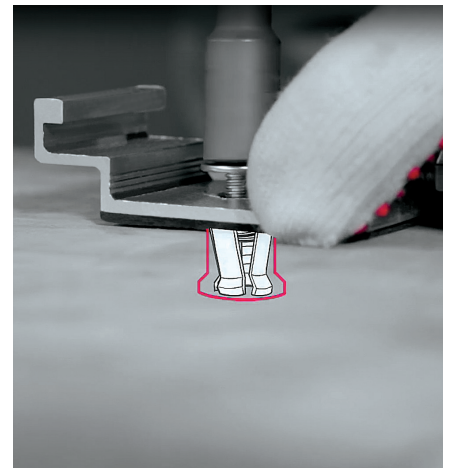
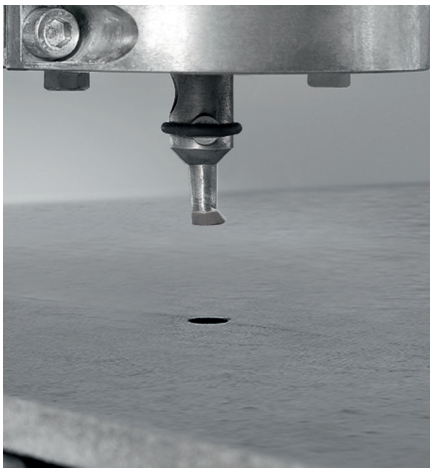




# FIXING

BY UNDERCUT TECHNIQUE





## Quality forms the basis of our work

The corporate structure of our family-run company, based in the area of Bergisches Land, is medium-sized, which gives us a partner-like flexibility and reliability. This service is supported by our professional knowledge and our continuous and close cooperation with specialized institutions and universities. Fixing professionals can rely on the high quality of KEIL's products. We offer you reliable solutions for attachments in ventilated rainscreens.

Our fifty years experience in drilling and fixing enables us to be your competent partner. Our field service and our technicians will be pleased to give comprehensive and professional advice on your specific fixing issue.

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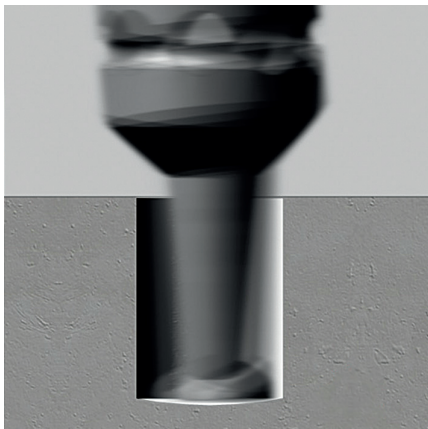
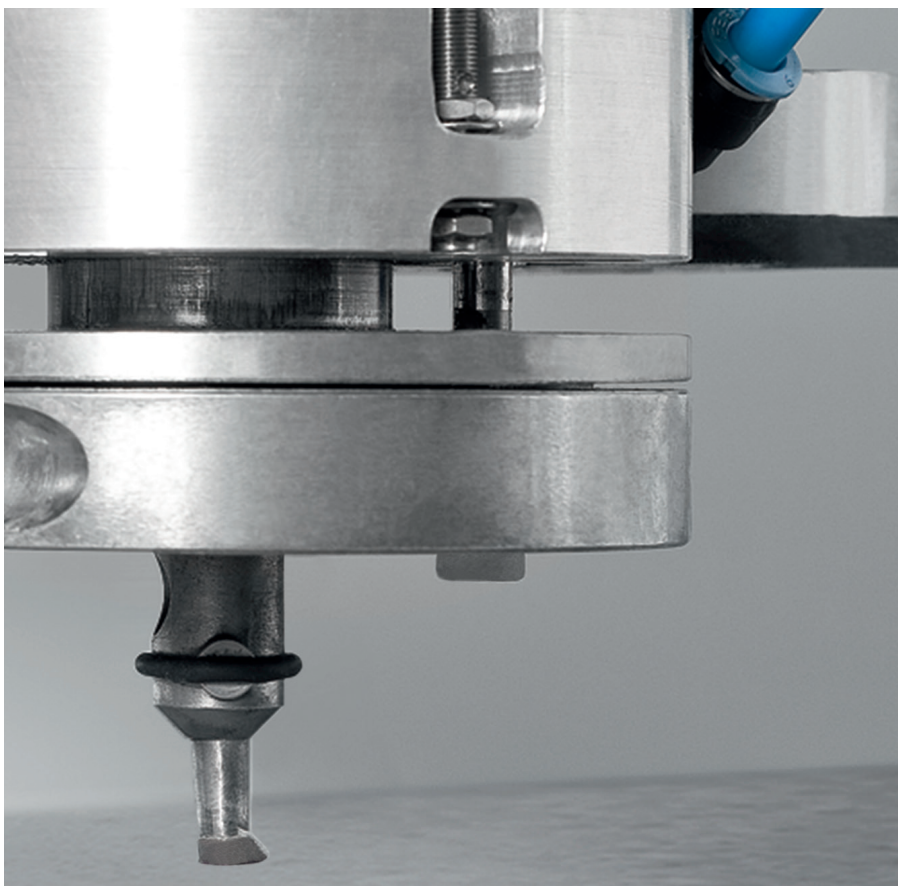
Title: Sapphire, Berlin, DE © André Baschlaw, Berlin www.baschlaw-fotografie.de; Page 3: Sapphire, Berlin, DE © Corrado Ravazzini, Tiles by Casalgrande Padana

# UNDERCUT – AN OVERVIEW



SSC - University of Cologne, Cologne, DE © KEIL

High-quality façade panels transform dreary buildings into fascinating objects. Architects will face creative design possibilities. The underlying secret is the invisible attachment by an elaborate fixing device called undercut technique.



