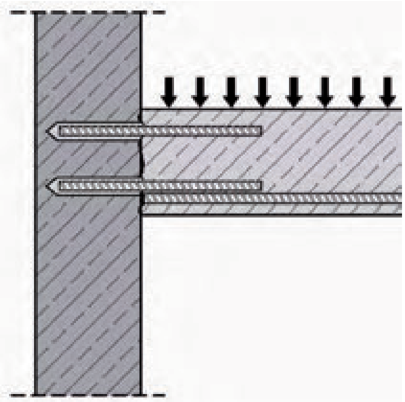
Post-installed rebar.

In compliance with AS 3600-2009

Post-installed rebar connections



Basics of post-installed rebar connections

Hilti HIT-RE 500 post-installed rebar

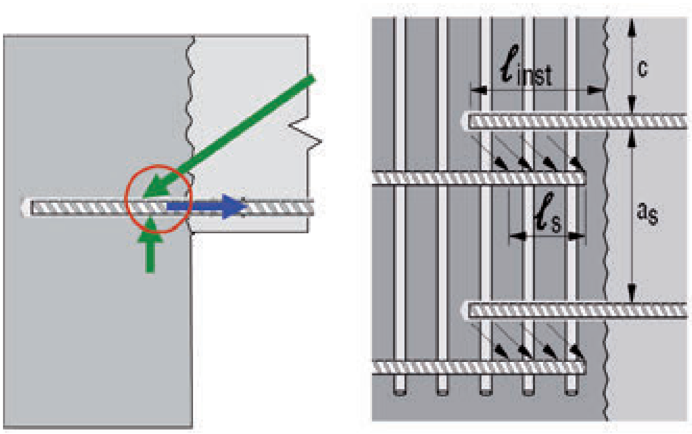
Hilti HIT-HY 200 post-installed rebar

Contents

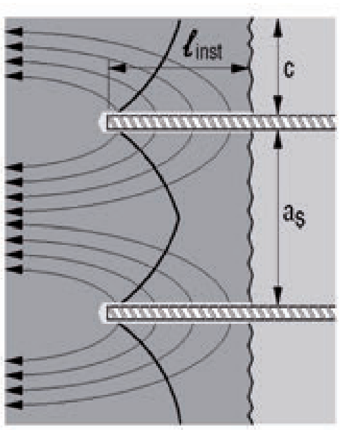
1. Basics of post-installed rebar connections

1.1 Definition of rebar

Reinforcement anchorages or splices that are fixed into already cured concrete by Hilti HIT injection adhesives in drilled holes are called “Post-installed rebar connections” as opposed to normal, so called “cast-in” reinforcement. Many connections of rebars installed for good detailing practice will not require specific design considerations. But post-installed rebars which become part of the structural system have to be designed as carefully as the entire structure. While European Technical Approvals prove that in basic load situations, post-installed rebars behave like cast-in bars, a number of differences needs to be considered in special design situations such as fire or load cases where hooks or bends would be required for cast-in anchorages. The following chapters are intended to give the necessary information to safely design and specify post-installed reinforcement connections.



structural rebar situations: “anchorage node in equilibrium” and “splice”



anchor situation

This section of the Fastening Technology Manual deals with reinforcement connections designed according to structural reinforced concrete design principles. The task of structural rebars is to take tensile loads and since concrete failure is always brittle, reinforced concrete design assumes that concrete has no tensile strength. Therefore structural rebars can end / be anchored in only two situations:

- the bar is not needed anymore (the anchorage is a node in equilibrium without tensile stress in concrete)
- another bar takes over the tensile load (overlap splice)

Situations where the concrete needs to take up tensile load from the anchorage or where rebars are designed to carry shear loads should be considered as “rebar used as anchors” and designed according to anchor design principles as given e.g. in the guidelines of EOTA [3]

Unlike in anchor applications, reinforcement design is normally done for yielding of the steel in order to obtain ductile behaviour of the structure with a good serviceability. The deformations are rather small in correlation to the loads and the crack width limitation is around wk ~0.3mm. This is an important factor when considering resistance to the environment, mainly corrosion of the reinforcement.

In case of correct design and installation the structure can be assumed as monolithic which allows us to look at the situation as if the concrete was poured in one. Due to the allowed high loads the required embedment depth can be up to 80d (diameter of rebar).

1.2 Advantages of post-installed rebar connections

With the use of the Hilti HIT injection systems it is possible to connect new reinforcement to existing structures with maximum confidence and flexibility.

- **design flexibility**
- **form work simplification**
- **reliable like cast-in**
- **defined load characteristics**
- **horizontal, vertical and overhead**
- **simple, high confidence application**

1.3 Application examples

Post-installed rebar connections are used in a wide range of applications, which vary from new construction projects, to structure upgrades and infrastructure requalifications.

Post-installed rebar connections in new construction projects

Diaphragm walls

Slab connections

Misplaced bars

Vertical/horizontal connections

Post-installed rebar connections in structure upgrades

Wall strengthening

New slab constructions

Joint strengthening

Cantilevers/balconies

Post-installed rebar connections in infrastructure requalifications

Slab widening

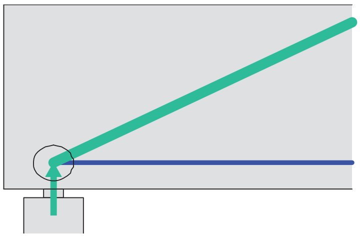
Structural upgrade

Slab strengthening

Sidewalk upgrade

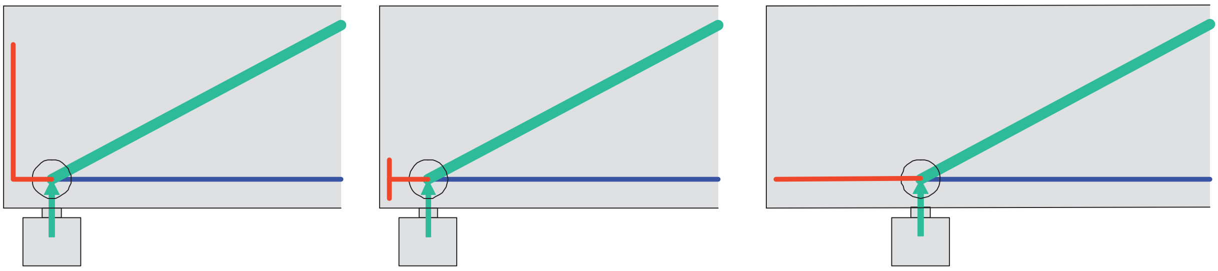
1.4 Anchorage and splice

Development length



Simple support

Reinforced concrete is often designed using strut and tie models. The forces are represented by trusses and the nodes of these trusses have to be in equilibrium like in the figure to the left: the concrete compression force (green line), the support force (green arrow) and the steel tensile force (blue). The model assumes that the reinforcing bar can provide its tensile force on the right side of the node while there is no steel stress at all on the left side, i.e. the bar is not needed any more on the left side of the node. Physically this is not possible, the strut and tie model is an idealisation. The steel stress has to be developed on the left side of the node. This is operated by bond between steel and concrete. For the bar to be able to develop stress it needs to be extended on the left side of the node. This extension is called "development length" or "anchorage length". The space on the left side of the node shown in the figure above is not enough to allow a sufficient development of steel stress by bond. Possible approaches to solve this problem are shown the figure below: either an extension of the concrete section over the support or a reduction of the development length with appropriate methods. Typical solutions are hooks, heads, welded transverse reinforcement or external anchorage.



Typical solutions for anchoring of the reinforcement

Overlap splices

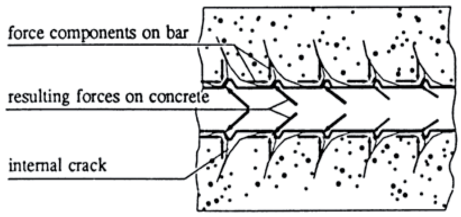
In case that the equilibrium of a node cannot be established without using the tensile capacity of the concrete, the tensile force of a (ending) bar must be transmitted to other reinforcement bars. A common example is starter bars for columns or walls. Due to practical reasons foundations are often built with rebars much shorter than the final column height, sticking out of the concrete. The column reinforcement will later be spliced with these. The resulting tension load in the column reinforcement due to bending on the column will be transferred into the starter bars through an overlap splice.

