HILTI

HILTI HIT INJECTION SYSTEM FOR REBAR APPLICATIONS

- **Hilti HIT-RE 500 V3**
- **Hilti HIT-RE 100**
- **Hilti HIT-HY 200**

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1. POST-INSTALLED SIMPLY WORKS BETTER THAN CAST-IN

by Jakob Kunz

Post-installed reinforcement works at least as well as cast-in rebars. This has been proven by the comprehensive testing required for European Technical Approvals or post-installed reinforcement connections. Consequently, the design process is straightforward and in accordance with structural concrete codes (ACI 318 & Eurocode 2) for post-installed overlap splices, reinforcement anchorage at simple supports and connections of columns mainly loaded in compression.

Only straight bars can be post-installed in cured concrete, but cast-in reinforcement often uses hooks to reduce anchorage length or bends to divert forces. Hilti has thus invested in extensive research to find solutions that allow post-installed reinforcement to be used in situations where standard structural concrete detailing would require hooks or bends. A revolutionary new design method has now been developed on the basis of this research.

Hilti HIT Rebar Design Method

According to structural concrete building codes, the bond strength of cast-in bars is limited, even where depth of concrete cover is considerable.

Accordingly, in some zones such as in walls where anchorage depth is often limited, welded transverse reinforcement or hooks are used to compensate for the reduction in available anchorage depth.

The Hilti Rebar Design Method also makes it possible to reduce anchorage length while maintaining the high bond strength needed to replace hooks or welded transverse reinforcement.

Better results through more detailed research

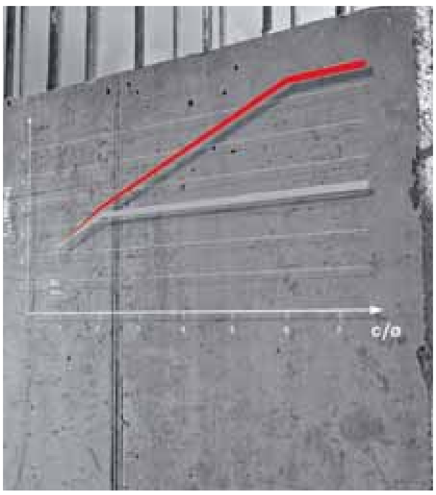
Research has shown that the bond strength of bars anchored with Hilti adhesive mortars is higher than that of cast-in-place bars, provided there is adequate concrete cover[1].

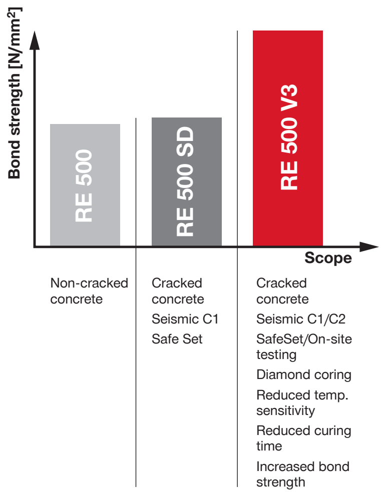
The Hilti HIT Rebar Design Method takes advantage of this increased bond strength in order to achieve anchorage length reductions of up to 50% compared to the figures given in building codes.

Frame node connections with straight bars

According to standard reinforcement design concepts, bends are required at moment-resisting connections.

Working together with the Technical University of Munich and the American University of Beirut, Hilti has carried out theoretical and laboratory research in order to propose an adequate strut-and-tie model that takes the specific characteristics of frame node connections with straight bars[2] into account.





Connection of members under tension

Where a connection is made between concrete members under predominant tension, the principles of anchor design should be applied[3].

As a specialist in anchoring to concrete, Hilti is well qualified to provide the appropriate solutions. Factors such as the possibility of concrete cone breakout must be given special consideration.

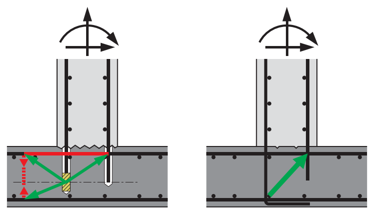
Post-installed reinforcement for shear loads

Thanks to many years of research, Hilti is also in an excellent position to provide solutions for post-installed shear interface reinforcement[4] for concrete overlays or post-installed punching shear reinforcement[5].

Hilti HIT Rebar Design Method

Bond strength depends on concrete cover. Where cover is limited, splitting is the controlling factor and the red and grey lines therefore show more or less linear functions.

Where cover is sufficient, pull-out begins to become the controlling factor. With Hilti adhesives, the cover limit is usually higher than that specified for cast-in in concrete building codes (f_{bd}=bond strength, c=cover, Ø=bar diameter).



Strut-and-tie modeling of frame node connections for straight (post-installed) and bent (standard cast-in) bars.

Dr. Jakob Kunz is Scientific Consultant for the Hilti Anchor Business Unit. He gained his doctorate at the ETH (Swiss Federal Institute of Technology) in Zurich and Lausanne and has been with Hilti as a research engineer, project manager and chief scientific officer since 1989. Dr. Jakob Kunz specializes in the fields of fastening technology and reinforced concrete design. He is a member of fib, IABSE, ACI and SIA 179

References

1) Kunz, J., Muenger F.: Splitting and Bond Failure of Post-Installed Rebar Splices and Anchorings. Bond in Concrete. fib, Budapest, 20 to 22 November 2002.
2) Hamad, B.S., Al-Hammoud, R., Kunz, J.: Evaluation of Bond Strength of Bonded-In or Post-Installed Reinforcement. ACI Structural Journal, V. 103, No. 2, March–April 2006.
3) Design of Bonded Anchors. EOTA Technical Report TR 029. European Organisation for Technical Approvals, June 2007.
4) Randk, N.: Untersuchungen zur Kräfteübertragung zwischen Alt- und Neubeton bei unterschiedlicher Fugenrauhigkeit. University of Innsbruck, Austria, 1997 (Thesis in German).
5) Fernandez Ruiz, M., Muttoni, A., Kunz, J.: Strengthening of Flat Slabs Against Punching Shear Using Post-Installed Shear Reinforcement. ACI Structural Journal, V. 107, No. 4, July–August 2010.

2. BASIC CONSIDERATIONS FOR FIRE DESIGN OF POST-INSTALLED REINFORCEMENT

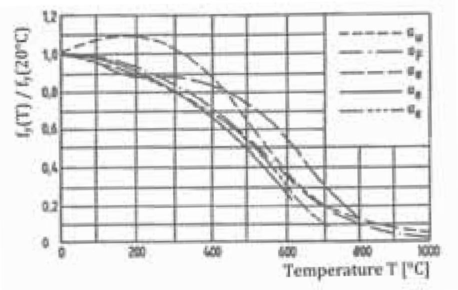


Fig. 1. Strength reduction of carbon steel due to temperature (various sources)

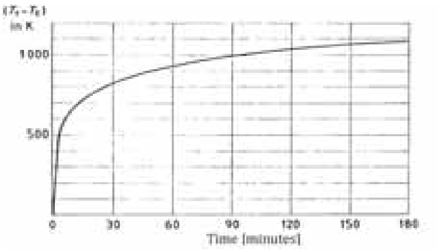
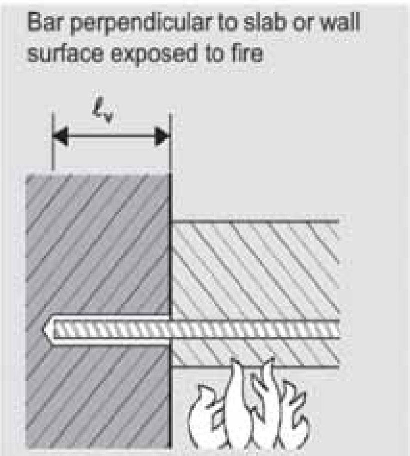
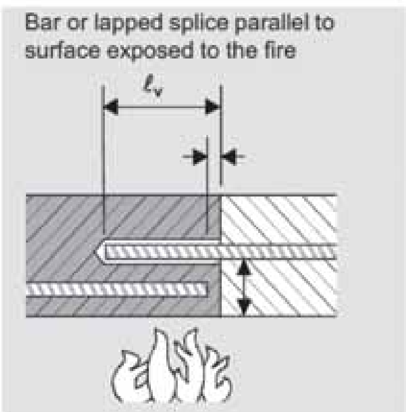


Fig.2 Standard temperature / time curve (ISO 834)

Fire Exposure Condition





State of the Art assessment of fire resistance for reinforced concrete structures

Codes

Specify minimum concrete cover for protection of the reinforcement against high temperature depending on the required fire rating.
Since, in case of fire, the behaviour of the bonding material for post-installed bars is somewhat different to cast-in reinforcement some back ground information is necessary to provide equivalent behaviour of the post installed system.

Behaviour of steel in high temperatures

Steel changes material properties when its temperature is increased. This is especially the case for yield strength as shown by fig.1.
▶ **Note: at 560°C steel yield is approx. half of yield strength at room temperature.**

Safety approach for fire design

The safety approach for fire design is semi- empirical because it is impossible to determine a fire statistically. Therefore a standard fire temperature/time curve ISO 834 (fig. 2) has been agreed on for normal cases. In some cases, especially in road tunnels more stringent temperature/time curves are applied.
▶ **Note: Safety concept is based on experience, many simplifications on the safe side have been accepted for design.**

Fire resistance of bonded-in bars

Scope

The sensitivity for high temperatures of the adhesives used for bonded-in bars is higher than the bond of cast-in bars. A design concept is provided for the design of fire resistance for bonded-in bars with equivalent safety compared to cast-in bars.

Tests and design concept

Tests to evaluate the relationship between temperature and bond of the adhesives have been performed. Taking into account the temperature gradients in the concrete for the various fire ratings a design concept was derived. Testing, high temperature – bond relation and the design tables are shown in the corresponding reports.

Conclusion

Be aware that steel yield under fire is reduced considerably, and safety factors for fire design are reduced accordingly as specified in the code.
Note that the fire design tables **must not be used for cold design** (accepted bond stress under fire may be above the values acceptable for safe cold design).

a) The maximum load for each individual fire design is performed by the engineer.
The designer determines his individual load depending on the load situation and individual safety factor combination used.
With this load value he can determine the anchorage length by means of the Hilti fire design tables.

b) It does not mean that the adhesives withstands the same temperatures as the steel does, but the tables specify cover and anchorage length that are necessary to withstand for the same duration the same force as is expected from the steel.

c) It is evident that for simplification the maximum load can be used on the safe side to determine anchorage length, but maybe steel holds not the same force under fire in the new building member e.g. with less cover.
Therefore if shorter embedment is requested it is worth to calculate the correct design load for fire.
That is especially true if higher safety factors or global safety factors for cold design are used (than there is more reserve in the steel).

3. APPROVALS AND REPORTS FOR HILTI HIT-RE 500 V3, HIT-RE 100 AND HIT-HY 200

European Technical Assessment ETA

Previously European Technical Approval is a document that provides information on the assessment of the performance of product regarding its essential characteristics according to the new Construction Products Regulation (EU/305/2011).

International Code Council Evaluation Service ICC-ES

Hilti HIT-RE 500 V3, HIT-RE 100 and HIT-HY 200 are recognized under the 2015 International Building Code (IBC) for designing post-installed reinforcing bars within the development and splice provisions of American Concrete Institute (ACI) 318 Chapters 12 and 21.

Fire Evaluation by CSTB

Hilti HIT-RE 500 V3 and HIT-HY 200 have gone through the evaluation of the fire behaviour used in conjunction with concrete reinforcing rebar by CSTB, member of EOTA. Hilti HIT-RE 500 V3 is approved for fire applications with an exposure time up to 4h. The ETA approval provides the reduction factor to be applied at the bond strength as function of the temperature.

Techincal Application Document DTA for Rebar in Seismic

Hilti HIT-RE 500 V3 and HIT-HY 200 are qualified for structural rebar application in seismic zones by CSTB. The product, to be qualified for seismic, must have: ETA rebar, ETA anchor, ICC-ES report with qualification for seismic.

Swiss Association for Protection against Corrosion SGK

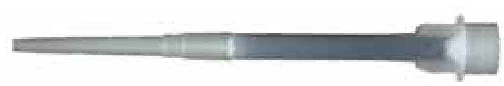
The Swiss Association for Protection against Corrosion SGK evaluation of the corrosion behaviour of fastenings post-installed in concrete using the Hilti HIT-RE 500 V3, HIT-RE 100 and HIT-HY 200 injection systems in relation to their use in field practice and compared with the behaviour of cast-in reinforcement.

CE Marking – CE Conformity for Hilti HIT-RE 500 V3, HIT-RE 100 and HIT-HY 200
NSF Certification – Hilti HIT-RE 500 V3, HIT-RE 100 and HIT-HY 200 are certified for water treatment application
LEED Certification – Hilti HIT-RE 500 V3, HIT-RE 100 and HIT-HY 200 are qualified for LEED specification on VOC emission and VOC content

4. HIT DISPENSER SYSTEM

As you regulate the desired amount of mortar dispensed with each pull of trigger, you save time during installation, reduce your cost per rebar installed and minimize the risks associated with improper installation, especially with our cordless battery HDE 500-A22 dispenser.

Mixer



HIT-RE-M Mixer

- For HIT-RE 500 V3 all sizes
- For HIT-RE 100 all sizes
- For HIT-HY 200 all sizes

Applications

- Injection of Hilti HIT adhesive mortar for fastening anchor rods and rebars in concrete and masonry
- External power source is not required
- Suitable for serial fastening and/or injection in deep holes

Advantages

- Easy injection even at low temperature
- Fast, easy foil pack loading
- Lifetime of HDE 500-A22 is up to 950 foil packs – 5 times more with manual dispenser
- HDE 500-A22 is covered under Hilti Lifetime Services LTS with no repair costs for up to 6 months from date of purchase
- Battery and charger are under the program of LTS with 2 years no repair cost

Productivity

Hilti cordless dispenser HDE 500-A22 makes chemical injection fast and smooth without wastage. It provides high productivity with battery operated and speed regulation.

Cost Saving

Precise control of the chemical consumption with dosing knob and automatic release mechanism greatly reduces minimum 10% of chemical wastage.

Ease Of Use

Chemical injection couldn't get easier with Hilti cordless dispenser HDE 500-A22 with high dispensing capacity. Battery compatible with all Hilti 22 V cordless tools.

