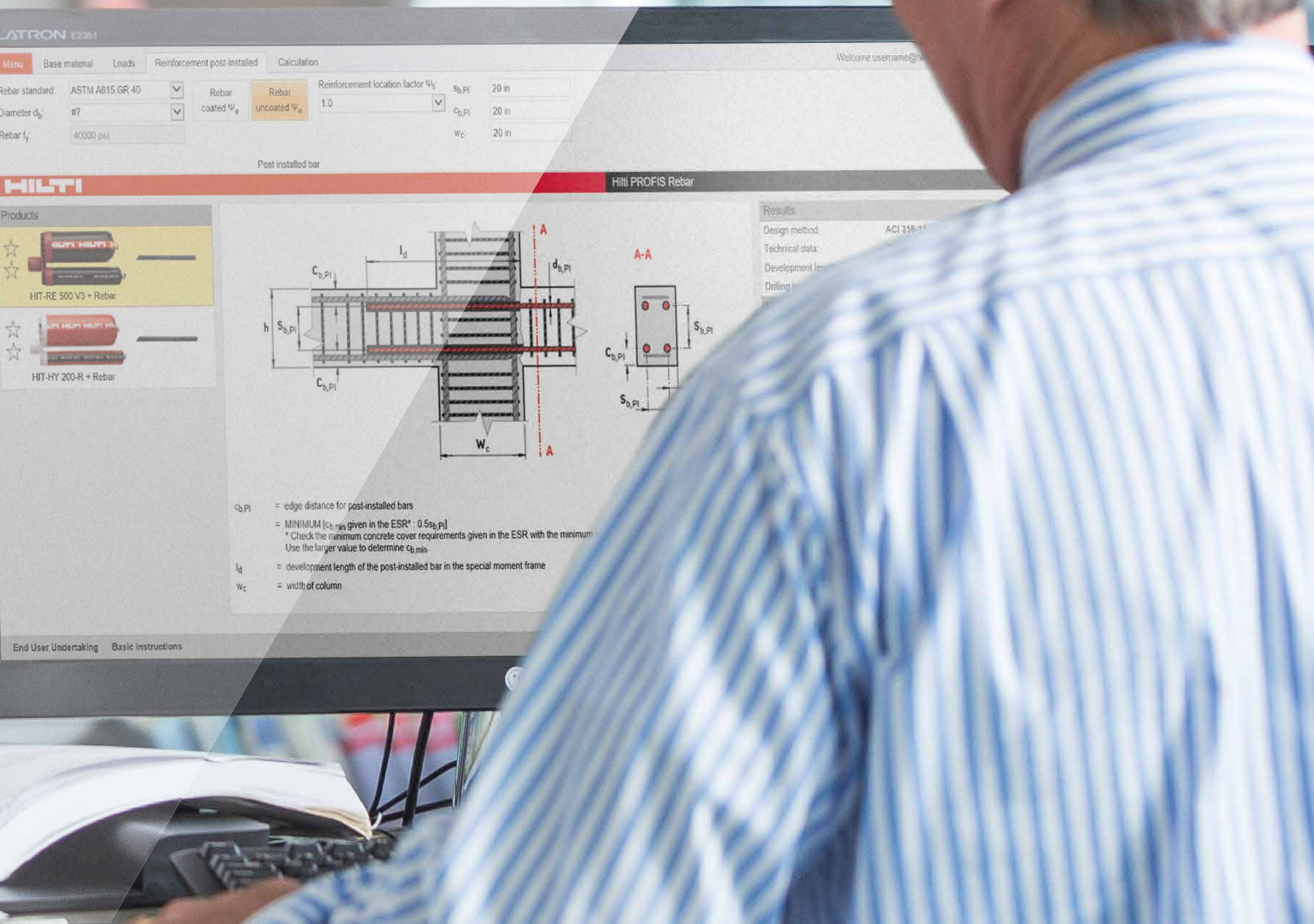




THE (R)EVOLUTION IN POST-INSTALLED REBAR

Hilti HIT-HY 200-R V3 and TR 069:
More applications in post-installed
rebar connections



