Deutsches Institut für Bautechnik

Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

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European Technical Assessment

ETA-06/0253 of 21 June 2021

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	KEIL undercut anchor KH
Product family to which the construction product belongs	Anchor for the rear fixing of façade panels made of selected natural stones according to EN 1469:2015
Manufacturer	KEIL Befestigungstechnik GmbH Olpener Straße 13a 51766 Engelskirchen DEUTSCHLAND
Manufacturing plant	Plant 1
This European Technical Assessment contains	29 pages including 4 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330030-00-0601, Edition 10/2018
This version replaces	ETA-06/0253 issued on 9 November 2020

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Specific Part

1 Technical description of the product

The KEIL undercut anchor KH is a special anchor made of stainless steel consisting of a crosswise slotted anchor sleeve with an M6 internal thread, at the upper edge of which a hexagon is formed to it and a respective hexagon bolt with an integrated tooth lock washer as well as distance washer for levelling of thickness tolerances Δd_p = +6 mm / ±0 mm. Alternatively, instead of the hexagon bolt with an integrated tooth lock washer, a threaded pin or threaded rod is used. The anchor is put into an undercut drill hole and by driving-in the screw it is placed form-fitted and deformation-controlled.

The product description is given in Annex A. The material values, dimensions and tolerances of the components of the fastener not indicated in the annexes shall correspond to the values laid down in the technical documentation[1].

2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the fastener is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the fasteners of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance to breakout or pull-out failure under tension load	See Annex C 1 and C 2
Characteristic resistance to breakout or pull-out failure under shear load	See Annex C 1 and C 2
Characteristic resistance to breakout or pull-out failure under combined tension and shear load	See Annex C 1 and C 2
Edge distance and spacing	See Annex C 1
Durability	Corrosion Resistance Class (CRC) III in accordance with EN 1993-1-4:2015
Characteristic resistance to steel failure under tension and shear loads	See Annex C 2

[1] The technical documentation comprises all information of the holder of this ETA necessary for the production, installation and maintenance of the fastener; these are in particular design drawings. The part to be treated confidentially is deposited with Deutsches Institut für Bautechnik and, as far as this is relevant to the tasks of the approved bodies involved in the procedure of attestation of conformity, shall be handed over to the approved body.

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with EAD No. 330030-00-0601 the applicable European legal act is: [97/161/EG].
The system to be applied is: 2+

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 21 June 2021 by Deutsches Institut für Bautechnik

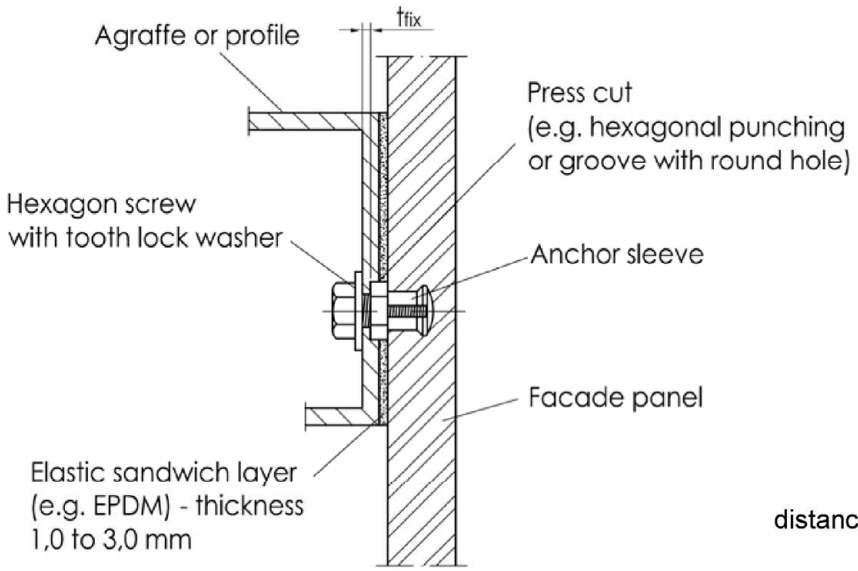
Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Aksünger