Drilling

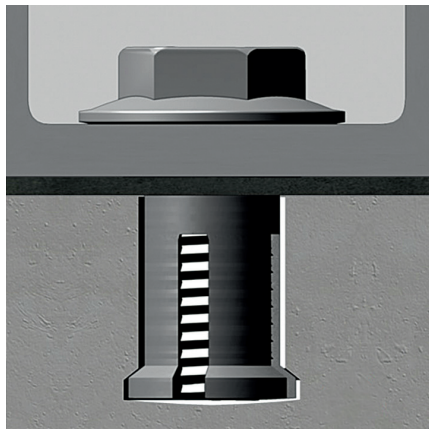
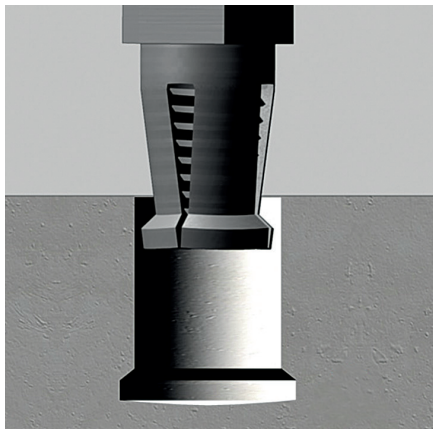


Undercutting

- ▶ Cylindrical drilling and conical undercutting are carried out in one single process and by only one tool.
- ▶ Different levels of automation are possible, depending on the type of machinery and the material of the panel.
- ▶ Drilling time for ceramics is less than 10 seconds.
- ▶ Panels of any desired size and weight will get a patented undercut in a precise and consistent symmetric shape.



SSC - University of Cologne, Cologne, DE © KEIL

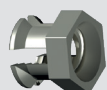
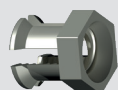
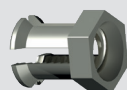
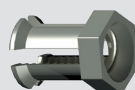
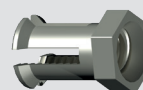
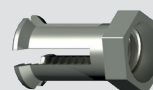
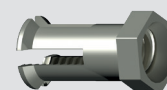


The undercut technique is as simple as it is ingenious. By means of a patented drilling system a blind hole with an expanded base is drilled into the backside of the façade panel. Subsequently, the KEIL undercut façade anchor is inserted into the hole. This anchor guarantees a positive-locking attachment, which is free of expansion force. As soon as the panel is equipped with brackets, it can be mounted directly on to the substructure.

#### Assembly

- ▶ For the assembly, an undercut anchor is inserted into the hole and locked positively by a screw.
- ▶ The assembly is fast, safe and simple.

#### Insertion depths

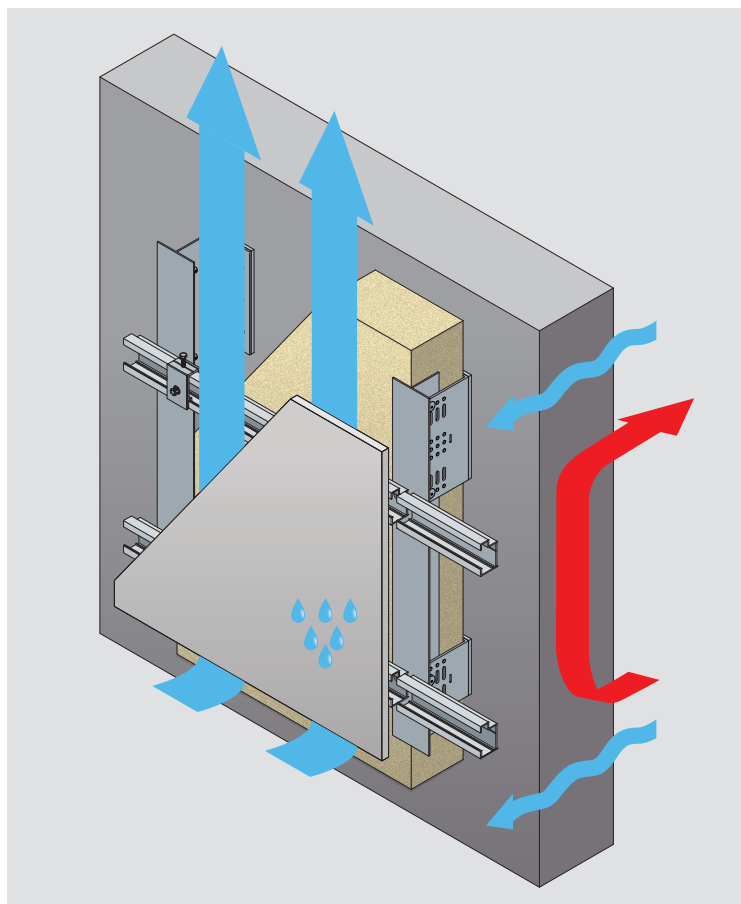

 $h_s = 4,0 \text{ mm}$ 

 $h_s = 5,5 \text{ mm}$ 

 $h_s = 7,0 \text{ mm}$ 

 $h_s = 8,5 \text{ mm}$ 

 $h_s = 10,0 \text{ mm}$ 

 $h_s = 11,5 \text{ mm}$ 

 $h_s = 13,0 \text{ mm}$ 

 $h_s = 15 \text{ mm}$

# VHF – VENTILATED RAINSCREENS



Antel Tower, Montevideo, UY © Ricardo Almeida

Due to their enormous freedom of design, – e.g. concerning colour, material surface – ventilated rainscreens (VHF) offer a special identity for buildings and their inhabitants. They can be easily planned and sustainably incorporated into the overall concept of the assessment of the life cycle.