ASTRON E2351

Menu Base material Loads Reinforcement post-installed Calculation

Welcome username@

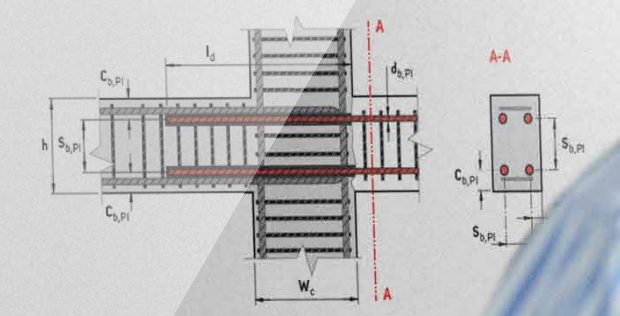
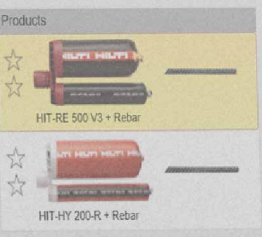
Rebar standard: ASTM A615 GR 40
Diameter d_b : #7
Rebar f_y : 40000 psi

Rebar: Rebar uncoated ψ_e
Reinforcement location factor ψ_s : 1.0

$s_{b,PI}$: 20 in
 $c_{b,PI}$: 20 in
 w_c : 20 in

Post installed bar

Hilti PROFIS Rebar



Results
Design method: ACI 318-11
Technical data:
Development length:
Drilling:

$c_{b,PI}$ = edge distance for post-installed bars
= MINIMUM [$c_{b,PI}$ given in the ESR* : 0.5 d_b,PI]
* Check the minimum concrete cover requirements given in the ESR with the minimum
Use the larger value to determine $c_{b,PI}$
 l_d = development length of the post-installed bar in the special moment frame
 w_c = width of column

End User Undertaking Basic Instructions

UNTIL NOW WITH LIMITATIONS

Up until now, Eurocode 2 limited the application range of post-installed rebar connections



THE (R)EVOLUTION

Post-installed rebar connections have become a trusted, everyday solution in recent years. They are used in both retrofit work and in new construction – for a wide range of applications like slab-to-wall connections, anchoring of stair landings, connecting cantilever slabs with slabs or anchoring columns in existing foundations.

When strengthening existing concrete structures – e.g. to improve performance due to refurbishment – post-installed rebar is used to widen cantilever slabs, to rehabilitate edges of slabs and to close breakthroughs.

Until as recently as 2018, post-installed rebar was assessed through Technical Report 023, which was then superseded by the EAD 330087. However, neither of these reports covered planning or design.

After several years of intense research and testing, TR 069 broadens the scope of post-installed rebar applications. Hilti can now offer you a revolutionary system for post-installed rebar connections, consisting of:

- A brand-new design method – TR 069, as published by EOTA
- A new product – Hilti HIT-HY 200-R V3 injectable mortar, with strong ETAs
- New software – PROFIS Rebar, for convenient calculation and creation of all necessary documentation

Before we go into the details of the future of post-installed rebar, let's have a look at how we are dealing with it today.

[▶ LEARN MORE ABOUT HILTI HIT-HY 200-R V3](#)

»The new TR 069 covers the design of reinforced concrete connections, which were up to now only possible by drilling ›around the corner‹.«



STATUS QUO

Post-installed rebar connections

The design of post-installed rebar connections in combination with products assessed based on EAD 330087 / TR023 can be carried out following the provisions of the valid European reinforced concrete standard (Eurocode 2). The assessment process is intended to verify the equivalency of the load-displacement behavior between cast-in and post-installed rebar.

Obviously, only applications which can be designed with straight deformed cast-in bars in accordance with Eurocode 2 can be designed and executed with post-installed rebar. Typically, moment-resisting reinforced concrete connections must be designed and executed as lap splicing. This, however, is not feasible in many cases where advance planning is required.