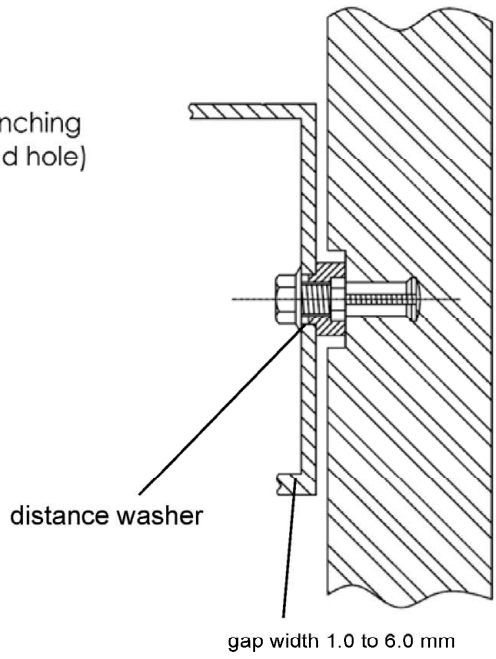
Deutsches Institut für Bautechnik DIBt

Installed anchor

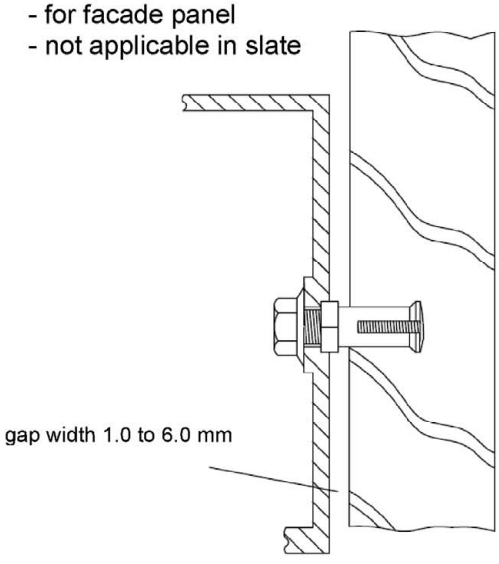
Example without distance washer



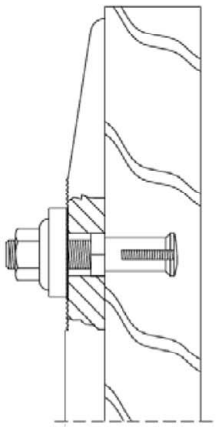
Example with distance washer



Example Stand-off fixing
- for facade panel
- not applicable in slate



Example Flush fixing
- for reveal panel
- applicable for slate panels



KEIL undercut anchor KH	Annex A 1
Product description Installed anchor	

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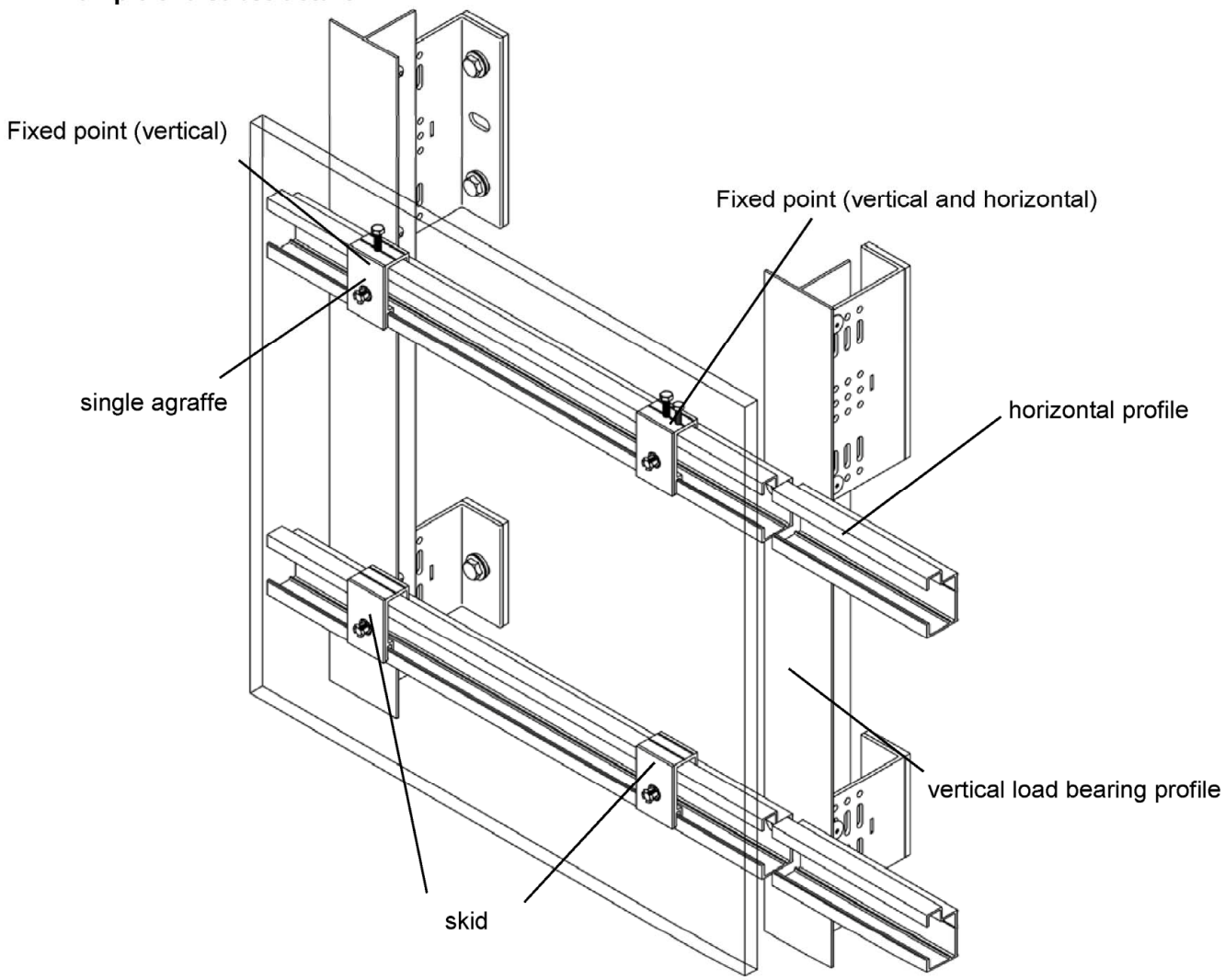
Example of a substructure



KEIL undercut anchor KH

Product description
Example of substructure and fixing of the panel

Annex A 2

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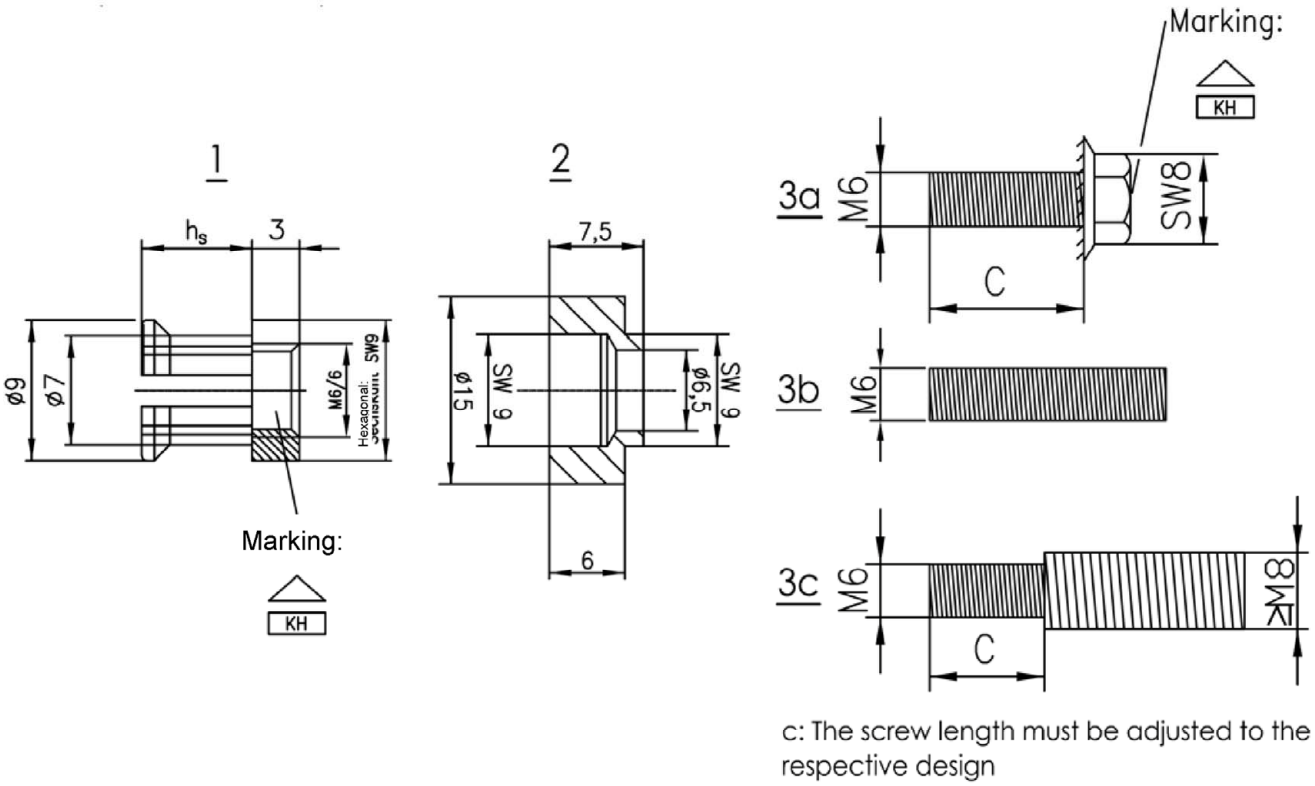
Anchor (dimensions in mm)



c: The screw length must be adjusted to the respective design

Table A1: Dimensions and Materials

Anchor type			**KH 7**	**KH 10**	**KH 15**
anchorage depth	h_s =	[mm]	7,0	10	15
screw length	c =	[mm]	h_s + 3mm + t_{fix}		
installation torque moment	T_{inst}	[Nm]	2,5 ≤ T_{inst} ≤ 4,0		
Materials					
1	anchor sleeve		stainless steel 1.4404 according to EN 10 088:2014		
2	washer		aluminum 3.1645/ EN AW-2007 according to EN 573-3:2013-12		
3a	hexagon screw with tooth lock washer		stainless steel 1.4401, 1.4404 or 1.4578 according to EN 10 088:2014		
3b	threaded pin		stainless steel 1.4401, 1.4404 or 1.4578 according to EN 10 088:2014		
3c	threaded bold		stainless steel 1.4401, 1.4404 or 1.4578 according to EN 10 088:2014		

KEIL undercut anchor KH

Product description
Example of substructure and fixing of the panel

Annex A 3

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Specifications of intended use

Anchorages subject to:
Static and quasi-static loads.

Base materials:
- Facade panels made of natural stone according EN 1469:2015
- Natural stone free of fractures, mechanically effective cracks and aging.
- Natural stone according to Table B1
- Parameters of facade panel according to Table B2 to B4

Table B1: Natural stone group

Group of stone		Natural stone	Conditions
I	High-quality intrusive rocks (plutonic rocks)	granite, granitite, syenite, tonalite, diorite, monzonite, gabbro other magmatic plutonic rocks	none
II	Metamorphic rocks with "hard stone character"	quarzite, granulite, gneiss, migmatite, slate [1]	slate type: only slates according to Table B2 and Table B3
III	High-quality extrusive rocks (volcanic rocks)	basalt and basaltlava damaging ingredients (see Sonnenbrennerbasalt) may not existent	Density: basalt: $\rho \geq 2{,}7$ kg/dm³ basaltlava: $\rho \geq 2{,}2$ kg/dm³
IV	Sedimentary rocks with "hard stone character" [3,4]	sandstone and limestone	sandstone: $\rho \geq 2{,}1$ kg/dm³

[1] For façade panels made of natural stones with planes of anisotropy, the difference between the bending strengths determined parallel to the planes of anisotropy and perpendicular to the edges of the planes of anisotropy shall not be more than 50 %.