## Ventilated rainscreens

For a ventilated rainscreen, the cladding will not be applied directly onto the masonry, but mounted onto a substructure. Thus, insulation (moisture, thermal, sound and fire protections) and weather protection are constructionally separated. This method creates a ventilation space between the components, which regulates the moisture balance within the building structure.

Today's ventilated rainscreens are amongst the most successful façade systems. Current studies of the façade market verify that, besides its functional safety, architects most highly appreciate the creative possibilities of a ventilated rainscreen.

The system of the ventilated rainscreen allows for a choice of the most different claddings. Therefore, the design of the façade can be individually matched to the characteristics of a building. Even combinations of different materials can be easily implemented – by the use of different cladding materials.

## Longevity and efficiency

Due to their long lifetime and the low maintenance and repair costs, ventilated rainscreens prove a very efficient and sustainable investment. Furthermore, the constructional separation of the functions of thermal and weather protection makes it less damage prone than other façade systems.

## Design variety and building culture

A wide range of materials is available for the cladding of a ventilated rainscreen. Durability, light fastness and frost-resistance of these materials are the basic requirements for the increasingly demanded longevity of the façade. Proven materials are ceramics, porcelain stone-ware, natural stone, HPL and fibre-enforced resin composite panels, fibre cement panels etc.

## Safety

The substructure is the static connection between the exterior bearing wall and the façade cladding. Substructures are three-dimensionally adjustable and lie tension-free around the building structure. Uneven surfaces and wall projections can be counterbalanced and special requirements concerning fire protection, sound insulation or lightning protection can be implemented without any problems and in a creatively appealing way.

## Climate control

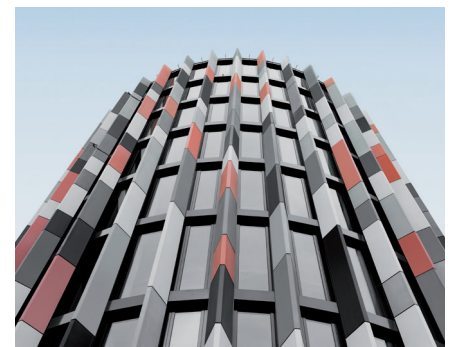
Within the system of the ventilated rainscreen, the components of insulation (thermal insulation, cold insulation and fire protection) and cladding (weather protection) are constructionally separated. The use of mineral insulation materials with heat conductivity groups O35 or O32 is a frequent practice with ventilated rainscreens on buildings of any height or use. The requirements of the current energy saving regulations are fulfilled, as the system allows for the incorporation of any required insulation. The ventilation space between the components regulates the moisture balance within the building structure. Building moisture and moisture due to occupancy are discharged reliably through this ventilation space. Moist external walls will desiccate within a short period of time, permanently ensuring the optimum indoor climate.



Whitehall Station - South Ferry, New York, US © KEIL



Nike Store, Miami FL, US © Michael Wells



Main Point Karlin, Prague, CZ, Ditz Fejer © Rieder Group



Maison Cannes, Cannes, FR © Mathieu Ducros, Material: HI-MACS® - Design: Pierre Guidoni, Jean Rogliano - Fabrication: Menuiserie Bateau

**FVHF®**  
WIR SIND MITGLIED

Fachverband Baustoffe und Bauteile für vorgehängte hinterlüftete Fassaden e.V. (FVHF)

The FVHF is the lobby of the manufacturers of claddings, substructures and thermal insulation materials as well as anchoring, connecting and fixing elements for ventilated rainscreens (VHF).

Sponsoring member:

DEUTSCHE NATURSTEIN AKADEMIE

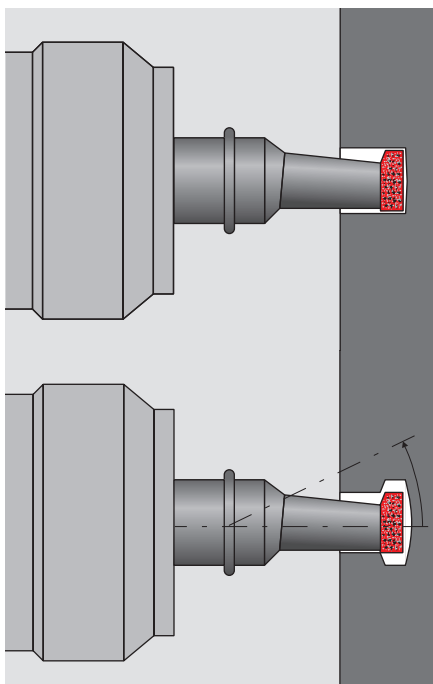
Deutscher Naturwerkstein-Verband e.V.