EXTENDED POSSIBILITIES

On the way to a broader
application range

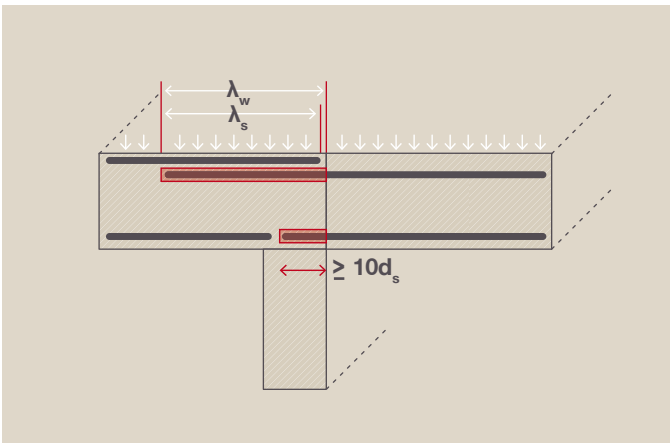


RIGID CONNECTIONS

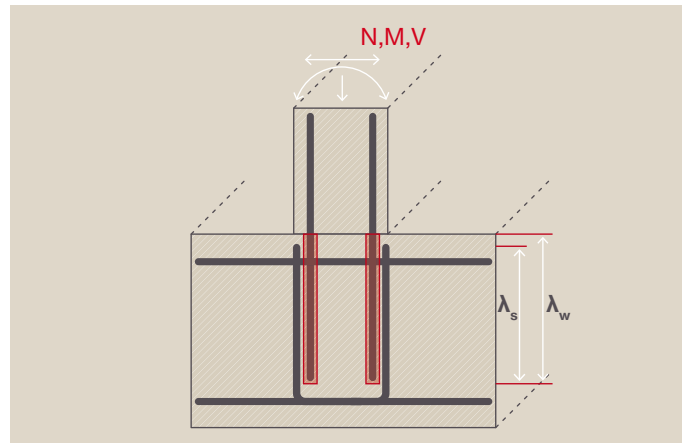
Until now, only with splice

To this day, post-installed rebar connections according to EAD 330087 can only be executed with straight rebar, which are permitted in accordance with EN 1992-1-1. This means that the moment-resisting connections need to be executed with splices.

Execution of a post-installed, moment-resisting concrete rebar connection by splicing, as required by EAD 330087:



Slab-to-slab connection using splice
(schematic drawing)

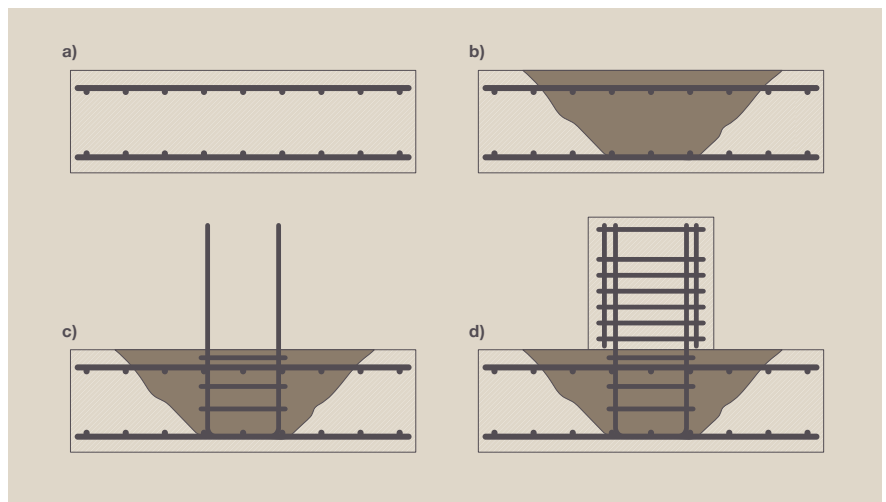


Column or wall connection using splice with load-bearing rebar
(schematic drawing)



