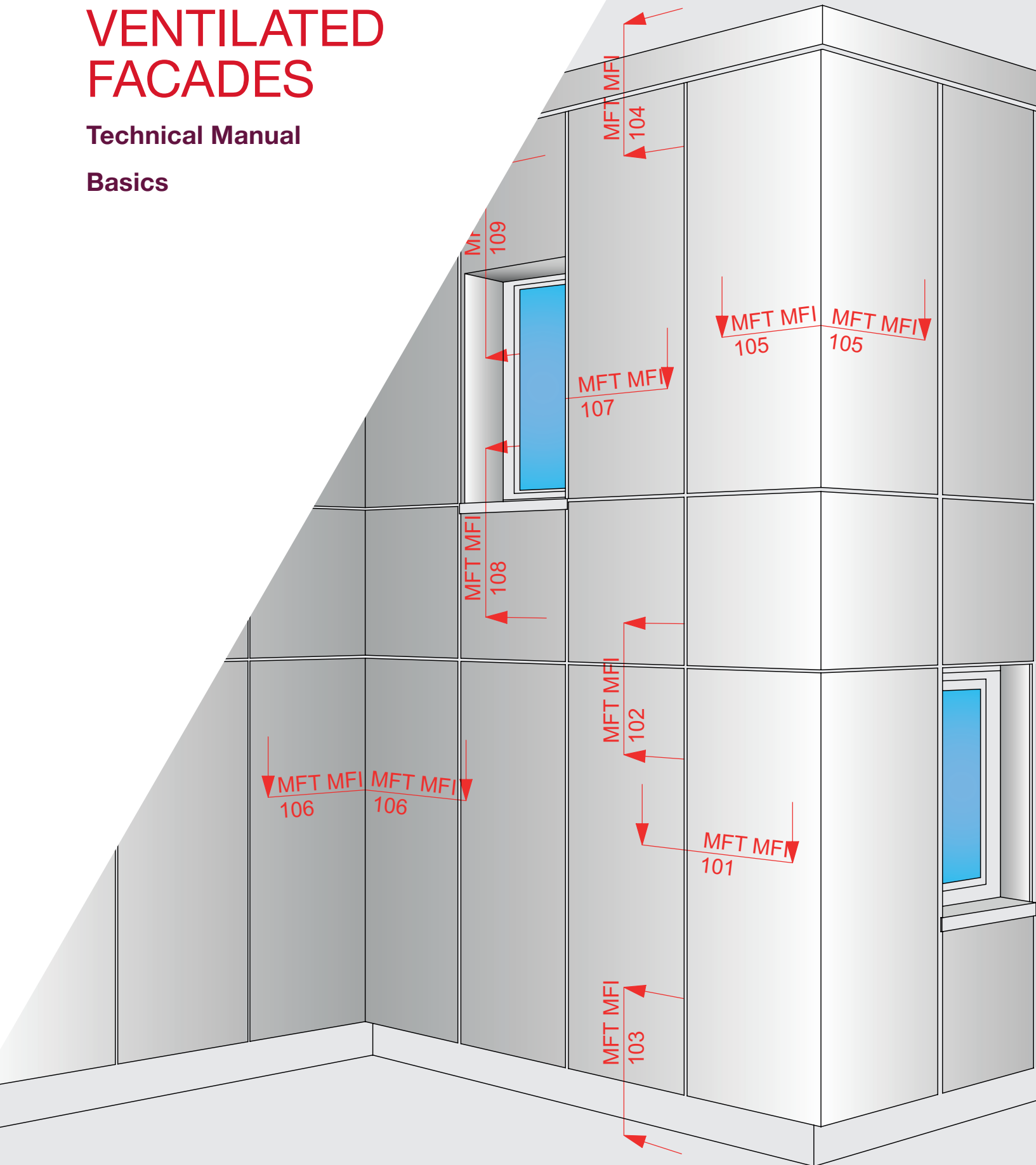




VENTILATED FACADES

Technical Manual

Basics



CONTENTS AND OVERVIEW OF BASICS

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OVERVIEW

Rain screens/ventilated facades

The need to adhere to ecological and cost-efficiency specifications is becoming an increasingly important part of the planning and construction of buildings. Energy savings, energy efficiency (up to and including so-called passive houses), costs and attractive appearance are important criteria about which decisions have to be made. Facade structures must fulfil high demands in terms of long-term requirements such as protection from the elements, thermal insulation, durability and low maintenance, design elements, fire protection, soundproofing as well as ecological requirements. The decision to incorporate a rain screen/ventilated facade in the design of the building makes it possible to take all of these aspects into account in the optimal way.

A conservative approach to the use of natural resources and the comfort and well-being of the building's occupants as well as the reduction of long-term cost factors (e.g. building costs, service life, maintenance costs) are further advantages of rain screens/ventilated facades. Moreover, when it comes to appearance and design considerations, rain screens/ventilated facades open up a multitude of possibilities. Energy generation systems (solar thermal and photovoltaic) can also be incorporated in the design. In terms of building physics and from a technical as well as cost efficiency point of view, a rain screen/ventilated facade provides the optimum solution for the outer skin of a building, not only in new construction but also in renovation projects.

