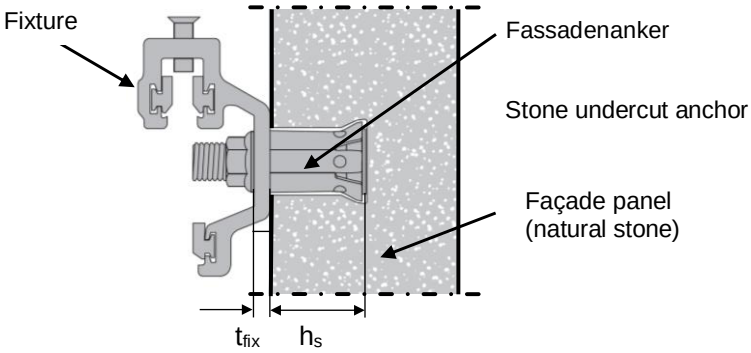
HSU-R

APPLICATION

Fastening stone panel of facade



Advantages

- Performance assessed by European Approval body per the latest standard.
- Impossible for damaging spinning lock or undercut elements during installation
- Clear visual check for undercut completion (Hilti red line mark for undercut portfolio)
- Optimized sleeve size for reducing the possibility of spinning after installation.

Basic information

Base material:		Natural stone
Corrosion protection:	A4 316	Stainless steel grade A4

APPLICABLE NATURAL STONE PANNELS

All stone groups are applicable

Stone group		Natural stone type	Boundary conditions
I	High quality intrusive rocks (plutonic rocks)	E.g. granite, granitite, tonalite, diorite, monzonite, gabbro	None
II	Metamorphic rocks with „hard stone characteristics “	E.g. quarzite, granulite, gneiss, migmatite	None
III	High quality extrusive rocks (volcanic rocks)	Basalt and basaltic lava	Minimum density ρ: basalt: 2,7 kg/dm³ basaltic lava: 2,2 kg/dm³
IV	Sedimentary rocks with „hard stone characteristics “1)	Sandstone and limestone	Minimum density ρ: sandstone: 2,1 kg/dm³

1) For façade panels made of natural stones with planes of anisotropies, the difference between the flexural strength determined parallel to the planes of anisotropy and perpendicular to the edges of the planes of anisotropy shall not be more than 50 %.
2) Natural stone free of open seams and mechanically active cracks and alterations.

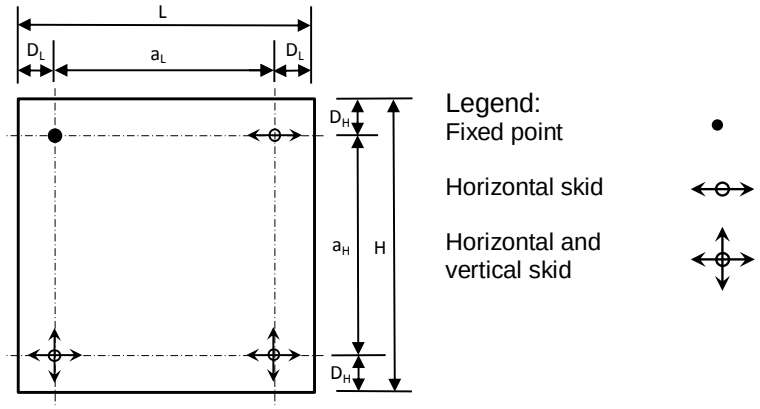
Properties of applicable natural stone panels

Panel thickness (stone group I / II (Tab. B1))	h	[mm]	20 ≤ d ≤ 70
Minimum panel thickness (stone group I / II (Tab. B1))	h_{min}	[mm]	h_s + 5 mm
Panel thickness (stone group III / IV (Tab. B1))	h	[mm]	25 (30)[1] ≤ h ≤ 70
Minimum panel thickness (stone group III / IV (Tab. B1))	h_{min}	[mm]	h_s + 10 mm
Maximum panel size	A	[m²]	3,0
Maximum side length	H und L	[m]	3,0
Number of anchors (rectangular arrangement)	N	[-]	4
Minimum edge distance[2]	D_L, D_H	[mm]	50
Maximum edge distance	D_L, D_H	[mm]	0,25 · L und 0,25 · H
Minimum spacing[2]	a_L and a_H	[mm]	8 · h_s

[1] For sandstone, limestone and basaltic lava: panel thickness ≥ 30 mm, if the panel manufacturer warranted lowest expected value (5 % fractile) of the flexural strength is < 8 N/mm².

