Technical Notice 2.2/18-1795_V1

Built-up cladding with acrylic resin

HI-MACS®
Cladding system

Seen for registration

Charles Baloche

Owner: LG Hausys Ltd
One IFC Bldg., 10, Gukjegeumyung-ro, Yeongdeungpo-gu,
Seoul, 07326, Rep. of Korea

Tel.: (+82) 2 6930 0124
Fax: (+82) 2 6930 0888
Contact : Andy LIM
E-mail: rukibana@lghausys.com
Website: http://www.lghausys.com/

Co-Owner: LG Hausys Europe GmbH
Lyoner Strasse15, Atricom C6,
D-60528 Frankfurt am Main, Germany

Tel.: (+49) 69 5830 29466
Contact : Tim Yoo Chin Lie
E-mail: timlie@lghausys.com
Website: http://himacs.eu/fr

Distributor:

Specialised Group no. 2.2

Built-up cladding, wall panel and ordinary weatherboard products and processes

Published on

CCFAT COMMISSION CHARGÉE DE FORMULER LES AVIS TECHNIQUES

Commission responsible for formulating Technical Notices and Application Specification Documents

(Decree of 21 March 2012)

Secretariat of the commission of Technical Notice
CSTB, 84 avenue Jean Jaurès, Champs sur Marne, FR-77447 Marne la Vallée Cedex 2
Tel.: +33 (0)1 64 68 82 82 - Website: www.ccfat.fr

The Technical Notices are published by the Secretariat of Technical Notices, administered by the CSTB. The authenticated versions are freely available on CSTB's website (http://www.cstb.fr)

On 18 December 2018, the "Built-up cladding, wall panel and ordinary weatherboard products and processes" Specialised Group no. 2.2 of the Commission tasked with drafting Technical Notices assessed the HI-MACS® built-up cladding process submitted by LG Hausys Ltd and LG Hausys Europe GmbH. It issued the following Technical Notice for this process. This Notice was drafted for uses in European France.

1. Succinct definition

1.1 Succinct description

The HI-MACS® cladding system comprises acrylic resin and mineral filler panels fitted with inserts, attached using aluminium clips slotted onto horizontal aluminium rails screwed onto a vertical aluminium frame joined to the main structure by fixing brackets.

General characteristics

- HI-MACS® panels:

  Solid, homogeneous panels comprising 40% PMMA (polymethyl methacrylate acrylic polymers), 60% ATH (aluminium trihydroxide), natural colour pigments and catalysts.
- Nominal panel thickness in mm: 12 mm.
- Standard (factory) panel sizes in mm: 760 x 3670.
- Installation sizes, obtained by bonding standard dimension sheet with HI-MACS® adhesive in the workshop:

  In closed or lap joint configuration, all heights up to 4600 mm and all widths up to 3,670 mm.

  In open joint configuration, all heights and widths up to 2,000 mm.
- Surface density: 20.86 kg/m^2.
- One colour with various finishes available: matte, semi-gloss or gloss (see §3.1 of the Specifications File).

1.2 Identification

The HI-MACS® panel elements with a QB certificate can be identified by the "Specific Requirements of QB Certification (QB15) for built-up cladding, wall panels and ordinary weatherboarding, and eave cladding" label.

The labelling complies with § 6 of the Specifications File.

2. NOTICE

2.1 Accepted field of use

- Installation of built-up cladding on flat or vertical new and existing walls, primed masonry (in accordance with NF DTU 20.1) or concrete (in accordance with DTU 23.1), at ground floor or upper levels.
- Can be installed on sloped surfaces with negative external wall slopes from 0° to 90° and to clad eaves of horizontal, flat concrete substrates that are new or in use, inaccessible (over 3m above ground) and have no playground nearby, and according to the provisions set out in § 9.7 of the Specifications File.
- The panels can also be installed on window lintels.
- Wind exposure corresponding to positive and negative pressure under normal wind conditions, as per the amended NV65 rules, with maximum value of 1500Pa, with:
  - maximum 600mm clip attachment interaxial
  - maximum 600mm interaxial between frame posts
  - maximum 600mm interaxial between horizontal rails
  - distance from edge between 100mm and 150mm
- The HI-MACS® built-up cladding process may be used in seismic zones and for buildings listed in §2 of the Specifications File.

2.2 Process assessment

2.21 Compliance with current laws and regulations and other 'fit for use' criteria.

Stability

The built-up cladding does not play a role in distributing load, bracing or resisting safety contact impacts. It is incumbent on the supporting structure.

The built-up cladding's stability on that structure is sufficient for the proposed field of use.

Fire safety

The checks to perform (namely in relation to the C+D rule, including for current buildings) must take into account the following characteristics:

- Reaction to fire rating: see §B at the back of the Specifications File.
- Panel HHV (higher heating value): 181.48 MJ/M².

Accident prevention during installation

Can normally be ensured.

Seismic zone installation

The HI-MACS® built-up cladding process can be used in seismic zones and on buildings listed in §2 of the Specifications File.

Thermal insulation

Compliance with current Thermal Regulations must be checked on a case by case basis, according to the building to be clad.

Thermal calculation elements

The surface heat transfer coefficient U_p for a wall incorporating an exterior insulation system using ventilated cladding is calculated using the following formula:

$$U_p = U_c + \sum_i \frac{\psi_i}{E_i} + n \cdot \chi_j$$

Where:

- U_c is the surface heat transfer coefficient of the long-run section, in W/(m^2.K).
- ψ_i is the linear heat transfer coefficient of built-in heat bridge i, in W/(m.K), (frames).
- E_i is the interaxial distance of the linear heat bridge i, in m.
- n is the number of separate heat bridges per m² of wall.
- χ_j is the separate heat transfer coefficient of the built-in thermal bridge j, in W/K (fixing brackets).

The coefficients ψ and χ must be determined by digital simulation in accordance with the method given in the Th-Bât rules, Thermal Bridges booklet. In the absence of digitally-calculated values, the default values given in §2.4 of the Opaque Walls booklet in the *"RT: valeurs et coefficients pour l'application des règles Th-Bât"* (TR: values and coefficients for applying Th-Bât rules) may be used.

In terms of singular points, losses from cladding flashing must also be taken into account.

Air- and water-tightness

Air: Provided by the supporting wall

Water: Provided sufficiently by the long-run section through narrow open joints between adjacent panels, given the vertical nature of the structure and presence of the air gap; and by singular points through the cladding flashing.

The system enables the creation of type XIII walls as per the document: "General design and installation rules for exterior thermal insulation holding a Technical Notice" (CSTB specifications 1833 of March 1983). The supporting walls must meet the requirements of Chapters 2 and 4 of this document and be air-tight.

Environmental data

The HI-MACS® process has no Environmental Declaration (ED) and cannot claim any specific environmental performance. Note: EDs do not fall within the process's 'fit for use' assessment scope.

Health aspects

This notice is drafted given the owner's written commitment to comply with regulations, namely the set of regulatory duties relating to products that may contain hazardous substances, in terms of their manufacture, inclusion in structures in the accepted field of use and utilisation. The scope of this notice does not include checking the information and declarations submitted for current regulations compliance The owner of this notice remains fully liable for that information and those declarations.

Impact performance

The external impact performance of the HI-MACS® process, in accordance with the P08-302 standard and 3546-V2 and 3534 CSTB Specifications, corresponds to the Q4 exposure rating for hard to replace walls.

2.22 Durability & Maintenance

The individual durability of the system components and their compatibility enable the evaluation that this built-up cladding presents satisfactory durability equivalent to that of traditional cladding.

The main structure's durability is improved by installing this built-up cladding, namely for associated thermal insulation.

2.23 Manufacture & Checks

This notice is drafted taking into account the checks and manufacture verification methods described in the Applicant's Technical File (ATF).

HI-MACS® panel manufacture is subjected to systematic self-testing which is regularly monitored by the CSTB and enables appropriate consistency in quality to be achieved.

The manufacturer invoking this Technical Notice must be able to produce a QB certificate issued by the CSTB certifying that the product complies with the characteristics described in the certification reference document following an assessment according to the test methods set out in that reference document.

Products that hold a valid certificate can be identified by the logo QB along with the factory ID and product ID numbers.

2.24 Supply

The items supplied by LG Hausys essentially comprise HI-MACS® panels and HI-MACS® adhesive.

The panels are machined and pre-drilled. They are supplied along with the Keil insert and cap screw by a QB certified HI-MACS® fabricator to installation companies. The QB certified HI-MACS® fabricator must perform the bonding. All bonding must be within the maximum dimensions given in §1.1 of this Notice.

The installation company must install the Keils inserts and the clips. The insert/clip and screw installation must comply with the requirements in the Specifications File (see §3.22).

The Keils inserts and their screws are systematically and solely supplied by the QB certified HI-MACS® fabricator.

All other components (rails, primary frame sections, fixing brackets, fixing clips, screws and wall plugs) are directly supplied by the installer in accordance with the description in the Specifications File.

2.25 Installation

This built-up cladding poses no specific difficulty in terms of installation, subject to having first assessed the material, created a layout drawing of the complementary flashing and components, and complied with the installation terms.

At the request of the installation company, LG Hausys can provide technical assistance.

The inserts are installed at the worksite by workers who have undergone training to receive a personal training certificate issued by LG Hausys or in the workshop by the fabricator.

2.3 Technical Instructions

2.31 Design terms

A layout drawing must be created in order to define the number and position of the inserts per sheet as well as the type of joint between panels (see §9.5 in the Specifications File). There is no specific direction for laying.

Attachments

Attachments to the support structure must be selected according to the wind exposure conditions and their calculated breakout resistance values in the intended material.

For aggregate concrete and masonry, the ultimate limit state resistance of pins is calculated according to the ETA or EAD as per the ETAG 001, 020 or 029 and corresponding DEE.

For materials whose characteristics are unknown, the ultimate limit state resistance of pins must be assessed prior to use, in accordance with the document "On-site determination of the ultimate limit state resistance of a mechanical attachment for built-up cladding" (CSTB Specifications 1661-V2).

Aluminium frame

The frame is a freely expandable design, as per the instructions in the "General design and installation rules for the metal frame and thermal insulation of built-up cladding holding a Technical Notice" (CSTB Specifications 3194 and its amendment 3586-V2), in addition to those below:

- Aluminium: Series 3000 minimum and offering an elasticity limit Rp0.2 over 180 MPa.
- The frame must comprise an EN-AW 6063 T66-type aluminium alloy BWM section (see §3.5 of the Specifications File).
- The evenness of uprights will have to be verified between adjacent uprights with a maximum permissible difference of 2 mm.
- The permissible vertical load resistance of the fixing brackets to be taken into account must be equal to deformation under load of 1 mm.
- The interaxial distance of posts is 600 mm maximum.

The vertical frame must be subject to a calculation grade for each worksite issued by the installation company, with assistance from the owner, LG Hausys, if required.

2.32 Installation terms

For HI-MACS® panels, it is prohibited to bridge joints between successive unspliced posts in a rigid manner.

Conclusions

Overall assessment

Use of the HI-MACS® system in the approved field of use (see paragraph 2.1) receives a favourable assessment.

Validity

From the date of publication shown on the first page, until 31 March 2022.

For Specialised Group 2.2
The President

3. Additional comments from the Specialised Group

This is a new request.

Regarding wind resistance, the permissible values under stated normal wind conditions in terms of negative pressure effects take into account a safety coefficient equal to 5 on the failure value, which is determined through insert breakout tests.

There are limitations on installation in seismic zones.

This Technical Notice is subject to a QB product certification of HI-MACS® panels.

Spokesperson for Specialised Group 2.2

Specifications File
compiled by the applicant

A. Description

1. Principle

The HI-MACS® cladding system is a built-up cladding process comprising acrylic resin and mineral filler panels. HI-MACS® panels are drilled in the factory and stainless steel inserts are fitted in blind holes.

During installation, the panels are directly attached to horizontal aluminium rails by clips fitted with Keil inserts. The vertical frame is attached to the load bearing structure by fixing brackets. The horizontal and vertical joints can be open, closed or lap.

2. Field of use

- Installation of built-up cladding on flat or vertical new and existing walls, primed masonry (in accordance with NF DTU 20.1) or concrete (in accordance with DTU 23.1), at ground floor or upper levels.
- Can also be installed on sloped surfaces with negative external wall slopes from 0° to 90° and to clad eaves of horizontal, flat concrete substrates that are new or in use, inaccessible (over 3m above ground) and have no playground nearby, and according to the provisions set out in § 9.7 of the Specifications File.
- The panels can also be installed on window lintels.
- Wind exposure corresponding to positive and negative pressure under normal wind conditions, as per the amended NV65 rules, with maximum value of 1500Pa, with:
  - maximum 600mm clip attachment interaxial
  - maximum 600mm interaxial between frame posts
  - maximum 600mm interaxial between horizontal rails
  - distance from edge between 100mm and 150mm
- The HI-MACS® built-up cladding process may be used in seismic zones and for buildings listed in the table below (as per the Decree of 22 October 2010 and its amendments):

Seismic zones	Classes of the importance categories of buildings			
	I	II	III	IV
1	X	X	X	X
2	X	X	❶	
3	X	❷		
4	X	❷		

X	Installation authorised without specific provisions according to the accepted field of use,
❶	Installation authorised without specific provisions according to the accepted field of use for single-level educational institutions (Category III building size) fulfilling the conditions of paragraph 1.1[11] of the Aseismic Construction Rules PS-MI 89, revised 92 (NF P06-014),
❷	Installation authorised without specific provisions according to the accepted field of use for Category II building sizes fulfilling the conditions of paragraph 1.1[1] of the Aseismic Construction Rules PS-MI 89, revised 92 (NF P06-014).
	Installation not authorised

For structure heights ≤ 3.5m, installation of the HI-MACS® built-up cladding process in seismic zones is authorised without specific provisions, regardless of the building size category or seismic zone (see ENS Guide).

3. Elements and materials

3.1 HI-MACS® panels

Solid, homogeneous panels comprising 40% PMMA (polymethyl methacrylate acrylic polymers), 60% ATH (aluminium trihydroxide), natural colour pigments and catalysts.

Dimensional characteristics

- Standard panel manufacturing format:

  760 mm (width) x 3670 mm (length)

  Panel installation dimensions:
  - Minimum: 300 x 300 mm
  - Maximum: 3670 mm (width) x 4600 mm (length)

  These dimensions are achieved by workshop bonding with HI-MACS® adhesive (see §4 and 7). The adhesive code depends on the panel colour.
- Thickness: 12 mm
- Dimensional tolerances of standard manufacture panels:
  - Length and width: - 0 / + 10 mm
  - Thickness: 12 mm ± 0.4 mm
  - Flatness: < 2mm/m
  - Squaring: < 1mm/m
- Dimensional tolerances of panels cut to size:
  - Length and width: ± 3 mm
  - Thickness: 12 mm ± 0.5 mm
  - Flatness: < 2mm/m
  - Squaring: < 1mm/m
- Cutting, machining:
  - Dimensional tolerances of panels on request: ± 1 mm
- KEIL insert pre-drilling:
  - Maximum horizontal interaxial: 600 mm
  - Maximum vertical interaxial: 600 mm
  - Minimum distance between insert centre and edges: 100 mm
  - Maximum distance between insert centre and edges: 150 mm
- Nominal surface densities:
  - 12 mm: 20.86 kg/m²
- Standard finish of panels exiting the factory: matte.

  A matte, semi-gloss or high gloss finish can be achieved in the workshop by a IQB certified fabricator.
- Standard panel colour: 1 Alpine White standard colour - S828(H16)

  This colour is monitored by the CSTB based on the internal manufacturing production control system.

  Other shades and appearances validated in the factory may be proposed as part of the extension of the current range based on the internal manufacturing follow-up and external follow-up of the CSTB.

Mechanical characteristics

The other characteristics of elements are given in table 1 at the end of the Technical Record.