Forces are transmitted from one bar to another by lapping the bars. The detailing of laps between bars shall be such that:

- the transmission of the forces from one bar to the next is assured
- spalling of the concrete in the neighbourhood of the joints does not occur
- large cracks which affect the performance of the structure do not develop

1.5 Bond of cast-in ribbed bars

General behaviour



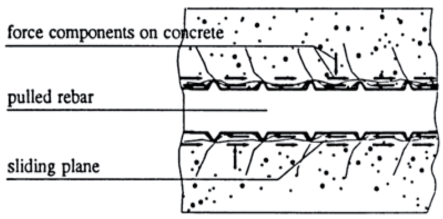
Load transfer from ribbed bars into

For ribbed bars, the load transfer in concrete is governed by the bearing of the ribs against the concrete. The reacting force within the concrete is assumed to be a compressive strut with an angle of 45°.

For higher bond stress values, the concentrated bearing forces in front of the ribs cause the formation of cone-shaped cracks starting at the crest of the ribs. The resulting concrete keyed between the ribs transfer the bearing forces into the surrounding concrete, but the wedging action of the ribs remains limited. In this stage the displacement of the bar with respect to the concrete (slip) consists of bending of the keys and crushing of the concrete in front of the ribs.

The bearing forces, which are inclined with respect to the bar axis, can be decomposed into directions parallel and perpendicular to the bar axis. The sum of the parallel components equals the bond force, whereas the radial components induce circumferential tensile stresses in the surrounding concrete, which may result in longitudinal radial (splitting / spalling) cracks. Two failure modes can be considered:

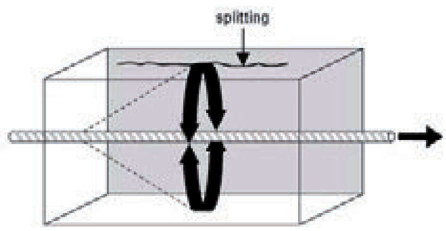
Bond failure



Bond failure of ribbed bars

Bond failure is caused by pull-out of the bar if the confinement (concrete cover, transverse reinforcement) is sufficient to prevent splitting of the concrete cover. In that case the concrete keys are sheared off and a sliding plane around the bar is created. Thus, the force transfer mechanism changes from rib bearing to friction. The shear resistance of the keys can be considered as a criterion for this transition. It is attended by a considerable reduction of the bond stress. Under continued loading, the sliding surface is smoothed due to wear and compaction, which will result in a further decrease of the bond stress, similar to the case of plain bars.

Splitting failure



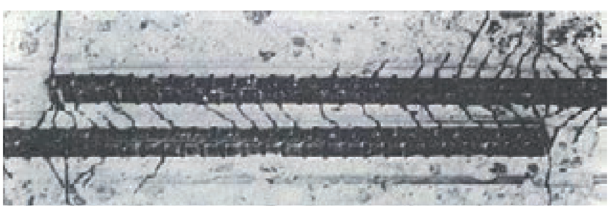
Splitting

Bond splitting failure is decisive if the radial cracks propagate through the entire cover. In that case the maximum bond stress follows from the maximum concrete confinement, which is reached when the radial cracks have penetrated the cover for about 70%. Further crack propagation results in a decrease of the confining stresses. At reaching the outer surface these stresses are strongly reduced, which results in a sudden drop of the bond stress.

Influence of spacing and cover on splitting and spalling of concrete

In most cases the reinforcement bars are placed close to the surface of the concrete member to achieve good crack distribution and economical bending capacity. For splices at wide spacing (normally in slabs, left part of figure left), the bearing capacity of the concrete depends only on the thickness of the concrete cover. At narrow spacing (normally in beams, right part of figure above) the bearing capacity depends on the spacing and on the thickness of the cover. In the design codes the reduction of bearing capacity of the cover is taken into account by means of multiplying factors for the splice length.

Load transfer in overlap splices


Load transfer at lap splices

The load transfer between bars is performed by means of compressive struts in the concrete, see figure left. A 45° truss model is assumed. The resulting perpendicular forces act as splitting forces. The splitting forces are normally taken up by the transverse reinforcement. Small splitting forces are attributed to the tensile capacity of the concrete. The amount of the transverse or tie reinforcement necessary is specified in the design codes.

1.6 Specifics of post-installed reinforcing bars

General behaviour

The load transfer for post-installed bars is similar to cast-in bars if the stiffness of the overall load transfer mechanism is similar to the cast-in system. The efficiency depends on the strength of the adhesive mortar against the concentrated load near the ribs and on the capacity of load transfer at the interface of the drilled hole.

In many cases the bond values of post-installed bars are higher compared to cast-in bars due to better performance of the adhesive mortar. But for small edge distance and/or narrow spacing, splitting or spalling forces become decisive due to the low tensile capacity of the concrete.

Post-installed reinforcement approvals

There are European Technical Approvals for post-installed rebar connections. Systems getting such approvals have to be assessed according to the EOTA technical guideline TR023 [2] (available in the EOTA website). Requirements for a positive assessment are an installation system providing high installation quality for deep holes and an adhesive fulfilling the test requirements of the guideline TR023. Obtaining the approval is basically the proof that the post-installed rebars work at least as well as cast-in rebars (with respect to bond strength and displacement); consequently, the design of the rebar anchorage is performed according to structural concrete design codes, in the case of Europe this is Eurocode 2 [1].

High quality adhesives required

Assessment criteria

EOTA TR023 [2] specifies a number of tests in order to qualify products for post-installed rebar applications. These are the performance areas checked by the tests:

1. Bond strength in different strengths of concrete
2. Substandard hole cleaning
3. Wet concrete
4. Sustained load and temperature influence
5. Freeze-thaw conditions
6. Installation directions
7. Maximum embedment depth
8. Avoidance of air bubbles during injection
9. Durability (corrosion, chemical attack)

Approvals with or without exceptions

If an adhesive fulfills all assessment criteria of EOTA TR023, rebar connections carried out with this adhesive can be designed with the bond strength and minimum anchorage length according to Eurocode 2 [1] as outlined in section 2.2 of this document.

Adhesives which do not fully comply with all assessment criteria can still obtain an “approval with exceptions”.

- If the bond strength obtained in tests does not fulfil the specified requirements, then bond strengths lower than those given by Eurocode 2 shall be applied. These values are given in the respective ETA.
- If it cannot be shown that the bond strength of rebars post-installed with a selected product and cast-in rebars in cracked concrete (w=0.3mm) is similar, then the minimum anchorage length $\ell_{b,min}$ and the minimum overlap length $\ell_{0,min}$ shall be increased by a factor 1.5.

2. Design of post-installed reinforcement

There are two design methods which are supported by Hilti:

1. Based on the approval (ETA) for the mortar system qualified according to EOTA TR023 [2] which allows to use the accepted structural code Eurocode 2 EN 1992-1-1:2011, chapters 8.4: "anchorage of longitudinal reinforcement" and 8.7 "Laps and mechanical couplers" taking into account some adhesive specific parameters. This method is called

   "ETA/EC2 design method"

   Paragraph 2.2 shows application range.

2. The design approach of Eurocode 2 has been extended on the basis of extensive internal as well as external research as well as assessments. This method is called

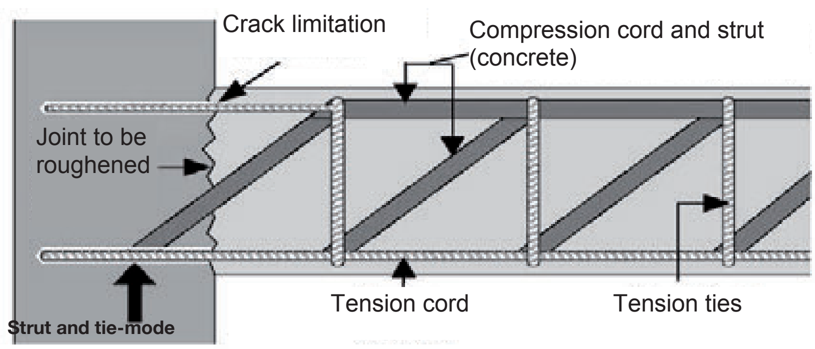
   "Hit rebar design method"

   See section 2.3 for an overview of the design approach.

