HIT-SHEAR STRENGTHENING SYSTEM

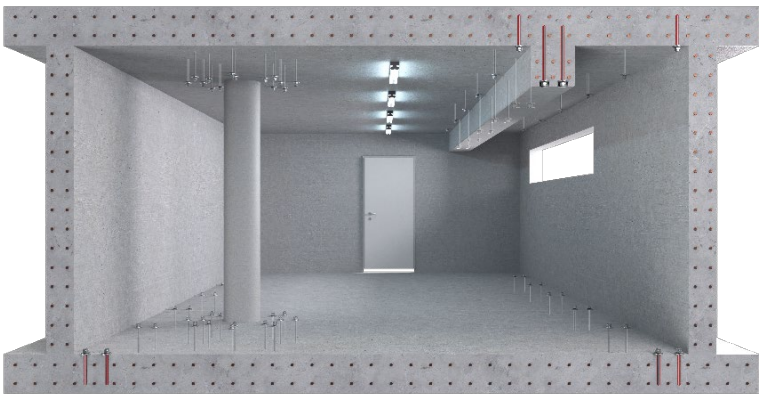
Product Technical Datasheet

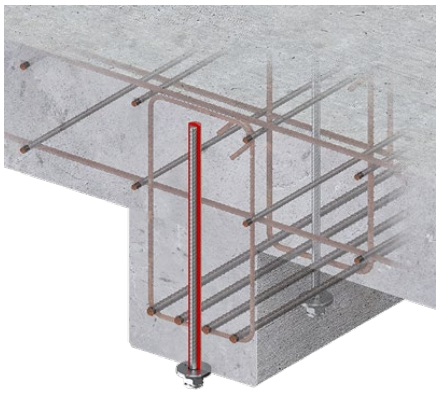
Update: Jan 25

HIT-Shear with HIT-RE 500 V4 injection mortar, HAS/HAS-U threaded rods, Filling Set

for strengthening concrete in shear (DIBt aBG Z-15.5-383, based on DIN EN 1992-1-1/NA)

HIT-Shear Strengthening system components		Benefits
	Hilti HIT-RE 500 V4 (in 330 / 500 ml foil pack)	- Suitable in concrete strength classes C20/25-C50/60. - Suitable for dry and water-saturated concrete, and water-filled holes. - Suitable for either Hilti hollow drill bit for Hammer Drilling or Diamond Coring with Roughening tool - Temperature range of the base material: -5°C to +40°C - Long working time at elevated temperatures - HAS-U anchor rods have engraved marking on the head for easy verification of steel grade and bar length even after installation
	HAS 8.8 HAS-A4 (M12 – M24)	
	HAS-U 8.8 HAS-U A4 (M12-M24)	**Application: Shear strengthening of concrete members** Increasing loads on existing structures may result in existing reinforced concrete members not having sufficient resistance in bending, shear, compression, or torsion, thus needing strengthening. HIT-Shear offers a minimally invasive strengthening solution that increases the shear resistance of concrete members by increasing available cross-sectional steel when installed from one side. strengthened member can safely resist additional loads, preventing the need to demolish and rebuild.
	Filling Set and Locking Nut accessory	Design of the verification and strengthening scheme is possible: - Using the German National Approval (aBG) - Integrated in the PROFIS Engineering suite





Application conditions

Base material

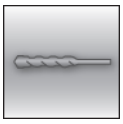
Concrete

Load conditions

Static/ Quasi-static

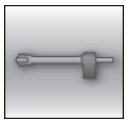
Fatigue

Drilling, cleaning, setting



Hammer drilled holes

Diamond cored holes with Roughening Tool



Hollow Drill Bit drilled holes

Other information

PROFIS Engineering design Software

Linked Approvals/Certificates and Instructions for use

Approval no.	Application / loading condition	Authority / Laboratory	Date of issue	Date of expiry
aBG Z-15.5-383	Shear Strengthening Static quasi-static and fatigue	DIBt, Berlin	21-10-2024	08-5-2029

The instructions for use can be viewed using the link in the instructions for use table or the QR code/link in the Hilti webpage table

Instructions for use (IFU)

Material and Application			
Application	IFU- HIT-Shear one-sided installation		
Injection mortar	IFU Hilti HIT-RE 500 V4 (330/500 ml)		IFU Hilti HIT-RE 500 V4 (1400 ml)
Dispenser	IFU HDM	IFU HDE	IFU HIT-P8000D