3.2 Clips

The specific panel installation clip is the BWM ATK 103 P-20 clip for Keil (see figures 6a, 6b and 6c). It is threaded with an EN-AW 6063 T66-type aluminium alloy in accordance with the NF EN 755-2 standard and comprises a section in cellular rubber built into the contact area.

There are three types of clips behind the HI-MACS® panels (see fig. 6c). The position of the clips on the panel is shown in figure 7.

The fixed and adjustment clips are the same parts. However, for the fixed clip two U-shaped parts are attached with screws either side of the clip (see fig. 6c).

There are three types of single and double clip positions;

- The fixed clip, which holds the panel in place vertically and horizontally, is positioned on the far left end and top rail of the panel.
- The adjustment clip, which is located on the far right and top rail of the panel, holds the panel in place vertically but allows for horizontal expansion.
- The standard clip, which is to be used for all other attachment points, allows for horizontal and vertical expansion.

The clips come in two different widths: 36mm and 140mm. They are required to have one hexagonal hole for the single 36mm clip and two hexagonal holes for the double 140mm clip intended to hold the Keil

[1] Paragraph 1.1 of the NF P06-014 standard describes its field of application.

inserts on the back of the HI-MACS® panel. These clips are supplied pre-drilled by the clip supplier (see figures 6a, 6b and 6c).

The fixed and adjustment clips are only installed on the upper rail of each panel. The fixed clip is systematically positioned on the far left of the panel and the adjustment clip on the far right. The fixed and adjustment clips have an adjustment screw (M6) to ensure the panel is horizontal (see figures 6a, 6b and 6c).

The fixed and adjustment clips on the upper horizontal rail hold the panel's own weight plus the wind load. The other clips provide stability in wind.

If the panel surface is equal to or less than 10m², the single clip is used. For larger surfaces, the double clip must be used (see figure 7).

- Single fixed clip: BWM ATK 103 P-20 réf. #28636,
- Single adjustment clip: BWM ATK 103 P-20 réf. #28636,
- Double fixed clip: BWM ATK 103 P-20 réf. #028140,
- Double adjustment clip: BWM ATK 103 P-20 réf. #028140,
- Standard clip: BWM ATK 103 P-20 ref.#28536.

The clip positions correspond to the inserts on the rear side of the panels according to the layout drawing created by the installation company in accordance with the LG Hausys QB certified fabricator and owner of the Technical Notice.

3.3 Clip attachments on the back of the panels

The Keil insert must be positioned in the blind hole. It is prohibited to insert a washer between the insert and HI-MACS® panel or between the screw and insert (see figures 3a and 3b).

The hexagonal hole must perfectly fit the Keil insert's hexagonal head. The insert head must be flush with the clip.

The clips are attached to the back of the panels using a hexagonal head stainless steel blind screw made by Keil, with the product code M6 x 13 Hs = 8.5 (17mm hexagonal head and 13mm screw body, see figure 3b).

It is screwed in by using a light pressure on the clip. Using the Keil insert enables the screw to be locked in thanks to the four undercuts that form this shape-lock insert.

Horizontal immobilisation of fixed clips

The horizontal immobilisation of fixed clips is provided by two U-shaped parts positioned either side of the clip (see figure 6c, installing a fixed clip). The U-shaped parts are made from 1.4016 stainless steel and supplied with the clips. The two U-shaped parts are attached to the horizontal rails with self-tapping screws MD 4.2 x 16, Würth Zebra Pias SHR-BO-LIKPF- AW20 (Art. 020614216). These screws are made from 1.4301 A2 stainless steel. Horizontal rails (C)

The specific rails for installing the panels are BWM ATK 103 P-20 3mm rails, ref. #668420 (see figure 5).

The ATK 103 P-20 sections are threaded with an EN-AW 6063 T66 type aluminium alloy in accordance with the NF EN 755-2 standard, as per the dimensional tolerances in accordance with the NF EN 755-9 standard, and are supplied with a maximum length of 3.7m.

The ATK 103 P-20 long-run sections are attached to the vertical posts in accordance with the CSTB Specifications 3194.

Finger jointing the sections is not permitted. The ATK 103 P-20 section joint must be positioned to the right of a post with T-shaped flashing 100mm in width. The rails on each side of that joint must be attached to at least two supports. The connection on one of those sides must not be more than 250mm away from the primary vertical frame.

3.4 Horizontal rail attachments to the primary frame

The BWM ATK 103 P-20 3mm rails are attached to the primary frame listed in §3.6 using SNA 5x12 K14 blind rivets with two rivets per joint between the rail and main frame (see figure 1, step 3). These SNA 5x12 K14 blind rivets must comprise an EN AW5754 aluminium alloy connector and a 1.4541 stainless steel spool.

3.5 Aluminium frame (T)

The freely expandable design frame system complies with the requirements in the CSTB Specifications 3194 and its amendments 3586-V2.

The primary frame is considered to be a protected, ventilated area.

The flashing length is 6m maximum and 100mm wide minimum on the panel ends and 40mm in the middle (see figure 9).

The frame may comprise the following EN-AW 6063 T66 type aluminium alloy components:

- BWM ATK 100 Minor T100/52/2 section ref. #632700 (see figure 4), 6m long, for posts to the right of vertical joints between panels
- BWM ATK 100 Minor T40/52/2 section ref. #632740 (see figure 4), 6m long, for intermediate posts

3.6 Insulation

Insulating, ACERMI-certified, compliant with the requirements of the CSTB Specifications 3194 and its amendment 3586-V2.

3.7 Associated accessories

The window support sheet, boards and lintels can be created with HI-MACS® panels on clean frames or with metal flashing sections normally used when creating singular points for traditional cladding.

4. Manufacturing

HI-MACS® panels are manufactured by LG Hausys at its factory in South Korea.

HI-MACS® panel manufacture follows the stages below:

- Raw materials delivered.
- Raw materials blended (ATH, MMA, PMMA, pigments and catalyst).
- Panels poured in a continuous line.
- Panels machined and cut to standard size.
- Sanding.
- Calibration.
- Quality checks.
- Coating, branding and packaging.

HI-MACS® panel processing is performed at the site of LG Hausys QB certified fabricators, who are committed to complying with the specifications, and follows the various stages below:

- Cutting to size.
- Insert drilling.
- For bonding, exclusively use LG HI-MACS® adhesive.
- Full polymerisation with drying time is 75±10 minutes at 17-25°C.
- Cleaning joints with alcohol.
- Joining components to bond by clamping with clamps.
- Sanding.
- Coating, branding and packaging.

5. Production control

HI-MACS® panel manufacture is subjected to systematic self-testing which is regularly monitored by the CSTB and enables appropriate consistency in quality to be achieved.

The manufacturer holds a QB certificate.

On raw materials

Supplier specifications

- Aluminium tri-hydroxide level checks
- PMMA and MMA acrylic resin checks
- Pigment checks
- Additive checks

In the process of manufacturing

- Dimension checks

  Thickness, length, width, flatness, squaring: once every 50 panels.
- Colour checks with spectrophotometer (L, a, b, ΔE) once every 10 panels.
- Visual surface defect checks on every panel as per NF EN ISO 19712-2-5.

On finished products

- Density checks, NF EN ISO 1183, once per manufacture batch, 1.63 g/ml ≤ D ≤ 1.83 g/ml.
- Dimensional stability at 70°C, as per EN 438-2 section 17, one panel per manufacture batch.
- Resistance to a large diameter ball bearing impact, NF EN ISO 19712-2,8, once per manufacture batch: ≥1800mm.
- UV resistance, NF EN ISO 19712-2.9, once per manufacture batch.
- Barcol hardness check, NF EN ISO 19712-2.15, once per manufacture batch: ≥ 58.
- Dimensional checks (length, width, thickness) after processing upon request: ± 1 mm

QB certified values:

- Insert breakout resistance (Method B3, Annex 4 of the QB15 brand reference document) ≥ 4.5 kN once per week in manufacture.
- Flexural resistance as per NF EN ISO 178 once per manufacture batch: pressure ≥ 65 MPa, module ≥ 8900 MPa.

6. Product details

HI-MACS® panels with a QB certificate can be identified by the "Specific requirements of QB certification for built-up cladding, wall panels and ordinary weatherboarding, and eave cladding" label and namely comprise:

On the product

- The QB logo
- The certificate number,
- The identification mark of the manufacturing lot

On pallets

- The QB logo
- The certificate number,
- Manufacturer name
- Product's commercial name
- Technical Notice number

7. Supply and technical assistance

LG Hausys does not install the panels itself. It retails and delivers HI-MACS® panels for the HI-MACS® cladding system to QB certified fabricators.

All other components (attachments, fixing brackets, primary frames, rails, clips, etc.) are directly procured by the installing company, in accordance with the recommendations of this Specifications File.

LG Hausys delivers panels in standard factory sizes which must be cut, machined, bonded and predrilled (blind holes for the inserts) by the LG Hausys QB certified fabricators who have committed to complying with the specifications.

Using standard factory sizes, the LG Hausys QB certified fabricators can create all types of rectangular sub-sizes to match the prepared layout drawing, up to a maximum installation size of 4600 x 3670mm (H x W).

The inserts are installed at the worksite by workers who have undergone training to receive a personal training certificate issued by LG Hausys or in the workshop by the fabricator.

LG Hausys Europe has a technical department that can provide technical assistance, at the installer's request, during the project preparation and installation stages.

Transport

The sheet must be transported by a carrier or articulated lorry directly to the customer or worksite in order to avoid additional loading/unloading. If the sheet are in small sizes or quantities, they are dispatched in wooden crates. If they exceed 1200mm wide by 2000/2500mm long, they are dispatched on a trestle. Sheet over 2500mm long must be laid flat, one on top of the other, with wooden braces between each sheet to avoid any rubbing and protect the polished side.

8. Installing thermal insulation and the primary frame

8.1 Thermal insulation

The ACERMI-certified insulation is installed in accordance with the provisions in the "General design and installation rules for the metal frame and thermal insulation of built-up cladding holding a Technical Notice" (CSTB 3194 specification and its amendment 3586-V2).

8.2 Aluminium frame

The installation of the metal frame must comply with the prescriptions of the CSTB Specifications 3194 and its amendment 3586-V2, reinforced by those below:

- The evenness of uprights must be verified between adjacent uprights with a maximum permissible difference of 2 mm.
- The permissible vertical load resistance of the pin to be taken into account must be that corresponding to a deformation under load equal to 1 mm.
- The interaxial distance of posts is 600mm maximum (see figure 9).

9. Application

9.1 General laying principles

While being transported and when stored on site, cladding panels are protected from damage. Cladding panels must not be hung in an abrupt manner (if necessary, use lifting machinery to hang the cladding panels). Cladding panels with cracks appearing must not be installed.

Installation work must be done using scaffolding, a scissor lift or mast climbing platform. Hoisting beams and suction pads can be used to help manoeuvre them.

This cladding requires a layout drawing showing the location of inserts. This drawing is created by the installation company in agreement with the LG Hausys QB certified fabricator providing the panels and the Technical Notice owner.

The cladding is installed from the bottom to the top by successive horizontal rows. The installation company positions clips to the right of the Keil insert: M6 x 13 Hs = 8.5 (17mm hexagonal head and 13mm screw body) The HI-MACS® panels fitted with fixing clips on the back are positioned on the front of the rails and slid down until the clips interlock with the rails.

The following operations must be performed when installing:

- Marking out and cutting as per the layout drawing
- Installing vertical aluminium frames
- Installing horizontal aluminium rails
- Adjusting: flatness, verticality, levelness, interaxial distance of frames according to layout drawing.
- Attaching clips on the back of the HI-MACS® panels
- Installing panels
- Treating singular points

9.2 Installing horizontal rails

BWM ATK 103 P-20 rails are attached at height to the primary frame using rivets, with two rivets per joint between the rail and vertical flashing (see figure 1).

The holes for the rivets can be premesured and drilled by the frame suppliers.

The BWM ATK 103 P-20 rails allow for overhangs of 250mm maximum.

A template system (see figure 28) is used to install parallel horizontal rails. A template is used to ensure the precision of installed horizontal rail interaxial distances. The template comprises four standard clips positioned with interaxial distances of 600mm (vertical) and 1000mm (horizontal).

The principle for using the template is as follows:

- Install the level starting rail permanently with rivets.
- Install the other rails by temporarily using the clamps.
- Lock the template on the starting rail and following rails.
- Check the position of the following rails. Adjust if required.
- Install the level starting rail permanently with rivets.

9.3 Installing panels

9.31 Clip attachment on the back of the panels

The position of the clips on the panel is shown in figure 7.

The fixed and adjustment clips are placed on the top horizontal rail. The standard clips are positioned on all horizontal rails, including the top rail.

The fixed clip is positioned on the far left of the panel and the adjustment clip on the far right. Together, they hold the panel's own weight and some of the wind load. The standard clips provide stability in wind.

The hexagonal head Keil insert must be installed by the installation company at the worksite. This operation must be performed on a horizontal work surface with the panel laid flat and the presentation side face down.

The installation company must ensure that, once attached to the panel, the clips are not too tight. In fact, the clips must be able to be manually turned after being attached in order to ensure they perfectly align and to enable them to interlock with the horizontal rail when the panel is installed.

The installer must ensure that the clips attached to the back of the HI-MACS® panels align horizontally by interlocking those clips with an empty BWM ATK 103 P-20 rail.

9.32 Installing the Keil insert

The insert must be installed in accordance with the specifications and building plans, using the tools listed in the installation instructions supplied by Keil.

The screw is attached and torque tightened to 2.5-4.0 Nm using a calibrated torque wrench.

9.4 Vertical compartmentalisation of air gap

Compartmentalisation of the air gap must be provided for at the corner of adjacent façades. This partitioning is formed using durable materials (aluminium sheet or galvanised steel sheet of at least Z 275) which, for the entire cladding height, must be suitable for blocking any lateral in-draft of air.

9.5 Treatment of seals

The HI-MACS® panel width is variable and can be up to 3.67m. The maximum height for LG HI-MACS® panels is 4.6m.

Open, closed and lap joints enable the free movement of panels when they expand (see figure 12).

The vertical and horizontal joints are open, closed (by metal saddle or formed flashing (see figure 12)) or lap for panels over 2000mm wide or high.

For heights and widths over 2000mm, the joints are closed or lap. The joint details are given in figure 12.

The thermal expansion coefficient to take into account is $45x10^{-6}$ mm/mm/°C for a Delta T of 80°C (min: -20ºC/max: 60ºC).

The determined expansion X in mm of the panels is given in the tables below, taking into consideration the manufacturing tolerances and Delta T of 80°C, according to the following equations:

$$X = (45x10^{-6}) \times (W \text{ or } H) \times 80$$

X = expansion (mm)

W = panel width (mm)

H = panel height (mm)

Width: W (mm)	X(mm)	Joint type
0 ≤ L < 1200	5	Open, closed, or lap joints
1200 ≤ L < 1400	6	
1400 ≤ L < 1700	7	
1700 ≤ L < 2000	8	
2000 ≤ L < 2300	9	Closed, or lap joints
2300 ≤ L < 2600	10	
2600 ≤ L < 2800	11	
2800 ≤ L < 3100	12	
3100 ≤ L < 3400	13	
3400 ≤ L ≤ 3670	14	

Height: H (mm)	X(mm)	Joint type
0 ≤ L < 1200	5	Open, closed, or lap joints
1200 ≤ L < 1400	6	
1400 ≤ L < 1700	7	
1700 ≤ L < 2000	8	
2000 ≤ L < 2300	9	Closed, or lap joints
2300 ≤ L < 2600	10	
2600 ≤ L < 2800	11	
2800 ≤ L < 3100	12	
3100 ≤ L < 3400	13	
3400 ≤ L ≤ 3700	14	
3700 ≤ H < 3900	15	
3900 ≤ H < 4200	16	
4200 ≤ H < 4600	17	

9.6 Ventilation of the air gap

A 20mm minimum air gap is always created between the support wall's external bare side or insulation and the back of the attached surface, along with the air inflows and outflows, as per the CSTB Specifications 3316-V2 and 3194 and its amendment 3586-V2.