2.1 Loads on reinforcing bars

Strut and tie model

Strut and tie models are used to calculate the load path in reinforced concrete members. Where a non-linear strain distribution exists (e.g. supports) strut and tie models may be used {Clause 6.5.1(1), EC2: EN 1992-1-1:2011}.

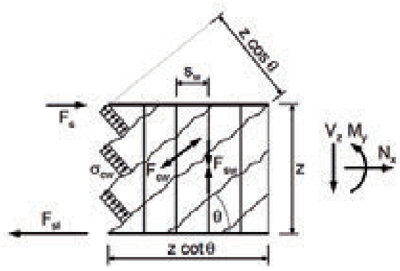


Strut and tie models consist of struts representing compressive stress fields, of ties representing the reinforcement and of the connecting nodes. The forces in the elements of a strut and tie model should be determined by maintaining the equilibrium with the applied loads in ultimate limit state. The ties of a strut and tie model should coincide in position and direction with the corresponding reinforcement {Clause 5.6.4, EC2: EN 1992-1-1:2011 Analysis with strut and tie models}.

In modern concrete design codes the strut angle θ can be selected within certain limits, roughly between 30° and 60°. Many modern concrete design codes show a figure similar to the following:

The equilibrium equations in horizontal direction gives the force in the reinforcement:

$$F_{sl} = \frac{M_y}{z} + \frac{N_x}{2} + \frac{V_z \cot\theta}{2}$$



Truss model in modern codes

2.2 Approval based ETA/EC2 design method

Application range

The principle that rebars are anchored "where they are not needed any more" (anchorage) or where the force is taken over by another bar (splice) and the fact that only straight rebars can be post-installed lead to the application range shown by the figures taken from EOTA TR023 [2]:

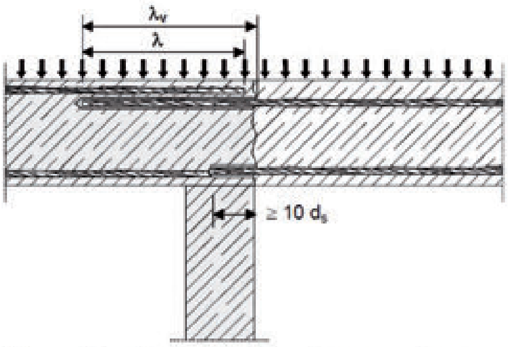


Figure 1.1: Overlap joint for rebar connections of slabs and beams

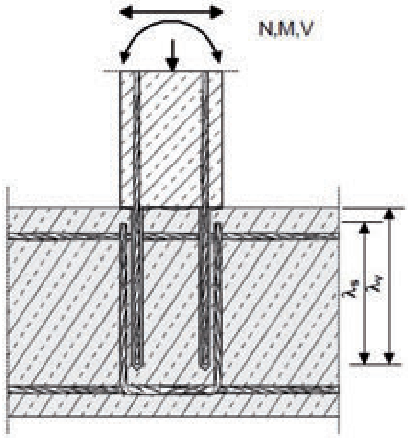


Figure 1.2: Overlap joint at a foundation of a column or wall where the rebars are stressed in tension

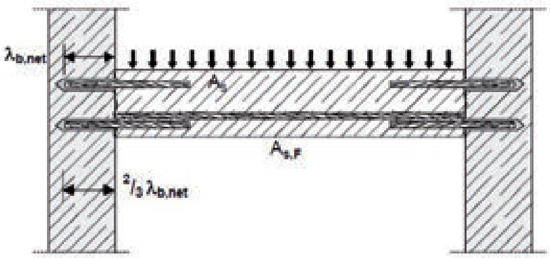


Figure 1.3: End anchoring of slabs or beams, designed as simply supported

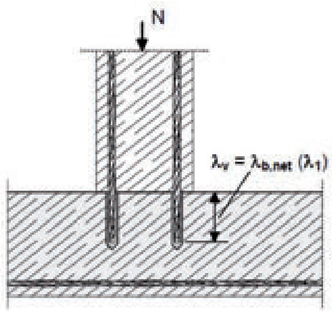


Figure 1.4: Rebar connection for components stressed primarily in compression. The rebars are stressed in compression

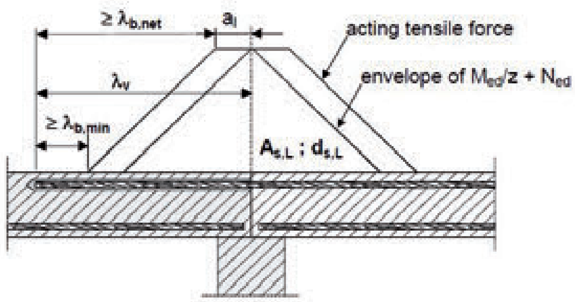


Figure 1.5: Anchoring of reinforcement to cover the line of acting tensile force

Note to Figure 1.1 to 1.5:

In the Figures no transverse reinforcement is plotted, the transverse reinforcement as required by EC 2 shall be present.

The shear transfer between old and new concrete shall be designed according to EC 2.

Application range according to EOTA TR023

All other applications lead to tensile stress in the concrete. Therefore, the principle "works like cast-in" would not be true any more. Such cases must be considered with specific models exceeding the approval based approach to post-installed rebar connections

2.3 HIT-rebar design method

While the EC2/ETA design method is of direct and simple use, it has two main drawbacks

- The connection of simply supported slabs to walls is only possible if the wall is thick enough to accommodate the anchorage length. As reductions of the anchorage length with hooks or welded transverse reinforcement cannot be made with post-installed reinforcement, it often occurs that the wall is too small. However, if the confinement of the concrete is large enough, it is actually possible to use the full bond strength of the adhesive rather than the bond strength given by Eurocode 2. The so-called "splitting design" allows to design for the full strength of the adhesive.
- According to traditional reinforced concrete principles, moment resisting frame node connections required bent connection bars. In this logic, they can therefore not be made with straight post-installed rebar connections.

2.3.1 Splitting design

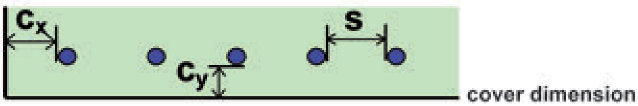
The factor α_2 of Eurocode 2 [1] gives an explicit consideration for splitting and spalling as a function of concrete cover and bar spacing. European Technical Approvals recommend the same procedure for post-installed rebar connections:

$$l_{bd,spl} = \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}} \cdot \alpha_2$$

$$f_{bd} \quad \textit{according to technical data (ETA's for post-installed anchors)} \qquad (1)$$

$$\alpha_2 = 1 - 0.15 \cdot \frac{c_d - \phi}{\phi}$$

$$c_d = \min(c_x; c_y; s/2)$$



This function is adapted and extended for post-installed reinforcement for the HIT-Rebar design concept: Eurocode 2 limits the α_2 value to $\alpha_2 \geq 0.7$. This can be interpreted as follows: as long as α_2 exceeds 0.7, spalling of the concrete cover or splitting between bars will be the controlling mode of failure. If α_2 is less than 0.7, corresponding to cover dimensions of $c_d/\phi > 3$, the cover is large enough so that splitting cannot occur any more and pullout will control. Assuming an infinitely strong adhesive, there would be no such lower limit on α_2 and the bond stress, at which splitting occurs can be expressed as:

$$f_{bd,spl1} = \frac{f_{bd}}{1 - 0.15 \cdot \dfrac{c_d - \phi}{\phi}}$$

For cover dimensions exceeding the range of Eurocode 2, i.e. for $c_d/\phi > 3$ (bonded-in bars only), an adapted factor α_2' is used to create a linear extension of the bond strength function:

$$\alpha_2' = \frac{1}{\dfrac{1}{0.7} + \delta \cdot \dfrac{c_d - 3 \cdot \phi}{\phi}}$$

$$f_{bd,spl2} = \frac{f_{bd}}{\max[\alpha_2';\ 0.25]}$$

where δ is a factor defining the growth of the linear function for $f_{bd,spl,2}$; it is calibrated on the basis of tests.
In order to avoid unreasonably low values of α_2', its value is limited to $\alpha_2' \geq 0.25$

2.3.2 Extension of the AS3600-2009 approach – HIT-rebar design method

The basic development length for a deformed bar in tension is calculated from

$$L_{sy.tb} = \frac{0.5 k_1 k_3 f_{sy} d_b}{k_2 \sqrt{f'_c}} \geq 29 k_1 d_b$$

where,

K_1 =1.3 for a horizontal bar with more than 300mm of concrete cast below the bar;
or
= 1.0 otherwise