The main advantages of rain screens/ventilated facades

- Lasting protection from the elements provided by the cladding
- High functionality in terms of building physics – thermal insulation stays permanently dry thanks to ventilation
- High energy efficiency through use of insulating materials suitable for rain screens/ventilated facades plus innovative substructures make it possible to achieve almost any desired U-value
- Simple solutions comprising adjustable substructures for use on uneven, difficult supporting surfaces
- A comfortable indoor climate thanks to a vapor diffusion coefficient that decreases from inside towards the outside
- Cooling effect in summer thanks to the temperature barrier effect of the ventilation cavity – excess heat is dissipated through this cavity
- Thermal insulation in winter thanks to the increased heat transition resistance of the ventilation cavity
- Sustainable method of construction thanks to long life, low maintenance and separate layers (easy demolition and recycling)
- Reliable fire protection through the corresponding choice of system components and building materials classes
- Soundproofing: the high noise absorption characteristics of mineral wool insulation in conjunction with thick cladding is capable of achieving a high noise reduction factor
- Lightning protection: metal substructures and cladding can serve as a natural lightning conductor, or can be connected to separate lightning conductor systems

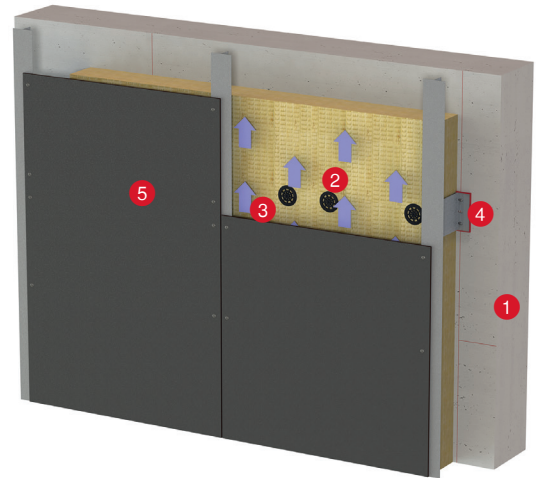
OVERVIEW

A ventilated facade is an outside wall cladding application in which the ventilation zone behind the cladding material is in contact with the atmosphere.

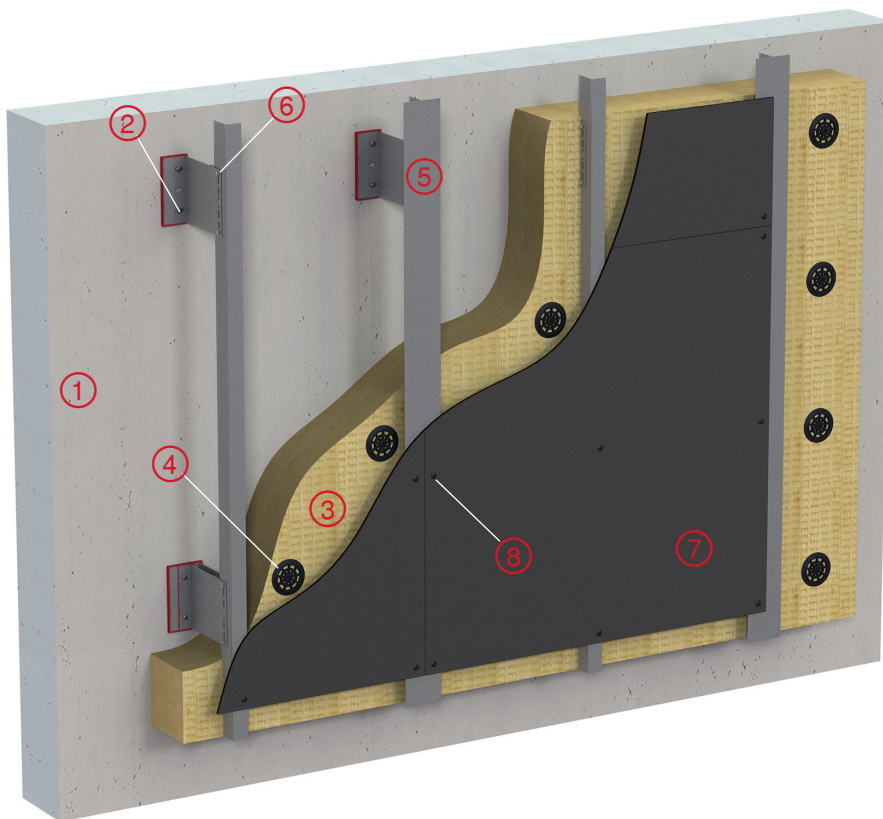
- A ventilated facade is a multi-layered system, which can guarantee long term functionality; combining functional, economical and aesthetic properties; it insulates and protects the primary structure from weather exposure.
- It fulfills all necessary requirements in terms of building physics and static design.

A ventilated facade comprises 5 main parts:

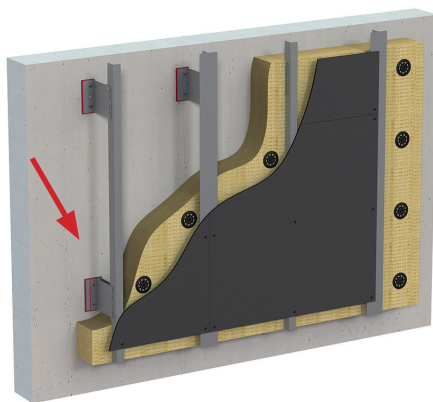
- ① Base material
- ② Insulation with fasteners
- ③ Ventilation gap
- ④ Substructure
- ⑤ Facade panel/cladding material



Schematic structure of a ventilated facade



- ① Base material
- ② Bracket fastener
- ③ Insulation
- ④ Insulation fastener
- ⑤ Bracket/profile
- ⑥ Profile fastener
- ⑦ Cladding material
- ⑧ Cladding fastener

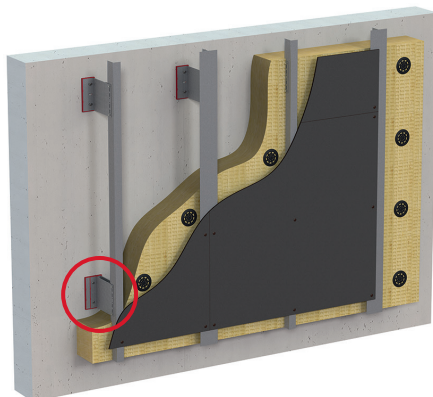


BASE MATERIALS

Surfaces to which the facade can be anchored may consist of standardized materials (e.g. concrete, brick, steel, timber, etc.) or non-standardized materials. Surface layers such as rendering, coatings or facings do not count as load-bearing materials.

