

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

ETA-06/0253
of 21 November 2016

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
Im Auel 42
51766 Engelskirchen
DEUTSCHLAND

Manufacturing plant

KEIL Befestigungstechnik GmbH, Deutschland

This European Technical Assessment
contains

27 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

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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 $\Delta d_p = +6 \text{ mm} / \pm 0 \text{ mm}$. 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.

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 anchor 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 anchors 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 for tension and shear loads	See Annex C 1
Anchor distances and spacing	See Annex C 1

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	No performance assessed

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.

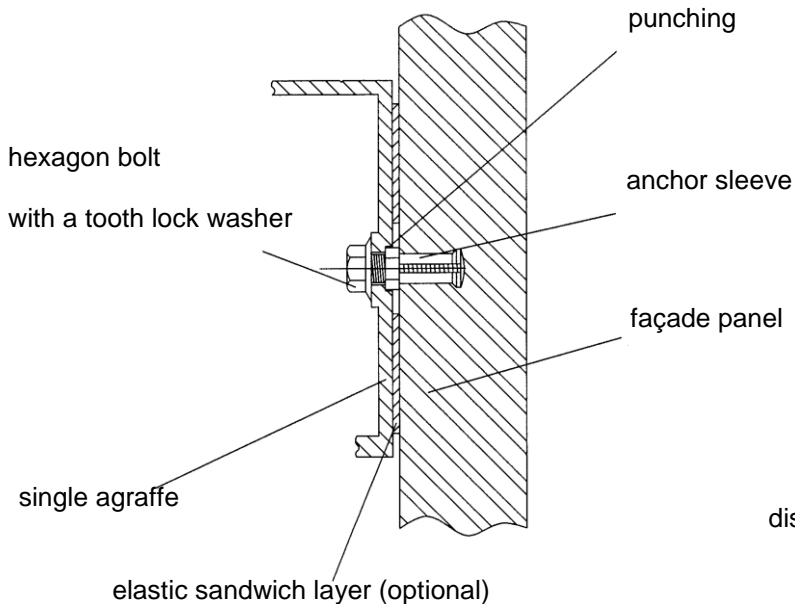
Issued in Berlin on 21 November 2016 by Deutsches Institut für Bautechnik