K_2 = (132 – d_b) / 100, and

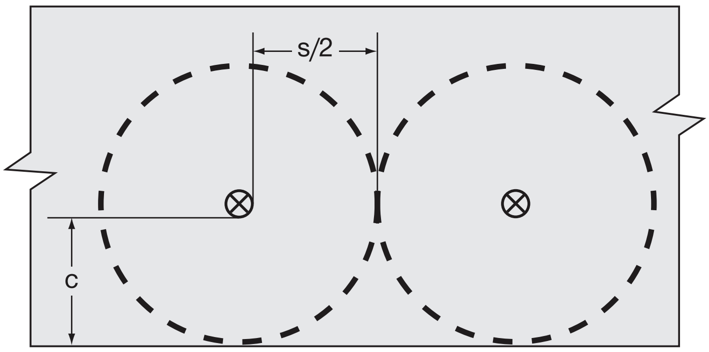
K_3 = 1.0 - 0.15 x (c_d– d_b) / d_b (within the limits 0.7 ≤ k_3 ≤ 1.0)

Based on section 2.3.1, the same approach can be applied to AS3600-2009.
Accordingly, the k_3 value may be replaced by:

$$K'_3 = \frac{1}{\frac{1}{0.7} + \delta \frac{c_d - 3d_b}{d_b}} \geq 0.25 \text{ for } c_d > 3d_b$$

δ is the reduction factor for splitting with large concrete cover – Hilti additional data, based on further testing.

The confinement Cd is defined as:

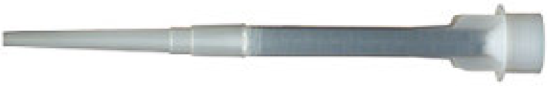


$$c_d \leq \min\left\{c; \frac{s}{2}\right\}$$

3. Hilti HIT-RE 500 post-installed rebars

Injection mortar system

Hilti HIT-RE 500
330 ml foil pack
(also available as 500 ml and 1400 ml foil pack)



Static mixer

rebar

Benefits

- suitable for non-cracked concrete C 20/25 to C 50/60
- high loading capacity
- suitable for dry and water saturated concrete
- under water application
- large diameter applications
- high corrosion resistant
- long working time at elevated temperatures
- odourless epoxy

Concrete | Fire rated | European Technical Approval | DIBt approval | Drinking water approved | Corrosion tested | PROFIS rebar design software | SAFEset approved automatic cleaning

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	DIBt, Berlin	ETA-08/0105 / 2008-07-30
European technical approval	DIBt, Berlin	ETA-04/0027 / 2009-05-20
DIBt approval	DIBt, Berlin	Z-21.8-1790 / 2009-03-16
Fire test report	IBMB Braunschweig	3357/0550-5 / 2002-07-30
Assessment report (fire)	Warringtonfire	WF 166402 / 2007-10-26

Setting details

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

Curing time for general conditions

Data according ETA-08/0105, issue 2008-06-30			
Temperature of the base material	Working time t_{gel} in which rebar can be inserted and adjusted	Initial curing time $t_{cure,ini}$	Curing time t_{cure} before rebar can be fully loaded
5 °C ≤ T_{BM} < 10 °C	2 h	18 h	72 h
10 °C ≤ T_{BM} < 15 °C	90 min	12 h	48 h
15 °C ≤ T_{BM} < 20 °C	30 min	9 h	24 h
20 °C ≤ T_{BM} < 25 °C	20 min	6 h	12 h
25 °C ≤ T_{BM} < 30 °C	20 min	5 h	12 h
30 °C ≤ T_{BM} < 40 °C	12 min	4 h	8 h
T_{BM} = 40 °C	12 min	4 h	4 h

For dry concrete curing times may be reduced according to the following table. For installation temperatures below +5 °C all load values have to be reduced according to the load reduction factors given below.

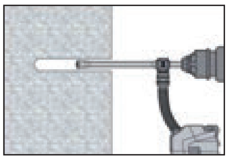
Curing time for dry concrete

Additional Hilti technical data				
Temperature of the base material	Working time t_{gel} in which rebar can be inserted and adjusted	Initial curing time $t_{cure,ini}$	Reduced curing time t_{cure} before rebar can be fully loaded	Load reduction factor
T_{BM} = -5 °C	4 h	36 h	72 h	0,6
T_{BM} = 0 °C	3 h	25 h	50 h	0,7
T_{BM} = 5 °C	2 ½ h	18 h	36 h	1
T_{BM} = 10 °C	2 h	12 h	24 h	1
T_{BM} = 15 °C	1 ½ h	9 h	18 h	1
T_{BM} = 20 °C	30 min	6 h	12 h	1
T_{BM} = 30 °C	20 min	4 h	8 h	1
T_{BM} = 40 °C	12 min	2 h	4 h	1

Setting instructions

Bore hole drilling

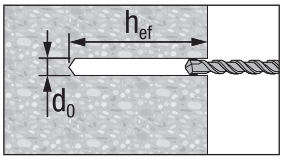
a) Hilti hollow drill bit (for dry and wet concrete only)



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 bore hole while drillin when used in accordance with the user's manual.

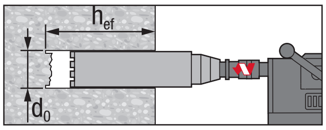
After drilling is complete, proceed to the "injection preparation" step in the instructions for use.

b) Hammer drilling (dry or wet concrete and installation in flooded holes (no sea water))



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

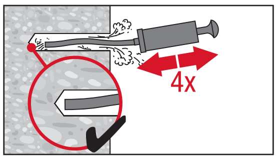
c) Diamond coring (for dry and wet concrete only)



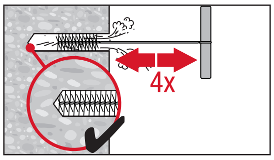
Diamond coring is permissible when diamond core drilling machine and the corresponding core bit are used.

Bore hole cleaning **Just before setting an anchor, the bore hole must be free of dust and debris.**

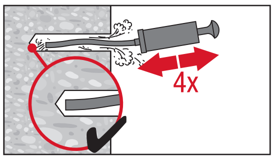
a) Manual Cleaning (MC) for bore hole diameters d_0 ≤ 20mm and bore hole depth h_0 ≤ 20d or h_0 ≤ 250 mm (d = diameter of element)



The Hilti manual pump may be used for blowing out bore holes up to diameters d_0 ≤ 20 mm and embedment depths up to h_{ef} ≤ 10d.
Blow out at least 4 times from the back of the bore hole until return air stream is free of noticeable dust

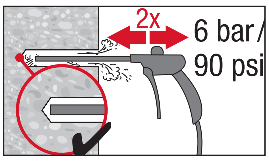


Brush 4 times with the specified brush size (brush ∅ ≥ bore hole ∅) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the bore hole -- if not the brush is too small and must be replaced with the proper brush diameter.

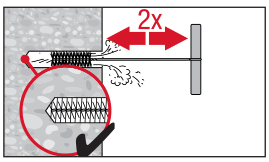


Blow out again with manual pump at least 4 times until return air stream is free of noticeable dust.

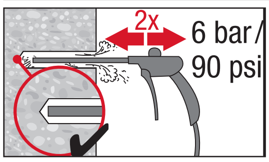
b) Compressed air cleaning (CAC) for all bore hole diameters d_0 and all bore hole depth h_0



Blow 2 times from the back of the hole (if needed with nozzle extension) over the hole length with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust. Bore hole diameter ≥ 32 mm the compressor must supply a minimum air flow of 140 m³/hour.



Brush 2 times with the specified brush size 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 bore hole -- if not the brush is too small and must be replaced with the proper brush diameter.

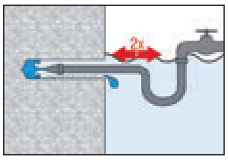


Blow again with compressed air 2 times until return air stream is free of noticeable dust.

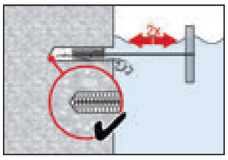
Setting instructions

Bore hole cleaning **Just before setting an anchor, the bore hole must be free of dust and debris.**

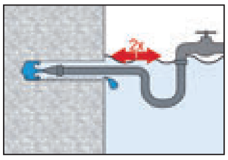
c) Cleaning for under water for all bore hole diameters d_0 and all bore hole depth h_0



Flush 2 times the hole by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.