Link to Hilti Webpage

Injection mortars / Dispenser / Accessories					
Hilti HIT-RE 500 V4	HDE 500-22	HDE 500-A12	Hilti HIT-P8000D	Filling set	PS 300

Strengthening Elements	
HAS-U 8.8	HAS 8.8

Specific properties of the Strengthening Elements

Mechanical properties of the Hilti HAS and HAS-U strengthening element and Hilti Filling Set

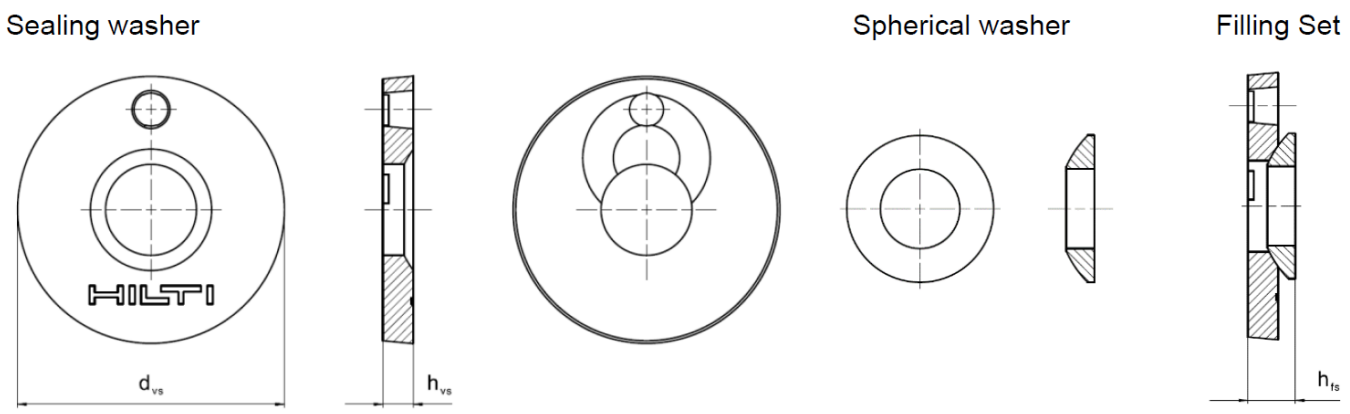
Designation	Material
Steel elements made of carbon steel	
HAS 8.8, HAS-U 8.8	Strength class 8.8, $f_{uk} = 800\ N/mm^2$, $f_{yk} = 640\ N/mm^2$, Elongation at fracture $(l_0 = 5d) > 12\%$ ductile Electroplated zinc coated $\geq 5\ \mu m$
Nut	Strength class 8.8, $f_{uk} = 800\ N/mm^2$, $f_{yk} = 640\ N/mm^2$, Electroplated zinc coated $\geq 5\ \mu m$
Hilti Filling Set	Filling washer: Electroplated zinc coated $\geq 5\ \mu m$ Spherical washer: Electroplated zinc coated $\geq 5\ \mu m$ Lock nut: Electroplated zinc coated $\geq 5\ \mu m$
Steel elements made of stainless steel with corrosion resistance class (CRC) III according to DIN EN 1993-1-4:2015-10	
HAS A4, HAS-U A4	Strength class 70, $f_{uk} = 700\ N/mm^2$, $f_{yk} = 450\ N/mm^2$, Elongation at fracture $(l_0 = 5d) > 12\%$ d ductile Stainless steel according to DIN EN 10088-1:2014-12
Nut	Strength class 70, $f_{uk} = 700\ N/mm^2$, $f_{yk} = 450\ N/mm^2$, Stainless steel 1.4401, 1.4404, 1.4578, 1.4571, 1.4362 according to DIN EN 10088-1:2014-12
Hilti Filling Set A4	Filling washer: Stainless steel according to DIN EN 10088-1:2014-12 Spherical washer: Stainless steel according to DIN EN 10088-1:2014-12 Lock nut: Stainless steel according to DIN EN 10088-1:2014-12

