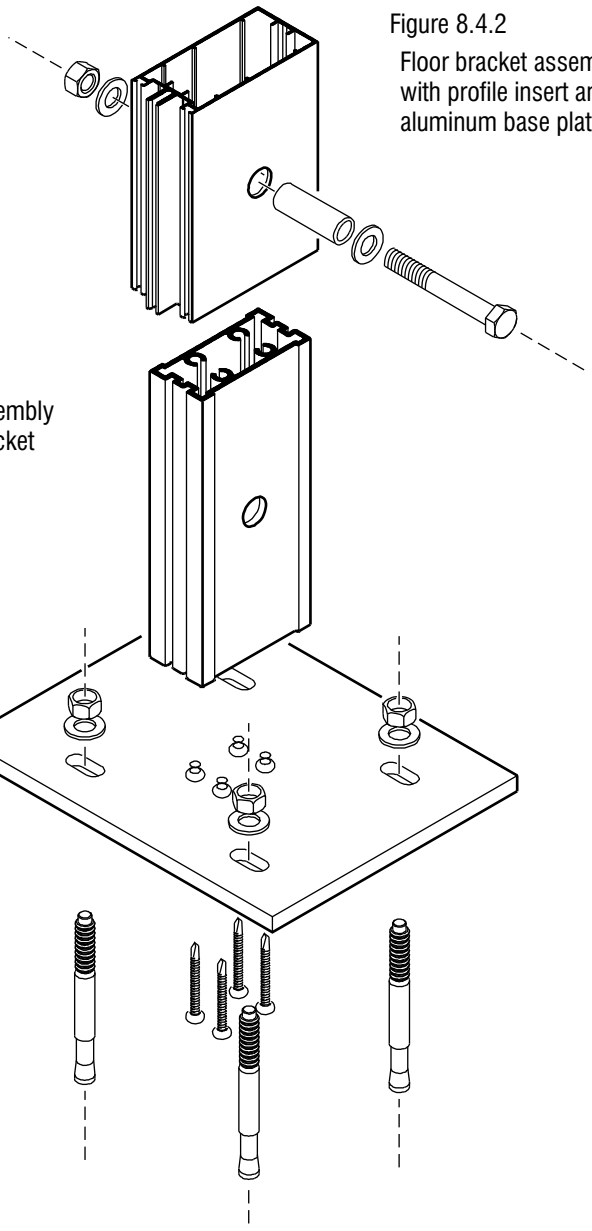
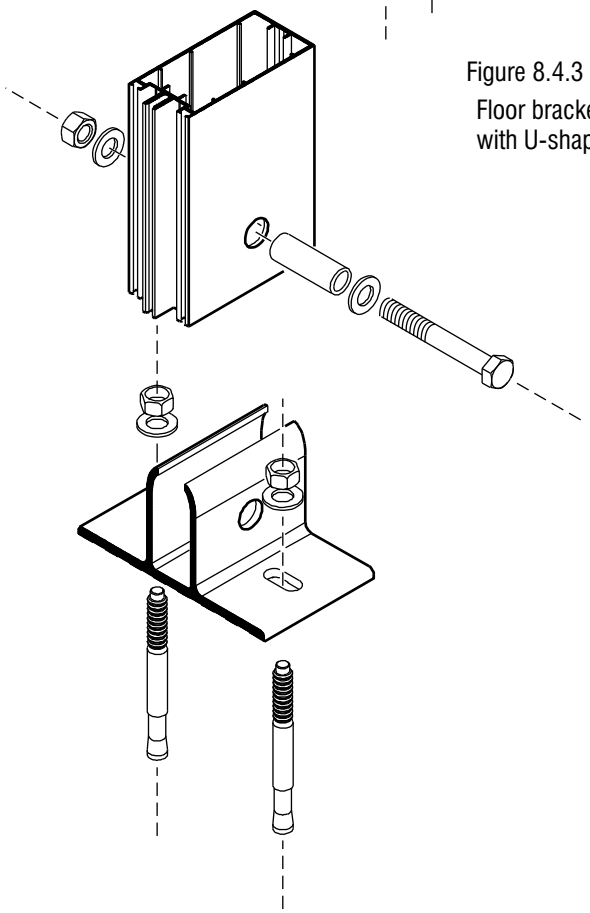


Figure 8.4.3
Floor bracket assembly
with U-shape bracket



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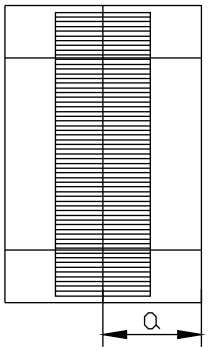
1. General Remarks

The following data and tables are provided as a guide for calculating wind loads, snow loads, and dead loads for various aluminum constructions. This information has been developed by engineers and is intended to be used by engineers as a supplement and not as a replacement to the European-Union building codes and standards, the national building codes and standards specific to each country or the general conditions and technical reports that apply to any particular project. Load bearing requirements and reinforcements must be specified according to individual calculations. All calculations and specifications should be made by a registered/authorize architect or engineer or company that has experience with curtain wall design in your local area. We do not assume any liability for calculations made using the following information. These calculations do not replace the necessary structural engineering surveys.

2. Column calculations

2.1 Moment of inertia formula for the columns

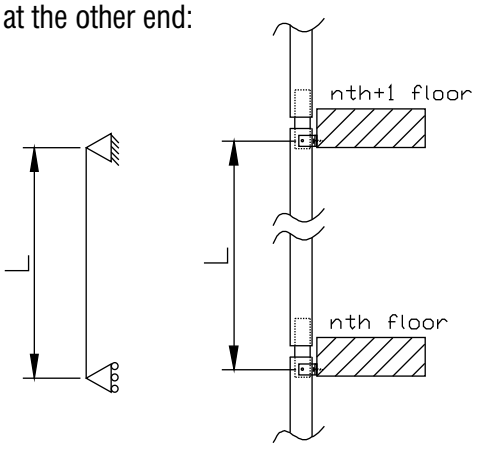
In Aluminium curtain wall systems, the choice of the profile to be used at a particular structure is based on the calculation of the required Moment of Inertia (MoI) of the aluminium profiles. The column must be stiff enough not to deform excessively when is subjected to the maximum design loads. The amount of column bending should be small enough to prevent the glazing to crack. The main loading of the columns is due to the wind pressure. It is assumed that each column is loaded by the force that half glass panel transmits to it on one side, and half glass panel on the other side, resulting in rectangular loading (see figure below). The columns can be supported in different ways, and the corresponding formulae for the Moment of Inertia (MoI) must be used during calculations. Here we will consider three different column support configurations:



In the following equations:
I : Required Moment of Inertia of the column (cm^4)
W : Wind load (kN/m^2)
L : Length (m)
E : Young's Modulus of Elasticity (GPa)
a : Distance between columns (m)
F = , or 0.015m, whichever is smaller (glazing requirement-see below)

2.1.1 One end simply supported, with rolling support at the other end:

$$I = \frac{5 \times W \times a \times L^4}{384 \times E \times F} \times 100$$



This is the typical support case for curtain wall columns that span from floor to floor at a multistory building. The top end of the column can pivot around the screw that connects it with the structural bracket, and the lower end can slide on the insert that connects it with the column below.

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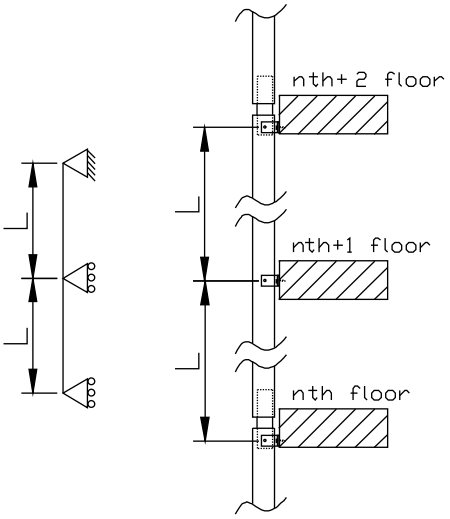
2.1.2 One end simply supported, and rolling support at the middle and at the other end:

$$I = \frac{5 \times W \times a \times L^4}{922 \times E \times F} \times 100$$



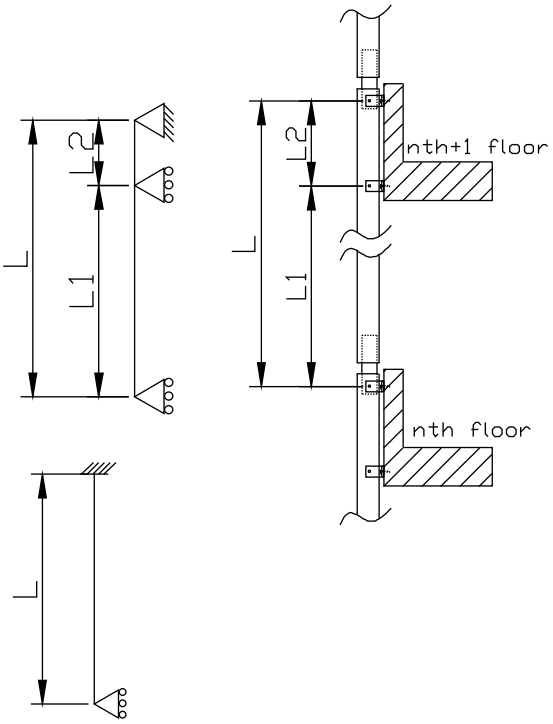
In this case we support the column with a support bracket at the middle, situated at the intermediate floor, if the column spans two floors. Alternatively the middle bracket can be fixed on a steel beam, mounted horizontally in the space between two floors. Note that the length L in this case is the distance between the support points and not the total column length.

2.1.3 One end simply supported, with a rolling support near the simple support, and a rolling support at the other end. Here we have two cases:

2.1.3a If

$$\frac{L_2}{L_1} \geq 0.2$$

$$I = \frac{W \times a \times L_1^2}{384 \times E \times F} \times \left(9 \times L \times L_1 - 3 \times L^2 - 4 \times L_1^2\right) \times 100$$



This formula can be used in the case where there is a reinforced concrete wall section at each floor. This allows the column to be supported at three points, two of them being close to each other at the top, and one at the bottom.

2.1.3b If $\frac{L_2}{L_1} < 0.2$ $\qquad I = \frac{W \times a \times L^4}{185 \times E \times F} \times 100$

In this case the upper end of the column is essentially fixed. This can be achieved using two brackets quite close to each other, or by using one bracket which is big enough to accommodate two holes and two mounting screws along the direction of the length of the column.

3. Value of wind pressure (W)

The value of the wind pressure to be used in the calculations depends primarily on the height from the floor level where the curtain wall is situated. As a guideline, the wind pressure values with respect to the structure height are given in the table below:

Building height (m)	Wind Pressure (kN/m²)
0 - 8	0.5
8 - 20	0.8
20 - 100	1.1

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In some cases a correction factor must be used, to take into account specific environmental conditions. As a design rule, the wind pressure caused by a certain wind speed is given by the equation:

Where:

W : Wind load (kN/m^2)

V : Design (maximum) wind speed (km/hr)

$$W = \frac{483 \times V^2}{10^7}$$

4. Allowable deflection (F)

In accordance with EN 13830: 2003

The curtain walling shall be sufficiently rigid to resist the declared wind loads for serviceability (5.2.3. c), both positive and negative, when tested in accordance with EN 12179. It shall transfer the declared wind loads to the building's structure, safely, via the fixings intended for that purpose. The declared wind load results from testing in accordance with EN 12179.

Under the declared wind loads the maximum frontal deflection of the curtain walling's framing members shall not exceed L/200, or 15 mm, whichever is the less, when measured between the points of support or anchorage to the building's structure, in compliance with EN 13116.

5. Transverse calculations

The transverse loading is mainly due to the weight of the glazing along the vertical direction, and due to the wind load horizontally.

6. Required glazing thickness

For single glazing, the minimum thickness is calculated using the following equations:

1) For , $\frac{D_g}{D_s} \leq 3$ $\quad e = \sqrt{\frac{1000 \times D_g \times D_s \times W}{72}}$

2) For, $\frac{D_g}{D_s} > 3$ $\quad e = \frac{L \times \sqrt{1000 \times W}}{4.9}$

In the above equations:

e : Minimum theoretical glass thickness (mm)

W : Wind load (kN/m^2)

D_s : The smaller glazing dimension (width or length) (m)

D_g : The greater glazing dimension (width or length) (m)

in accordance with EN 13830: 2003

The curtain walling shall sustain its self-weight plus any attachments incorporated into it by original design. It shall transfer the weight to the building structure, safely, via the fixings intended for that purpose.

Self-weights shall be determined in accordance with EN 1991-1-1.

The maximum deflection of any main horizontal framing from vertical loads shall not exceed L/500 or 3 mm, whichever is the less.

Always consult the glazing manufacturer when calculating the required glazing thickness and maximum allowable dimensions.

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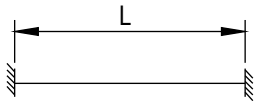
In case that a double glazing is the minimum total thickness of both glass panels will be equal to the minimum single glazing thickness multiplied by 1.5. For a Triplex glazing the minimum total thickness of both glass panels will be equal to the minimum single glazing thickness multiplied by 1.7.

7. Glazing weight

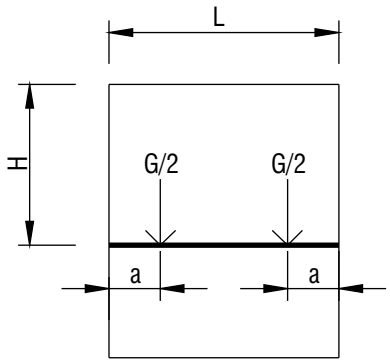
After selecting the glass thickness to be used, the total weight of the glazing can be calculated: we have 2.5kg per m^2 of glazing area per mm of glass thickness. For example, a 10mm thick glass (or a double glazing with 5+5 or 4+6 mm glass panels) will weight 25 kg per m^2. Always consult with glazing manufacturing for glazing weight and maximum glazing panel size.

8. Moment of inertia formulae for the Transverse



The transverse is supported by two fixed supports at both ends.

Bending in the vertical plane



The required MoI for the transverse for bending in the vertical plane (due to the weight of the glazing) is given by the equation:

$$I_y = \frac{G \times a}{48 \times E \times F_T} \times \left(3 \times L^2 - 4 \times a^2\right)$$

Bending in the horizontal plane

The required MoI for the transverse for bending in the horizontal plane (due to the wind pressure) is given by the equation (fixed support at both ends):

$$I_x = \frac{W \times H \times a^4}{384 \times E \times F} \times 100$$

In the above equations:

Ix = Required Moment of Inertia of the transverse for bending in the horizontal plane (cm^4)
Iy = Required Moment of Inertia of the transverse for bending in the vertical plane (cm^4)
W = Wind load (kN/m^2)
G = Total glazing weight (kg)
H = Glazing height (m)
a = Distance of the glazing support wedge from the transverse end (a =0,15m)
L = Width of glazing (m)
E = Young's Modulus of Elasticity (GPa)

Ft = $\frac{L}{500}$,or 0,003m , whichever is smaller (EN 13830)

F = $\frac{L}{200}$, or 0.015m, whichever is smaller (EN 13830)

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9. Procedure for the static pre-dimensioning of facade profiles

1, Determine the required moment of inertia for mullion and transom based on wind loads and installation height

2, Determine the required moment of inertia (deflection) for transom based on insert element weight and centre-to-centre distances

3, Verify wether dimensioning of T-bracket and glass retainer is sufficient with regard to requirements

The sequence of procedure may be changed, but all items for static pre-dimensioning must be checked!

10. Example calculation

The following pages give examples of various situations and how to calculate the required moment of inertia for mullions and transoms. After determinig the required values you should choose the correct profile or profile combination from the profile load bearing chart on the Table 7.7.

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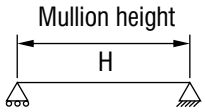
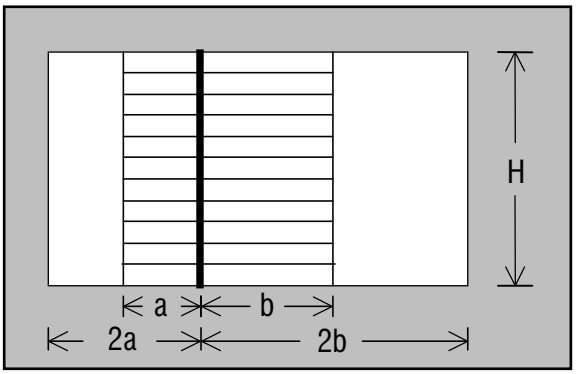
11.1 Example of a calculation for a uniform load with two supports

Mullion pre-dimensioning



Installation height		15 m
Correction factor		$F_W = 1,6$
Pane width	2a	120 cm
Pane width	2b	320 cm
Height between supports	H	300 cm
Load width (Case C)	a	60 cm
Load width (Case A)	b	150 cm



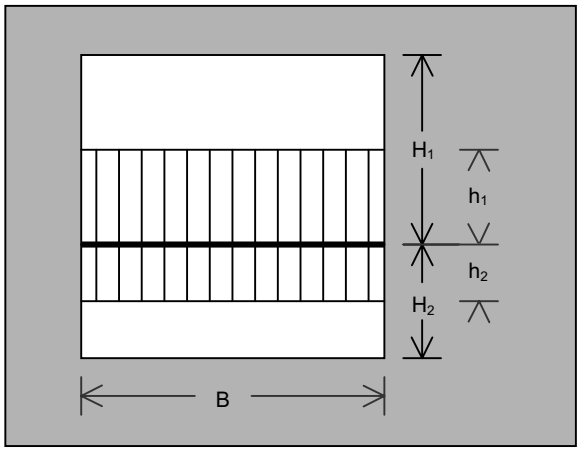
Required I_x in accordance with Table 5a:

$I_{x,a}$	=	30,1 cm^4
$I_{x,b}$	=	75,3 cm^4
$I_{x,total}$	=	105,4 cm^4

$I_{x,req} = F_w * I_{x,total} = 1,6 * 105,4\,cm^4 = 168,7\,cm^4$

Transom pre-dimensioning

Installation height		15 m
Correction factor		$F_W = 1,6$
Panewidth B		200 cm
Pane height H_1		200 cm
Pane height H_2		100 cm
Load width h_1 (Case C)		100 cm
Load width h_2 (Case C)		50cm



Required I_x in accordance with Table 5a:

$I_{x,1}$	=	14,9 cm^4
$I_{x,2}$	=	7,4 cm^4
$I_{x,total}$	=	22,3 cm^4

$I_{x,req} = F_w * I_{x,total} = 1,6 * 22,3\,cm^4 = 35,7\,cm^4$

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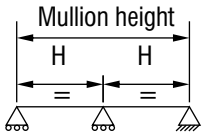
11.2 Determining the required moment of inertia for mullion and transom based on wind loads and installation height



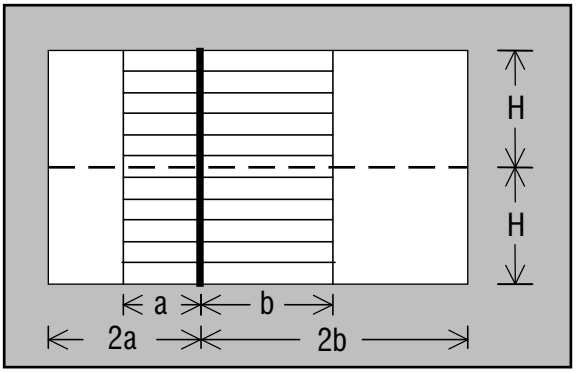
Example of a calculation for uniform load with three supports

Mullion pre-dimensioning

Installation height 80 m
Correction factor $F_w = 2,2$

Pane width 2a 200cm
Pane width 2b 200cm
Height H 350cm
between supports

Load width a 100cm
(Case C)
Load width b 100cm
(Case A)



Required I_x in accordance with Table 6a:

$I_{x,a} = 38,8\ cm^4$
$I_{x,b} = 38,8\ cm^4$
$I_{x,total} = 77,6\ cm^4$

$I_{x,req} = F_w * I_{x,total} = 2,2 * 77,6\ cm^4 = 170,7\ cm^4$

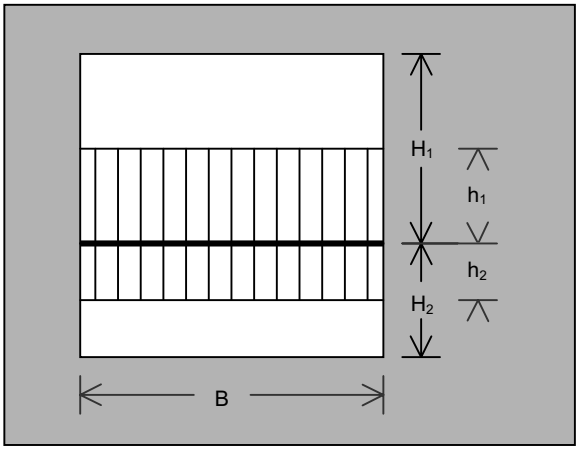
Selected profile: 500011 $I_x = 272,5\ cm^4$
Alernate selection: 500009 + 500085 $I_x = 233,5\ cm^4$

Transom pre-dimensioning

Installation height 80 m
Correction factor $F_W = 2,2$

Pane width B 200 cm
Pane height H_1 200 cm
Pane height H_2 50 cm

Load width h_1 100 cm
(Case C)
Load width h_2 25 cm
(Case C)



Required I_x in accordance with Table 5a:

$I_{x,1} = 14,9\ cm^4$
$I_{x,2} = 3,8\ cm^4$
$I_{x,total} = 18,7\ cm^4$

$I_{x,req} = F_w * I_{x,total} = 2,2 * 18,7\ cm^4 = 41,1\ cm^4$

Selected profile: 500007 $I_x = 74,5\ cm^4$

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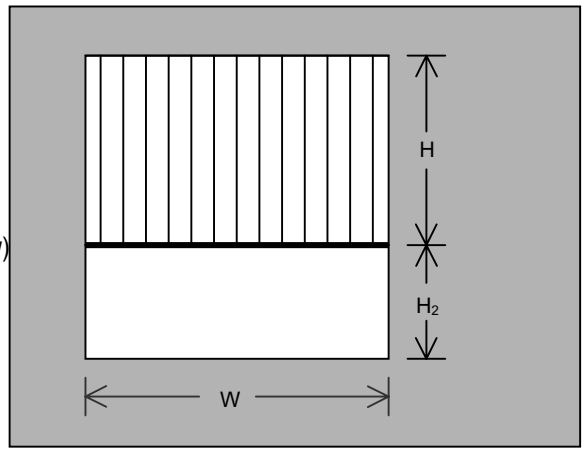
11.3 Determining the required moment of inertia I_y (deflection) for transom based on insert element weight and centre-to-centre distances

Panel height H = 200cm
Panel width W = 200cm
Glass thickness = 16mm

Reading value I_y = 23,2 cm^4 / kN
from Table 7 and 7a
Correction factor F_W = 1,33

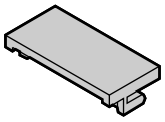
I_{yreq} = (reading value) * (correction factor Fw)

I_{yreq} = 23,2 * 1,33 = 31 cm^4



I_y of transom profile 500 007 is = 24,76 cm^4, this is smaller than the required amount!
Now you must select a new profile: 500 011 with an I_y = 38,9 cm^4
Alternate selection: 500007 +500084 with an I_y = 49,5 cm^4

11.4 Verify the maximum weight capacity of the glazing bridge



720 50 061	Glazing thickness = 24-30mm	Maximum glazing weight = 180Kg
720 50 062	Glazing thickness = 30-36mm	Maximum glazing weight = 270Kg
720 50 063	Glazing thickness = 36-42mm	Maximum glazing weight = 360Kg

Insert element area = 2,0 m x 2,5 m = 5 m^2 =
mullion centre-to-centre distance x transom centre-to-centre distance
Insert element weight = 200 kg ≅ 2,0 kN
Glazing thickness = 32 mm (6/16/5/5)
Installation height = untill 100 m

The appropriate glazing bridge is the 720 50 062

30 mm and 36 mm = 270Kg = 2,70 kN

Result: reading value higher than insert element weight = > ok

11.5 Total result of example calculation

1. Required moment of inertia of mullion $I_{x\,mullion}$ = 170,7 cm^4
   Required moment of inertia of transom $I_{x\,transom}$ = 41,1 cm^4
   Required moment of inertia of transom $I_{y\,req,}$ = 31 cm^4

2. Load capacity of glazing bridge is taken from the article 720 50 062 with a rebate width between 30 mm and 36 mm = 270Kg = 2,70 kN

Selected mullion profile: 500 013 with I_x = 433,10 cm^4, I_y = 45,78 cm^4

Selected transom profile: 500 011 with I_x = 272,45 cm^4, I_y = 38,87 cm^4

Due to the high glazing panel weight and the large centre-to-centre distance, profile 500011 was chosen for the transom, As the transom must not be deeper than the mullion, profile 500013 had to be chosen for the mullion as well, even though a smaller dimension would have been possible from the wind load requirements.