Member:

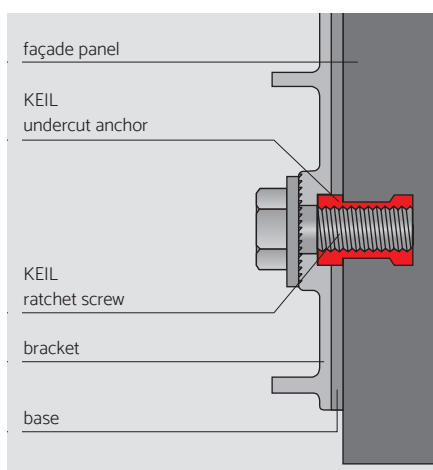
MADE IN GERMANY

Associate member:

# UNDERCUT- THE SYSTEM



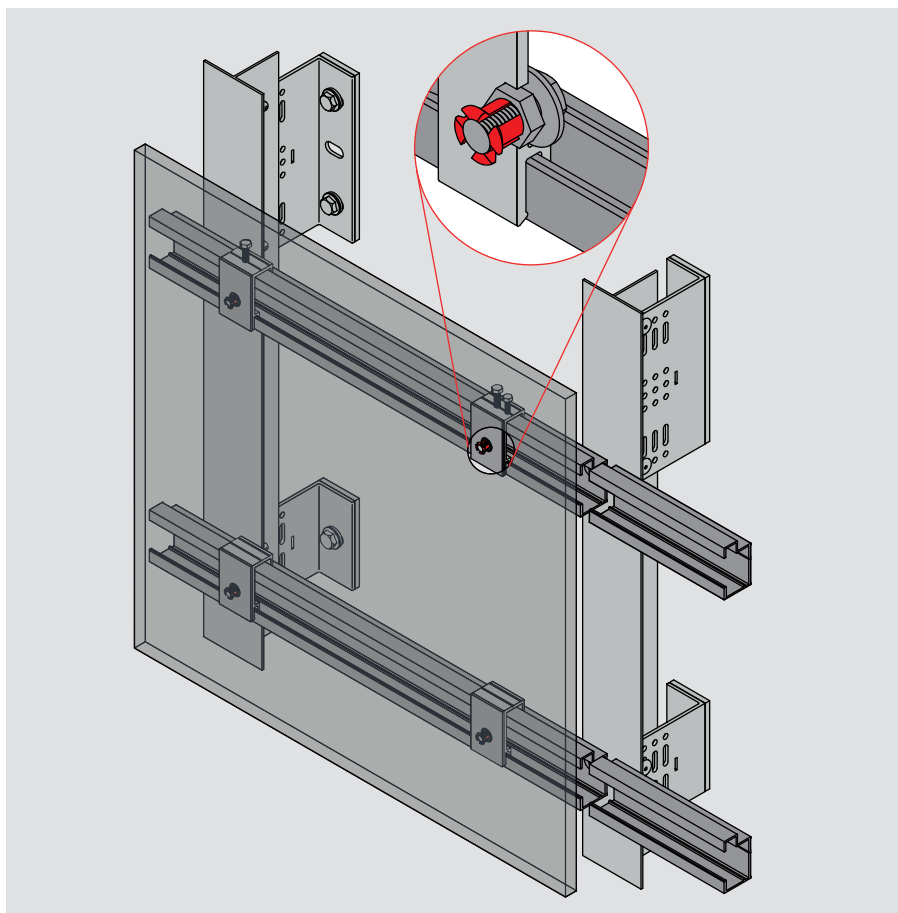
Drilling and undercutting in one step



Structure

## Safety instructions

Safety and product liability require, that the KEIL undercut fixing system must always be used as one unit. The function will only be guaranteed, if the coordinated KEIL products (anchor with screw or grub screw, chuck and façade drill) are used in combination. The use as a system is also regulated in the approvals hitherto granted resp. applied for. Parts of the KEIL undercut fixing system are patented.



## The KEIL undercut drilling

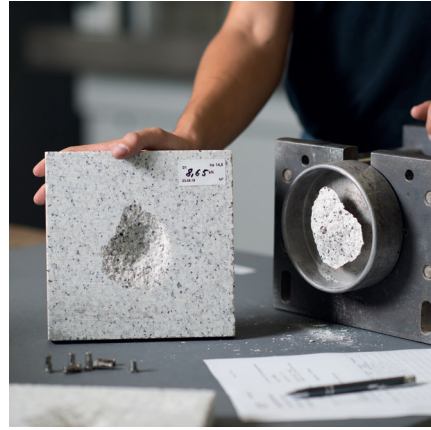
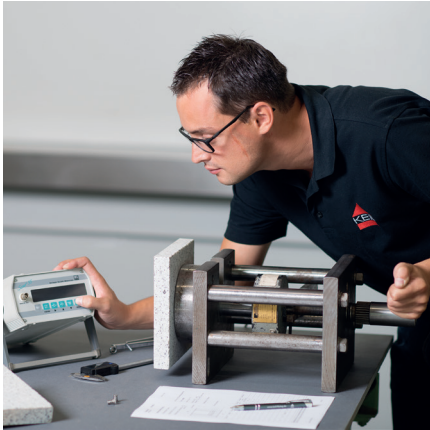
Cylindrical drilling and conical undercutting are carried out with only one tool and in one single step. Different levels of automation are possible, depending on the type of machinery and material. Drilling time in ceramics is less than 10 seconds. Panels of any size and weight will get a patented undercutting with a precise and consistent symmetric shape. For a cylindrical drilling with a diameter of  $\varnothing 7$  mm, the diameter of the undercut will be  $\varnothing 9$  mm. For the assembly, the undercut anchor is placed in the drill hole and locked positively with a screw. Quick, simple and safe, with customary tools, e.g. cordless screwdrivers.