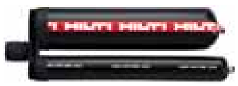
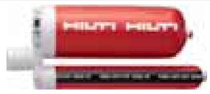
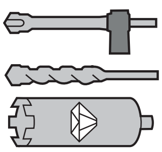
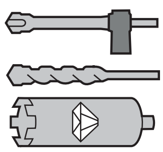
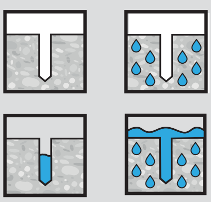
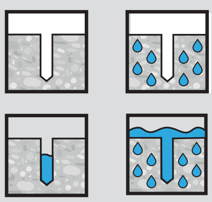
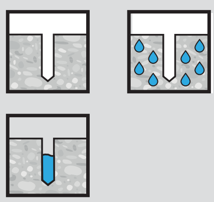
Technical data	
Dosing function	6 ml per graduation (1 = 6 ml)
Weight tool w/o cartridge holder	1905g
Weight 500ml black cartridge holder	240g
Weight 500ml red cartridge holder	275g
Tool Length	443mm
Tool width	118mm
Speed	110 s/litre
Weight battery B 22/5.2 Li-Ion	780g
Weight battery B 22/2.6 Li-Ion	480g

product design award 2013

reddot design award winner 2013

HILTI LIFETIME SERVICE ™ | up to 6 Months NO COSTS | Lifetime REPAIR COST LIMIT | Lifetime MANUFACTURER'S WARRANTY

5. DIFFERENCES OF HILTI HIT-RE 500 V3, HIT-RE 100 AND HIT-HY 200

	Slow cure portfolio		Fast cure portfolio
	HIT-RE 500 V3	HIT-RE 100	HIT-HY 200-R
			
Performance	★★★	★★	★★★
Productivity	★★★	★★	★★★
Reliability	★★★	★★★	★★★
Proven performance.			
ETA assessment	ETA-16/0143 ETA-16/0142	ETA-15/0883 ETA-15/0882	ETA 11/0493 ETA 12/0006 ETA 11/0492
Base material	■ Uncracked concrete ■ Cracked concrete	■ Uncracked concrete ■ Cracked concrete	■ Uncracked concrete ■ Cracked concrete
Recommended application	■ Best product for rebar applications ■ Anchor applications	■ Day-to-day rebar and anchoring applications	■ Best product for anchor applications ■ Rebar applications
Rebar design	■ Rebar designed to yield at reduced embedment depth	■ Rebar designed at minimum embedment depth	■ Rebar design for fast cure solution with minimum embedment depth.
Fire approval	■ Anchor ■ Rebar	■ Anchor	■ Anchor ■ Rebar
PROFIS design Software	■ Anchor ■ Rebar		■ Anchor ■ Rebar
Work time at 30 °C	15 min	12 min	9 min
Cure time at 30 °C	5 hours	8 hours	1 hour
Drilling method	 SAFESET		 SAFESET
Base material condition			

THE BEST BECOMES LEGENDARY

Hilti HIT-RE 500 V3 injectable mortar

6. HILTI HIT-RE 500 V3 INJECTION SYSTEM

The Best Becomes Legendary

How do we take the best and make it even better? By listening to you!

Fifteen years ago, Hilti set legendary standards for designers and contractors alike with HIT-RE 500. And because you needed increased performance and maximum reliability for dynamic loading applications, Hilti introduced HIT-RE 500 SD in 2007.

The new Hilti HIT-RE 500 V3 delivers the ultimate in performance for nearly all applications while addressing challenging project requirements such as boundary conditions, design flexibility and tight project deadlines. And, when used in conjunction with SafeSet technology, HIT-RE 500 V3 keeps your project moving by eliminating installation errors almost entirely.

Applications

- All structural post-installed rebar applications, e.g. starter bars, beam to column connections, wall extensions, etc. designed according to Eurocode 2 (EC2)
- Diamond cored holes
- Dust free installation e.g. hospitals
- Suitable for dry, wet concrete
- Static, quasi static, fatigue

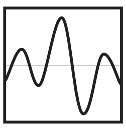
Advantages

- Up to 70% reduction of design anchorage lengths as compared to cast-in rebars
- Increased application range, from splices via simply supported beams up to moment resisting connections
- Support your project risk mitigation strategy and proper installation with SafeSet technology, an approved system
- The fastest slow curing product in the market
- Withstands extreme temperature conditions
- Speed up project processes by overlapping design and construction phases

Design solutions under all conditions...

The long service life of facilities makes it difficult to anticipate future requirements. Therefore, products specified should carry the widest range of conditions and resistance values.

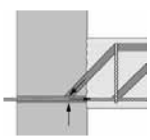
HIT-RE 500 V3 is approved for static, quasistatic, seismic and fatigue loading and also covers fire.

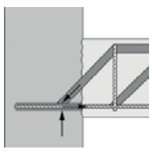

Seismic loading


Fire loading

... with optimization possibilities...

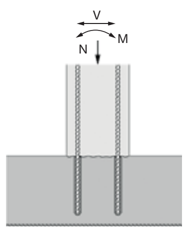
HIT-RE 500 V3 delivers highest bond strength values under nearly all conditions. However, according to EC2, the design bond strength is limited to the performance of cast-in bars. Research has shown that the bond strength of post-installed bars anchored with HIT-RE 500 V3 is markedly higher than that of cast-in place. The Hilti HIT Rebar design Method follows the EC2 design steps. By using an increased bond strength, anchorage lengths and costs are reduced signifi cantly. Discover why 35% of Hilti customers trust the HIT Rebar design Method - simply contact one of our field engineers to learn more.


Following the EC2 the design solution could be unfeasible and un-economical.


Following the HIT Rebar design Method a feasible and economical solution is possible.

... and extension of the range of applications.

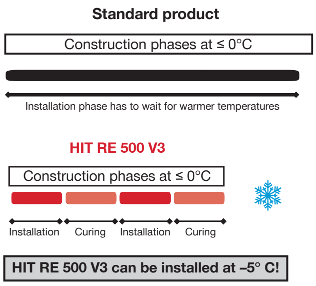
Post-installed rebar connections loaded with a bending moment are typically solved with cast-in bent rebars according to EC2/TR023. And, because designers asked for a reliable solution using post-installed straight bars, we worked to make it a reality. Together with the Technical University of Munich and the American University of Beirut, Hilti developed an adequate strut and tie model that takes the specific characteristics of frame node connections with straight bars into account. The Hilti HIT Rebar design Method published in several national and international scientific journals, is highly recognized by the designer community.



Moment resisting connection with straight bars can be designed by making use of the strut and tie model developed by Hilti.

Hilti HIT-RE 500 V3 keeps your project moving.

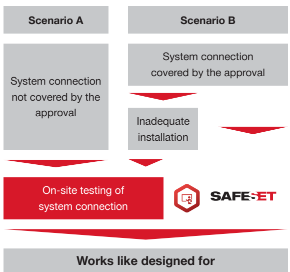
Hilti developed the fastest slow cure on the market with HIT-RE 500 V3. Contractors can now finish installations in half the time as compared to other leading mortars, thanks to its accelerated curing time and working time. And, because HIT-RE 500 V3 is the only mortar that can cure down to -5°C, construction processes can begin earlier.



Hilti HIT-RE 500 V3 reduces project risks

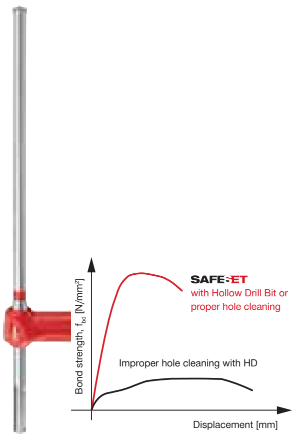
Every project is site specific as execution is influenced by several conditions. Poor execution can lead to structural deflection and extensive rehabilitation effort and re-design.

The Hilti HIT-RE 500 V3 injection system supports your project risk mitigation strategy by incorporating several measures from SafeSet technology in addition to on-site testing to reduce the risk of human error.

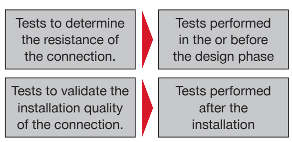


SafeSet for hammer drilled holes: Hollow Drill Bit

Hilti Hollow Drill Bit (HDB) takes hole cleaning out of the equation to ensure maximum loads in all hammer drilling (HD) applications and virtually dust-free environments.

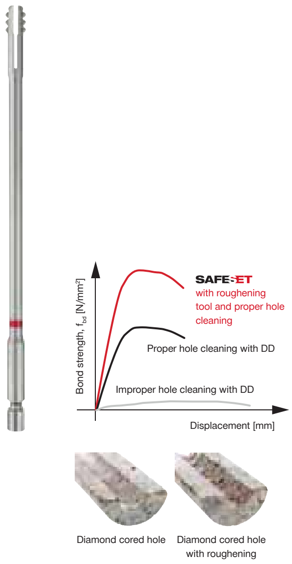


On-site testing



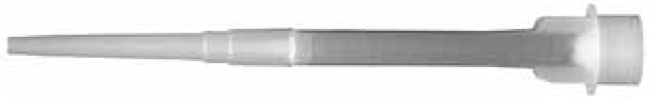
SafeSet for diamond cored holes: Roughening Tool

The roughening tool (RT) prepares the diamond cored holes to achieve resistance values and performance equal to hammer drilled boreholes.



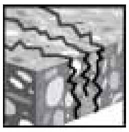
On site testing provides clarity in unknown base materials while providing necessary input values for your design.

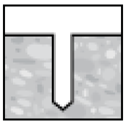
Hilti HIT-RE 500 V3 mortar with rebar (as post-installed connection)

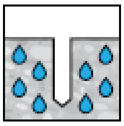
Injection mortar system		Benefits
	Hilti HIT-RE 500 V3 330 ml foil pack (also available as 500 ml and 1400 ml foil pack)	- **SAFEset** technology: Hilti hollow drill bit for hammer drilling and roughening tool for diamond coring - suitable for concrete C 12/15 to C 50/60 - high loading capacity - suitable for dry and water saturated concrete - for rebar diameters up to 40 mm - non corrosive to rebar elements - long working time at elevated temperatures - suitable for embedment length till 3200 mm - fire time exposure up to 4h
	Statik mixer	
	Rebar	

Base material

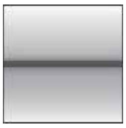

Concrete (uncracked)


Concrete (cracked)


Dry concrete


Wet concrete

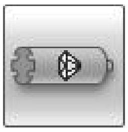
Load conditions


Static/ quasi-static


Fire resistance

Installation conditions


Hammer drilling


Diamond coring

SAFEset

Hilti SAFEset technology with hollow drill bit and roughening tool

Other informations

European Technical Approval

CE conformity


PROFIS Rebar design Software

SGK

Corossion tested

Service temperature range

Temperature range: -40°C to +80°C (max. long term temperature +50°C, max. short term temperature +80°C).

Approvals / certificates

Description	Authority / Laboratory	No. / date of issue
European technical assessment	CSTB, Marne la Vallée	ETA-16/0142 / 2016-04-18
European technical assessment	CSTB, Marne la Vallée	ETA-16/0143 / 2016-04-18
Fire evaluation	CSTB, Marne la Vallée	MRF 1526054277/B / 2016-04-12

a) All data given in this section according to the approvals mentioned above ETA-16/0142 issue 2016-04-18 and ETA-16/0143 issue 2016-03-29.

Materials

Reinforcmenent bars according to EC2 Annex C Table C.1 and C.2N.

Properties of reinforcement

Product form		Bars and de-coiled rods	
Class		B	C
Characteristic yield strength f_{yk} or $f_{0,2k}$ (MPa)		400 to 600	
Minimum value of $k = (f_t/f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force, ε_{uk} (%)		≥ 5,0	≥ 7,5
Bendability		Bend / Rebend test	
Maximum deviation from nominal mass (individual bar) (%)	Nominal bar size (mm) ≤ 8 > 8	 ± 6,0 ± 4,5	
Bond: Minimum relative rib area, $f_{R,min}$	Nominal bar size (mm) 8 to 12 > 12	 0,040 0,056	

Setting details

For detailed information on installation see instruction for use given with the package of the product.

Curing time for general conditions[1)]

Data according ETA-16/0142, issue 2016-04-18			
Temperature of the base material	**Working time in which rebar can be inserted and adjusted t_{gel}**	**Initial curing time $t_{cure,ini}$**	**Curing time before rebar can be fully loaded t_{cure}**
5 °C ≤ T_{BM} < -1 °C	2 h	48 h	168 h
0 °C ≤ T_{BM} < 4 °C	2 h	24 h	48 h
5 °C ≤ T_{BM} < 9 °C	2 h	16 h	24 h
10 °C ≤ T_{BM} < 14 °C	1,5 h	12 h	16 h
15 °C ≤ T_{BM} < 19 °C	1 h	8 h	16 h
20 °C ≤ T_{BM} < 24 °C	30 min	4 h	7 h
25 °C ≤ T_{BM} < 29 °C	20 min	3,5 h	6 h
30 °C ≤ T_{BM} < 34 °C	15 min	3 h	5 h
35 °C ≤ T_{BM} < 39 °C	12 min	2 h	4,5 h
T_{BM} = 40 °C	10 min	2 h	4 h

1) The curing time data are valid for dry base material only. In wet base material the curing times must be doubled.

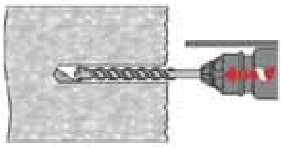
Setting instruction

Review the Material Safety Data Sheet (MSDS) before use for proper and safe handling!
Wear well-fitting protective goggles and protective gloves when working with Hilti HIT-RE 500 V3.
Important: Observe the installation instruction of the manufacturer provided with each foil pack.

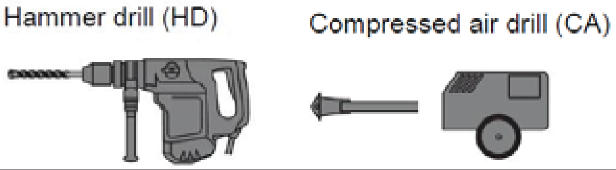
Hole drilling

Note: Before drilling, remove carbonized concrete; clean contact areas
In case of aborted drill hole the drill hole shall be filled with mortar.

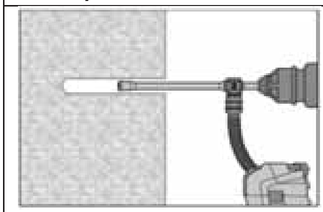
a) Hammer drilling



Drill hole to the required embedment depth with a hammer drill set in rotation-hammer mode or a compressed air drill using an appropriately sized carbide drill bit.

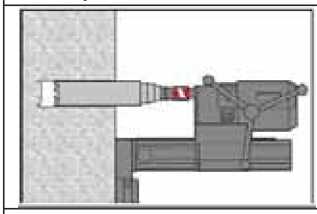


b) Hammer drilling with Hilti hollow drill bit: for dry and wet concrete only.