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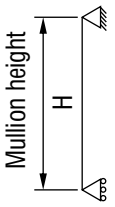
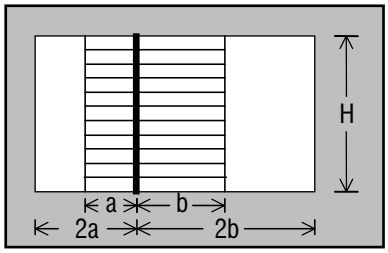
Table 7.1.1: Required moments of inertia I_x for a uniform load with two supports
Modulus of elasticity aluminium = 7000 kN/cm² - deflection $f_{max} = l / 200$, or ≦ 15mm

$$I_x = \frac{5 W a H^4}{384 E f}$$

W = dynamic wind pressure kN/m²
a = load width
b = load width
H = height between brackets
E = modulus of elasticity 7000 kN/cm²
f = maximum deflection ≦ 8mm





H = mullion height in cm
2a = width between mullions in cm
2b = width between mullions in cm

load width in cm

height in cm	20	30	40	50	60	70	80	90	100	110
100	0,4	0,6	0,7	0,9	1,1	1,3	1,5	1,7	1,9	2,0
110	0,5	0,7	1,0	1,2	1,5	1,7	2,0	2,2	2,5	2,7
120	0,6	1,0	1,3	1,6	1,9	2,3	2,6	2,9	3,2	3,5
130	0,8	1,2	1,6	2,0	2,5	2,9	3,3	3,7	4,1	4,5
140	1,0	1,5	2,0	2,6	3,1	3,6	4,1	4,6	5,1	5,6
150	1,3	1,9	2,5	3,1	3,8	4,4	5,0	5,7	6,3	6,9
160	1,5	2,3	3,0	3,8	4,6	5,3	6,1	6,9	7,6	8,4
170	1,8	2,7	3,7	4,6	5,5	6,4	7,3	8,2	9,1	10,1
180	2,2	3,3	4,3	5,4	6,5	7,6	8,7	9,8	10,8	11,9
190	2,6	3,8	5,1	6,4	7,7	8,9	10,2	11,5	12,8	14,0
200	3,0	4,5	6,0	7,4	8,9	10,4	11,9	13,4	14,9	16,4
210	3,4	5,2	6,9	8,6	10,3	12,1	13,8	15,5	17,2	18,9
220	4,0	5,9	7,9	9,9	11,9	13,9	15,8	17,8	19,8	21,8
230	4,5	6,8	9,1	11,3	13,6	15,8	18,1	20,4	22,6	24,9
240	5,1	7,7	10,3	12,9	15,4	18,0	20,6	23,1	25,7	28,3
250	5,8	8,7	11,6	14,5	17,4	20,3	23,3	26,2	29,1	32,0
260	6,5	9,8	13,1	16,3	19,6	22,9	26,2	29,4	32,7	36,0
270	7,3	11,0	14,6	18,3	22,0	25,6	29,3	33,0	36,6	40,3
280	8,2	12,3	16,3	20,4	24,5	28,6	32,7	36,8	40,8	44,9
290	9,1	13,6	18,1	22,7	27,2	31,8	36,3	40,8	45,4	49,9
300	10,0	15,1	20,1	25,1	30,1	35,2	40,2	45,2	50,2	55,2
310	11,5	17,2	22,9	28,6	34,4	40,1	45,8	51,5	57,3	63,0
320	13,0	19,5	26,0	32,5	39,0	45,5	52,0	58,5	65,0	71,5
330	14,7	22,1	29,4	36,8	44,1	51,5	58,8	66,2	73,5	80,9
340	16,6	24,9	33,1	41,4	49,7	58,0	66,3	74,6	82,9	91,1
350	18,6	27,9	37,2	46,5	55,8	65,1	74,4	83,7	93,0	102,3
360	20,8	31,2	41,7	52,1	62,5	72,9	83,3	93,7	104,1	114,6
370	23,2	34,9	46,5	58,1	69,7	81,3	93,0	104,6	116,2	127,8
380	25,9	38,8	51,7	64,6	77,6	90,5	103,4	116,4	129,3	142,2
390	28,7	43,0	57,4	71,7	86,1	100,4	114,8	129,1	143,4	157,8
400	31,7	47,6	63,5	79,4	95,2	111,1	127,0	142,9	158,7	174,6
410	35,0	52,6	70,1	87,6	105,1	122,6	140,2	157,7	175,2	192,7
420	38,6	57,9	77,2	96,5	115,8	135,1	154,4	173,6	192,9	212,2
430	42,4	63,6	84,8	106,0	127,2	148,4	169,6	190,8	212,0	233,2
440	46,5	69,7	93,0	116,2	139,4	162,7	185,9	209,2	232,4	255,6
450	50,9	76,3	101,7	127,1	152,6	178,0	203,4	228,8	254,3	279,7
460	55,5	83,3	111,0	138,8	166,6	194,3	222,1	249,9	277,6	305,4
470	60,5	90,8	121,0	151,3	181,5	211,8	242,0	272,3	302,6	332,8
480	65,8	98,7	131,7	164,6	197,5	230,4	263,3	296,2	329,1	362,1
490	71,5	107,2	143,0	178,7	214,5	250,2	286,0	321,7	357,4	393,2
500	77,5	116,3	155,0	193,8	232,5	271,3	310,0	348,8	387,5	426,3
550	113,5	170,2	227,0	283,7	340,4	397,2	453,9	510,6	567,4	624,1
600	160,7	241,1	321,4	401,8	482,1	562,5	642,9	723,2	803,6	883,9

Note: When calculating the required moment of inertia for steel, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. (E=21000 kN/cm²)

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Table 7.1.1: Required moments of inertia I_x for a uniform load with two supports (continued)
Modulus of elasticity aluminium = 7000 kN/cm² - deflection $f_{max} = l / 200$, or ≦ 15mm

$I_{x\ required} = (I_{xa} + I_{xb}) * Fw$

I_{xa} = moment of inertia from table 5a
I_{xb} = moment of inertia from table 5a
Fw= correction factor from table 5b

This chart is made for a dynamic wind pressure of 0,5kN/m . A correction factor "Fw" must be used in order to calculate the required dynamic wind pressure.

Table 7.1.2:

Height above ground (m)	Dynamic pressure kN/m²	Factor Fw
0 - 8	0,5	1,0
8 - 20	0,8	1,6
20 - 100	1,1	2,2
> 100	1,3	2,6

load width in cm

height in cm	120	130	140	150	160	170	180	190	200	210
100	2,2	2,4	2,6	2,8	3,0	3,2	3,3	3,5	3,7	3,9
110	3,0	3,2	3,5	3,7	4,0	4,2	4,5	4,7	5,0	5,2
120	3,9	4,2	4,5	4,8	5,1	5,5	5,8	6,1	6,4	6,8
130	4,9	5,3	5,7	6,1	6,5	6,9	7,4	7,8	8,2	8,6
140	6,1	6,6	7,1	7,7	8,2	8,7	9,2	9,7	10,2	10,7
150	7,5	8,2	8,8	9,4	10,0	10,7	11,3	11,9	12,6	13,2
160	9,1	9,9	10,7	11,4	12,2	13,0	13,7	14,5	15,2	16,0
170	11,0	11,9	12,8	13,7	14,6	15,5	16,4	17,4	18,3	19,2
180	13,0	14,1	15,2	16,3	17,4	18,4	19,5	20,6	21,7	22,8
190	15,3	16,6	17,9	19,1	20,4	21,7	23,0	24,2	25,5	26,8
200	17,9	19,3	20,8	22,3	23,8	25,3	26,8	28,3	29,8	31,3
210	20,7	22,4	24,1	25,8	27,6	29,3	31,0	32,7	34,5	36,2
220	23,8	25,7	27,7	29,7	31,7	33,7	35,7	37,6	39,6	41,6
230	27,2	29,4	31,7	33,9	36,2	38,5	40,7	43,0	45,3	47,5
240	30,9	33,4	36,0	38,6	41,1	43,7	46,3	48,9	51,4	54,0
250	34,9	37,8	40,7	43,6	46,5	49,4	52,3	55,2	58,1	61,0
260	39,2	42,5	45,8	49,0	52,3	55,6	58,8	62,1	65,4	68,7
270	43,9	47,6	51,3	54,9	58,6	62,2	65,9	69,6	73,2	76,9
280	49,0	53,1	57,2	61,3	65,3	69,4	73,5	77,6	81,7	85,8
290	54,4	59,0	63,5	68,0	72,6	77,1	81,7	86,2	90,7	95,3
300	60,3	65,3	70,3	75,3	80,4	85,4	90,4	95,4	100,4	105,5
310	68,7	74,4	80,2	85,9	91,6	97,3	103,1	108,8	114,5	120,3
320	78,0	84,5	91,0	97,5	104,0	110,5	117,0	123,5	130,0	136,5
330	88,2	95,6	102,9	110,3	117,7	125,0	132,4	139,7	147,1	154,4
340	99,4	107,7	116,0	124,3	132,6	140,9	149,1	157,4	165,7	174,0
350	111,7	121,0	130,3	139,6	148,9	158,2	167,5	176,8	186,1	195,4
360	125,0	135,4	145,8	156,2	166,6	177,0	187,5	197,9	208,3	218,7
370	139,4	151,1	162,7	174,3	185,9	197,5	209,2	220,8	232,4	244,0
380	155,1	168,1	181,0	193,9	206,9	219,8	232,7	245,6	258,6	271,5
390	172,1	186,5	200,8	215,2	229,5	243,9	258,2	272,5	286,9	301,2
400	190,5	206,3	222,2	238,1	254,0	269,8	285,7	301,6	317,5	333,3
410	210,3	227,8	245,3	262,8	280,3	297,9	315,4	332,9	350,4	367,9
420	231,5	250,8	270,1	289,4	308,7	328,0	347,3	366,6	385,9	405,2
430	254,4	275,6	296,8	318,0	339,2	360,4	381,6	402,8	424,0	445,2
440	278,9	302,1	325,4	348,6	371,8	395,1	418,3	441,6	464,8	488,0
450	305,1	330,5	356,0	381,4	406,8	432,2	457,7	483,1	508,5	533,9
460	333,1	360,9	388,7	416,4	444,2	472,0	499,7	527,5	555,2	583,0
470	363,1	393,3	423,6	453,8	484,1	514,4	544,6	574,9	605,1	635,4
480	395,0	427,9	460,8	493,7	526,6	559,5	592,5	625,4	658,3	691,2
490	428,9	464,7	500,4	536,2	571,9	607,6	643,4	679,1	714,9	750,6
500	465,0	503,8	542,5	581,3	620,0	658,8	697,5	736,3	775,0	813,8
550	680,9	737,6	794,3	851,1	907,8	964,5	1021,3	1078,0	1134,8	1191,5
600	964,3	1044,6	1125,0	1205,4	1285,7	1366,1	1446,4	1526,8	1607,1	1687,5

Note: When calculating the required moment of inertia for steel, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. (E=21000 kN/cm²)

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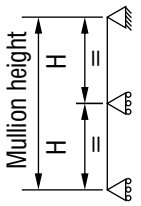
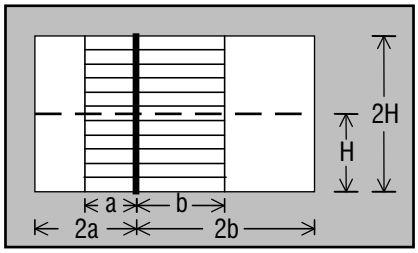
Table 7.2.1: Required moments of inertia I_x for a uniform load with three supports
Modulus of elasticity aluminium = 7000 kN/cm^2 - deflection $f_{max} = l / 200$, or ≦ 15mm

$$I_x = \frac{5\ W\ a\ H^4}{922\ E\ f}$$

W = dynamic wind pressure kN/m^2
a = load width
b = load width
H = height between brackets
E = modulus of elasticity 7000 kN/cm^2
f = maximum deflection ≦ 8mm





2H = mullion height in cm
2a = width between mullions in cm
2b = width between mullions in cm

load width in cm

height between support brackets in cm	20	30	40	50	60	70	80	90	100	110
250	2,0	3,0	4,0	5,0	6,1	7,1	8,1	9,1	10,1	11,1
260	2,4	3,5	4,7	5,9	7,1	8,3	9,4	10,6	11,8	13,0
270	2,7	4,1	5,5	6,9	8,2	9,6	11,0	12,4	13,7	15,1
280	3,2	4,8	6,3	7,9	9,5	11,1	12,7	14,3	15,9	17,5
290	3,7	5,5	7,3	9,1	11,0	12,8	14,6	16,4	18,3	20,1
300	4,2	6,3	8,4	10,5	12,6	14,6	16,7	18,8	20,9	23,0
310	4,8	7,2	9,5	11,9	14,3	16,7	19,1	21,5	23,8	26,2
320	5,4	8,1	10,8	13,5	16,2	19,0	21,7	24,4	27,1	29,8
330	6,1	9,2	12,2	15,3	18,4	21,4	24,5	27,6	30,6	33,7
340	6,9	10,4	13,8	17,3	20,7	24,2	27,6	31,1	34,5	38,0
350	7,8	11,6	15,5	19,4	23,3	27,1	31,0	34,9	38,8	42,6
360	8,7	13,0	17,3	21,7	26,0	30,4	34,7	39,0	43,4	47,7
370	9,7	14,5	19,4	24,2	29,0	33,9	38,7	43,6	48,4	53,2
380	10,8	16,2	21,5	26,9	32,3	37,7	43,1	48,5	53,8	59,2
390	11,9	17,9	23,9	29,9	35,8	41,8	47,8	53,8	59,7	65,7
400	13,2	19,8	26,4	33,1	39,7	46,3	52,9	59,5	66,1	72,7
410	14,6	21,9	29,2	36,5	43,8	51,1	58,4	65,7	73,0	80,3
420	16,1	24,1	32,1	40,2	48,2	56,2	64,3	72,3	80,4	88,4
430	17,7	26,5	35,3	44,1	53,0	61,8	70,6	79,5	88,3	97,1
440	19,4	29,0	38,7	48,4	58,1	67,8	77,4	87,1	96,8	106,5
450	21,2	31,8	42,4	52,9	63,5	74,1	84,7	95,3	105,9	116,5

Note:
The longest bar available from Alumil is 750cm. Thererfore it is unneccessary to calculate a mullion height greater than 750cm. This means the height between the support brackets for a three support load must be less than or equal to 375cm. For dimensions greater than those found on tables 5a and 6a, please consult with the engineering department at your local Alumil supplier.

Note: When calculating the required moment of inertia for steel, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. (E=21000 kN/cm^2)

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Table 7.2.1: Required moments of inertia I_x for a uniform load with three supports (continued)
Modulus of elasticity aluminium = 7000 kN/cm² - deflection $f_{max} = l / 200$, or ≦ 15mm

$I_{x\ required} = (I_{xa} + I_{xb}) * Fw$

I_{xa} = moment of inertia from table 6a
I_{xb} = moment of inertia from table 6a
Fw= correction factor from table 6b

This chart is made for a dynamic wind pressure of 0,5kN/m . A correction factor "Fw" must be used in order to calculate the required dynamic wind pressure.

Table 7.2.2:

Height above ground (m)	Dynamic pressure kN/m²	Factor Fw
0 - 8	0,5	1,0
8 - 20	0,8	1,6
20 - 100	1,1	2,2
> 100	1,3	2,6

load width in cm

height between support brackets in cm	120	130	140	150	160	170	180	190	200	210
250	12,1	13,1	14,1	15,1	16,1	17,1	18,2	19,2	20,2	21,2
260	14,2	15,3	16,5	17,7	18,9	20,1	21,2	22,4	23,6	24,8
270	16,5	17,8	19,2	20,6	22,0	23,3	24,7	26,1	27,4	28,8
280	19,0	20,6	22,2	23,8	25,4	27,0	28,6	30,2	31,7	33,3
290	21,9	23,7	25,6	27,4	29,2	31,0	32,9	34,7	36,5	38,4
300	25,1	27,2	29,3	31,4	33,5	35,6	37,7	39,7	41,8	43,9
310	28,6	31,0	33,4	35,8	38,2	40,5	42,9	45,3	47,7	50,1
320	32,5	35,2	37,9	40,6	43,3	46,0	48,7	51,4	54,2	56,9
330	36,7	39,8	42,9	45,9	49,0	52,1	55,1	58,2	61,2	64,3
340	41,4	44,9	48,3	51,8	55,2	58,7	62,1	65,6	69,0	72,5
350	46,5	50,4	54,3	58,1	62,0	65,9	69,8	73,6	77,5	81,4
360	52,0	56,4	60,7	65,1	69,4	73,7	78,1	82,4	86,7	91,1
370	58,1	62,9	67,8	72,6	77,4	82,3	87,1	92,0	96,8	101,6
380	64,6	70,0	75,4	80,8	86,2	91,5	96,9	102,3	107,7	113,1
390	71,7	77,7	83,6	89,6	95,6	101,6	107,5	113,5	119,5	125,5
400	79,3	85,9	92,6	99,2	105,8	112,4	119,0	125,6	132,2	138,8
410	87,6	94,9	102,2	109,5	116,8	124,1	131,3	138,6	145,9	153,2
420	96,4	104,5	112,5	120,5	128,6	136,6	144,6	152,7	160,7	168,7
430	105,9	114,8	123,6	132,4	141,3	150,1	158,9	167,7	176,6	185,4
440	116,1	125,8	135,5	145,2	154,9	164,5	174,2	183,9	193,6	203,3
450	127,1	137,7	148,3	158,8	169,4	180,0	190,6	201,2	211,8	222,4

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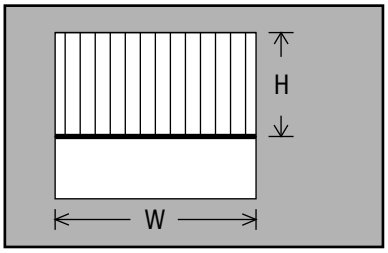
Note: When calculating the required moment of inertia for steel, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. (E=21000 kN/cm²)

Table 7.3.1: Required moments of inertia I_y for dead loads on transoms
Modulus of elasticity aluminium = 7000 kN/cm² - deflection $f_{max} = l / 500$, or ≦ 3mm

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

G = force of panel (Kp)
a = distance to glazing support (15cm)
H = panel height in cm
W = panel width in cm
E = modulus of elasticity 7000 kN/cm²
f = maximum deflection l /500 or ≦ 3mm



panel width in cm — This chart is for 12mm glazing thickness (6/12/6 or 6/15/6)

panel height in cm

	20	30	40	50	60	70	80	90	100	110
100	0,0	0,1	0,3	0,5	0,7	1,0	1,3	1,7	2,1	2,6
110	0,0	0,1	0,3	0,5	0,8	1,1	1,5	1,9	2,3	2,8
120	0,0	0,2	0,3	0,6	0,9	1,2	1,6	2,1	2,6	3,1
130	0,0	0,2	0,4	0,6	0,9	1,3	1,7	2,2	2,8	3,4
140	0,0	0,2	0,4	0,7	1,0	1,4	1,9	2,4	3,0	3,6
150	0,0	0,2	0,4	0,7	1,1	1,5	2,0	2,6	3,2	3,9
160	0,0	0,2	0,5	0,8	1,2	1,6	2,1	2,7	3,4	4,1
170	0,0	0,2	0,5	0,8	1,2	1,7	2,3	2,9	3,6	4,4
180	0,0	0,2	0,5	0,9	1,3	1,8	2,4	3,1	3,8	4,7
190	0,0	0,3	0,5	0,9	1,4	1,9	2,5	3,3	4,0	4,9
200	0,0	0,3	0,6	1,0	1,4	2,0	2,7	3,4	4,3	5,2
210	0,0	0,3	0,6	1,0	1,5	2,1	2,8	3,6	4,5	5,4
220	0,0	0,3	0,6	1,1	1,6	2,2	2,9	3,8	4,7	5,7
230	0,1	0,3	0,7	1,1	1,7	2,3	3,1	3,9	4,9	6,0
240	0,1	0,3	0,7	1,2	1,7	2,4	3,2	4,1	5,1	6,2
250	0,1	0,3	0,7	1,2	1,8	2,5	3,3	4,3	5,3	6,5
260	0,1	0,3	0,7	1,3	1,9	2,6	3,5	4,4	5,5	6,7
270	0,1	0,4	0,8	1,3	2,0	2,7	3,6	4,6	5,7	7,0
280	0,1	0,4	0,8	1,4	2,0	2,8	3,7	4,8	6,0	7,2
290	0,1	0,4	0,8	1,4	2,1	2,9	3,9	5,0	6,2	7,5
300	0,1	0,4	0,9	1,4	2,2	3,0	4,0	5,1	6,4	7,8
310	0,1	0,4	0,9	1,5	2,2	3,1	4,1	5,3	6,6	8,0
320	0,1	0,4	0,9	1,5	2,3	3,2	4,3	5,5	6,8	8,3
330	0,1	0,4	0,9	1,6	2,4	3,3	4,4	5,6	7,0	8,5
340	0,1	0,4	1,0	1,6	2,5	3,4	4,5	5,8	7,2	8,8
350	0,1	0,5	1,0	1,7	2,5	3,5	4,7	6,0	7,4	9,1
360	0,1	0,5	1,0	1,7	2,6	3,6	4,8	6,2	7,7	9,3
370	0,1	0,5	1,1	1,8	2,7	3,7	5,0	6,3	7,9	9,6
380	0,1	0,5	1,1	1,8	2,8	3,8	5,1	6,5	8,1	9,8
390	0,1	0,5	1,1	1,9	2,8	3,9	5,2	6,7	8,3	10,1
400	0,1	0,5	1,1	1,9	2,9	4,0	5,4	6,8	8,5	10,4
410	0,1	0,5	1,2	2,0	3,0	4,1	5,5	7,0	8,7	10,6
420	0,1	0,6	1,2	2,0	3,0	4,2	5,6	7,2	8,9	10,9
430	0,1	0,6	1,2	2,1	3,1	4,3	5,8	7,4	9,2	11,1
440	0,1	0,6	1,3	2,1	3,2	4,4	5,9	7,5	9,4	11,4
450	0,1	0,6	1,3	2,2	3,3	4,5	6,0	7,7	9,6	11,6
460	0,1	0,6	1,3	2,2	3,3	4,6	6,2	7,9	9,8	11,9
470	0,1	0,6	1,3	2,3	3,4	4,7	6,3	8,0	10,0	12,2
480	0,1	0,6	1,4	2,3	3,5	4,8	6,4	8,2	10,2	12,4
490	0,1	0,6	1,4	2,4	3,5	4,9	6,6	8,4	10,4	12,7
500	0,1	0,7	1,4	2,4	3,6	5,0	6,7	8,6	10,6	12,9
550	0,1	0,7	1,6	2,7	4,0	5,6	7,4	9,4	11,7	14,2
600	0,1	0,8	1,7	2,9	4,3	6,1	8,0	10,3	12,8	15,5

Note: When calculating the required moment of inertia for steel, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. (E=21000 kN/cm²)

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Table 7.3.1: Required moments of inertia I_y for dead loads on transoms
Modulus of elasticity aluminium = 7000 kN/cm², deflection $f_{max} = l / 500$, or ≦ 3mm

$I_{y,req} = I_y * Fw$

I_y = Required moment of inertia from Table 7a

Fw = Correction factor from Table 7b

Table 7.3.2: Correction factor Fw

Glazing thickness	Fw	Glazing thickness	Fw
6	0,50	16	1,33
8	0,67	18	1,50
10	0,80	20	1,67
12	1,00	22	1,83
14	1,16	24	2,00

This chart is for 12mm glazing thickness (6/12/6 or 6/15/6)

panel width in cm

panel height in cm

	120	130	140	150	160	170	180	190	200	210
100	3,1	3,6	4,2	4,9	5,9	7,1	8,5	9,9	11,6	13,5
110	3,4	4,0	4,7	5,4	6,5	7,8	9,3	10,9	12,8	14,8
120	3,7	4,4	5,1	5,8	7,1	8,5	10,1	11,9	13,9	16,1
130	4,0	4,7	5,5	6,3	7,7	9,2	11,0	12,9	15,1	17,5
140	4,3	5,1	5,9	6,8	8,3	10,0	11,8	13,9	16,3	18,8
150	4,6	5,5	6,4	7,3	8,9	10,7	12,7	14,9	17,4	20,2
160	4,9	5,8	6,8	7,8	9,5	11,4	13,5	15,9	18,6	21,5
170	5,3	6,2	7,2	8,3	10,1	12,1	14,4	16,9	19,7	22,9
180	5,6	6,6	7,6	8,8	10,7	12,8	15,2	17,9	20,9	24,2
190	5,9	6,9	8,0	9,3	11,2	13,5	16,1	18,9	22,1	25,6
200	6,2	7,3	8,5	9,7	11,8	14,2	16,9	19,9	23,2	26,9
210	6,5	7,6	8,9	10,2	12,4	14,9	17,7	20,9	24,4	28,2
220	6,8	8,0	9,3	10,7	13,0	15,6	18,6	21,9	25,5	29,6
230	7,1	8,4	9,7	11,2	13,6	16,4	19,4	22,9	26,7	30,9
240	7,4	8,7	10,2	11,7	14,2	17,1	20,3	23,9	27,9	32,3
250	7,7	9,1	10,6	12,2	14,8	17,8	21,1	24,9	29,0	33,6
260	8,0	9,5	11,0	12,7	15,4	18,5	22,0	25,9	30,2	35,0
270	8,4	9,8	11,4	13,1	16,0	19,2	22,8	26,9	31,4	36,3
280	8,7	10,2	11,9	13,6	16,6	19,9	23,7	27,9	32,5	37,7
290	9,0	10,6	12,3	14,1	17,2	20,6	24,5	28,8	33,7	39,0
300	9,3	10,9	12,7	14,6	17,8	21,3	25,4	29,8	34,8	40,4
310	9,6	11,3	13,1	15,1	18,4	22,0	26,2	30,8	36,0	41,7
320	9,9	11,7	13,5	15,6	18,9	22,8	27,0	31,8	37,2	43,0
330	10,2	12,0	14,0	16,1	19,5	23,5	27,9	32,8	38,3	44,4
340	10,5	12,4	14,4	16,6	20,1	24,2	28,7	33,8	39,5	45,7
350	10,8	12,7	14,8	17,0	20,7	24,9	29,6	34,8	40,6	47,1
360	11,1	13,1	15,2	17,5	21,3	25,6	30,4	35,8	41,8	48,4
370	11,4	13,5	15,7	18,0	21,9	26,3	31,3	36,8	43,0	49,8
380	11,8	13,8	16,1	18,5	22,5	27,0	32,1	37,8	44,1	51,1
390	12,1	14,2	16,5	19,0	23,1	27,7	33,0	38,8	45,3	52,5
400	12,4	14,6	16,9	19,5	23,7	28,4	33,8	39,8	46,4	53,8
410	12,7	14,9	17,4	20,0	24,3	29,2	34,6	40,8	47,6	55,2
420	13,0	15,3	17,8	20,5	24,9	29,9	35,5	41,8	48,8	56,5
430	13,3	15,7	18,2	20,9	25,5	30,6	36,3	42,8	49,9	57,8
440	13,6	16,0	18,6	21,4	26,0	31,3	37,2	43,8	51,1	59,2
450	13,9	16,4	19,1	21,9	26,6	32,0	38,0	44,8	52,3	60,5
460	14,2	16,8	19,5	22,4	27,2	32,7	38,9	45,8	53,4	61,9
470	14,5	17,1	19,9	22,9	27,8	33,4	39,7	46,8	54,6	63,2
480	14,8	17,5	20,3	23,4	28,4	34,1	40,6	47,8	55,7	64,6
490	15,2	17,8	20,7	23,9	29,0	34,8	41,4	48,7	56,9	65,9
500	15,5	18,2	21,2	24,4	29,6	35,6	42,3	49,7	58,1	67,3
550	17,0	20,0	23,3	26,8	32,6	39,1	46,5	54,7	63,9	74,0
600	18,6	21,8	25,4	29,2	35,5	42,7	50,7	59,7	69,7	80,7

Note: When calculating the required moment of inertia for steel, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. (E=21000 kN/cm²)

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12.1 Pre-dimensioning of a three-hinged frame

12.2 Load tables based on a uniform load of 1 kN/m ^{2}

12.3 Required moment of inertia for rafter due to wind load, snow load and dead weight with roof inclination (normal area, no corners or edges!)