## The KEIL undercut anchor

The KEIL undercut anchor for the hidden attachment of thin panels is manufactured from stainless steel. Its geometry, which matches the KEIL undercut drill hole, guarantees an attachment free from expansion pressure in all common panel materials from a panel thickness of 6 mm onwards. Different insertion depths are possible, depending on the thickness of the panel or the necessary bearing capacity. The KEIL undercut anchor is designed to carry more weight than that of the panel material. Due to its high assembly safety, the KEIL undercut anchor offers significant advantages. The displacement-controlled assembly of the anchor in all panel thicknesses will be carried out quickly, simply and safely with the aid of the coordinated KEIL system: anchor, bracket and KEIL ratchet screw with integrated screw lock. Only two parts (anchor sleeve and screw) are necessary for a secure fastening. Other screw-in parts for the KEIL undercut anchor allow for your individual connection variant, e.g.:

- ▶ connection to substructures
- ▶ connection to cassette designs
- ▶ attachment to reveal panels with interior angles
- ▶ direct attachment to the wall with fork or plug-in anchors
- ▶ fixing of wash basins, work tops, furniture, grave borders or radiators made from natural stone





## 1 Pull-out tests

How efficient are the materials of KEIL's products? Which KEIL anchors are the best for a particular building project? We offer our customers pull-out tests on our premises.

The resulting data will provide an orientation for applications for approval.

## 2 Support for approvals

KEIL will be pleased to advise you on obtaining approval from building supervision authorities or European Technical valuations with the KEIL undercut techniqe.

Approvals for a variation of materials and formats with and without substructure are available.

[www.keil-fixing.de/en/approvals](http://www.keil-fixing.de/en/approvals)



## 3 Recommendations on handling and implementation / training

We are pleased to offer you a presentation of the advantages, the handling and the drilling technique of the undercut system.

If you have any questions concerning the planning of your individual façade fixing, please contact our service team.

## 4 Drilling

If required, we are pleased to offer you drilling capacities at our factory. These can be matched with your requirements and are also sufficiently available for large projects.

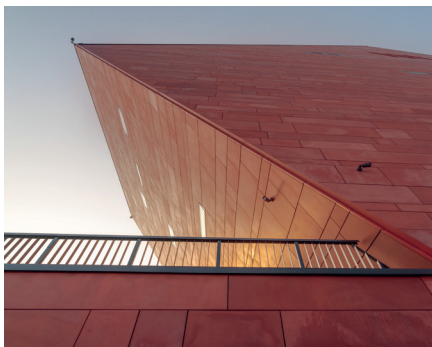
## 5 Rental service

KEIL as well as a variety of national and international distributors offer different drilling machines for drilling undercut holes. Please make use of this possibility to temporarily expand your available machinery or to have the optimum machine for a special object at your disposal without locking any capital.

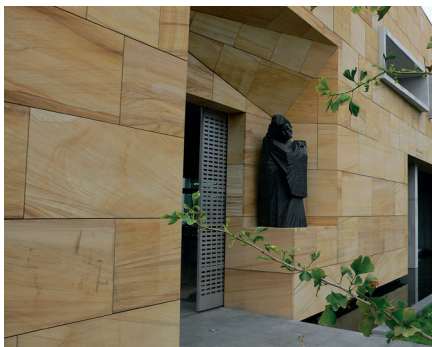


Please find our current overview of relevant documents on planning permissions under [www.keil-fixing.de/en/approvals](http://www.keil-fixing.de/en/approvals).

# KEIL – ADVANTAGES



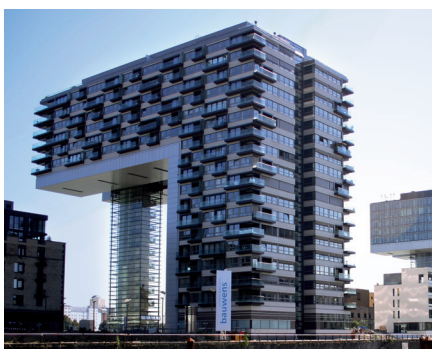
Museum of WW II, Gdańsk, PL © Kwadrat Gdyni



Buddhist Temple, Christchurch, NZ © KEIL



Museum of Liverpool, Liverpool, GB © Vincent Phillips



Pandion Vista, Cologne, DE © KEIL

## Quality and safety

- ▶ Highest safety owing to a wide range of patents and approvals, e.g. European Technical Approvals (ETA) for the attachment of façade panels.
- ▶ Highest quality MADE IN GERMANY using material A4.
- ▶ Complete system, approved by building inspectorate, sophisticated, highly tried and trusted.
- ▶ Hurricane proof and earthquake tested up to magnitude 9.4 on the open-ended Richter scale.
- ▶ Proven in climate zones all over the world.
- ▶ Non-combustible, mechanical and permanently safe attachment guarantees highest retention force without stress on the façade panel.
- ▶ Higher pull-out load for the same panel thickness than with conventional systems, which support the edges of the panel.