Dipl.-Ing. Andreas Kummerow
p. p. Head of Department

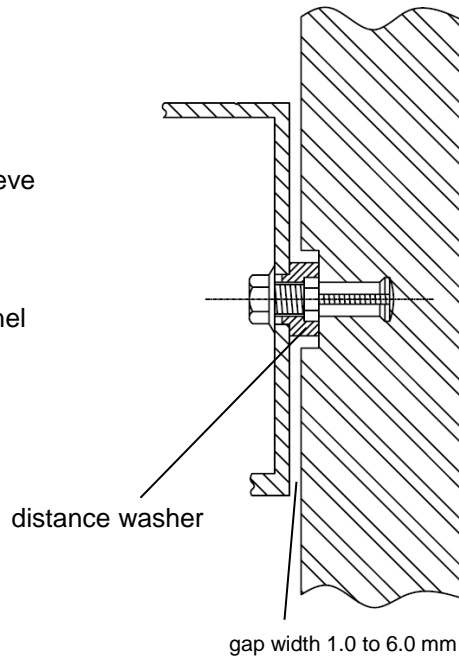
beglaubigt:
Aksünger

Installed anchor

Example without distance washer

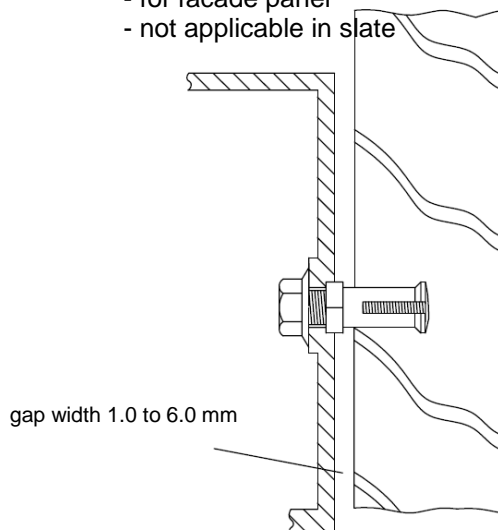


Example with distance washer



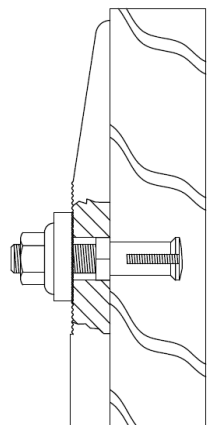
Stand-off fixing

- for facade panel
- not applicable in slate



Flush fixing

- for reveal panel
- applicable for slate panels

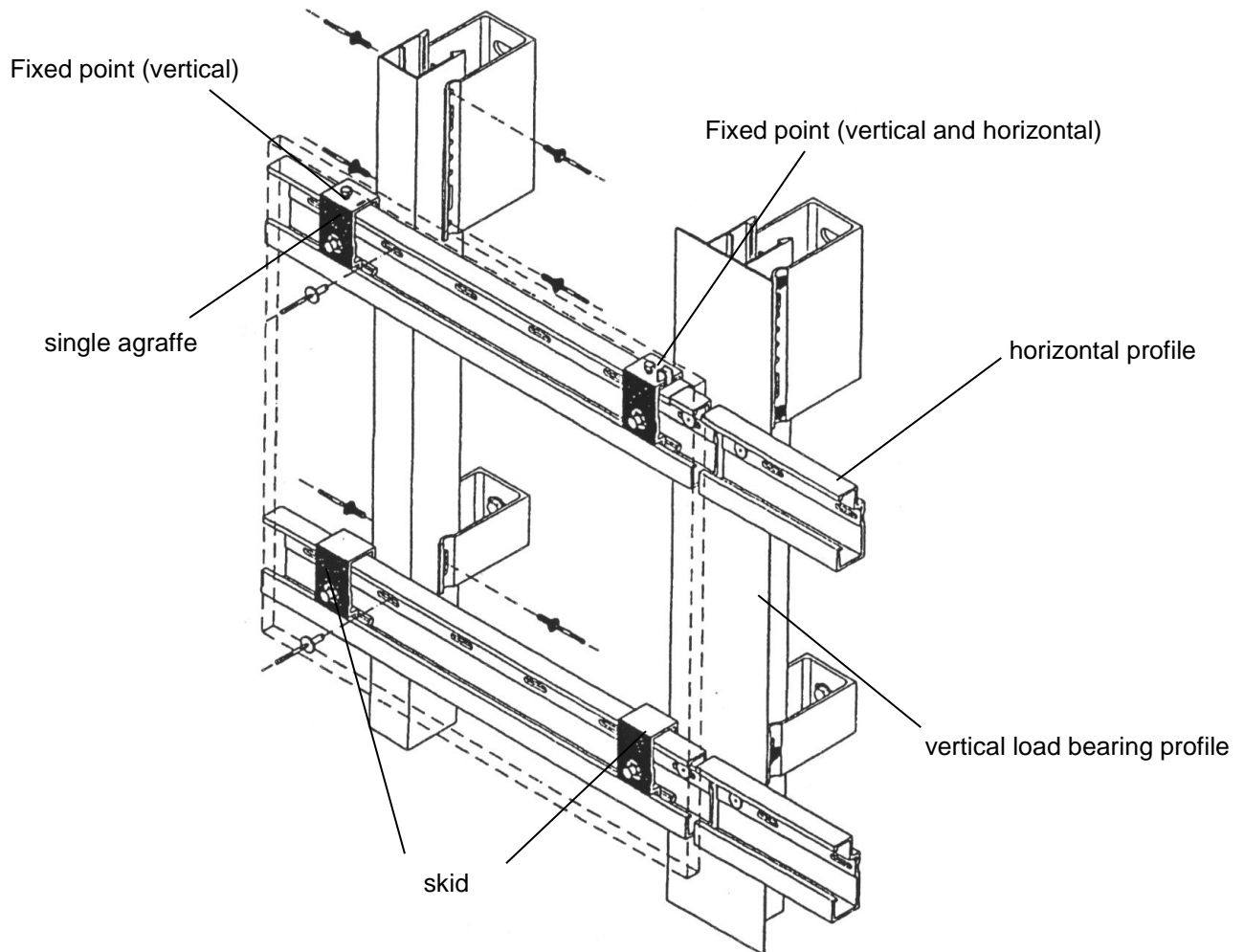


KEIL undercut anchor KH

Product description
Installed anchor

Annex A 1

Example of a substructure



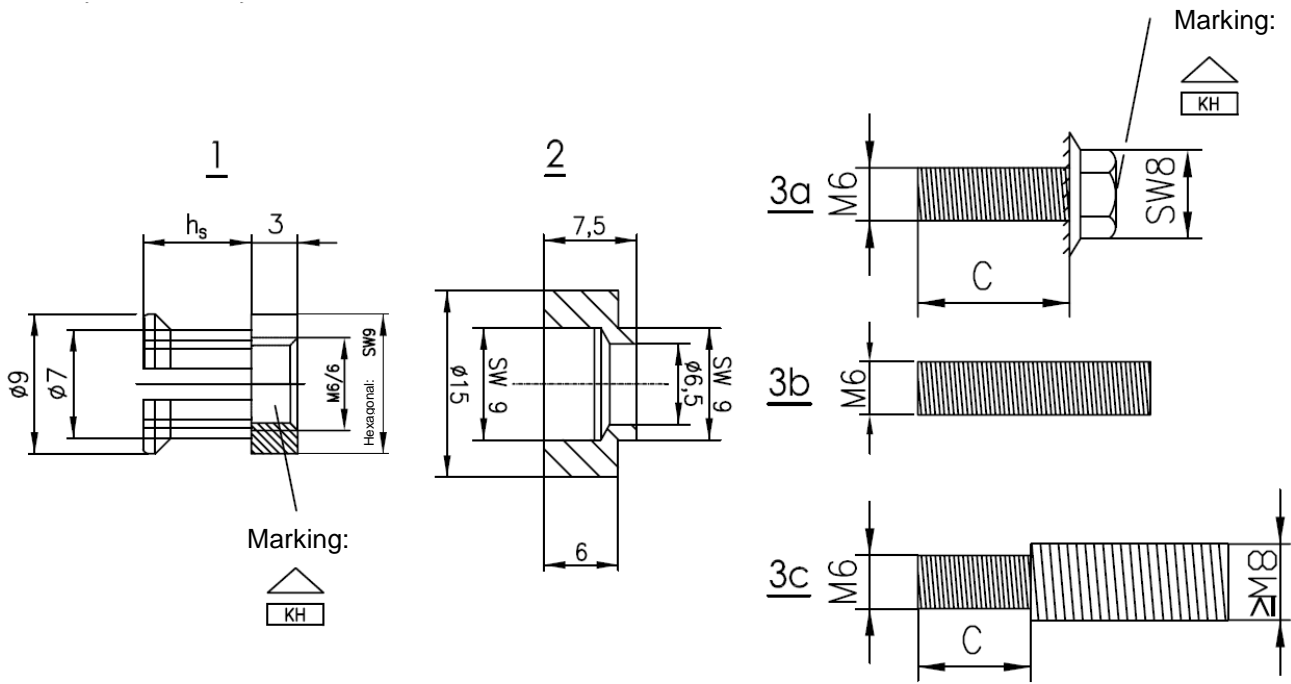
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KEIL undercut anchor KH

Product description
Example of substructure and fixing of the panel

Annex A 2

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]	$h_s + 3\text{mm} + t_{\text{fix}}$		
installation torque moment	T_{inst} [Nm]	$2,5 \leq T_{\text{inst}} \leq 4,0$		
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

Specifications of intended use

Anchorage subject to:

Static and quasi-static loads.

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions.
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist.

Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Base materials:

- natural stone façade panels shall be correspond according to EN 1469:2015
- the material used is free of crevices and mechanical effective cracks and alterations.
- Natural stone according to Table B1
- Parameters of facade panel according to Table B2 and B3

Table B1: Dimensions and materials

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"	quartzite, granulite, gneiss, migmatite, slate ¹	slate type: only CS 50, SIN 120 and SIN 150 according to Table B2
III	High-quality extrusive rocks (volcanic rocks)	basalt and basaltlava damaging ingredients (see Sonnenbrennerbasalt) may not exist	Density: basalt: $\rho \geq 2,7 \text{ kg/dm}^3$ basaltlava: $\rho \geq 2,2 \text{ kg/dm}^3$
IV	Sedimentary rocks with "hard stone character" ^{3,4}	sandstone and limestone	sandstone: $\rho \geq 2,1 \text{ kg/dm}^3$

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 %.

Table B2: Characteristic values of anchors and façade and reveal panel made of sleeve CS 50, SIN 120 or SIN 150

Sleeve		CS 50	SIN 120	SIN 150