9.7 Installation on sloped walls with negative external wall slopes from 0° to 90°

9.71 Installation on negative external wall slopes from 0° to 15°

Installation possible on negative external wall slopes from 0° to 15° without any specific provisions other than those listed in the preceding paragraphs.

9.72 Installation on window lintels and negative external wall slopes from 15° to 90°

Installation on window lintels and eaves is permitted for the HI-MACS® system on new and existing horizontal concrete walls that are hard to reach (over 3m above ground), with no playground nearby, in accordance with the following instructions:

- The maximum size of panels is 760 x 3670mm.
- The interaxial distance between primary frames, horizontal rails and clips cannot exceed 500mm.
- One clip on the first row must be attached by a locking screw (self-tapping 5.5/50mm screw) to stop sideways movement (see figure 24).
- The eaves frame must be independent of the cladding structure.
- The distance from the inserts to the panel edge must be 100-150mm.
- The fixing brackets are positioned either side of the frame facing each other.
- The interaxial distance between brackets must be calculated according to the restrictions of the system's own weight and assessed on a case by case basis.
- The frame must be subject to a calculation grade for each worksite issued by the installation company, with assistance from LG Hausys, if required.
- Water diversion flashing must be installed or drip transfer flashing must be created at the foot of the built-up cladding.

9.8 Singular points

Figures 13 to 26 constitute a catalogue of examples for the treatment of singular points.

10. Maintenance and repair

10.1 Maintenance

The HI-MACS® panels are easy to clean and require no special maintenance. The non-porous nature of the surface resin ensure dirt cannot enter the panels. Therefore only periodic cleaning is required.

10.2 Cleaning

To clean, simply use a mop with water and a cleaning brush. Wet the surface first, then use a blue Scotch Brite® sponge in circular movements with a gentle cream cleaning product containing microparticles.

More stubborn marks

When panels have stubborn marks, such as glue, ink, paint, lipstick or other residue, clean them with a neutral detergent. These chemical cleaners must be used in accordance with health and safety guidelines.

Marks caused by scratches

Use sandpaper (#600 course grain to #100 fine grain) or a scouring pad to remove scratches and other marks on panels. Deep scratches may be filled with adhesive then sanded, or the section may be cut out and replaced.

10.3 Replacing a panel

The panel replacement functional diagram is given in figure 27.

To perform this operation, the installer must be assisted by an LG Hausys QB certified fabricator.

Cut out a 2cm strip from the top section of the HI-MACS® panel in order to remove it. Then remove the two U-shaped parts either side of the fixed clip. Replace the panel and put it back in position. Then bond the top of the panel with a 2cm strip of HI-MACS® panel using HI-MACS® rigid adhesive. Wait for the full adhesive polymerisation time. You can then sand the joint and panel surface to blend the alteration.

Bonding must be done under ideal polymerisation conditions (ideally between 10-20°C) and in a clean setting.

The panel was drilled with a conical-shaped hole in the factory, in a specific manner on CNC by the HI-MACS® QB certified fabricator. The fixed point is then created by inserting a 5.5/50mm self-tapping screw through that hole to the clip and rail. The fabricator can then plug the hole by gluing on a conical plug and sanding it. The plug's conical shape hides the alteration. The panel's front aspect is therefore unaltered.

B. Experimental results

The process has undergone the following tests:

- Density and thermal expansion coefficient: test report MPA no. P 1804-128a of 4 July 2018.
- Flexural, bonded joint stress and insert breakout after ageing tests: test report CSTB no. FaCeT 18-26074727/D of 6 September 2018
- Initial tests: test report no. 21247447_002 of TÜV Rheinland as per NF EN ISO 19712-2:2007.
- HHV determination: test report Crepim no.2078/01/339 A-1 of 23 May 2018.
- Reaction to fire rating report: Crepim no. 2078/01/339 A-1 of 23 May 2018, for HI-MACS® S828 Alpine White panels. M1 rating.

  This test validates the following provisions:
  - Nominal thickness: 12mm
  - Nominal volumetric mass: 1750 kg/m^3
  - Tested colours: S828 Alpine White.

System tests

- Wind effect resistance tests: test report CSTB no. FaCeT 18-26074727/A and C of 6 September 2018.
- Impact resistance tests: test report no. FaCeT 18-26074727/B of 6 September 2018.

C. References

C1. Environmental Data[2]

The HI-MACS® process is not the subject of an Environmental Declaration (ED). It may therefore not vindicate any specific environmental performance.

The data resulting from the DEs is particularly used for the calculation of environmental impacts of structures in which the specified processes are likely to be included.

C2. Other references

In France, 1,000 m² has been installed since 2010.

Globally, 35,000 m² has been installed since 2009.

[2] Not assessed by the Specialised Group as part of this Notice

Tables and figures of the Technical Record

Table 1 - Characteristics of elements

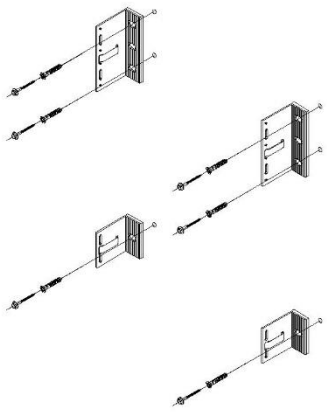
Characteristics	**Value**	**Test method**
Thermal expansion coefficient	$45x10^{-6}$ [l/°C]	EN 14581
Volumetric mass	1.738 [g/cm³]	ISO 1183
Elasticity module	8900 [MPa]	EN ISO 178
Flexural resistance	65 [MPa]	EN ISO 178
Impact resistance for a large diameter ball bearing	≥ 1,800 mm, no fissure	ISO 19712-2 §8
Resistance to dry and wet heat	No fissure or visible blister	ISO 19712-2 §12
	4-5	ISO 19712-2 §13 (method A)
	5	ISO 19712-2 §13 (method B)
Hardness	289 N/mm²	ISO 19712-2 §15 (Hardness indentation ball)
	120	ISO 19712-2 §15 (Rockwell hardness)

Summary of figures

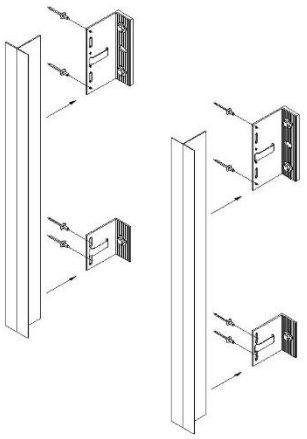
Key

1	Panel
2	Pin
3	Fixing bracket
4	Primary frame
5	Rails
6	Clip
7	U-shaped part
8	Insert
9	Rivet
10	Self-tapping screw
11	Adjustment screw
12	Concrete
13	Insulation
14	Coping
15	Flashing
16	Rodent mesh
17	Joint cover sheet
18	Compartmentalising sheet
19	Separation sheet

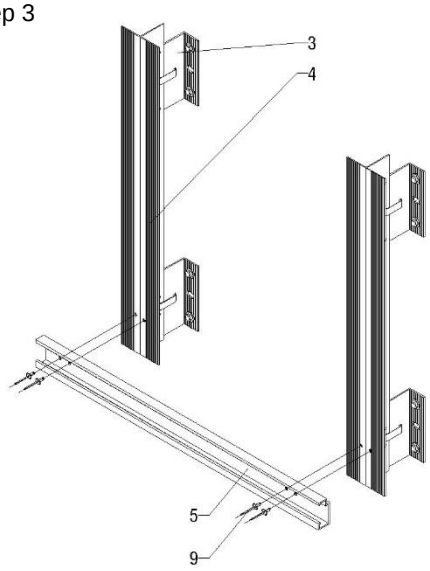
Step 1



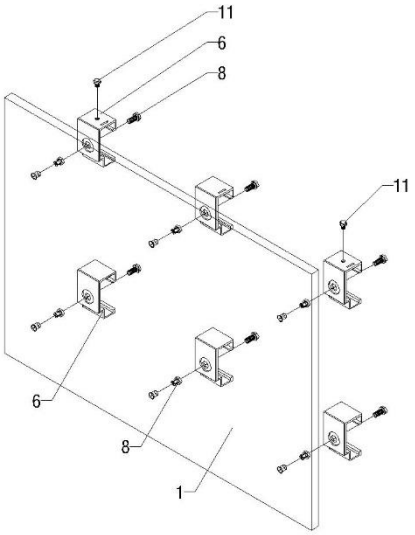
Step 2



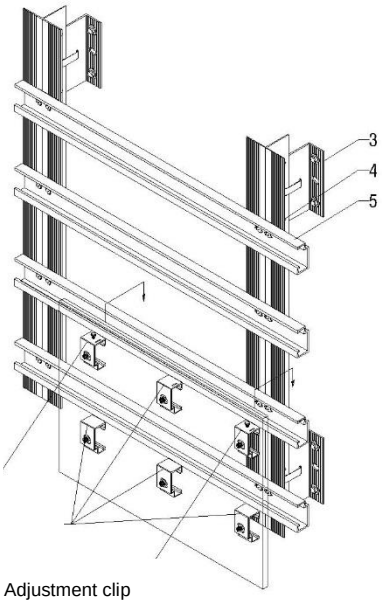
Step 3



Step 4



Step 5



Fixed clip

Standard clip:

Adjustment clip

Step 6

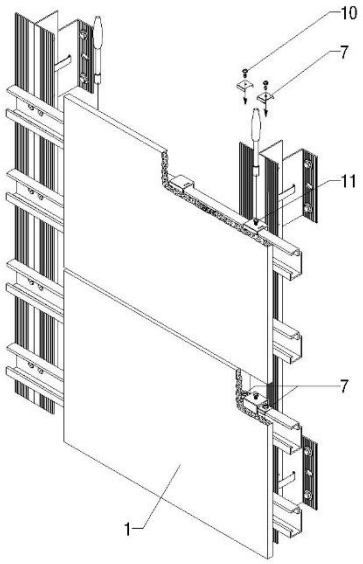
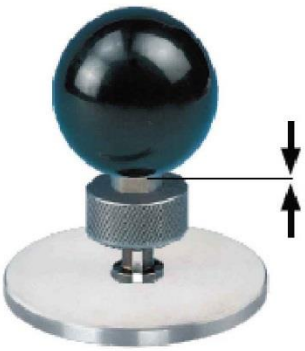
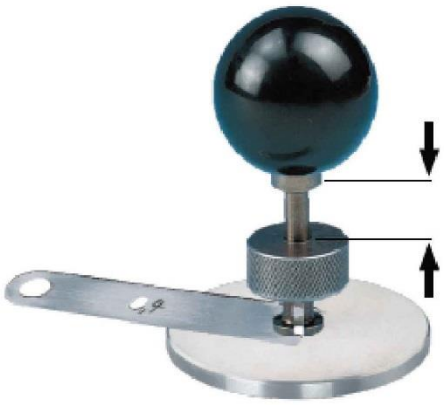


Figure 1 – Panel and metal frame assembly functional diagram

Insert the base section of the control gauge in the machined hole that holds the insert.

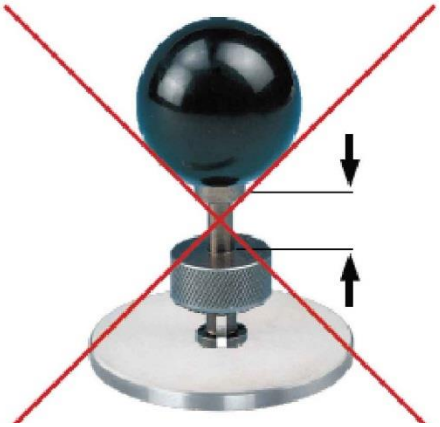


1 - Lock the gauge in position.



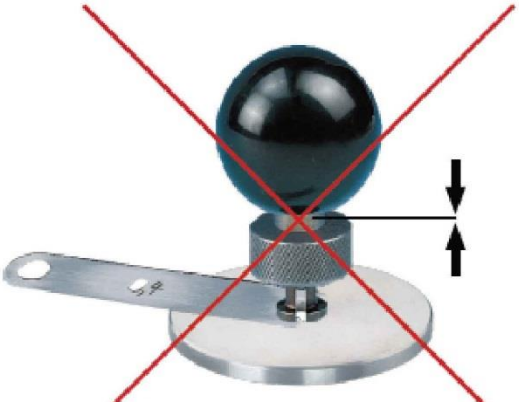
2 - Place the thickness wedge between the panel and base section of the control gauge. The machined hole is compliant if you cannot push the gauge down to the base section

Incorrect drilling



You cannot push the gauge down to the base section without the thickness wedge.

Fault: The hole has been machined too deep.



You cannot push the gauge down to the base section with the thickness wedge.

Fault:

- The hole has not been machined deep enough.
- Worn drill bit.

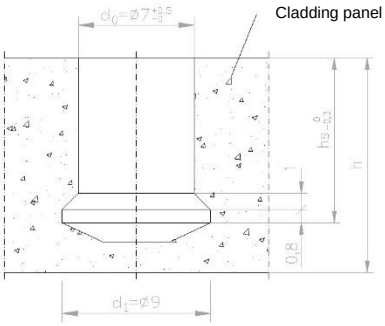
Figure 2 - Drill size check procedure

Keil Undercut Anchor KH

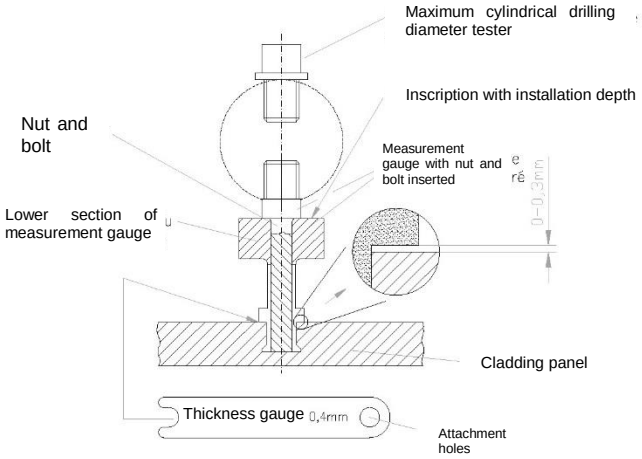
Geometry of drill hole

Geometry of Keil cladding drill bit and test/adjustment tools

Geometry of drill hole

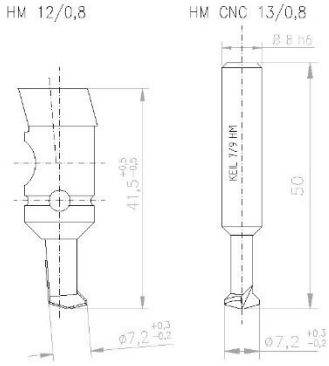


Test/adjustment tools



Geometry of Keil cladding drill bit

for 7/9 Keil cladding drill bit



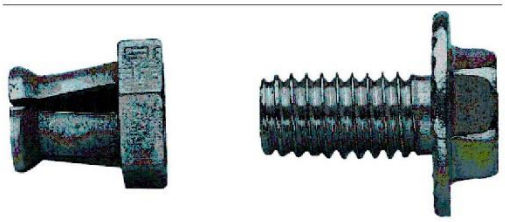
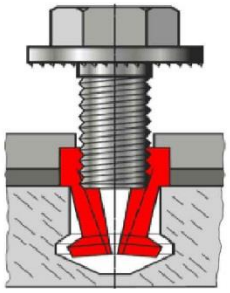
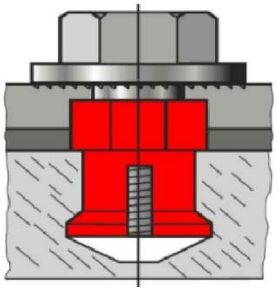


Figure 3a - Geometry of KEIL-1

Installation



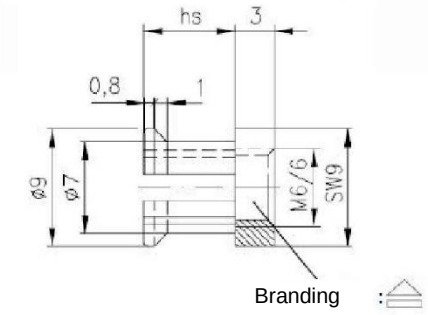
a) Insert the sleeve in the hole and drill the screw in the sleeve