Dimensions of the filling washer for use with standard nut

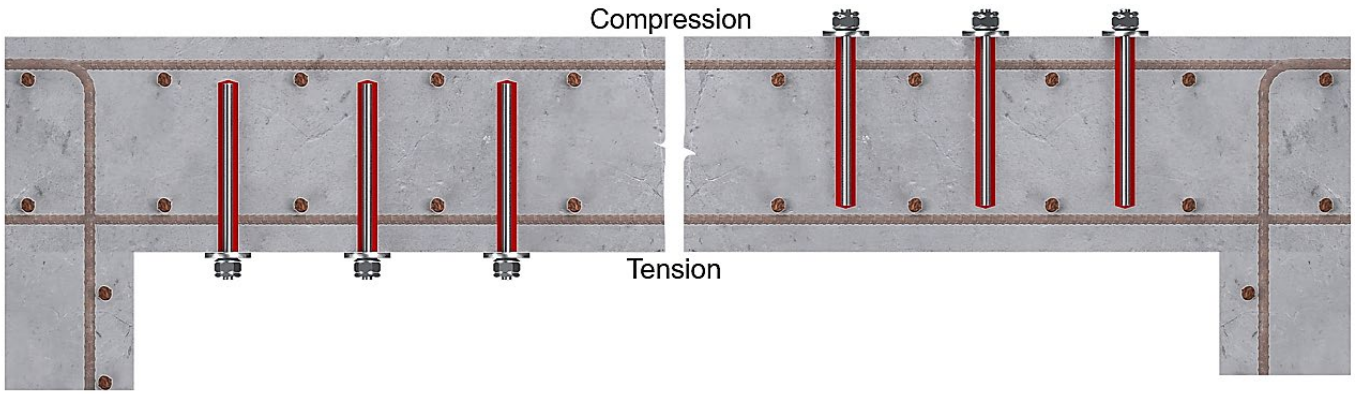
Mechanical properties of Filling set are standardized and can be taken from the link given in Approvals / Certificates table

Dimensions filling washer

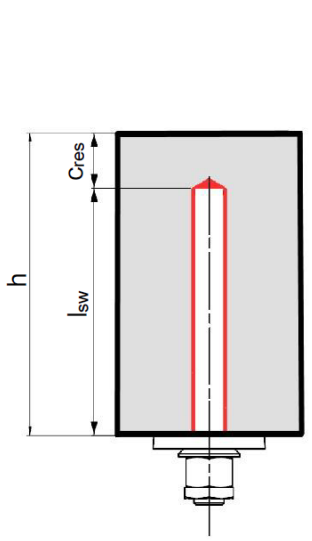
Anchor size			M12	M16	M20	M24
Diameter	d_{vs}	[mm]	44	52	60	70
Height of filling washer	h_{vs}	[mm]	5	6	6	6
Height of filling washer and spherical washer	h_{fs}	[mm]	10	11	13	15



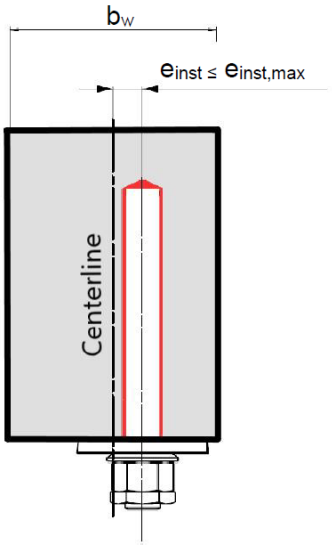
Cross-section of HIT-Shear installed from either the tension or compression side of a concrete member



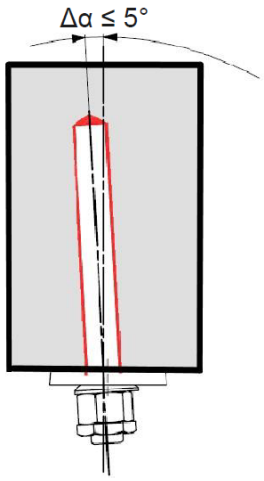
Installation Parameters and Permitted Tolerances



Member cross-section



Transverse eccentricity



Angular deviation

$\mathbf{b_w}$	: cross-sectional width
$\mathbf{h}$	: height of the concrete member
$\mathbf{c_{res}}$	: defined residual concrete cover above the end of the threaded rod to the concrete surface
$\mathbf{l_{sw}}$	: $\mathbf{h - c_{res}}$ = embedment depth of the threaded rod
$\mathbf{e_{inst}}$	: eccentricity of the threaded rods
$\mathbf{e_{inst,max}}$	: $\boldsymbol{min(50\ mm, b_w/6)}$ = maximum eccentricity of the threaded rods
$\mathbf{\Delta\alpha_{max}}$	: maximum permissible angle of inclination (= 5°) of the threaded rods with respect to the line of action of the shear force (perpendicular to the longitudinal axis of the concrete member)