Panel thickness	$h_{\text{nom}} \geq [\text{mm}]$	10		
Maximum size of panel	$A \leq [\text{m}^2]$	1,0		
Maximum side length	$H \text{ oder } L \leq [\text{m}]$	1,2		
Number of anchors (rectangular arrangement)	[-]	4 or 6	4	4
Density	$\gamma = [\text{kN/m}^3]$	28,0		
E-Modulus	$E = [\text{N/mm}^2]$	130000	120000	90000
Bending stress	$\sigma_{5\%} \geq [\text{N/mm}^2]$	40	25	30

KEIL undercut anchor KH

Intended use
Specifications

Annex B 1

Tabelle B3: Characteristic values of anchors and facade and reveal panel made of natural stone

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

1) for sandstone, limestone and basaltlava: panel thickness $h_{nom} \geq 30 \text{ mm}$, if from the panel manufacturer warrented lowest expect-value (5% fractile) oft he bending tensile strength is $< 8 \text{ N/mm}^2$.

2) only stand-off fixing

KEIL undercut anchor KH

Intended use
Specifications

Annex B 2

Design:

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

1.1 General

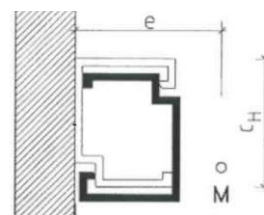
In Annex D several panel systems are listed as a function of the panel thickness, anchorage depth, edge distance, panel size, number of agraffes and the kind of support. The substructure has to be symmetrical.

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.

$$W_{Ek} \leq W_{Tab} \tag{1}$$

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 1 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:

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

with: L_i = equivalent support width (Anhang D 1)
 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 $E \geq 70.000 \text{ N/mm}^2$.

KEIL undercut anchor KH

Intended use
Specifications

Annex B 3

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).

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

- 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), 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.

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

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

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 5 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 5:
 - 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 5).

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 22 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.