$E = 7000\ kN/cm^2$

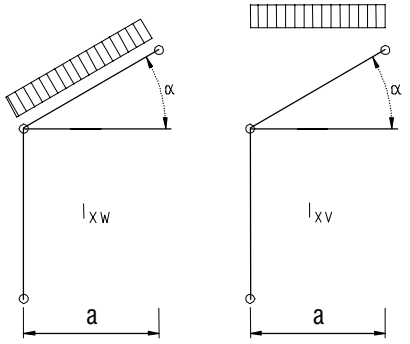

Table 7.4: Moment of inertia for various inclinations

Inclination α	15°		30°		45°		60°	
System depth a (m)	I_{xw} rafter [cm^4]	I_{xv} rafter [cm^4]	I_{xw} rafter [cm^4]	I_{xv} rafter [cm^4]	I_{xw} rafter [cm^4]	I_{xv} rafter [cm^4]	I_{xw} rafter [cm^4]	I_{xv} rafter [cm^4]
0,5	0,8	0,7	1,1	0,8	2,0	1,0	5,6	1,4
0,6	1,3	1,2	1,9	1,4	3,4	1,7	9,6	2,4
0,7	2,1	2,0	2,9	2,2	5,4	2,7	15,3	3,8
0,8	3,2	3,0	4,4	3,3	8,1	4,0	22,9	5,7
0,9	4,5	4,2	6,3	4,7	11,5	5,8	32,5	8,1
1,0	6,2	5,8	8,6	6,4	15,8	7,9	44,6	11,2
1,1	8,2	7,7	11,4	8,6	21,0	10,5	59,4	14,9
1,2	10,7	10,0	14,8	11,1	27,3	13,6	77,1	19,3
1,3	13,6	12,7	18,9	14,2	34,7	17,3	98,1	24,5
1,4	17,0	15,9	23,6	17,7	43,3	21,7	122,5	30,6
1,5	20,9	19,5	29,0	21,7	53,3	26,6	150,7	37,7
1,6	25,4	23,7	35,2	26,4	64,6	32,3	182,9	45,7
1,7	30,4	28,4	42,2	31,7	77,5	38,8	219,3	54,8
1,8	36,1	33,7	50,1	37,6	92,1	46,0	260,4	65,1
1,9	42,5	39,6	58,9	44,2	108,3	54,1	306,2	76,6
2,0	49,5	46,2	68,7	51,5	126,3	63,1	357,1	89,3
2,1	57,3	53,5	79,6	59,7	146,2	73,1	413,4	103,4
2,2	65,9	61,5	91,5	68,6	168,1	84,0	475,4	118,8
2,3	75,3	70,3	104,5	78,4	192,0	96,0	543,2	135,8
2,4	85,6	79,9	118,8	89,1	218,2	109,1	617,1	154,3
2,5	96,7	90,3	134,2	100,7	246,6	123,3	697,5	174,4
2,6	108,8	101,5	151,0	113,3	277,4	138,7	784,6	196,2
2,7	121,9	113,7	169,1	126,8	310,7	155,3	878,7	219,7
2,8	135,9	126,8	188,6	141,5	346,5	173,2	980,0	245,0
2,9	151,0	140,9	209,5	157,2	384,9	192,5	1088,8	272,2
3,0	167,2	156,0	232,0	174,0	426,2	213,1	1205,4	301,3
3,1	184,5	172,1	256,0	192,0	470,2	235,1	1330,0	332,5
3,2	202,9	189,3	281,5	211,1	517,2	258,6	1462,9	365,7
3,3	222,5	207,6	308,8	231,6	567,2	283,6	1604,3	401,1
3,4	243,4	227,1	337,7	253,3	620,4	310,2	1754,6	438,7
3,5	265,5	247,7	368,4	276,3	676,7	338,4	1914,1	478,5
3,6	288,9	269,5	400,8	300,6	736,4	368,2	2082,9	520,7
3,7	313,6	292,6	435,2	326,4	799,5	399,7	2261,3	565,3
3,8	339,8	317,0	471,4	353,6	866,1	433,0	2449,6	612,4
3,9	367,3	342,7	509,6	382,2	936,3	468,1	2648,2	662,0
4,0	396,3	369,7	549,9	412,4	1010,2	505,1	2857,1	714,3
4,1	426,8	398,2	592,1	444,1	1087,8	543,9	3076,8	769,2
2,2	65,9	61,5	91,5	68,6	168,1	84,0	475,4	118,8
4,3	492,3	459,3	683,1	512,3	1254,9	627,5	3549,4	887,4
4,4	527,5	492,1	731,9	548,9	1344,5	672,3	3802,9	950,7
4,5	564,2	526,4	782,9	587,2	1438,3	719,1	4068,1	1017,0
4,6	602,7	562,3	836,3	627,2	1536,3	768,2	4345,4	1086,3
4,7	642,9	599,8	892,0	669,0	1638,7	819,4	4635,0	1158,7
4,8	684,8	638,9	950,2	712,6	1745,5	872,8	4937,1	1234,3
4,9	728,5	679,7	1010,8	758,1	1856,9	928,5	5252,2	1313,0
5,0	774,0	722,2	1073,9	805,5	1973,0	986,5	5580,4	1395,1

Note: When calculating the required moment of inertia for steel, you should multiply the value on Tables 7.1-7.6 by 0,33 to compensate for the modulus of elasticity of steel. ($E=21000\ kN/cm^2$)

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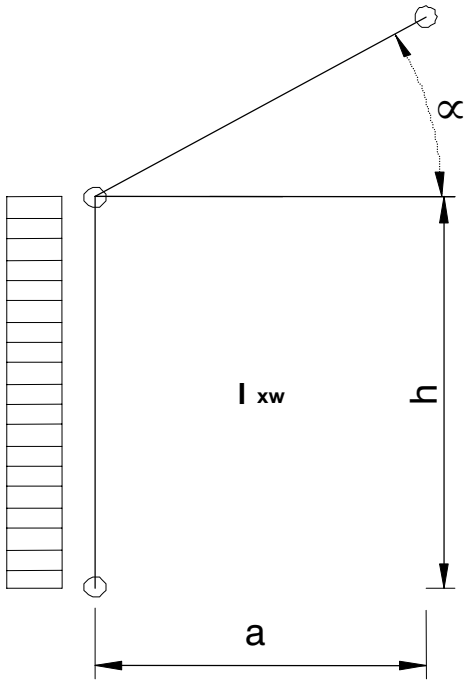
12.4 Required mullion moment of inertia due to uniform load (with $f_{perm,} = h/300$) with load 1 kN/m² and width 1 m



Kink height h [m]	$I_{xw\ mullion}$ [cm⁴]
1,0	5,6
1,1	7,4
1,2	9,6
1,3	12,3
1,4	15,3
1,5	18,8
1,6	22,9
1,7	27,4
1,8	32,5
1,9	38,3
2,0	44,6
2,1	51,7
2,2	59,4
2,3	67,9
2,4	77,1
2,5	87,2
2,6	98,1
2,7	109,8
2,8	122,5
2,9	136,1
3,0	150,7
3,1	166,2
3,2	182,9
3,3	200,5
3,4	219,3
3,5	239,3
3,6	260,4
3,7	282,7
3,8	306,2
3,9	331,0
4,0	357,1

12.5 Calculation parameters

B = Load width [m]
q = Dynamic pressure in accordance with DIN 1055, part 4
Building height 0 - 8 m q = 0,5 kN/m²
Building height 8 - 20 m q = 0,8 kN/m²
Building height 20 - 100 m q = 1,1 kN/m²
q_s = Snow load in accordance with DIN 1055, part 5, in dependence on the location
q_E = Dead weight in accordance with DIN 1055, part 1, in dependence on the insert element
k_s = Diminution factor for snow load in accordance with DIN 1055, part 5
g = Load conversion factor for dead weight with sloping roofs
c_p = Aerodynamic pressure coefficient in accordance with DIN 1055, part 4

Roof inclination	15°	30°	45°	60°
ks	1,0	1,0	0,6	0,1
g	1,035	1,155	1,414	2,000
cp	Coefficient according to the valid standard			

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12.6 List of loads for final dimensioning of three-hinged frame loads

12.6.1 Mullion dimensioning

For the type of load "wind pressure" the result is as follows:

$$I_{req,\,mullion} = B \cdot I_{xw\,mullion} \cdot q \cdot (c_p \cdot 1{,}25)$$

For the type of load "wind suction" the result is as follows:

$$I_{req,\,mullion} = B \cdot I_{xw\,mullion} \cdot q \cdot c_p$$

12.6.2 Rafter dimensioning

For the type of load "dead weight" and "snow load":

$$I_{req,\,rafter} = B \cdot [I_{xv\,rafter} \cdot (\gamma \cdot q + k_S \cdot q_S)]$$

For the type of load "dead weight" and 0,5 "snow load" and "wind load"

$$I_{req,\,rafter} = B \cdot [I_{xv\,rafter} \cdot \gamma (q_E + 0{,}5 \cdot k_S \cdot q_S) + (I_{xw\,rafter} \cdot c_p \cdot 1{,}25 \cdot q)]$$

| For wind pressure only (roof inclination exceeding 25°), otherwise 1,0

For the type of load "dead weight" and "snow load" and 0,5 "wind load":

$$I_{req,\,rafter} = B \cdot [I_{xv\,rafter} \cdot (g \cdot q + k_S \cdot q_S) + (0{,}5 \cdot I_{xw\,rafter} \cdot c_p \cdot 1{,}25 \cdot q)]$$

| For wind pressure only (roof inclination exceeding 25°), otherwise 1,0

For the type of load "wind suction" - "dead weight":

$$I_{erf,\,rafter} = B \cdot [I_{xv\,rafter} \cdot c_{p\,suction} \cdot q - I_{xv\,rafter} \cdot g \cdot q_E]$$

The maximum value of the determined results is decisive for the pre-dimensioning of the three-hinged frame!

Building Physics

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12.7 Example calculation

Given:

Load width	B	=	1 m	Wind load q	=	0,5 kN/m²
System depth	a	=	3,5 m	Pressurecoefficient vertical c_p	=	0,8
Folding height	h	=	2,2 m	Pressurecoefficient sloping area c_p	=	-0,6 DIN 1055 part 4 tab, 12
Roofinclination		=	15°	Snowload q_S	=	0,75 kN/m²
Glassthickness		=	14mm	Diminishing factor k_S	=	1,00 DIN 1055 part 5 tab, 1
				Deadweight q_E	=	0,39 kN/m² (glass weight + profile weight)
				Load conversion factor g	=	1,035

12.7.1 Mullion dimensioning

For the type of load "wind pressure" the result is:

$$I_{req,\,mullion} = B \cdot I_{xw\,mullion} \cdot q \cdot (c_p \cdot 1{,}25)$$

$$I_{req,\,mullion} = 1 \cdot 59{,}4 \cdot 0{,}5 \cdot (0{,}8 \cdot 1{,}25) = 29{,}7\,cm^4$$

12.7.2 Rafter dimensioning

For the type of load "dead weight" and "snow load":

$$I_{req,\,rafter} = B \cdot [I_{xv\,rafter} \cdot (\gamma \cdot q_E + k_S \cdot q_S)]$$
$$I_{req,\,rafter} = 1 \cdot [247{,}7 \cdot (1{,}035 \cdot 0{,}39 + 1{,}00 \cdot 0{,}75)] = 285{,}8\,cm^4$$

For the type of load "dead weight" and 0,5"snow load" and "wind load":

$$I_{req,\,rafter} = B \cdot [I_{xv\,rafter} \cdot (\gamma \cdot q + 0{,}5 \cdot k_S \cdot q_S) + (I_{xw\,rafter} \cdot 1 \cdot 1{,}25 \cdot q)]$$
$$I_{req,\,rafter} = 1 \cdot [247{,}7 \cdot (1{,}035 \cdot 0{,}39 + 0{,}5 \cdot 1{,}00 \cdot 0{,}75) + (265{,}5 \cdot (-0{,}6) \cdot 1 \cdot 0{,}5)] = 113{,}2\,cm^4$$

For the type of load "dead weight" and "snow load" and 0,5 "wind load":

$$I_{req,\,rafter} = B \cdot [I_{xv\,rafter} \cdot (\gamma \cdot q + k_S \cdot q_S) + (0{,}5 \cdot I_{xw\,rafter} \cdot 1 \cdot 1{,}25 \cdot q)]$$
$$I_{req,\,rafter} = 1 \cdot [247{,}7 \cdot (1{,}035 \cdot 0{,}39 + 1{,}00 \cdot 0{,}75) + (0{,}5 \cdot 265{,}5 \cdot (-0{,}6) \cdot 1 \cdot 0{,}5)] = 245{,}9\,cm^4$$

For the type of load "wind suction" -"dead weight" (to be calculated only in case of relevant wind suction forces):

$$I_{req,\,rafter} = B \cdot [I_{xv\,rafter} \cdot c_{p\,suction} \cdot q\,\gamma\, I_{xv\,rafter} \cdot g \cdot q_E]$$
$$I_{req,\,rafter} = 1 \cdot [247{,}7 \cdot (-0{,}6) \cdot 0{,}5 - 247{,}7 \cdot 1{,}035 \cdot 0{,}39] = -174{,}3\,cm^4$$

From the type of load with the highest requirements the following results with regard to pre-dimensioning:

$$I_{y\,req} = 285{,}8\,cm^4$$

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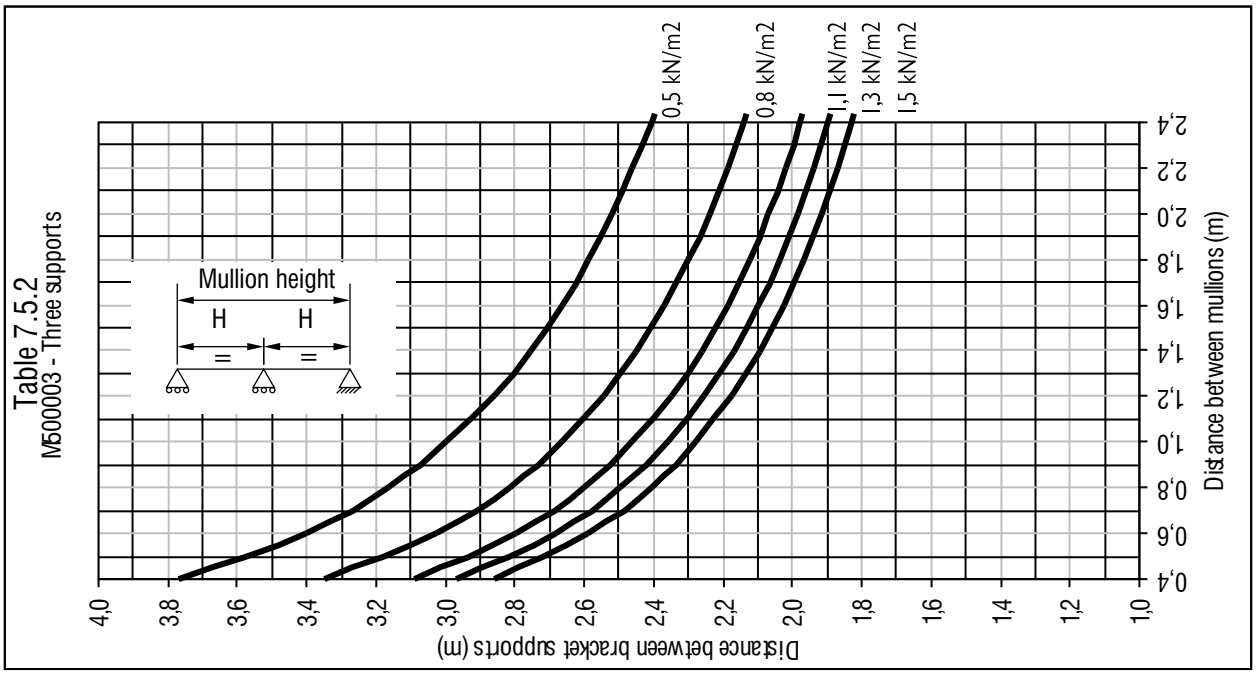
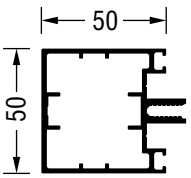
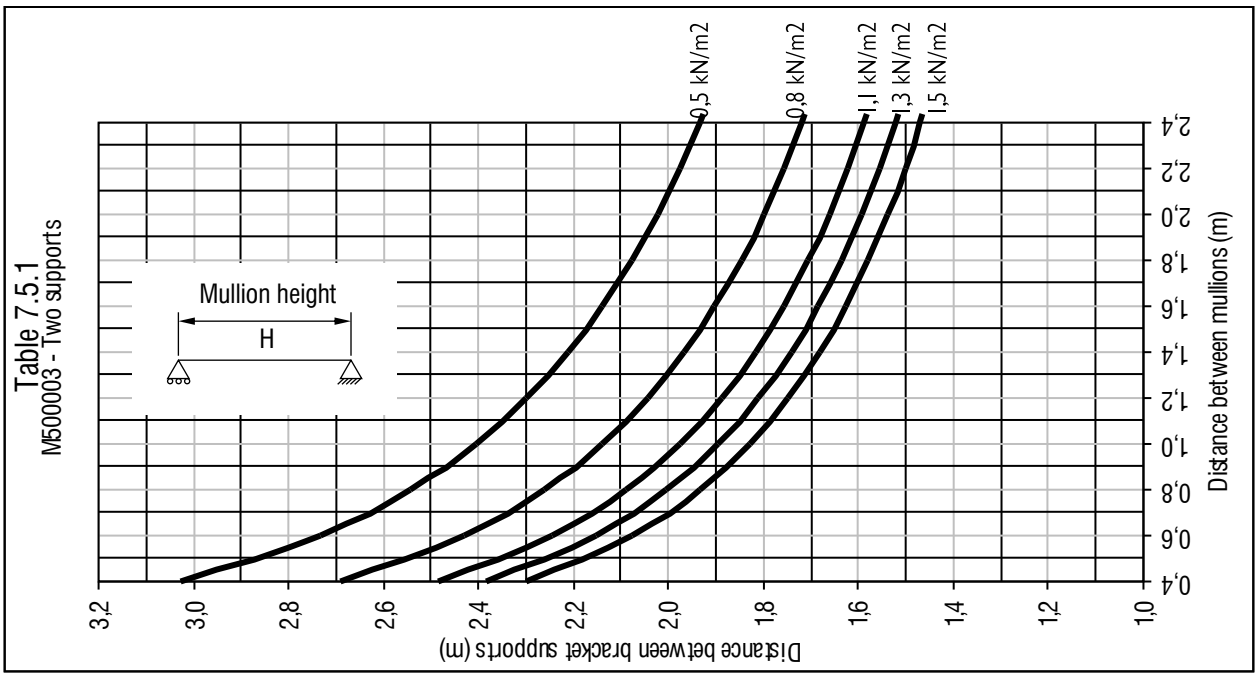


M500003



Ix = 20,81 cm4
Iy = 16,69 cm4

Note: The distance "H" is the distance between support points and is not necessarily the mullion height.



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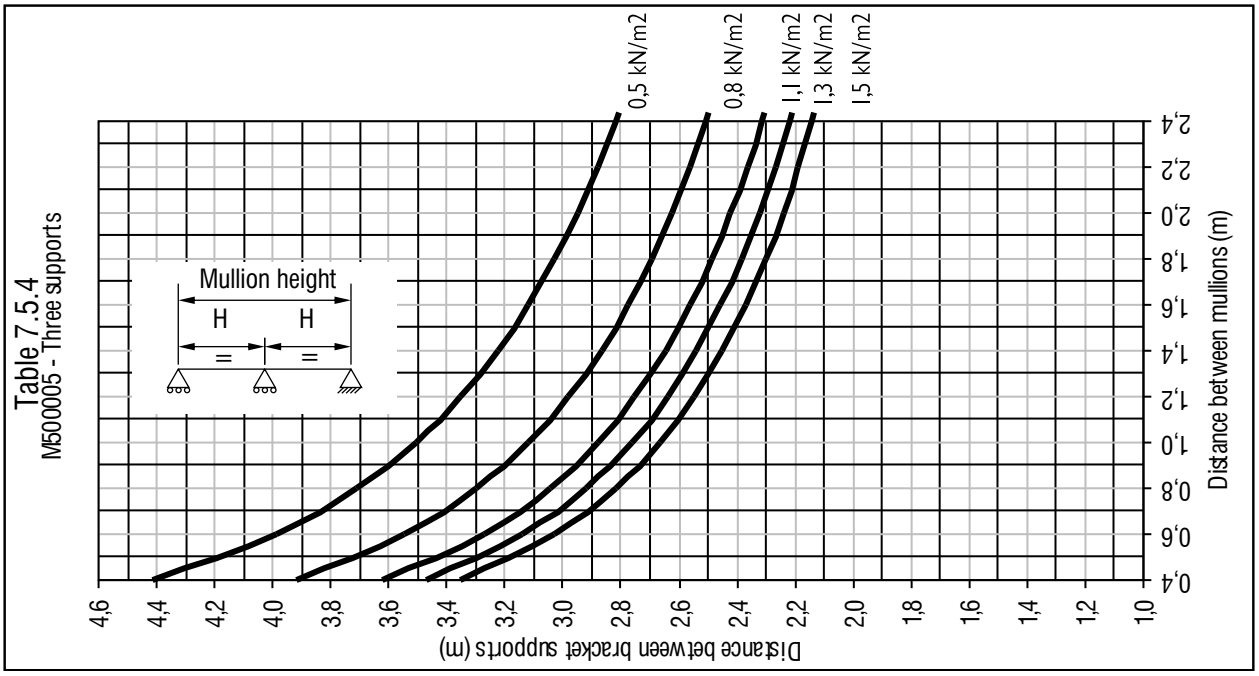
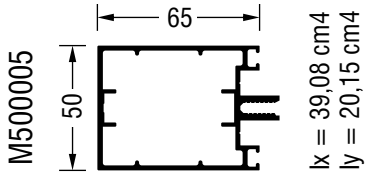
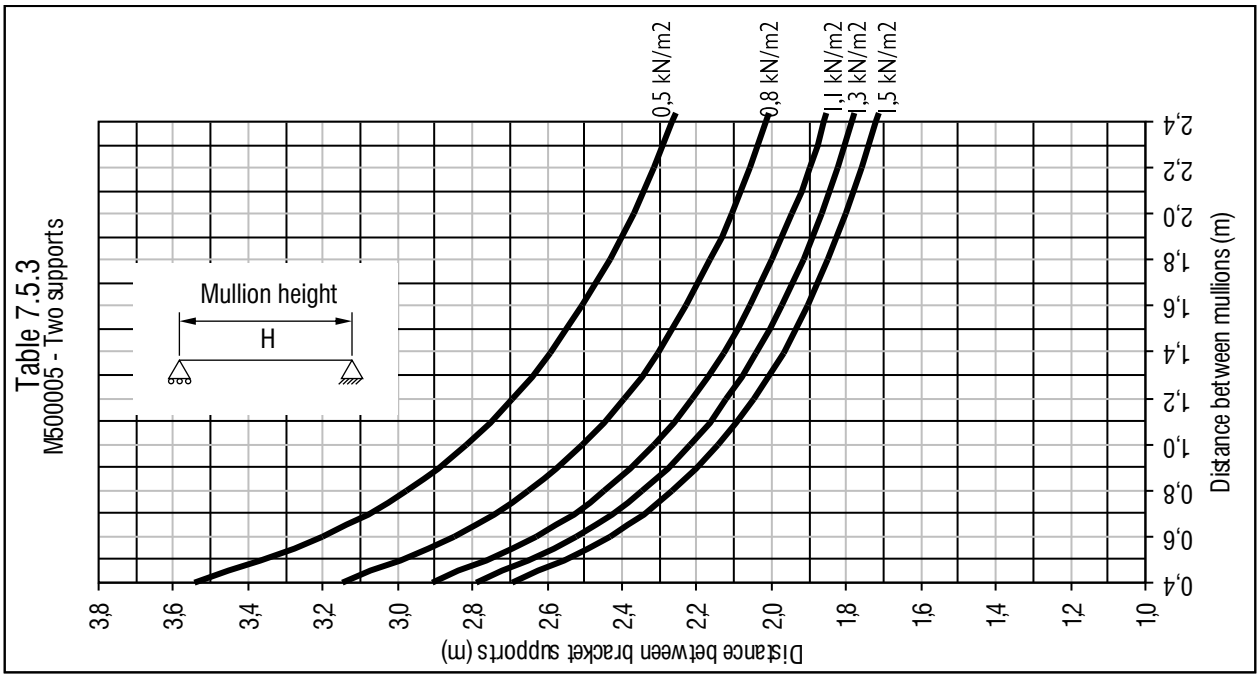


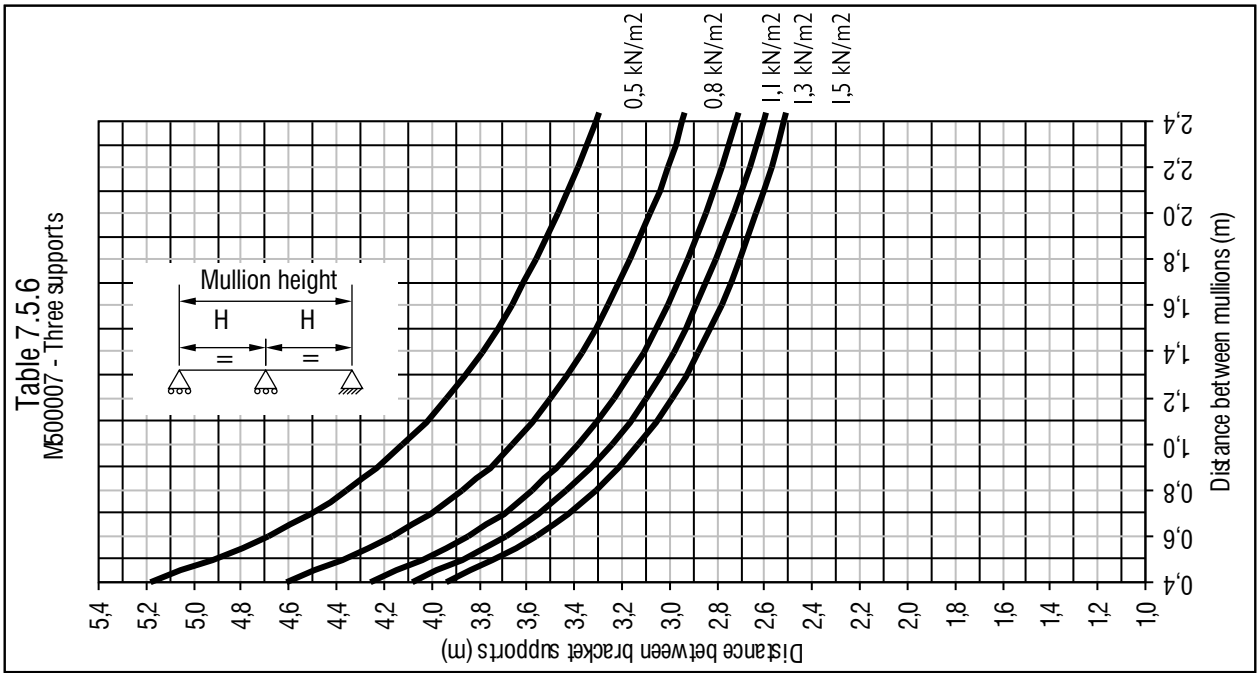


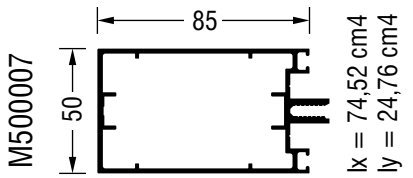
Note: The distance "H" is the distance between support points and is not necessarily the mullion height.



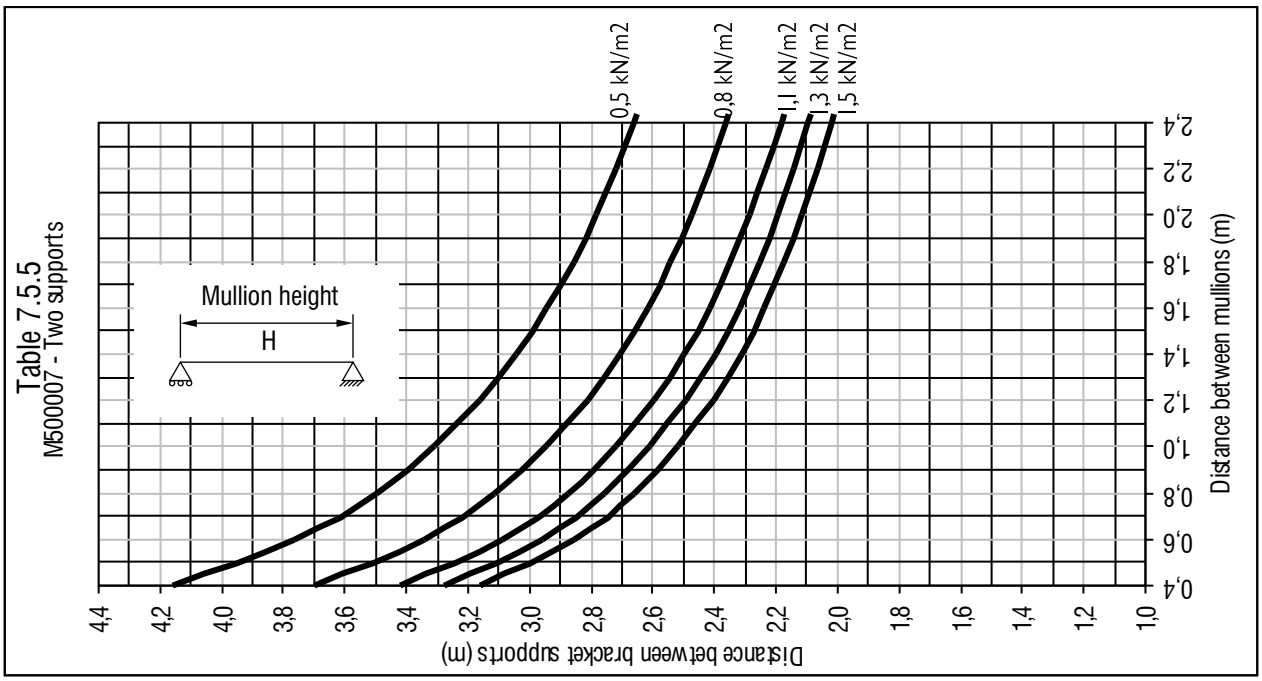
Valid for aluminium (E = 7000kN/cm2) and $f_{max} = l /300$ or 8mm

Wind load charts for mullions





Note: The distance "H" is the distance between support points and is not necessarily the mullion height.