Design according to *aBG Z-15.5-383* for static and fatigue conditions

Based on DIN EN 1992-1-1/NA and DIN EN 1992-2/NA, the **static** verification must fulfil:

$$\boldsymbol{V_{Ed} \leq V_{Rd} = \min\left(V_{Rd,max}; V_{Rd,s}\right)} \quad \text{Eq. (1)}$$

Where,

$$\boldsymbol{V_{Rd,max} = \frac{\alpha_{cw} \cdot b_{w,eff} \cdot z \cdot \upsilon_1 \cdot f_{cd}}{\cot\theta + \tan\theta}} \quad \text{Eq. (2)}$$

- $b_{w,eff} = b_w - \min\left(50\ mm\ ; \frac{b_w}{6}\right)$
- $z = 0{,}9d \leq \max\left(d - 2c_{v,l}\ ; d - c_{v,l} - 30\ mm\right)$
- $\alpha_{cw} = 1$
- $\upsilon_1 = 0{,}75$
- $f_{cd} = \alpha_{cc} f_{ck}/\gamma_c$, with $\alpha_{cc} = 0{,}85$ and $\gamma_c = 1{,}5$
- DIN EN 1992-1-1/NA Strut angle limits for buildings:
  - $1 \leq \cot\theta \leq \frac{1{,}2+1{,}4\sigma_{cp}/f_{cd}}{1-V_{Rd,cc}/V_{Ed}} \leq 3{,}0$, with $V_{Rd,cc} = 0{,}5 \cdot 0{,}48 \cdot f_{ck}^{1/3}\left(1 - 1{,}2\frac{\sigma_{cp}}{f_{cd}}\right) \cdot b_{w,eff} \cdot z$
- DIN EN 1992-2/NA Strut angle limits for bridges:
  - $1 \leq \cot\theta \leq \frac{1{,}2+1{,}4\sigma_{cp}/f_{cd}}{1-V_{Rd,cc}/V_{Ed}} \leq 1{,}75$, with $V_{Rd,cc} = 0{,}5 \cdot 0{,}48 \cdot f_{ck}^{1/3}\left(1 - 1{,}2\frac{\sigma_{cp}}{f_{cd}}\right) \cdot b_{w,eff} \cdot z$

$$\boldsymbol{V_{Rd,s} = k_{pi} \cdot k_s \cdot a_{sw} \cdot z \cdot f_{ywd} \cdot \cot\theta} \quad \text{Eq. (3)}$$

- $a_{sw} = \frac{n_{swt} \cdot A_{sw}}{s_{wl}}$
- For other parameters: refer to Tables (a) and (b)

Fatigue verification is required only when:

$$\boldsymbol{\Delta V_{Ed,fat} > 0{,}33 V_{Ed}} \quad \text{Eq. (4)}$$

- For up to 5x10^6 cycles
- Fatigue strength of the strengthening elements considered in design, $\Delta\sigma_s \leq 60\ N/mm^2$

Table (a)

Strengthening element	Element diameter	Design value of yield Strength of the elements in Eq. (3) f_{ywd} [N/mm^2]	Cross-sectional area of strengthening element in Eq. (3) A_{sw} [mm^2]
HAS 8.8, HAS-U 8.8, HAS A4, HAS-U A4	M12	390	84,3
	M16		157,0
	M20		245,0
	M24		353,0

Table (b)

Parameters for shear strengthening	Element diameter		Tension-to-compression installation (Configuration A)	Compression-to-tension installation (Configuration B)
Coefficient for post-installed shear strengthening k_{pi} [-]	M12		0,735	0,588
	M16	h ≥ 400 mm		
		200 mm ≤ h < 400 mm	0,529	0,423
	M20		0,735	0,588
	M24			
Size-dependent coefficient k_s [-]	M12		$\begin{cases} 1{,}0 & when\ z \leq 0{,}75m \\ 1{,}15 - 0{,}20 \cdot z & when\ z > 0{,}75m \end{cases}$	
	M16			
	M20			
	M24			

For specific design cases, refer to PROFIS Engineering.