## Assembly

- ▶ Highest assembly safety for the façade company due to a self-controlling system: The KEIL undercut anchor can only be mounted into a correctly drilled hole.
- ▶ Short lead time due to an easily established and clearly defined drilling and assembly process.
- ▶ Contrary to many alternative systems, a certification of the operators will not be necessary.
- ▶ Assembly independent of temperature, climate and weather conditions.
- ▶ The possibility of a high level of prefabrication allows for an assembly independent of place and time.
- ▶ Approved and uncomplicated fixing of reveal panels.
- ▶ Tolerances in panel thickness can be balanced automatically by spacer discs.
- ▶ Precise drilling technique (façade drill rotates at 10.000 rpm. in a deflected condition) guarantees a drill hole of a consistent geometry.
- ▶ Optimal use of the technical material characteristics due to a variable position of the undercut anchors.
- ▶ The panel will not be pierced.

## Efficiency

- ▶ All required thermal resistances in new buildings and modernisation can be implemented, guaranteeing a pronounced energy efficiency.
- ▶ Due to the constructional separation of insulation and weatherproofing all used materials can be separated and recycled, should the construction be dismantled later on.
- ▶ Subsequent replacement of façade panels e.g. for repairs.
- ▶ Thin façade panels from a thickness of 6 mm onwards – economic and resource-friendly.
- ▶ Assembly of anchor and bracket in one process on the building site.
- ▶ Economical transport of the drilled panels without protruding fixing elements.

## Advantages of the system

- ▶ Bigger façade panels of the same thickness can be attached with undercut anchors than with fixing devices according to DIN 18516-3.
- ▶ Breaking loads are up to seven times higher than with attachments on the edge of the panel (e.g. pin anchors).
- ▶ Minimisation of bending stress in the façade panel in comparison to attachments on the edge of the panel.
- ▶ Stress is not reduced to the edges of the panel, as common with pin attachment.

## Design and aesthetics

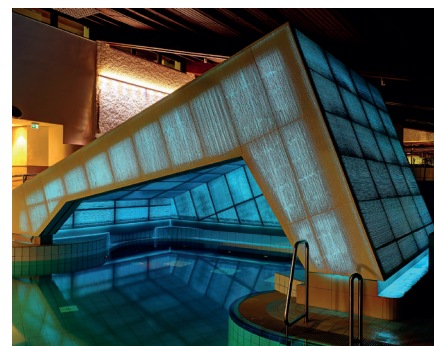
- ▶ Creativity has no limits. Be it elegant, traditional, modern, delicate or unconventional – even the boldest façade ideas can be implemented and allow for free planning.
- ▶ The façade shows a clean, uninterrupted image without visible fixing points.
- ▶ More than 50 different panel materials are available, e.g. ceramics, porcelain stoneware, natural stone, synthetic materials/HPL, fibre cement, glass fibre reinforced concrete, glass ceramics, artificial stone, UHPC, polymer concrete, solid surface materials or glass.
- ▶ Combinations and alternations of different materials, shapes and colours are possible and assist in implementing planned effects.
- ▶ Variable panel formats.
- ▶ Closed or open joints without visible anchors are distinctive of high quality façades.
- ▶ Due to the attachment on the back side of the panel, there will be no dirt or rust streaks.
- ▶ In comparison to the attachment on the edge of the panel, larger sized panels can be fixed with a high safety level.
- ▶ Your property will increase in value in regard to acceptance and marketing.
- ▶ Technical equipment can be integrated behind the façade, e.g. lighting, sun protection, supply cables, gutters, lightning protection, security systems.
- ▶ Aesthetics and energy efficiency are not mutually exclusive.



Vanke Pavilion (EXPO 2015), Mailand, IT © Hutton + Crow, Studio Libeskind



Penthouse, Hamburg, DE © Klaus Stemmler, Material: HI-MACS® - Design: Gerdt Architektur - Fabrication: Kiebitzberg GmbH & Co.KG



Obermaintherme, Bad Staffelstein, DE © LUCEM light transmitting concrete



Alice Trully Hall, New York, US © KEIL

## Sophisticated and approved by building authorities

Undercut attachments for façade panels in ventilated rainscreens are nowadays state-of-the-art. The Deutsches Institut für Bautechnik (DIBt; German institute for building technique) drew up an approval concept for this purpose.

### General building approvals

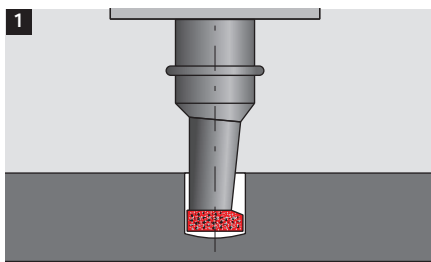
General building approvals will be granted for construction products and techniques within the scope of state regulation for which there are no generally acknowledged technical regulations, especially DIN norms, or which differ from them in a significant way. They are reliable verifications of applicability of construction products resp. of types of construction in regard to constructional requirements of buildings.

### European Technical Assessments

European Technical Assessments (ETA) will be issued for construction products in the scope of the EU Construction Products Regulation. They evaluate the performance of a construction product.



Please find our current overview of relevant documents on planning permissions under [www.keil-fixing.de/en/approvals](http://www.keil-fixing.de/en/approvals).

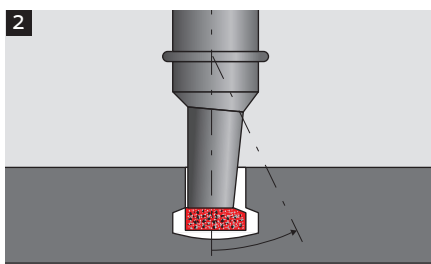


## Drilling and undercutting

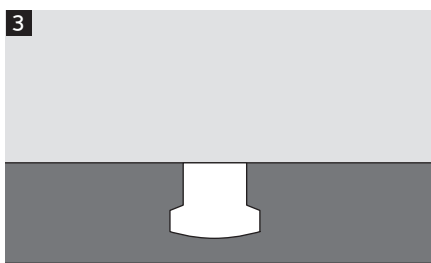
Facade panels must be provided with undercut drill holes on the back side. These holes must be drilled with KEIL system tools under workshop conditions.