KEIL undercut anchor KH	Annex B 1
Intended use Specifications	

Deutsches Institut für Bautechnik DIBt

Table B2: Characteristic values of anchors, façade, reveal panel and soffit made of natural stone

Natural stone exceed slate			
Panel thickness		h_{nom} [mm]	20 (30) [1] ≤ h_{nom} ≤ 70
Maximum size of panel		A ≤ [m²]	3,0
Maximum side length		H or L ≤ [m]	3,0
Number of anchors (rectangular arrangement)		[-]	4
Anchorage depth		h_s = [mm]	10 or 15
Nominal diameter of drill hole		∅ d_0 = [mm]	7
Edge distance of anchor		a_r = [mm]	50 mm ≤ a_r ≤ 0,25L or 0,25H
Spacing of anchor for reveal panel		b_r = [mm]	40 mm ≤ b_r = 0,2H or 0,2L
Spacing		a ≥ [mm]	8 h_s
Screw length	without distance washer	c = [mm]	h_s + 3 mm + t_{fix}
	with distance washer		h_s + 7,5 mm + t_{fix}
Remaining wall thickness [2]		R ≥ [mm]	0,4 h_{nom}
Bending stress	Epprechtstein yellow	$\sigma_{5\%}$ ≥ [N/mm²]	15,6
	Padang light	$\sigma_{5\%}$ ≥ [N/mm²]	10,3
	Sto-Kilzinger sandstone	$\sigma_{5\%}$ ≥ [N/mm²]	4,3

[1] for sandstone, limestone and basaltlava: panel thickness h_{nom} ≥ 30 mm, if from the panel manufacturer warrented lowest expect-value (5% fractile) of the bending tensile strength is < 8 N/mm².

[2] only stand-off fixing

Table B3: Characteristic values of anchors, façade, reveal panel and soffit made of slate CS 50, SIN 120 or SIN 150

Slate		**CS 50**	**SIN 120**	**SIN 150**
Panel thickness	h_{nom} ≥ [mm]	10		
Maximum size of panel	A ≤ [m²]	1,0		
Maximum side length	H oder L ≤ [m]	1,2		
Number of anchors (rectangular arrangement)	[-]	4 or 6	4	4
Density	γ = [kN/m³]	28,0		
E-Modulus	E = [N/mm²]	130000	120000	90000
Bending stress	$\sigma_{5\%}$ ≥ [N/mm²]	40	25	30

KEIL undercut anchor KH

Intended use
Specifications

Annex B 2

Table B4: Characteristic values of anchors, façade, reveal panel and soffit made of slate Primero Vulcano Schiefer

Slate		
Panel thickness	$h_{nom} \geq$ [mm]	20
Number of anchors (rectangular arrangement)	[-]	4
Density	γ = [kN/m³]	28
E-Modulus	E,mean = [N/mm²]	65000
Bending stress	$\sigma_{5\%} \geq$ [N/mm²]	35,0

Use conditions (Environmental conditions):

- In accordance with EN 1993-1-4:2015 dependent on Corrosion Resistancy Class (see ETA section 3.1).

Design:

- The facade anchorage must be dimensioned for the respective application under the responsibility of an engineer experienced in the field of facade construction.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored.
- Anchorages under static or quasi-static loading are designed in accordance with: EOTA Technical Report TR062 "Design of fasteners for facade panels made of natural stone".

Installation:

- The drillings are done at the factory or on site under workshop conditions; when making the drillings on site the execution is supervised by the responsible project supervisor or a skilled representative of the project supervisor.
- Making of the undercut drilling is done with the drill bit according to Annex B 4 and a special drilling device in accordance with the information deposited with Deutsches Institut für Bautechnik.
- The drill dust must be removed from the borehole.
- In case of aborted hole: new drilling at a minimum distance away of twice the depth of the aborted hole.
- the geometry of the drill hole is checked on 1 % of all drillings. The following dimensions shall be checked and documented according to manufacturer's information and testing instructions by means of a measuring device according to Annex B 7:
    - Volume of the undercut drill hole
    - Depth position of the undercut; the distance between the lower edge of the measuring device and the façade panel is between 0,0 and 0,3 mm (see Annex B 4).

  If the tolerances are exceeded, the geometry of the drill hole shall be checked on 25% of the drillings performed. No further drill hole may exceed the tolerances otherwise all the drill holes shall be controlled. Drilling holes falling below or exceeding the tolerances shall be rejected.
  Note: Checking the geometry of the drill hole on 1 % of all drillings means that on one of the 25 panels (this corresponds to 100 drillings in façade panels with four anchors) one drilling shall be checked. If the tolerances given in Annex B 4 are exceeded the extent of the control shall be increase to 25 % of the drillings, i.e. one drilling each shall be checked on all the 25 panels.
- During transport and storage on site the façade panels are protected from damages; the façade panels are not be hung up jerkily (if need be lifters shall be used for hanging up the façade panels); façade panels and reveal panels respectively with incipient cracks are not be installed.
- Between agraffe and façade panel an elastic sandwich layer may be placed.
- Overhead installation is allowed

KEIL undercut anchor KH	Annex B 3
Intended use Specifications	

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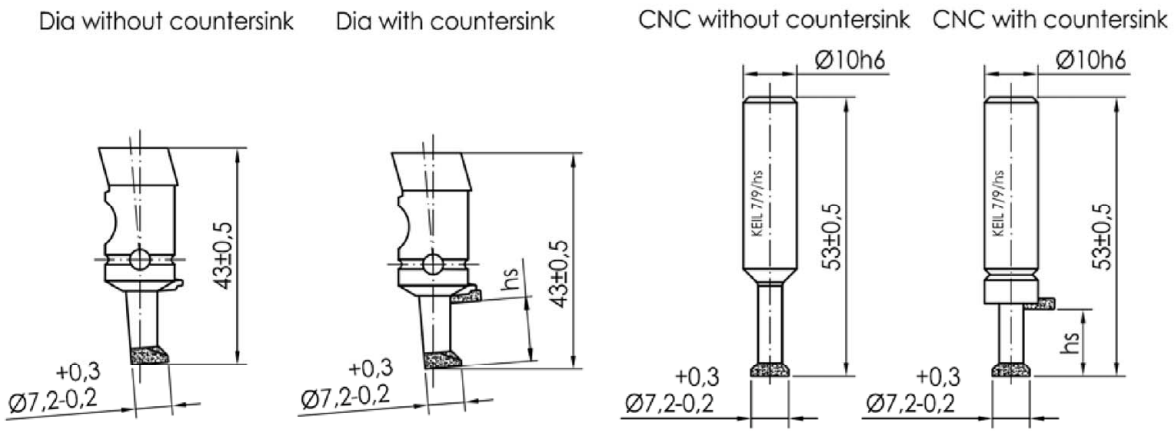
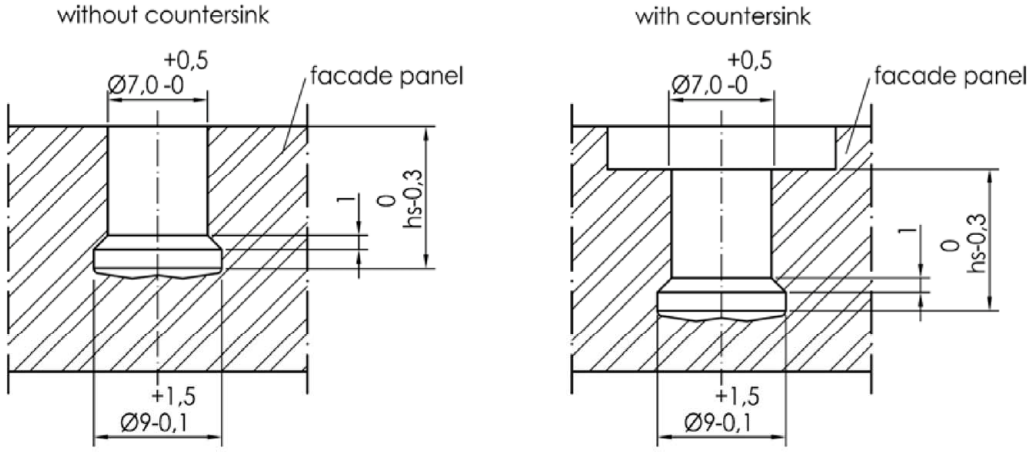
Geometry of the facade drill