Detailing rules according to *aBG Z-15.5-383*

Minimum spacing and maximum strengthening ratio:

Element diameter	Minimum longitudinal spacing, $s_{wl,min}$ [mm]	Minimum transverse spacing, $s_{wt,min}$ [mm]	Maximum shear strengthening ratio, $\rho_{sw,max}$ (1) [%]
M12	120	120	0,8
M16	160	160	
M20	200	200	
M24	240	240	

(1) The shear strengthening ratio must be calculated as $\rho_w = a_{sw}/b_w$, where a_{sw} is the stressed area of post-installed steel strengthening per unit length of the concrete member, and b_w is the minimum concrete cross-section width between tension and compression chords.

Maximum spacing for Linear members:

Shear force utilization (1)	Maximum longitudinal spacing, $s_{wl,max}$	Maximum transverse spacing, $s_{wt,max}$
$V_{Ed}/V_{Rd,max} \leq 0{,}3$	$\min(0{,}7\ h, 300\ mm)$	$\min(h, 800\ mm)$
$0{,}3 < V_{Ed}/V_{Rd,max} \leq 0{,}6$	$\min(0{,}5\ h, 300\ mm)$	$\min(h, 600\ mm)$
$V_{Ed}/V_{Rd,max} > 0{,}6$	$\min(0{,}25\ h, 200\ mm)$	

(1) $V_{Rd,max}$ calculated according to design eq.(2)

Maximum spacing for Planar members:

Shear force utilization (1)	Maximum longitudinal spacing, $s_{wl,max}$	Maximum transverse spacing, $s_{wt,max}$
$V_{Ed}/V_{Rd,max} \leq 0{,}3$	$0{,}7h$	h
$0{,}3 < V_{Ed}/V_{Rd,max} \leq 0{,}6$	$0{,}5h$	
$V_{Ed}/V_{Rd,max} > 0{,}6$	$0{,}25h$	

(1) $V_{Rd,max}$ calculated according to design eq. (2)

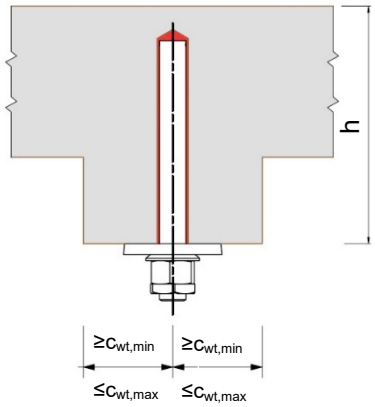
Minimum and maximum edge distances:

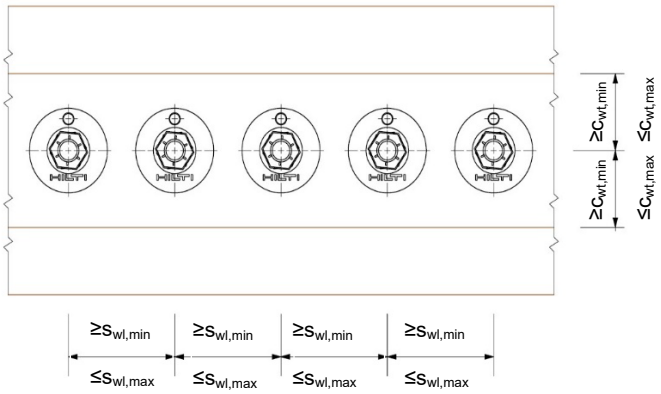
Drilling system	Rod size	Minimum edge distance, $c_{wt,min}$		Maximum edge distance, $c_{wt,max}$	
		Without Drilling Aid	With Drilling Aid	Linear members	Planar members
Hammer drilling (HD), Hammer drilling with Hilti hollow drill bits (HDB) (1) and Diamond coring with Roughening tool (RT)	M12	$45\ mm + 0{,}06 l_{sw}$	$45\ mm + 0{,}02 l_{sw}$	175 mm	$\max(175\ mm, 0{,}5h)$
	M16	$50\ mm + 0{,}06 l_{sw}$	$50\ mm + 0{,}02 l_{sw}$		
	M20	$55\ mm + 0{,}06 l_{sw}$	$55\ mm + 0{,}02 l_{sw}$	250 mm	$\max(250\ mm, 0{,}5h)$
	M24	$60\ mm + 0{,}06 l_{sw}$	$60\ mm + 0{,}02 l_{sw}$		
Pneumatic drilling (CA)	M12	$50\ mm + 0{,}08 l_{sw}$	$50\ mm + 0{,}02 l_{sw}$	175 mm	$\max(175\ mm, 0{,}5h)$
	M16				
	M20	$55\ mm + 0{,}08 l_{sw}$	$55\ mm + 0{,}02 l_{sw}$	250 mm	$\max(250\ mm, 0{,}5h)$
	M24	$60\ mm + 0{,}08 l_{sw}$	$60\ mm + 0{,}02 l_{sw}$		

Note: The minimum concrete cover according to DIN EN 1992-1-1 must be observed.