The following are suitable base materials:

- Concrete in accordance with EN 206
- Bricks in accordance with EN 771
- Sand-lime block in accordance with EN 771
- Aerated concrete in accordance with EN 771
- Timber in accordance with EN 14081
- Composite lumber in accordance with EN 14080
- Steel frame structures in accordance with EN 1090
- Existing/unclassified masonry (load-bearing capacity must be verified by pull-out tests)
- Sandwich components (e.g. metal, concrete or lightweight concrete) may be considered suitable only after verification



BRACKET FASTENERS

Bracket fasteners are used to anchor substructures to load-bearing base materials.

The bracket fasteners must comply with national and/or European regulations or approval requirements and must also meet the manufacturer's installation specifications. The applicable approval must cover the application for which these items are used, i.e. suitability for the demands of rain screen/ventilated facade installation. Where applicable, corrosion protection measures must also be implemented and the compatibility of materials taken into account.

The load-bearing capacity of the bracket fastener must also be verified by carrying out on-the-spot pull-out tests in accordance with, e.g. ETAG 020 Annex B, ETAG 029 Annex B or an equivalent test method.

The most common bracket fastening methods are:

- Anchor fastening on brick and concrete
- Screw fastening on timber or steel
- Direct fastening on concrete

Anchoring on concrete and brick

Mechanical or chemical anchors can be used.

Concrete



Frame anchors



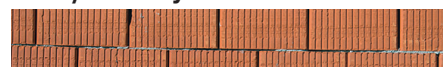
Expansion and screw anchors



Chemical anchors



Brick/masonry



Frame anchors



Chemical anchors



BRACKET FASTENERS

Screw fastening on timber or steel

Before the right screw for fastening brackets can be selected, the properties of the material, i.e. the thickness of the timber or steel must be known.

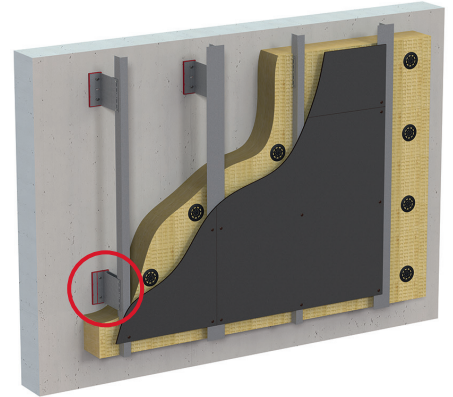


Wood:

S-MD 51 S 5.5x50

Steel:

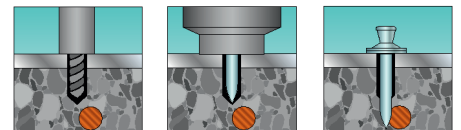
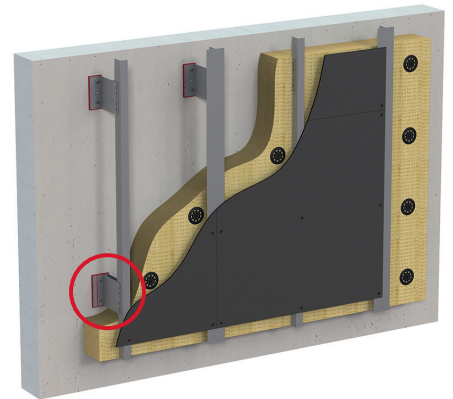
- Thickness 1.25–4 mm: S-MD 51 LS/LSS 5.5xL
- Thickness 2–6 mm: S-MD 53 LS/LSS 5.5xL
- Thickness 4.60–12 mm: S-MD 55 LS/LSS 5.5xL

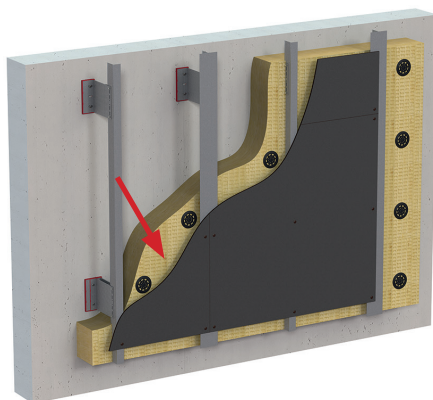


BRACKET FASTENING

Direct fastening on concrete

With the direct fastening technique, a powder-actuated fastening tool is used to drive a nail into a pre-drilled 5 mm hole. The pre-drilled hole serves to guide the nail and ensures extremely high load levels. As the hole is drilled to a depth of only 23 mm, no reinforcing bars are hit during drilling.





INSULATION

A layer of thermal insulation between the supporting surface and the ventilation cavity. Depending on the type of insulating material used, it may also fulfil fire protection and soundproofing requirements.

Thermal insulation for rain screen/ventilated facades must consist of an insulating material of a type suitable for the intended purpose (exterior wall insulation behind cladding).

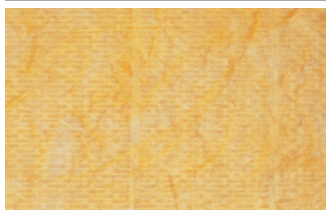
The insulation must meet the following requirements:

- Able to retain its shape
- Able to retain its dimensions
- Completely hydrophobized and non-vapor retardant (as necessary)
- Non-flammable (as necessary)

The following types of facade insulation can be used, for example:

- Mineral wool
- Foam glass
- Rigid foam sheet
- Wood fiber board

Mineral wool



Foam glass



Rigid foam sheet



Wood fiber board



- Insulation sheets must be tightly butted together and fitted in a “brickwork” pattern. This is particularly important at the corners of the building.
- The thermal insulation must be snugly fitted around the points where the substructure penetrates the insulating material.
- Where water spray is to be expected, moisture-resistant insulating material must be used.
- As a basic rule, national regulations and installation instructions issued by the manufacturer must be observed.