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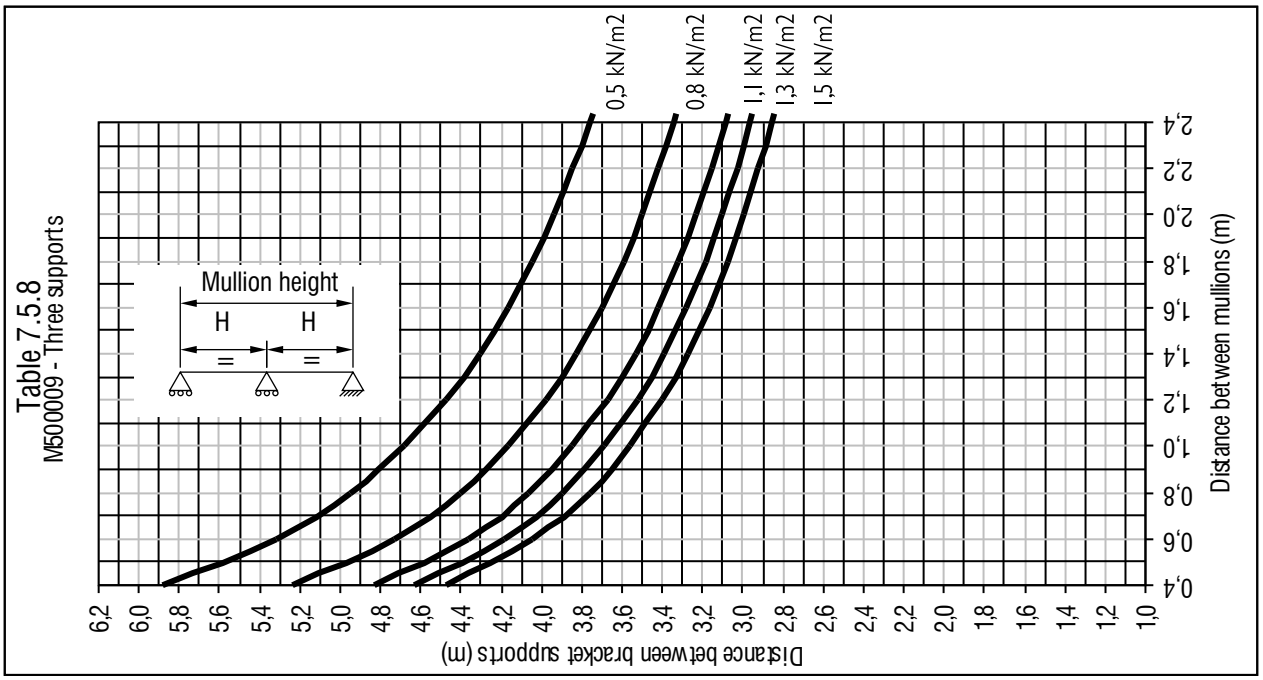
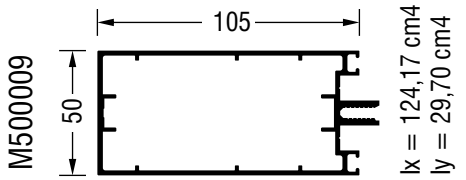
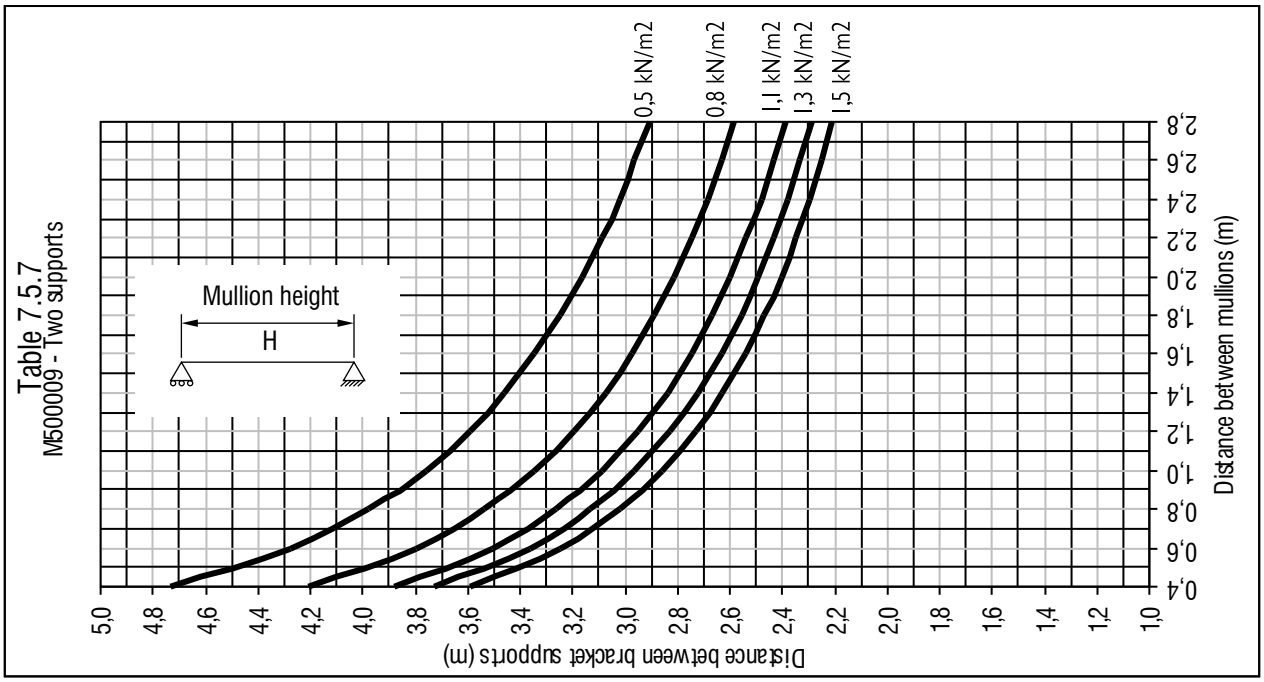




Note: The distance "H" is the distance between support points and is not necessarily the mullion height.



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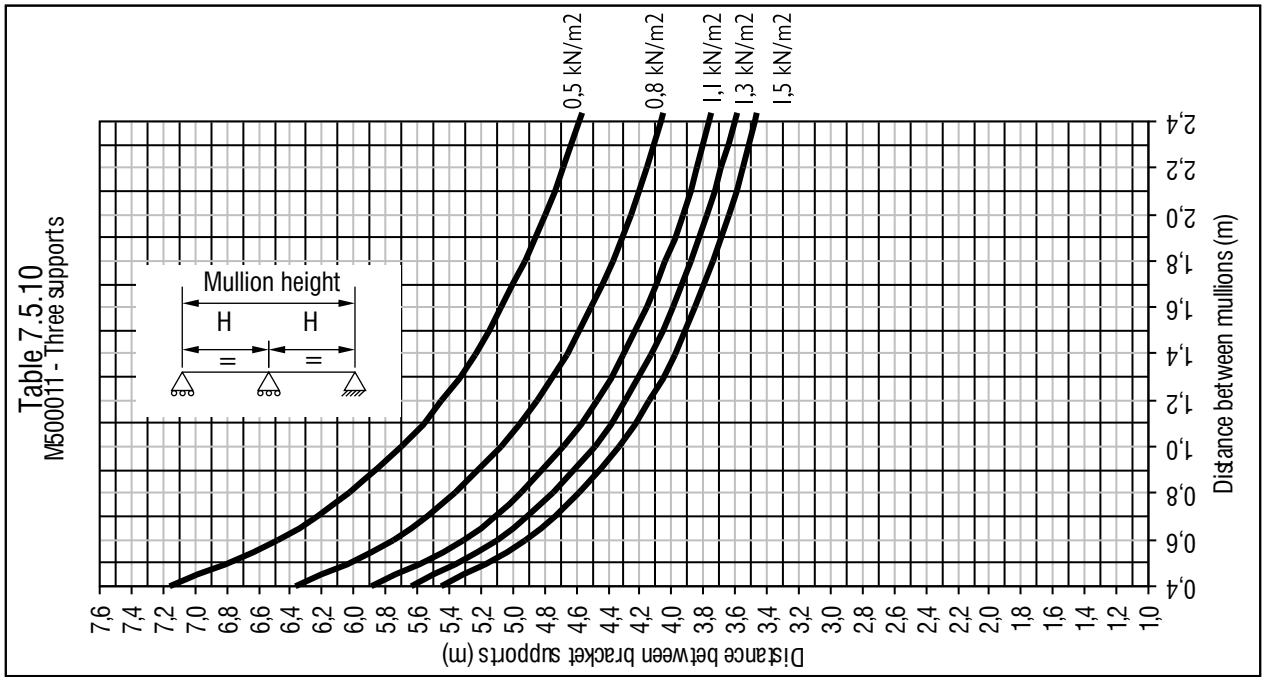

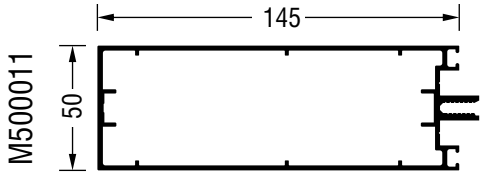

Ix = 272,45 cm4
Iy = 38,87 cm4

Example: If you have two supports and a wind load of 0,8kN/m2 with a height "H" of 3,4m and a width "L" of 1,5m the mullion M500011 is insufficient. For these parameters you either have to choose to use the mullion M500011 with three supports or the M500011 and M500064 with two supports (see page 7-034).

Note: The distance "H" is the distance between support points and is not necessarily the mullion height.

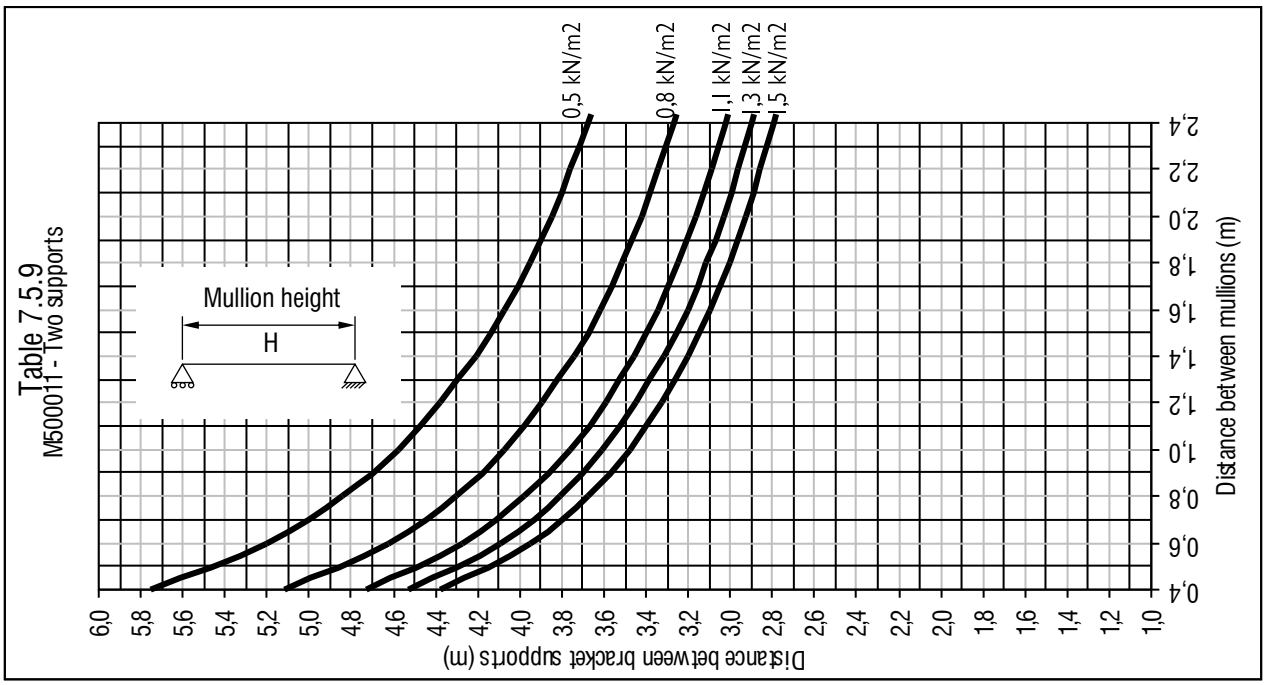

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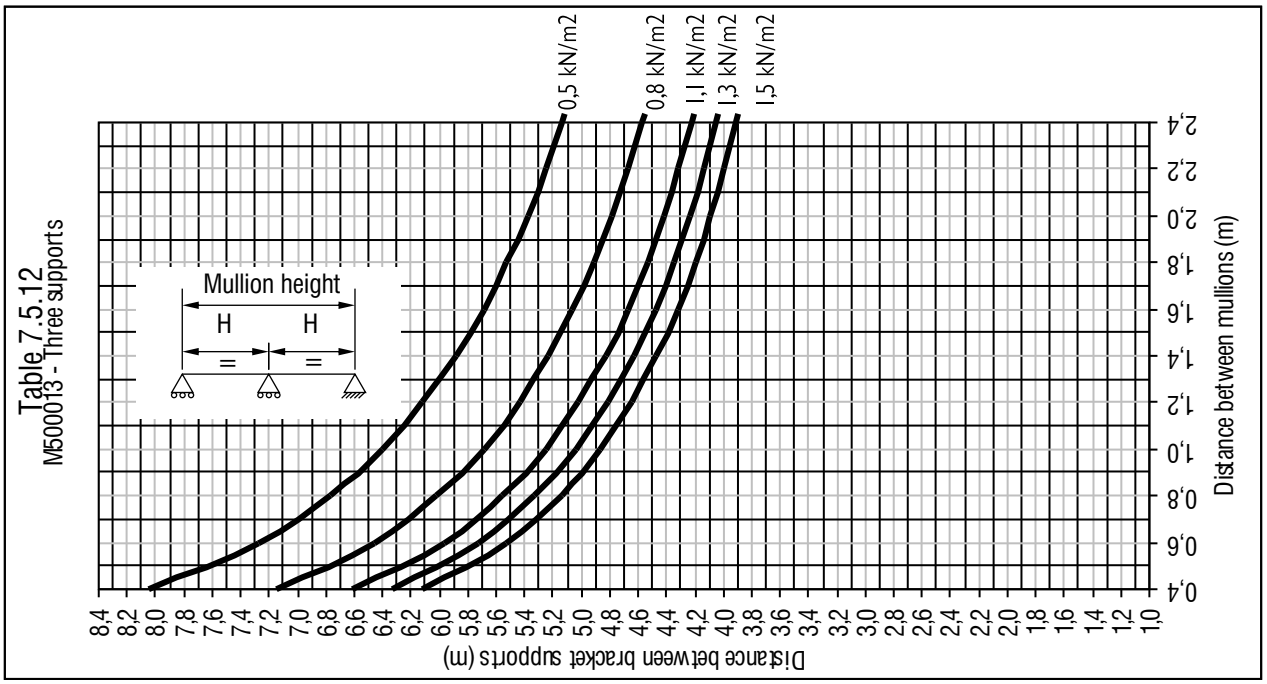
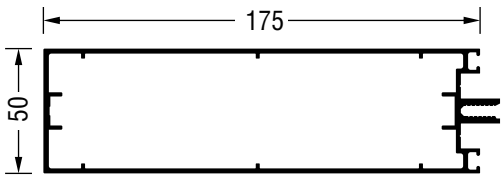
Table 7.5.12
M500013 - Three supports



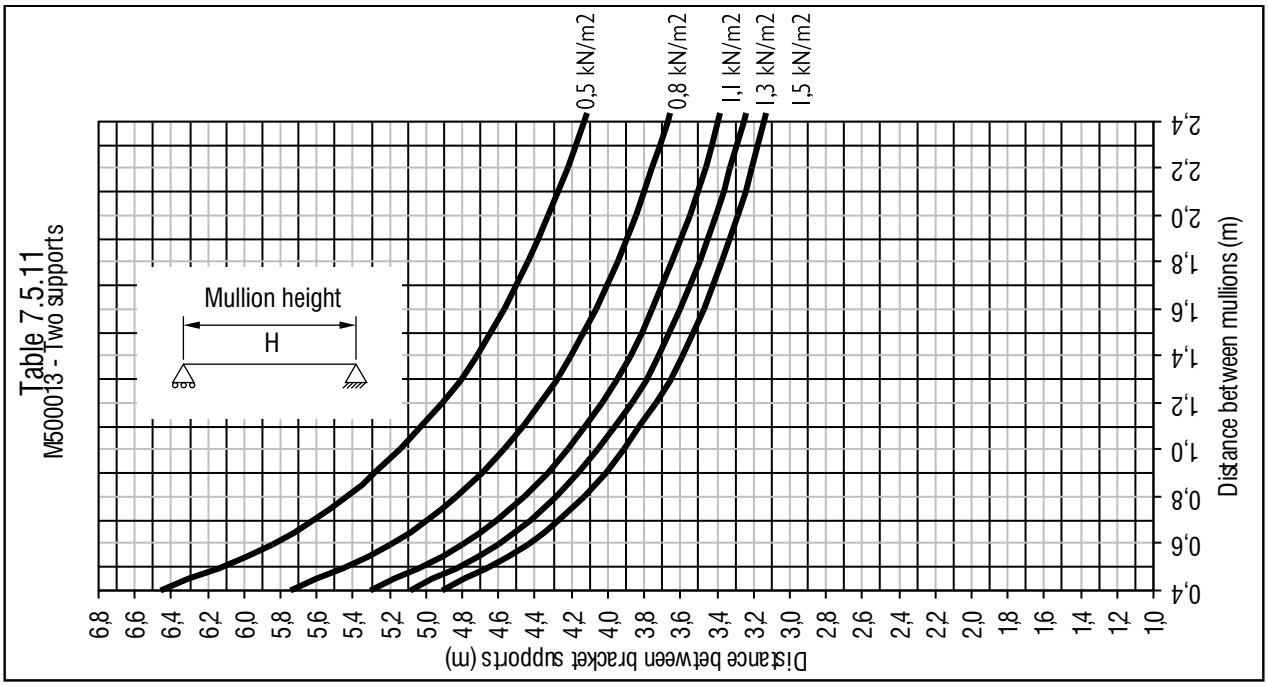
M500013



Ix = 433,10 cm4
Iy = 45,78 cm4

Note: The distance "H" is the distance between support points and is not necessarily the mullion height.

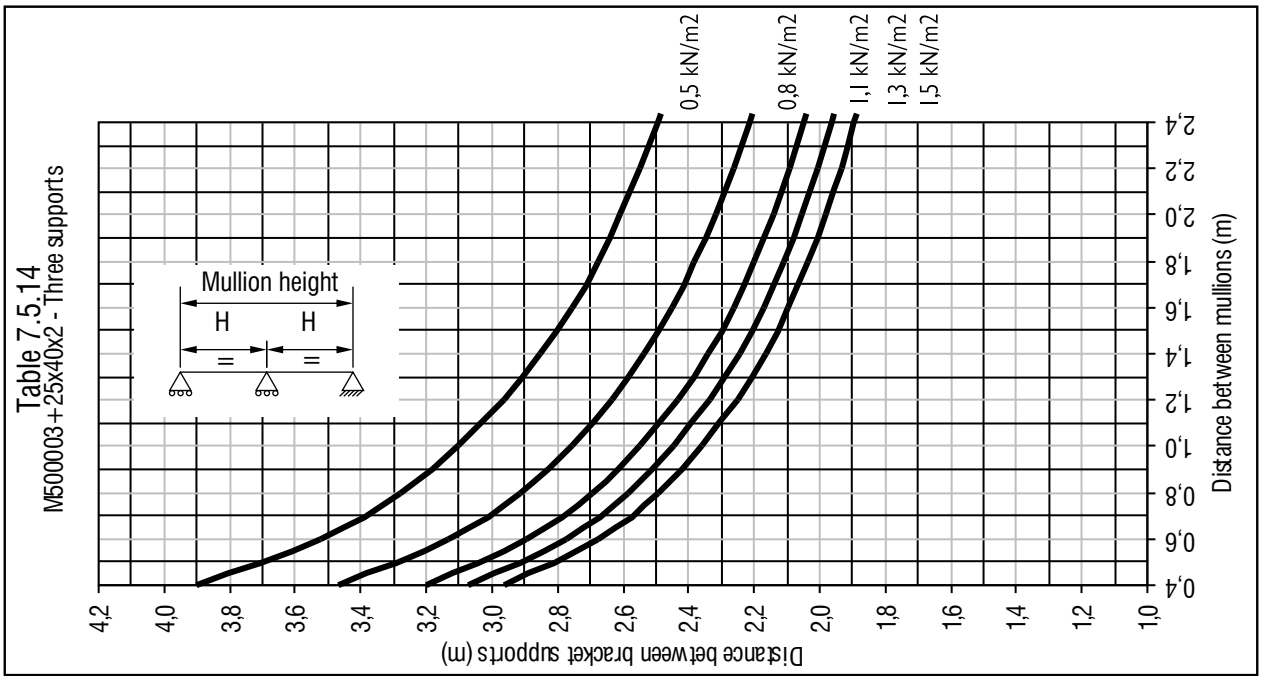
Table 7.5.11
M500013 - Two supports



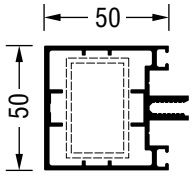
Valid for aluminium (E = 7000kN/cm2) and f_{max} = l /300 or 8mm

Building Physics

Wind load charts for mullions



M500003
25x40x2



Ix = 23,24 cm4
Iy = 21,86 cm4

Note: The distance "H" is the distance between support points and is not necessarily the mullion height.

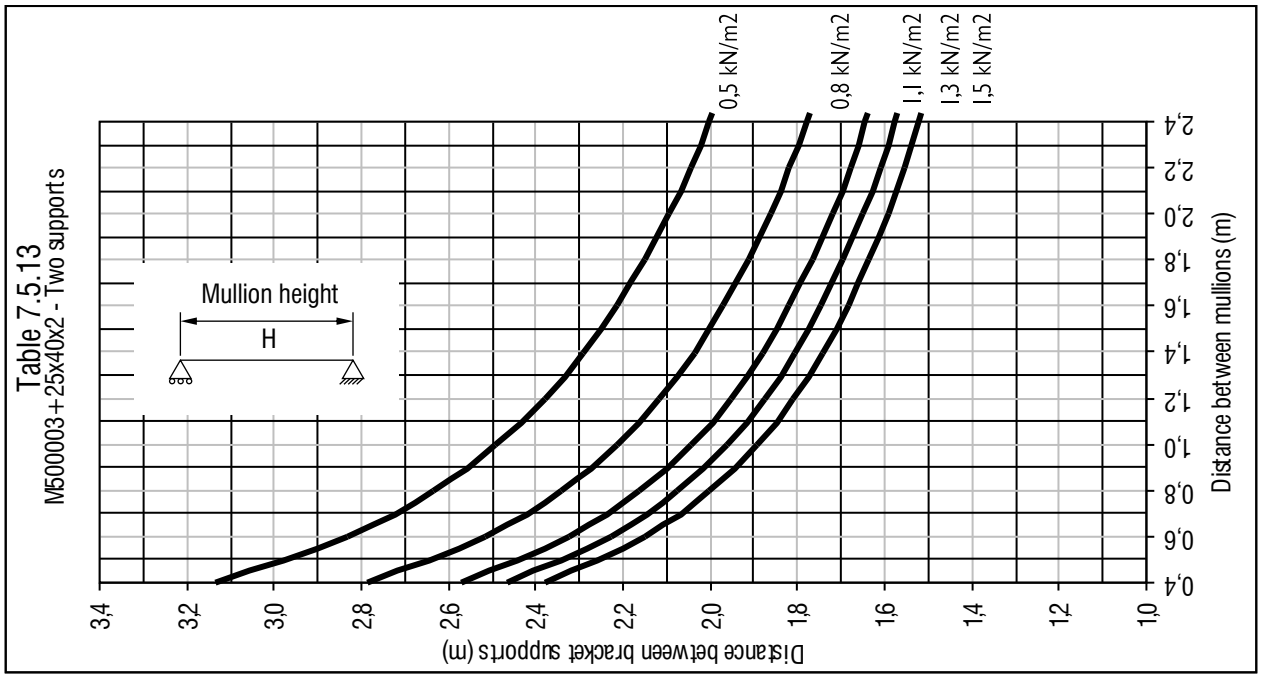


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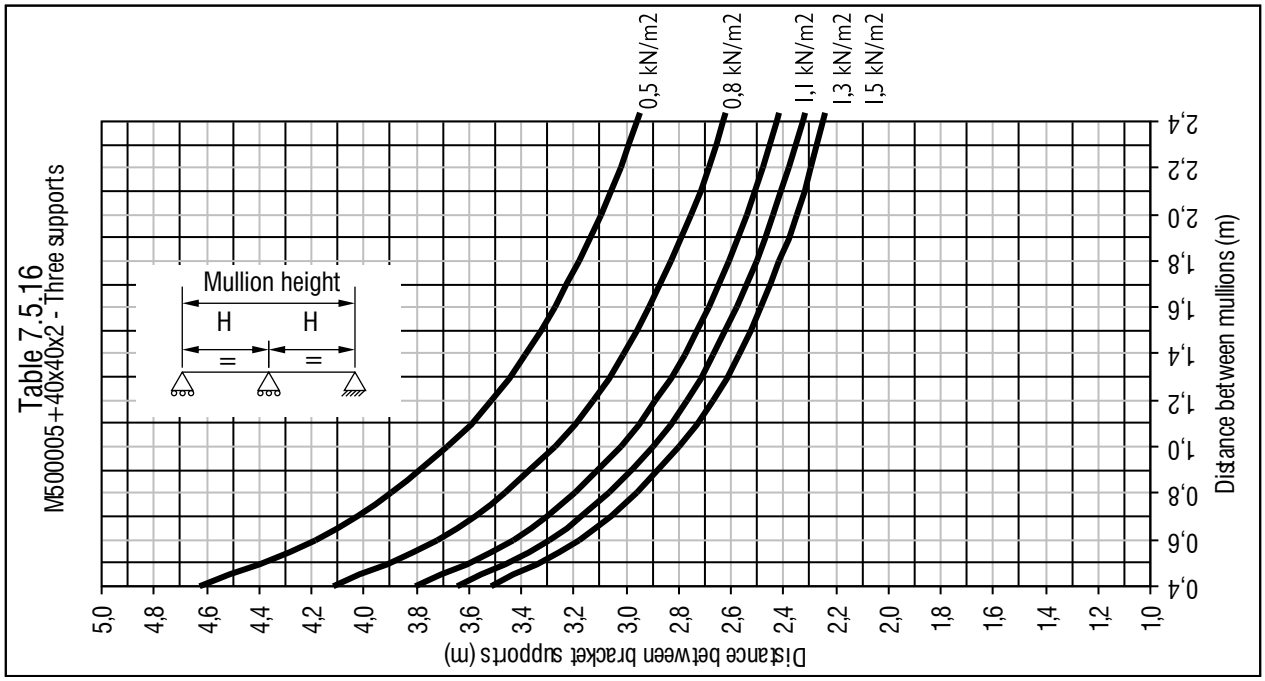
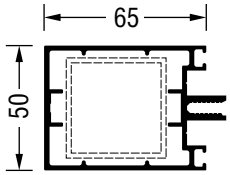
Table 7.5.16
M500005+40x40x2 - Three supports