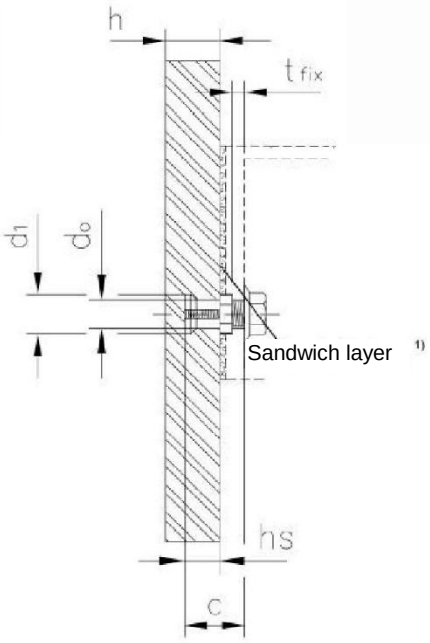


b) Anchor installed

Locking sleeve (mm)

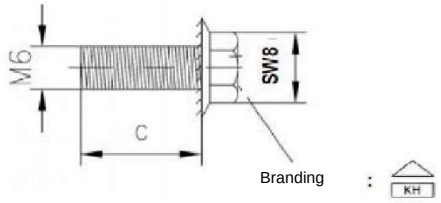
1.4404 EN 10088 stainless steel





Hex bit screw with locking washer

Inox 1.4401, 1.4404 ou 1.4578 EN 10088



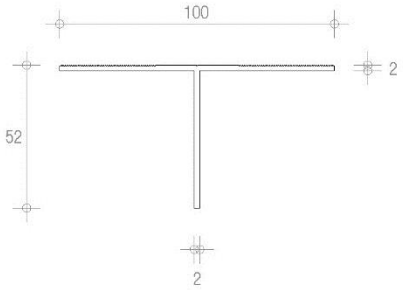
1) Elastic sandwich layer (e.g. EPDM) - Thickness 1,0 à 3,0 mm

Values for installing the anchor

Anchor type			KH
Depth adjustment	H_s =	[mm]	8.5
Panel thickness	h ≥	[mm]	12.0
Diameter of drill hole	d_0 =	[mm]	7.0
Diameter of undercut	d_1 =	[mm]	9.0
Screw length	c =	[mm]	H_s + 3mm + t_{fix}
Tightening torque installation	T_{inst}	[Nm]	2.5 ≤ T_{inst} ≤ 4.0

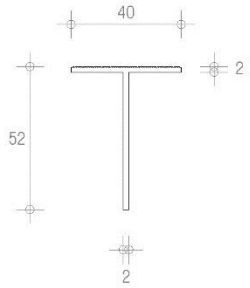
Figure 3b - Geometry of Keil-2

T40/52/2 – ATK 100: Mechanical and Geometric Characteristics



Area	268.8 mm²
Centre of gravity	Xs=50.00 mm
	Ys=9.19 mm
Moment of inertia	Ixx=55110 mm4
	Iyy=137600 mm4
	Ixy=0.123 mm4
Section module	Wx+=1287 mm³
	Wx-=5998 mm³
	Wy+=2751 mm³
	Wy-=2751 mm³

T100/52/2 – ATK 100: Mechanical and Geometric Characteristics



Area	159.2 mm²
Centre of gravity	Xs=20.24 mm
	Ys=14.83 mm
Moment of inertia	Ixx=42670 mm4
	Iyy=10530 mm4
	Ixy=-517.7 mm4
Section module	Wx+=1148 mm³
	Wx-=2878 mm³
	Wy+=520 mm³
	Wy-=533 mm³

Figure 4 - Primary frame

Horizontal rail ATK 103 P–20

Unperforated

Art. 668420

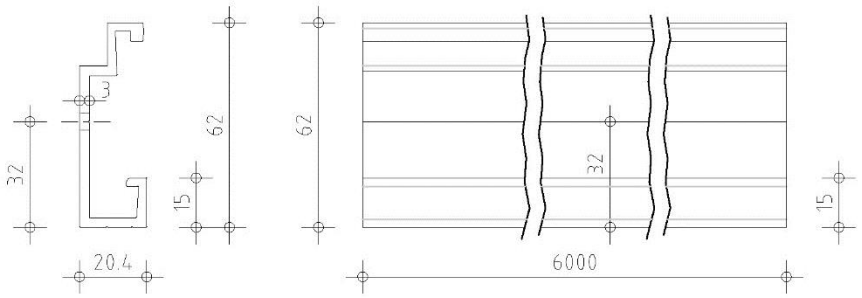


Figure 5 - Horizontal rail

ATK 103 P-20 clip for Keil Hexagonal

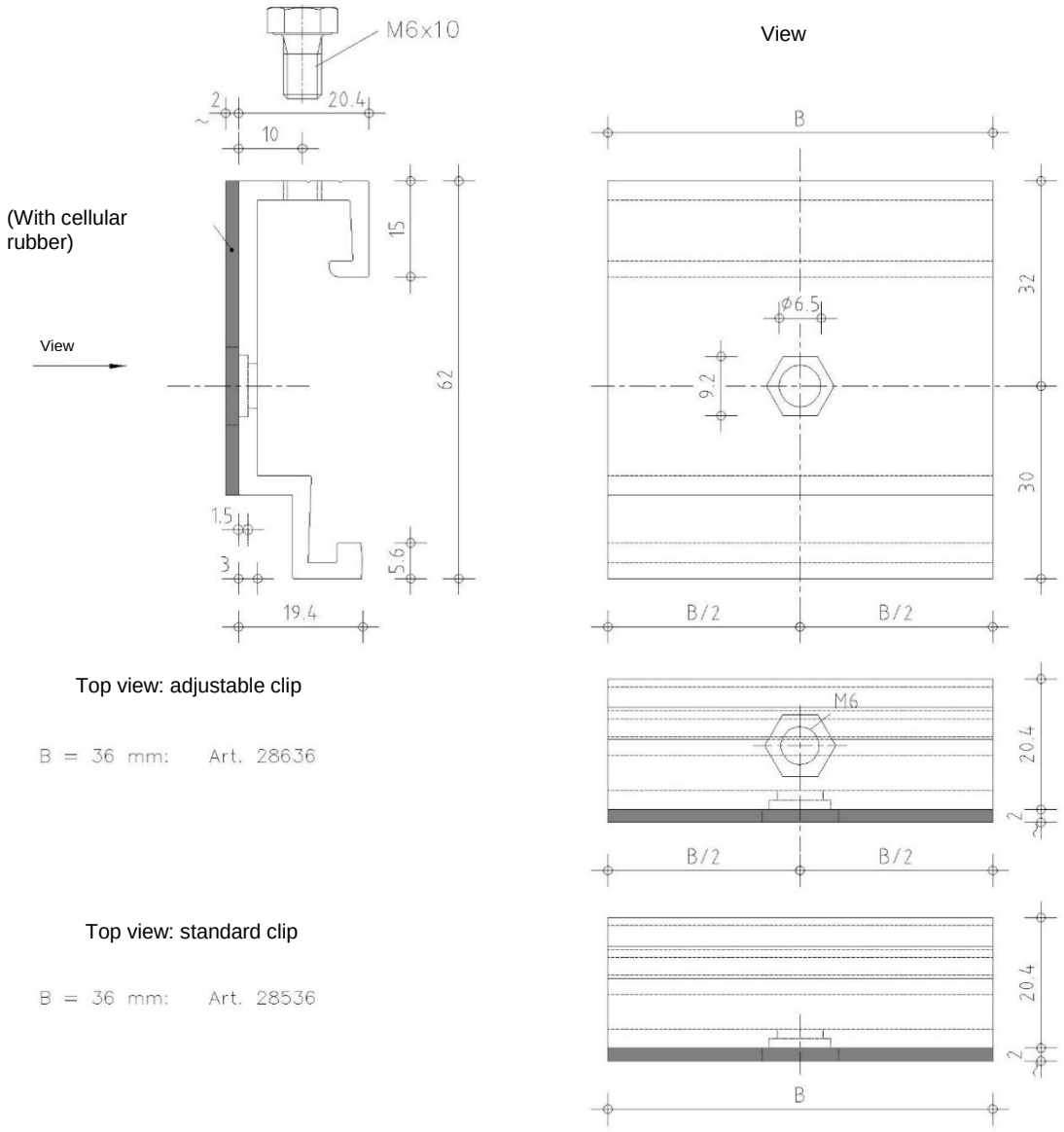


Figure 6a - Single clip

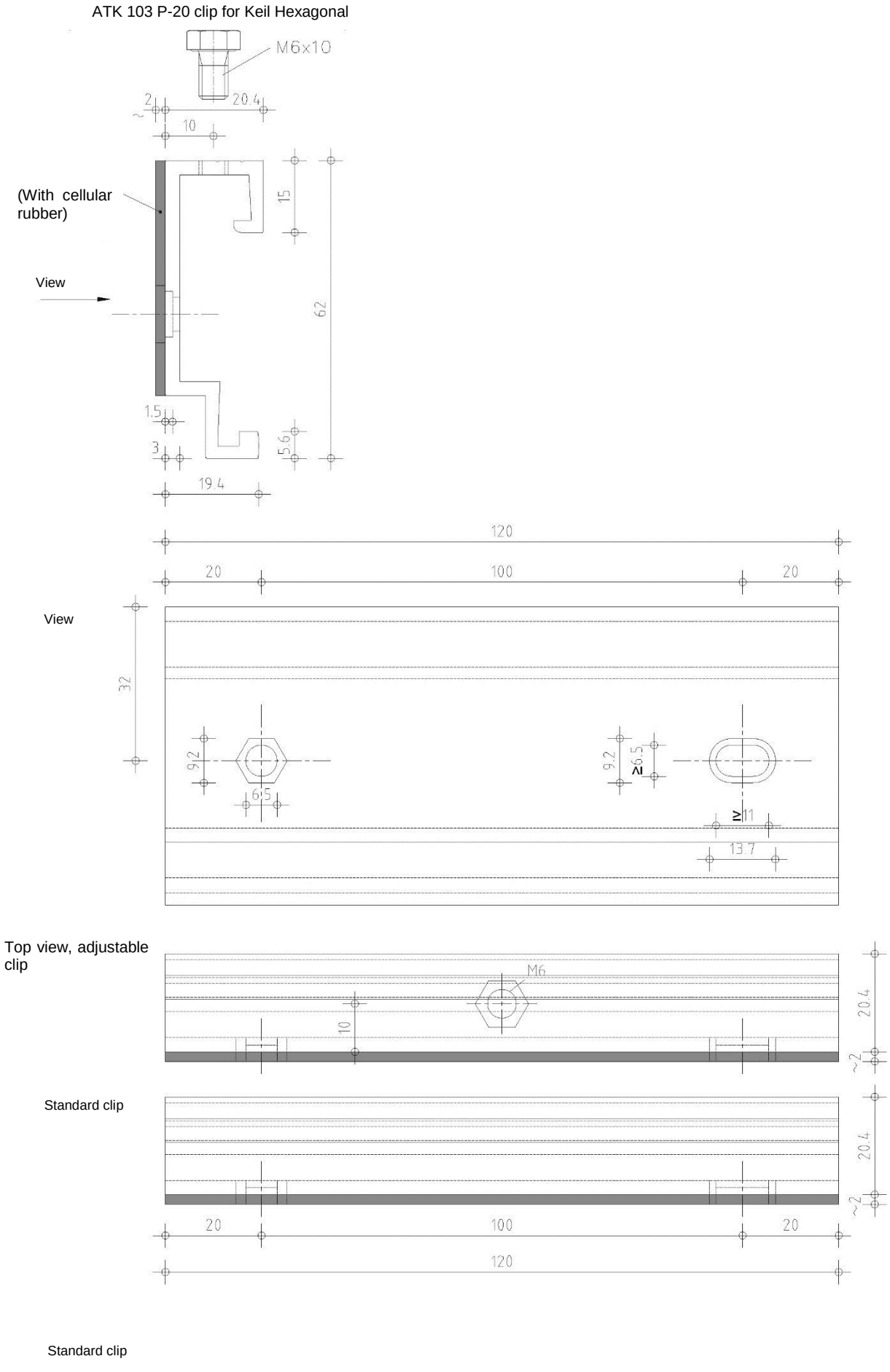
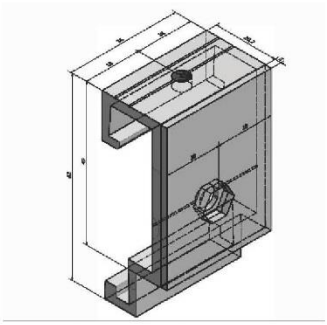
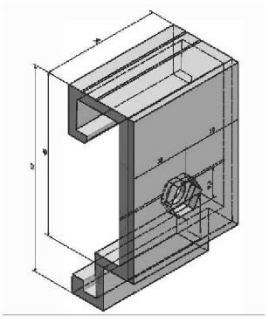