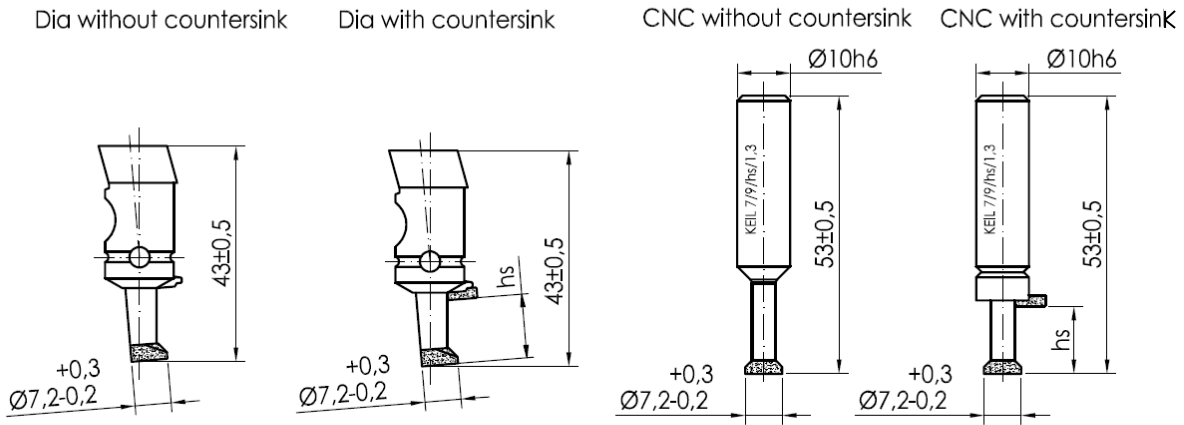
- During transport and storage on site the façade panels are protected from damages; the façade panels are not be hung up jerkily (if need be lifters shall be used for hanging up the façade panels); façade panels and reveal panels respectively with incipient cracks are not be installed.
- Between agraffe and façade panel an elastic sandwich layer may be placed.