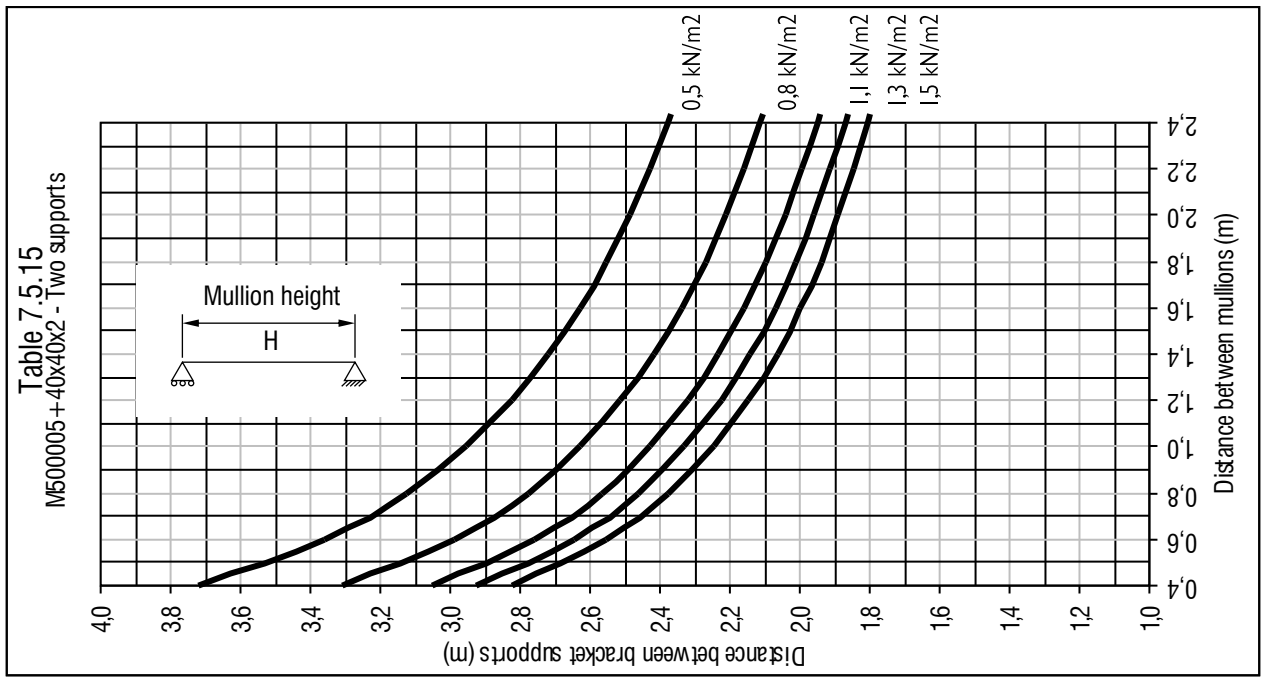
M500005
40x40x2



Ix = 46,42 cm4
Iy = 27,49 cm4

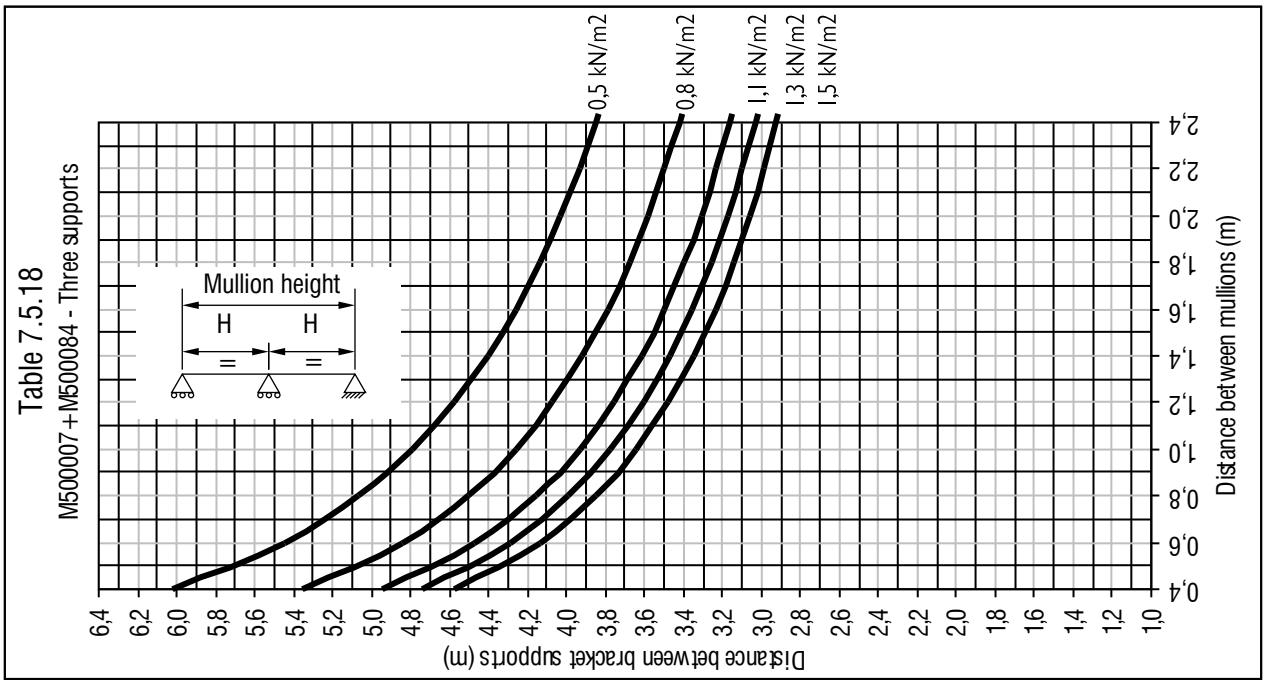
Note: The distance "H" is the distance between support points and is not necessarily the mullion height.

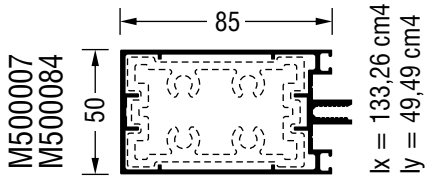
Table 7.5.15
M500005+40x40x2 - Two supports



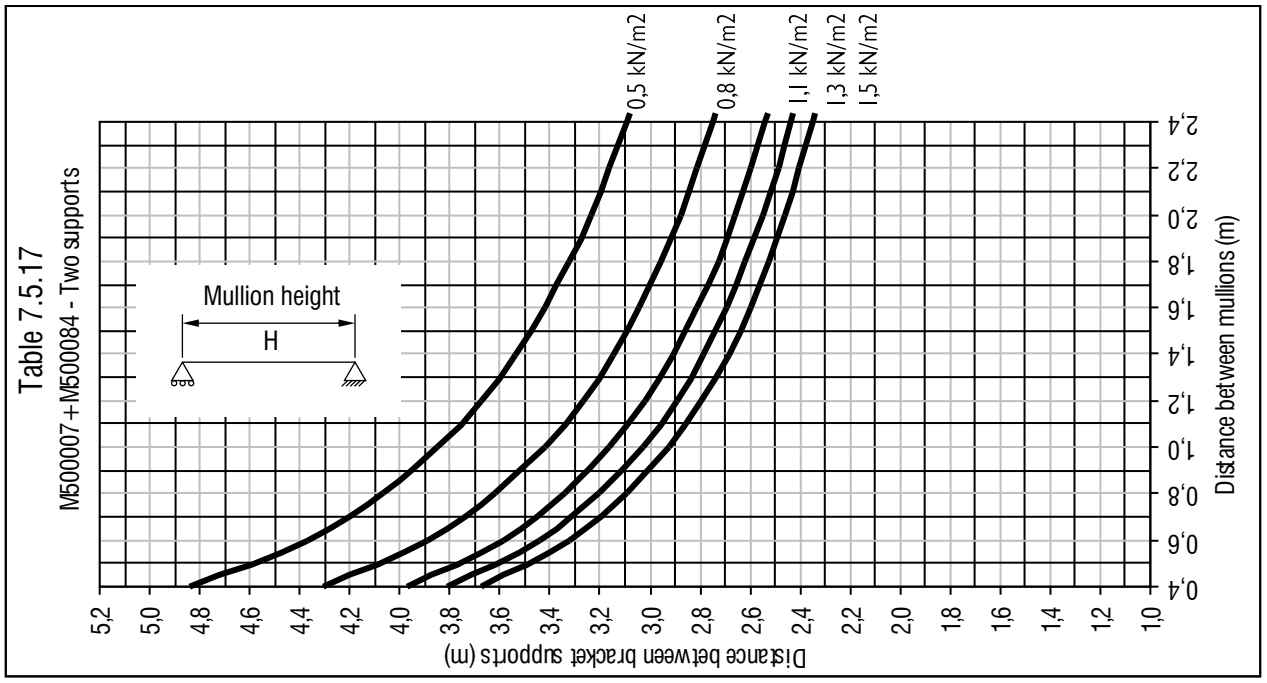
Valid for aluminium (E = 7000kN/cm2) and $f_{max} = l/300$ or 8mm

Wind load charts for mullions





Note: The distance "H" is the distance between support points and is not necessarily the mullion height.



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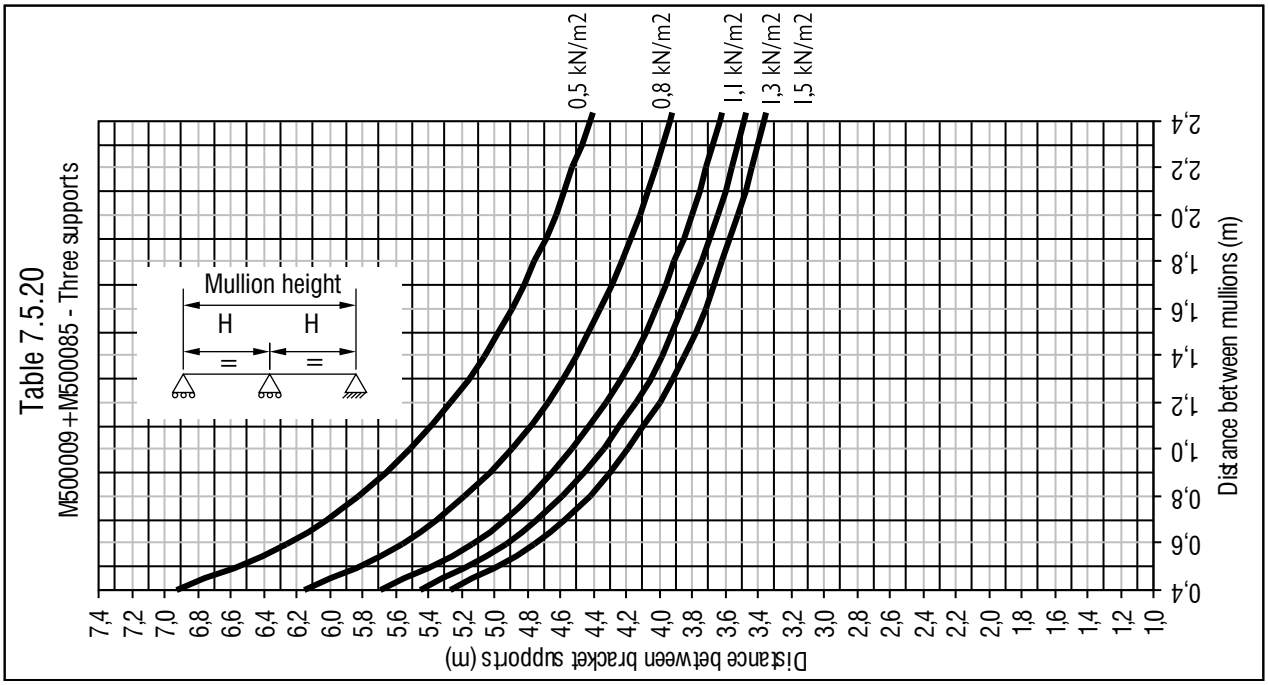
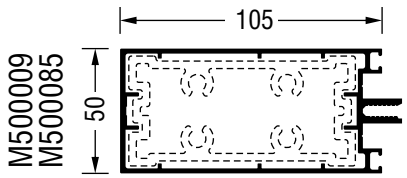
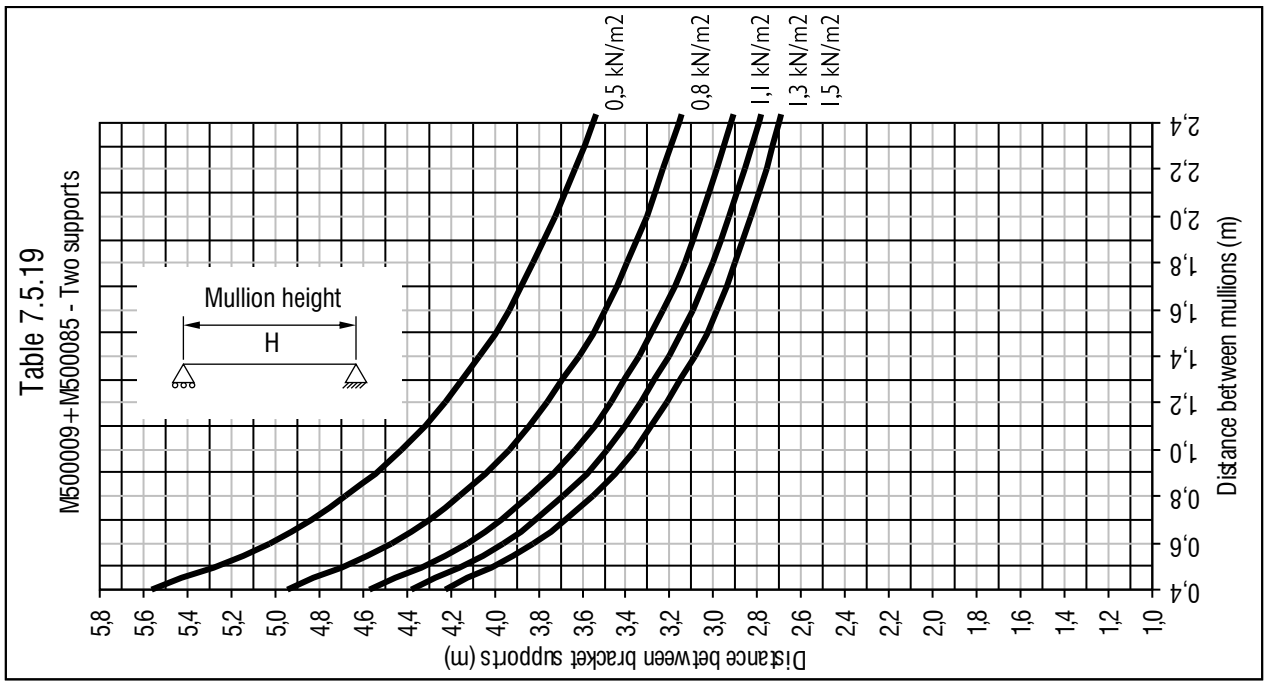




Ix = 233,53 cm4
Iy = 58,54 cm4

Note: The distance "H" is the distance between support points and is not necessarily the mullion height.



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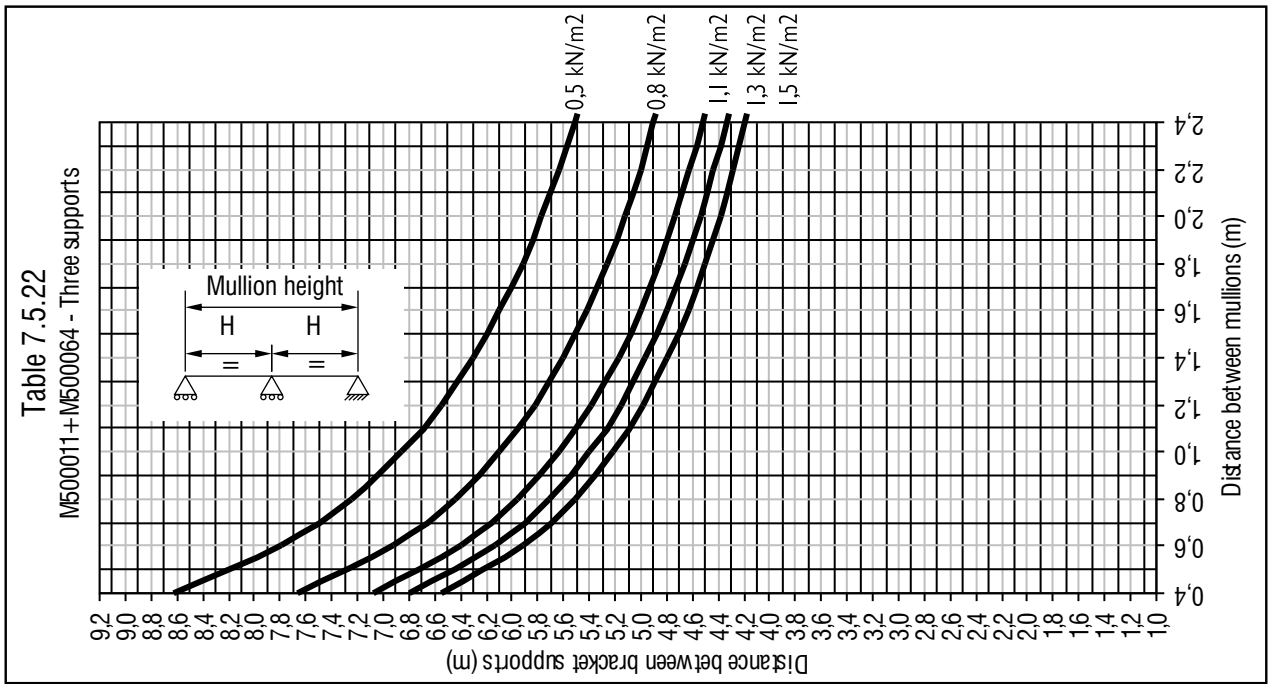
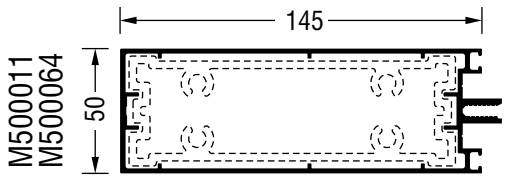
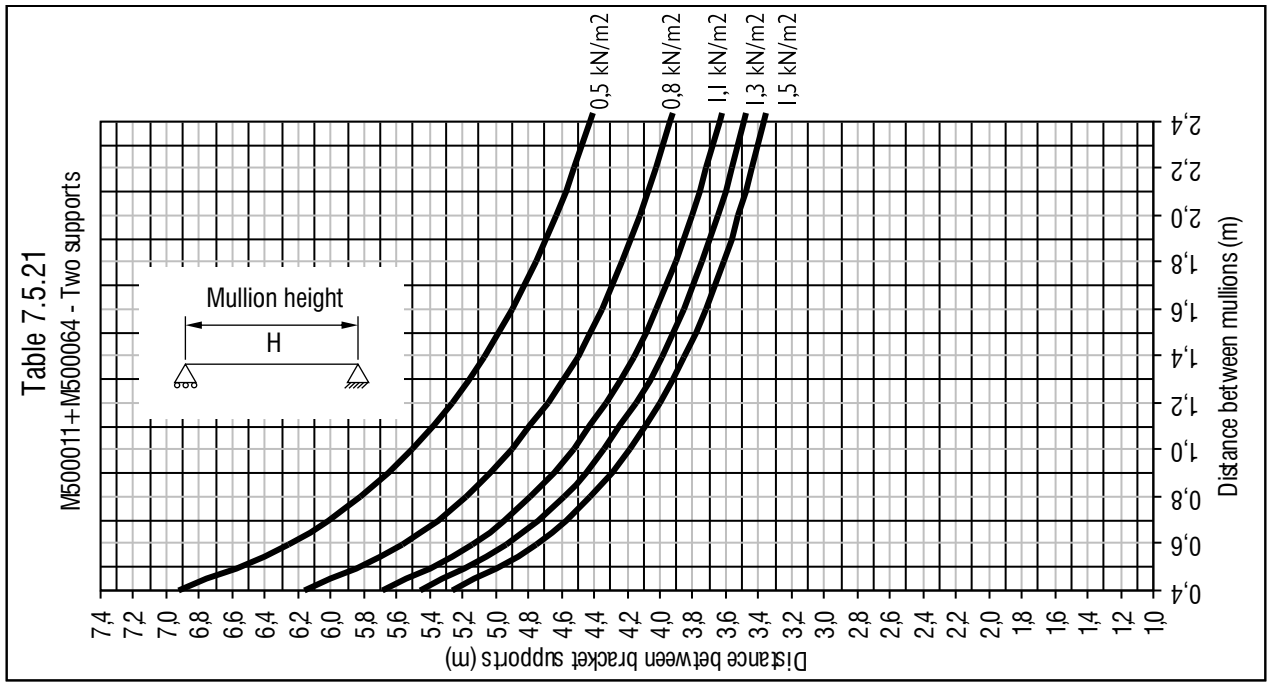




Ix = 565,08 cm4
Iy = 75,95 cm4

Example: If you have two supports and a wind load of 0,8kN/m2 with a height "H" of 3,4m and a width "L" of 1,5m the mullion M500011 is insufficient. For these parameters you either have to choose to use the mullion M500011 with three supports or the M500011 and M500064 with two supports (see page 7-028).

Note: The distance "H" is the distance between support points and is not necessarily the mullion height.



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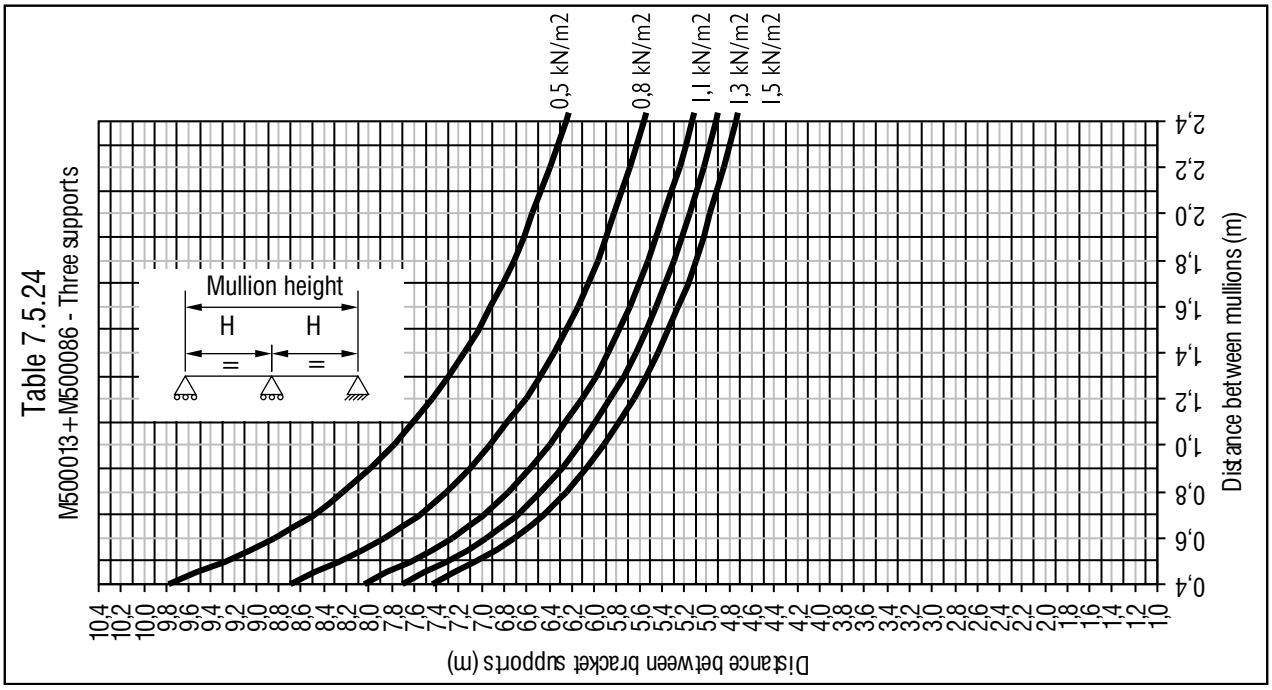
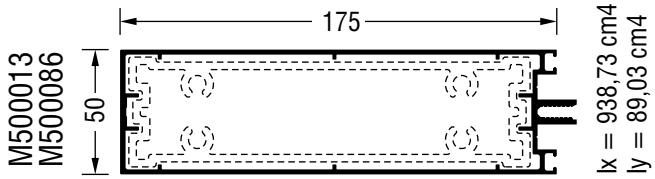
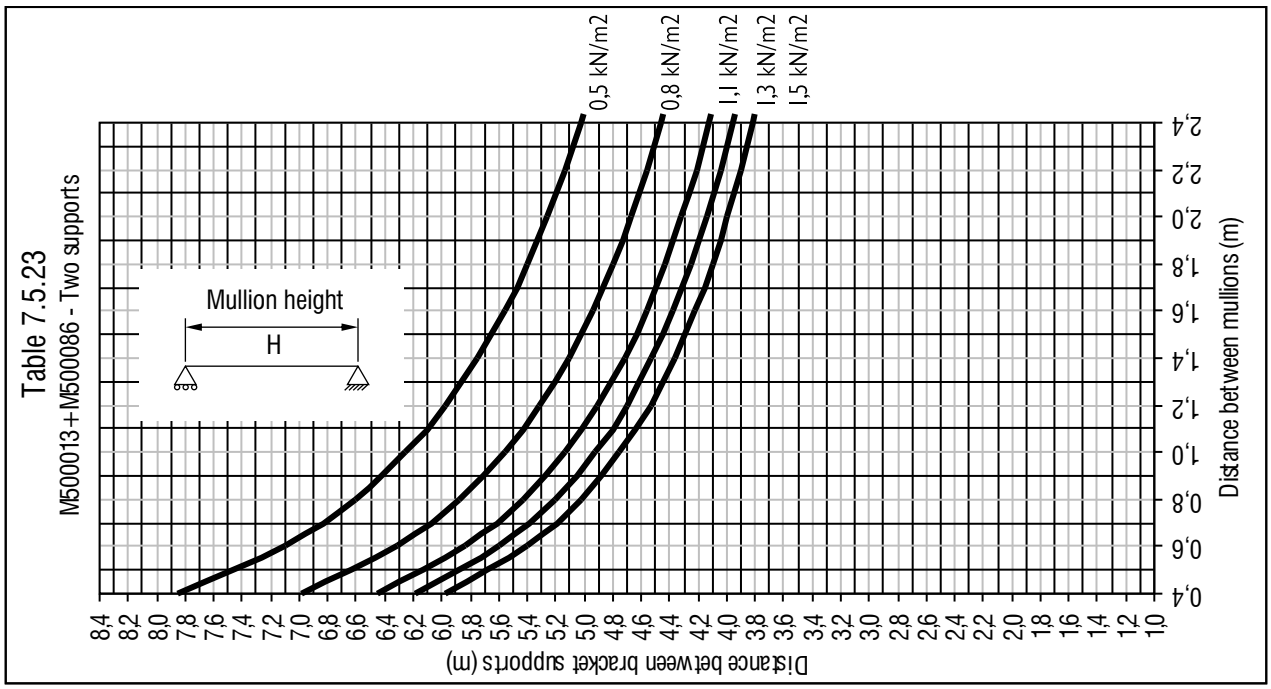




Ix = 938,73 cm4
Iy = 89,03 cm4

Note: The distance "H" is the distance between support points and is not necessarily the mullion height.