INSULATION FASTENERS

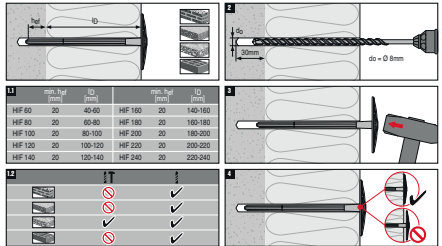
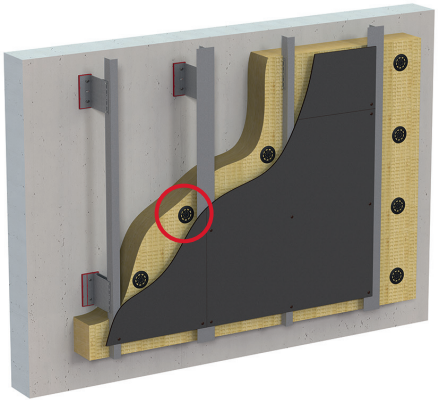
The insulation sheets must be fitted without gaps and reliably, permanently secured (depending on the type of substructure, anchors, adhesive, clamps, screws or mechanical pressure may be used). The wind loads to be expected, also during construction, must be taken into account. Excessive compression of the insulating material at the fastening points should be avoided.

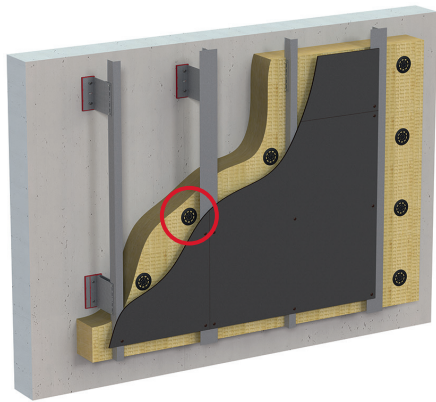
Hilti offers a range of insulation fasteners:

- **Insulation fastener with direct fastening (X-IE)**
- **Insulation fastener (HIF)**
- Insulation fastener with expansion pin (IZ)
- Fire-resistant metal insulation fastener (IDMR/IDMS)
- Insulation fastener for thermal optimized fastening (S-ID + S-IP)
- Insulation fastener for fire resistant fastening (S-ID + S-IW)

Characteristics X-IE	
Base material	Concrete
Insulation thickness	60 – 200 mm
Load capacity	High
Washer diameter	90 mm
Insulation material	Mineral wool, EPS
Necessary accessories	DX 460 and cartridge 6.8/11

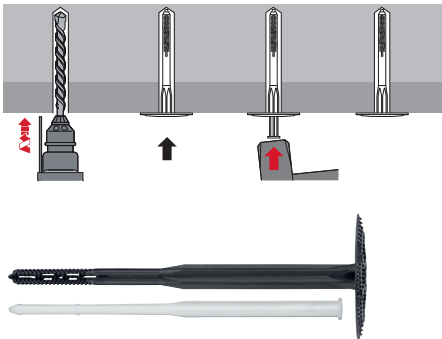
Characteristics HIF	
Base material	Concrete, aerated concrete, brick
Insulation thickness	60 – 240 mm
Load capacity	Medium
Washer diameter	90 mm
Insulation material	Mineral wool, EPS
Necessary accessories	Hammer



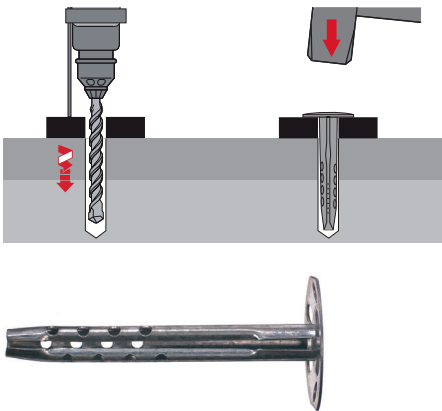


INSULATION FASTENERS

- Direct fastening (X-IE)
- Insulation fastener (HIF)
- **Insulation fastener with expansion pin (IZ)**
- **Fire-resistant metal insulation fastener (IDMR/IDMS)**
- Insulation fastener for thermal optimized fastening (S-ID + S-IP)
- Insulation fastener for fire resistant fastening (S-ID + S-IW)



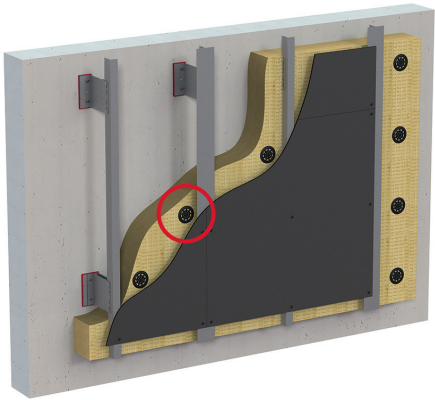
Characteristics IZ	
Base material	Concrete, aerated concrete, brick
Insulation thickness	30 – 210 mm
Load capacity	Medium-high
Washer diameter	90 mm
Insulation material	Mineral wool, EPS
Necessary accessories	Hammer