The KEIL system tool consists of the KEIL facade drill bit, the KEIL drill head and the undercut drilling machine (e.g. KEIL portable drilling machine, KEIL drilling table or automated drilling machine with KEIL chuck).

The undercut drilling is carried out in one single step (cylindrical drilling **1** and undercutting **2**).



The undercut anchor can only be assembled correctly, if there is a precise undercut drill hole **3**. The KEIL depth control guide, which matches the insertion depth of the anchor, will periodically monitor the geometry of the drill hole. The insertion depth  $h_s$  is set by this depth control guide and all major measurements of the drill hole can be monitored efficiently.



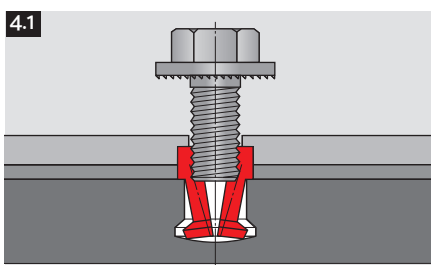
## Variant 1 (type AA): anchor sleeves and bolt with locking ratchets (screw) for defined clamping thicknesses, e.g. brackets.

The undercut anchor consists of an anchor sleeve with matching hex screw.

The drill hole, the anchor sleeve and the thread length of the screw must be tailored to the desired insertion depth  $h_s$  of the undercut anchor and the bracket of choice. Only the use of matching parts will guarantee a quick, simple and safe assembly.

### Assembly process:

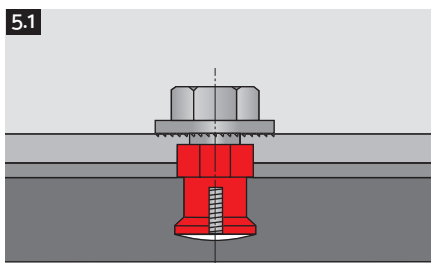
1. Insert the at the base compressed anchor sleeve, together with the required bracket, into the undercut hole **4.1**.
2. Screw in the screw, exerting gentle pressure on the bracket (in order to fix the anchor) **5.1**.  
The locking ratchets of the screw will cut into the bracket, securing the screw.



For this type of installation, the bracket and the KEIL undercut anchor will form a solid unit.

The anchor sleeve is expanded to its original dimensions by inserting the screw to a controlled depth, making it sit snugly against the undercut area of the drill hole. After the assembly, the anchor will sit in the undercut hole free of expansion pressure (i.e. the bracket can still be rotated with a certain amount of physical effort).

**Note:** If the matching screw is used for a defined clamping thickness, the screw-in depth will always be correct. The assembly is quick, simple and safe. The exact screw-in depth is determined by the system of the KEIL plug-in bolts in the same way. The screwed in part must fit flush with the tip of the anchor sleeve.



**Caution:** Before any assembly, please check, if the screwed in part fits flush with the tip of the anchor sleeve by way of a test assembly.

## Variant 2 (type BH/CA): anchor sleeves and threaded pins for variable clamping thicknesses

The undercut anchor consists of an anchor sleeve with matching threaded pin.

The drill hole, the anchor sleeve and the threaded pin must be tailored to the desired insertion depth  $h_s$  of the undercut anchor and the bracket of choice. Only the use of matching parts will guarantee a quick, simple and safe assembly.

### Assembly process:

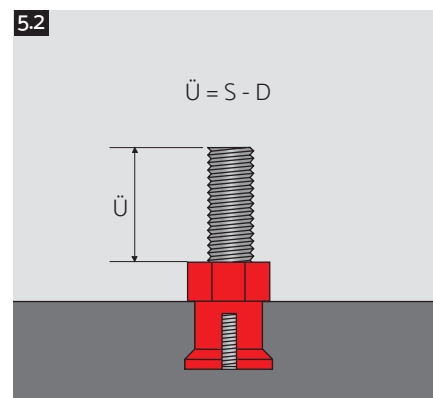
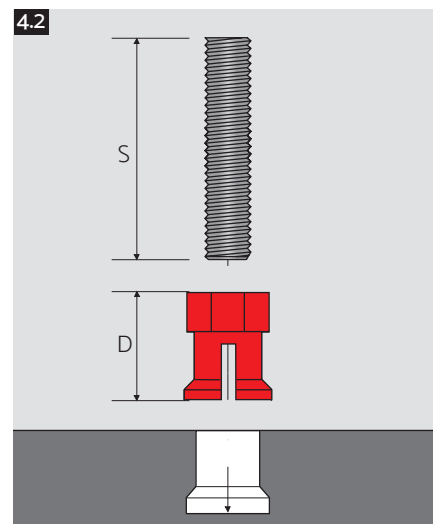
1. Insert the at the base compressed anchor sleeve into the undercut hole **4.2**.
2. Insert the threaded pin into the screw-in-tool.
3. Hold the anchor sleeve with an open-ended spanner and screw in the threaded pin with the screw-in tool up to the stop – undo the screw-in tool.
4. Control measurement  $\ddot{U}$  **5.2**.
5. Screw on the bracket with the nut.