Valid for aluminium (E = 7000kN/cm2) and $f_{max} = l /300$ or 8mm

Building Physics

Dead load charts for transoms

M500003
25x40x2

Ix = 23,24 cm4
Iy = 21,86 cm4

Table 7.6.2

M500003

Ix = 20,81 cm4
Iy = 16,69 cm4

Table 7.6.1

Note: The glass thickness does not include the thickness of the spacer. The density of the glass is assumed to be 2600 Kg/m3.

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Valid for aluminium (E = 7000 kN/cm2) and f = 3 mm

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M500005

Ix = 39,08 cm4
Iy = 20,15 cm4

Table 7.6.3

Note: The glass thickness does not include the thickness of the spacer. The density of the glass is assumed to be 2600 Kg/m3.

M500005
40x40x2

Ix = 46,42 cm4
Iy = 27,49 cm4

Table 7.6.4

Valid for aluminium (E = 7000kN/cm2) and f = 3mm

Building Physics

Dead load charts for transoms

M500007
M500084

Ix = 133,26 cm4
Iy = 49,49 cm4

Table 7.6.6

M500007

Ix = 74,52 cm4
Iy = 24,76 cm4

Table 7.6.5

Note: The glass thickness does not include the thickness of the spacer. The density of the glass is assumed to be 2600 Kg/m3.

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Building Physics

Valid for aluminium (E = 7000 kN/cm2) and f = 3 mm

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M500009

Ix = 124,1 cm4
Iy = 29,60 cm4

Table 7.6.7

M500009
M500085

Ix = 233,53 cm4
Iy = 58,54 cm4

Table 7.6.8

Note: The glass thickness does not include the thickness of the spacer. The density of the glass is assumed to be 2600 Kg/m3.

Valid for aluminium (E = 7000kN/cm2) and f = 3mm

Building Physics

Dead load charts for transoms

M500011
M500064

Ix = 565,08 cm4
Iy = 75,95 cm4

Table 7.6.10

M500011

Ix = 272,45 cm4
Iy = 38,87 cm4

Table 7.6.9

Note: The glass thickness does not include the thickness of the spacer. The density of the glass is assumed to be 2600 Kg/m3.

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Building Physics

Valid for aluminium (E = 7000 kN/cm2) and f = 3 mm

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M500013

Ix = 433,10 cm4
Iy = 45,78 cm4

Table 7.6.11

Note: The glass thickness does not include the thickness of the spacer. The density of the glass is assumed to be 2600 Kg/m3.

M500013
M500086

Ix = 938,73 cm4
Iy = 89,03 cm4

Table 7.6.12

Valid for aluminium (E = 7000kN/cm2) and f = 3mm

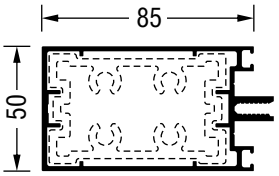
Building Physics

13.1 Determining the required moment of inertia I_y (deflection) for transom based on glass thickness and the charts from section 4.10

Panel height H = 200cm
Panel width W = 200cm
Glass thickness = 16mm

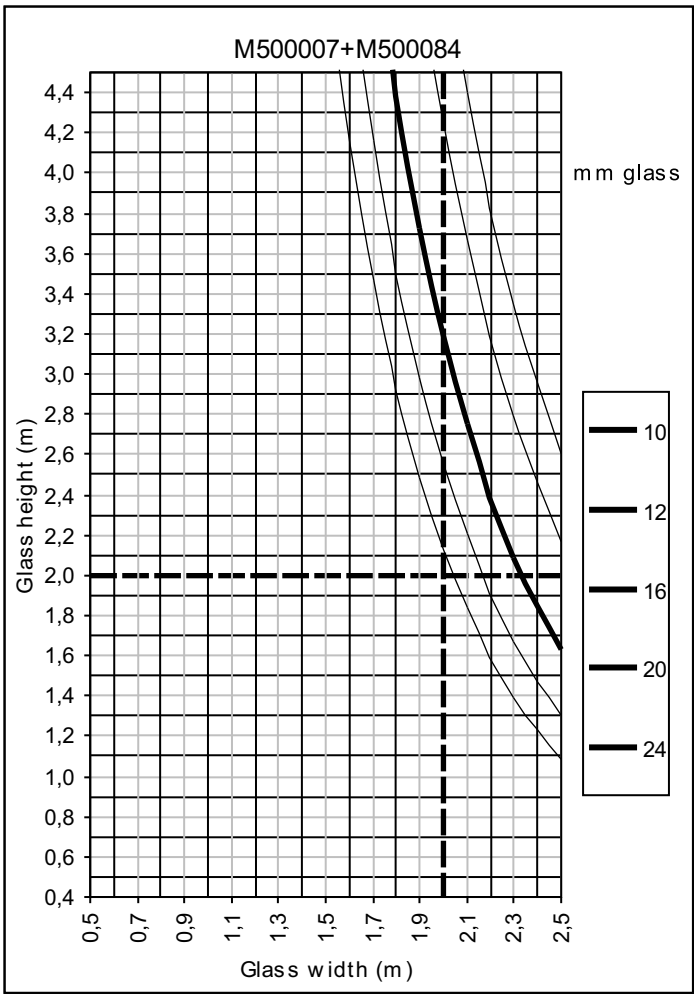
M500007
M500084

Ix = 133,26 cm4
Iy = 49,49 cm4



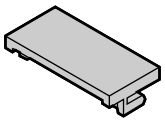
You should choose Table 7.6.6, because where the lines for 2m height cross with 2m width the point lies underneath the curve for 16mm glass thickness. This means that the moment of inertia of the transom Iy = 49,49 is acceptable for the dead load of the glazing panel.

Table 7.6.6



Alternate selection: M500011 with an I_y = 38,9 cm^4
See Table 7.6.9

13.2 Verify the maximum weight capacity of the glazing bridge



720 50 061	Glazing thickness = 24-30mm	Maximum glazing weight = 180Kg
720 50 062	Glazing thickness = 30-36mm	Maximum glazing weight = 270Kg
720 50 063	Glazing thickness = 36-42mm	Maximum glazing weight = 360Kg

Insert element area = 2,0 m x 2,0 m = 4 m^2 =
mullion centre-to-centre distance x transom centre-to-centre distance
Insert element weight = 167 kg ≅ 1,7 kN
Glazing thickness = 28 mm (6/12/5/5) this is 16mm of glass with a 12mm spacer
Installation height = untill 80 m

The appropriate glazing bridge is the 720 50 061

24 mm and 30 mm = 180Kg = 1,8 kN

Result: reading value higher than insert element weight = > ok

Building Physics

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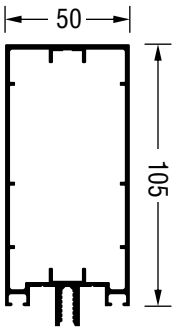
13.3 Example of a calculation using the charts from section 4.9 and 4.10

Mullion pre-dimensioning

Installation height		15 m
Wind load		0,8 kN/m^2
Panel Width	W	200 cm
Panel Height	H	200 cm

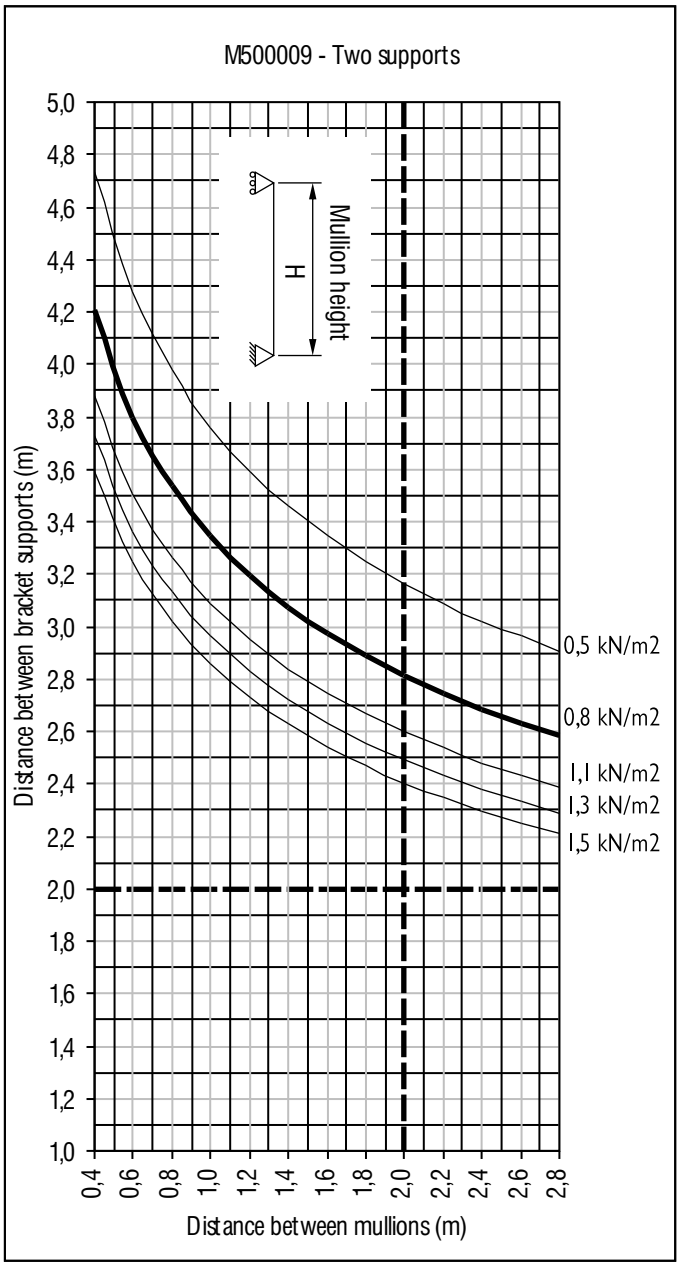
M500009



Ix = 124,17 cm4
Iy = 29,70 cm4

You should choose Table 7.5.7, because where the lines for 2m height cross with 2m width the point lies underneath the curve for 0,8kN/m2 of wind load. This means that the moment of inertia of the mullion Ix = 124,17cm4 is acceptable for the applied wind load. You may have chosen the mullion M500007 from Table 7.5.5, but it is recommended that the mullion is larger than the transom.

Table 7.5.7



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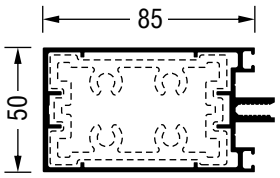
13.3 Example of a calculation using the charts from section 4.9 and 4.10

Transom pre-dimensioning

Installation height		15 m
Wind load		0,8 kN/m^2
Panel Width	W	200 cm
Panel Height	H	200 cm

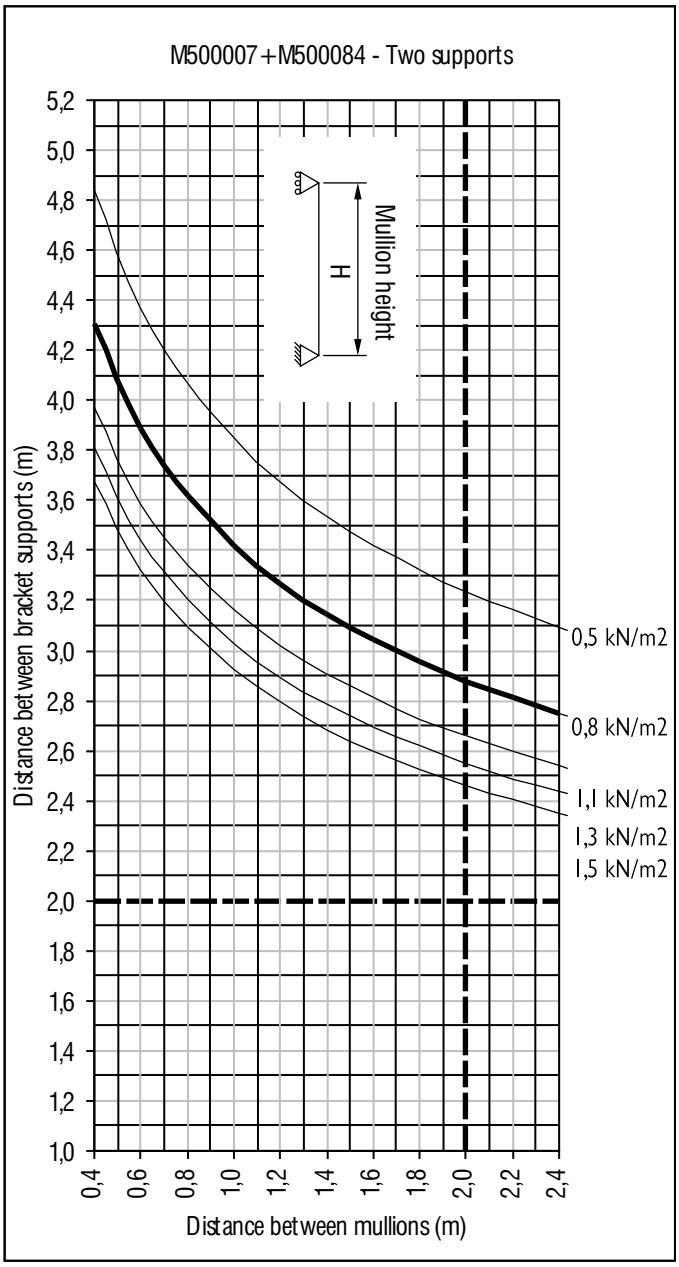
M500007
M500084

Ix = 133,26 cm4
Iy = 49,49 cm4



We must also check the transom we have chosen to see if it has an adequate Ix value for the required wind load. From Table 7.5.17 we can see that the transom M500007 with its insert profile M500084 who has an Ix value of 133,26cm4 is adequate for a wind load of 0,8kN/m2 with the given panel size. We can not choose a smaller transom because of the dead load of the large glazing panel. (see 13.1)

Table 7.5.17



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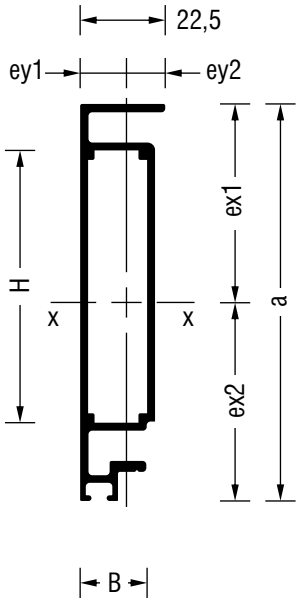
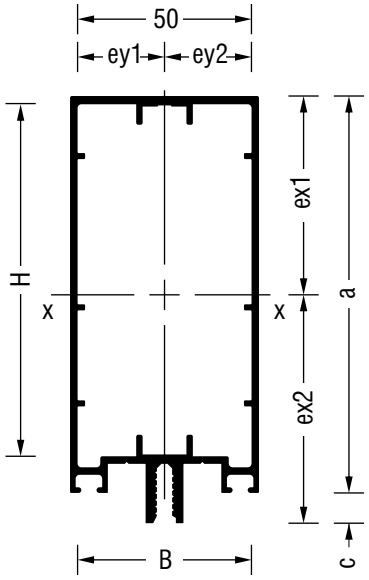
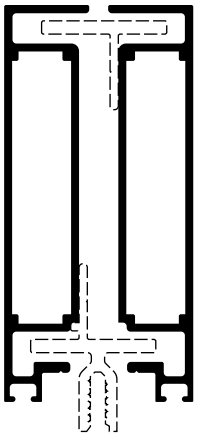
Profile load bearing diagram





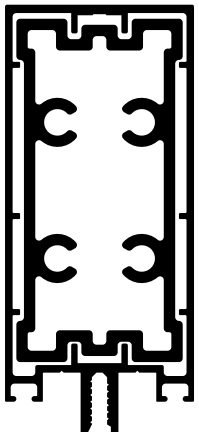
Examples for calculating moment of inertia

Ix for assembled profile = Ix1+Ix2
Iy for assembled profile = Iy1+Iy2



Ix = 125 cm4
Iy = 6,8 cm4

Ix for assembled profile = Ix1+Ix2
Iy for assembled profile = Iy1+Iy2



Ix = 233,6 cm4
Iy = 58,5 cm4

Note: Do not calculate the profiles M500054 and M500055 for the moment of inertia value.

Table 7.7 Profile load bearing chart

Profile code	a (mm)	c (mm)	Perimeter (mm)		Ix (cm^4)	Iy (cm^4)	Wx (cm^3)	Wy (cm^3)
			Mech	Total				
M500001	12	8	24	263	0,7	5,9	0,53	2,36
M500002	50		72,5	226	7,5	1,5	2,78	1,07
M500003	50	8	150	312	20,8	16,7	6,93	6,68
M500004	65		87,5	256	16,1	2,0	4,68	1,45
M500005	65	8	180	341,5	39,1	20,2	10,65	8,08
M500006	85		107,5	296	34,6	2,7	7,81	1,99
M500007	85	8	220	382	74,5	24,7	15,59	9,88
M500008	105		127,5	336	62,5	3,4	11,52	2,53
M500009	105	8	260	422	124,2	29,7	21,16	11,88
M500010	145		167,5	416	153,9	4,7	20,74	3,55
M500011	145	8	340	502	272,5	38,9	34,06	15,56
M500012	175		197,5	476	259,9	5,7	29,17	4,33
M500013	175	8	400	562	433,1	45,8	45,28	18,32
M500014	85	8	240	563	94,2	94,2	18,26	18,26
M500015	20	8	40	314	1,5	6,5	1,04	2,60
M500016	65	8	115	452	32,3	11,7	8,26	3,80
M500017			57,7	137	3,8	0,1	1,29	0,14
M500064				382	292,6	37,1	44,74	16,86
M500065				371	70,6	1,2	12,84	2,40
M500084				262	58,7	24,7	16,58	11,23
M500085				302	109,4	28,8	24,10	13,09
M500086				442	505,6	43,2	62,89	19,64
M500087				178	8,6	0,6	3,44	1,13
M500088				271	21,6	0,9	6,17	1,64
M500089				431	132,0	1,3	18,86	2,83
M500090				321	66,1	66,1	16,73	16,78
S-25-40-2				130	2,4	5,2	1,92	2,60
S-40-40-2				160	7,3	7,3	3,65	3,65

For profile combinations the moment of inertia values may be added together to achieve the new value.

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Table 7.7 Profile load bearing chart

Profile code	Area (mm^2)	Weight (gr/m)	e_{x1} (mm)	e_{x2} (mm)	e_{y1} (cm)	e_{y2} (cm)	B (mm)	H (mm)
M500001	304	821	6,80	13,20	25,00	25,00	-	-
M500002	330	891	23,00	27,00	8,50	14,00	15,6	17,0
M500003	577	1558	28,00	30,00	25,00	25,00	46,0	38,1
M500004	393	1061	30,60	34,40	8,70	13,80	15,6	32,0
M500005	637	1720	36,30	36,70	25,00	25,00	46,0	53,1
M500006	477	1288	40,70	44,30	8,90	13,60	15,6	52,0
M500007	717	1936	47,80	45,20	25,00	25,00	46,0	73,1
M500008	561	1515	50,75	54,25	9,05	13,45	15,6	72,0
M500009	804	2171	58,70	54,30	25,00	25,00	46,0	93,1
M500010	729	1968	70,80	74,20	9,25	13,25	15,6	112,0
M500011	963	2600	80,00	73,00	25,00	25,00	46,0	133,1
M500012	855	2309	85,90	89,10	9,35	13,15	15,6	142,0
M500013	1083	2924	95,65	87,35	25,00	25,00	46,0	163,1
M500014	1026	2770	41,40	51,60	41,40	51,60	73,3	73,3
M500015	354	956	14,45	13,55	25,00	25,00		
M500016	473	1277	39,10	33,90	19,20	30,80		53,1
M500017	125	338	29,50	28,00	1,35	7,10		
M500064	1458	3937	65,40	65,40	22,00	22,00		
M500065	608	1642	55,00	55,00	8,60	5,00		
M500084	1098	2965	35,40	35,40	22,00	22,00		
M500085	1218	3289	45,40	45,40	22,00	22,00		
M500086	1638	4423	80,40	80,40	22,00	22,00		
M500087	305	824	25,00	25,00	8,30	5,30		
M500088	458	1237	35,00	35,00	8,10	5,50		
M500089	698	1885	70,00	70,00	9,00	4,60		
M500090	1194	3224	39,50	31,80	31,90	39,4		
S-25-40-2	244	659	12,50	12,50	20,00	20,00		
S-40-40-2	304	821	20,00	20,00	20,00	20,00		

For profile combinations the moment of inertia values may be added together to achieve the new value.

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Building codes and reference material

EN 1990:	(Eurocode 0) Basis of structural design
EN 1991:	(Eurocode 1) Actions on structures
EN 1992:	(Eurocode 2) Design of concrete structures
EN 1993:	(Eurocode 3) Design of steel structures
EN 1994:	(Eurocode 4) Design of composite steel and concrete
EN 1995:	(Eurocode 5) Design of timber structures
EN 1996:	(Eurocode 6) Design of masonry structures
EN 1997:	(Eurocode 7) Geotechnical design
EN 1998:	(Eurocode 8) Design of structures for earthquake
EN 1999:	(Eurocode 9) Design of aluminium structures
EN 14351-1 -	Windows and doors - Product standard, performance characteristics - Part 1: Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics;
EN 13830 -	Curtain walling - Product standard;
EN 1279-1 -	Glass in building - Insulating glass units - Part 1: Generalities, dimensional tolerances and rules for the system description;
EN 1279-2 -	Glass in building - Insulating glass units - Part 2: Long term test method and requirements for moisture penetration;
EN 1279-3 -	Glass in building - Insulating glass units - Part 3: Long term test method and requirements for gas leakage rate and for gas concentration tolerances
EN 1279-4 -	Glass in building - Insulating glass units - Part 4: Methods of test for the physical attributes of edge seals
EN 1279-5 -	Glass in building - Insulating glass units - Part 5: Evaluation of conformity
EN 1279-6 -	Glass in building - Insulating glass units - Part 6: Factory production control and periodic tests;
DIN 4109 -	Sound insulation in buildings; requirements and testing
DIN 1055-1 -	Action on structures - Part 1: Densities and weights of building materials, structural elements and stored materials
DIN 1055-2 -	Design Loads for Buildings; Soil Characteristics; Specific Weight, Angle of Friction, Cohesion, Angle of Wall Friction
DIN 1055-3 -	Actions on structures - Part 3: Self-weight and imposed load in building
DIN 1055-4 -	Actions on structures - Part 4: Wind loads
DIN 1055-5 -	Actions on structures - Part 5: Snowloads and ice loads
DIN 1055-6 -	Actions on structures - Part 6: Design loads for buildings and loads in silo bins
DIN 1055-7 -	Actions on structures - Part 7: Thermal actions
DIN 1055-8 -	Actions on structures - Part 8: Actions during execution
DIN 1055-9 -	Actions on structures - Part 9: Accidental actions
DIN 4113-1 -	Aluminium constructions under predominantly static loading; static analysis and structural design
DIN 4113-1/A1 -	Aluminium constructions under predominantly static loading - Part 1: Static analysis and structural design; Amendment A1
DIN 4113-2 -	Aluminium constructions under predominantly static loading - Part 2: Static analysis, structural design and execution of welded constructions
DIN V 4113-3 -	Aluminium constructions under predominantly static loading - Part 3: Execution and qualification of constructors
EN 674 -	Glass in building - Determination of the thermal transmittance (U value) - Guarded hot plate method;
EN 673 -	Glass in building - Determination of thermal transmittance (U value) - Calculation method (including Amendment A1:2000 + Amendment A2:2002);
BS 8118-1:1991 -	Structural use of aluminium. Code of practice for design (Structural design, Design, Aluminium, Aluminium alloys, Structural members, Structural systems, Loading, Construction materials, Deformation, Corrosion protection, Joints, Joining processes, Approval testing, Acceptance (approval), Metal sections, Beams, Plate girders, Fatigue, Stress, Static loading, Reports, Safety measures, Design calculations)
ENV 1627 -	Windows, doors, shutters - Burglar resistance - Requirements and classification;
EN 1627 -	Burglar resistant construction products (not for precast concrete parts) - Requirements and classification;

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Building codes and reference material

EN ISO 10077-1 - Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 1: General (ISO 10077-1:2006);
EN ISO 10077-2 - Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames (ISO/FDIS 10077-2:2003);
EN ISO 12567-1 - Thermal performance of windows and doors - Determination of thermal transmittance by hot box method - Part 1: Complete windows and doors (ISO 12567-1:2000);
EN ISO 12567-2 - Thermal performance of windows and doors - Determination of thermal transmittance by hot box method - Part 2: Roof windows and other projecting windows (ISO 12567-2:2005);
EN 12210 - Windows and doors - Resistance to wind load - Classification (includes Corrigendum AC:2002);
EN 12758 - Glass in building - Glazing and airborne sound insulation - Definitions and determination of properties;
DIN 4108-1 - Thermal insulation in buildings; quantities and units
DIN 4108-2 - Thermal protection and energy economy in buildings - Part 2: Minimum requirements to thermal insulation
DIN 4108-3 - Thermal protection and energy economy in buildings - Part 3: Protection against moisture subject to climate conditions; Requirements and directions for design and construction
DIN 4108-4 - Thermal insulation and energy economy in buildings - Part 4: Hygrothermal design values
DIN 4108-6 - Thermal protection and energy economy in buildings - Part 6: Calculation of annual heat and energy use
DIN 4108-7 - Thermal insulation and energy economy of buildings - Part 7: Airtightness of building, requirements, recommendations and examples for planning and performance
DIN 4108-10 - Thermal insulation and energy economy in buildings - Application-related requirements for thermal insulation materials - Part 10: Factory made products
EN 13050 - Curtain walling - Watertightness - Laboratory test under dynamic condition of air pressure and water spray;
EN 12179 - Curtain walling - Resistance to wind load - Test method
EN 13116 - Curtain walling - Resistance to wind load - Performance requirements;
EN 13241-1:2003 - Industrial, commercial and garage doors and gates. Product standard. Products without fire resistance or smoke control characteristics
EN 949 - Windows and curtain walling, doors, blinds and shutters - Determination of the resistance to soft and heavy body impact for doors;
EN 14019 - Curtain Walling - Impact resistance - Performance requirements;
EN 1364 - Fire resistance tests for non-loadbearing elements: Curtain walling - Full configuration (complete assembly);
EN 1670 - Building hardware - Corrosion resistance - Requirements and test methods;
EN 12152 - Curtain walling - Air permeability - Performance requirements and classification;
EN 12153 - Curtain walling - Air permeability - Test methods;
EN 12154 - Curtain walling - Watertightness - Performance requirements and classification;
EN 12155 - Curtain walling - Watertightness - Laboratory test under static pressure;
EN 12179 - Curtain walling - Resistance to wind load - Test method;
EN 12365-1 - Building hardware - Gaskets and weatherstripping for doors, windows, shutters and curtain walling - Part 1: Performance requirements and classification;

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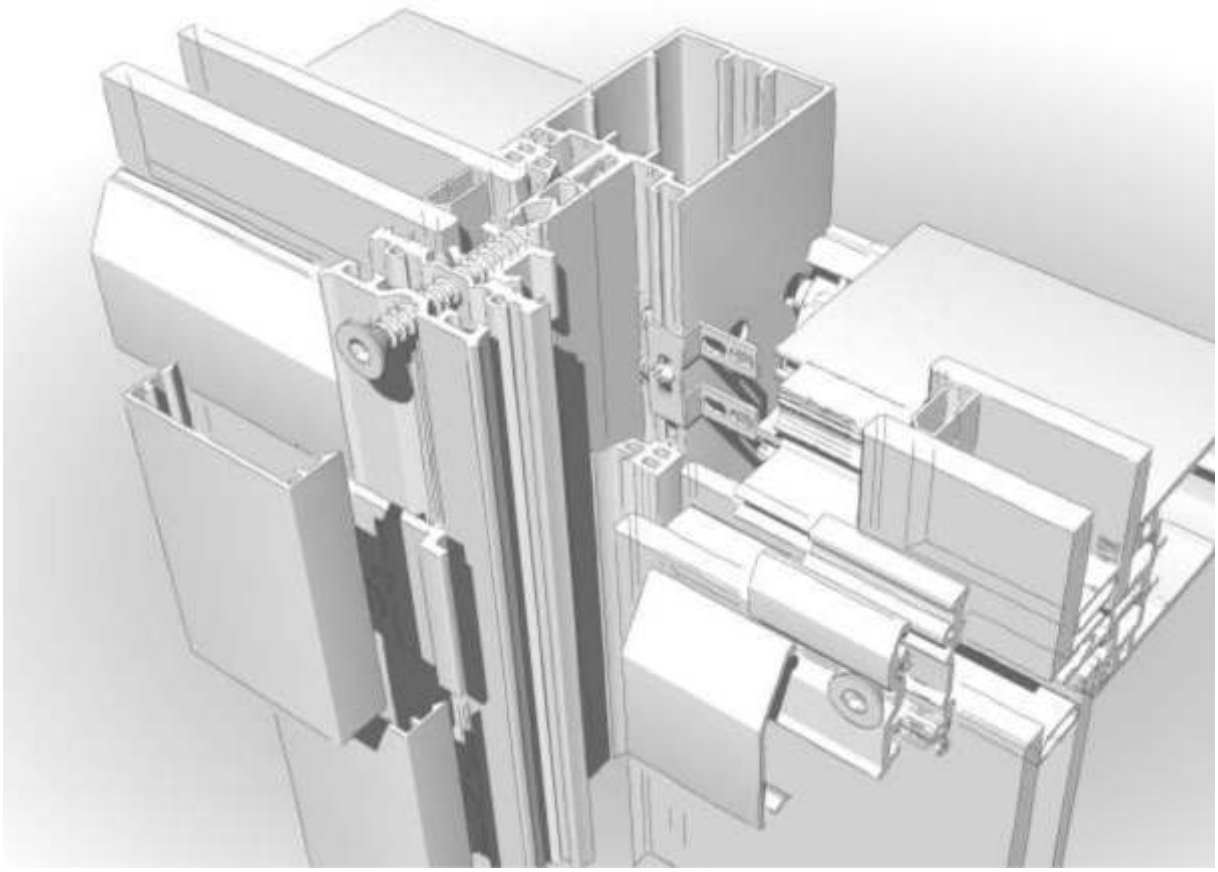
Terminology for Curtain Walls



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A

Absorptance. The ratio of radiant energy absorbed to total incident radiant energy in a glazing system.