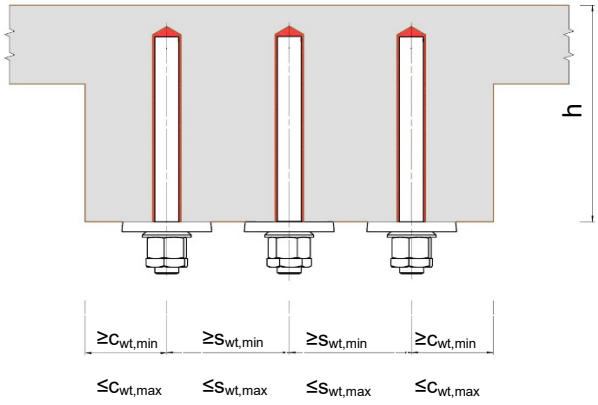
Edge distances and spacing for the strengthening element

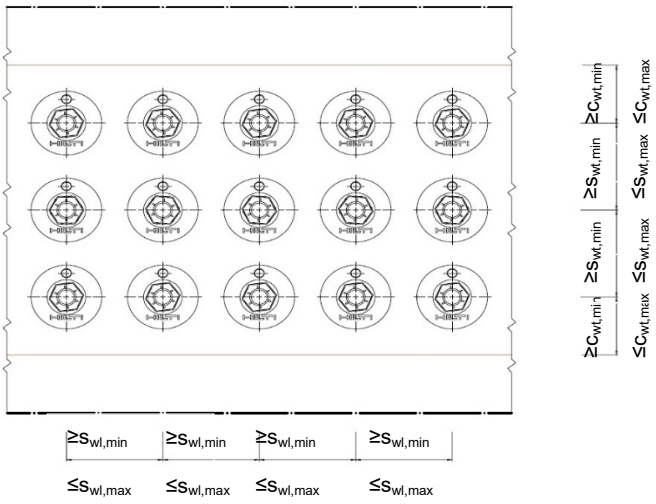
Strengthening elements in beam with one row:



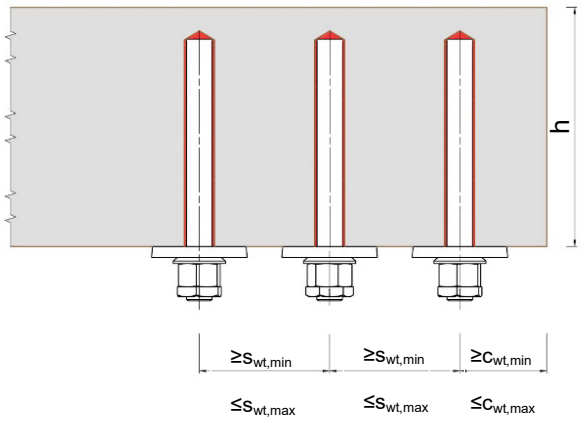


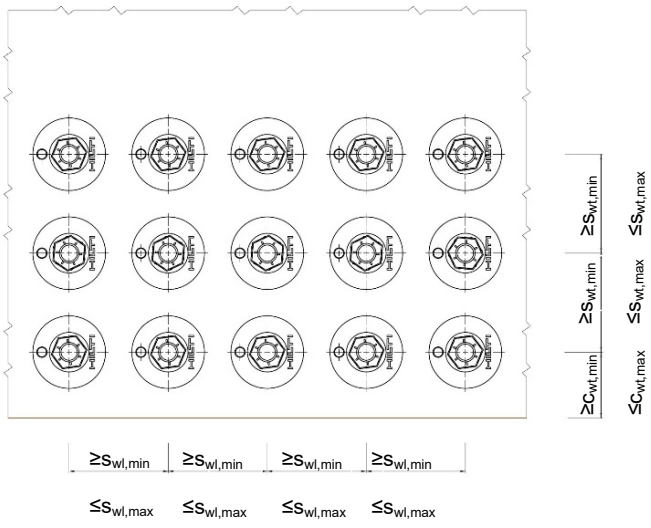
Strengthening elements in beam with multiple rows:





Strengthening elements in slab with multiple rows:





Setting information

Installation temperature
-5 °C to +40 °C

Service temperature range
Hilti HIT-RE 500 V4 injection mortar with strengthening element HAS / HAS-U may be applied in the temperature ranges given below. An elevated base material temperature may lead to a reduction of the design bond resistance.