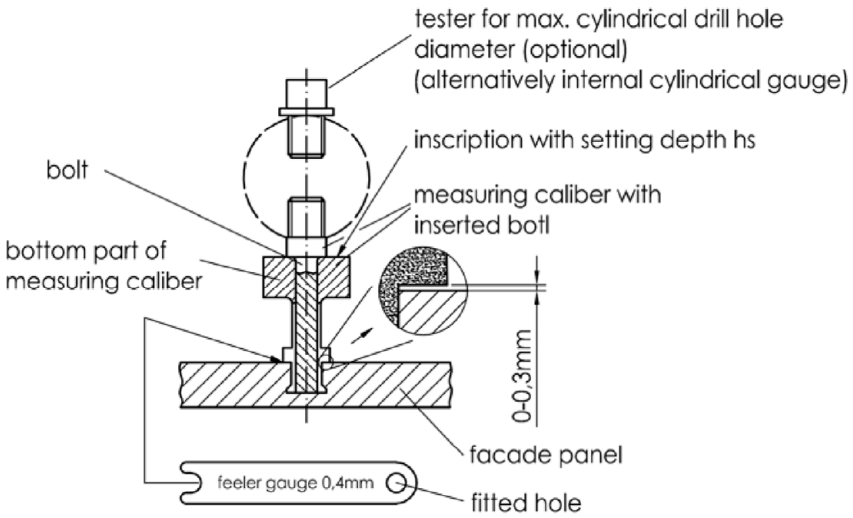
for KEIL facade drill bit 7/9



Geometry of the drill hole



KEIL measuring device



Drawing scale not true to real scale

KEIL undercut anchor KH	Annex B 4
Intended use Setting tools and testing equipment	

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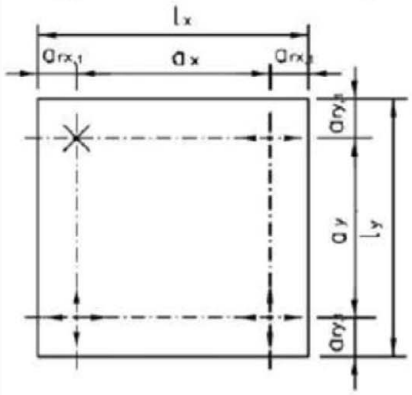
Supports – Definition of edge distances and spacing



Legend:

a_{rx}, a_{ry}	=	edge distance – anchor distance to the panel edge
a_x, a_y	=	spacing – distance between the anchors
l_x	=	length of the panel in horizontal direction
l_y	=	length of the panel in vertical direction
	=	fixed bearing (fixed support)
	=	horizontal slide bearing (slide support)
	=	horizontal and vertical slide bearing (slide support)

Figure 2: Façade panel with 4 agraffes – support condition 1

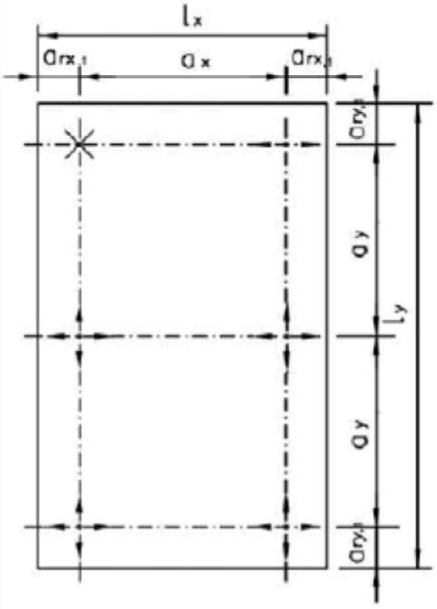


Figure 3: Façade panel with 6 agraffes – support condition 2

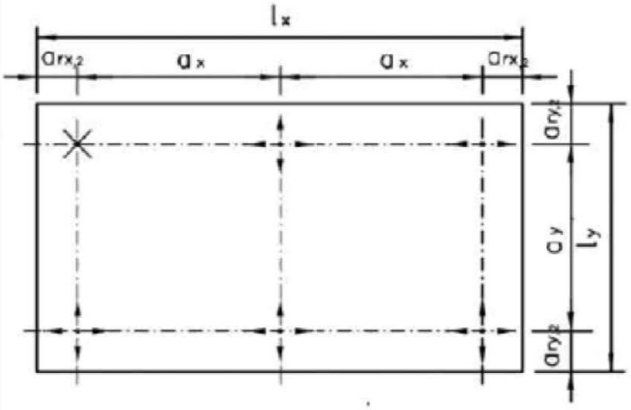


Figure 4: Façade panel with 6 agraffes – support condition 3

KEIL undercut anchor KH	Annex B 5
Intended use Supports - definition of edge distance and spacing	

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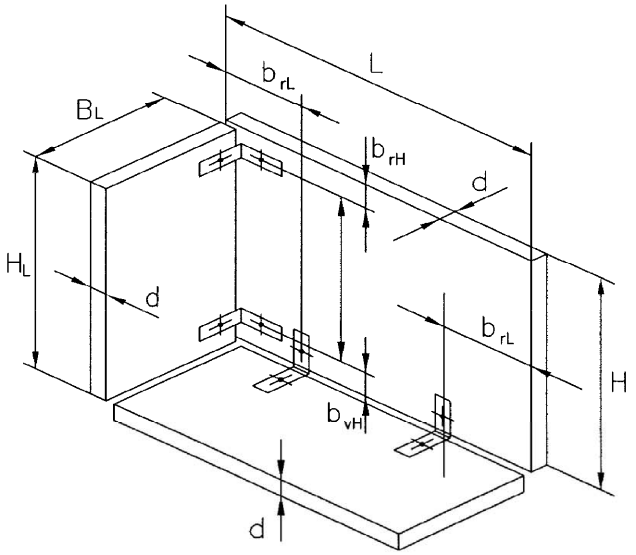
Definition of dimensions of the reveal angles and soffits



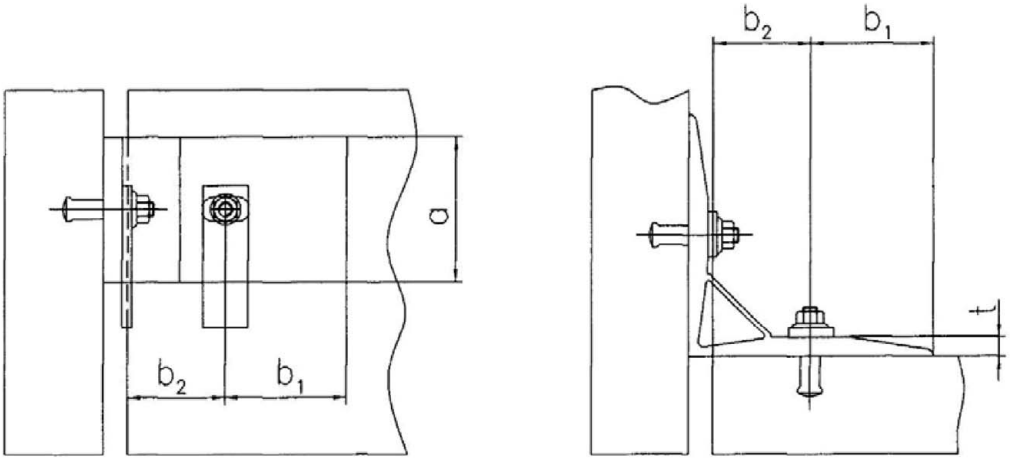


Table B5: Characteristic values of the reveal angles

		stainless steel 1.4401. 1.4404 bzw. 1.4571 EN 10088-3:2014	**aluminium EN 755:2016**
angle thickness	t [mm]	$t \geq 4$	$t \geq 5$
angle width	a [mm]	$40 \leq a \leq 100$	$40 \leq a \leq 100$
Distance between the centre of anchor to outer edge of reveal angle	b_1 [mm]	$25 \leq b_1 \leq 10\ t$	$25 \leq b_1 \leq 8\ t$
Distance between the centre of anchor to inner edge of reveal angle	b_2 [mm]	$40 \leq b_2 \leq 10\ t$	$40 \leq b_2 \leq 8\ t$
cross tension stiffness	c_q [MN/m]	$c_q \leq 2{,}5$	