Acrylic. A thermoplastic with good weather resistance, shatter resistance, and optical clarity, used for glazing.

Aerogel. A microporous, transparent silicate foam used as a glazing cavity fill material, offering possible U-values below 0.10 BTU/(h-sq ft-˚F) or 0.56 W/(sq m-˚C).

Air infiltration. The amount of air leaking in and out of a building through cracks in walls, windows and doors.

Air-leakage (air infiltration).The amount of air leaking in and out of a building through cracks in walls, windows, and doors.

Air-leakage rating. A measure of the rate of air-leakage around a window, door, or skylight in the presence of a specific pressure difference. It is expressed in units of cubic feet per minute per square foot of frame area (cfm/sq ft). Formerly expressed as cubic feet per minute per foot of window perimeter length (cfm/ft) but not now in use. The lower a window's air-leakage rating, the better its airtightness.

Annealed glass. Standard sheet of float glass which has not been heat-treated.

Annealing. Heating above the critical or recrystallization temperature, then controlled cooling of metal, glass, or other materials to eliminate the effects of cold-working, relieve internal stresses, or improve strength, ductility, or other properties.

Argon. An inert, nontoxic gas used in insulating glass units to reduce heat transfer.

Awning. Window similar to a casement except the sash is hinged at the top and always swings out.

B

Back ventilation. Ventilation of cold facade cavity to eliminate moisture

Bay window. An arrangement of three or more individual window units, attached so as to project from the building at various angles. In a three-unit bay, the center section is normally fixed, with the end panels operable as single-hung or casement windows.

Bead. A wood strip against which a swinging sash closes, as in a casement window. Also, a finishing trim at the sides and top of the frame to hold the sash, as in a fixed sash or a double-hung window. Also referred to as bead stop.

Bottom rail. The bottom horizontal member of a window sash.

Bow window. A rounded bay window that projects from the wall in an arc shape, commonly consisting of five sashes.

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C

Casement. A window sash that swings open on side hinges: in-swinging are French in origin; out-swinging are from England.

Casing. Exposed molding or framing around a window or door, on either the inside or outside, to cover the space between the window frame or jamb and the wall.

Caulking. A mastic compound for filling joints and sealing cracks to prevent leakage of water and air, commonly made of silicone, bituminous, acrylic, or rubber-based material.

Clerestory. A window in the upper part of a lofty room that admits light to the center of the room.

Cold facade. curtain wall construction with outside air ventilated cavity and inside thermal insulation and sealing

Composite frame. A frame consisting of two or more materials for example, an interior wood element with an exterior fiberglass element.

Condensation. The deposit of water vapor from the air on any cold surface whose temperature is below the dew point, such as a cold window glass or frame that is exposed to humid indoor air.

Conduction. Heat transfer through a solid material by contact of one molecule to the next. Heat flows from a higher-temperature area to a lower-temperature one.

Convection. A heat transfer process involving motion in a fluid (such as air) caused by the difference in density of the fluid and the action of gravity. Convection affects heat transfer from the glass surface to room air, and between two panes of glass.

Coping. Component which protects the junction between the curtain walling and the roof edge from weather

Cradle guide. Specially profiled continuous recess or projection designed into or separately attached to the mullion to provide a location guide for an access cradle

Curtain walling. External building facade produced with framing made mainly of metal, timber or PVC-U, usually consisting of vertical and horizontal structural members, connected together and anchored to the supporting structure of the building, which provides, by itself or in conjunction with the building construction, all the normal functions of an external wall, but does not contribute to the load bearing characteristics of the building structure

D

Desiccant. An extremely porous crystalline substance used to absorb moisture from within the sealed air space of an insulating glass unit.

Dewpoint. The temperature at which water vapor in air will condense at a given state of humidity and pressure.

Divided light. A window with a number of smaller panes of glass separated and held in place by muntins.

Double glazing. In general, two thicknesses of glass separated by an air space within an opening to improve insulation against heat transfer and/or sound transmission. In factory-made double glazing units, the air between the glass sheets is thoroughly dried and the space is sealed airtight, eliminating possible condensation and providing superior insulating properties.

Double skin facade. Curtain wall construction comprising an outer skin of glass and an inner wall constructed as a curtain wall that together with the outer skin provide the full function of a wall

Drainage hole. Opening through which water drains to the building exterior

Drip. A projecting fin or a groove at the outer edge of a sill, soffit, or other projecting member in a wall designed to interrupt the flow of water downward over the wall or inward across the soffit.

E

Electrochromics. Glazing with optical properties that can be varied continuously from clear to dark with a low-voltage signal. Ions are reversibly injected or removed from an electrochromic material, causing the optical density to change.

Emittance. The ratio of the radiant flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

Evacuated glazing. Insulating glazing composed of two glass layers, hermetically sealed at the edges, with a vacuum between to eliminate convection and conduction. A spacer system is needed to keep the panes from touching.

Exterior stop. The removable glazing bead that holds the glass or panel in place when it is on the exterior side of the light or panel, in contrast to an interior stop located on the interior side of the glass.

External glazing gasket. Preformed resilient profiled length of sealing material installed between the external face of a glass pane, insulating glass unit or infill panel and the surrounding frame, glazing bead or pressure plate

Extrusion. The process of producing vinyl or aluminum shapes by forcing heated material through an orifice in a die. Also, any item made by this process.

Eyebrow windows. Low, inward-opening windows with a bottom-hinged sash. These attic windows built into the top molding of the house are sometimes called "lie-on-your-stomach" or "slave" windows. Often found on Greek Revival and Italianate houses.

F

Fanlight. A half-circle window over a door or window, with radiating bars. Also called circle top transom.

Fenestration. The placement of window openings in a building wall, one of the important elements in controlling the exterior appearance of a building. Also, a window, door, or skylight and its associated interior or exterior elements, such as shades or blinds.

Fiberglass. A composite material made by embedding glass fibers in a polymer matrix. May be used as a diffusing material in sheet form, or as a standard sash and frame element.

Fixed light. A pane of glass installed directly into non-operating framing members; also, the opening or space for a pane of glass in a non-operating frame.

Fixed panel. An inoperable panel of a sliding glass door or slider window.

Fixed window. A window with no operating sashes.

Flashing. Sheet metal or other material applied to seal and protect the joints formed by different materials or surfaces.

Float glass. Glass formed by a process of floating the material on a bed of molten metal. It produces a high-optical-quality glass with parallel surfaces, without polishing and grinding.

Fogging. A deposit of contamination left on the inside surface of a sealed insulating glass unit due to extremes of temperatures or failed seals.

Frame. The fixed frame of a window which holds the sash or casement as well as hardware.

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G

Gas fill. A gas other than air, usually argon or krypton, placed between window or skylight glazing panes to reduce the U-factor by suppressing conduction and convection.

Glass. An inorganic transparent material composed of silica (sand), soda (sodium carbonate), and lime (calcium carbonate) with small quantities of alumina, boric, or magnesia oxides.

Glazing. The glass or plastic panes in a window, door, or skylight.

Glazing bead. length of profiled material used around the periphery of a pane of glass, insulating glass unit or infill panel to secure it in its frame

Greenhouse window. A three-dimensional window that projects from the exterior wall and usually has glazing on all sides except the bottom, which serves as a shelf.

H

Head. Horizontal structural framing member positioned at the top of the curtain wall or at the top of an area of glass, windows, panels or doors

Head track. The track provided at the head of a sliding glass door. Also, the head member incorporating the track.

Heat-absorbing glass. Window glass containing chemicals (with gray, bronze, or blue-green tint) which absorb light and heat radiation, and reduce glare and brightness. See also Tinted glass.

Heat gain. The transfer of heat from outside to inside by means of conduction, convection, and radiation through all surfaces of a house.

Heat loss. The transfer of heat from inside to outside by means of conduction, convection, and radiation through all surfaces of a house.

Heat-strengthened glass. Glass that is reheated, after forming, to just below melting point, and then cooled, forming a compressed surface that increases its strength beyond that of typical annealed glass.

Hinged windows. Windows (casement, awning, and hopper) with an operating sash that has hinges on one side. See also Projected window.

Hopper. Window with sash hinged at the bottom.

Horizontal slider. A window with a movable panel that slides horizontally.

I

Infill panel. Translucent or opaque filler or facing material, either of one piece or an assembly, installed within a surrounding frame

Infiltration. See air leakage.

Infrared radiation. Invisible, electromagnetic radiation beyond red light on the spectrum, with wavelengths greater than 0.7 microns.

Insulating glass unit. Composite unit of two or more panes of glazing hermetically sealed to provide an improved performance of thermal and acoustic insulation

Insulated shutters. Insulating panels that cover a window opening to reduce heat loss.

Internal glazing gasket. Preformed resilient shaped length of sealing material installed between the internal face of a glass pane, insulating glass unit or infill panel and its surrounding frame or glazing bead

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Insulating value. See U-factor.

Insulation. Construction materials used for protection from noise, heat, cold or fire.

Interlocker. An upright frame member of a panel in a sliding glass door which engages with a corresponding member in an adjacent panel when the door is closed. Also called interlocking stile.

J

Jalousie. Window made up of horizontally-mounted louvered glass slats that abut each other tightly when closed and rotate outward when cranked open.

Jamb. vertical structural framing member positioned at the vertical edge of the curtain wall

K

Krypton. An inert, nontoxic gas used in insulating windows to reduce heat transfer.

KWH. KiloWatt Hour. Unit of energy or work equal to one thousand watt-hours.

L

Laminated glass. Two or more sheets of glass with an inner layer of transparent plastic to which the glass adheres if broken. Used for safety glazing and sound reduction.

Lift. Handle for raising the lower sash in a double-hung window. Also called sash lift.

Light. A window; a pane of glass within a window. Double-hung windows are designated by the number of lights in upper and lower sash, as in six-over-six. Also spelled informally lite.

Light-to-solar-gain ratio. A measure of the ability of a glazing to provide light without excessive solar heat gain. It is the ratio between the visible transmittance of a glazing and its solar heat gain coefficient. Abbreviated LSG.

Lintel. A horizontal member above a window or door opening that supports the structure above.

Liquid crystal glazing. Glass in which the optical properties of a thin layer of liquid crystals are controlled by an electrical current, changing from a clear to a diffusing state.

Long-wave infrared radiation. Invisible radiation, beyond red light on the electromagnetic spectrum (above 3.5 micro meters), emitted by warm surfaces such as a body at room temperature radiating to a cold window surface.

Low-conductance spacers. An assembly of materials designed to reduce heat transfer at the edge of an insulating window. Spacers are placed between the panes of glass in a double- or triple-glazed window.

Low-emittance (Low-E) coating. Microscopically thin, virtually invisible, metal or metallic oxide layers deposited on a window or skylight glazing surface primarily to reduce the U-factor by suppressing radiative heat flow. A typical type of low-E coating is transparent to the solar spectrum (visible light and short-wave infrared radiation) and reflective of long-wave infrared radiation.

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M

Meeting rail. The part of a sliding glass door, a sliding window, or a hung window where two panels meet and create a weather barrier.

Metal-clad windows. Exterior wood parts covered with extruded aluminum or other metal, with a factory-applied finish to deter the elements.

Micron. One millionth (10^{-6}) of a metric meter.

Movement joint. Joint to take up thermal or other movements arising from the curtain wall or the supporting structure

Mullion. Vertical structural framing member of a curtain wall.

Mullion cover cap. Profiled external cover applied, usually snap fitted, over the face of the mullion pressure plate to provide an architectural finish

Muntin. A secondary framing member (horizontal, vertical, or diagonal) to hold the window panes in the sash. This term is often confused with mullion.

Muntin grilles. Wood, plastic, or metal grids designed for a single-light sash to give the appearance of muntins in a multilight sash, but removable for ease in cleaning the window.

N

Nailing fin. An integral extension of a window or patio door frame which generally laps over the conventional stud construction and through which nails are driven to secure the frame in place.

O

Obscure glass. Any textured glass (frosted, etched, fluted, ground, etc.) used for privacy, light diffusion, or decorative effects.

Operable window. Window that can be opened for ventilation.

Operator. Crank-operated device for opening and closing casement or jalousie windows.

P

Pane. One of the compartments of a door or window consisting of a single sheet of glass in a frame; also, a sheet of glass.

Panel. A major component of a sliding glass door, consisting of a light of glass in a frame installed within the main (or outer) frame of the door. A panel may be sliding or fixed.

Panning. In replacement window work, the outside aluminum trim that can extend around the perimeter of the window opening; used to cover up the old window material. Panning can be installed in the opening before the window, or can be attached directly to the window before installation.

Particle dispersed glazing. Glazing in which the orientation of small particles between two sheets of glass is controlled electrically, thus changing its optical properties.

Parting stop. A narrow strip, either integral or applied, that holds a sash or panel in position in a frame.

Perimeter seal. Joint between the curtain wall and adjacent construction designed to give continuity at both the air and water barriers of the wall

Photochromics. Glazing with the optical properties that change in response to the amount of incident light.

Picture window. A large, fixed window framed so that it is usually, but not always, longer horizontally than vertically to provide a panoramic view.

Pivot window. A window with a sash that swings open or shut by revolving on pivots at either side of the sash or at top and bottom.

Plastic film. A thin plastic substrate, sometimes used as the inner layers in a triple- or quadruple-glazed window.

Plastics. Artificial substances made of organic polymers that can be extruded or molded into various shapes including window frames and sashes.

Plate glass. A rolled, ground, and polished product with true flat parallel plane surfaces affording excellent vision. It has been replaced by float glass.

Polyvinylchloride (PVC). An extruded or molded plastic material used for window framing and as a thermal barrier for aluminum windows.

Pressure equalisation. Method of sealing and compartmenting the wall that enables the rapid minimisation of differential air pressure between cold facade cavities or glazing rebates and the external air

Pressure plate. Length of profiled material applied around the perimeter of a pane of glass, insulating glass unit or infill panel to provide structural restraint and compress the glazing gasket**.**

Projected window. A window fitted with one or more sashes opening on pivoted arms or hinges. Refers to casements, awnings, and hoppers.

R

Radiation. The transfer of heat in the form of electromagnetic waves from one separate surface to another. Energy from the sun reaches the earth by radiation, and a person's body can lose heat to a cold window or skylight surface in a similar way.

Rail. Horizontal member of a window sash.

Reflectance. The ratio of reflected radiant energy to incident radiant energy.

Reflective glass. Window glass coated to reflect radiation striking the surface of the glass.

Refraction. The deflection of a light ray from a straight path when it passes at an oblique angle from one medium (such as air) to another (such as glass).

Relative humidity. The percentage of moisture in the air in relationship to the amount of moisture the air could hold at that given temperature. At 100 percent relative humidity, moisture condenses and falls as rain.

Retrofitting. Adding or replacing items on existing buildings. Typical retrofit products are replacement doors and windows, insulation, storm windows, caulking, weatherstripping, vents, landscaping.

Roof window. A fixed or operable window similar to a skylight placed in the sloping surface of a roof.

Rough opening. The opening in a wall into which a door or window is to be installed.

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S

Safety glass. A strengthened or reinforced glass that is less subject to breakage or splintering.

Sash. The portion of a window that includes the glass and the framing sections directly attached to the glass, not to be confused with the complete frame into which the sash sections are fitted.

Screen. Woven mesh of metal, plastic, or fiberglass stretched over a window opening to permit air to pass through, but not insects.

Sealant. A compressible plastic material used to seal any opening or junction of two parts, such as between the glass and a metal sash, commonly made of silicone, butyl tape, or polysulfide.

Setting block. Small block of suitable material, placed under the lower edge of a pane of glass, insulating glass unit or infill panel when setting it in a frame

Shade screen. A specially fabricated screen of sheet material with small narrow louvers formed in place to intercept solar radiation striking a window; the louvers are so small that only extremely small insects can pass through. Also called sun screen. Also, an awning with fixed louvers of metal or wood.

Sheet glass. A transparent, flat glass found in older windows, now largely replaced by float glass.

Short-wave infrared radiation. Invisible radiation, just beyond red light on the electromagnetic spectrum (between 0.7 and 2.5 microns), emitted by hot surfaces and included in solar radiation.

Sill. horizontal framing member positionedat the base of an area of glass, windows, panels or doors

Sill track. The track provided at the sill of a sliding glass door. Also, the sill member incorporating such a track.

Simulated divided lights. A window that has the appearance of a number of smaller panes of glass separated by muntins, but actually is a larger glazing unit with the muntins placed between or on the surfaces of the glass layers.

Single glazing. Single thickness of glass in a window or door.

Single-hung window. A window consisting of two sashes of glass, the top one stationary and the bottom movable.

Skylight (operable or pivot). A roof window that gives light and ventilation.

Sliding glass door. A door fitted with one or more panels that move horizontally on a track and/or in grooves. Moving action is usually of rolling type (rather than sliding type). Also called gliding door, rolling glass door, and patio sliding door.

Sliding window. A window fitted with one or more sashes opening by sliding horizontally or vertically in grooves provided by frame members. Vertical sliders may be single- or double-hung.

Solar control coatings. Thin film coatings on glass or plastic that absorb or reflect solar energy, thereby reducing solar gain.

Solar radiation. The total radiant energy from the sun, including ultraviolet and infrared wave lengths as well as visible light.

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Solar screen. A sun shading device, such as screens, panels, louvers, or blinds, installed to intercept solar radiation.

Solar spectrum. The intensity variation of sunlight across its spectral range.

Sound Transmission Class (STC). The sound transmission loss rating of a material over a selected range of sound frequencies. The higher the number, the less sound transmitted.

Spandrel area. Area of a curtain wall between two horizontal zones, normally between glazing and concealing the edge of the floor slab

Spandrel panel. Panel within the spandrel area

Spectrally selective coating. A coated or tinted glazing with optical properties that are transparent to some wavelengths of energy and reflective to others. Typical spectrally selective coatings are transparent to visible light and reflect short-wave and long-wave infrared radiation.

Spigot. Profiled structural connecting piece shaped for installation within the hollow profile of a framing member

Stick construction. Carrier framework of site assembled components supporting glass, insulating glass units and infill panels

Stile. The upright or vertical edges of a door, window, or screen.

Stool. The shelf-like board of the interior part of the window sill, against which the bottom rail of the sash closes.

Stop. The molding on the inside of a window frame against which the window sash closes; in the case of a double-hung window, the sash slides against the stop. Also called bead, side stop, window stop, and parting stop.

Storm windows. A second set of windows installed on the outside or inside of the primary windows to provide additional insulation and wind protection.

Structural fixing bracket. Assembly of structural components designed to transmit all actions on the curtain wall back to the building structure while allowing any required movement

Structural sealant glazed system SSGS. Means of bonding the glass units onto an internal frame with minimal mechanical retention, to provide a flush glazed wall

Sun control film. A tinted or reflective film applied to the glazing surface to reduce visible, ultra-violet, or total transmission of solar radiation. Reduces solar heat gain in summer and glare. Some can be removed and reapplied with changing seasons.

Superwindow. A window with a very low U-factor, typically less than 0.15, achieved through the use of multiple glazings, low-E coatings, and gas fills.

Switchable glazings. Glazings with optical properties that can be reversibly switched from clear to dark or reflective.

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T

T-connector. (T-cleat, transom cleat) Profiled connector shaped for installation within the hollow cavity of a transom for structural connection to a mullion

Tempered glass. Treated glass that is strengthened by reheating it to just below the melting point and then suddenly cooling it. When shattered, it breaks into small pieces. Approximately five times stronger than standard annealed glass; is required as safety glazing in patio doors, entrance doors, side lights, and other hazardous locations. It cannot be recut after tempering.

Thermal break. Element of low thermal conductivity incorporated into an assembly to reduce the flow of heat between more conductive materials

Thermal expansion. Change in dimension of a material as a result of temperature change.

Thermal mass. Mass in a building (furnishings or structure) that is used to absorb solar gain during the day and release the heat as the space cools in the evening.

Thermochromics. Glazing with optical properties that can change in response to temperature changes.

Thermogram. An image of an object taken with an infrared camera that shows surface temperature variations.

Threshold. The member that lies at the bottom of a sliding glass door or swinging door; the sill of a doorway.

Tilt window. A single- or double-hung window whose operable sash can be tilted into the room for interior washability.

Tinted glass. Glass colored by incorporation of a mineral admixture. Any tinting reduces both visual and radiant transmittance.

Transmittance. The percentage of radiation that can pass through glazing. Transmittance can be defined for different types of light or energy, e.g., visible light transmittance, UV transmittance, or total solar energy transmittance.

Transom. Horizontal structural framing member of a curtain wall

Transom cover cap. Profiled external cover applied, usually snap fitted, over the face of the transom pressure plate to provide an architectural finish

Transom window. The window sash located above a door. Also called transom light.

Triple glazing. Three panes of glass or plastic with two air spaces between.

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U

U-factor (U-value). A measure of the rate of non-solar heat loss or gain through a material or assembly. It is expressed in units of Btu/hr-sq ft-˚F (W/sq m-˚C). Values are normally given for NFRC/ASHRAE winter conditions of 0˚ F (18˚ C) outdoor temperature, 70˚ F (21˚ C) indoor temperature, 15 mph wind, and no solar load. The U-factor may be expressed for the glass alone or the entire window, which includes the effect of the frame and the spacer materials. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating value.

Ultraviolet light (UV). The invisible rays of the spectrum that are outside of the visible spectrum at its short-wavelength violet end. Ultraviolet rays are found in everyday sunlight and can cause fading of paint finishes, carpets, and fabrics.

Unitised construction. Pre-assembled, interlinking, storey height or multi-storey height facade modules, complete with infill panels

V

Vapour control layer. Layer comprising a material or coating with greater resistance to vapour transmission than the other layers of the wall and designed to control vapour movement through the wall

Vent. The movable framework or sash in a glazed window that is hinged or pivoted to swing open.

Vinyl. Polyvinyl chloride material, which can be both rigid or flexible, used for window frames.

Vinyl-clad window. A window with exterior wood parts covered with extruded vinyl.

Visible light. The portion of the electromagnetic spectrum that produces light that can be seen. Wavelengths range from 380 to 720 nanometers.

Visible transmittance (VT). The percentage or fraction of the visible spectrum (380 to 720 nanometers) weighted by the sensitivity of the eye, that is transmitted through the glazing.

W

Warm-edge technology. The use of low-conductance spacers to reduce heat transfer near the edge of insulated glazing.