KEIL undercut anchor KH	Annex B 4
Intended use Specifications	

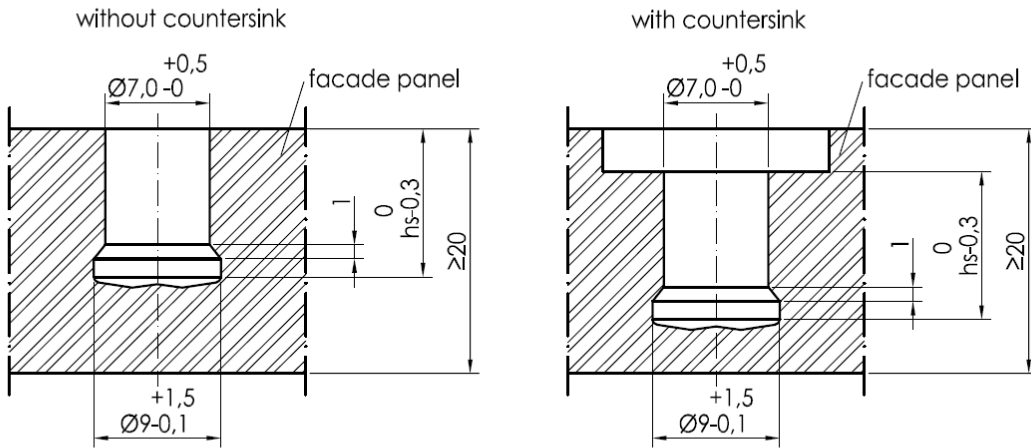
English translation prepared by DIBt

Geometry of the KEIL facade drill

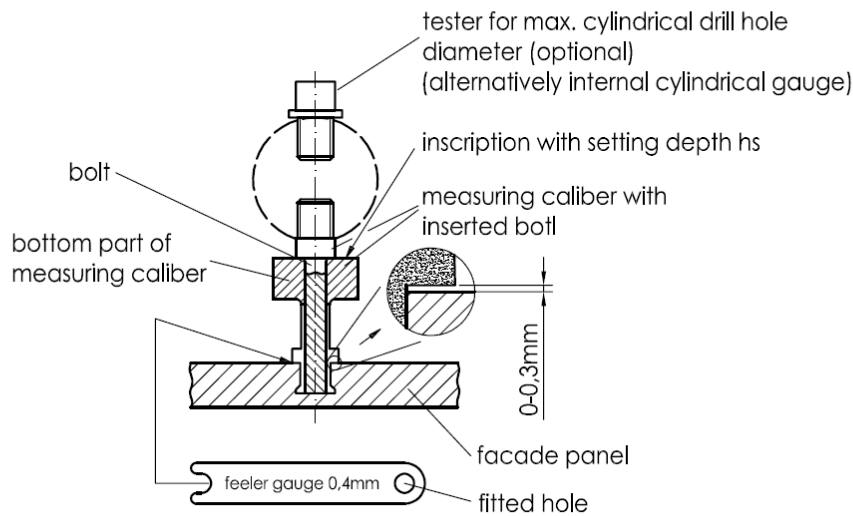
for KEIL facade drill bit 7/9



Geometry of the drill hole



KEIL measuring device



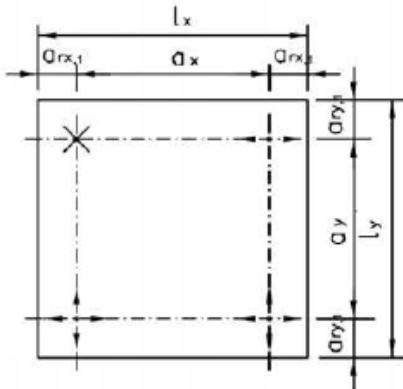
Drawing scale not true to real scale

KEIL undercut anchor KH

Intended use
Setting tools and testing equipment

Annex B 5

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

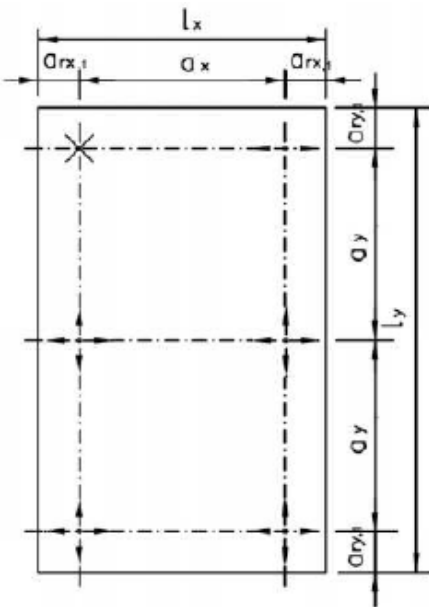


Figure 3: Façade panel with 6 agraffes – support condition 2

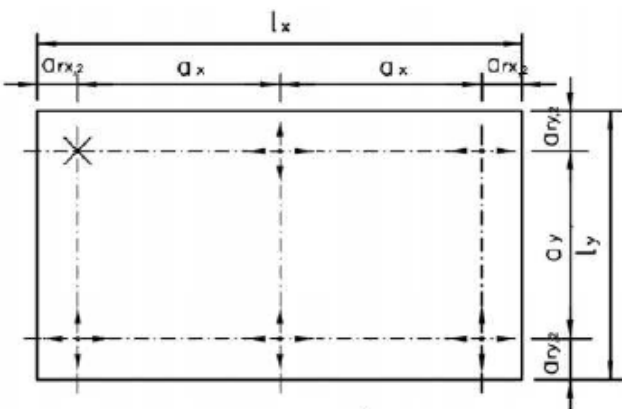