KEIL undercut anchor KH

Intended use
Reveal angle and soffit of the panel made of natural stone (except slate)

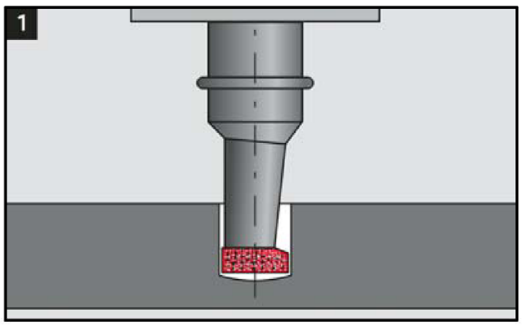
Annex B 6

Deutsches Institut für Bautechnik DIBt

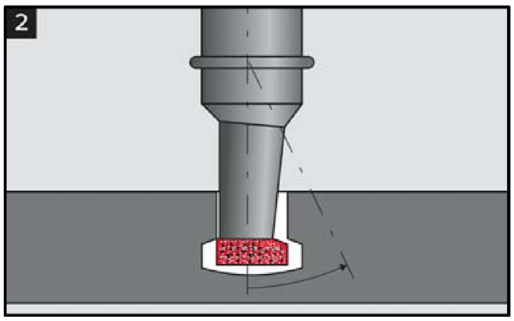
Installation instructions

1. Drilling the undercut hole

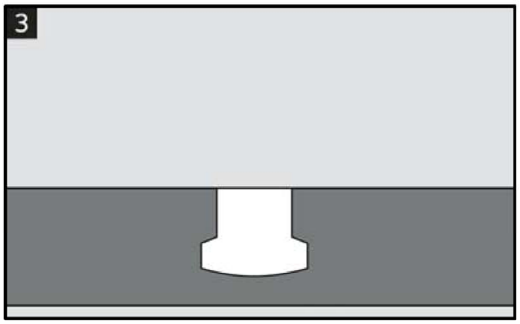
a) cylindrical drilling



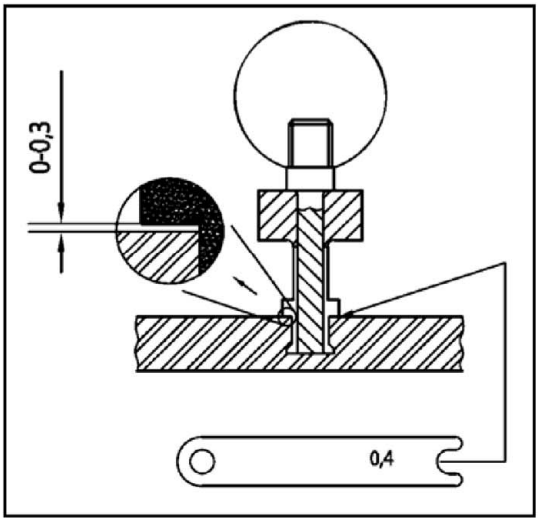
b) undercutting and cleaning



c) finished undercut hole



2. Checking the undercut hole



with KEIL depth control guide

KEIL undercut anchor KH	Annex B 7
Intended use Installation instructions	

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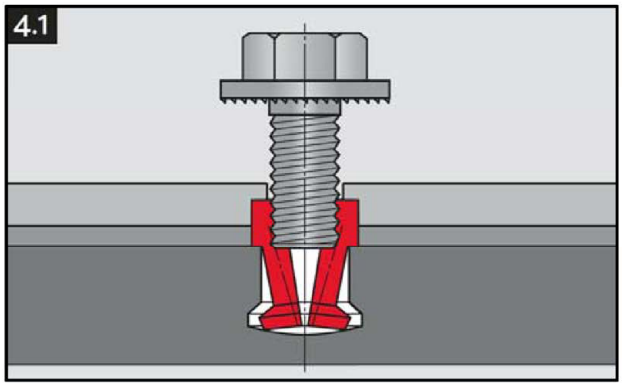
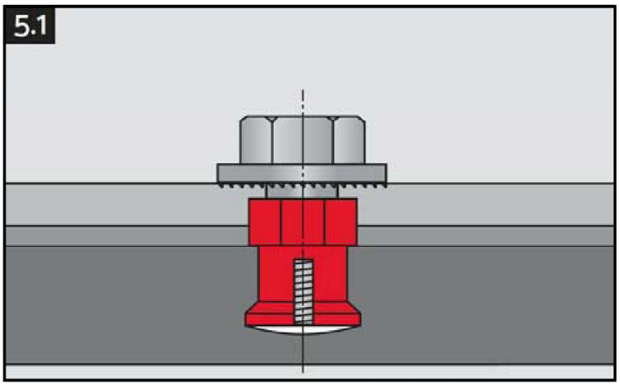
3. Installation of anchor (sleeve and screw)

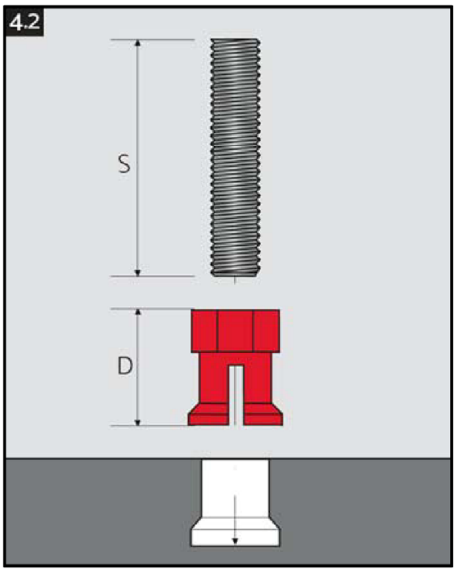


a) Insert the sleeve in the undercut hole and screw in the screw in the sleeve

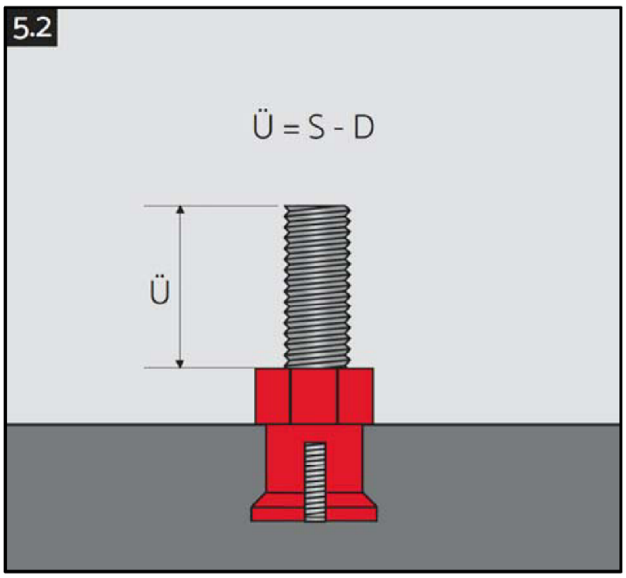


b) Installed anchor

4. Installation of anchor (sleeve and grub screw)



a) Insert the sleeve in the undercut hole and screw in the grub screw in the sleeve