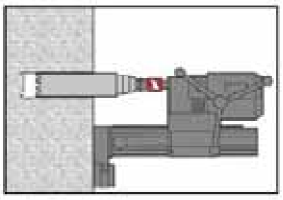
Drill hole to the required embedment depth with an appropriately sized Hilti TE-CD or TE-YD hollow drill bit with Hilti vacuum attachment.
This drilling system removes the dust and cleans the drill hole during drilling when used in accordance with the user's manual.
After drilling is complete, proceed to the "injection preparation" step in the installation instruction.

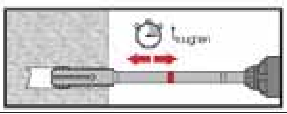
c) Diamond coring: for dry and wet concrete only.



Diamond coring is permissible when suitable diamond core drilling machines and the corresponding core bits are used.

d) Diamond coring followed by roughening with Hilti Roughening tool: for dry and wet concrete only.



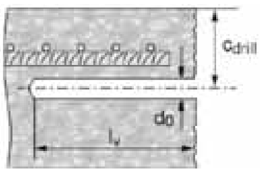


Diamond coring is permissible when suitable diamond core drilling machines and the corresponding core bits are used.

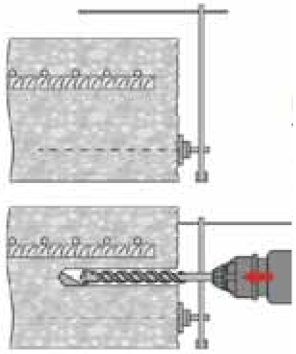
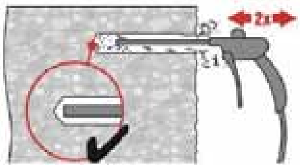
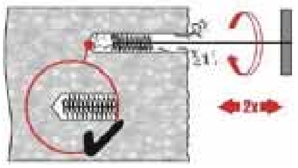
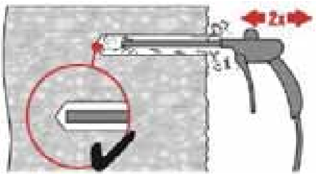
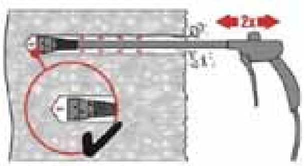
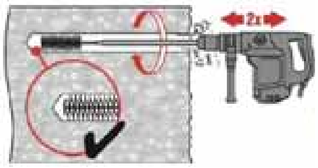
For the use in combination with Hilti roughening tool TE-YRT.

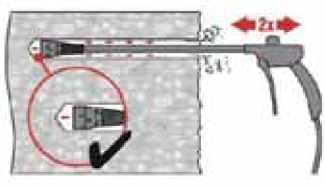
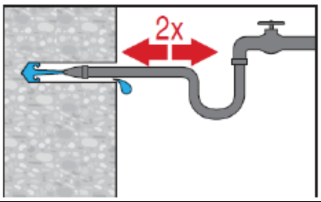
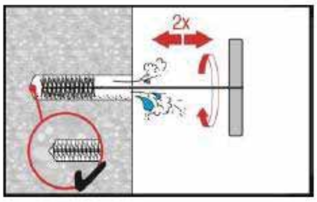
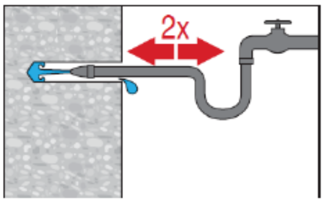
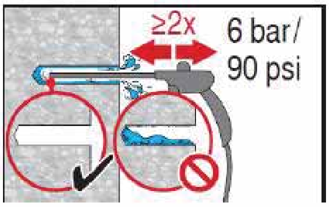
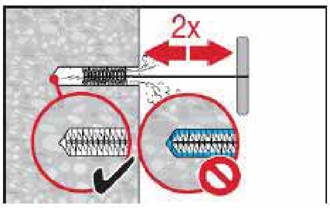
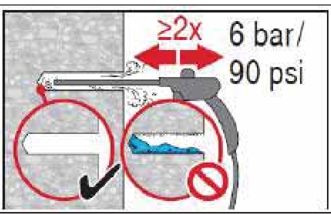
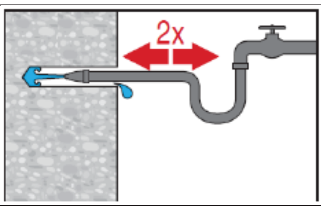
Before roughening the borehole needs to be dry. Check usability of the roughening tool with the wear gauge RTG.
Roughen the borehole over the whole length to the required h_{ef}.

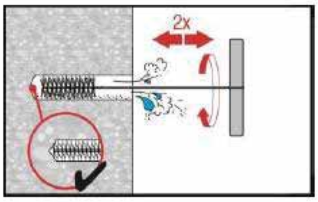
Splicing applications



Measure and control concrete cover c.
$c_{drill} = c + d_0/2$
Drill parallel to surface edge and to existing rebar.
Wher applicable use Hilti drilling aid HIT-BH.

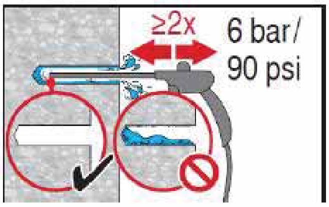
Drilling aid	
	Ensure that the drill hole is parallel to the existing rebar. Three different options can be considered: • Hilti drilling aid HIT-BH • Lath or spirit level • Visual check
Drill hole cleaning	Just before setting the bar, the drill hole must be free of dust and debris by one of two cleaning methods described below. Inadequate hole cleaning = poor load values.
Compressed air cleaning (CAC) For all drill diameters d_0 and all drill hole depths $h_0 \leq 20 \cdot d$	
	Blow 2 times from the back of the hole (if needed with nozzle extension) over the whole length with oil-free compressed air (min. 6 bar at 6 m^3/h) until return air stream is free of noticeable dust.
	Brush 2 times with the specified brush HIT-RB size (brush Ø ≥ borehole Ø) by inserting the round steel brush to the back of the hole (if needed with nozzle extension) in a twisting motion and removing it. The brush must produce natural resistance as it enters the drill hole. If this is not the case, please use a new brush or a brush with a larger diameter.
	Blow 2 times again with compressed air until return air stream is free of noticeable dust. If required use additional accessories and extensions for air nozzle and brush to reach back of hole.
Compressed Air Cleaning (CAC)	For drill holes deeper than 250 mm (for ϕ 8 to ϕ 12) or deeper than 20·ϕ (for ϕ > 12 mm)
	Use the appropriate air nozzle Hilti HIT-DL. Blow two times from the back of the hole over the hole length with oil-free compressed air until return air stream is free of noticeable dust. Safety tip: Do not inhale concrete dust. Use of the dust collector Hilti HIT-DRS is recommended.
	Screw the round steel brush HIT-RB in one end of the brush extension HIT-RBS, so that the overall length of the brush is sufficient to reach the base of the drill hole. Attach the other end of the extension to the TE-C/TE-Y chuck. Safety tip: Start machine brushing operation slowly Start brushing operation once the brush is inserted in the borehole.

	Use the appropriate air nozzle Hilti HIT-DL. Blow two times from back of the hole over the hole length with oil-free compressed air until return air stream is free of noticeable dust. Safety tip: Do not inhale the concrete dust. Use of the dust collector Hilti HIT-DRS is recommended.
Cleaning of diamond cored holes: For all drill hole diameters d_0 and all drill hole depths h_0	
	Flush 2 times by inserting a water hose (water-line-pressure) to the back of the hole until water runs clear.
	Brush 2 times with the specified brush by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it. The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø). If this is not the case, please use a new brush or a brush with a larger diameter.
	Flush 2 times by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.
	Blow 2 times from the back of the hole (if needed woth nozzle extension) over the whole length with oil-free compressed air (min. 6 bat at 6 m^3/h) until return air stream is free of noticeable dust and water. For drill hole diameters ≥ 32 mm the compressor has to supply a minimum air flow of 140 m^3/h.
	Brush 2 times with the specified brush size (brush Ø ≥ drill hole Ø) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a teisitng motion snd removing it. The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø). If this is not the case, please use a new brush or a brush with a larger diameter
	Blow 2 times with compressed air until return air stream is free of noticeable dust and water.
Cleaning of diamond cored holes followe by roughening: For all drill hole diameters d_0 and all drill hole depths h_0	
	Flush 2 times by inserting a water hose (water-line-pressure) to the back of the hole until water runs clear.



Brush 2 times with the specified brush by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.

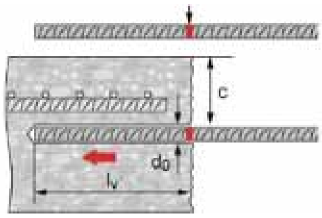
The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø). If this is not the case, please use a new brush or a brush with a larger diameter.



Blow 2 times from the back of the hole (if needed woth nozzle extension) over the whole length with oil-free compressed air (min. 6 bat at 6 m^3/h) until return air stream is free of noticeable dust and water.

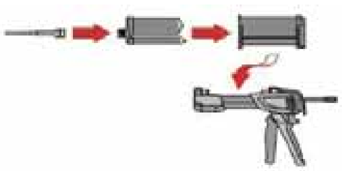
For drill hole diameters ≥ 32 mm the compressor has to supply a minimum air flow of 140 m^3/h.

Rebar preparation

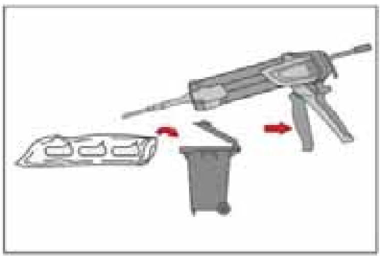


Before use, make sure the rebar is dry and free of oil or other residue.
Mark the embedment depth on the rebar. (e.g. with tapte) , ℓ_v
Insert rebar in borehole, to verify hole and setting depth ℓ_v.

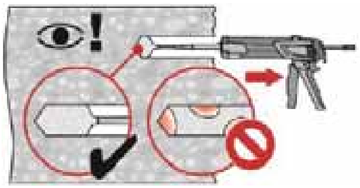
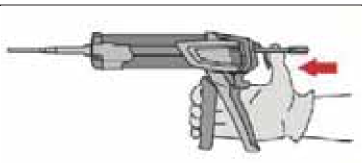
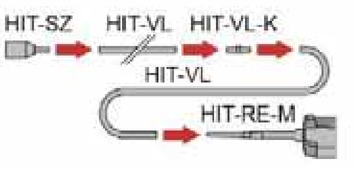
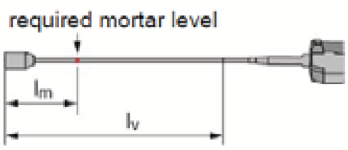
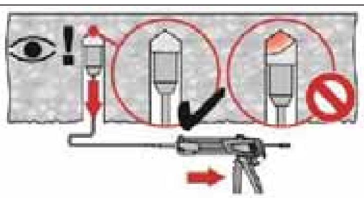
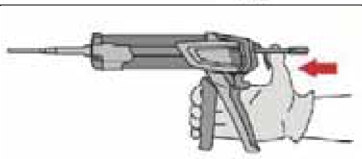
Injection preparation

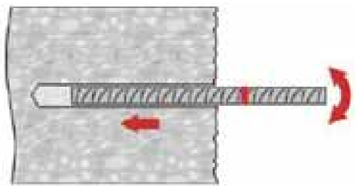
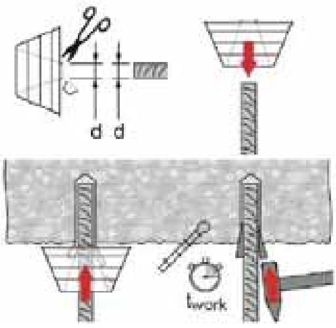
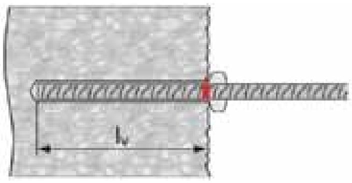
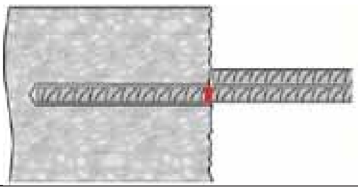
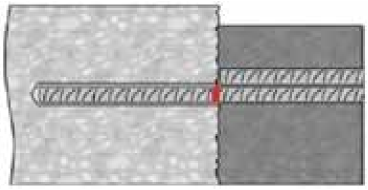


Tightly attach Hilti mixing nozzle HIT-RE-M to foil pack manifold.
Do not modify the nixing nozzle.
Observe the instruction for use of the dispenser.
Check foil pack holder for proper function. Insert foil pack into foil pack holder and put holder into dispenser.



The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded.
After changing a mixing nozzle, the first few trigger pulls must be discarded as decribed above. For each new foil pack a new mixing nozzle must be used.
Discard quantities are
- 3 strokes for 330 ml foil pack,
- 4 strokes for 500 ml foil pack,
- 65 ml for 1400 ml foil pack.

Inject adhesive	Injecz adhesive form the back of the drill hole without forming air voids.
Injection method for drill hole depth ≤ 250 mm (without overhead applications)	
	Inject the adhesive from the back of the hole towards the front and slowly withdraw the mixing nozzle step by step after each trigger pull. Fill holes approximately 2/3 full to ensure that the annular gap between the rebar and the concrete is completely filled with adhesive over the embedment length.
	After injecting, depressurize the dispenser by pressing the release trigger. This will prevent further mortar discharge from the mixing nozzle.
Injection method for drill hole depth > 250 mm or overhead application	
	Assemble mixing nozzle HIT-RE-M, extension(s) and piston plug HIT-SZ. For combinations of several injection extansions use coupler HIT-VL K. A substitution of the injection extansion for a plastic hose or a combination of both is permitted. The combination of HIT-SZ piston plug with HIT-VL 16 pipe and then HIT-VL 16 tube support proper injection.
	Mark the required mortar level ℓ_m and embedment depth ℓ_v with tape or marker on the injection extension. estimation: $l_m = 1/3 \cdot l_v$ precise formula for optimum mortar volume: $l_m = l_v \cdot (1,2 \cdot (\phi^2 / d_0^2) – 0,2)$
	For overhead installationthe injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug. Insert piston plug to back of the hole and inject adhesive. During injection the piston plug will be naturally extruded out of the drill hole by the adhesive pressure.
	After injecting, depressurize the dispenser by pressing the release trigger. This will prevent further mortar discharge from the mixing nozzle.