This requirement to construct moment-resisting rebar connections using a splice can have a crucial impact on the construction workflow, economics and safety:

- A splice (planned overlap of a cast-in rebar with a post-installed rebar) in new construction needs to be planned and be in place. This is not always the case.
- As concrete-pouring is done bit by bit, rebar can be exposed, which can lead to different issues: Influencing logistics, damaged rebar and also safety hazards.
- The load-bearing capacity of a splice consisting of two rebar with different properties is dependent of the capacity of the lesser rebar, i.e. the one that is cast-in. This is why the potential of the used mortar can usually not be fully leveraged. This can lead to overlap lengths that can be uneconomical.
- In renovation, a rebar connection with splice needs to be executed by partial demolition to expose the existing rebar, weld the new rebar onto it and then close the connection with concrete again, all of which is very time- and thus cost-intensive.



Schematic depiction of executing a rebar connection with partial demolition

A MILESTONE

New design method for post-installed rebar connections

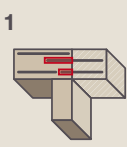
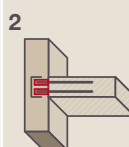
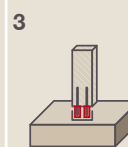
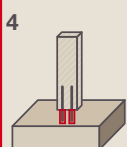
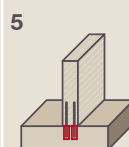
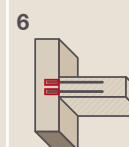
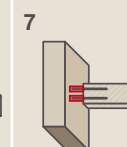
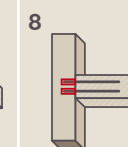
THE NEW DESIGN CONCEPT

Technical Report TR 069 covers the design of post-installed, moment resisting concrete connections