b) Installed anchor

KEIL undercut anchor KH	Annex B 8
Intended use Installation instructions	

Deutsches Institut für Bautechnik DIBt

Characteristic load-bearing capacity of the anchor

Table C1: Characteristic values for facade panels and reveal panels

Natural stone			Epprechstein yellow	Padang light		Sto-Kilzinger Sandstein
Country of origin			Germany	China		Poland
Petrographic desription			granite	granite		sandstone
Panel thickness	h_{nom} =	[mm]	20	20		30
Embedment depth	h_s =	[mm]	15	10	15	15
Edge distance	$a_r \geq$	[mm]	100	50	50	100
Spacing	$a \geq$	[mm]	120	80	120	120
Characteristic resistance						
under tension load	N_{Rk} =	[kN]	4,6	2,5	3,6	2,9
under shear load	V_{Rk} =	[kN]	5,1	3,2	4,2	3,0
Combined tension and shear load						
Value for tri-linear function	X	[-]	1,2	1,2		1,2

Table C2: Characteristic values for facade panels made of slate CS 50, SIN 120 und SIN 150

			CS 50[1)]		SIN 120[1)]	SIN 150[1)]
Country of origin			Brasilia		Spain	Spain
Petrographic desription			slate		slate	slate
Embedment depth	h_s =	[mm]	7			
Edge distance	$a_r \geq$	[mm]	50	100	50	
Spacing	$a \geq$	[mm]	100	200	100	
Characteristic resistance						
Characteristic resistance to tension load	N_{Rk} =	[kN]	1,1	1,5	1,3	1,2
Characteristic resistance to shear load	V_{Rk} =	[kN]	1,6	1,9	2,7	3,0
Combined tension and shear load						
Value for tri-linear function	X	[-]	1,0	1,0	1,0	1,0

[1)] According to Table B3

KEIL undercut anchor KH	Annex C 1
Performance Characteristic resistance	

Deutsches Institut für Bautechnik DIBt

Table C3: Characteristic values for facade panels made of slate Primero Vulcano Schiefer

Country of origin			Spain
Petrographic desription			slate
Embedment depth	h_s =	[mm]	15
Edge distance	$a_r \geq$	[mm]	50
Spacing	$a \geq$	[mm]	100
Characteristic resistance			
Characteristic resistance to tension load	N_{Rk} =	[kN]	4,2
Characteristic resistance to shear load	V_{Rk} =	[kN]	6,0
Combined tension and shear load			
Value for tri-linear function	X	[-]	1,2

1) According to Table B4

Table C4: Characteristic resistance for steel failure

Characteristic resistance			
Characteristic resistance under tension load	$N_{Rk,s}$	[kN]	14,1
Partial safety factor for tension load	γ_{Ms} 1)	[-]	1,87
Characteristic resistance under shear load	$V_{Rk,s}$	[kN]	7,0
Partial safety factor	γ_{Ms} 1)	[-]	1,56

1) In absence of national regulations.

Table C5: reduction factor α_{TR}

Reduction factor	α_{TR}	[-]	1,0

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Design of slate according to table B 3

1 Admissible wind loads for selective panel sizes and bearing conditions for slate panels CS 50, SIN 120 and SIN 150

1.1 General

In Annex D 3 to D 12 several panel systems are listed as a function of the panel thickness, anchorage depth, edge distance, panel size, number of agraffes and the kind of support. The substructure has to be symmetrical.

For flush-fixed profiles following has to be considered:

c_H = height of the agraffe

Classification of the profiles in the following ratios:
$e/c_H \leq 0{,}75$
$e/c_H \leq 0{,}54$
$e/c_H \leq 0{,}33$

e = distance between of the facade panel and shear centre of the horizontal profile (s. figure 1)

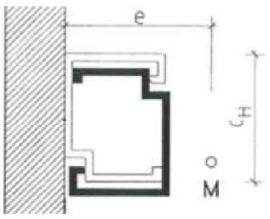

figure 1: Open profile with shear centre

The proof of structural stability is fulfilled if Eq. (1) is satisfied.

$$w_{Ek} \leq w_{Tab} \quad (1)$$

mit: w_{Ek} = characteristic wind load according to EN 1991-1-4
w_{Tab} = value of admissible wind loads, see Annex D
Following partial safety factors are fundamental for evaluation:
$\gamma_G = 1{,}35$; $\gamma_Q = 1{,}5$; $\gamma_M = 1{,}8$.

The constructional requirements of Annex D 3 for the support with 6 fixing points must be fulfilled.

For subframes supporting three fixing points of a one panel or unsymmetrical supported panels with 4 fixing points, the moment of inertia of profiles must be at minimum:

$$I_Y\,[cm^4] = 65{,}2 \bullet L_i\,[m] - 58{,}5 \text{ (gilt für: } 0{,}9\text{ m} \leq L_i \leq 1{,}4\text{ m)} \quad (2)$$

with: L_i = equivalent support width (Annex D 3)
I_Y = moment of inertia of profiles (y-axis of the profile: parallel to the façade panel layer)

The module of elasticity of the profiles has to be $E \geq 70.000$ N/mm².

KEIL undercut anchor KH	Annex D 1
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1.2 Smaller panel dimensions

In case of smaller panel dimensions for panels supported with 4 anchors Eq. (3) must be satisfied. For positioning of the fixings the relation of edge distance to length of the panel must be kept. The minimum edge distances can be taken from the respective Tables (Annex D 3 to D 12).

$$w_{Ek} \leq 0{,}9 \times \frac{A_{Tab}}{A_{vorh}} w_{Tab} \qquad (3)$$

mit: w_{Ek} = characteristic wind load according to EN 1991-1-4
w_{Tab} = value of admissible wind loads aus Anhang D
A_{Tab} = panel size given in the Tables (Annex D 3 to D 12), related to admissible wind loads of the Tables
A_{vorh} = existing panel size (area)

1.3 Unsymmetrical substructure

Unsymmetrical substructures can only be applied for panels supported with 4 fixing points. In this case Eq. (4) has to be fulfilled.

$$w_{Ek} \leq 0{,}5\, w_{Tab} \qquad (4)$$

mit: w_{Ek} = characteristic wind load according to EN 1991-1-4
w_{Tab} = value of admissible wind loads according to Annex D 3 to D 12

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Dimensioning aid

The following bearing conditions are to use for the admissible wind loads in Annex D 4 to D 12.
By object-releated calculation other admissible wind load tables may be determined.

Maximum support spacing and location of the substructure fixings

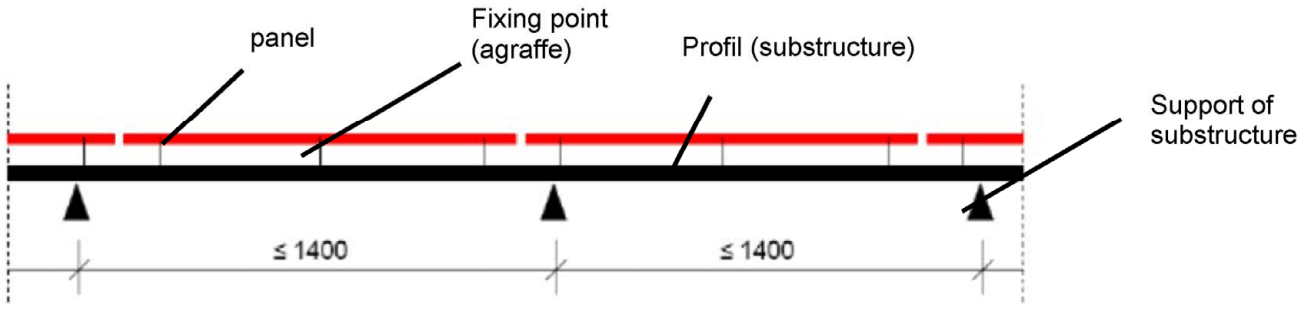

Figure 5: Profiles, supporting three fixing points of a panel, have a maximum spacing of the supports of 1.4 m.