Setting the element	Before use verify that the element is dry and free of oil and other contaminants.
	For easy installation insert the rebar slowly twisted into the drill hole until the embedment mark is at the concrete surface level.
	For overhead application: During insertion of the rebar, mortar might flow out of the borehole. For collection of the flowing mortar, HIT-OHC may be used. Support the rebar and secure it from falling till mortar started to harden, e.g. using wedges HIT-OHW. For overhead installation use piston plugs and fix embedded parts with e.g. wedges.
	After installing the rebar the annular gap must be completely filled with mortar. Proper installation: • desired anchoring embedment l_v is reached: embedment mark at concrete surface. • excess mortar flows out of the drill hole after the rebar has been fully inserted until the embedment mark.
	Observe the working time t_{work}, which varies according to temperature of base material. Minor adjustments to the rebar position may be performed during the working time.
	Full load may be applied only after the curing time t_{cure} has elapsed.

Fitness for use

Some creep tests have been conducted in accordance with EAD 330087-00-0601 in the following conditions : in dry environnement at 50 °C during 90 days.
These tests show an excellent behaviour of the post-installed connection made with HIT-RE 500 V3: low displacements with long term stability, failure load after exposure above reference load.

Resistance to chemical substances

Categories	Chemical substances	Resistant	Non resistant
Alkaline products	Drilling dust slurry pH = 12,6	+	
	Potassium hydroxide solution (10%) pH = 14	+	
Acids	Acetic acid (10%)		+
	Nitric acid (10%)		+
	Hydrochloric acid (10%)		+
	Sulfuric acid (10%)		+
Solvents	Benzyl alcohol		+
	Ethanol		+
	Ethyl acetate		+
	Methyl ethyl keton (MEK)		+
	Trichlor ethylene		+
	Xylol (mixture)	+	
Products from job site	Concrete plasticizer	+	
	Diesel	+	
	Engine oil	+	
	Petrol	+	
	Oil for form work	+	
Environnement	Sslt water	+	
	De-mineralised water	+	
	Sulphurous atmosphere (80 cycles)	+	

Electrical Conductivity

HIT-RE 500 V3 in the hardened state **is not conductive electrically**. Its electric resistivity is $66 \cdot 10^{12}\,\Omega$.m (DIN IEC 93 – 12.93). It is adapted well to realize electrically insulating anchorings (ex: railway applications, subway).

Drilling diameters

Rebar [mm]	Drill bit diameters d_0 [mm]					
	Hammer drill (HD)	Hollow Drill Bit (HDB)	Compressed air drill (CA)	Diamond coring		
				Dry (PCC)	Wet (DD)	With roughening tool (RT)
10	14 (12 [a)])	14 (12 [a)])	-	-	14 (12 [a)])	-
12	16 (14 [a)])	16 (14 [a)])	17	-	16 (14 [a)])	-
14	18	18	17	-	18	18
16	20	20	20	-	20	20
18	22	22	22	-	22	22
20	25	25	26	-	25	25
22	28	28	28	-	28	28
24	32	32	32	-	32	32
25	32	32	32	-	32	32
26	35	35	35	35	35	35
28	35	35	35	35	35	35
30	37	-	35 / 37	35	37	-
32	40	-	40	47	40	-
34	45	-	42	47	45	-
36	45	-	45	47	47	-
40	55	-	57	52	52	-

a) Max. installation length l = 250 mm.

Basic design data for rebar design according to rebar ETA

Bond strength in N/mm² according to ETA 16/0142 for hammer drilling, hammer drilling with hollow drill bit TE-CD, TE-YD, compressed air drilling, dimond coring dry and diamond coring wet followed by roughening with Hilti roughening tool TE-YRT

Rebar [mm]	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
10 - 40	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3

Bond strength in N/mm² according to ETA 16/0142 for diamond coring wet

Rebar [mm]	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
10 - 12	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,0
14 - 16	1,6	2,0	2,3	2,7	3,0	3,4	3,7	3,7	3,7
20 - 36	1,6	2,0	2,3	2,7	3,0	3,4	3,4	3,4	3,4
40	1,6	2,0	2,3	2,7	3,0	3,0	3,0	3,0	3,0

Pullout design bond strength for Hit Rebar design Method

Design bond strength [$f_{bd,po} = \tau_{Rk}/\gamma_{Mp}$] in N/mm² according to ETA-16/0143 for uncracked concrete C20/25

Temperaure range	Dilling method	Rebar [mm]								
		10	12	14	16	20	25	28	30	32
I: 40°C/24° C	Hammer drilled holes	9,3	9,3	9,3	9,3	9,3	8,7	8,7	8,7	8,7
	Hammer drilled holes with hollow drill bit	-	9,3	9,3	9,3	9,3	8,7	8,7	-	-
	Diamond cored holes with roughening tool	-	-	9,3	9,3	9,3	8,7	8,7	-	-
	Diamond cored holes	5,0	5,0	5,0	4,3	4,3	4,3	4,5	4,5	4,5
	Hammer drilled holes in water filled holes	5,7	5,7	5,7	5,7	5,7	5,2	5,2	5,2	5,2
I: 70°C/43° C	Hammer drilled holes	7,3	7,3	7,3	6,7	6,7	6,7	6,3	6,3	6,3
	Hammer drilled holes with hollow drill bit	-	7,3	7,3	6,7	6,7	6,7	6,3	-	-
	Diamond cored holes with roughening tool	-	-	7,3	6,7	6,7	6,7	6,3	-	-
	Diamond cored holes	3,6	3,6	3,6	3,1	3,3	3,3	3,3	3,3	3,3
	Hammer drilled holes in water filled holes	4,3	4,3	4,3	4,3	4,0	4,0	4,0	3,8	3,8

Design bond strength [$f_{bd,po} = \tau_{Rk}/\gamma_{Mp}$] in N/mm² according to ETA-16/0143 for cracked concrete C20/25

Temperaure range	Dilling method	Rebar [mm]								
		10	12	14	16	20	25	28	30	32
I: 40°C/24° C	Hammer drilled holes	5,7	6,3	6,3	6,3	6,7	6,7	7,3	7,3	7,3
	Hammer drilled holes with hollow drill bit	-	6,3	6,3	6,3	6,7	6,7	7,3	-	-
	diamond cored holes with roughening tool	-	-	6,3	6,3	6,7	6,7	7,3	-	-
II: 70°C/43° C	Hammer drilled holes	4,7	5,3	5,3	5,3	5,3	5,3	5,3	5,3	5,3
	Hammer drilled holes with hollow drill bit	-	5,3	5,3	5,3	5,3	5,3	5,3	-	-
	diamond cored holes with roughening tool	-	-	5,3	5,3	5,3	5,3	5,3	-	-

Increasing factors in concrete for $f_{bd,po}$ according to ETA-16/0143 for uncracked and cracked concrete

Dilling method	Concrete class	Rebar [mm]								
		10	12	14	16	20	25	28	30	32
Hammer drilled holes Hammer drilled holes with hollow drill bit Diamond cored holes	C 30/37	1,04								
	C40/50	1,07								
	C50/60	1,09								
Diamond cored holes with roughening tool	C 30/37 - C50/60	1,0								

Additional Hilti Technical Data:

Reduction factor for splitting with large concrete cover: δ = 0,306 (Hilti additional data)

Amplification factor α_{lb} for the minimum anchorage length and minimum lap length according to EN 1992-1-1

For Hammer drilling, Hammer drilling with Hilti Hollow Drill Bit, Compressed air drilling, Diamond coring followed by roughening with Hilti roughwning tool									
Rebar [mm]	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
10 - 40	1,0								

For diamond coring dry and wet									
Rebar [mm]	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
10 - 12	1,0								
14 - 36	Linear interpolation between diameter								
40	1,0	1,0	1,0	1,0	1,2	1,3	1,4	1,4	1,4

Hilti HIT-RE 500 V3 injection adhesive with Rebar application
(HIT Rebar Design Method based on Chemical Bond Strength)
for Standard application/simply supported elements

Design Resistance for concrete grade (Fcu) = **30 N/mm²**
Steel yield strength = **460 N/mm²**
Installation condition = **Dry concrete**
Temperature = **Range I (-40°C to +80°C)**

Bar size	ø	[mm]	**10**	**12**	**16**	**20**	**25**	**32**	**40**
Drill bit size	D_0	[mm]	12, 14	14, 16	20	25	30, 32	40	55
Chemical bond based on ETA approval	$F_{bd,po}$	[N/mm²]	9.51	9.51	9.51	9.51	8.83	8.83	5.37
Design Yield	Nrd	[kN]	34.4	49.5	88.1	137.6	215.0	352.3	550.5
Length to develop yield	l_b	[mm]	115	138	184	230	310	397	815
	Embedment depth		**Design loads in [kN/bar]**						
Deformed high bond reinforcing bars; Loads in [kN/bar] for ruling values steel, bond and concrete; Pre-drilled hole to be clean at time of installation; Anchorage: linst	**80**	[mm]							
	100	[mm]	29.9						
	120	[mm]	**34.4**	43.0					
	140	[mm]	**34.4**	**49.5**					
	160	[mm]	**34.4**	**49.5**	76.4				
	180	[mm]	**34.4**	**49.5**	86.0				
	200	[mm]	**34.4**	**49.5**	**88.1**	119.4			
	220	[mm]	**34.4**	**49.5**	**88.1**	131.4			
	250	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	173.3		
	300	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	208.0		
	320	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	283.9	
	350	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	310.6	
	400	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	270.2
	450	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	303.9
	500	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	337.7
	550	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	371.5
	600	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	405.3
	700	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	472.8
	800	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	540.3
	900	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	**550.5**
	1000	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	**550.5**
	1100	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	**550.5**
	1200	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	**550.5**
	1300	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	**550.5**
	1400	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**	**550.5**

Note:

Data and results must be checked for agreement with the actual existing conditions and for plausibility.

The calculation shown are proposals only and should be finally checked and approved by architect or engineer responsible for the project.

Hilti HIT-RE 500 V3 injection adhesive with Rebar application
(HIT Rebar Design Method based on Chemical Bond Strength)
for Standard application/simply supported elements

Design Resistance for concrete grade (Fcu) = **35 N/mm²**
Steel yield strength = **460 N/mm²**
Installation condition = **Dry concrete**
Temperature = **Range I (-40°C to +80°C)**

Bar size		ø	[mm]	10	12	16	20	25	32	40
Drill bit size		D_o	[mm]	12, 14	14, 16	20	25	30, 32	40	55
Chemical bond based on ETA approval		$F_{bd,po}$	[N/mm²]	9.65	9.65	9.65	9.65	8.96	8.96	5.46
Design Yield		Nrd	[kN]	34.4	49.5	88.1	137.6	215.0	352.3	550.5
Length to develop yield		l_b	[mm]	113	136	182	227	305	391	803
		Embedment depth		Design loads in [kN/bar]						
Deformed high bond reinforcing bars Loads in [kN/bar] for ruling values steel, bond and concrete Pre-drilled hole to be clean at time of installation	Anchorage: linst	80	[mm]							
		100	[mm]	30.3						
		120	[mm]	34.4	43.7					
		140	[mm]	34.4	49.5					
		160	[mm]	34.4	49.5	77.6				
		180	[mm]	34.4	49.5	87.3				
		200	[mm]	34.4	49.5	88.1	121.3			
		220	[mm]	34.4	49.5	88.1	133.4			
		250	[mm]	34.4	49.5	88.1	137.6	176.0		
		300	[mm]	34.4	49.5	88.1	137.6	211.2		
		320	[mm]	34.4	49.5	88.1	137.6	215.0	288.3	
		350	[mm]	34.4	49.5	88.1	137.6	215.0	315.4	
		400	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	274.4
		450	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	308.7
		500	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	343.0
		550	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	377.3
		600	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	411.6
		700	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	480.1
		800	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	548.7
		900	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	550.5
		1000	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	550.5
		1100	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	550.5
		1200	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	550.5
		1300	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	550.5
		1400	[mm]	34.4	49.5	88.1	137.6	215.0	352.3	550.5

Note:

Data and results must be checked for agreement with the actual existing conditions and for plausibility.

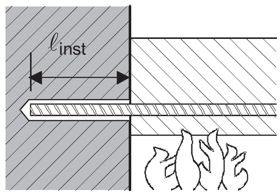
The calculation shown are proposals only and should be finally checked and approved by architect or engineer responsible for the project.

Fire Resistance

According to MRF 1526054277 / B

a) Anchoring application

a) Anchoring application beam-wall connection with a concrete cover of 20 mm



Maximum force in rebar in conjunction with HIT-RE 500 V3 as a function of embedment depth for the fire resistance classes F30 to F240 (yield strength f_{yk} = 500 N/mm² and concrete class C20/25) according EC2[a].