Figure 4: Façade panel with 6 agraffes – support condition 3

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KEIL undercut anchor KH

Intended use
Supports - definition of edge distance and spacing

Annex B 6

Definition of dimensions of the reveal angles

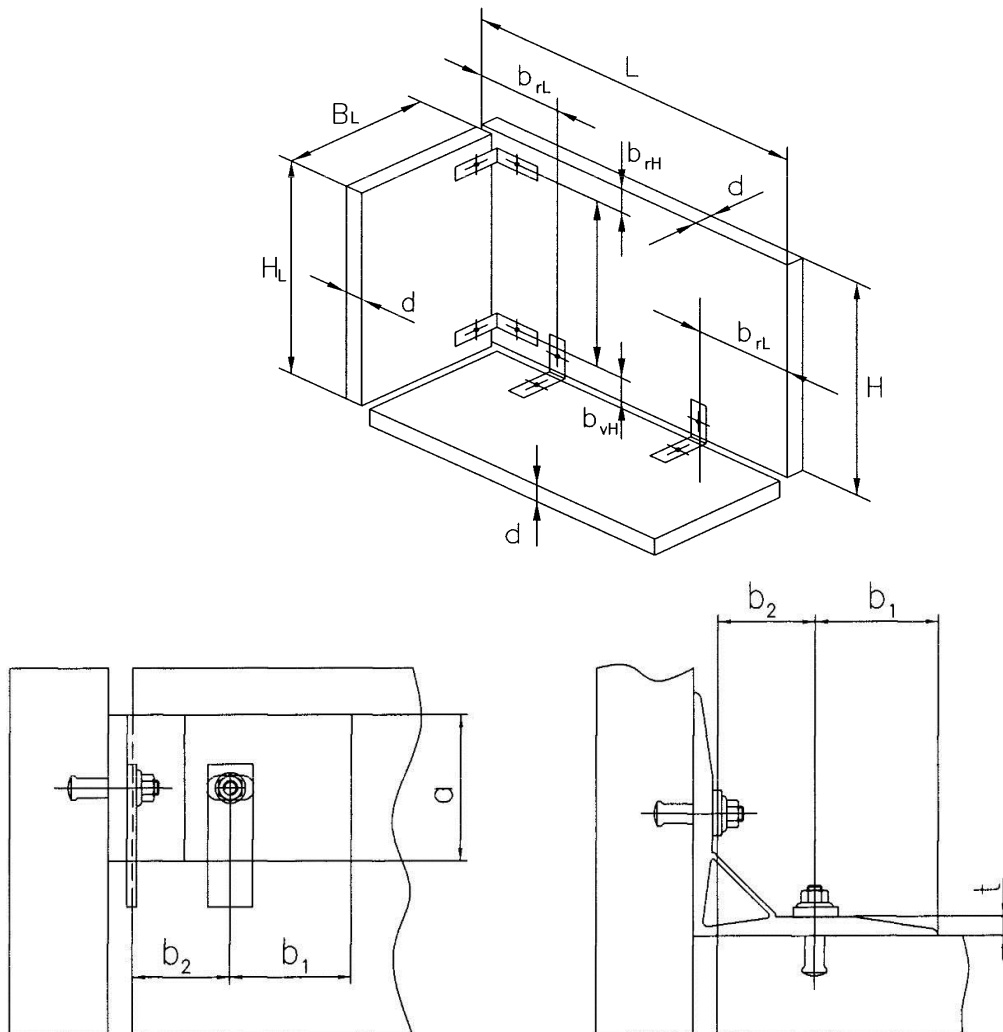


Table B4: Characteristic values of the reveal angles

		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

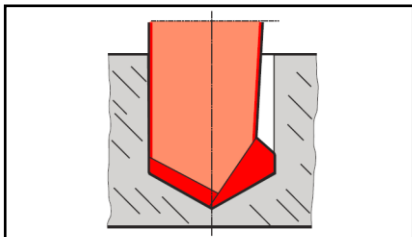
Intended use
Reveal angle of the panel made of natural stone (except slate)

Annex B 7

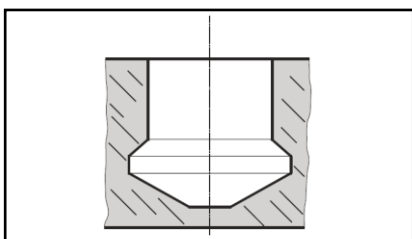
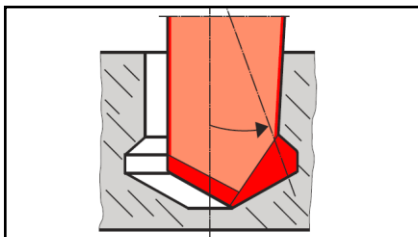
Installation instructions