[2] For small fitting or fill-in pieces the minimum edge distance or spacing shall be chosen per the geometrical boundary conditions. In case of design under static loading using FEM, smaller edge distances are allowed.

Figure B1: Façade panel with fixing points



DESIGN INFORMATION

Introduction

- Anchorage of facade panels are designed under the responsibility of an engineer experienced in anchorages and facade engineering.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the façade anchor is indicated on the design drawings.
- All loading data provided in this technical data sheet is evaluated based on EAD 330030-00-0601 for single anchor under static or quasi static loading independent the source of the data.

Basic load data (single anchor)

- All data in this section applies to correct anchor setting (see instruction for use, setting parameters)
- The resistance of steel failure provided by this technical data manual may not be lowest resistance for all failure modes of a stone undercut placed into nature stone.
- The resistance in natural stone provided by this technical data manual are valid only for the exact same natural stone panels or for those panels with equal or higher flexural strength, equal or larger edge distances and thicknesses.
- The resistance of the stone panel shall be verified in addition to the anchor resistance.
- For natural stone panels, which are not listed in this technical data manual, additional tests and evaluation per EAD 330030-00-0601 shall be used by responsible engineer to define the final resistance.

Characteristic resistance under tension and shear load – steel resistance

Anchor size		M6	M8
$N_{Rk,s}$	[kN]	16,1	29,3
$V_{Rk,s}$	[kN]	8,0	14,6

Design resistance under tension and shear load – steel resistance

Anchor size		M6	M8
$N_{Rd,s}$	[kN]	11,5	20,9
$V_{Rd,s}$	[kN]	6,4	11,9

Safety factor used: $\gamma_{Ms,N}$ = 1,4; $\gamma_{Ms,V}$ = 1,25

Characteristic resistance – in natural stone panels

- All load information relates to the base material information.
- The load listed is the minimal characteristic value among all failure modes.
- Characteristic value represents 5% - fractile of ultimate loads with confidence level of 75% using logarithmical normal distribution of the single test results and an unknown standard deviation of the population.
- Reduction factor α_{exp} depending on stone class is already included.

No.	Base material	Data source	Size		M6		M8	
			Setting depth h_s [mm]		13	15	15	21
1	Group I, Granite, Padang Cristallo[1)]	ETA	N_{Rk}	[KN]	4,0	-	6,0	-
			V_{Rk}	[KN]	6,6	-	6,9	-
2	Group I, Gabbro, Nero Assoluto[2)]	ETA	N_{Rk}	[KN]	11,6	-	17,0	-
			V_{Rk}	[KN]	11,8	-	21,4	-
3	Group I, Limestone, Jura Limestone[3)]	ETA	N_{Rk}	[KN]	-	5,4	-	8,9
			V_{Rk}	[KN]	-	7,3	-	9,6
4	Group I, Granite, China G3554	Hilti Technical Data	N_{Rk}	[KN]	9,5	12,1	12,4	19,4
			V_{Rk}	[KN]	6,3	6,3	6,3	10,0

Design resistance – in natural stone panels

Design resistance is based on Partial safety factor γ_M =1,8 per EOTA TR XXX

Design principle

$\frac{N_{Ed}}{N_{Rd}} \leq 1,0$ and $\frac{V_{Ed}}{V_{Rd}} \leq 1,0$ Equation 1 and 2

$\frac{N_{Ed}}{N_{Rd}} + \frac{V_{Ed}}{V_{Rd}} \leq X$ Equation 3

Combined tension and shear resistance factor X in Equation 3 is 1.0, unless special noted.

$N_{Rk} = N_{u,5\%} \bullet \alpha_{exp}$ Equation 4

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

With:

α_{exp} = 1,0 stone group I and II

$\alpha_{exp} = 1,25 \bullet \frac{\sigma_{um,exp}}{\sigma_{um}} \leq 1,0$ stone group III and IV (default value without testing α_{exp} = 0,78)

$N_{u,5\%}$ and $V_{u,5\%}$, $\sigma_{um,exp}$ and σ_{um} in accordance with EAD 330030-00-0601, Annex A.