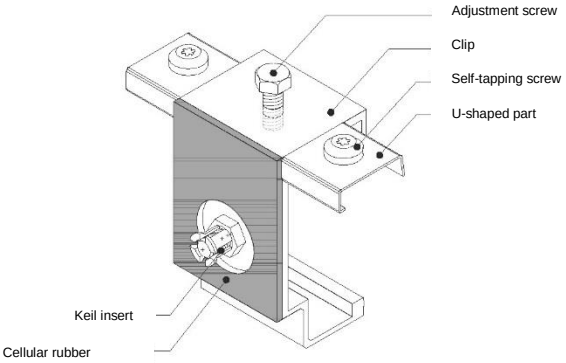
Figure 6b - Double clip



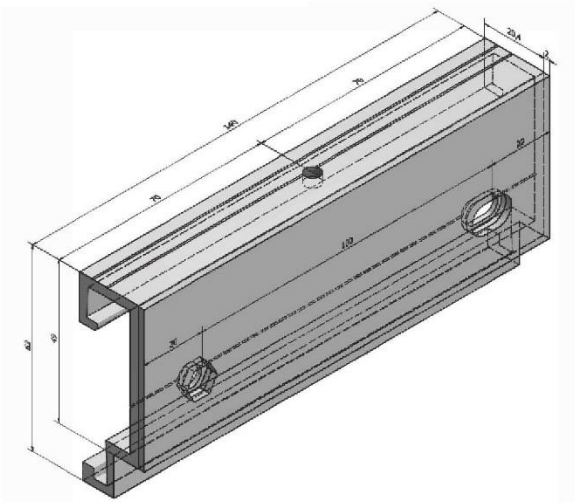
Single fixed and adjustment clip



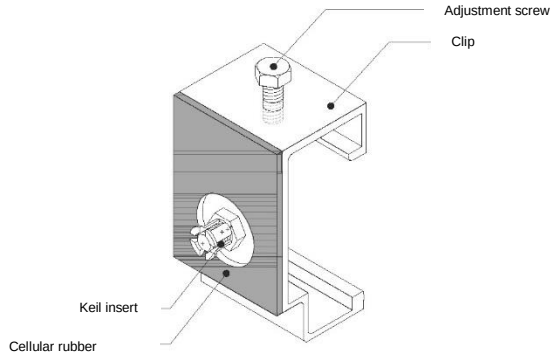
Single standard clip



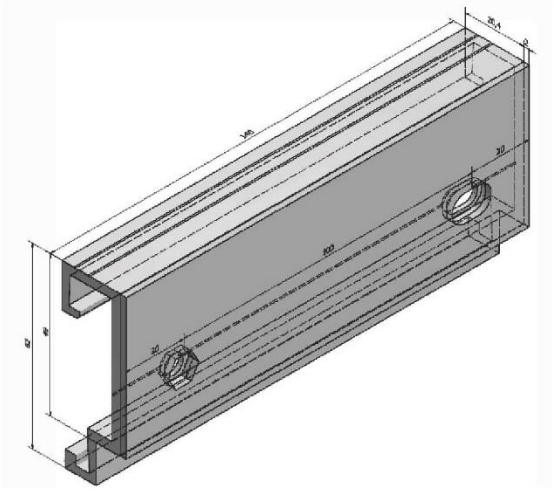
Installing the fixed clip



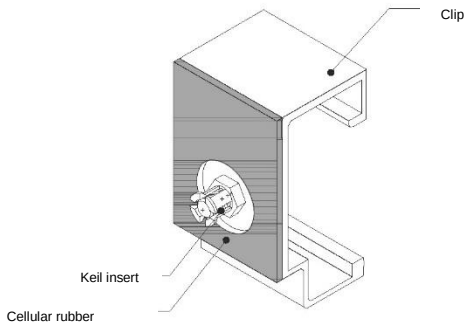
Double fixed and adjustment clip



Installing the adjustment clip



Double standard clip



Installing the standard clip

Figure 6c - 3D clips

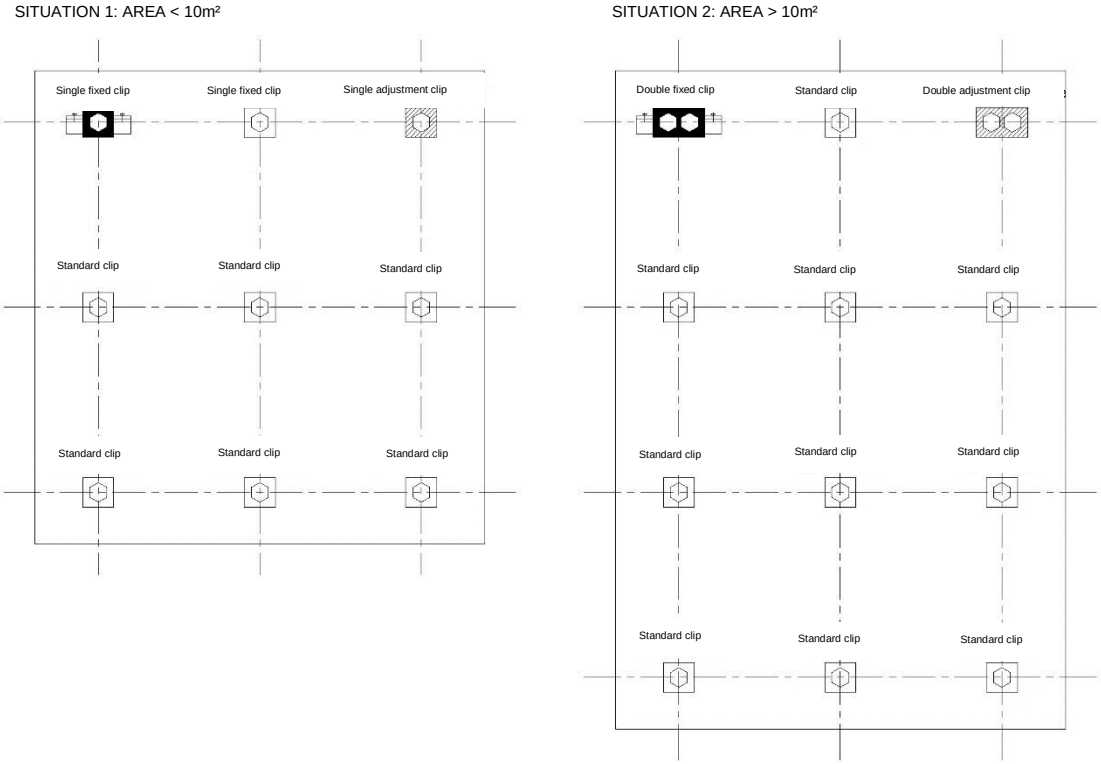
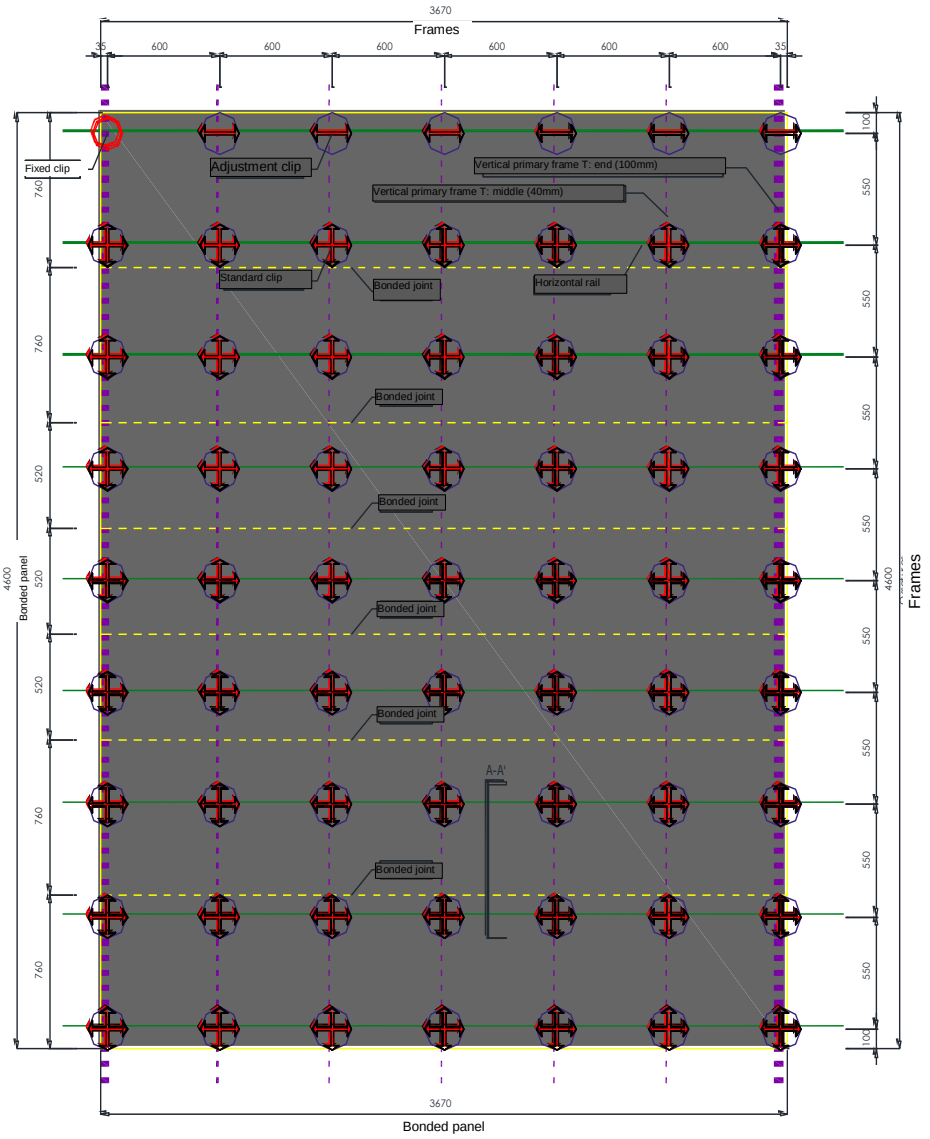


Figure 7 - Positioning clip types



Example of clip distribution on maximum panel (4600 H x 3670 W)

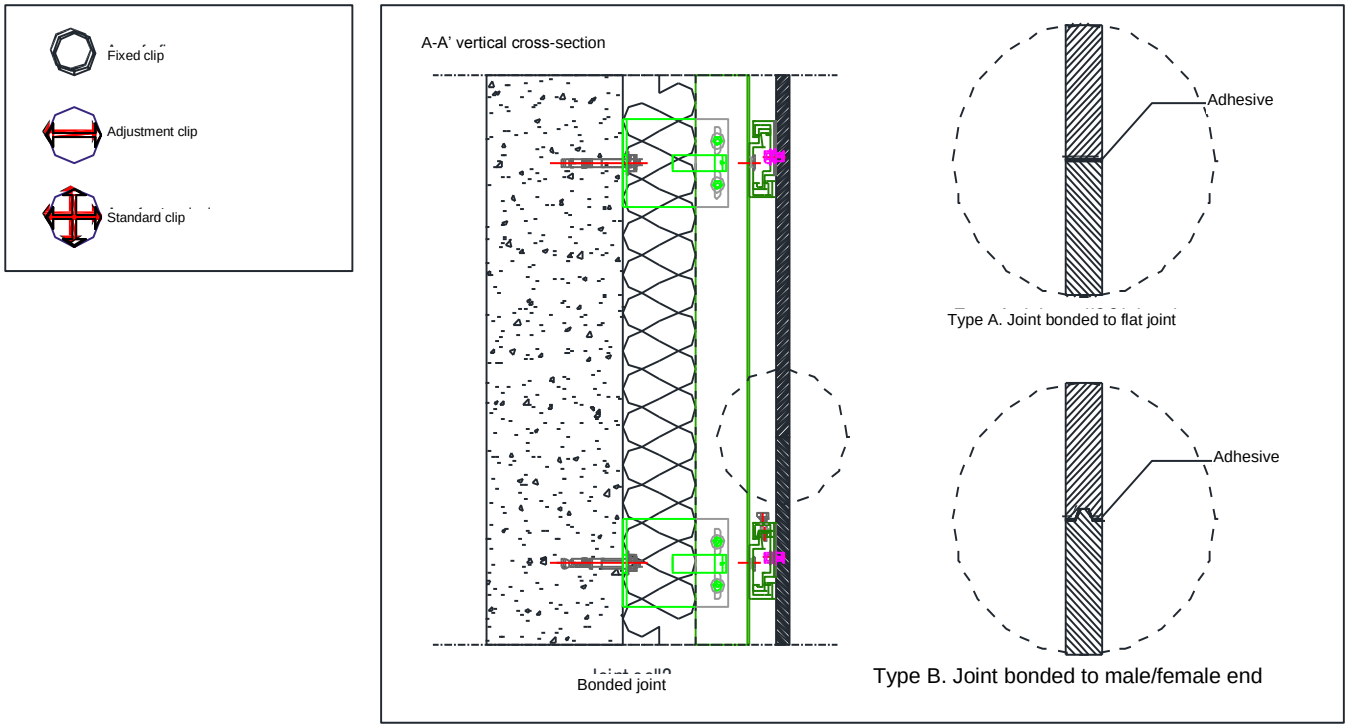


Figure 8 - Expansion recovery

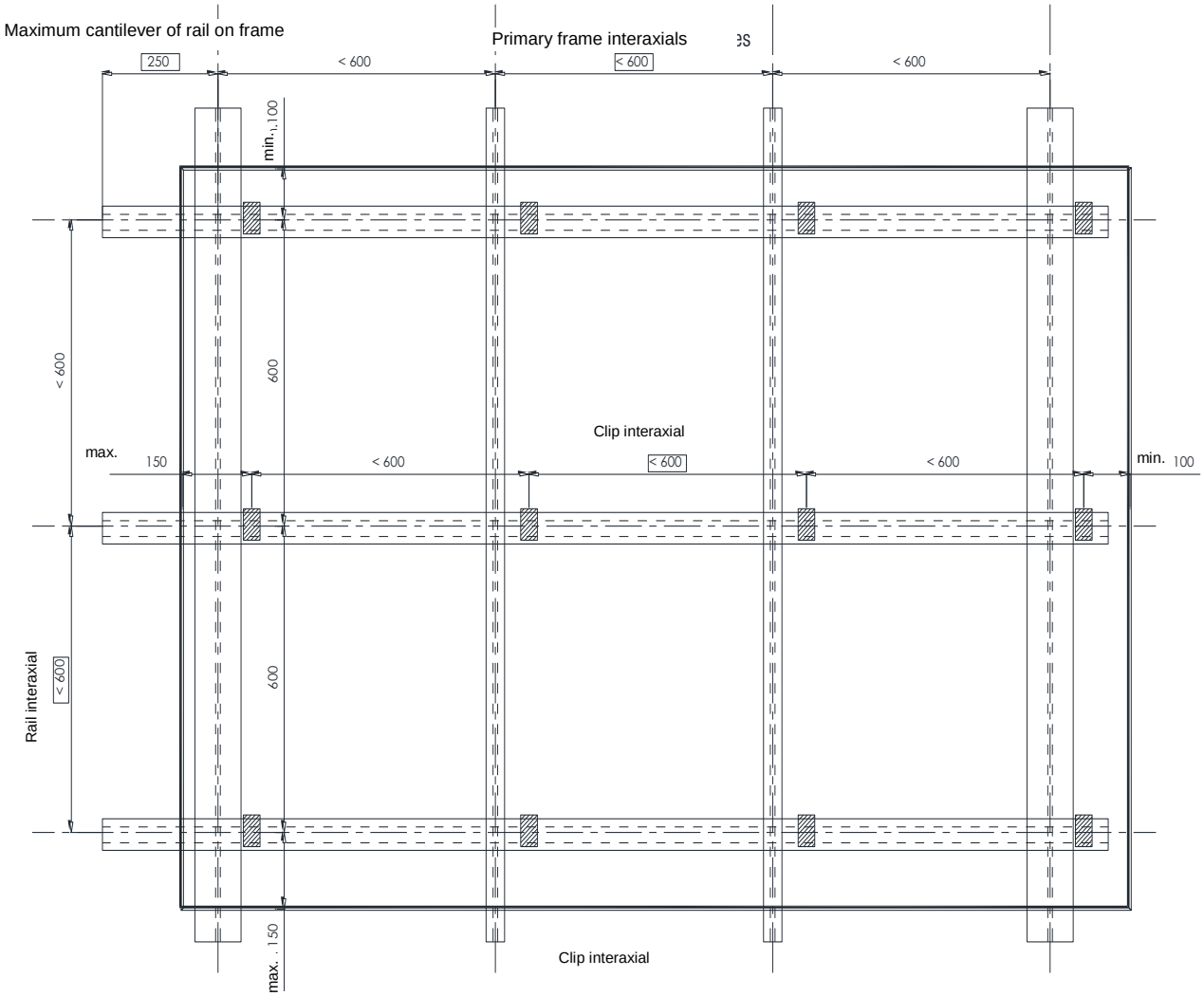
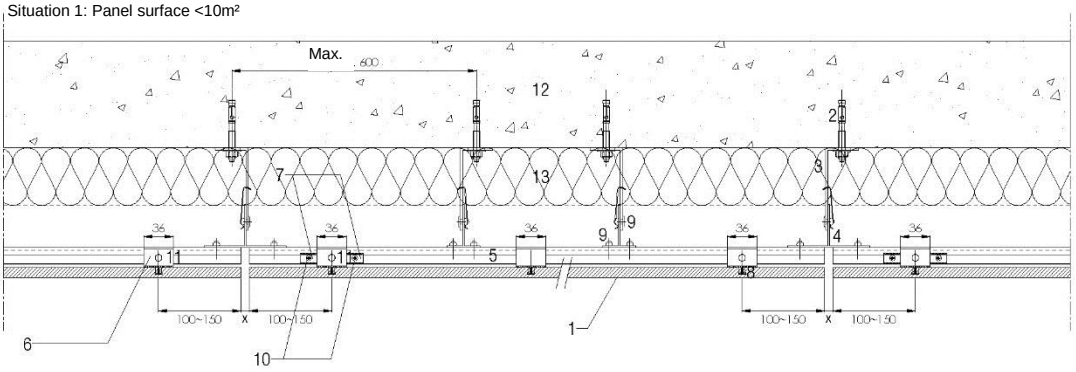
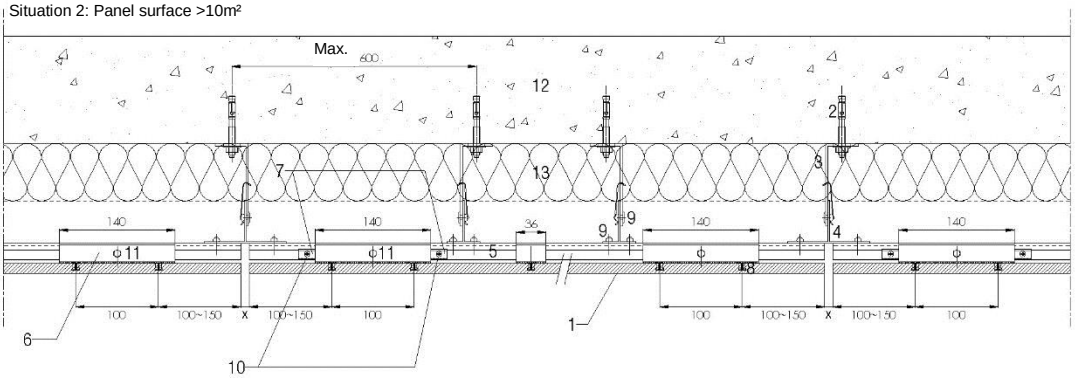