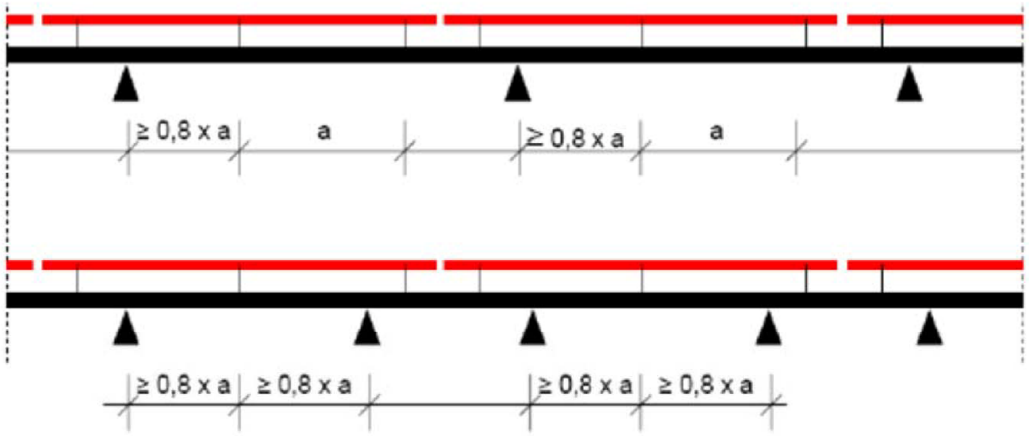

Figure 6: In profiles, supporting three fixing points of a panel, the central fixing points must have a minimum distance of 0,8 x a (a= spacing of the fixing points of the panel) to the supports.

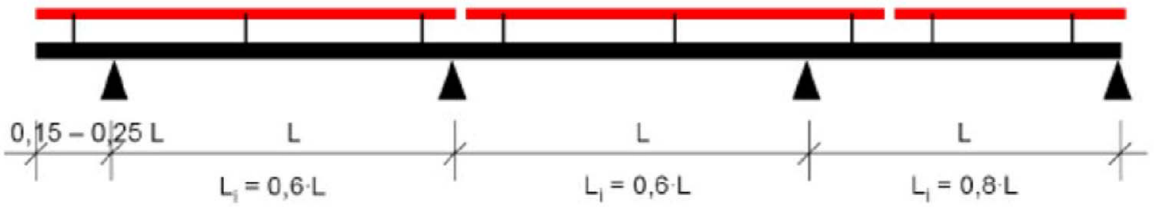

Figure 7: Equivalent support spacing

KEIL undercut anchor KH	Annex D 3
Informative Maximum support spacing and location of the substructure fixings for slate CS 50, SIN 120 and SIN 150	

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Dimensioning aid for facade panels made of slate CS 50

Table D1: admissible wind loads – flush-fixed, $e/c_H = 0{,}75$; $a_r \geq 50$ mm

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10	7	50-150	50-150	600 x 600	4	1	3,6
	12,5							3,3
	15							3,0
2	10	7	50-150	50-200	600 x 900	4	1	2,0
	12,5							1,7
	15							1,5
3	10	7	50-150	100-250	600 x 1200	4	1	1,2
	12,5							1,0
	15							0,7
4	10	7	50-200	50-200	750 x 750	4	1	1,9
	12,5							1,6
	15							1,4
7	10	7	50-100	100-150	600 x 1200	6	2 3	1,3
	12,5							1,1
	15							0,8
8	10	7	50-100	150-225	1000 x 1000	6	2 3	0,6

Table D2: admissible wind loads – flush-fixed, $e/c_H = 0{,}75$; $a_r \geq 100$ mm

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10	7	100-150	100-150	600 x 600	4	1	4,0
	12,5							4,7
	15							4,4
2	10	7	100-150	100-200	600 x 900	4	1	2,2
	12,5							2,7
	15							2,4
3	10	7	100-150	100-250	600 x 1200	4	1	1,3
	12,5							1,6
	15							1,4
4	10	7	100-200	100-200	750 x 750	4	1	1,9
	12,5							2,5
	15							2,2
5	10	7	100-200	100-200	900 x 900	4	1	1,4
	12,5							1,3
	15							1,0
6	10	7	100-200	100-200	1000 x 1000	4	1	1,0
	12,5							0,8
	15							0,5
7	10	7	100	100-150	600 x 1200	6	2 3	2,0
	12,5							1,8
	15							1,5
8	10	7	100	150-225	1000 x 1000	6	2 3	0,8
	12,5							0,8
	15							0,5

KEIL undercut anchor KH

Annex D 4

Informative
Dimensioning aid for façade panels made of slate CS 50

Table D3: admissible wind loads – flush-fixed, e/c_H = 0,54; $a_r \geq 50$ mm

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10	7	50-150	50-150	600 x 600	4	1	3,8
	12,5							3,5
	15							3,3
2	10	7	50-150	50-200	600 x 900	4	1	2,2
	12,5							2,0
	15							1,8
3	10	7	50-150	100-250	600 x 1200	4	1	1,5
	12,5							1,2
	15							1,0
4	10	7	50-200	50-200	750 x 750	4	1	2,1
	12,5							1,9
	15							1,7
7	10	7	50-100	100-150	600 x 1200	6	2 3	1,6
	12,5							1,3
	15							1,1
8	10	7	50-100	150-225	1000 x 1000	6	2 3	0,9

Table D4: admissible wind loads – flush-fixed, e/c_H = 0,54; $a_r \geq 100$ mm

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10	7	100-150	100-150	600 x 600	4	1	4,2
	12,5							5,0
	15							4,8
2	10	7	100-150	100-200	600 x 900	4	1	2,4
	12,5							2,9
	15							2,7
3	10	7	100-150	100-250	600 x 1200	4	1	1,5
	12,5							1,9
	15							1,7
4	10	7	100-200	100-200	750 x 750	4	1	2,1
	12,5							2,8
	15							2,5
5	10	7	100-200	100-200	900 x 900	4	1	1,6
	12,5							1,6
	15							1,3
6	10	7	100-200	100-200	1000 x 1000	4	1	1,2
	12,5							1,0
	15							0,8
7	10	7	100	100-150	600 x 1200	6	2 3	2,0
	12,5							2,1
	15							1,8
8	10	7	100	150-225	1000 x 1000	6	2 3	1,0
	12,5							1,1
	15							0,9

KEIL undercut anchor KH

Annex D 5

Informative
Dimensioning aid for façade panels made of slate CS 50

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Table D5: admissible wind loads – flush-fixed, $e/c_H = 0{,}33$; $a_r \geq 50$ mm

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10	7	50-150	50-150	600 x 600	4	1	4,0
	12,5							3,8
	15							3,7
2	10	7	50-150	50-200	600 x 900	4	1	2,4
	12,5							2,3
	15							2,1
3	10	7	50-150	100-250	600 x 1200	4	1	1,7
	12,5							1,5
	15							1,3
4	10	7	50-200	50-200	750 x 750	4	1	2,3
	12,5							2,1
	15							2,0
7	10	7	50-100	100-150	600 x 1200	6	2 3	1,8
	12,5							1,6
	15							1,4
8	10	7	50-100	150-225	1000 x 1000	6	2 3	1,1
	12,5							0,9
	15							0,7

Table D6: admissible wind loads – flush-fixed, $e/c_H = 0{,}33$; $a_r \geq 100$ mm