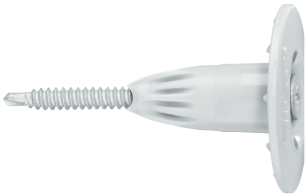
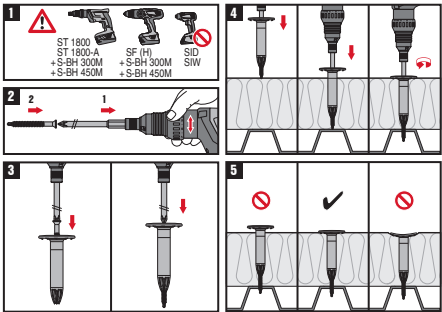
Characteristics IDMR/IDMS	
Base material	Concrete
Insulation thickness	60 – 240 mm
Load capacity	Medium
Washer diameter	90 mm
Insulation material	Mineral wool, EPS
Necessary accessories	Hammer

INSULATION FASTENERS

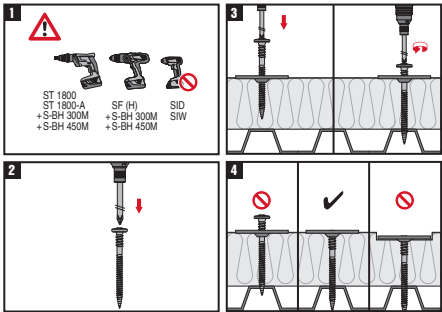
- Direct fastening (X-IE)
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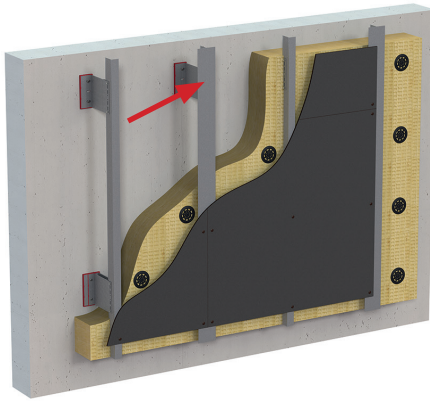


Characteristics S-ID + S-IP (thermal optimized fastening)	
Base material	Steel profile 1.2–3.0 mm, sheathing boards, timber OSB/3
Insulation thickness	40–240 mm
Load capacity	Medium/high
Insulation material	Mineral wool, rigid foam panels
Necessary accessories	Cordless drills/screwdrivers, driver bit



Characteristics S-ID + S-IW (fire resistant fastening)	
Base material	Steel profile 1.2–3.0 mm, sheathing boards, timber OSB/3
Insulation thickness	40–240 mm
Load capacity	High
Insulation material	Mineral wool, rigid foam panels
Necessary accessories	Cordless drills/screwdrivers, driver bit

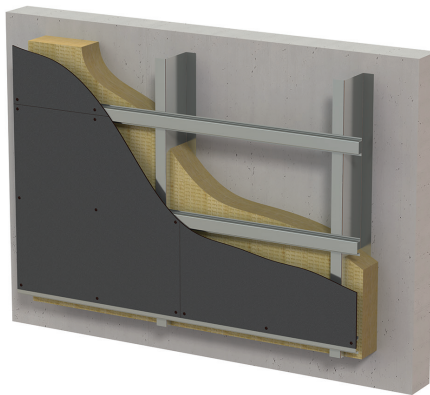




BRACKETS/PROFILES

The substructure is the static connecting link between the load-bearing outer wall and the facade cladding. It generally consists of wall brackets and load-bearing metal profiles (e.g. brackets with sliding and fixed points and load-bearing profiles made from aluminum, hot-dip galvanized steel or stainless steel) and/or timber (e.g. lathing or cross lathing, load-bearing lathing, wood materials) or glass-fiber reinforced plastics.

The substructure must be designed, planned and installed in accordance with type of supporting wall material, the static requirements of the building physics and the requirements in terms of durability.



Metal substructures

Metal substructures may be manufactured from the following:

- Corrosion-resistant steel in accordance with EN 10088 (e.g. 1.4401, 1.4404, 1.4571)
- Aluminum alloys as per EN 573, EN 755 und EN 485 (z.B. EN AW 6063 T66)
- Combinations of metal and fiber-reinforced plastics
- Batch galvanized steel as per ISO 1461 or hot-dip galvanized steel as per EN 10346 (e.g. S350 GD) with corrosion protection as per EN 10169 where necessary

Substructure components are generally as follows:

- Wall brackets, stand-off bolts or rod systems
- Thermal separators/isolators (depending on the application)
- Anchoring components
- Load-bearing profiles (L-, T-, Z-, Ω -profiles or similar)
- Fasteners
- Accessory items (e.g. hooks or U-bolts, clamps, system parts, etc.)

BRACKETS/PROFILES

Timber substructures

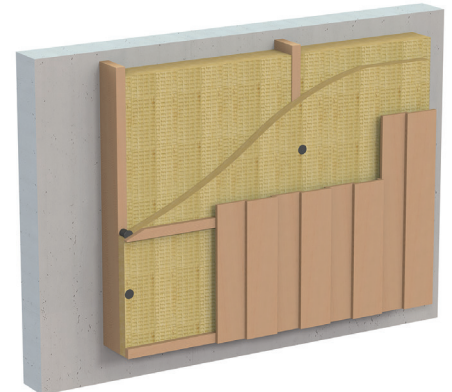
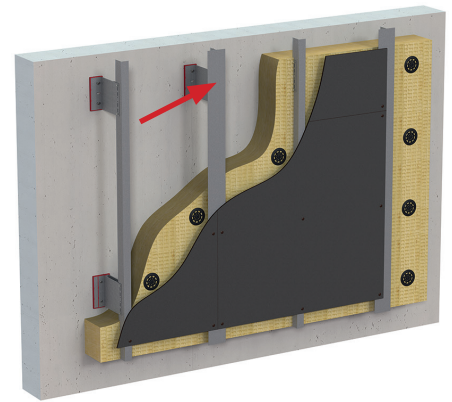
Seasoned timber or laminated wood parts are to be used for the substructure. The applicable national regulations regarding wood preservation must be observed.