Figure 9 - Clip and frame interaxial distances

Situation 1: Panel surface <10m²

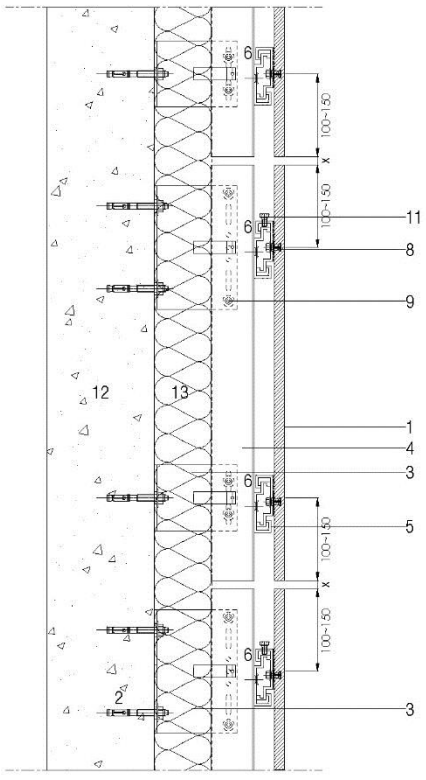


Situation 2: Panel surface >10m²



*NB: X = according to table in §9.5

Figure 10 - Horizontal cross-section of panel surface



*NB: X = according to table in §9.5

Figure 11 - Vertical cross-section

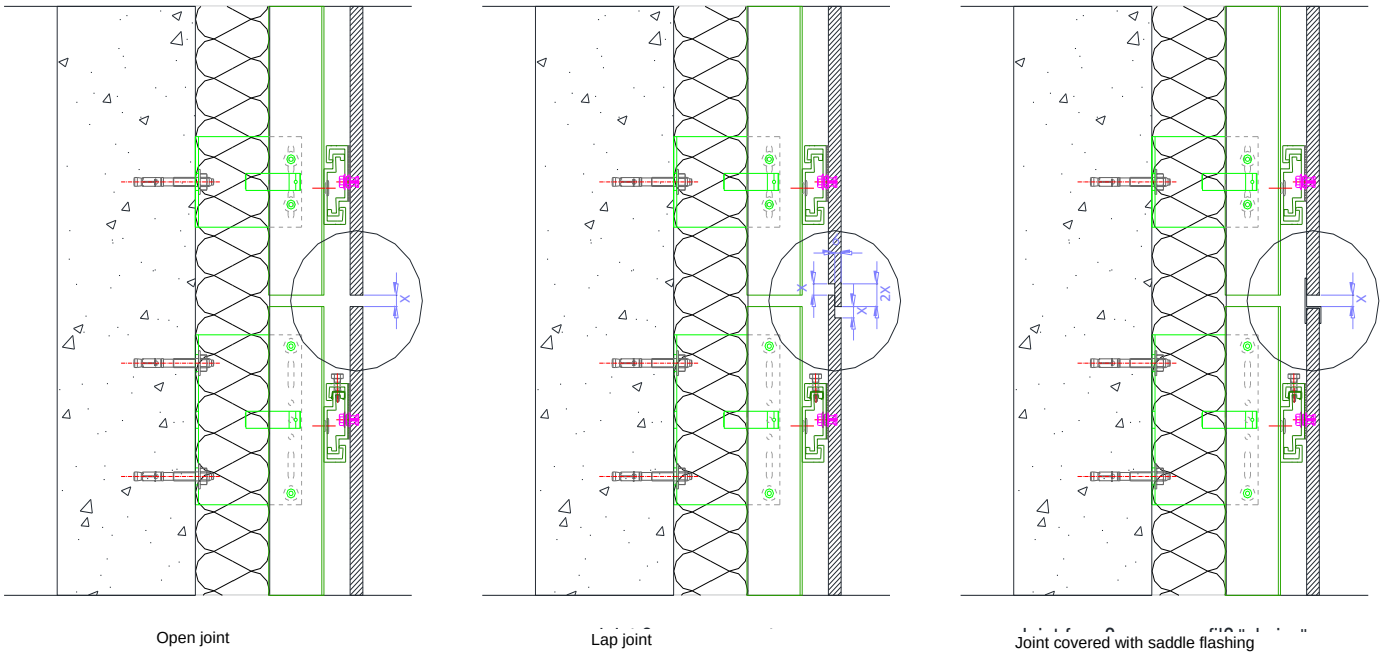


Figure 12 - Various treatments of horizontal and vertical joint

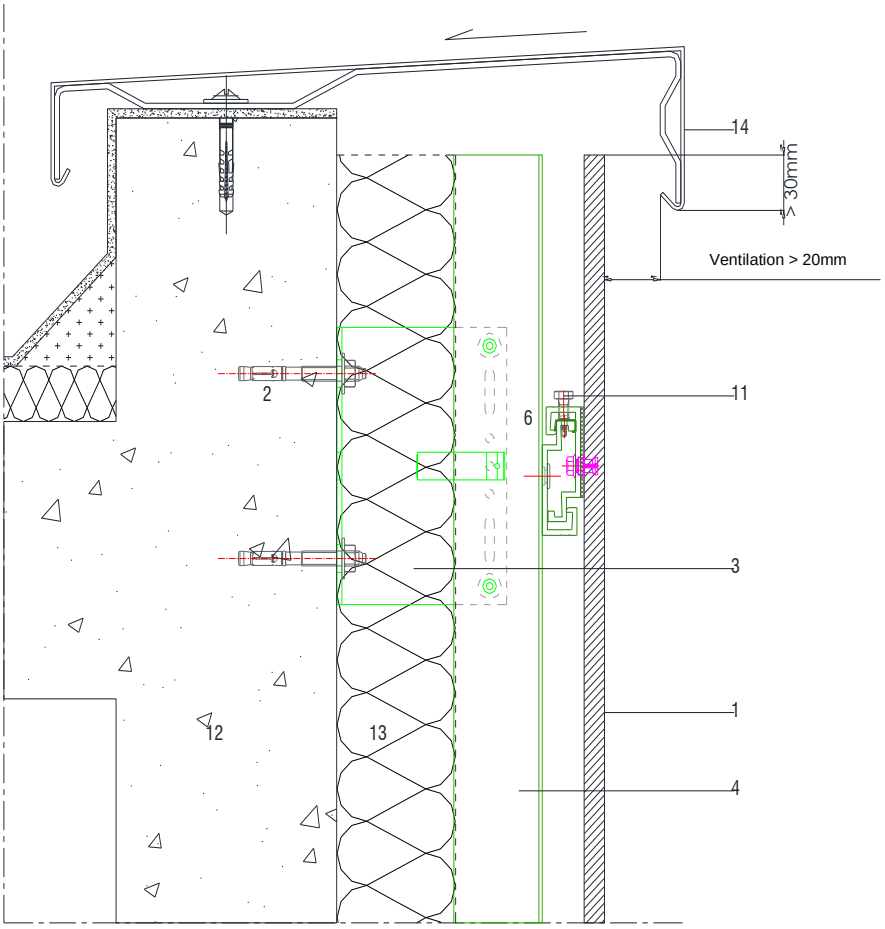


Figure 13 - Parapet cap

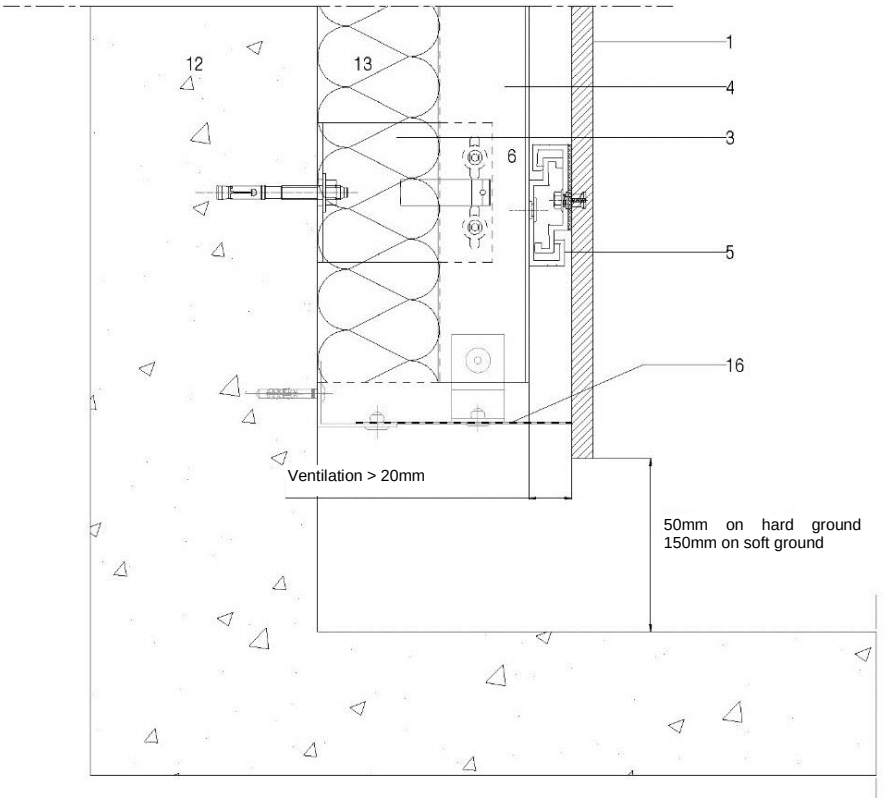


Figure 14 - Start of cladding