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10	7	100-150	100-150	600 x 600	4	1	4,4
	12,5							5,2
	15							5,1
2	10	7	100-150	100-200	600 x 900	4	1	2,6
	12,5							3,2
	15							3,0
3	10	7	100-150	100-250	600 x 1200	4	1	1,7
	12,5							2,2
	15							2,0
4	10	7	100-200	100-200	750 x 750	4	1	2,3
	12,5							3,0
	15							2,9
5	10	7	100-200	100-200	900 x 900	4	1	1,8
	12,5							1,8
	15							1,6
6	10	7	100-200	100-200	1000 x 1000	4	1	1,4
	12,5							1,3
	15							1,1
7	10	7	100	100-150	600 x 1200	6	2 3	2,0
	12,5							2,3
	15							2,1
8	10	7	100	150-225	1000 x 1000	6	2 3	1,2
	12,5							1,4
	15							1,2

KEIL undercut anchor KH

Informative
Dimensioning aid for façade panels made of slate CS 50

Annex D 6

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Dimensioning aid for facade panels made of slate SIN 120

Table D7: admissible wind loads – flush-fixed, $e/c_H = 0{,}75$

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10,0	7	50-150	50-150	600 x 600	4	1	2,2
	12,5							3,3
	15,0							3,0
	17,5							2,8
	20,0							2,6
2	10,0	7	50-150	50-200	600 x 900	4	1	1,1
	12,5							1,8
	15,0							1,5
	17,5							1,3
	20,0							1,1
3	10,0	7	50-150	100-250	600 x 1200	4	1	0,5
	12,5							1,0
	15,0							0,8
	17,5							0,6
	20,0							0,3
4	10,0	7	50-200	50-200	750 x 750	4	1	0,9
	12,5							1,7
	15,0							1,4
	17,5							1,2
	20,0							0,9
5	10,0	7	100-200	100-200	900 x 900	4	1	0,6
	12,5							0,8
	15,0							0,5
	17,5							0,3
	20,0							0,1
6	10,0	7	100-200	100-200	1000 x 1000	4	1	0,3
	12,5							0,4
	15,0							0,2

KEIL undercut anchor KH

Informative
Dimensioning aid for façade panels made of slate SIN 120

Annex D 7

Deutsches Institut für Bautechnik DIBt

Table D8: admissible wind loads – flush-fixed, $e/c_H = 0{,}54$

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10,0	7	50-150	50-150	600 x 600	4	1	2,4
	12,5							3,5
	15,0							3,3
	17,5							3,1
	20,0							2,9
2	10,0	7	50-150	50-200	600 x 900	4	1	1,3
	12,5							2,0
	15,0							1,8
	17,5							1,7
	20,0							1,5
3	10,0	7	50-150	100-250	600 x 1200	4	1	0,7
	12,5							1,3
	15,0							1,1
	17,5							0,9
	20,0							0,7
4	10,0	7	50-200	50-200	750 x 750	4	1	1,1
	12,5							1,9
	15,0							1,7
	17,5							1,5
	20,0							1,4
5	10,0	7	100-200	100-200	900 x 900	4	1	0,8
	12,5							1,1
	15,0							0,9
	17,5							0,7
	20,0							0,5
6	10,0	7	100-200	100-200	1000 x 1000	4	1	0,6
	12,5							0,7
	15,0							0,5
	17,5							0,3
	20,0							0,1

KEIL undercut anchor KH

Informative
Dimensioning aid for façade panels made of slate SIN 120

Annex D 8

Deutsches Institut für Bautechnik DIBt

Table D9: admissible wind loads – flush-fixed, $e/c_H = 0{,}33$

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10,0	7	50-150	50-150	600 x 600	4	1	2,6
	12,5							3,8
	15,0							3,7
	17,5							3,5
	20,0							3,4
2	10,0	7	50-150	50-200	600 x 900	4	1	1,5
	12,5							2,3
	15,0							2,2
	17,5							2,0
	20,0							1,9
3	10,0	7	50-150	100-250	600 x 1200	4	1	0,9
	12,5							1,6
	15,0							1,4
	17,5							1,3
	20,0							1,2
4	10,0	7	50-200	50-200	750 x 750	4	1	1,3
	12,5							2,2
	15,0							2,0
	17,5							1,9
	20,0							1,8
5	10,0	7	100-200	100-200	900 x 900	4	1	1,0
	12,5							1,3
	15,0							1,2
	17,5							1,0
	20,0							0,9
6	10,0	7	100-200	100-200	1000 x 1000	4	1	0,8
	12,5							0,9
	15,0							0,8
	17,5							0,7
	20,0							0,5

KEIL undercut anchor KH

Informative
Dimensioning aid for façade panels made of slate SIN 120

Annex D 9

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Dimensioning aid for facade panels made of slate SIN 150

Table D10: admissible wind loads – flush-fixed, e/c_H = 0,75

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10,0	7	50-150	50-150	600 x 600	4	1	2,8
	12,5							3,4
	15,0							3,1
	17,5							2,9
	20,0							2,7
2	10,0	7	50-150	50-200	600 x 900	4	1	1,5
	12,5							1,9
	15,0							1,6
	17,5							1,4
	20,0							1,2
3	10,0	7	50-150	100-250	600 x 1200	4	1	0,8
	12,5							1,1
	15,0							0,9
	17,5							0,6
	20,0							0,4
4	10,0	7	50-200	50-200	750 x 750	4	1	1,3
	12,5							1,7
	15,0							1,5
	17,5							1,3
	20,0							1,0
5	10,0	7	100-200	100-200	900 x 900	4	1	0,9
	12,5							0,8
	15,0							0,6
	17,5							0,4
	20,0							0,1
6	10,0	7	100-200	100-200	1000 x 1000	4	1	0,6
	12,5							0,5
	15,0							0,2

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Table D11: admissible wind loads – flush-fixed, $e/c_H = 0{,}54$

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10,0	7	50-150	50-150	600 x 600	4	1	3,0
	12,5							3,6
	15,0							3,4
	17,5							3,2
	20,0							3,1
2	10,0	7	50-150	50-200	600 x 900	4	1	1,7
	12,5							2,1
	15,0							1,9
	17,5							1,7
	20,0							1,6
3	10,0	7	50-150	100-250	600 x 1200	4	1	1,0
	12,5							1,4
	15,0							1,2
	17,5							1,0
	20,0							0,8
4	10,0	7	50-200	50-200	750 x 750	4	1	1,5
	12,5							2,0
	15,0							1,8
	17,5							1,6
	20,0							1,4
5	10,0	7	100-200	100-200	900 x 900	4	1	1,1
	12,5							1,1
	15,0							0,9
	17,5							0,7
	20,0							0,6
6	10,0	7	100-200	100-200	1000 x 1000	4	1	0,8
	12,5							0,7
	15,0							0,5
	17,5							0,4
	20,0							0,2

KEIL undercut anchor KH

Informative
Dimensioning aid for façade panels made of slate SIN 150

Annex D 11

Deutsches Institut für Bautechnik DIBt

Table D12: admissible wind loads – flush-fixed, $e/c_H = 0{,}33$

System	d = [mm]	h_v = [mm]	$a_{rx,1}$ $a_{ry,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 5)	Admissible windloads w_{Tab} [kN/m²]
1	10,0	7	50-150	50-150	600 x 600	4	1	3,2
	12,5							3,9
	15,0							3,8
	17,5							3,6
	20,0							3,5
2	10,0	7	50-150	50-200	600 x 900	4	1	1,9
	12,5							2,4
	15,0							2,3
	17,5							2,1
	20,0							2,0
3	10,0	7	50-150	100-250	600 x 1200	4	1	1,2
	12,5							1,6
	15,0							1,5
	17,5							1,4
	20,0							1,2
4	10,0	7	50-200	50-200	750 x 750	4	1	1,7
	12,5							2,3
	15,0							2,1
	17,5							2,0
	20,0							1,9
5	10,0	7	100-200	100-200	900 x 900	4	1	1,3
	12,5							1,4
	15,0							1,2
	17,5							1,1
	20,0							1,0
6	10,0	7	100-200	100-200	1000 x 1000	4	1	1,0
	12,5							1,0
	15,0							0,9
	17,5							0,7
	20,0							0,6

KEIL undercut anchor KH

Informative
Dimensioning aid for façade panels made of slate SIN 150

Annex D 12