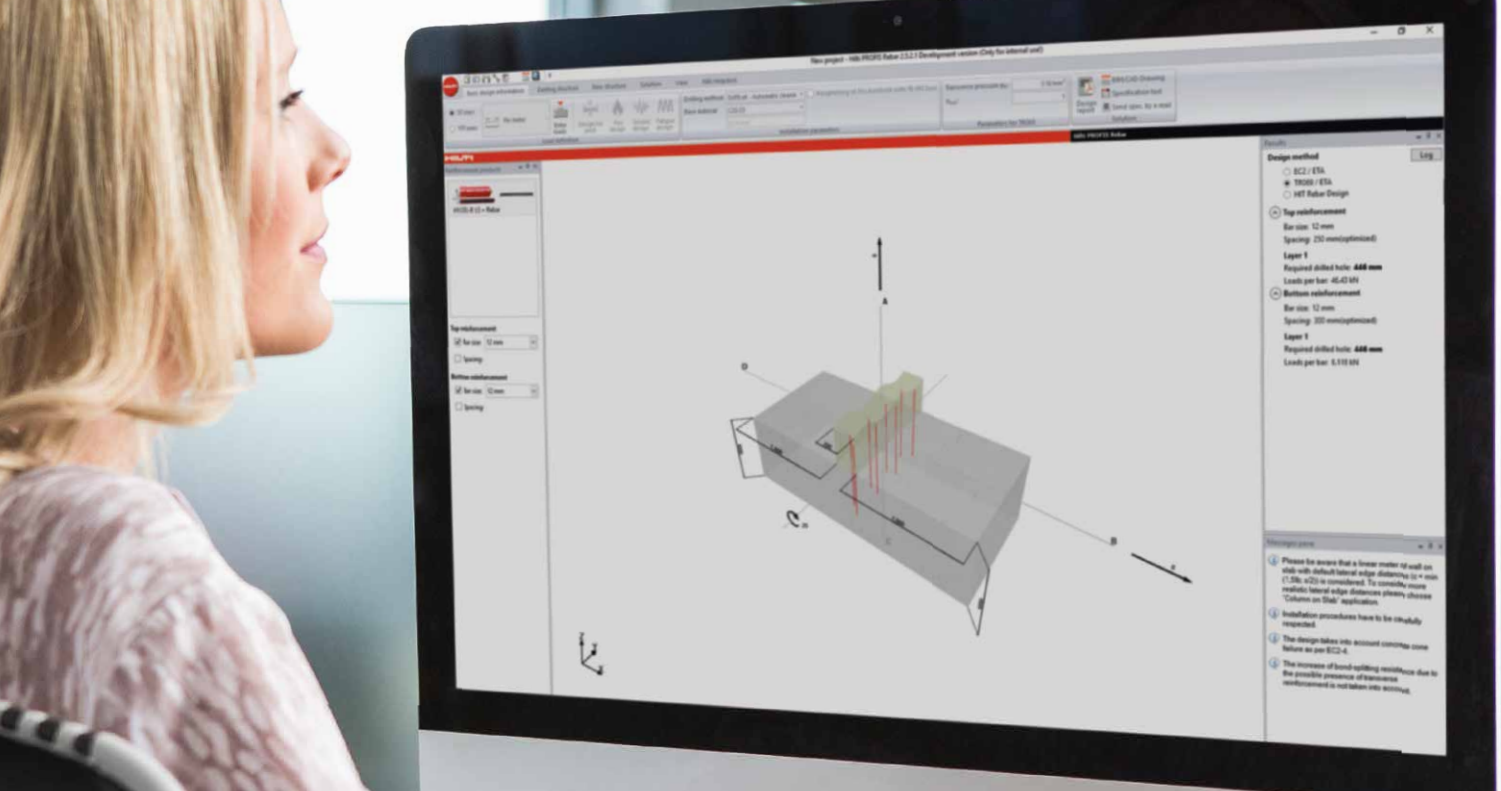
The new Technical Report TR 069, published in 2019 “Design method for anchorages of post-installed reinforcing bars (rebar) with improved bond-splitting behavior as compared to EN 1992-1-1” allows for the design of post-installed, moment-resisting reinforced concrete connections under static loading conditions without using a splice configuration. To do so, the product used for post-installed

rebar must be assessed following the EAD 332402-00-0601 “Post-Installed Reinforcing Bar (Rebar) Connections with Improved Bond-Splitting Behavior Under Static Loading”. The latter includes methods and criteria to assess the real bond-splitting behavior rebar systems, which, depending on the product characteristics, can be significantly higher than for cast-in rebars in accordance to Eurocode 2.

TR 069

Connection type	Rigid connection with splice			Rigid or flexible connection without splice				
Element	1  Slab to wall	2  Beam to wall	3  Beam to column	4  Column to foundation	5  Wall to foundation	6  Slab to wall	7  Beam to wall	8  Beam to column
Design method	EC2			TR 069 / EC2				

Applications of rebar connections covered by EAD 33087 No. 1-3 (EN1992-1-1) and EAD 334202 No. 4-8 (TR 069)



HILTI HIT-HY 200-R V3: QUALIFIED THROUGH EAD 332402-00-0601

Significant advantages in planning

Hilti HIT-HY 200-R V3 injectable mortar system is qualified through EAD 332402-00-0601 and can thus be designed and executed by TR 069. This offers you the following advantages:

- Significant increase of application range for post-installed rebar connections
- Flexibility during planning and detailing of moment-resisting reinforced concrete connections
- Less interruption of the construction process due to partial demolition
- Less health and safety risks related to cast-in rebar sticking out of the concrete
- Use the performance of the injection mortar to its fullest extent, optimizing the design solution
- Much longer-lasting, safer post-installed rebar connections that hold true for up to 100 years for tunnels and bridges, or up to 50 years for buildings – their entire estimated life cycle
- Project planning, design and documentation of the calculation process for post-installed rebar using the Hilti PROFIS Rebar design software