1. Drilling the undercut hole

a) cylindrical drilling

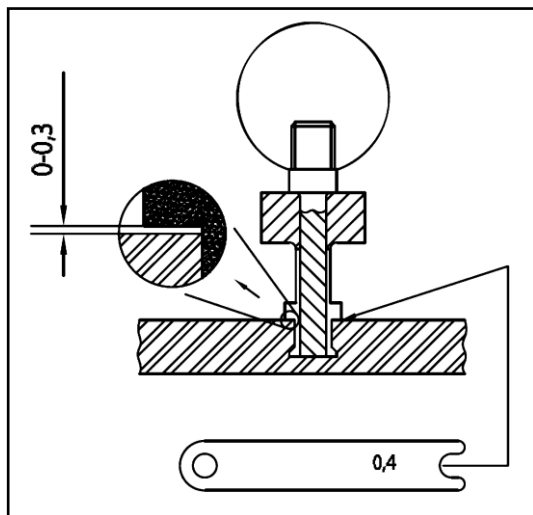


b) undercutting and cleaning



c) finished undercut hole

2. Checking the undercut hole



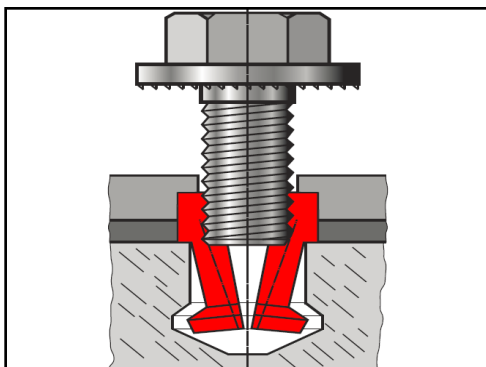
with KEIL depth control guide

KEIL undercut anchor KH

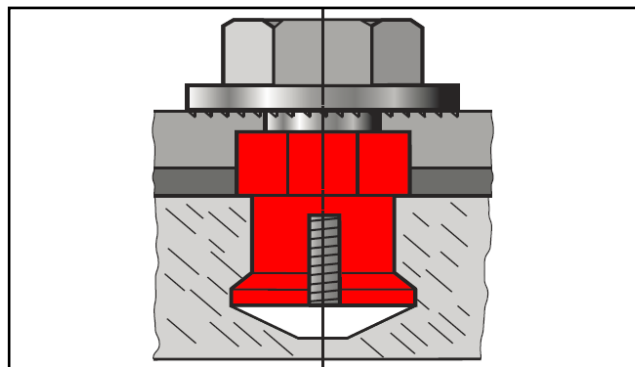
Intended use
Installation instructions

Annex B 8

3. Installation of anchor (sleeve and screw)

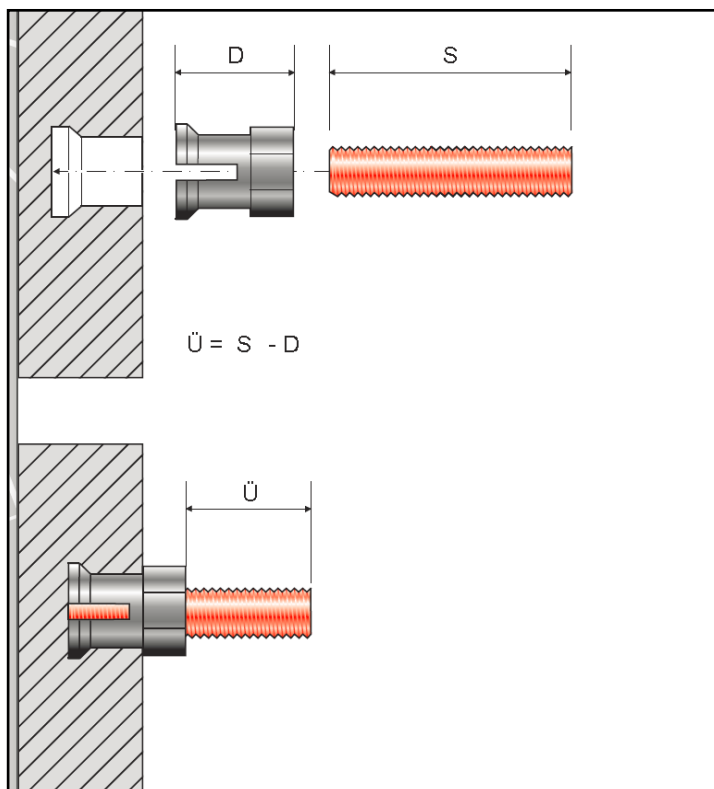


a) Insert the sleeve in the undercut hole and drill the screw in the sleeve



b) Installed anchor

4. Installation of anchor (sleeve and grub screw)



a) Insert the sleeve in the undercut hole

b) Drill the grub screw in the sleeve

c) Installed anchor

KEIL undercut anchor KH

Intended use
Installation instructions

Annex B 9

Characteristic load-bearing capacity of the anchor

Table C1: Characteristic values for facade panels and reveal panels

Natural stone		Epprechstein yellow ¹⁾	Padang light ¹⁾	Sto-Kilzinger Sandstein ¹⁾
Setting depth	$h_s =$ [mm]	15	10	15
Edge distance	$a_r \geq$ [mm]	100	50	100
Spacing	$a \geq$ [mm]	120	80	120
Characteristic resistance to tension load	$N_{Rk}^{1)} =$ [kN]	4,6	3,6	2,9
Characteristic resistance to shear load	$V_{Rk}^{1)} =$ [kN]	5,1	4,2	3,0

¹⁾ According to Table B3, for other natural stones the characteristic resistances may be determined as follows:

$$N_{Rk} = N_{u,5\%} \cdot \alpha_{exp}$$

$$V_{Rk} = V_{u,5\%} \cdot \alpha_{exp}$$

with:

$$\alpha_{exp} = 1,0 \quad \text{Group of stone I and II}$$

$$\alpha_{exp} = 1,25 \cdot \frac{\sigma_{um,exp}}{\sigma_{um}} \leq 1,0 \quad \text{Group of stone III and IV}$$

$\sigma_{5\%}$, $N_{u,5\%}$ und $V_{u,5\%}$, $\sigma_{um,exp}$ and σ_{um} according to EAD 330030-00-0601, Annex A

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

sleete		CS 50 ¹⁾		SIN 120 ¹⁾	SIN 150 ¹⁾
Setting depth	$h_s =$ [mm]	7			
Edge distance	$a_r \geq$ [mm]	50	100	50	
Spacing	$a \geq$ [mm]	100	200	100	
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

¹⁾ According to Table B2

KEIL undercut anchor KH

Performance
Characteristic resistance

Annex C 1

Dimensioning aid

The following bearing conditions are to use for the admissible wind loads in Annex D 2 to D 9. By object-related calculation other admissible wind load tables may be determined.