Temperature range	Base material temperature	Maximum long term base material temperature	Maximum short term base material temperature
Temperature range	-40 °C to +60 °C	+43 °C	+60 °C

Maximum short term base material temperature
Short-term elevated base material temperatures are those that occur over brief intervals, e.g., from diurnal cycling.

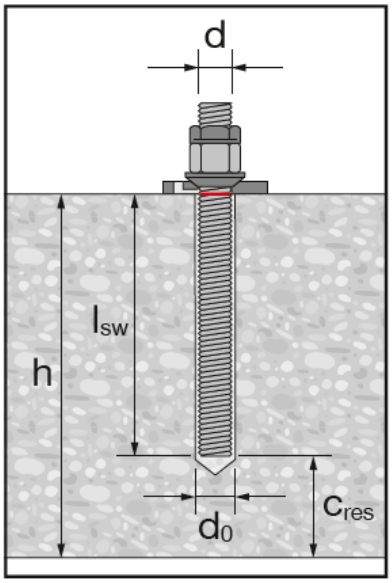
Maximum long term base material temperature
Long-term elevated base material temperatures are roughly constant over significant periods of time.

Working time and curing time (1) (2)

Temperature of the base material, T	Maximum working time, t_{max}	Minimum curing time, t_{cure}
-5 °C to -1 °C	2 h	168 h
> -1 °C to 4 °C	2 h	48 h
> 4 °C to 9 °C	2 h	24 h
> 9 °C to 14 °C	1,5 h	16 h
> 14 °C to 19 °C	1 h	16 h
> 19 °C to 24 °C	30 min	7 h
> 24 °C to 29 °C	20 min	6 h
> 29 °C to 34 °C	15 min	5 h
> 34 °C to 39 °C	12 min	4,5 h
> 39 °C to 40 °C	10 min	4 h

1) The curing time data are valid for dry base material only. In wet base material, the curing times must be doubled.
2) The minimum temperature of the foil pack is +5° C.

Installation parameters			M12	M16		M20	M24
Element diameter	d	[mm]	12	16		20	24
Nominal drill bit diameter	d_0	[mm]	14	18		22	28
Minimum concrete cross-section depth	h_{min}	[mm]	200	200	400	600	
Maximum concrete cross-section depth	h_{max}	[mm]	2200				
Embedment depth	l_{sw}	[mm]	$h - c_{res}$				
Residual concrete cover at the position of the drill hole	c_{res}	[mm]	35	35	40	45	60
Maximum installation torque	$T_{inst} \leq$	[Nm]	40	80		150	200



Maximum embedment depth $l_{sw,max}$ depending on threaded rod diameter and mortar dispenser [1)]

Threaded rod diameter	Injection mortar dispenser		
	HDM 330, HDM 500	HDE 500	HIT-P8000D
	$l_{sw,max}$ [mm]	$l_{sw,max}$ [mm]	$l_{sw,max}$ [mm]
M12	1000	1000	1000
M16		1400	1400
M20	700	1800	1800
M24	500		2140

[1)] The embedment depth is dependent on the drilling methods, please see the IFU for further details.

Drilling and Installation equipment

For detailed setting information on installation see instructions for use given with the product.

Scanning		PS 300 Ferroscan system
Rotary Hammers (Corded and Cordless)		TE 2 - TE 70
Diamond Coring Machines		DD EC-1, DD 100 … DD 160
Dispenser		HDE HDM PE-8000D
Other tools		Blow out pump, Compressed air gun, Set of cleaning brushes
		Hammer drill bit TE-CX, TE-YX, TE-C, TE-Y
		Hollow drill bit TE-CD, TE-YD
		Diamond core bit SP-L, SP-HX, SP-H, P-U
		Roughening tools TE-YRT
		Piston plug