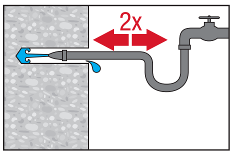


Brush 2 times with the specified brush size (brush ∅ ≥ bore hole ∅) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the bore hole -- if not the brush is too small and must be replaced with the proper brush diameter.

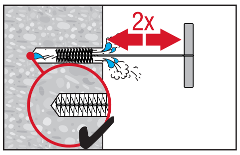


Flush the hole again 2 times by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.

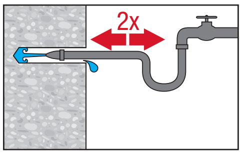
d) Cleaning of hammer drilled flooded holes and diamond cored holes for all bore hole diameters d_0 and all bore hole depth h_0



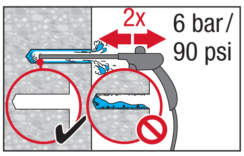
Flush 2 times the hole by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.



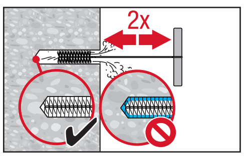
Brush 2 times with the specified brush size (brush ∅ ≥ bore hole ∅) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the bore hole -- if not the brush is too small and must be replaced with the proper brush diameter.



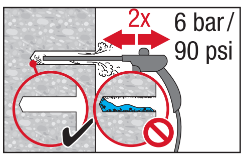
Flush 2 times the hole by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.



Blow 2 times from the back of the hole (if needed with nozzle extension) over the hole length with oil-free compressed air (min. 6 bar at 6 m^3/h) until return air stream is free of noticeable dust and water
Bore hole diameter ≥ 32 mm the compressor must supply a minimum air flow of 140 m^3/hour.



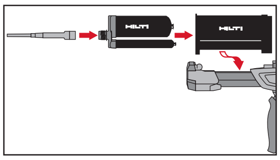
Brush 2 times with the specified brush size (brush ∅ ≥ bore hole ∅) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the bore hole -- if not the brush is too small and must be replaced with the proper brush diameter.



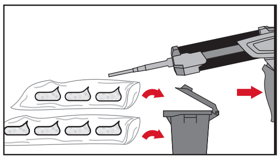
Blow again with compressed air 2 times until return air stream is free of noticeable dust.

Setting instructions

Injection preparation



Tightly attach new Hilti mixing nozzle HIT-RE-M to foil pack manifold (snug fit). Do not modify the mixing nozzle. Observe the instruction for use of the dispenser. Check foil pack holder for proper function. Do not use damaged foil packs / holders. Swing foil pack holder with foil pack into HIT dispenser.



The foil pack opens automatically as dispensing is initiated. Discard initial adhesive. Depending on the size of the foil pack an initial amount of adhesive has to be discarded.

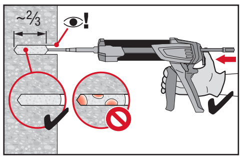
Discard quantities are:

3 strokes for 330 ml foil pack,

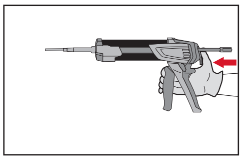
4 strokes for 500 ml foil pack

65 ml for 1400 ml foil pack

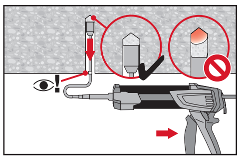
Inject adhesive from the back of the borehole without forming air voids



Inject the adhesive starting at the back of the hole, slowly withdrawing the mixer with each trigger pull. Fill holes approximately 2/3 full. It is required that the annular gap between the anchor and the concrete is completely filled with adhesive along the embedment length.



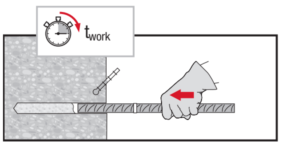
After injection is completed, depressurise the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.



Overhead installation and/or installation with embedment depth h_{ef} > 250mm. For overhead installation the injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug HIT-SZ. Insert piston plug to back of the hole and inject adhesive. During injection the piston plug will be naturally extruded out of the bore hole by the adhesive pressure.

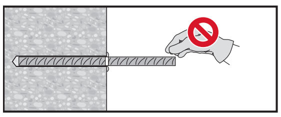
Under water application: fill bore hole completely with mortar

Setting the element

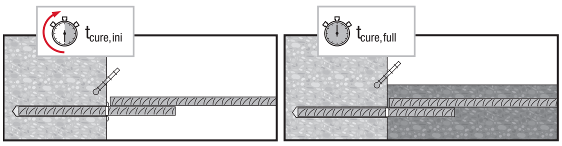


Before use, verify that the element is dry and free of oil and other contaminants.

Mark and set element to the required embedment depth untill working time t_{work} has elapsed



For overhead installation use piston plugs and fix embedded parts with e.g. wedges HIT-OHW



Loading the anchor:

After required curing time t_{cure} the anchor can be loaded.

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 in the hardened state **does not conduct 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)	Compressed air drill (CA)	Diamond coring Wet (DD)	Diamond coring Dry (PCC)
10	14 (12[a])	-	14 (12[a])	-
12	16 (14[a])	17	16 (14[a])	-
16	20	20	20	-
20	25	26	25	-
24	32	32	32	35
28	35	35	35	35
32	40	40	40	47
36	45	45	47	47
40	55	57	52	52

a) Max. installation length ℓ = 250mm

Design process – 3 steps

Step 1: Determine anchorage length based on the bond strength of the product

Hammer or compressed air drilling. Dry concrete. Uncracked concrete C20/25.									
	Bar diameter								
	Data according to ETA 04/0027, issue 26 June 2013							**Hilti tech data**	
	N10	N12	N16	N20	N24	N28	N32	N36	N40
Sectional Area of As (mm^2)	79	113	201	314	452	616	804	1018	1257
Design Yield Fsy (KN)	40	57	101	157	226	308	402	509	629
$f^*_{bd,po}$ (MPa)	8.57		8.0		7.43			6.24	5.76
Required Length based on ETA Bond (mm) L_{sb}	**149**	**176**	**251**	**312**	**404**	**471**	**538**	**721**	**869**
For anchor installed in wet concrete or flooded hole multiply L_{sb} by	1.20								
If the hole was produced by wet diamond coring** L_{sb}	191	227	384	525	741	919	1200	-	-

*Design bond strength in N/mm² according to ETA 04/0027 $f_{bd,po}$ = τRk/γMp), then increased by 20% for dry concrete.
Valid for temperature range I : 40°C / 24°C

**For wet diamond coring, the anchors shall not be installed in flooded hole.

Effect of concrete compressive strength:

For concrete with different compressive strength, L_{sb} shall be divided by $f_{B,p}$

Concrete compressive strength f'c,cyl Mpa	20	25	32	40	50
$f_{B,p}$	1	1.02	1.048	1.07	1.09

The final required length $L_{sb,f}$ shall be equal: $L_{sb,f} = L_{sb} / f_{B,p}$

Step 2: Calculate of the basic anchorage depth $L_{sy,tb}$ (mm) to develop yield of post-installed rebar in tension as per AS 3600-2009. Extension Approach

With the Reduction factor for splitting with large concrete cover / confinement: δ = 0.306 (HILTI additional data), applicable for both HILTI products HIT-RE 500 and HIT-HY 200, K'_3 shall be calculated from:

$$K'_3 = \frac{1}{\frac{1}{0.7} + \delta \frac{C_d - 3d_b}{d_b}} \geq 0.25 \text{ for } C_d > 3d_b$$

The basic anchorage depth $L_{sy,tb}$ can therefore be taken from the following tables:

$L_{sy,tb}$ for diameter of rebar = 10mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
$2.d_b$	389	348	308	275	246
$3.d_b$	321	287	254	227	203
$4.d_b$	264	236	209	187	167
$5.d_b$	225	201	178	159	142
$6.d_b$	195	175	154	139	137
$7.d_b$	173	155	142	-	-
$8.d_b$	155	146	-	-	-
$9.d_b$	149	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 12mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
$2.d_b$	475	425	376	336	301
$3.d_b$	391	350	309	277	247
$4.d_b$	322	288	255	228	204
$5.d_b$	274	245	217	194	173
$6.d_b$	238	213	188	164	161
$7.d_b$	211	188	168	-	-
$8.d_b$	189	173	-	-	-
$9.d_b$	176	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 16mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
$2.d_b$	655	586	518	463	415
$3.d_b$	540	483	427	382	341
$4.d_b$	445	398	351	314	281
$5.d_b$	378	338	299	267	239
$6.d_b$	329	294	260	235	230
$7.d_b$	291	260	240	-	-
$8.d_b$	261	246	-	-	-
$9.d_b$	251	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 20mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
2.d_b	849	759	671	600	537
3.d_b	699	625	552	494	442
4.d_b	575	515	455	407	364
5.d_b	489	438	387	346	309
6.d_b	425	380	336	301	286
7.d_b	376	337	298	292	-
8.d_b	337	306	-	-	-
9.d_b	312	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 24mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
2.d_b	1056	944	835	747	668
3.d_b	870	778	687	615	550
4.d_b	716	641	566	506	453
5.d_b	609	545	481	430	385
6.d_b	529	474	419	378	371
7.d_b	468	419	385	-	-
8.d_b	420	396	-	-	-
9.d_b	404	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 28mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
2.d_b	1279	1144	1011	905	809
3.d_b	1054	942	833	745	666
4.d_b	868	776	686	614	549
5.d_b	738	660	583	522	466
6.d_b	641	574	507	454	432
7.d_b	567	507	449	440	-
8.d_b	509	462	-	-	-
9.d_b	471	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 32mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
2.d_b	1521	1360	1202	1075	962
3.d_b	1252	1120	990	885	792
4.d_b	1031	922	815	729	652
5.d_b	877	784	693	620	554
6.d_b	762	682	603	539	494
7.d_b	674	603	533	503	-
8.d_b	605	541	513	-	-
9.d_b	548	527	-	-	-
10.d_b	538	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 36mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
$2.d_b$	1782	1594	1409	1260	1127
$3.d_b$	1467	1313	1160	1038	928
$4.d_b$	1209	1081	955	855	764
$5.d_b$	1027	919	812	726	661
$6.d_b$	893	799	706	674	-
$7.d_b$	790	707	688	-	-
$8.d_b$	721	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 40mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
$2.d_b$	2066	1848	1633	1461	1307
$3.d_b$	1701	1522	1345	1203	1076
$4.d_b$	1401	1253	1108	991	886
$5.d_b$	1191	1065	942	842	797
$6.d_b$	1036	926	829	812	-
$7.d_b$	916	852	-	-	-
$8.d_b$	869	-	-	-	-

Step 3: Determine the basic anchorage depth Lsy (mm) to develop yield of post-installed rebar shall be:

$$L_{sy} \geq \{L_{sb,f}\,;\,L_{sy,tb}\}$$

Embedment depth to develop less than the yield strength

The embedment depth to develop less than the yield of the bar shall be as per clause 13.1.2.4 of AS 3600-2009.
Only for wet diamond core drilling, the minimum anchorage length shall be increased by 1.5 in compliance with ETA-08/0105, issue 2008-06-03.

Spliced connection

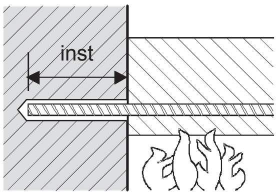
When a post-installed rebar is required to form a splice with an existing cast-in rebar, the rules of AS 3600-2009, 13.2.2 shall be applied to calculate the required embedment depth of the post-installed rebar with HIT-RE 500.

Post-installed rebar in compression

The required embedment depth of a post-installed rebar in compression with HIT-RE 500 shall be calculated in compliance with AS 3600-2009, 13.1.5.

Fire resistance according to DIBt Z-21.8-1790

a) fire situation “anchorage”



Maximum force in rebar in conjunction with HIT-RE 500 as a function of embedment depth for the fire resistance classes F30 to F180 (yield strength f_{yk} = 500 N/mm²) according EC2[a)].

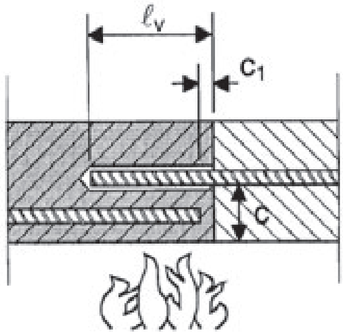
Bar	Drill hole	Max. $F_{s,T}$	inst	Fire resistance of bar in [kN]				
[mm]	[mm]	[kN]	[mm]	R30	R60	R90	R120	R180
8	10	16,19	80	2.4	1.0	0.5	0.3	0
			95	3.9	1.7	0.3	0.6	0.1
			115	7.3	3.1	1.7	1.1	0.4
			150	16.2	8.2	4.6	3.1	1.4
			180		16.2	10.0	6.7	2.9
			205			16.2	12.4	5.1
			220				16.2	7.0
			265					16.2
10	12	25,29	100	5.7	2.5	1.3	0.8	0.2
			120	10.7	4.4	2.5	1.7	0.7
			140	17.6	7.8	4.4	3.0	1.3
			165	25.3	15.1	8.5	5.8	2.6
			195		25.3	17.6	12.2	5.1
			220			25.3	20.7	8.7
			235				25.3	11.8
			280					25.3
12	16	36,42	120	12.8	5.3	3.0	2.0	0.8
			150	25.2	12.2	6.9	4.7	2.1
			180	36.4	24.3	15.0	10.1	4.4
			210		36.2	27.4	20.6	8.5
			235			36.4	31.0	14.2
			250				36.4	19.1
			295					36.4
14	18	49.58	140	24.6	10.9	6.1	4.2	1.9
			170	39.1	23.5	13.5	9.2	4.1
			195	49.6	35.6	24.7	17.1	7.2
			225		49.6	39.2	31.3	13.5
			250			49.6	43.4	22.3
			265				49.6	29.5
			310					49.6
16	20	64,75	160	39.2	21.3	11.9	8.1	3.6
			190	55.8	37.9	25.5	17.3	7.3
			210	64.8	49.0	36.5	27.5	11.3
			240		64.8	53.1	44.1	20.9
			265			64.8	57.9	33.7
			280				64.8	42.0
			325					64.8

[mm]	[mm]	[kN]	[mm]	R30	R60	R90	R120	R180
20	**25**	**101,18**	200	76,6	54,3	38,7	27,5	11,4
			240	101,2	82,0	66,4	55,1	26,1
			270		101,2	87,1	75,9	45,6
			295			101,2	93,2	62,9
			310				101,2	73,2
			355					101,2
25	**30**	**158,09**	250	139,0	111,1	91,6	77,6	39,9
			275	158,1	132,7	113,2	99,2	61,3
			305		158,1	139,1	125,1	87,2
			330			158,1	146,7	108,8
			345				158,1	121,8
			390					158,1
28	**35**	**198.3**	280	184,7	153,4	131,6	115,9	73,5
			295	198,3	168,0	146,1	130,4	88,0
			330		198,3	180,0	164,3	121,9
			350			198,3	183,6	141,2
			370				198,3	160,6
			410					198,3
32	**40**	**259,02**	320	255,3	219,6	194,7	176,7	128,2
			325	259,0	225,1	200,2	182,2	133,8
			360		259,0	238,9	220,9	172,5
			380			259,0	243,1	194,6
			395				259,0	211,2
			440					259,0
40	**47**	**404,71**	400	404,7	385,1	353,9	331,5	270,9
			415		404,7	374,6	352,2	291,6
			440			404,7	386,8	326,2
			455				404,7	346,9
			500					404,7

[a)] For tables according the standards to DIN 1045-1988, NF-ENV 1991-2-2(EC2), Österreichische Norm B 4700-2000, British-, Singapore- and Australian Standards see Warringtonfire report WF 166402 or/and IBMB Braunschweig report No 3357/0550-5.

b) fire situation parallel

Max. bond stress, τ_T, 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.



$F_{s,T} \le (\ell_{inst} - c_f) \cdot \phi \cdot \pi \cdot \tau_T$. where: $(\ell_{inst} - c_f) \ge \ell_s$;

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 80ϕ

τ_T = bond stress when exposed to fire

Critical temperature-dependent bond stress, τ_c, concerning "overlap joint" for Hilti HIT-RE 500 injection adhesive in relation to fire resistance class and required minimum concrete coverage c.