No.	Base material	Data source	Size		M6		M8	
			Setting depth h_s [mm]		13	15	15	21
1	Group I, Granite, Padang Cristallo[1)]	ETA	N_{Rd}	[KN]	2,2 X= 1.2	2,2	3,3	-
			V_{Rd}	[KN]	3,6	3,6	3,8	-
2	Group I, Gabbro, Nero Assoluto[2)]	ETA	N_{Rd}	[KN]	6,4	-	9.4	-
			V_{Rd}	[KN]	6,5	-	11,9	-
3	Group I, Limestone, Jura Limestone[3)]	ETA	N_{Rd}	[KN]	-	3.0	-	4.9
			V_{Rd}	[KN]	-	4,0	-	5.3
4	Group I, Granite, China G3554	Hilti Technical Data	N_{Rd}	[KN]	5.3	6.7	6.9	10.7
			V_{Rd}	[KN]	3,4	3,4	3,4	5,5

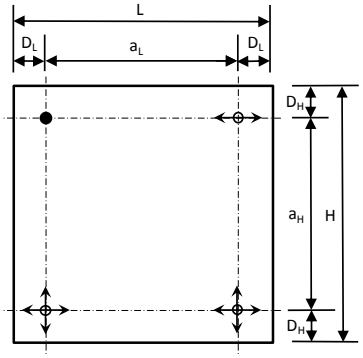
Base material information corresponding to the resistance in natural stone panels

No.	Base material	Characteristic Flexural strength of panel [MPa]	Size		M6		M8	
			Setting depth h_s [mm]		13	15	15	21
1	Group I, Granite, Padang Cristallo[1)]	12,4	Edge distance	[mm]	100	100	100	100
			Panel thickness	[mm]	30	30	30	30
2	Group I, Gabbro, Nero Assoluto[2]	26,3	Edge distance	[mm]	150	150	150	150
			Panel thickness	[mm]	25	25	25	25
3	Group I, Limestone, Jura	14,1	Edge distance	[mm]	150	150	150	150
			Panel thickness	[mm]	35	35	35	35
4	Group I, Granite, China G3554	15	Edge distance	[mm]	150	150	150	150
			Panel thickness	[mm]	30	30	30	50

Design example

Stone Material Property Information

Stone Material name: Padang Cristallo
flexural strength σ_{rk}: 13 [MPa] characteristic value
Length L: 650 [mm]
Height H: 1200 [mm]
Thickness d: 30 [mm]
Position D_L: 150 [mm]
Position D_H: 100 [mm]



Action on the most loaded anchor:

Tension Load N_{rk} 1.3 [kN]
Shear Load V_{rk} 2.1 [kN]

Design

1. Application feasibility check:

   Stone group is No.1.
   Maximum panel size L and H < 3m; OK
   Thickness d > 20mm; OK
   Position D_L and D_H > 50mm, D_L < 0.25 X 650 mm, D_H < 0.25 X 1200 mm; OK

   This stone panel is applicable.

2. Design resistance check:

   Stone panel used has a larger edge distance and flexural strength than the data No.1 provided in this FTM, and has the same thickness, therefore the technical data No.1 in this FTM can be used directly for this design.

   $\frac{N_{Ed}}{N_{Rd}} = 1.3/2.2 \leq 0.59$ and $\frac{V_{Ed}}{V_{Rd}} = 2.2/3.6 \leq 0.58$

   $\frac{N_{Ed}}{N_{Rd}} + \frac{V_{Ed}}{V_{Rd}} = 0.59 + 0.58 = 1.17 \leq X\ (1.2)$

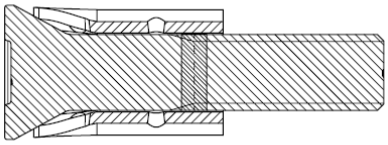
Conclusion: HSU-R M6X13 fulfill the requirement

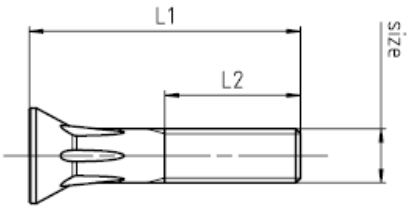
MECHANICAL PROPERTY

Anchor size		M6	M8
Nominal tensile strength $f_{uk,thread}$	[N/mm²]	800	800
Stressed cross-section A_s	[mm²]	20.1	36.6

Expansion sleeve, bolt, hexagon nut, washer and flange nut are all made of Stainless steel A4 (EN ISO 3506)

ANCHOR DIMENSIONS

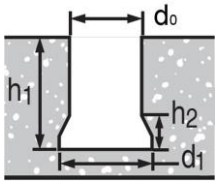




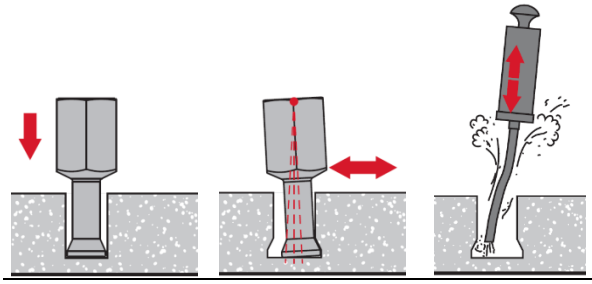
Anchor size			M6	M8
Maximum thickness of fixture	$t_{fix,max}$	[mm]	10	8
Minimum length of the anchor	$L_{1,\ min}$	[mm]	24	28
Maximum length of the anchor	$L_{1,\ max}$	[mm]	32	38
Length of expansion sleeve	L_2	[mm]	13/15	15/21