CLARITY

TR 069 combines norms and guidelines in concrete construction



DESIGN BY REQUIREMENTS OF REINFORCED CONCRETE

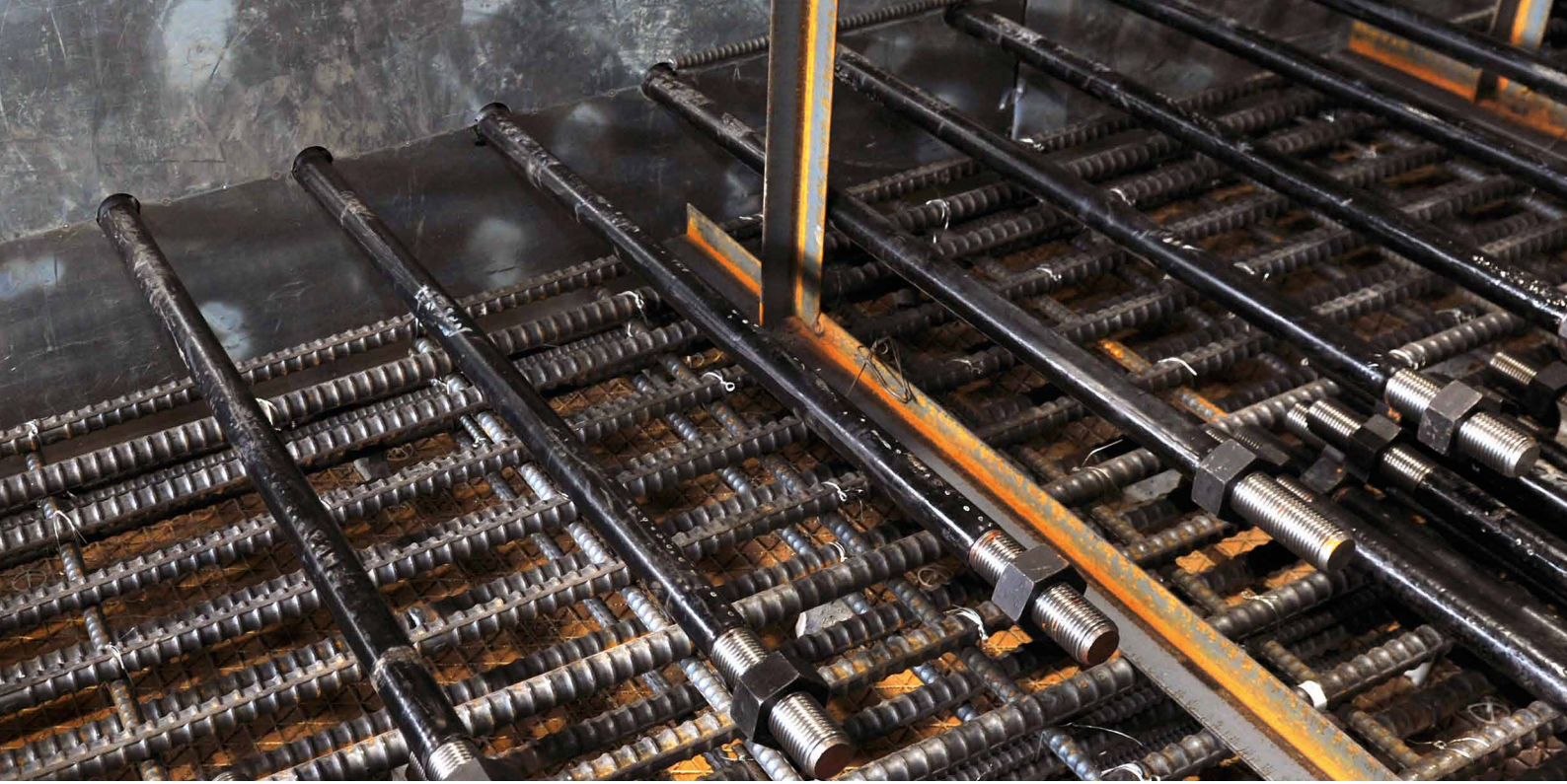
In TR 069, attestation in anchoring methods meets attestation in reinforced concrete engineering