Rebar	Max. $F_{s,T}$	ℓ_{inst}	Fire resistance of bar in [kN]					
[mm]	[kN]	[mm]	R30	R60	R90	R120	R180	R240
10	26,2	110	5,8	2,4	1,1	0,6	0,0	0,0
		150	10,1	6,5	3,8	2,5	1,2	0,5
		190	14,5	10,8	8,1	6,0	3,3	2,0
		230	18,8	15,1	12,4	10,3	6,7	4,4
		300	26,2	22,7	20,0	17,9	14,3	11,2
		340		26,2	24,3	22,2	18,6	15,6
		360			26,2	24,4	20,8	17,7
		380				26,2	23,0	19,9
		410					26,2	23,1
		440						26,2
12	37,7	140	10,9	6,5	3,5	2,3	1,0	0,3
		200	18,7	14,3	11,0	8,5	4,8	3,0
		260	26,5	22,1	18,8	16,3	12,0	8,3
		320	34,3	29,9	26,6	24,1	19,8	16,1
		350	37,7	33,8	30,5	28,0	23,7	20,0
		390		37,7	35,7	33,2	28,9	25,2
		410			37,7	35,8	31,5	27,8
		430				37,7	34,1	30,4
		460					37,7	34,3
		490						37,7
14	51,3	160	15,7	10,6	6,7	4,4	2,3	1,1
		220	24,8	19,7	15,8	12,9	8,0	5,1
		280	33,9	28,8	24,9	22,0	17,0	12,7
		340	43,0	37,9	34,1	31,1	26,1	21,8
		400	51,3	47,0	43,2	40,2	35,2	30,9
		430		51,3	47,7	44,8	39,7	35,4
		460			51,3	49,3	44,3	40,0
		480				51,3	47,3	43,0
		510					51,3	47,6
		540						51,3

Rebar	Max. $F_{s,T}$	ℓ_{inst}	Fire resistance of bar in [kN]					
[mm]	[kN]	[mm]	R30	R60	R90	R120	R180	R240
16	67	180	21,4	15,5	11,2	7,8	4,3	2,5
		240	31,8	25,9	21,6	18,2	12,5	8,2
		300	42,2	36,3	32,0	28,6	22,9	18,0
		360	52,6	46,8	42,4	39,0	33,3	28,4
		450	67,0	62,4	58,0	54,6	48,9	44,0
		480		67,0	63,2	59,8	54,1	49,2
		510			67,0	65,1	59,3	54,4
		530				67,0	62,8	57,8
		560					67,0	63,0
		590						67,0
20	104,7	220	35,5	28,1	22,6	18,5	11,4	7,3
		280	48,5	41,1	35,6	31,5	24,3	18,1
		340	61,5	54,1	48,6	44,5	37,3	31,1
		400	74,5	67,1	61,7	57,5	50,3	44,1
		460	87,5	80,1	74,7	70,5	63,3	57,1
		540	104,7	97,5	92,0	87,8	80,6	74,5
		580		104,7	100,7	96,5	89,3	83,1
		600			104,7	100,8	93,6	87,5
		620				104,7	98,0	91,8
		660					104,7	100,5
		680						104,7

b) anchoring application beam-wall connection with a concrete cover of 40 mm

Rebar	Max. $F_{s,T}$	ℓ_{inst}	Fire resistance of bar in [kN]					
[mm]	[kN]	[mm]	R30	R60	R90	R120	R180	R240
10	26,2	110	7,3	3,1	1,5	0,9	0,0	0,0
		150	11,6	7,3	4,5	3,0	1,3	0,6
		190	15,9	11,7	8,9	6,7	3,5	2,1
		230	20,3	16,0	13,2	11,0	7,2	4,6
		290	26,2	22,5	19,7	17,5	13,7	10,5
		330		26,2	24,0	21,9	18,0	14,9
		350			26,2	24,0	20,2	17,0
		370				26,2	22,3	19,2
		410					26,2	23,6
		440						26,2
12	37,7	140	12,6	7,5	4,3	2,8	1,1	0,3
		200	20,4	15,3	11,9	9,3	5,2	3,2
		260	28,2	23,1	19,7	17,1	12,5	8,8
		320	36,0	30,9	27,6	25,0	20,3	16,6
		340	37,7	33,5	30,2	27,6	22,9	19,2
		380		37,7	35,4	32,8	28,1	24,4
		400			37,7	35,4	30,7	27,0
		420				37,7	33,3	29,6
		460					37,7	34,8
		490						37,7
14	51,3	160	17,8	11,8	7,9	5,2	2,5	1,2
		220	26,9	20,9	17,0	13,9	8,5	5,5
		280	36,0	30,0	26,1	23,0	17,6	13,2
		340	45,1	39,1	35,2	32,1	26,7	22,4
		390	51,3	46,7	42,8	39,7	34,3	29,9
		430		51,3	48,8	45,8	40,4	36,0
		450			51,3	48,8	43,4	39,0
		470				51,3	46,4	42,1
		510					51,3	48,1
		540						51,3

Rebar [mm]	Max. $F_{s,T}$ [kN]	ℓ_{inst} [mm]	Fire resistance of bar in [kN]					
			R30	R60	R90	R120	R180	R240
16	67	180	23,8	16,9	12,5	9,0	4,6	2,7
		240	34,2	27,3	22,9	19,4	13,2	8,7
		300	44,6	37,7	33,3	29,8	23,6	18,6
		360	55,0	48,2	43,7	40,2	34,0	29,0
		430	67,0	60,3	55,8	52,3	46,1	41,2
		470		67,0	62,7	59,3	53,1	48,1
		500			67,0	64,5	58,3	53,3
		520				67,0	61,7	56,8
		560					67,0	63,7
		580						67,0
20	104,7	220	38,4	29,8	24,2	19,9	12,2	7,8
		300	55,7	47,2	41,6	37,3	29,5	23,3
		380	73,1	64,5	58,9	54,6	46,8	40,6
		460	90,4	81,9	76,3	71,9	64,2	57,9
		530	104,7	97,0	91,4	87,1	79,3	73,1
		570		104,7	100,1	95,8	88,0	81,8
		600			104,7	102,3	94,5	88,3
		620				104,7	98,9	92,6
		650					104,7	99,1
		680						104,7
25	163,6	280	64,2	53,6	46,6	41,1	31,4	23,7
		370	88,6	77,9	70,9	65,5	55,8	48,0
		460	113,0	102,3	95,3	89,9	80,2	72,4
		550	137,4	126,7	119,7	114,3	104,6	96,8
		650	163,6	153,8	146,8	141,4	131,7	123,9
		690		163,6	157,7	152,2	142,5	134,7
		720			163,6	160,4	150,7	142,9
		740				163,6	156,1	148,3
		770					163,6	156,4
		800						163,6
28	205,3	310	81,1	69,1	61,3	55,2	44,3	35,6
		370	99,3	87,3	79,5	73,4	62,5	53,8
		430	117,5	105,5	97,7	91,6	80,7	72,0
		490	135,7	123,7	115,9	109,8	98,9	90,2
		550	153,9	141,9	134,1	128,0	117,2	108,4
		610	172,1	160,1	152,3	146,2	135,4	126,6
		670	190,3	178,3	170,5	164,4	153,6	144,8
		720	205,3	193,5	185,7	179,6	168,7	160,0
		760		205,3	197,8	191,8	180,9	172,2
		790			205,3	200,9	190,0	181,3
		810				205,3	196,1	187,3
		850					205,3	199,5
		870						205,3
32	268,1	350	106,5	92,8	83,9	76,9	64,5	54,6
		410	127,3	113,6	104,7	97,8	85,3	75,4
		470	148,1	134,5	125,5	118,6	106,1	96,2
		530	168,9	155,3	146,3	139,4	127,0	117,0
		590	189,7	176,1	167,1	160,2	147,8	137,8
		650	210,6	196,9	187,9	181,0	168,6	158,6
		710	231,4	217,7	208,7	201,8	189,4	179,4
		820	268,1	255,8	246,9	240,0	227,5	217,6
		860		268,1	260,8	253,8	241,4	231,4
		890			268,1	264,2	251,8	241,8
		910				268,1	258,7	248,8
		940					268,1	259,2
		970						268,1

b) Overlap joint application

Max. bond stress, $f_{bd,FIRE}$, depending on actual clear concrete cover for classifying the fire resistance.
It must be verified that the actual force in the bar during a fire, $F_{s,T}$, can be taken up by the bar connection of the selected length, ℓ_{inst}. Note: Cold design for ULS is mandatory.

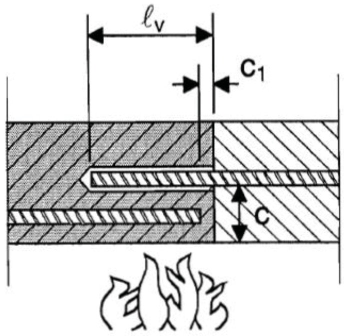
$F_{s,T} \leq (\ell_{inst} - c_f) \cdot \phi \cdot \pi \cdot f_{bd,FIRE}$ where: $(\ell_{inst} - c_f) \geq \ell_s$;

ℓ_s = lap length

ϕ = nominal diameter of bar

$\ell_{inst} - c_f$ = selected overlap joint length; this must be at least ℓ_s, but may not be assumed to be more than 80 ϕ

$f_{bd,FIRE}$ = bond stress when exposed to fire



Critical temperature-dependent bond stress, $f_{bd,FIRE}$, concerning "overlap joint" for Hilti HIT-RE 500 V3 injection adhesive in relation to fire resistance class and required minimum concrete coverage c.

Clear concrete cover c	Max. bond stress, τ_c [N/mm²]					
[mm]	R30	R60	R90	R120	R180	R240
30						
40	0,8					
50	1,1					
60	1,5					
70	2,1	0,9				
80	2,9	1,2				
90	3,5	1,5	0,9			
100		1,8	1,1	0,8		
110		2,3	1,4	1,0		
120		2,8	1,6	1,2		
130		3,4	2,0	1,4	0,9	
140		3,5	2,3	1,6	1,0	
150			2,8	1,9	1,1	0,8
160			3,3	2,2	1,3	0,9
170			3,5	2,5	1,5	1,1
180				2,9	1,7	1,2
190				3,4	1,9	1,4
200				3,5	2,2	1,5
210					2,5	1,7
220					2,8	1,9
230					3,1	2,1
240					3,5	2,3
250						2,6
260						2,9
270						3,2
280						3,5
290						

DESIGNED FOR SOLID PERFORMANCE

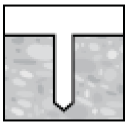
Hilti HIT-RE 100 injectable mortar

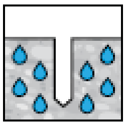
Hilti HIT-RE 100 mortar with rebar (as post-installed connection)

<table>
<tr><th>Injection mortar system</th><th></th><th>Benefits</th></tr>
<tr><td></td><td>Hilti
HIT-RE 100
330 ml foil pack
(also available as 500 ml and 1400 ml foil pack)</td><td rowspan="3">- suitable for concrete C 12/15 to C 50/60
- high loading capacity
- suitable for dry and water saturated concrete
- for rebar diameters up to 40 mm
- non corrosive to rebar elements
- long working time at elevated temperatures
- suitable for embedment length till 3200 mm</td></tr>
<tr><td></td><td>Statik mixer</td></tr>
<tr><td></td><td>Rebar</td></tr>
</table>

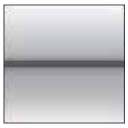
Base material


Concrete


Dry concrete

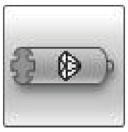

Wet concrete

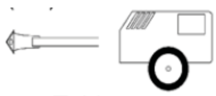
Load conditions


Static/ quasi-static

Installation conditions


Hammer drilling


Diamond coring


Compressed air drilling

Other informations

European Technical Approval

CE conformity

SGK

Corrosion tested

Service temperature range

Temperature range: -40°C to +80°C (max. long term temperature +50°C, max. short term temperature +80°C).

Approvals / certificates

Description	Authority / Laboratory	No. / date of issue
European technical assessment	DIBt	ETA – 15/0883 / 2016-04-21

[a] All data given in this section according to the approvals mentioned above ETA-15/0883 issue 2016-04-21

Materials

Reinforcmenent bars according to EC2 Annex C Table C.1 and C.2N.

Properties of reinforcement

Product form		**Bars and de-coiled rods**	
Class		B	C
Characteristic yield strength f_{yk} or $f_{0,2k}$ (MPa)		400 to 600	
Minimum value of $k = (f_t/f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force, ε_{uk} (%)		≥ 5,0	≥ 7,5
Bendability		Bend / Rebend test	
Maximum deviation from nominal mass (individual bar) (%)	Nominal bar size (mm) ≤ 8 > 8	± 6,0 ± 4,5	
Bond: Minimum relative rib area, $f_{R,min}$	Nominal bar size (mm) 8 to 12 > 12	0,040 0,056	

Setting details

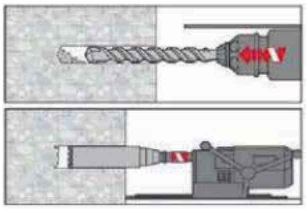
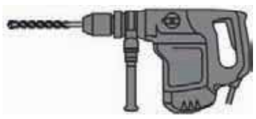
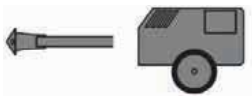
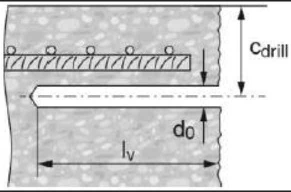
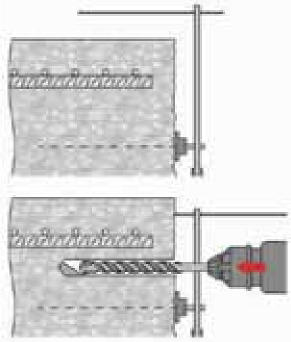
For detailed information on installation see instruction for use given with the package of the product.

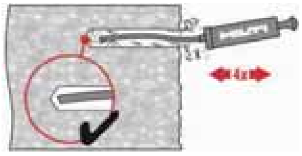
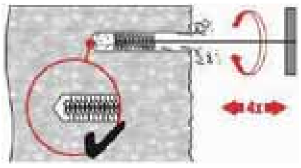
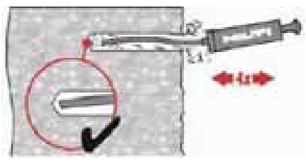
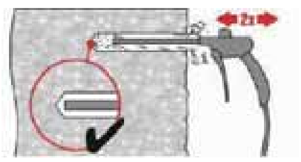
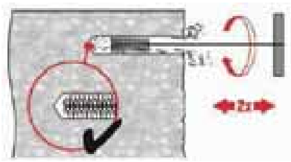
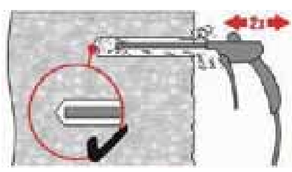
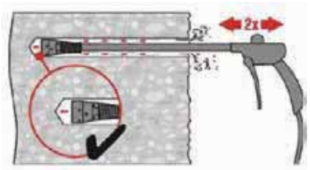
Curing time for general conditions[1)]

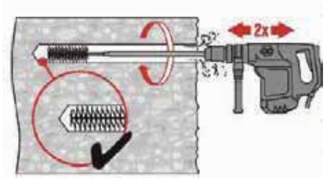
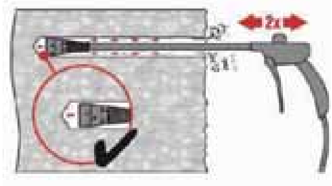
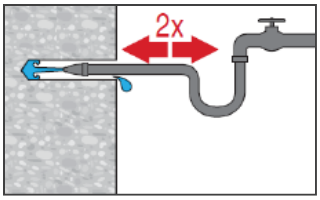
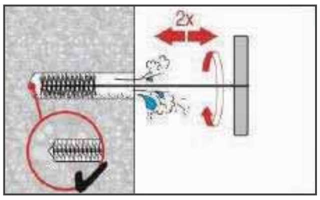
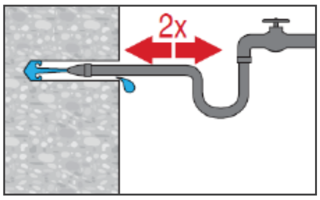
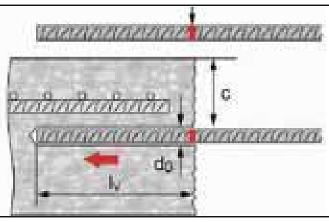
Data according ETA-15/0883, issue 2016-04-21			
Temperature of the base material	**Working time in which rebar can be inserted and adjusted t_{gel}**	**Initial curing time $t_{cure,ini}$**	**Curing time before rebar can be fully loaded t_{cure}**
5 °C ≤ T_{BM} ≤ 9 °C	2 h	18 h	72 h
9 °C < T_{BM} ≤ 14 °C	1,5 h	12 h	48 h
15 °C < T_{BM} ≤ 19 °C	30 min	8 h	24 h
20 °C < T_{BM} ≤ 24 °C	25 min	6 h	12 h
25 °C ≤ T_{BM} ≤ 29 °C	20 min	5 h	10 h
30 °C ≤ T_{BM} ≤ 39 °C	12 min	4 h	8 h
T_{BM} = 40 °C	12 min	2 h	4 h

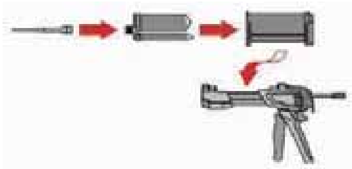
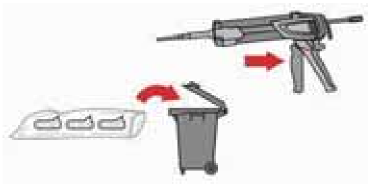
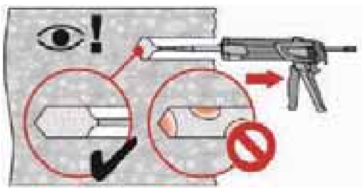
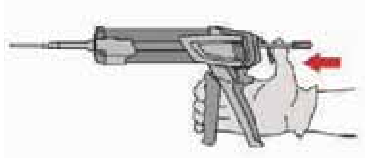
[1)] The curing time data are valid for dry base material only. In wet base material the curing times must be doubled. The temperature of the foil pack must be between +5° C and + 40° C during use.