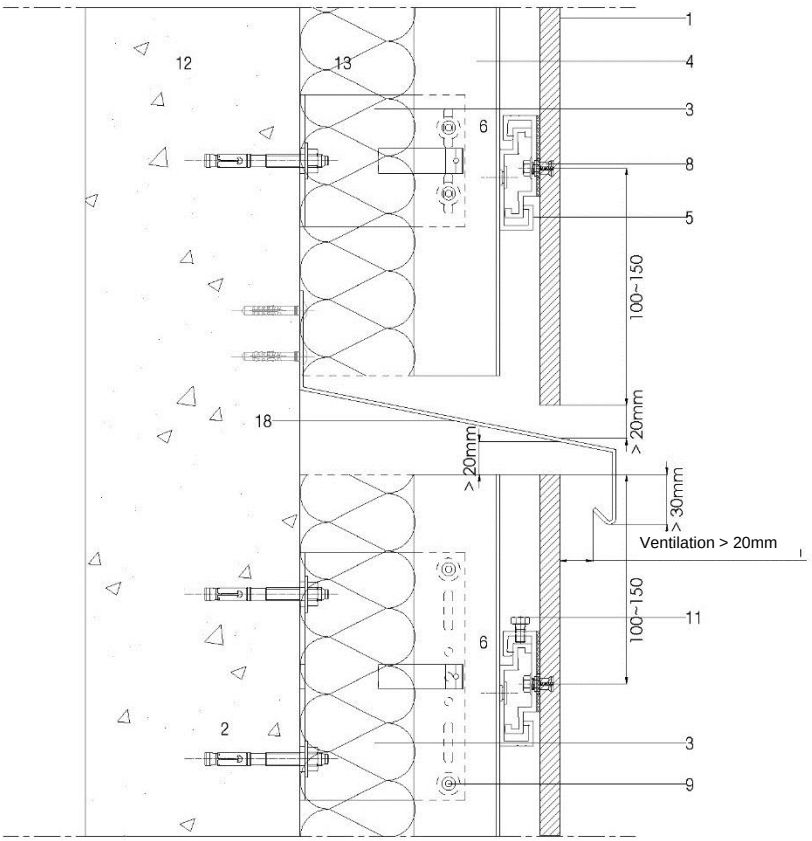


Figure 15 - Horizontal compartmentalisation of air gap

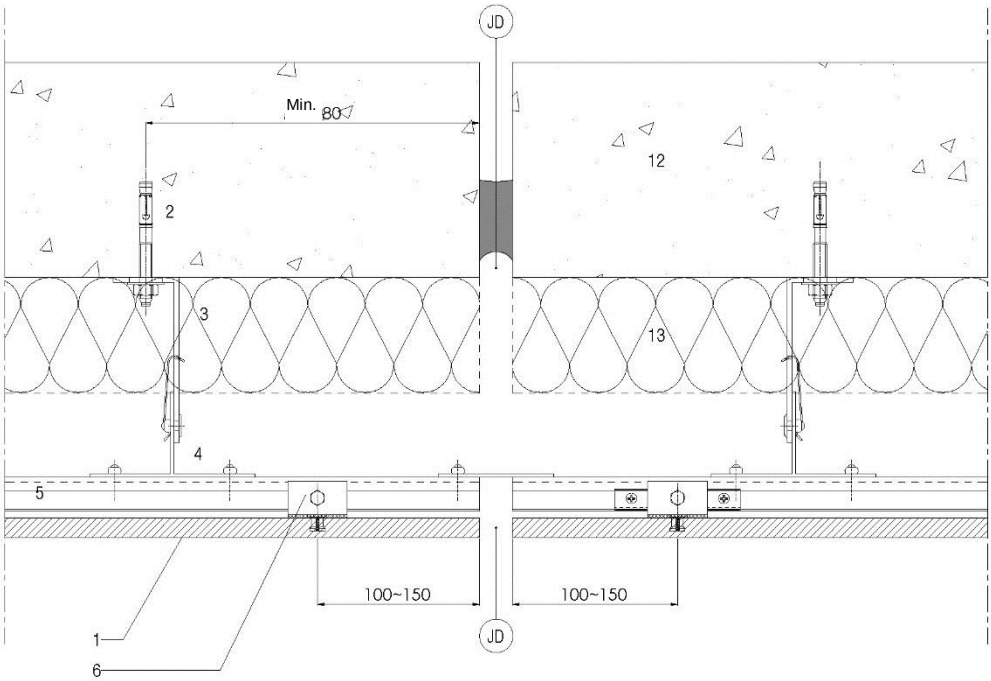


Figure 16 - Expansion joint

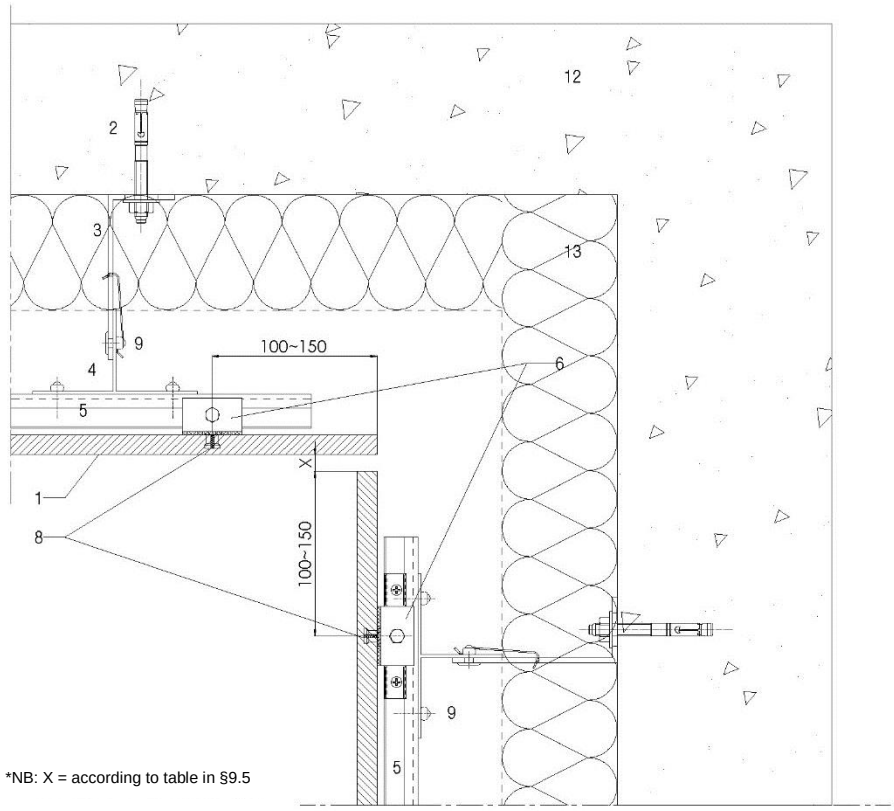


Figure 17 - Internal corner

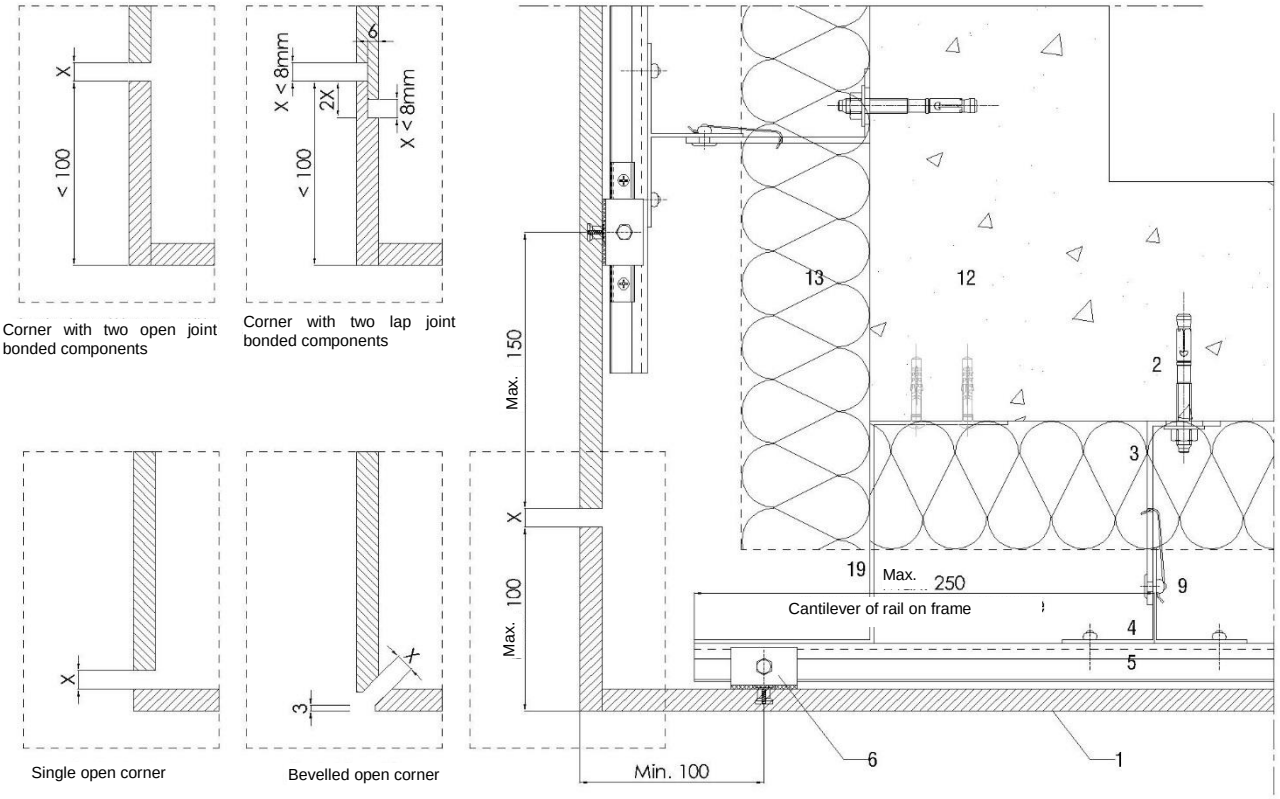


Figure 18 - External corner

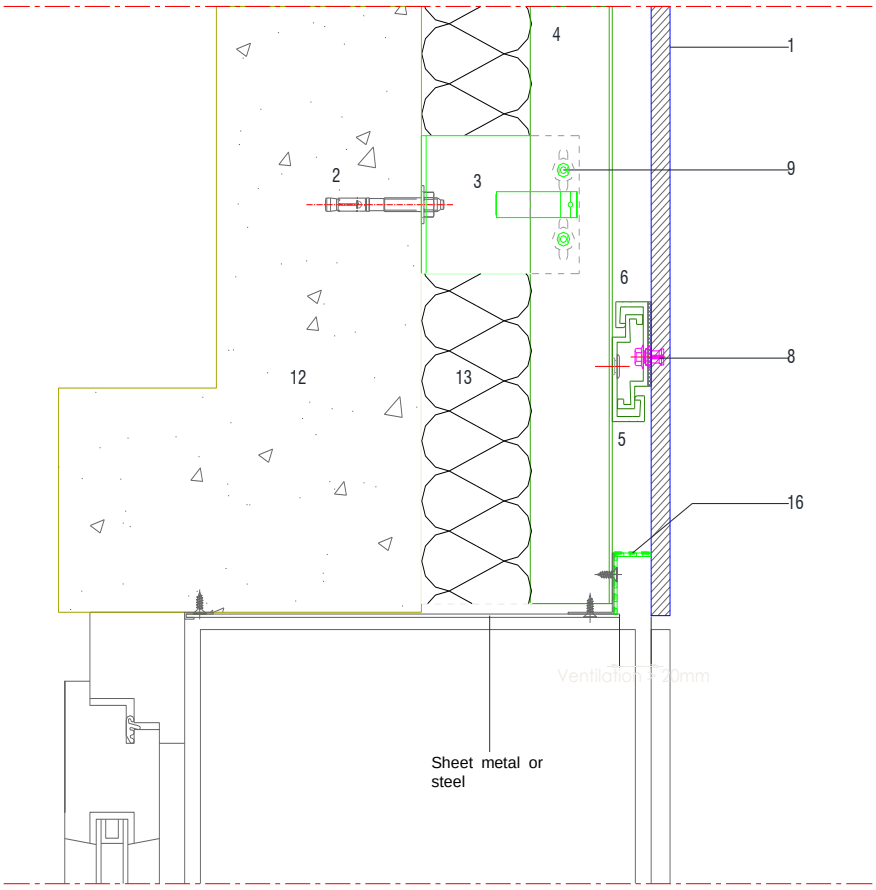


Figure 19 - Window lintel with sheet metal cladding

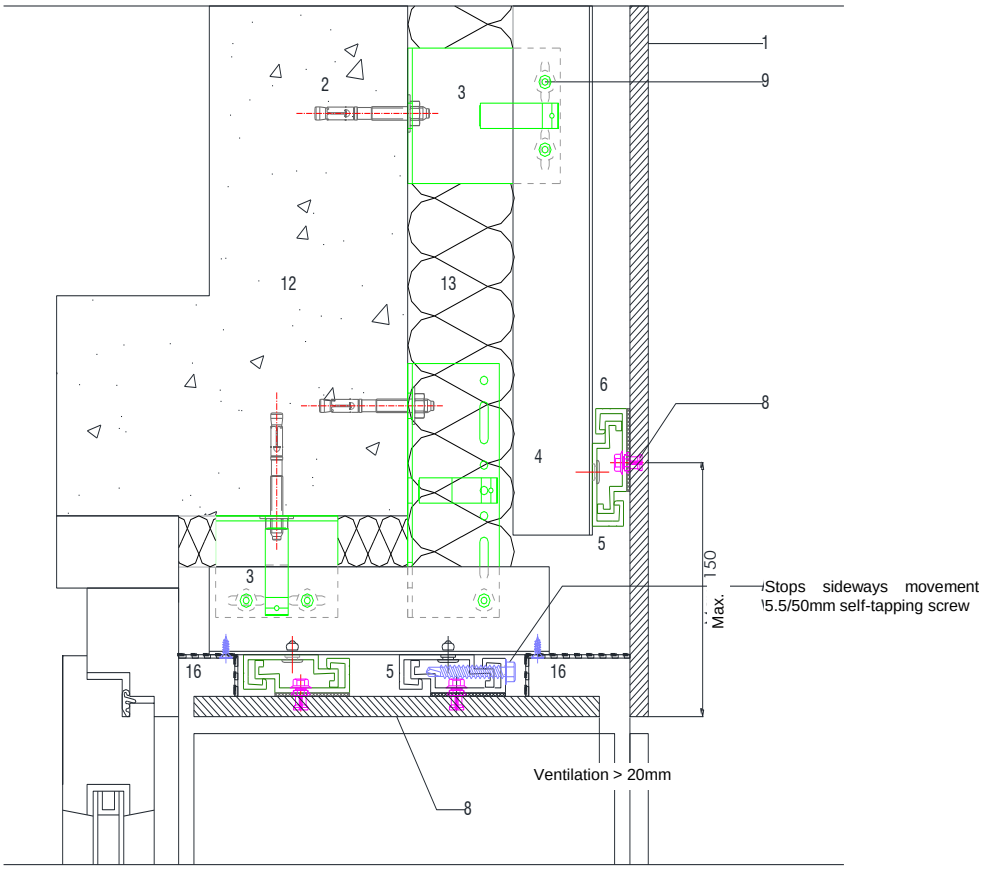


Figure 20 - Window lintel with HI-MACS® panel cladding

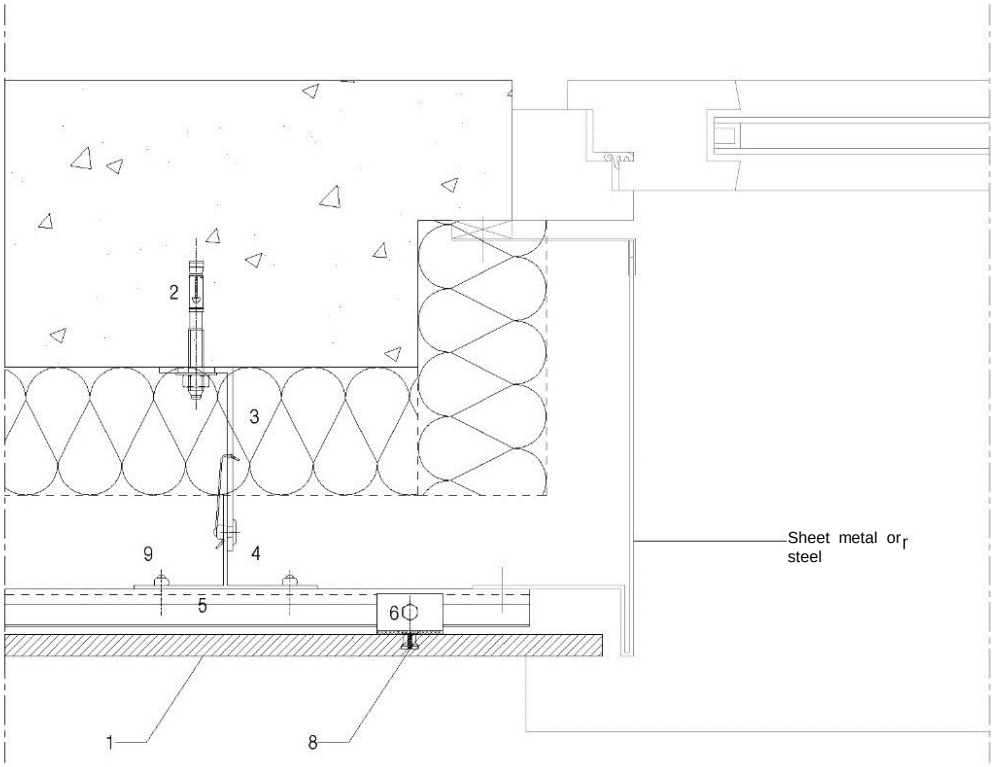
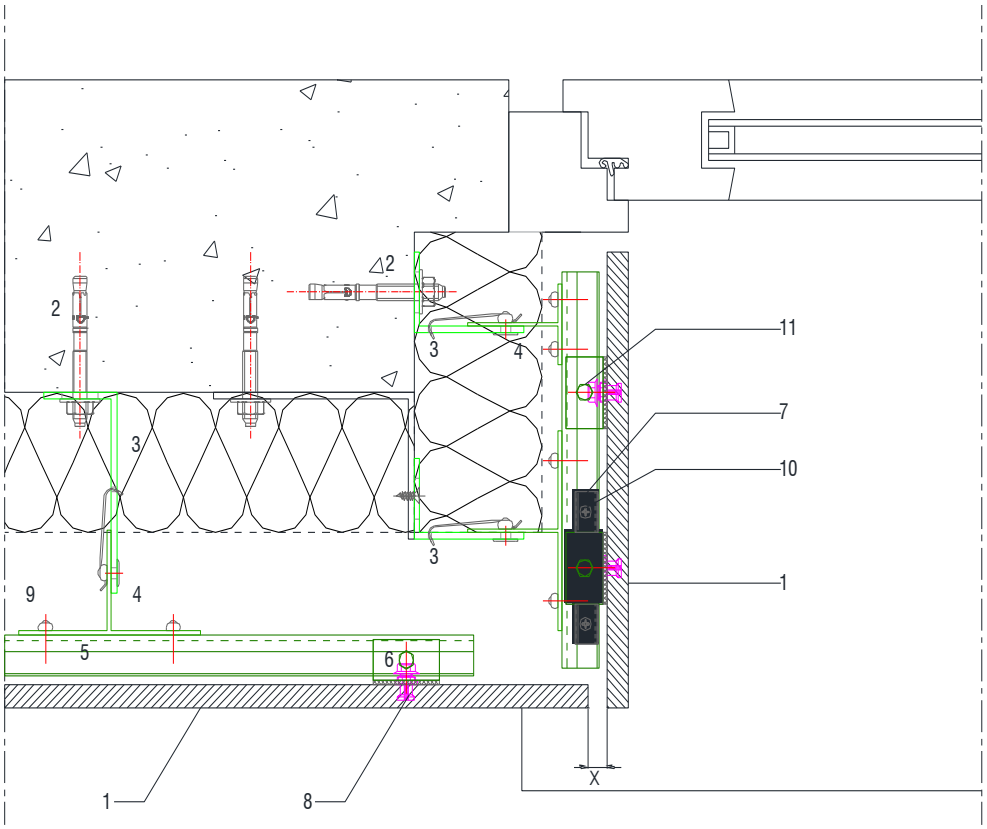