Maximum support spacing and location of the substructure fixings

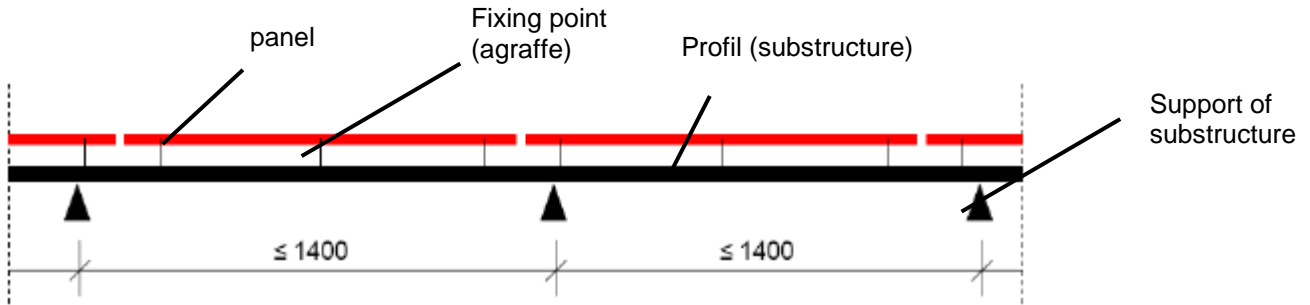


Figure 5: Profiles, supporting three fixing points of a panel, have a maximum spacing of the supports of 1.4 m.

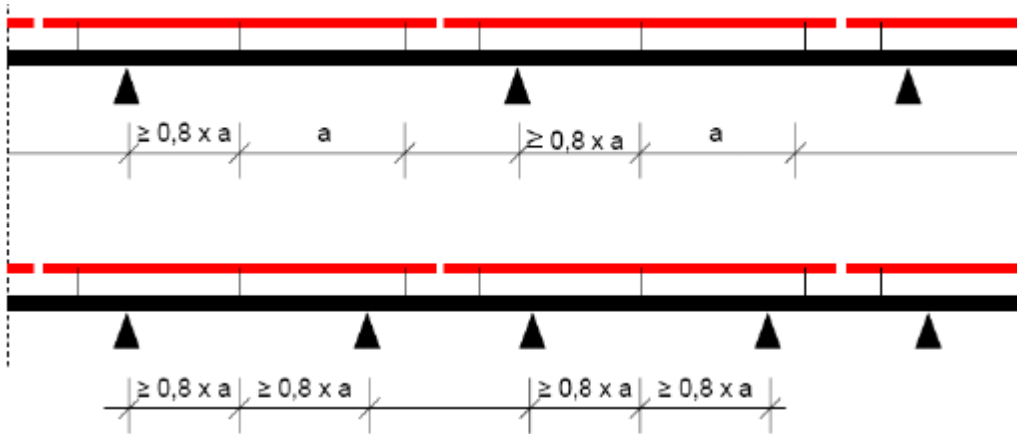


Figure 6: In profiles, supporting three fixing points of a panel, the central fixing points must have a minimum distance of $0,8 \times a$ (a = spacing of the fixing points of the panel) to the supports.

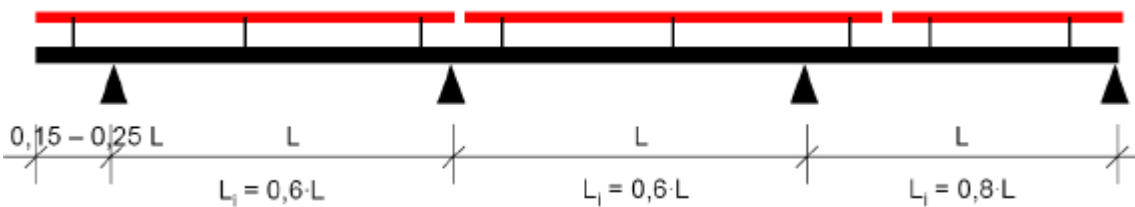


Figure 7: Equivalent support spacing

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KEIL undercut anchor KH

Informative

Maximum support spacing and location of the substructure fixings for sleete CS 50, SIN 120 and SIN 150

Annex D 1

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 6)	Admissible windloads w_{Tab} [kN/m ²]
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 6)	Admissible windloads w_{Tab} [kN/m ²]
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

Informative
Dimensioning aid for façade panels made of slate CS 50

Annex D 2

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 6)	Admissible windloads w_{Tab} [kN/m ²]
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 6)	Admissible windloads w_{Tab} [kN/m ²]
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

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Dimensioning aid for façade panels made of slate CS 50

Annex D 3

English translation prepared by DIBt

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 6)	Admissible windloads w_{Tab} [kN/m ²]
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 6)	Admissible windloads w_{Tab} [kN/m ²]
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

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Dimensioning aid for façade panels made of slate CS 50

Annex D 4

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]	$a_{px,1}$ $a_{py,2}$ [mm]	$a_{ry,1}$ $a_{rx,2}$ [mm]	Panel length x width [mm]	No. of agraffes	Support condition (Annex B 6)	Admissible windloads w_{Tab} [kN/m ²]
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 5

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 6)	Admissible windloads W_{Tab} [kN/m ²]
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 6

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 6)	Admissible windloads w _{Tab} [kN/m ²]
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 7

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 6)	Admissible windloads w_{Tab} [kN/m ²]
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

KEIL undercut anchor KH

Informative
Dimensioning aid for façade panels made of slate SIN 150

Annex D 8

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 6)	Admissible windloads w_{Tab} [kN/m ²]
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 9

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 6)	Admissible windloads w_{Tab} [kN/m ²]
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