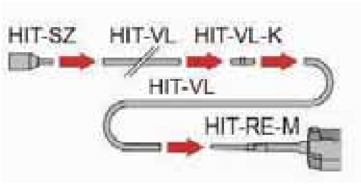
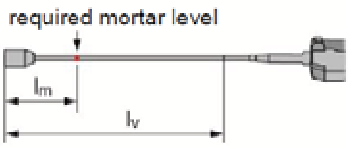
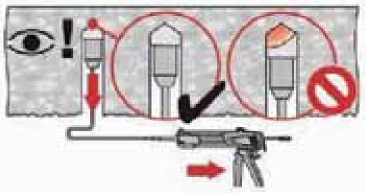
Setting instruction

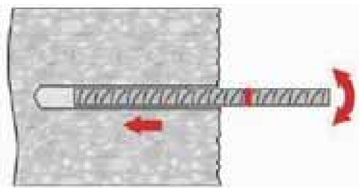
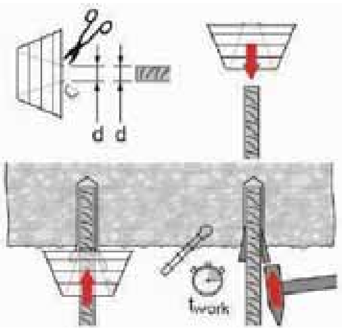
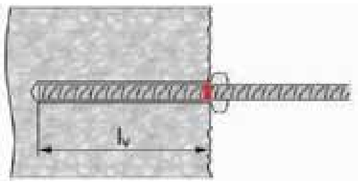
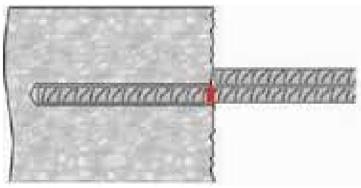
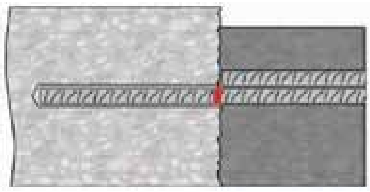
	Review the Material Safety Data Sheet (MSDS) before use for proper and safe handling! Wear well-fitting protective goggles and protective gloves when working with Hilti HIT-RE 100. Important: Observe the installation instruction of the manufacturer provided with each foil pack.
Drilling	Note: Before drilling, remove carbonized concrete; clean contact areas (see Annex B1) In case of aborted drill hole the drill hole shall be filled with mortar.
	Drill the hole to the required embedment depth using a hammer-drill with carbid drill bit set in rotation hammer mode, a compressed air drill or a diamond core machine. Hammer drill (HD)  Compressed air drill (CA)  Diamond core wet (DD) and dry (PCC) 
Spacing applications	
	• Measure and control concrete cover • $c_{drill} = c + d_0/2$ • Drill parallel to edge and to existing rebar • Where applicable use Hilti drilling aid HIT-HB
Drilling aid	Fore holes l_v > 20 cm use drilling aid
	Ensure that the drill hole is parallel to the existing rebar. Three different options can be considered: • Hilti drilling aid HIT-BH • Lath or spirit level • Visual check

Drill hole cleaning	The drill hole must be free of dust, debris, water, ice, oil, grease and other contaminants prior to mortar injection. Just before setting the bar, the drill hole must be free of dust and debris by one of two cleaning methods described below. Inadequate hole cleaning = poor load values.
Manual Cleaning (MC)	For drill hole diameters $d_0 \leq$ 20mm and drill hole depths $h_0 \leq 10 \cdot d$.
	Blow at least 4 times from the back of the drill hole until return air stream is free of noticeable dust.
	Brush 4 times with the specified brush by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it. The brush shall produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø) - If this is not the case, please use a new brush or a brush with a larger diameter.
	Blow at least 4 times from the back of the drill hole until return air stream is free of noticeable dust.
Compressed air cleaning (CAC)	For all drill hole diameters d_0 and all drill hole depths $h_0 \leq 20 \cdot d$
	Blow 2 times from the back of the hole (if needed with nozzle extension) over the whole length with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust.
	Brush 2 times with the specified brush by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it. The brush shall produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø) - If this is not the case, please use a new brush or a brush with a larger diameter.
	Blow 2 times again with compressed air until return air stream is free of noticeable dust. If required use additional accessories and extensions for air nozzle and brush to reach back of hole.
Compressed air cleaning (CAC)	For all drill holes deeper than 250 mm (for ϕ 8 to ϕ 12) or deeper than $20 \cdot \phi$ (for ϕ > 12 mm)
	Use the appropriate air nozzle Hilti HIT-DL. Blow two times from the back of the hole over the hole length with oil free compressed air until return air stream is free of noticeable dust. Safety tip: Do not inhale concrete dust. Use of the dust collector Hilti HIT-DRS is recommended.

	Screw the round steel brush HIT-RB in one end of the brush extension HIT-RBS, so that the overall length of the brush is sufficient to reach the base of the drill hole. Attach the other end of the extension to the TE-C/TE-Y chuck. Safety tip: Start machine brushing operation slowly Start brushing operation once the brush is inserted in the borehole.
	Use the appropriate air nozzle Hilti HIT-DL. Blow two times from back of the hole over the hole length with oil-free compressed air until return air stream is free of noticeable dust. Safety tip: Do not inhale the concrete dust. Use of the dust collector Hilti HIT-DRS is recommended.
In addition for wet diamond corind (DD) For all drill hole diameters d_0 and all drill hole depths h_0	
	Flush 2 times by inserting a water hose (water-line-pressure) to the back of the hole until water runs clear.
	Brush 2 times with the specified brush by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it. The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø). If this is not the case, please use a new brush or a brush with a larger diameter.
	Flush 2 times by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.
Rebar preparation	
	Before use, make sure the rebar is dry and free of oil or other residue. Mark the embedment depth on the rebar. (e.g. with tapte) **,** ℓ_v Insert rebar in borehole, to verify hole and setting depth ℓ_v.

Injection preparation	
	Tightly attach Hilti mixing nozzle HIT-RE-M to foil pack manifold. Do not modify the nixing nozzle. Observe the instruction for use of the dispenser. Check foil pack holder for proper function. Insert foil pack into foil pack holder and put holder into dispenser.
	The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded. After changing a mixing nozzle, the first few trigger pulls must be discarded as decribed above. For each new foil pack a new mixing nozzle must be used. Discard quantities are 3 strokes for 330 ml foil pack, 4 strokes for 500 ml foil pack, 65 ml for 1400 ml foil pack.
Inject adhesive	Inject adhesive form the back of the drill hole without forming air voids.
Injection method for drill hole depth ≤ 250 mm (without overhead applications)	
	Inject the adhesive from the back of the hole towards the front and slowly withdraw the mixing nozzle step by step after each trigger pull. Fill holes approximately 2/3 full to ensure that the annular gap between the rebar and the concrete is completely filled with adhesive over the embedment length.
	After injecting, depressurize the dispenser by pressing the release trigger. This will prevent further mortar discharge from the mixing nozzle.

Injection method for drill hole depth > 250 mm or overhead application	
	Assemble mixing nozzle HIT-RE-M, extension(s) and piston plug HIT-SZ. For combinations of several injection extansions use coupler HIT-VL K. A substitution of the injection extansion for a plastic hose or a combination of both is permitted. The combination of HIT-SZ piston plug with HIT-VL 16 pipe and then HIT-VL 16 tube support proper injection.
	Mark the required mortar level ℓ_m and embedment depth ℓ_v with tape or marker on the injection extension. estimation: $l_m = 1/3 \cdot l_v$ precise formula for optimum mortar volume: $l_m = l_v \cdot (1{,}2 \cdot (\phi^2 / d_0^2) – 0{,}2)$
	For overhead installationthe injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug. Insert piston plug to back of the hole and inject adhesive. During injection the piston plug will be naturally extruded out of the drill hole by the adhesive pressure.
	After injecting, depressurize the dispenser by pressing the release trigger. This will prevent further mortar discharge from the mixing nozzle.

Setting the element	Before use verify that the element is dry and free of oil and other contaminants.
	For easy installation insert the rebar slowly twisted into the drill hole until the embedment mark is at the concrete surface level.
	For overhead application: During insertion of the rebar, mortar might flow out of the borehole. For collection of the flowing mortar, HIT-OHC may be used. Support the rebar and secure it from falling till mortar started to harden, e.g. using wedges HIT-OHW. For overhead installation use piston plugs and fix embedded parts with e.g. wedges.
	After installing the rebar the annular gap must be completely filled with mortar. Proper installation: • desired anchoring embedment l_v is reached: embedment mark at concrete surface. • excess mortar flows out of the drill hole after the rebar has been fully inserted until the embedment mark.
	Observe the working time t_{work}, which varies according to temperature of base material. Minor adjustments to the rebar position may be performed during the working time.
	Full load may be applied only after the curing time t_{cure} has elapsed.

Drilling diameters

Rebar [mm]	Drill bit diameters d_0 [mm]			
	Hammer drill (HD)	Compressed air drill (CA)	Diamond coring	
			Dry (PCC)	Wet (DD)
8	12 (10[a])	-		12 (10[a])
10	14 (12[a])	-	-	14 (12[a])
12	16 (14[a])	17	-	16 (14[a])
14	18	17	-	18
16	20	20	-	20
18	22	22	-	22
20	25 / 24[b]	26	-	25
22	28	28	-	28
24	32	32	35	32
25	32 / 30[b]	32 / 30[b]	35	32
26	35	35	35	35
28	35	35	35	35
30	37	35	35	35
32	40	40	47	40
34	45	42	47	42
36	45	45	47	47
40	55	57	52	52

[a] Max. installation length l = 250 mm.
[b] Both values can be used

Basic design data for rebar design according to rebar ETA

Bond strength in N/mm² according to ETA – 15/0883 for good bond conditions for hammer drilling, compressed air drilling and diamond coring dry

Rebar [mm]	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 - 32	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
34	1,6	2,0	2,3	2,6	2,9	3,3	3,6	3,9	4,2
36	1,5	1,9	2,2	2,6	2,9	3,3	3,6	3,8	4,1
40	1,5	1,8	2,1	2,5	2,8	3,1	3,4	3,7	4,0

For all other bond condiions multiply the values by 0,7.

Bond strength in N/mm² according to ETA – 15/0883 for good bond conditions diamond coring wet

Rebar [mm]	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 - 32	1,6	2,0	2,3	2,7					
34	1,6	2,0	2,3	2,6					
36	1,5	1,9	2,2	2,6					
40	1,5	1,8	2,1	2,5					

For all other bond condiions multiply the values by 0,7.

Amplification factor α_{lb} for the minimum anchorage length and minimum lap length according to EN 1992-1-1

For Hammer drilling, Compressed air drilling and Diamond coring dry									
Rebar [mm]	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 - 40	1,0								

For diamond coring dry and wet									
Rebar [mm]	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 - 40	1,5								

Hilti HIT-RE 100 injection adhesive with Rebar application
(HIT Rebar Design Method based on Chemical Bond Strength)
for Standard application/simply supported elements

Design Resistance for concrete grade (Fcu) = 30 N/mm²
Steel yield strength = 460 N/mm²
Installation condition = Dry concrete
Temperature = Range I (-40°C to +40°C)

Bar size		ø	[mm]	**10**	**12**	**16**	**20**	**25**	**32**
Drill bit size		D_o	[mm]	12,14	14,16	20	24, 25	30, 32	40
Chemical bond based on ETA approval		$F_{bd,po}$	[N/mm²]	6.67	6.67	5.71	5.71	5.24	5.24
Design Yield		Nrd	[kN]	34.4	49.5	88.1	137.6	215.0	352.3
Length to develop yield		l_b	[mm]	164	197	307	383	523	669
		Embedment depth		**Design loads in [kN/bar]**					
Deformed high bond reinforcing bars **Loads in [kN/bar] for ruling values steel, bond and concrete** **Pre-drilled hole to be clean at time of installation**	**Anchorage: linst**	**80**	[mm]						
		100	[mm]	20.9					
		120	[mm]	25.1	30.2				
		140	[mm]	29.3	35.2				
		160	[mm]	33.5	40.2	46.0			
		180	[mm]	**34.4**	45.2	51.7			
		200	[mm]	**34.4**	**49.5**	57.4	71.8		
		220	[mm]	**34.4**	**49.5**	63.2	79.0		
		250	[mm]	**34.4**	**49.5**	71.8	89.8	102.8	
		300	[mm]	**34.4**	**49.5**	86.2	107.7	123.4	
		320	[mm]	**34.4**	**49.5**	**88.1**	114.9	131.6	168.5
		350	[mm]	**34.4**	**49.5**	**88.1**	125.7	144.0	184.3
		400	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	164.6	210.6
		450	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	185.1	237.0
		500	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	205.7	263.3
		550	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	289.6
		600	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	316.0
		700	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**
		800	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**
		900	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**
		1000	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**
		1100	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**
		1200	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**
		1300	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**
		1400	[mm]	**34.4**	**49.5**	**88.1**	**137.6**	**215.0**	**352.3**

Note:

Data and results must be checked for agreement with the actual existing conditions and for plausibility.