Warm facade. Curtain wall construction whose inner shell is thermally insulated and sealed against outside air

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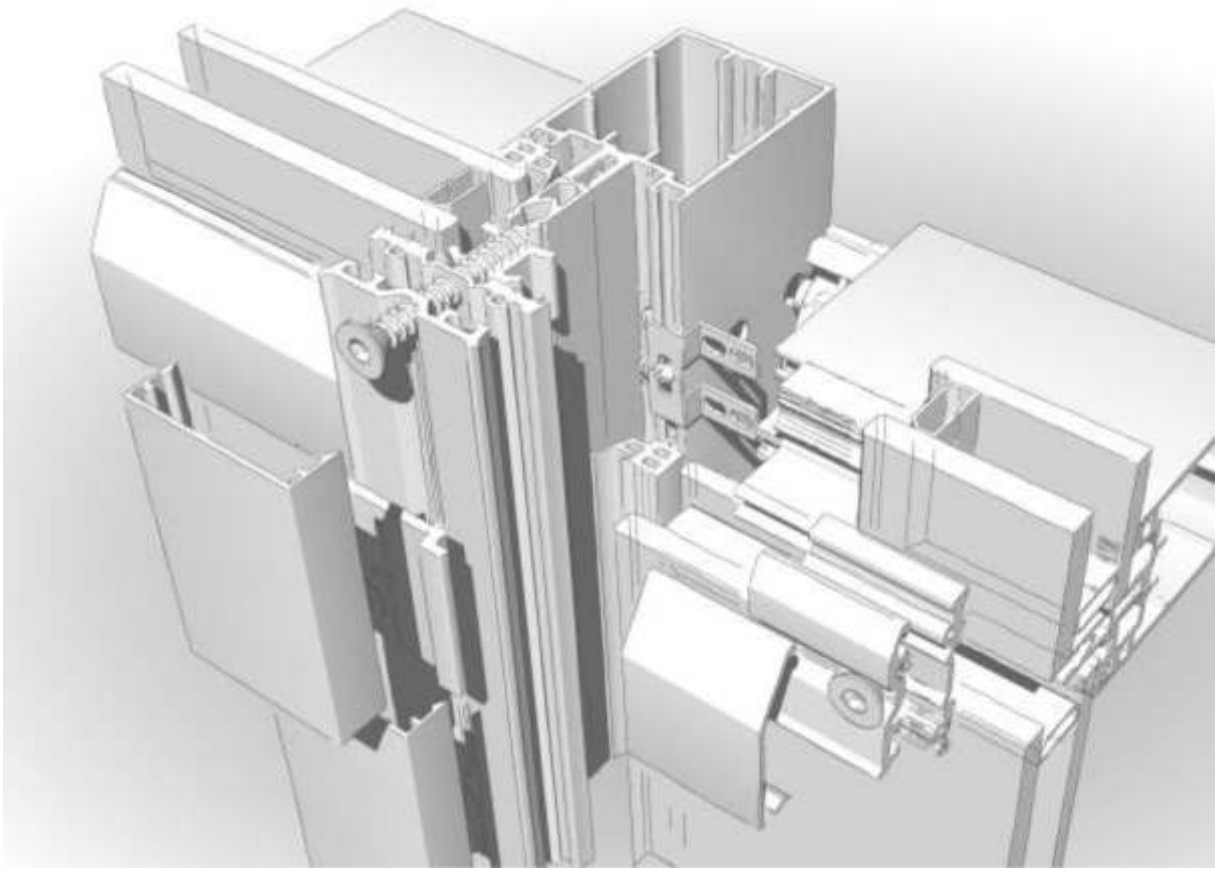

CE marking of curtain walling

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Guidance Sheet CE.01

FAECF

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EAA European Aluminium Association

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Contents

1 Foreword 3
2 Introduction 3
3 Definition of curtain walling 3
4 Construction Products Directive (CPD 89/106) and CE marking of products 4
5 Presumption of conformity and suitability for use of products 4
6 Essential characteristics for curtain walling 5
7 Special conditions in case of fire performance characteristics 5
8 When CE marking becomes obligatory for curtain walling 6
9 Different processes for special types of curtain walling 6
10 Field of application of EN 13830 for curtain walling 6
11 CE marking for curtain walling 7
12 How to decide performance levels 8
13 Initial Type Test (ITT) for determination of the performance characteristics 8
Annex 1: Ways to CE marking for windows, doors and curtain walling under System AoC 3 according to Guidance Paper M 10
Annex 2: Selection of representative test specimen and range of application 11
Annex 3: Bibliography 12

1 Foreword

FAECF Guidance Sheet

This FAECF Guidance Sheet provides an explanation to the product standard on curtain walling EN 13830 with more details for the manufacturer and reader of the standard. This Guidance Sheet provides guidance on how to read EN 13830 and shall enlighten some background details. This Guidance Sheet is not intended to be used as any kind of test method, nor for certification purposes. This paper is published by FAECF in cooperation with the EAA.

2 Introduction

Intention of CE marking

CE marking is a passport for the product for the whole European Economic Area (EEA). It covers all legal requirements addressed by the relevant harmonized technical specification prevailing in all EU Member States.
CE marking replaces any national mandatory marking, e.g. α-mark in Germany. No additional requirement can be imposed in national or regional building regulations. National building regulations have to be adapted, if they are contrary to the European rules or insist on national methods.
CE marking sets up a common level playing field by providing manufacturers with:

- Common European test methods and procedures
- Single assessment valid throughout Europe.

CE for curtain walling

With effect from 1st December 2005, curtain walling manufacturers will be required to apply CE marking. The mark will be applied to finished products and will not extend to installation/erection. CE marking will be MANDATORY and will constitute the system to which all entities must adhere, by law, in order to be able to sell their products in the European Union. CE marking will confirm that the finished product provides certain performance specifications for regulated requirements in relation to the intended uses.

3 Definition of curtain walling

What is curtain walling

According to prEN 13119 curtain walling is an external building facade produced with framing made mainly of metal, timber or PVC-U, usually consisting of vertical and horizontal structural members, connected together and anchored to the supporting structure of the building, which provides, by itself or in conjunction with the building construction, all the normal func-

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tions of an external wall, but does not contribute to the load bearing characteristics of the building structure.
Two examples of possible principles of curtain walling are shown in Fig. 1 and Fig. 2:

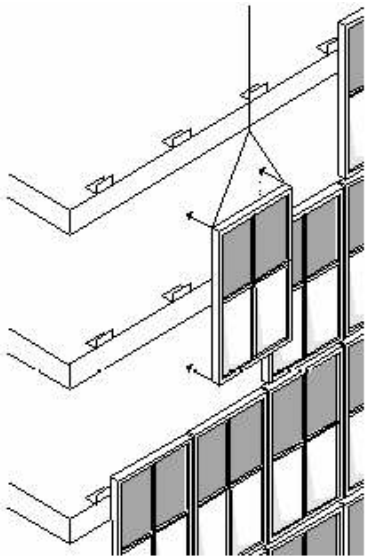

Fig. 1: Unitised construction

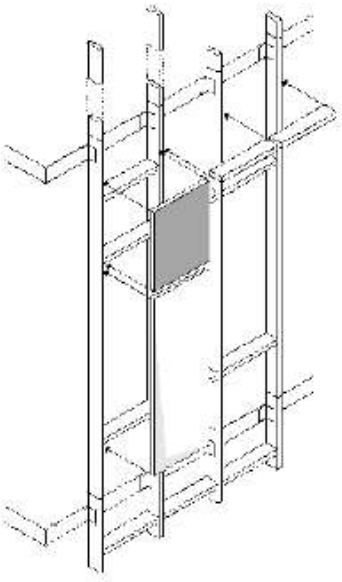

Fig. 2: Stick construction

4 Construction Products Di rective (CPD 89/106) and CE marking of products

Legal basis for CE marking

- The application of the CE mark implies that the construction products are suitable for intended use;
- Construction products means any product, which is produced for incorporation in a permanent manner in construction works;
- Products which enable the buildings in which they are used, provided it is adequately designed and built, to meet the six essential requirements established by the European Directive applicable to them (Construction Products Directive 89/106/EEC, also known as CPD) are deemed to be suitable for use;
- CE marking is compulsory and constitutes the system to which all manufacturers must adhere in orde to be entitled to sell their products in the European Union;
- The manufacturer, or his authorised epresentative established in EEA [European Economic Area], is responsible for affixing CE marking on the product, on a label affixed to the product, on its packaging or on the commercial documents which accompany it.

5 Presumption of conformity and suitability for use of products

- For building regulators a product is deemed to be suitable for the intended use if it has been shown to meet the essential requirements as described in the product standard;
- CE marking must be affixed to products which satisfy, chiefly, one of the following conditions:

• Conformity with the national standards which are identical to the harmonised European Standards EN, the details of which have been published in the European Official Journal;
• Conformity with European Technical Approvals ETAs issued on the basis of guidelines.
CE marking an relevance of technical specifications

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- Harmonised European Standards are produced by CEN (European Committee for Standardisation), whereas European Technical Approvals are issued by EOTA (European Organisation for Technical Approvals);
- The task of producing EN and the guidelines for the issue of ETA is delegated by the European Commission to CEN or EOTA depending on the product in question.

6 Essential characteristics for curtain walling

The performance specifications which CE marked curtain walling must comply shall be associated with essential applicable characteristics (s. Table 1). The product standard assesses the collected number of requirements throughout the EU's Member States. Therefore, it might happen that a certain characteristic, e.g. "reaction to fire" or "thermal shock resistance", is not required by the regulation in place of destination. In this case, manufacturers placing their products on this market are not obliged to determine or declare the performance of their products with regard to this characteristic and the option "No performance declared" (npd) in the information accompanying the CE marking may be used. The npd option may not be used, however, where the characteristic is subject to a threshold level. For an example see Fig. 4 (CE Marking).

Table 1: Essential characteristics according to EN 13830

Reaction to fire **		Thermal shock Resistance	
Fire resistance **		Resistance to live horizontal loads	
Fire propagation **		Air Permeability	
Watertightness		Water vapour permeability	
Resistance to dead load (self weight)		Thermal transmittance	
Resistance to wind load		Airborne sound insulation	
Resistance against impact		Durability	

** These requirements are deemed to be applicable when explicitly required by national building/ fire regulations.

7 Special conditions in case of fire performance characteristics

reaction to fire

For curtain walls concerned with uses subject to regulations on reaction to fire different Attestation of Conformity (AoC) systems apply (1 or 3) following levels or classes as defined in EN 13501-1 "Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests."

fire resistance

In case of fire resistance relevant classes apply in accordance with the classification criteria defined in prEN 13501-2 "Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance tests, excluding ventilation services".

At present it is not possible to provide a fire resistance classification of curtain walling due to the fact that the relevant test methods (prEN 1364-3 and prEN 1364-4) are not yet available.

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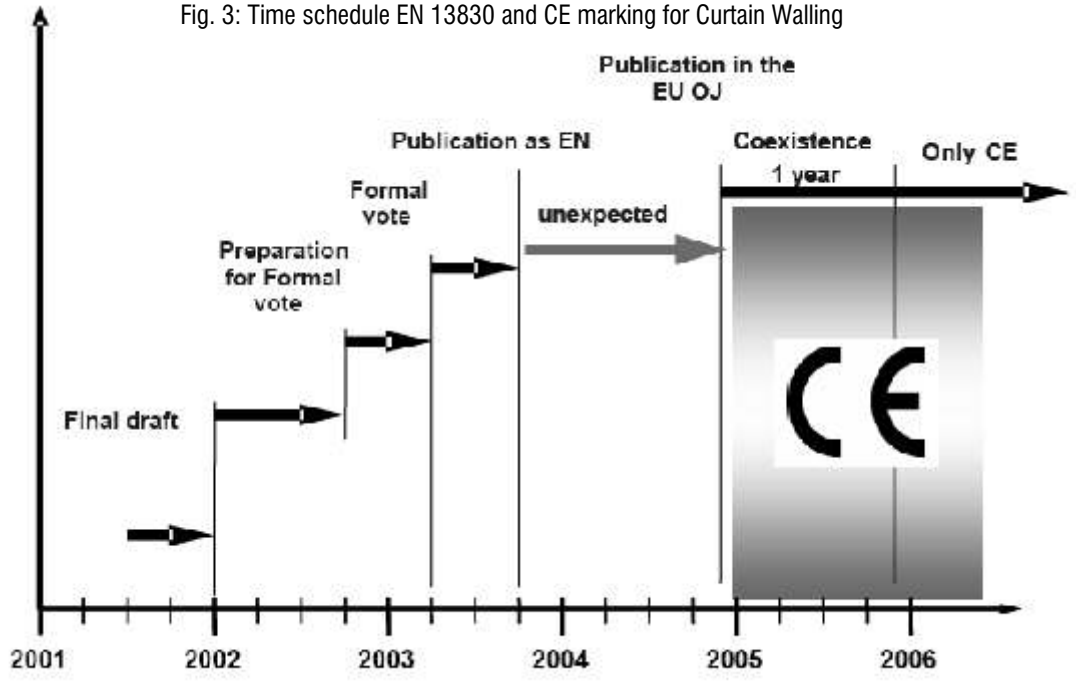
8 When CE marking become obligatory for curtain walling

After coexistence period CE marking is obligatory: 1st December 2005

- CE marking of curtain walling involves a process made up of the various stages necessary for the entry into effect of standards documents;
- More specifically, after the formal vote and publication of a harmonised European Standard EN standard, the one-year coexistence period begins during which the application of CE marking to products is voluntary;
- Upon expiry of the coexistence period, CE marking becomes mandatory ,i.e. only curtain walling with CE marking are legally allowed to be placed on the market.

Fig. 3: Time schedule EN 13830 and CE marking for Curtain Walling



Structural glazing, cladding and point fixed glazing needs European Technical Approvals

9 Different processes for special types of curtain walling

- For curtain walling without structural glazing, the process implies the conformity with the harmonised European Standard EN 13830 written by the Technical Committee TC 33 of CEN;
- For curtain walling with structural glazing, implies the compliance with the European Technical Approval (ETA) issued by the member organisations of EOTA according to the guidelines ETAG 002;
- For Cladding and point fixed glazing ETAGs are in preparation.

10 Field of application of EN 13830 for curtain walling

curtain walling ranging from a vertical position to 15˚ from the vertical, onto the building face

In general, the standard applies to curtain walling ranging from a vertical position to 15˚ from the vertical, onto the building face. For the purposes of affixing CE marking, curtain walling cannot be deemed to be a finished product until it is installed, because it is made up of a series of components which constitute curtain walling only when they are assembled on the work site.
The standard therefore applies to curtain walling in kit form, i.e. to a set of components which once assembled provide a finished product. Consequently it applies both to curtain walling which is designed, produced and installed on the basis of a commercial range system and to curtain walling produced or installed for a specific works site on the basis of a specific design.

EN 13830 is not applicable to
- all curtain walling with structural glazing.
- all fully glazed point fixed curtain walling.

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11 CE marking for curtain walling

CE marking means that each curtain walling kit must be accompanied by a document containing the following information (see Fig. 4):

- the graphic symbol of the CE marking;
- the last two digits of the year in which the CE mark was affixed;
- name or identifying mark and registered address of the manufacturer;
- product code;
- a list of the mandatory requirements with which the product complies.

CE 01234	CE conformity marking, consisting of the "CE" symbol given in directive 93/68/EEC Identification number of the certification body (where relevant)
Any Co. Ltd, PO Box 21, B-1050 02 01234 –CPD-00234	Name or identifying mark and registered address of the producer Last two digits of the year in which the marking was affixed Certificate number (where relevant)
EN 13830 Curtain wall product Intended to be used in City Office application	Number of European standard Description of product
Reaction to fire - Classes	Information on regulated characteristics
Fire resistance - npd	
Watertightness - class R6	
Resistance to own dead load - kN	
Wind load resistance - 1200 kN/m^2	
Impact resistance - Technical classes	
Thermal shock resistance - Glass type	
Resistance to horizontal load - kN at m sill height	
Thermal transmittance - npd	
Air permeability - class A3	
Airborne sound insulation - dB	

Fig. 4: Example of CE marking on accompanying papers

In the wording of the CPD, a "kit" is the equivalent of a "construction product". A construction product is a "kit" when it is a set of at least two separate components that need to be put together to be installed permanently in the works (i.e. to become an "assembled system").
For curtain walling the whole wall might be defined as a kit, if the performance level can be detected. Usually there will be more than one kit in a curtain walling, because of different performance areas. Therefore it is suggested to declare repeating modules as kits and to mark them with CE.

curtain walling kit

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12 How to decide performance levels

The manufacturer shall decide the performance levels to attribute to its products for all the performance characteristics required by CE marking. The requirements and respective performance levels chosen must comply with the requirements stated within the national reference standards (e.g. the national energy efficiency standards, the national building regulations/ acts) where these exist or come into force. In particular, the npd option (no performance declared) can be used if that requirement is not subject to regulation.

The manufacturer is responsible and must declare

13 Initial Type Test (ITT) for determination of the performance characteristics

According to the case in question, the manufacturer needs laboratory tests and/or calculations on test specimen(s) that are representative of the product range in accordance with the requirements of European reference standards, as shown in the table below.

ITT

No	Designation	Units	Class or Declared value					
1	Resistance to Wind load	kN/m^2	npd	Declared value				
2	Dead load	kN/m^2	npd	Declared value				
3	Resistance against Impact Internal *Drop height*	 *(mm)*	npd	I0 *(n.a.)*	I1 *(200)*	I2 *(300)*	I3 *(450)*	I4 *(700)*
4	External *Drop height*	 *(mm)*	npd	E0 *(n.a.)*	E1 *(200)*	E2 *(300)*	E3 *(450)*	E4 *(700)*
5	Air permeability Test pressure	 *(Pa)*	npd	A1 *(150)*	A2 *(300)*	A3 *(450)*	A4 *(600)*	AE *(>600)*
6	Watertightness Test pressure	 *(Pa)*	npd	R4 *(150)*	R5 *(300)*	R6 *(450)*	R7 *(600)*	RE *(>600)*
7	Airborne sound insulation R_w (C;Ctr)	dB	npd	Declared value				
8	Thermal transmittance U_{cw}	W/m^2K	npd	Declared value				
9	Fire resistance Integrity **(E)** **i → o, o → i, o ↔ i**	 *(min)*	npd	E 15	E 30	E 60	E 90	
10	Integrity and insulation **(EI)** **i → o, o → i, o ↔ i**	 *(min)*	npd	EI 15	EI 30	EI 60	EI 90	
11	Equipotentiality	Ohms	npd	Declared value				
12	Resistance to horizontal loads	kN at m sill height	npd	Declared value				

Fig. 5: Classification table EN 13830

Where the initial test report supplied to the manufacturer from the system house results from tests carried out by a Notified Body, it may be used for CE marking purposes without that the manufacturer needs involving a Notified Body to check the product (see Annex 1).

Usage of tests from system supplier

The assessment of performances [by means of laboratory tests or calculation methods, ITT], must be carried out ONCE ONLY at the beginning of the production under CE marking. The manufacturer shall, however, be required to guarantee the consistancey of its production over time that the performances initially provided by the curtain walling test specimen(s) are

One test for Europe

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maintained, and that the traceability of the products is ensured. The above must be ensured by means of a traceable Factory production control system (FPC).

Laboratory tests can be carried out anywhere in Europe at an organisation suitably notified by the individual Member States of the European Union. Notice has not yet been given of the accredited organisations in Europe. A list of notified bodies will be published at http://europa.eu.int/comm/enterprise/nando-is after EN13830 becomes harmonized.

Notified Bodies

Table 2: Tasks to be performed by Notified Body and the Manufacturer

Essential characteristic		ITT	FPC	INS	Essential characteristic		ITT	FPC	INS
Reaction to fire under AoC System 1		NB	M	NB	Thermal shock Resistance		M	M	
Reaction to fire under AoC System 3		NB	M		Resistance to live horizontal loads		NB	M	
Fire resistance		NB	M		Air Permeability		M	M	
Fire propagation		NB	M		Water vapour permeability		M	M	
Watertightness		M	M		Thermal transmittance		M	M	
Resistance to dead load (self weight)		NB	M		Airborne sound insulation		M	M	
Resistance to wind load		NB	M		Durability		M	M	
Resistance against impact		NB	M						

ITT = Initial Type Test FPC = Factory Production Control
INS = First inspection of FPC and permanent surveillance
NB = Notified Body M = Manufacturer

The manufacturer is responsible and needs to decide whether to carry out subsequent type tests in the event of later modifications to the product. In general, if the essential concept characteristics of the product remain unchanged (e.g. no changes are made to the design principle of the main sections), it should not be necessary to carry out new tests.

Minor modifications

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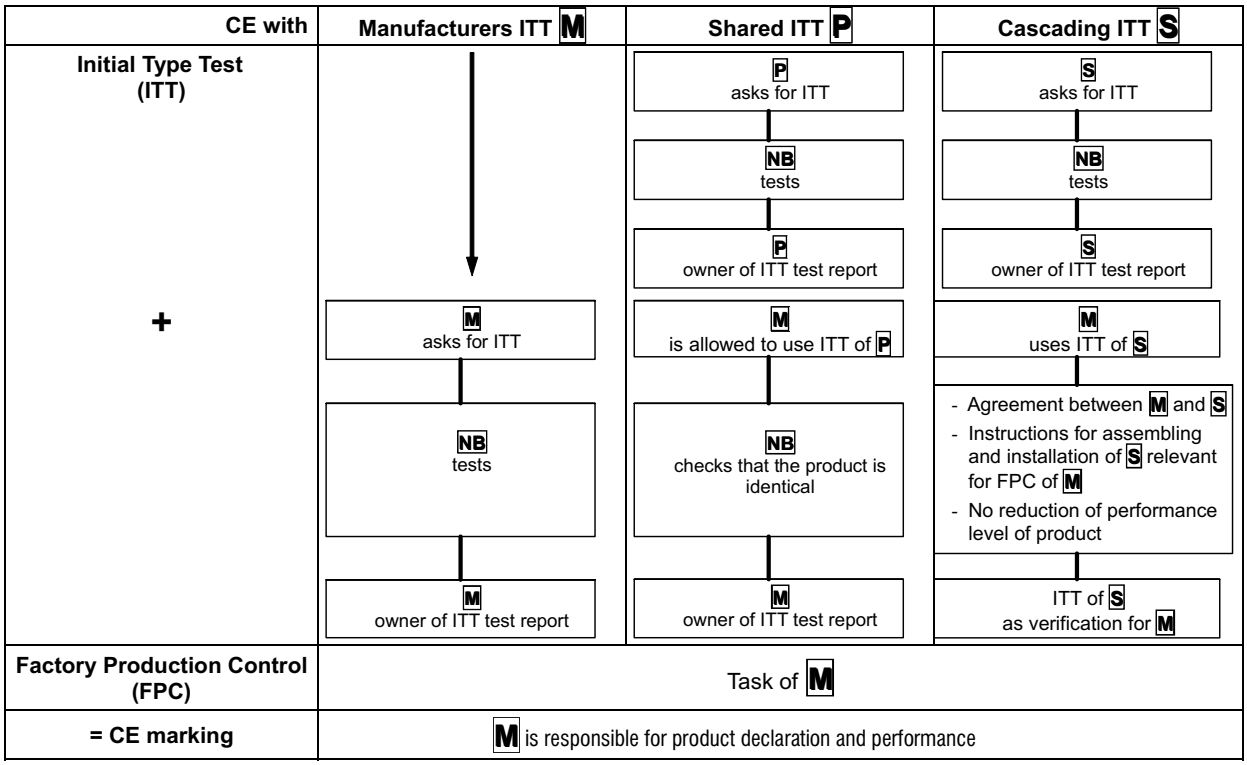
Annex 1: Ways to CE marking for windows , doors and curtain walling under System AoC 3 according to Guidance Paper M



Legend:

NB =	Notified Body	S =	System supplier
M =	Manufacturer	P =	Partner (e.g. second Manufacturer), industry (e.g. hardware producers) or designer

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Annex 2: Selection of representative test specimen and range of application

To reduce test costs, for curtain walling the notion of 'families' should be considered.
For each family one representative test specimen is tested and the test result can be used for all other members of the family. Using a "worst case scenario" is generally a good way of defining a family.
The product standard EN 13830 for curtain walling does not give any information or guidance on how such a product family should be defined and how a representative specimen for such a product family should be selected.
The following table contains an example specification for representative test specimen and the range of application for the main characteristics of curtain walling. Other characteristics can be added if required.

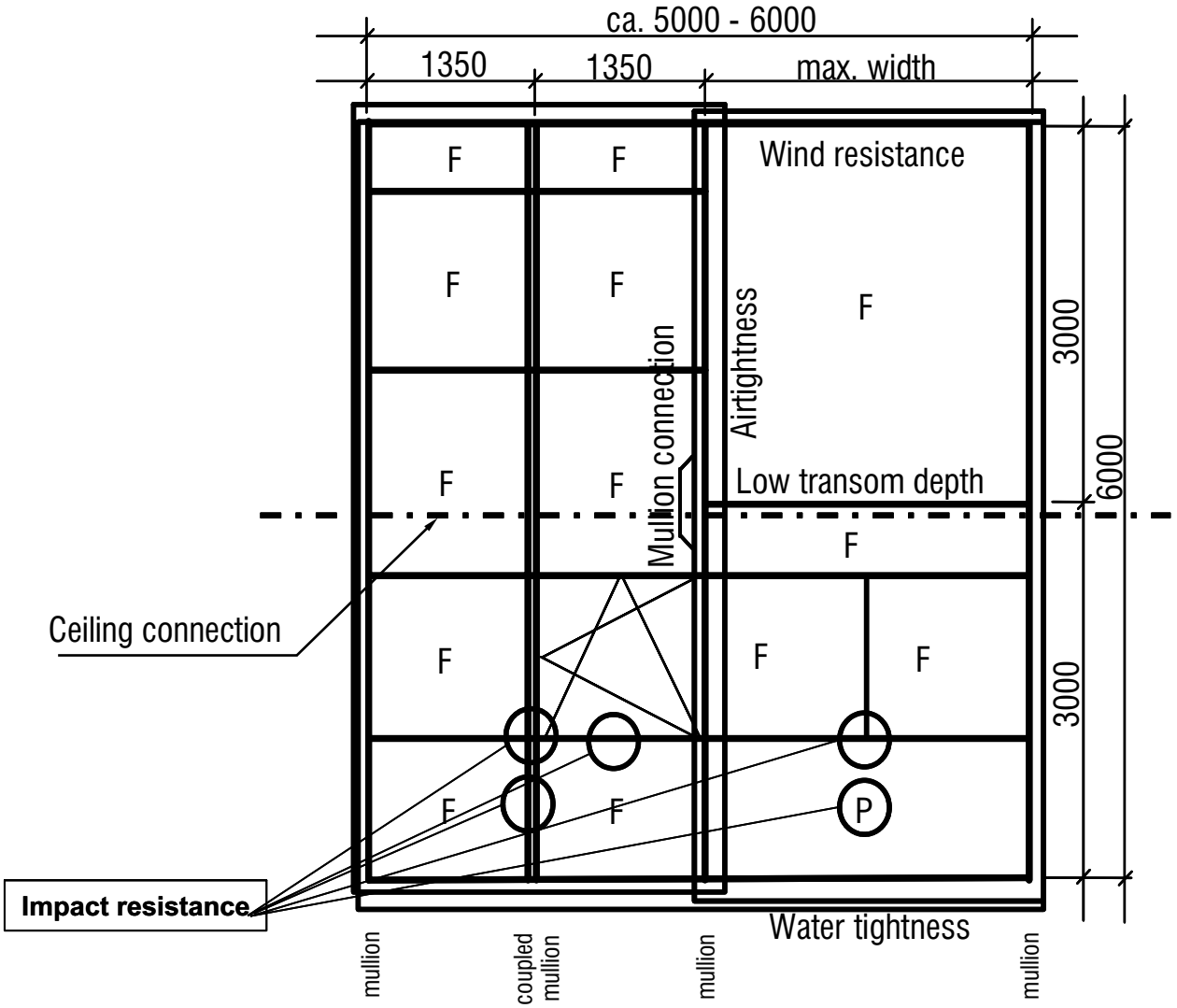

Fig. 6: Example of test specimen that is representative of the product range

Note: The coloured frames are marking the relevant part of test specimen for the characteristic. The test has do be performed with the test specimen in total.

Components of test specimen:
- All T-connector variants
- All sealing systems
- All support systems
- Different mullion and transom depths
- All drainage systems have to be considered

Sometimes additional tests have to be performed on smaller samples for individual components The range of application is listed in the following table:

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Characteristic	"worst case" test specimen design	range of application
resistance to wind load	max span of transoms and mullions for serviceability the cross-sections have to be dimensioned according to the design load by calculation	all smaller spans using calculation
Dead load (self weight)	max transom length, max glass weight the cross-sections have to be dimensioned according to the glass weight by calculation	all smaller and lighter products using static calculation
impact resistance	all typical glazing bars	products with similar construction details
air tightness	small elements, many joints all types of sealing systems, mullion-joints and T-connections	products with similar construction details
water tightness	all sealing systems all corner connections all drainage systems	all systems with similar construction details
sound insulation	in coordination with Notified Body	
thermal insulation	U_f of profiles can be calculated according to EN ISO 10077-2 (guidelines for profile systems are available at relevant institutes). U_{cw} is calculated for each kit	
fire characteristics	in coordination with Notified Body	
others	in coordination with Notified Body	

Annex 3: Bibliography

[1] EN 13830: 2003 Curtain Walli ng – Product Standard

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