The anchor sleeve is expanded to its original dimensions by screwing in the threaded pin to a controlled depth, making it sit snugly against the façade panel in the undercut area of the drill hole. After the assembly, the anchor will sit in the undercut hole free of expansion pressure

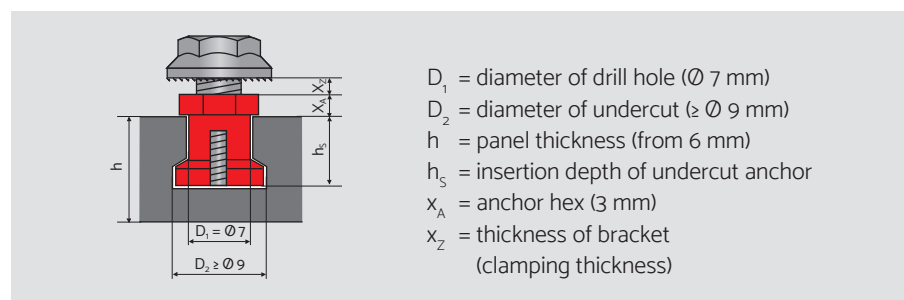
**Note:** The use of the matching assembly tool, the KEIL screw-in tool and attention to the assembly process will guarantee the correct screw-in depth. The correct projection  $\ddot{U}$  will automatically be adhered to.

**Caution:** Before any assembly, please check, if the screwed in part fits flush with the tip of the anchor sleeve and if the matching tool has been inserted by way of a test assembly.

The correct screw-in depth is also determined by the system for KEIL plug-in bolts (anchor type CA).



## Geometry of the drill hole – image



## Safety instructions (general)

Faultless performance can only be guaranteed, if all parts of the KEIL undercut system are being used. The controlled expansion of the anchor sleeve necessitates the exact attunement of the length of the screw to the anchor and the bracket by KEIL. The drilling of the undercut holes and the assembly should be carried out under workshop conditions. These can also be created on site. The dimensions of the undercut holes must be monitored according to the applicable regulations. Approvals, norms, regulations and relevant provisions applying for the construction and use must be adhered to. According to the EU construction products regulation declarations of performance for the CE label will be necessary. New ETAs will not contain any information about the use of the approved product any longer. Relevant regulations of use and approvals can be found in our download area under [www.keil-fixing.de/en](http://www.keil-fixing.de/en).



Type of machinery	Application	Portable drilling machine KSDV	Portable drilling machine KRDV
		portable - professional	portable
		p. 38	p. 40
<b>Undercut anchors</b>	p. 17	●	●
<b>Drilling tools</b>			
Façade drill bit diamond tipped	p. 28	●	●
Façade drill bit diamond tipped with countersink	p. 29	●	●
Façade drill bit diamond tipped R 1/2"	p. 30		
Façade drill bit diamond tipped CNC	p. 31		
Façade drill bit diamond tipped 9/12	p. 32	●	●
Façade drill bit diamond tipped with countersink 9/12	p. 33	●	●
Façade drill bit carbide tipped HM	p. 34		
Façade drill bit HM CNC	p. 35		
<b>Machine accessories</b>			
Circulation water supply	p. 48	●	●
Water pressure tank	p. 48	●	●
Filter cartridge (for circulation water supply)	p. 48	●	●
Collecting tray for KRT	p. 48		
Air connector	p. 49	●	●
Blow out nozzle for KSHV	p. 49		
Cooling lubricant	p. 49	●	●
Conversion set KRT "front face related drilling"	p. 49		
Drilling unit KG	p. 50		
Undercut unit HSE	p. 50		
Control for drilling unit KG	p. 50		
Chuck P	p. 51		
Transport case for KSDV, KRDV, KSHV	p. 51	●	●
Whetstones	p. 51	●	●
<b>Spare parts</b>			
Chuck for portable drilling machines	p. 52	●	●
Flushing chuck for KSDV, KRDV	p. 52	●	●
Chuck for undercut unit HSE	p. 52		
Flushing chuck for undercut unit HSE	p. 52		
Grooved ball bearing	p. 52	●	●
Silencer	p. 52	●	●
Fastener set 1	p. 53	●	●
Fastener set 2	p. 53		
Fastener set 3	p. 53		
Gasket for vacuum base	p. 53	●	●
Carbon brush set	p. 53	●	●
<b>Assembly aids</b>			
Depth control guide	p. 56	●	●
Washer for depth control guide	p. 59	●	●
Torque wrench 1-6 Nm	p. 60	●	●
Torque screwdriver 3.0 Nm	p. 60	●	●
Tool set	p. 61	●	●
Screw-in tool for stud bolts	p. 61	●	●



# CHECK LIST



for a request / order for finding the correct product.

## Which panel?

Customer

Material description:

---

Material thickness [mm]:

---

Tolerances in panel thickness [mm] +/-:

---

## Which substructure?

Customer/KEIL

Manufacturer:

---

Thickness of brackets [mm]:

---

Through bore for KEIL anchors:

Hex punched

Hex stamped

Groove

Miscellaneous:

---

## Which KEIL undercut anchor?

Customer/KEIL

Type AA anchor sleeve with screw

Type BH anchor sleeve with threaded pin and ratchet screw

Type CA anchor sleeve with thread bolt

Customized solution:

---

Anchor insertion depth  $h_3 =$   4  5.5  7  8.5  10  11.5  13  15 [mm]

---

Thread length M6x \_\_\_\_\_ [mm]

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