<table>
<tr><th>Clear concrete cover c</th><th colspan="5">Max. bond stress, τ_c [N/mm²]</th></tr>
<tr><th>[mm]</th><th>R30</th><th>R60</th><th>R90</th><th>R120</th><th>R180</th></tr>
<tr><td>30</td><td>0,7</td><td>0</td><td rowspan="5">0</td><td rowspan="7">0</td><td rowspan="12">0</td></tr>
<tr><td>35</td><td>0,8</td><td>0,4</td></tr>
<tr><td>40</td><td>0,9</td><td>0,5</td></tr>
<tr><td>45</td><td>1,0</td><td>0,5</td></tr>
<tr><td>50</td><td>1,2</td><td>0,6</td></tr>
<tr><td>55</td><td>1,4</td><td>0,7</td><td>0,5</td></tr>
<tr><td>60</td><td>1,6</td><td>0,8</td><td>0,5</td></tr>
<tr><td>65</td><td>1,9</td><td>0,9</td><td>0,6</td><td>0,4</td></tr>
<tr><td>70</td><td rowspan="22">2,2</td><td>1,0</td><td>0,7</td><td>0,5</td></tr>
<tr><td>75</td><td>1,2</td><td>0,7</td><td>0,5</td></tr>
<tr><td>80</td><td>1,4</td><td>0,8</td><td>0,6</td></tr>
<tr><td>85</td><td>1,5</td><td>0,9</td><td>0,7</td></tr>
<tr><td>90</td><td>1,7</td><td>1,1</td><td>0,8</td><td>0,5</td></tr>
<tr><td>95</td><td>2,0</td><td>1,2</td><td>0,9</td><td>0,5</td></tr>
<tr><td>100</td><td rowspan="16">2,2</td><td>1,4</td><td>1,0</td><td>0,6</td></tr>
<tr><td>105</td><td>1,6</td><td>1,1</td><td>0,6</td></tr>
<tr><td>110</td><td>1,7</td><td>1,2</td><td>0,7</td></tr>
<tr><td>115</td><td>2,0</td><td>1,4</td><td>0,7</td></tr>
<tr><td>120</td><td rowspan="12">2,2</td><td>1,6</td><td>0,8</td></tr>
<tr><td>125</td><td>1,7</td><td>0,9</td></tr>
<tr><td>130</td><td>2,0</td><td>1,0</td></tr>
<tr><td>135</td><td rowspan="9">2,2</td><td>1,1</td></tr>
<tr><td>140</td><td>1,2</td></tr>
<tr><td>145</td><td>1,3</td></tr>
<tr><td>150</td><td>1,4</td></tr>
<tr><td>155</td><td>1,6</td></tr>
<tr><td>160</td><td>1,7</td></tr>
<tr><td>165</td><td>1,9</td></tr>
<tr><td>170</td><td>2,1</td></tr>
<tr><td>175</td><td>2,2</td></tr>
</table>

4 Hilti HIT-HY 200-R post-installed rebars

Injection Mortar System

Hilti HIT-HY 200-R
500 ml foil pack
(also available as 330 ml foil pack)

Static mixer

rebar

Benefits

- 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

Concrete | Fire rated | European Technical Approval | Corrosion tested | PROFIS rebar design software | SAFEset approved automatic cleaning

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 / 2013-06-26 (HIT-HY 200-R) ETA-11/0492 / 2013-06-26 (HIT-HY 200-A)
Fire test report	CSTB, Paris	26033756

Setting details

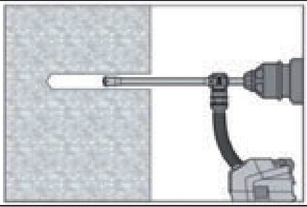
For detailed information on installation see instruction for use given with the package of the product.

Working time, curing time

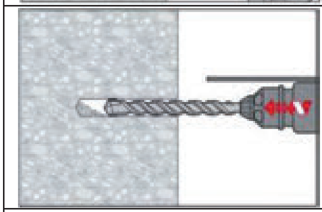
Temperature of the base material	HIT-HY 200-R	
	Working time t_{work} in which anchor can be inserted and adjusted	Curing time t_{cure} before anchor can be fully loaded
-10 °C to -5 °C	3 hour	20 hour
-4 °C to 0 °C	2 hour	7 hour
1 °C to 5 °C	1 hour	3 hour
6 °C to 10 °C	40 min	2 hour
11 °C to 20 °C	15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

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.

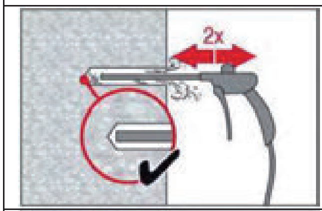


Drill hole to the required embedment depth using a hammer-drill with carbide drill bit set in rotation hammer mode, a Hilti hollow drill bit or a compressed air drill.

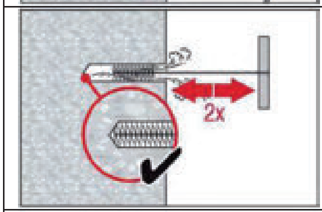
Bore hole cleaning Just before setting an anchor, the bore hole must be free of dust and debris by one of two cleaning methods described below

b) Compressed air cleaning (CAC)

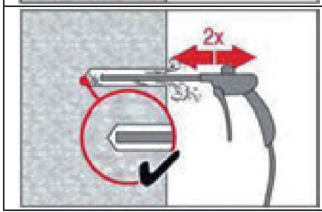
For all bore hole diameters d_0 and all bore hole depth h_0



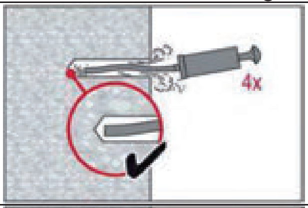
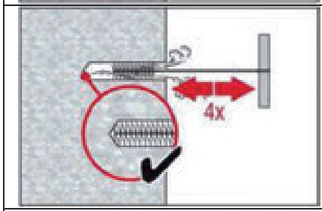
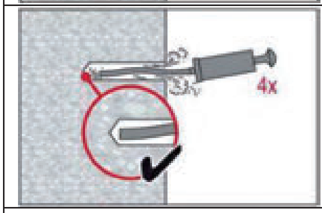
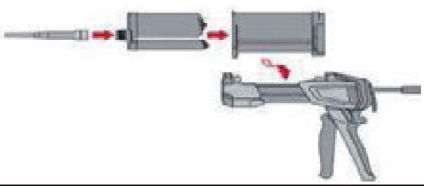
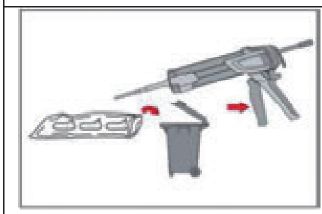
Blowing 2 times from the back of the hole with oil-free compressed air (min. 6 bar at 100 litres per minute (LPM)) until return air stream is free of noticeable dust. Bore hole diameter ≥ 32 mm the compressor must supply a minimum air flow of 140 m³/hour.
If required use additional accessories and extensions for air nozzle and brush to reach back of hole.



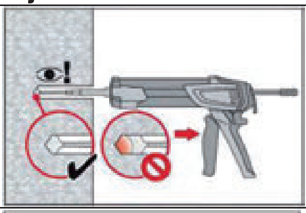
Brushing 2 times with the specified brush size (brush Ø ≥ borehole Ø) by inserting the round steel brush to the back of the hole in a twisting motion. The brush shall produce natural resistance as it enters the anchor hole. If this is not the case, please use a new brush or a brush with a larger diameter.



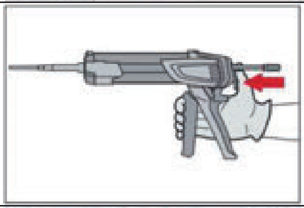
Blowing 2 times again with compressed air until return air stream is free of noticeable dust.

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.