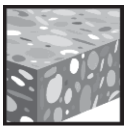
The calculation shown are proposals only and should be finally checked and approved by architect or engineer responsible for the project.

THE BEST JUST GOT BETTER

Hilti HIT-HY 200 injectable mortar

Hilti HIT-HY 200 mortar with rebar (as post-installed connection)

Injection mortar system		Benefits
	Hilti HIT-HY 200-R 330 ml foil pack (also available as 500 ml foil pack)	- **SAFE**set technology: drilling and borehole cleaning in one step with Hilti hollow drill bit - HY 200-R version is formulated for best handling and cure time specifically for rebar applications - Suitable for concrete C 12/15 to C 50/60 - Suitable for dry and water saturated concrete - For rebar diameters up to 32 mm - Non corrosive to rebar elements - Good load capacity at elevated temperatures - Suitable for embedment length up to 1000 mm - Suitable for applications down to -10 °C - Two mortar (A and R) versions available with different curing times and same performance
	Hilti HIT-HY 200-A 330 ml foil pack (also available as 500 ml foil pack)	
	Static mixer	
	Rebar	


Concrete


Fire resistance

European Technical Approval

SGK
Corrosion tested

PROFIS Rebar design software

SAFEset
Hilti SAFEset technology with hollow drill bit

Service temperature range

Temperature range: -40°C to +80°C (max. long term temperature +50°C, max. short term temperature +80°C).

Approvals / certificates

Description	Authority / Laboratory	No. / date of issue
European technical approval a)	DIBt, Berlin	ETA-12/0083 / 2013-06-05 (HIT-HY 200-R) ETA-11/0492 / 2013-06-05 (HIT-HY 200-A)
Fire test report	CSTB, Paris	26033756

a) All data given in this section according ETA-12/0083, issued 2013-06-05 and ETA-11/0492, issued 2013-06-05.

Materials

Reinforcement bars according to EC2 Annex C Table C.1 and C.2N.

Properties of reinforcement

Product form		**Bars and de-coiled rods**	
Class		B	C
Characteristic yield strength f_{yk} or $f_{0,2k}$ (MPa)		400 to 600	
Minimum value of $k = (f_t/f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force, ε_{uk} (%)		≥ 5,0	≥ 7,5
Bendability		Bend / Rebend test	
Maximum deviation from nominal mass (individual bar) (%)	Nominal bar size (mm) ≤ 8 > 8	 ± 6,0 ± 4,5	
Bond: Minimum relative rib area, $f_{R,min}$	Nominal bar size (mm) 8 to 12 > 12	 0,040 0,056	

Setting details

For detailed information on installation see instruction for use given with the package of the product.

Working time, curing time[a)]

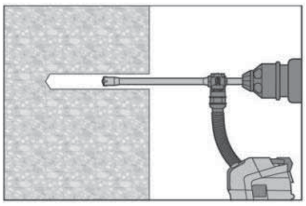
Temperature of the base material	**HIT-HY 200-R**	
	Working time in which anchor can be inserted and adjusted t_{work}	**Curing time before anchor can be fully loaded t_{cure}**
-10 °C to -5 °C	3 hour	20 hour
-4 °C to 0 °C	2 hour	7 hour
1 °C to 5 °C	1 hour	3 hour
6 °C to 10 °C	40 min	2 hour
11 °C to 20 °C	15 min	1 hour
21 °C to 30 °C	9 min	1 hour
31 °C to 40 °C	6 min	1 hour

Temperature of the base material	**HIT-HY 200-A**	
	Working time in which anchor can be inserted and adjusted t_{work}	**Curing time before anchor can be fully loaded t_{cure}**
-10 °C to -5 °C	1,5 hour	7 hour
-4 °C to 0 °C	50 min	4 hour
1 °C to 5 °C	25 min	2 hour
6 °C to 10 °C	15 min	1 hour
11 °C to 20 °C	7 min	30 min
21 °C to 30 °C	4 min	30 min
31 °C to 40 °C	3 min	30 min

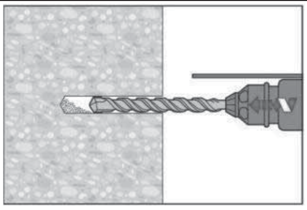
Setting instruction

a) Dry and water-saturated concrete, hammer drilling

Bore hole drilling



Drill hole to the required embedment depth with an appropriately sized Hilti TE-CD or TE-YD hollow drill bit with Hilti vacuum attachment. This drilling method properly cleans the borehole and removes dust while drilling. After drilling is complete, proceed to the “injection preparation” step in the instructions for use.

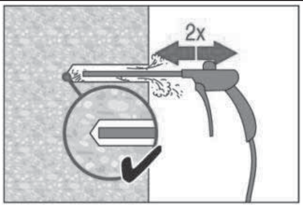


Drill hole to the required embedment depth using a hammer-drill with carbide drill bit set in rotation hammer mode, a Hilti hollow drill bit or a compressed air drill.

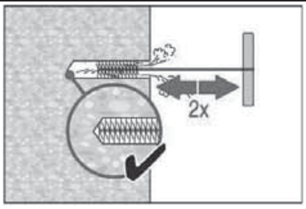
Bore hole cleaning Just before setting an anchor, the bore hole must be free of dust and debris by one of two cleaning methods described below

b) Compressed air cleaning (CAC)

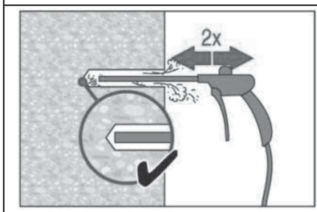
For all bore hole diameters d_0 and all bore hole depth h_0



Blowing 2 times from the back of the hole with oil-free compressed air (min. 6 bar at 100 litres per minute (LPM)) until return air stream is free of noticeable dust. Bore hole diameter ≥ 32 mm the compressor must supply a minimum air flow of 140 m^3/hour.
If required use additional accessories and extensions for air nozzle and brush to reach back of hole.



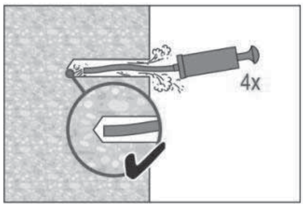
Brushing 2 times with the specified brush size (brush Ø ≥ borehole Ø) by inserting the round steel brush to the back of the hole in a twisting motion. The brush shall produce natural resistance as it enters the anchor hole. If this is not the case, please use a new brush or a brush with a larger diameter.



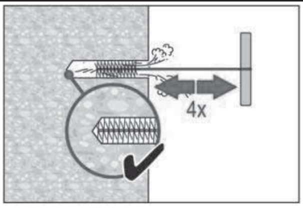
Blowing 2 times again with compressed air until return air stream is free of noticeable dust.

a) Manual Cleaning (MC)

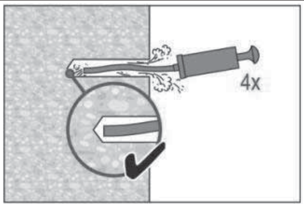
As an alternative to compressed air cleaning, a manual cleaning is permitted for hammer drilled boreholes up to hole diameters $d_0 \leq$ 20mm and depths ℓ_v resp. $\ell_{e,ges.}$ $\leq$ 160mm or 10 * d. The borehole must be free of dust, debris, water, ice, oil, grease and other contaminants prior to mortar injection.



4 strokes with Hilti blow-out pump from the back of the hole until return air stream is free of noticeable dust.

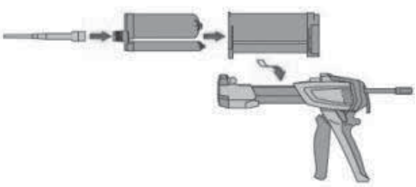


4 times with the specified brush size (brush Ø ≥ borehole Ø) by inserting the round steel wire brush to the back of the hole with a twisting motion

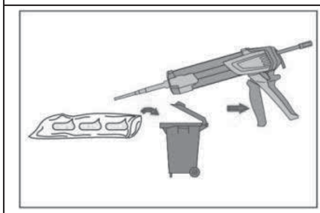


4 strokes with Hilti blow-out pump from the back of the hole until return air stream is free of noticeable dust.

Injection preparation

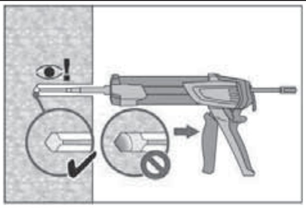


Observe the Instruction for Use of the dispenser.
Observe the Instruction for Use of the mortar.
Tightly attach Hilti HIT-RE-M mixing nozzle to foil pack manifold.
Insert foil pack into foil pack holder and swing holder into the dispenser.

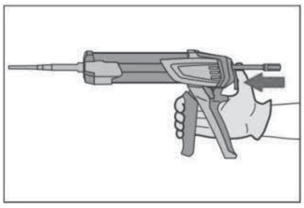


Discard initial adhesive. The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded.
Discard quantities are
2 strokes for 330 ml foil pack,
3 strokes for 500 ml foil pack,
4 strokes for 500 ml foil pack ≤ 5°C.

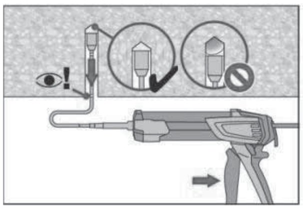
Inject adhesive from the back of the borehole without forming air voids



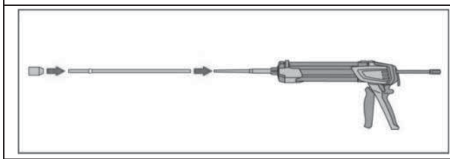
Injection method for borehole depth ≤ 250 mm:
Inject the mortar from the back of the hole towards the front and slowly withdraw the mixing nozzle step by step after each trigger pull. **Important! Use extensions for deep holes (> 250 mm)**. Fill holes approximately 2/3 full, or as required to ensure that the annular gap between the rebar and the concrete is completely filled with adhesive over the embedment length.



After injecting, depressurize the dispenser by pressing the release trigger (only for manual dispenser). This will prevent further mortar discharge from the mixing nozzle.

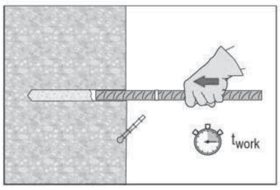


Piston plug injection for borehole depth > 250 mm or overhead applications: Assemble mixing nozzle, extension(s) and appropriately sized piston plug. Insert piston plug to back of the hole. Begin injection allowing the pressure of the injected adhesive mortar to push the piston plug towards the front of the hole. After injecting, depressurize the dispenser by pressing the release trigger. This will prevent further mortar discharge from the mixing nozzle.
The proper injection of mortar using a piston plug HIT-SZ prevents the creation of air voids. The piston plug must be insertable to the back of the borehole without resistance. During injection the piston plug will be pressed towards the front of the borehole slowly by mortar pressure. Attention! Pulling the injection or when changing the foil pack, the piston plug is rendered inactive and air voids may occur.

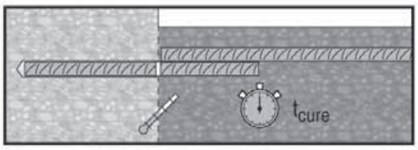


HDM 330	Manual dispenser	(330 ml)
HDM 500	Manual dispenser	(330 / 500 ml)
HDE 500-A22	Electric dispenser	(330 / 500 ml)

Setting the element



Before use, verify that the element is dry and free of oil and other contaminants.
Mark and set element to the required embedment depth until working time t_{work} has elapsed.



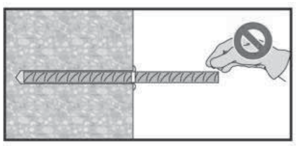
After installing the rebar the annular gap must be completely filled with mortar.

Proper installation can be verified when:

Desired anchoring embedment is reached ℓ_v:

Embedment mark at concrete surface.
Excess mortar flows out of the borehole after the rebar has been fully inserted until the embedment mark.

Overhead application: Support the rebar and secure it from falling till mortar started to harden.



Observe the working time “t_{work}”, which varies according to temperature of base material. Minor adjustments to the rebar position may be performed during the working time. After t_{cure} preparation work may continue.

For detailed information on installation see instruction for use given with the package of the product.

Resistance to chemical substances

Chemical	Resistance	Chemical	Resistance
Air	+	Gasoline	+
Acetic acid 10%	+	Glycole	o
Acetone	o	Hydrogen peroxide 10%	o
Ammonia 5%	+	Lactic acid 10%	+
Benzyl alcohol	-	Maschinery oil	+
Chloric acid 10%	o	Methylethylketon	o
Chlorinated lime 10%	+	Nitric acid 10%	o
Citric acid 10%	+	Phosphoric acid 10%	+
Concrete plasticizer	+	Potassium Hydroxide pH 13,2	+
De-icing salt (Calcium chloride)	+	Sea water	+
Demineralized water	+	Sewage sludge	+
Diesel fuel	+	Sodium carbonate 10%	+
Drilling dust suspension pH 13,2	+	Sodium hypochlorite 2%	+
Ethanol 96%	-	Sulfuric acid 10%	+
Ethylacetate	-	Sulfuric acid 30%	+
Formic acid 10%	+	Toluene	o
Formwork oil	+	Xylene	o

+ resistant
o resistant in short term (max. 48h) contact
- not resistant

Electrical Conductivity

HIT-HY 200 in the hardened state **is not conductive electrically**. Its electric resistivity is $15{,}5 \cdot 10^9\ \Omega \cdot cm$ (DIN IEC 93 – 12.93). It is adapted well to realize electrically insulating anchorings (ex: railway applications, subway).

Drilling diameters

Rebar (mm)	Drill bit diameters d_0 [mm]	
	Hammer drill (HD)	Compressed air drill (CA)
8	12 (10 [a)])	-
10	14 (12 [a)])	-
12	16 (14 [a)])	17
14	18	17
16	20	20
18	22	22
20	25	26
22	28	28
24	32	32
25	32	32
26	35	35
28	35	35
30	37	35
32	40	40

a) Max. installation length **l** = 250 mm.