INSTALLATION PARAMETERS

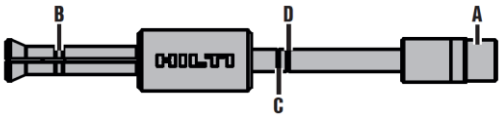
Size			M6	M8
Setting depth	h_s	[mm]	$(10 \le h_s \le 25)^{+0,4/-0,1}$	
Drill hole depth	h_1	[mm]	$h_s + 0,5$	
Diameter of drill hole	d_0	[mm]	$11^{+0,4/-0,2}$	$13^{+0,4/-0,2}$
Diameter of undercut	d_1	[mm]	$13,5_{\pm 0,3}$	$15,5_{\pm 0,3}$
Height of undercut	h_2	[mm]	$4,5\ _{\pm 0,5}$	$4,5\ _{\pm 0,5}$
Installation torque moment	T_{inst}	[Nm]	6	10
Width across flats	SW	[mm]	10	13
Max. diameter of clearance hole in fixture	d_f	[mm]	7	9
Max. fixture thickness	t_{fix}	[mm]	10	8



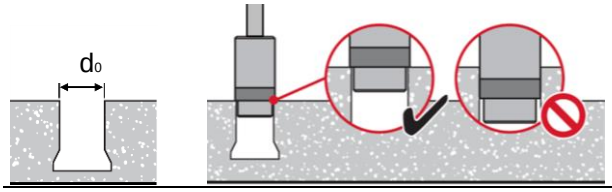
Drilling and cleaning of the undercut drill hole



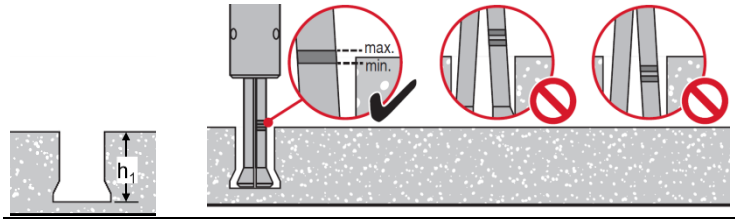
Checking dimensions of drill hole with gauge



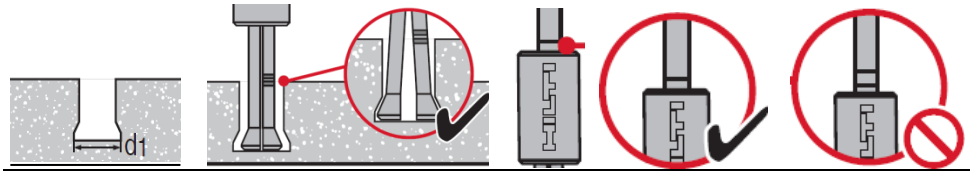
A) Drill hole diameter d_0



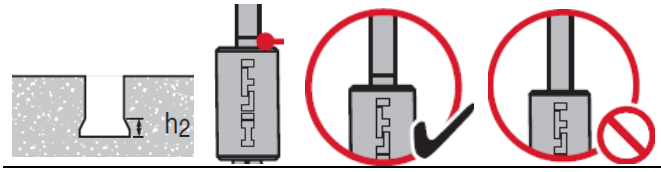
B) Drill hole depth h_1



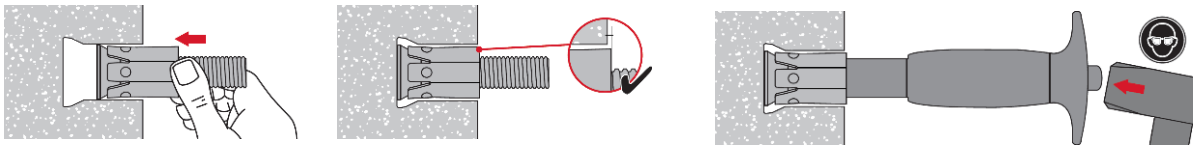
C) Diameter of the undercut d_1



D) *height of the undercut* h_2



Installation of the undercut anchor



Checking of the setting depth

Installation of the fixture