When timber substructures are used, compensation for unevenness of the wall surface or use of thick insulating materials is possible only to a certain extent.

Substructure components are generally as follows:

- Lathing (cross lathing)
- Anchors
- Load-bearing lathing
- Cladding/wood materials
- Fasteners

When cladding with exposed joints is to be installed, vertical load-bearing lathing with joint tapes or joint profiles with sealing lips or antipillary profiles are preferable (e.g. EPDM fluted tapes); simple, unprofiled sheet metal strips are generally unsuitable. Joint tapes or profiles positioned behind the cladding must be fixed to prevent slipping. It is recommended that horizontal profiles be interrupted at the joints in the cladding sections. Vertical profiles can be uninterrupted.



BRACKETS/PROFILES

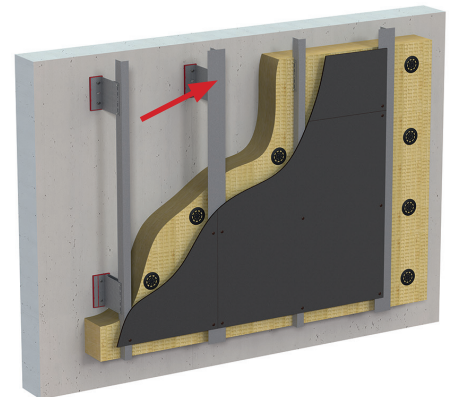
Composite substructures

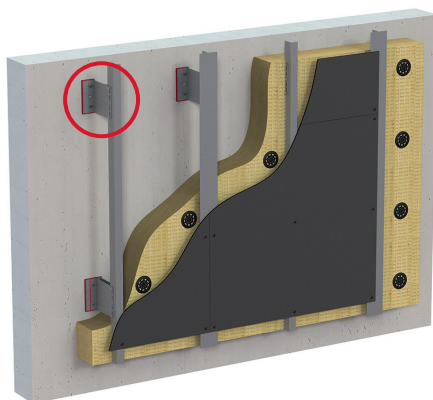
Composite substructures are a combination of metal, fiber-reinforced plastics and/or wood.

The substructure may consist of the following components:

- Brackets made from metal or fiber-reinforced plastics or combinations of these materials
- Stand-off bolts or distance pieces
- Thermal separators/isolators
- Anchor components
- Load-bearing profiles (L-, T-, Z-, Ω-profiles, or similar)
- Fasteners
- Load-bearing lathing
- Cladding/wood materials

During installation, the regulations or building codes applicable to metal as well as wood must be observed.





PROFILE FASTENERS

Fasteners are the components that connect or anchor the various parts of the substructure mechanically.

The fasteners must comply with national and/or European regulations or approval requirements as well as the manufacturer's specifications. The intended purpose and applicable approval must cover rain screen/ventilated facade applications. In addition, corrosion protection measures must be implemented and attention must be paid to the compatibility of materials with each other.

Fasteners may be of the following types:

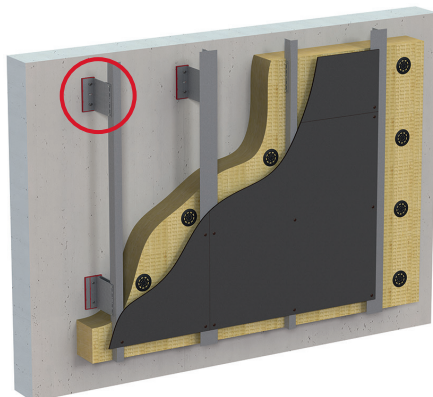
For metal substructures:

Screws (e. g. S-AD) or rivets

For timber substructures:

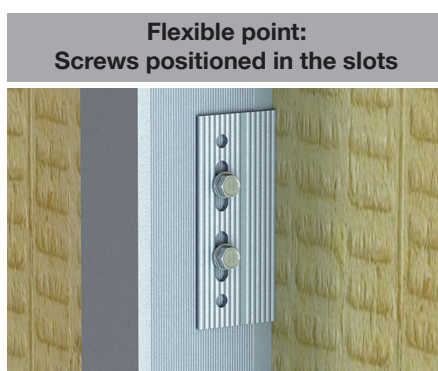
Screws

or combinations of these may be used.

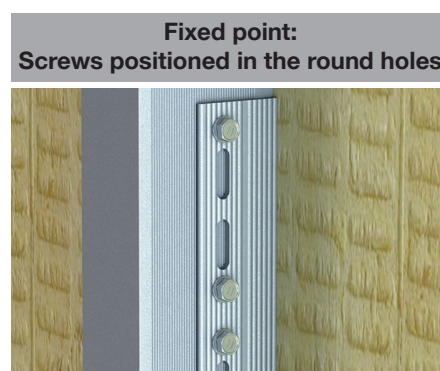


VERTICAL PROFILE FASTENERS

- The connection between the profile and the bracket is made with self-drilling screws (stainless A2 or A4), using fixed or flexible points.
- The fixed point takes the weight of the cladding material and substructure and the proportional wind load.
- The flexible points allow temperature expansion of the profiles and bear the proportional wind loads.
- Special screws (e.g. S-AD 01 S/SS 5.5 x L) are needed for this application (geometry and thread).



- Flexible point (sliding point): The screws must be positioned in the slots.
- The flexible points allow expansion of the profiles ($\approx 2 \text{ mm}$ per linear meter for $\Delta T = 80\text{K}$).