Basic design data for rebar design according to ETA

Bond strength

Bond strength in N/mm² according to ETA for good bond conditions

Rebar (mm)	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 - 32	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3

Hilti HIT HY-200-R injection adhesive with Rebar application
(HIT Rebar Design Method based on Chemical Bond Strength)
for Standard application/simply supported elements

Design Resistance for concrete grade (Fcu) =	**30 N/mm²**
Steel yield strength =	**460 N/mm²**
Installation condition=	**Dry concrete**
Temperature=	**Range II (-40°C to +80°C)**

Bar size		ø	[mm]	**10**	**12**	**16**	**20**	**25**	**32**
Drill bit size		D_o	[mm]	12,14	14,16	20	25	32	40
Chemical bond based on ETA approval		$F_{bd,po}$	[mm]	6.7	6.7	6.7	6.7	6.7	6.7
Length to develop yield		l_b	[mm]	164.3	197.1	262.9	328.6	410.7	525.7
		Embedment depth		**Design loads in [kN/bar]**					
Deformed high bond reinforcing bars **Loads in [kN/bar] for ruling values steel, bond and concrete** **Pre-drilled hole to be clean at time of installation**	**Anchorage: linst**	**80**	[mm]						
		100	[mm]	20.9					
		120	[mm]	25.1	30.2				
		140	[mm]	29.3	35.2				
		160	[mm]	33.5	40.2	53.6			
		180	[mm]	**34.4**	45.2	60.3			
		200	[mm]	**34.4**	**49.5**	67.0	83.8		
		220	[mm]	**34.4**	**49.5**	73.7	92.2		
		250	[mm]	**34.4**	**49.5**	83.8	104.7	130.9	
		300	[mm]	**34.4**	**49.5**	**88.1**	125.7	157.1	
		320	[mm]	**34.4**	**49.5**	**88.1**	134.0	167.6	214.5

Note:

Data and results must be checked for agreement with the actual existing conditions and for plausibility.

The calculation shown are proposals only and should be finally checked and approved by architect or engineer responsible for the project.

Hilti HIT HY-200-R injection adhesive with Rebar application
(HIT Rebar Design Method based on Chemical Bond Strength)
for Standard application/simply supported elements

Design Resistance for concrete grade (Fcu) =	**35 N/mm²**
Steel yield strength =	**460 N/mm²**
Installation condition=	**Dry concrete**
Temperature=	**Range II (-40°C to +80°C)**

Bar size	ø	[mm]	**10**	**12**	**16**	**20**	**25**	**32**
Drill bit size	D_o	[mm]	12,14	14,16	20	25	32	40
Chemical bond based on ETA approval	$F_{bd,po}$	[mm]	6.7	6.7	6.7	6.7	6.7	6.7
Length to develop yield	l_b	[mm]	164.3	197.1	262.9	328.6	410.7	525.7
	Embedment depth		**Design loads in [kN/bar]**					
Deformed high bond reinforcing bars **Loads in [kN/bar] for ruling values steel, bond and concrete** **Pre-drilled hole to be clean at time of installation** **Anchorage: linst**	**80**	[mm]						
	100	[mm]	20.9					
	120	[mm]	25.1	30.2				
	140	[mm]	29.3	35.2				
	160	[mm]	33.5	40.2	53.6			
	180	[mm]	**34.4**	45.2	60.3			
	200	[mm]	**34.4**	**49.5**	67.0	83.8		
	220	[mm]	**34.4**	**49.5**	73.7	92.2		
	250	[mm]	**34.4**	**49.5**	83.8	104.7	130.9	
	300	[mm]	**34.4**	**49.5**	**88.1**	125.7	157.1	
	320	[mm]	**34.4**	**49.5**	**88.1**	134.0	167.6	214.5

Note:

Data and results must be checked for agreement with the actual existing conditions and for plausibility.

The calculation shown are proposals only and should be finally checked and approved by architect or engineer responsible for the project.

9. SIMPLY DESIGNED WITH HILTI PROFIS REBAR 2.0

With Hilti PROFIS Rebar 2.0

Connections made in the great majority of standard applications, such as in walls, slabs, beams, foundations or supporting columns can be designed using the Hilti HIT post-installed rebar system. The system's versatility gives design engineers the flexibility they need to come up with the optimum solutions and specifications.

The task is further simplified by PROFIS Rebar 2.0, a software tool developed by Hilti that lets users design rebar connections according to the Hilti HIT Rebar Design Method or in accordance with the latest Eurocode guidelines.

Simply better designed

PROFIS Rebar 2.0 makes designing post-installed rebar connections easier than ever before. All that has to be entered is the information about loads and geometry - this clever PC application then guides the user to the optimum solution. The results can be exported in the form of a report containing the details needed for installation of the connections on the jobsite.

PROFIS Rebar 2.0 optimizes the solution provided by taking all aspects of the latest Hilti adhesive mortars and techniques into account. This cuts installation cost dramatically. In certain situations, embedment depth can be reduced by as much as 50%, resulting in a large saving in drilling and adhesive mortar cost. The Hilti HIT Rebar Design Method thus makes much more efficient use of the products employed and optimizes overall cost all the way from the specification stage to the final installation.

10. HILTI SERVICES FOR ENGINEERS

Technical advice

Hilti's qualified engineers and technicians provide consulting, support and advice free of charge. They'll be pleased to answer any question on the subject of post-installed rebar connections – on the phone, at your office or on site as per your convenience.

Anchor Fastening Technology Manual

This technical manual provides a wealth of information and practical examples of post-installed rebar connections as well as all the technical data for the Hilti HIT system for your easy reference.

User training

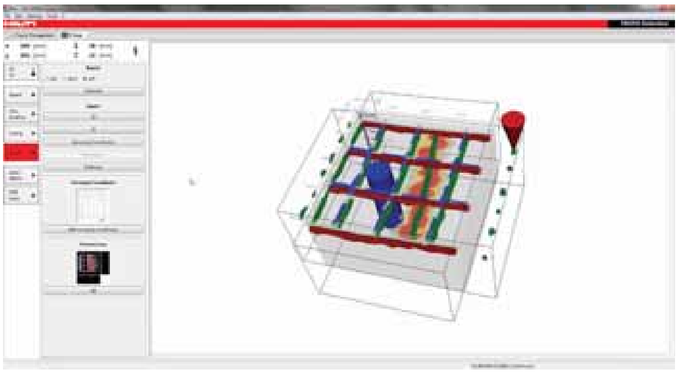
By providing special training, Hilti ensures that rebar installation personnel know how to use the HIT system in accordance with the proper procedures so that post-installed rebar connections can be made correctly.

Pull-out tests

Hilti offers the possibility of carrying out on-site rebar pull-out tests to validate expected loads.

Rebar analysis

The Hilti Ferroscan System provides information about existing reinforcement by determining its position, diameter and depth of coverage without the need for destructive procedures such as removal of concrete. Hilti PROFIS Ferroscan software simplifies the job of analyzing the data obtained.



The Hilti PROFIS Ferroscan software shows the position coverage and size of transverse and longitudinal reinforcement clearly.

11. HILTI SOLUTIONS FOR POST-INSTALLED REBAR CONNECTIONS

Design

Our dedicated and professional engineers provide you comprehensive, technical and engineering advice, design proposals, technical seminars, on-site testing and installation guidance in your office or at your jobsite.

The latest version of Hilti PROFIS Rebar puts post-installed rebar connection design and the calculation of overlap and anchorage lengths at your fingertips.

Detection

For the rapid detection, localization and documentation of reinforcement for the purpose of avoiding cutting through statically-relevant rebars. Also allows verification of reinforcement where plans no longer exist.

Drilling

Drill faster and more safely with Hilti combihammers and extra-rugged Hilti hammer drill bits or with Hilti high-performance diamond coring systems.

Cleaning

Hilti HIT Profis Rebar sets keep all the required cleaning accessories conveniently at hand.

Cutting

Hilti angle grinders featuring Smart Power and fitted with Hilti AC-D cutting discs are ideal for cutting rebars to length. Alternatively, Hilti cordless reciprocating saws provide total mobility.

Setting

Make a quick, easy, professional job of post-installed rebar connections – with Hilti HIT injectable mortars and efficient Hilti dispensers.

12. FREQUENTLY ASKED QUESTIONS

a) Why is it important not only to specify mortar but the overall application?
Post-installed rebar connections typically have significant embedment lengths. The equipment used must therefore allow drilling to be carried out accurately, avoiding crossing with neighboring holes. If dust remains on the walls of the holes drilled, bond strength as specified cannot be achieved. The holes must therefore be properly cleaned along their entire length using a steel brush fitted to an electric drill.

Injection without creation of air pockets and bubbles is possible only when it's done from the bottom of the hole and when mixer extensions and "piston" plugs are used. Air bubbles may cause pressure to build up when the rebar is inserted into the adhesive. This pressure can become so high that the adhesive is squirted out of the hole towards the worker, causing a hazard. Air can also inhibit proper curing of the adhesive and, last but not least, the presence of air impedes bonding, reducing the effective bonding length.

b) What does a European Technical Rebar Approval attest to an adhesive?
The product has passed a number of acceptance tests proving that the behavior of post-installed rebar connections is at least comparable to that of cast-in-place rebar connections (comparable load transfer with a comparable load-displacement behavior) under various conditions.

c) Which conditions are assessed for a European Technical Rebar Approval?
Bond strength in different grades of concrete, substandard hole cleaning, wet concrete, sustained load and temperature influence, freeze-thaw conditions, different installation directions, maximum embedment depth, avoidance of air bubbles during injection, durability (corrosion, chemical attack).

d) The acceptance tests don't include fire or fatigue loads. Can loads of this kind be taken up by post-installed reinforcement?
It's true that the adhesive forms a layer between the concrete and rebar, which may result in cast-in-place and post-installed rebar connections having significantly different characteristics under such conditions. Hilti has performed specific research on these loading conditions and can provide corresponding design recommendations.

e) What's the main difference between cast-in-place and post-installed reinforcement?
While detailing of cast-in-place reinforcement often requires bends or hooks or welded-on transverse reinforcement, post-installed reinforcement is limited to straight bar ends because only straight holes can be drilled.

f) What's the advantage of the Hilti HIT Rebar Design Method for post-installed anchorage where depth is limited, e.g. when connecting a slab to a wall?
With cast-in reinforcement, anchorage length can be reduced by using hooks or welded transverse reinforcement, which is not possible with post-installed reinforcement. Hilti adhesives, however, usually provide higher bond strength than that specified in building codes for cast-in-place reinforcement. Since such applications have a large concrete cover, the designer can take advantage of the high bond strength of the adhesive by reducing the anchorage length significantly.

g) How can moment-resisting connections be designed for post-installed reinforcement?
Such connections normally require bends in the connecting reinforcement. The Hilti HIT Rebar Design Method includes a strut-and-tie model for the design of moment-resisting connections with post-installed straight bars anchored using Hilti adhesives. Laboratory tests have proven this model to be correct and it has been assessed by independent experts.

h) How can concrete members under tension be connected using post-installed rebars?
Reinforcement in such members is usually hooked back by bending it around the perpendicular reinforcement in the base member which, again, isn't possible with post-installed reinforcement. As a highly experienced specialist in the field of anchoring to concrete, Hilti is well qualified to provide recommendations on how these principles should be used to connect such members. It should be noted that due to the possibility of concrete cone breakout failure, the design of connections of this kind must take brittle failure mode into account as it is done in Hilti PROFIS Rebar 2.0

i) Can the post-installation technology also be used for shear reinforcement?
Although this topic is still under research, Hilti already offers well-proven solutions for post-installed shear interface reinforcement and for post-installed punching shear reinforcement. Please ask Hilti Technical Service for details.

Our qualified and experienced account managers, design engineers and customer service representatives are at your service. Anytime.
For more information, please call us.

13. PROJECT REFERENCES IN MALAYSIA

- Baby G-Hotel, Penang
- Bakun Dam, Sarawak
- B. Braun Medical Industries, Penang
- Berjaya Central Park, Kuala Lumpur
- Capital Square, Kuala Lumpur
- CIMB Tower (KL Sentral, Lot A), Kuala Lumpur
- Custom & Immigration Quarantine Complex, Johor
- Da:Men, Petaling Jaya
- DNP Plaza, Kuala Lumpur
- Electrified Double Track Project
- First Solar Malaysia, Kulim
- Four Seasons Hotel, Kuala Lumpur
- G-Hotel, Penang
- Government Headquarter, Putrajaya
- IB Tower, Kuala Lumpur
- Icon City, Petaling Jaya
- Icon Residence, Mont Kiara
- Infenion, Kulim
- Jaya One Building, Petaling Jaya
- JKR Headquarter (KKR2), Johor
- Klang Valley Mass Rapid Transit (MRT) 2
- KLCC Convention Center, Kuala Lumpur
- KL Monorail Project
- KL Gateway, Kuala Lumpur
- Kompleks Tabung Haji, Putrajaya
- Kuala Lumpur International Airport (KLIA)
- Kuala Lumpur International Airport 2 (KLIA2)
- Kuantan Port Consortium Extension
- KWSP Building, Alor Setar
- Legoland Nusajaya, Johor
- Light Rail Transit Extension, Kuala Lumpur
- Manjung Power Plant
- M City, Kuala Lumpur
- Metro Rapid Transit Project
- Mid Valley II
- Nu Sentral (KL Sentral, Lot G), Kuala Lumpur
- Pavilion, Kuala Lumpur
- Penang Bridge 2nd Link (P2x)
- Penang Bridge Extension
- Petronas RAPID project, Pengerang, Johor
- Pinewoods Iskandar Malaysia Studio, Johor
- Prai Power Station
- Public Mutual Tower, Kuala Lumpur
- Queensbay Mall, Penang
- Sapura Tower, Lot 91, Kuala Lumpur
- Sepangga Bay, Sabah
- SMART Tunnel, Kuala Lumpur
- St. Regis (KL Sentral, Lot C), Kuala Lumpur
- Sunway Pyramid Hotel, Petaling Jaya
- Sunway Pyramid 2, Petaling Jaya
- Sunway Velocity, Kuala Lumpur
- Taiping Water Head Refurbishment, Perak
- Tapah Prison, Perak
- Teluk Gong Power Plant
- The Troika, Kuala Lumpur
- Times Square, Kota Kinabalu
- Tropicana City, Petaling Jaya
- Tun Razak Exchange, Kuala Lumpur
- Universiti Malaysia Sarawak, Sarawak
- Uptown Residence, Petaling Jaya
- Vale's Iron Ore Distribution Hub, Perak
- Vision City (Quill Mall), Kuala Lumpur
- W Hotel, Kuala Lumpur

Tun Razak Exchange, Kuala Lumpur

Light Rail Transit Extension, Kuala Lumpur

Petronas RAPID project, Pengerang, Johor

KL Pavilion, Kuala Lumpur

Mid Valley - The Gardens, Kuala Lumpur

Nu Sentral, Kuala Lumpur

Government Headquaters, Putrajaya

KL Convention Centre, Kuala Lumpur

Queensbay Mall, Penang

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