Figure 21 - Window board with sheet metal cladding



*NB: X = according to table in §9.5

Figure 22 - Window board with HI-MACS® panel cladding

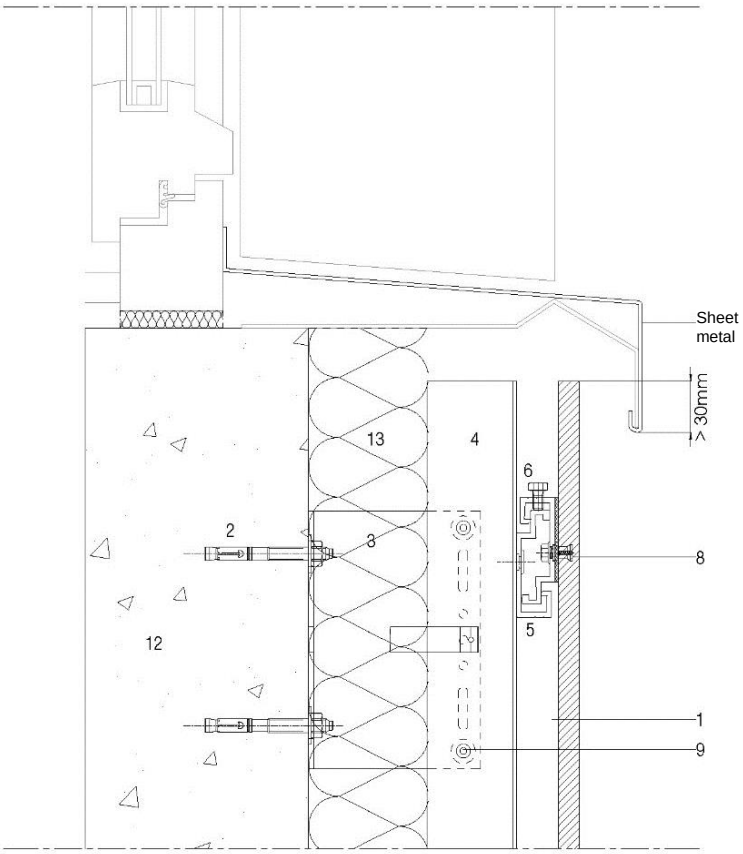
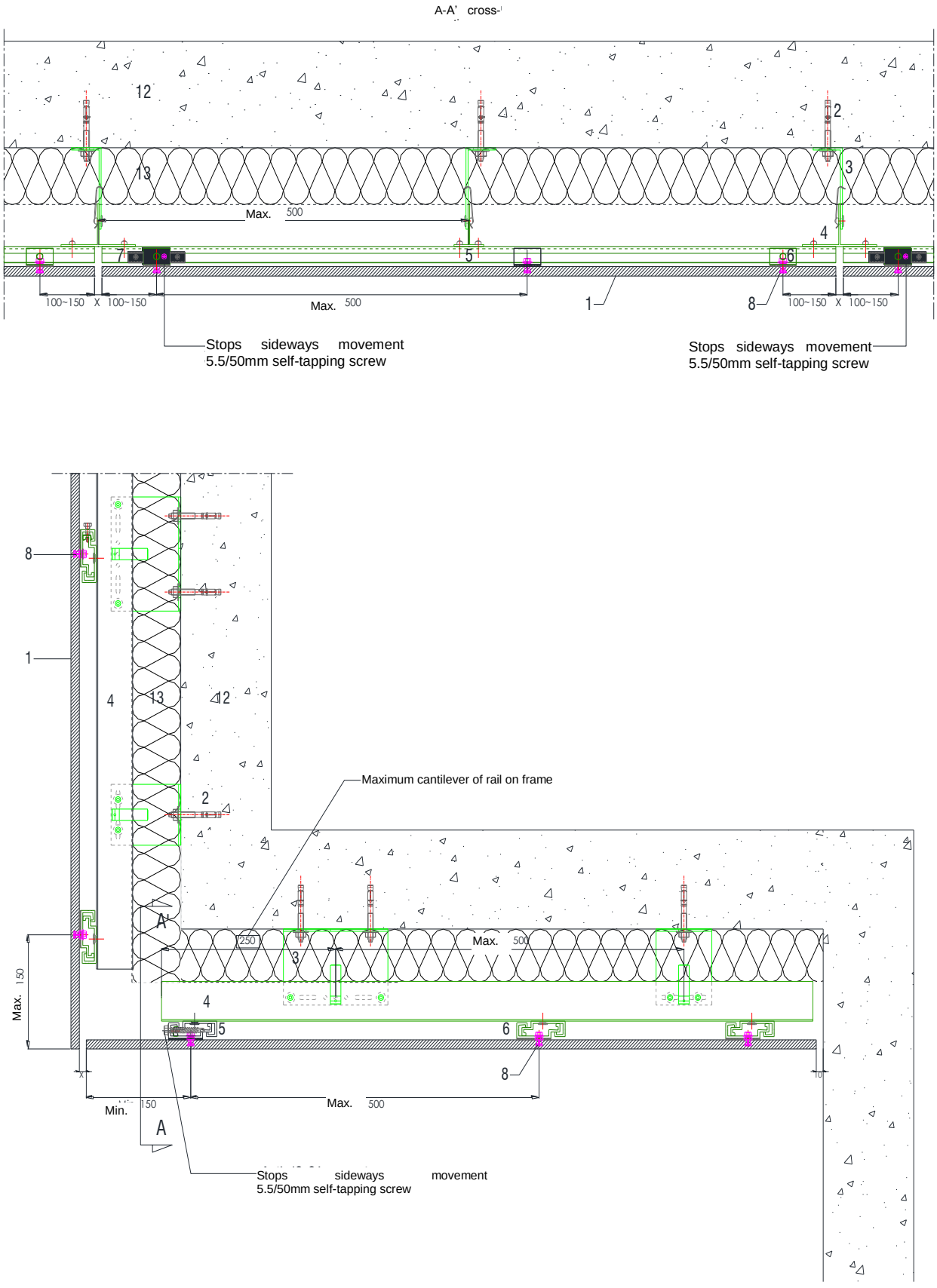
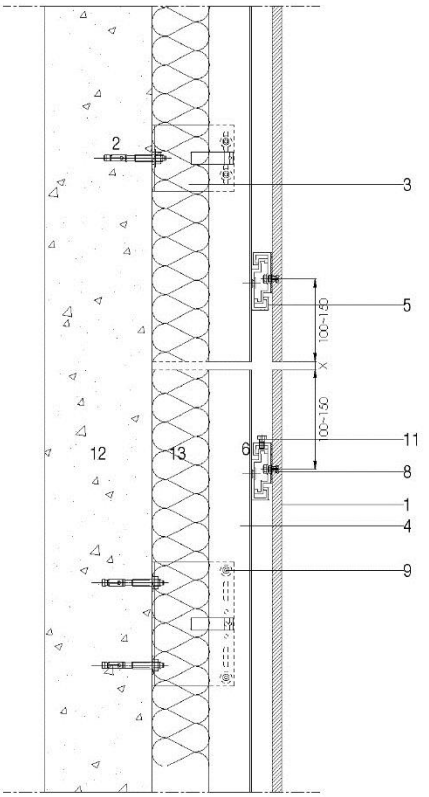


Figure 23 - Window support



*NB: X = according to table in §9.5

Figure 24 - Eaves cladding



*NB: X = according to table in §9.5

Figure 25 - Splitting the framework: Aluminium uprights of length ≤ 3 m

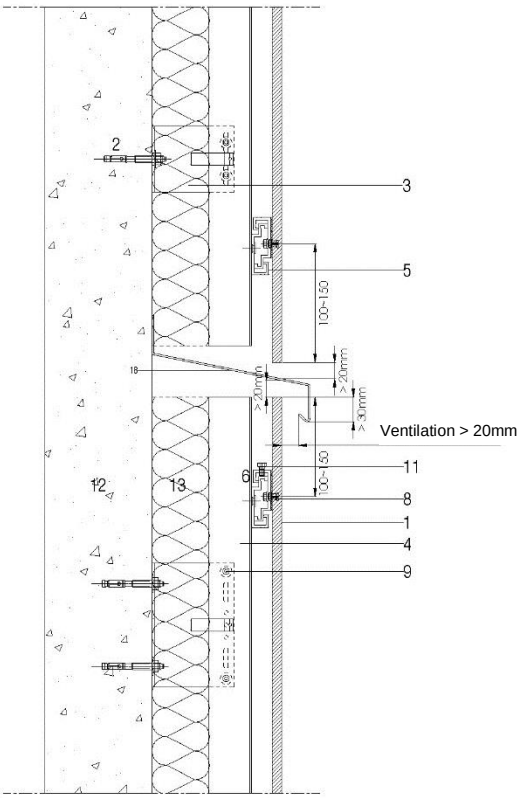
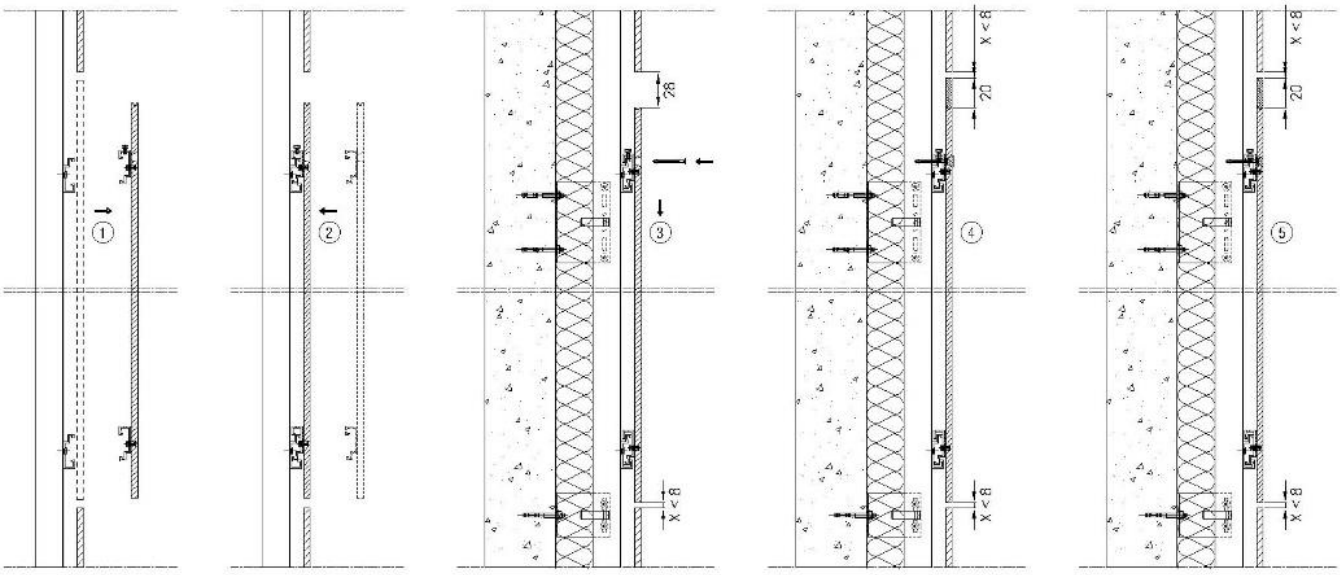


Figure 26 - Splitting the framework: Aluminium posts between 3m and 6m in length



Cut 2cm from the panel and remove the panel.

Push the replacement part until the clip rests against the rail.

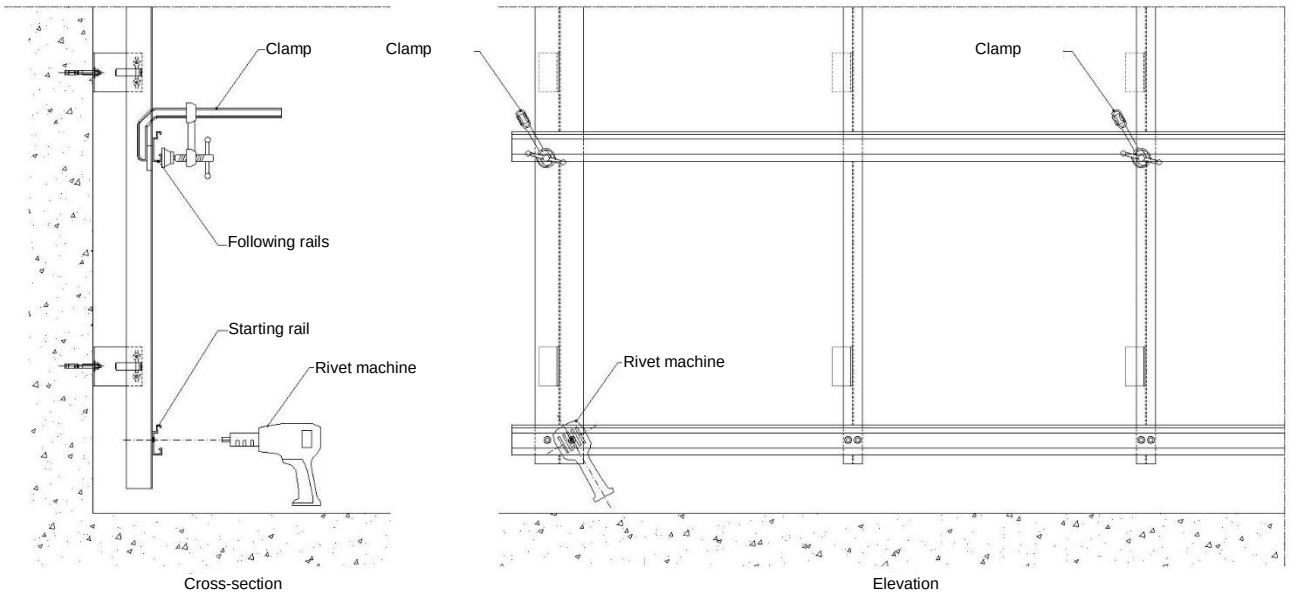
Lower the replacement part until the clip locks into the rail.

Bond the final strip and plug.

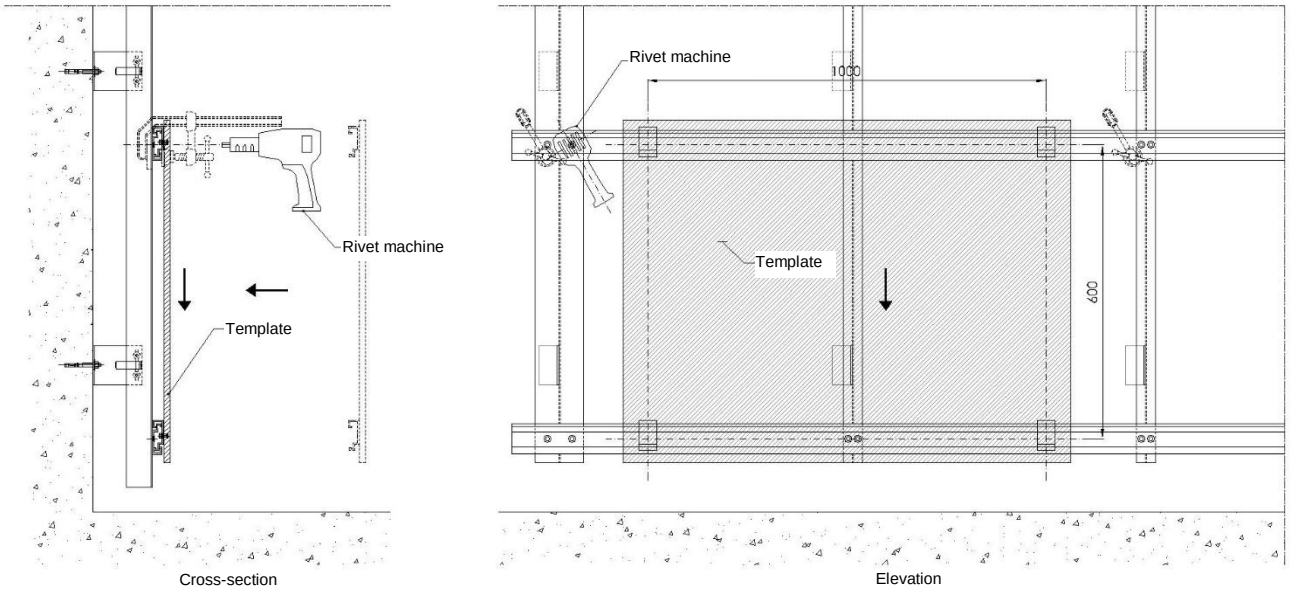
Sand the plug and final strip bonding.

*NB: X = according to table in §9.5

Figure 27 - Replacing a component



① Install the level starting rail permanently with rivets. Install the following rails by temporarily using the clamps.



② Lock the template on the starting rail and following rails. Check the position of the following rails. Adjust if required.
Install the level starting rail permanently with rivets.

Figure 28 – Template