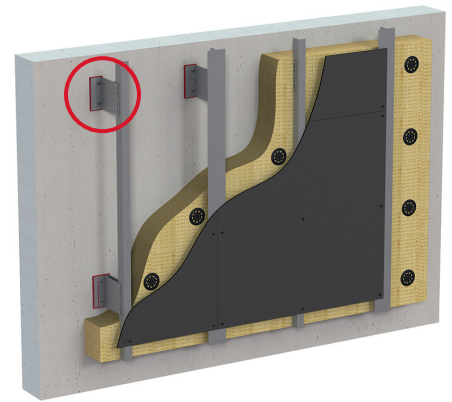


- Fixed point: The screws must be positioned in the round holes to avoid vertical movement. This allows the bracket to carry the dead load of the panel/cladding material and the horizontal wind loads.

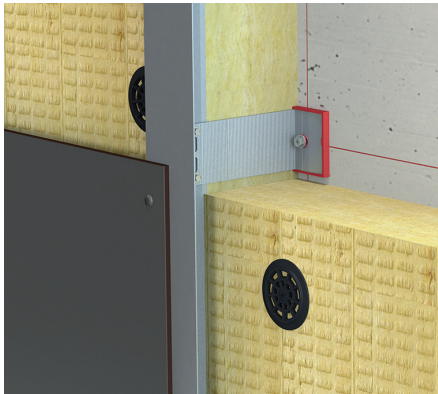
VERTICAL PROFILE FASTENERS

Hilti offers two vertical systems:

- 1-layer system
- 2-layer system

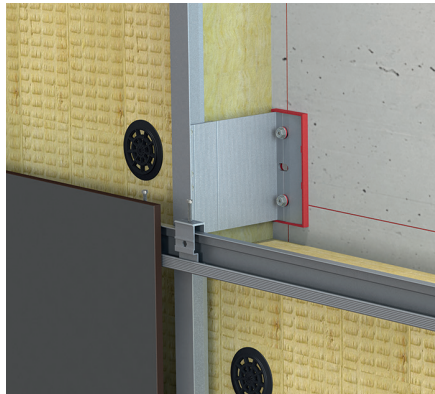


1-layer system



- Vertical bracket in line with the vertical profile.

2-layer system

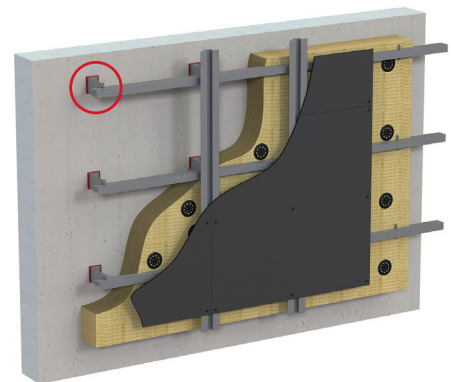


- Vertical bracket in line with the vertical profile for the 1st layer and the 2nd layer in horizontal alignment (2nd layer profiles with slotted holes for expansion compensation.)

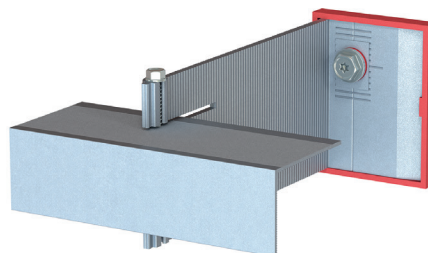
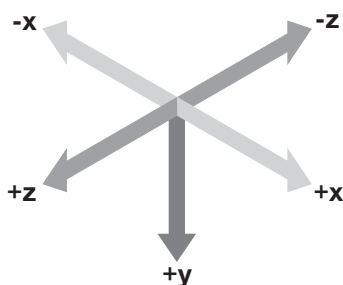
HORIZONTAL PROFILE FASTENERS

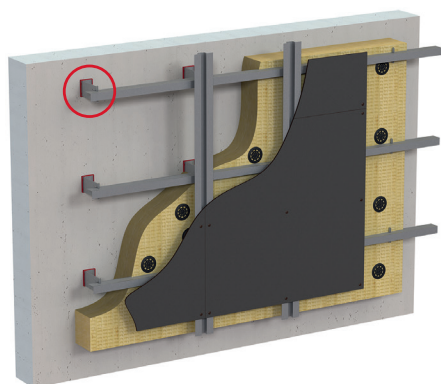
The connection between the profile and the bracket is made with pre-installed self-drilling screws (stainless A4) on the bracket. No fixed and flexible points are necessary due to the design and geometry of the bracket.

Installation scheme:



Fixed and flexible point

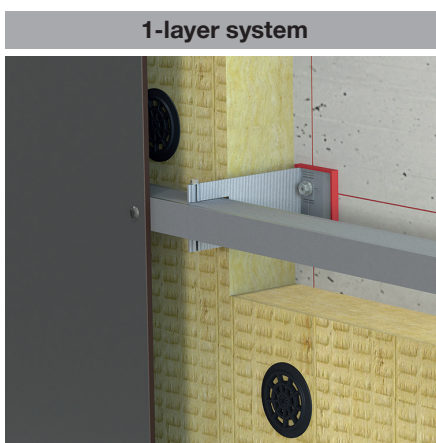




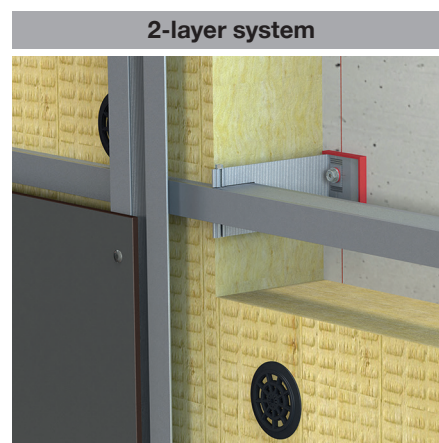
HORIZONTAL PROFILE FASTENERS

Hilti offers two horizontal systems:

- 1-layer system
- 2-layer system



- Vertical bracket equipped with a pre-installed screw
- Horizontal profile fastened with the pre-installed screw

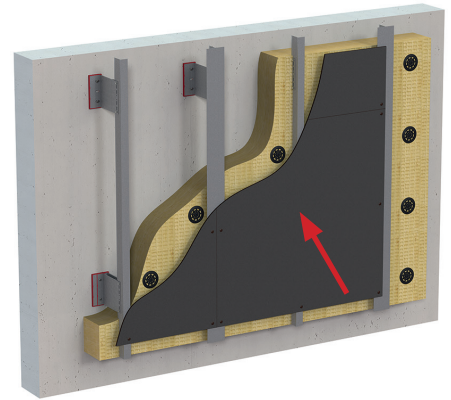


- Double-layer installation.
- Second-layer profile with fixed and flexible points (slotted holes in the profile) to allow the profile to expand against the first layer

CLADDING MATERIALS

When planning the cladding, in addition to the requirements in terms of protection from the elements, building physics, fire protection and durability, the following points must be taken into account:

- Type, color and means of fastening (visible or concealed)
- Joint spacing (panel size, joint grid, expansion joints, etc.) – the rain screen/ventilated facade can, in principle, be installed with open or closed joints
- Generally speaking, a joint gap of 8 to 10 mm should be planned for large-format cladding panels, but this may need to be increased depending on the material and the size of the panels
- Type of substructure
- Reflections from the surface of the material
- Color differences between material lots
- Alignment of the cladding panels
- Junctions and connections to other building parts in accordance with the manufacturer's instructions



All types of cladding require the facade to be divided up into areas. At penetrations in the wall (e.g. windows) there may be a need for cladding panels of a different size.

The cladding may be fastened using a visible or concealed system.

The number and type of fasteners to be used depend on static design calculations. The position of the fasteners must be taken into account in the static design calculations and the manufacturer's instructions regarding maximum spacing must be adhered to.

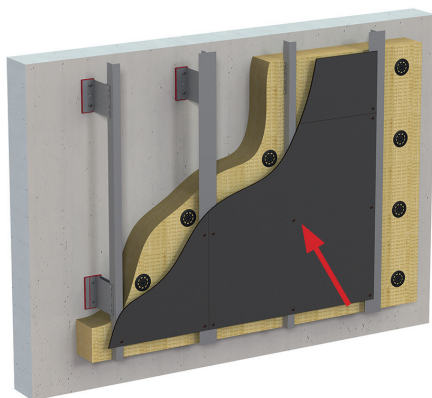
The cladding fastening system must avoid forces of constraint, e.g. through use of fixed and sliding points. Joint gap width must allow for the dimensional changes to be expected, taking the temperature at the time of installation into account.

Drilling and rivet setting gauges should be used in order to avoid forces of constraint in riveted joints.

Forces of constraint are also to be avoided at screw fastened joints through use of a depth gauge, correct tightening torque and screws with a thinner shank that allow the necessary room for movement.

With bonded joints, the joint surfaces must be clean and free of grease. The adhesive manufacturer's special instructions must be observed regarding pretreatment, application temperature, etc.

Where "hook-in" systems are used (e.g. with hooks, U-bolts or undercut anchors), possible movement of the substructure and its effects on the cladding panels must be taken into account (movement of the panels).

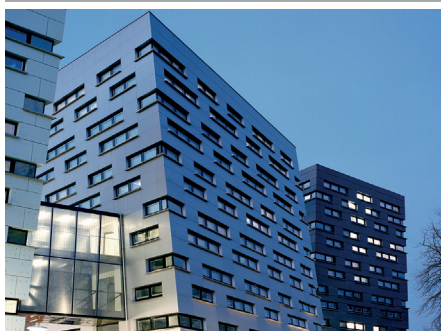


CLADDING MATERIALS

There are many different cladding materials available.
The most common ones are:

- Fiber-cement
- HPL (high-pressure laminate)
- Metal
- Render
- Ceramic
- Terracotta
- Stone
- Composite

Fiber-cement



HPL



Metal



Render



Ceramic



Terracotta



Stone



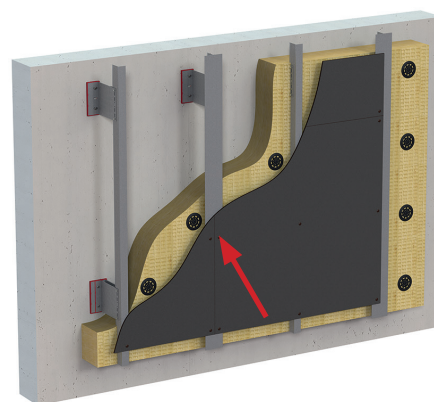
Composite

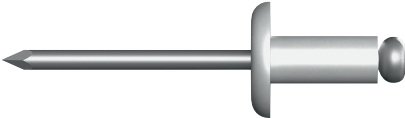







CLADDING FASTENERS

The following types of fasteners may be used:

- Rivets
- Screws
- Undercut anchors
- Adhesive bonding



Visible	Rivets	Screws	Clamps
			
Invisible	Adhesive bonding	System rail	Clamps
			

The fasteners must comply with national and/or European regulations or approval requirements and the manufacturer's specifications. The intended application stated in the approval must be suitable for the requirements of rain screen/ventilated facade systems. In addition, attention must be paid to corrosion protection and materials compatibility.

Only approved adhesive systems (test certificate issued by an accredited test institute or equivalent verification of suitability) may be used for the adhesive bonding of cladding panels to the substructure and these adhesive systems must be used in accordance with the manufacturer's instructions.