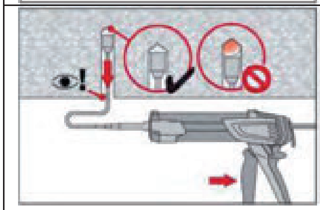
Inject adhesive from the back of the borehole without forming air voids



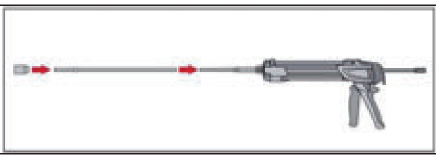
Injection method for borehole depth ≤ 250 mm:
Inject the mortar from the back of the hole towards the front and slowly withdraw the mixing nozzle step by step after each trigger pull. **Important! Use extensions for deep holes (> 250 mm)**. Fill holes approximately 2/3 full, or as required to ensure 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.

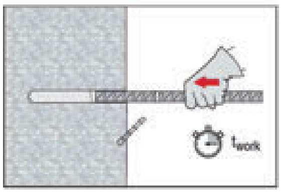


Piston plug injection for borehole depth > 250 mm or overhead applications: Assemble mixing nozzle, extension(s) and appropriately sized piston plug. Insert piston plug to back of the hole. Begin injection allowing the pressure of the injected adhesive mortar to push the piston plug towards the front 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.

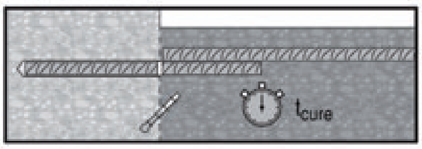


HDM 330	Manual dispenser	(330 ml)
HDM 500	Manual dispenser	(330 / 500 ml)
HDE 500-A22	Electric dispenser	(330 / 500 ml)

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.

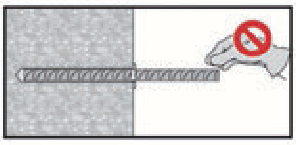


After installing the rebar the annular gap must be completely filled with mortar.

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 10^9 Ωcm (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)
10	14 (12[a])	-
12	16 (14[a])	17
16	20	20
20	25	26
24	32	32
28	35	35
32	40	40

[a] Max. installation length ℓ = 250mm

Design process – 3 steps

Step 1: Determine anchorage length based on the bond strength of the product

Hammer or compressed air drilling. Dry or wet concrete. Uncracked concrete C20/25.							
temperature range	Bar diameter Data according to ETA -12/0084						
	N10	N12	N16	N20	N24	N28	N32
Sectional Area of As (mm²)	79	113	201	314	452	616	804
Design Yield Fsy (KN)	40	57	101	157	226	308	402
$f^*_{bd,po}$ (MPa)	8.0						
Required Length based on ETABond (mm) Lsb	**159**	**189**	**251**	**312**	**375**	**438**	**500**

*Design bond strength in N/mm² according to ETA -12/0084 $f_{bd,po} = \tau Rk/\gamma Mp$).
Valid for temperature range I : 40°C / 24°C

Effect of concrete compressive strength:

For concrete with different compressive strength, L_{sb} shall be divided by $f_{B,p}$

Concrete compressive strength f'c,cyl Mpa	20	25	32	40	50
$f_{B,p}$	1	1.02	1.048	1.07	1.09

The final required length $L_{sb,f}$ shall be equal: $L_{sb,f} = L_{sb} / f_{B,p}$

Step 2: Calculate of the basic anchorage depth $L_{sy, tb}$ (mm) to develop yield of post-installed rebar in tension as per AS 3600-2009. Extension Approach

With the Reduction factor for splitting with large concrete cover / confinement: δ = 0.306 (HILTI additional data), applicable for both HILTI products HIT-RE 500 and HIT-HY 200, K'_3 shall be calculated from:

$$K'_3 = \frac{1}{\frac{1}{0.7} + \delta \frac{C_d - 3d_b}{d_b}} \geq 0.25 \text{ for } C_d > 3d_b$$

The basic anchorage depth $L_{sy,tb}$ can therefore be taken from the following tables:

$L_{sy,tb}$ for diameter of rebar = 10mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
$2.d_b$	389	348	308	275	246
$3.d_b$	321	287	254	227	203
$4.d_b$	264	236	209	187	167
$5.d_b$	225	201	178	159	146
$6.d_b$	195	175	152	149	-
$7.d_b$	173	156	-	-	-
$8.d_b$	159	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 12mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
$2.d_b$	475	425	376	336	301
$3.d_b$	391	350	309	277	247
$4.d_b$	322	288	255	228	204
$5.d_b$	274	245	217	194	173
$6.d_b$	238	213	189	177	-
$7.d_b$	211	185	180	-	-
$8.d_b$	189	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 16mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
$2.d_b$	655	586	518	463	415
$3.d_b$	540	483	427	382	341
$4.d_b$	445	398	351	314	281
$5.d_b$	378	338	299	267	239
$6.d_b$	329	294	260	235	230
$7.d_b$	291	260	240	-	-
$8.d_b$	261	246	-	-	-
$9.d_b$	251	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 20mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
2.d_b	849	759	671	600	537
3.d_b	699	625	552	494	442
4.d_b	575	515	455	407	364
5.d_b	489	438	387	346	309
6.d_b	425	380	336	301	286
7.d_b	376	337	298	292	-
8.d_b	337	306	-	-	-
9.d_b	312	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 24mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
2.d_b	1056	944	835	747	668
3.d_b	870	778	687	615	550
4.d_b	716	641	566	506	453
5.d_b	609	545	481	430	385
6.d_b	529	474	419	374	344
7.d_b	468	419	370	350	-
8.d_b	420	375	358	-	-
9.d_b	381	368	-	-	-
10.d_b	375	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 28mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
2.d_b	1279	1144	1011	905	809
3.d_b	1054	942	833	745	666
4.d_b	868	776	686	614	549
5.d_b	738	660	583	522	466
6.d_b	641	574	507	454	402
7.d_b	567	507	449	409	-
8.d_b	509	455	418	-	-
9.d_b	461	429	-	-	-
10.d_b	438	-	-	-	-

$L_{sy,tb}$ for diameter of rebar = 32mm					
Confinement c_d	$f'_{c,cy}$ = 20MPa	$f'_{c,cy}$ = 25MPa	$f'_{c,cy}$ = 32MPa	$f'_{c,cy}$ = 40MPa	$f'_{c,cy}$ = 50MPa
2.d_b	1521	1360	1202	1075	962
3.d_b	1252	1120	990	885	792
4.d_b	1031	922	815	729	652
5.d_b	877	784	693	620	554
6.d_b	762	682	603	539	482
7.d_b	674	603	533	477	459
8.d_b	605	541	477	467	-
9.d_b	548	490	-	-	-
10.d_b	500	-	-	-	-

Step 3: Determine the basic anchorage depth Lsy (mm) to develop yield of post-installed rebar shall be:

$$L_{sy} \geq \{L_{sb,f} ; L_{sy,tb}\}$$

Embedment depth to develop less than the yield strength

The embedment depth to develop less than the yield of the bar shall be as per clause 13.1.2.4 of AS3600-2009.

Spliced connection

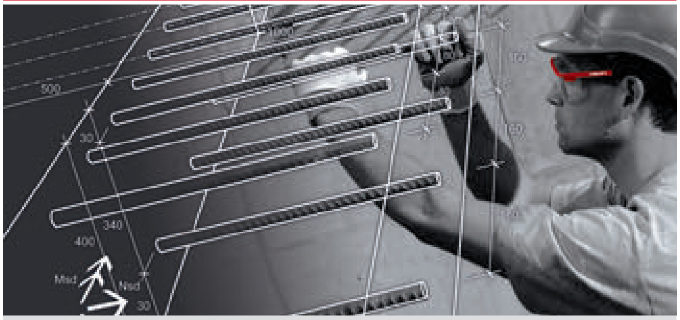
When a post-installed rebar is required to form a splice with an existing cast-in rebar, the rules of AS 3600-2009, 13.2.2 shall be applied to calculate the required embedment depth of the post-installed rebar with HIT-HY 200.

Post-installed rebar in compression

The required embedment depth of a post-installed rebar in compression with HIT-HY 200 shall be calculated in compliance with AS 3600-2009, 13.1.5.

Everything you need for fast, easy and reliable post-installed rebar.

Design



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

Detection

Ferroscan PS 200 – for the detection of reinforcing bars in concrete. Reduces the risk of hitting rebars when drilling. Provides accurate positioning, depth and diameter of rebar.

Drilling

Drill faster and safer with Hilti combihammers and extra-rugged hammer drill bits, or with Hilti diamond core drilling systems.

Cleaning

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

Cutting

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

Setting

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