The new TR 069 combines reinforced concrete design principles (EN1992-1-1) with anchoring to concrete principles (EN1992-4). Design following TR 069 is only possible if injection systems are assessed according to EAD 332402. An assessment according to EAD 33087 is not sufficient. Within TR 069 the individual failure modes of the system connection are explained in detail. They are:

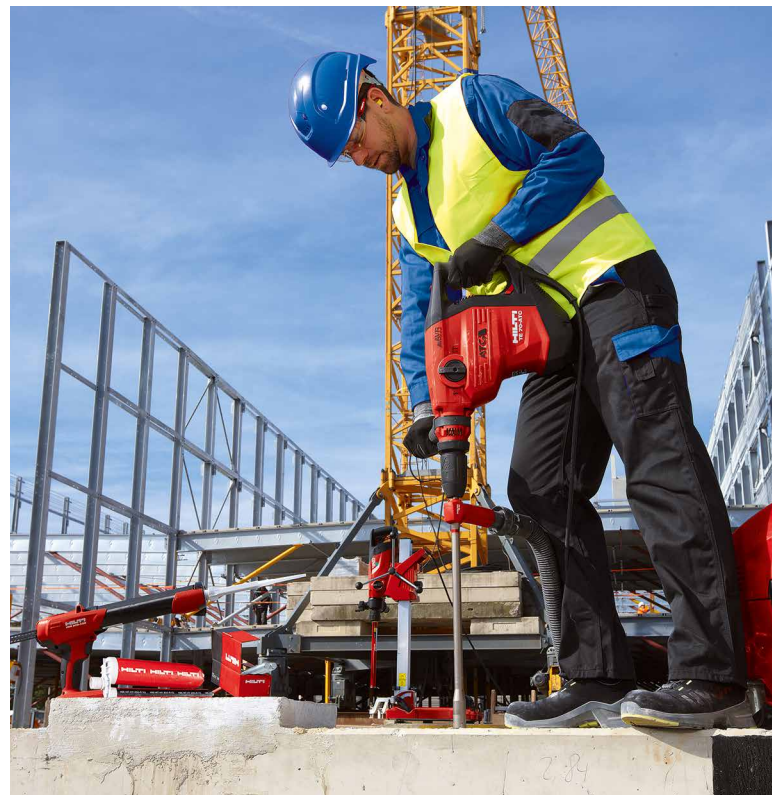
- Rebar steel yielding
- Concrete cone
- Bond splitting

The design is based on the hierarchy strength design principle, i.e., the lowest resistance of the individual failure modes is decisive. Yielding of the steel, concrete cone failure and bond-splitting failure of the post-installed rebar connection must be verified. In addition, the requirements of EN1992-1-1 in terms of minimum anchorage length must be fulfilled. In addition, TR 069 works within the following framework:

- The TR 069 provides a design of the post-installed rebar's anchorage length. The load transfer between new and existing concrete members shall be verified in accordance with EC2 (e.g., shear transfer at the interface and shear resistance of connecting member as well as nodal panel)



- This technical report covers post-installed rebar connections in reinforced or unreinforced, normal weight, non-carbonated C20/25 to C50/60 concrete
- During the assessment process, the bond-slip behavior for different concrete cover is tested. The resistance corresponding to bond-splitting failure, and its relevant parameters, are provided in the product ETA and obtained following the qualification process of EAD 332402.
- The safety concept (i.e. partial safety factors) adopted in TR 069 is the same as in EC2-1 (for steel yielding) and EC2-4 (for concrete cone and bond-splitting failure modes), which ensure a high level of compatibility of the design output in accordance with TR 069 with the EC2.



FITTING PERFECTLY

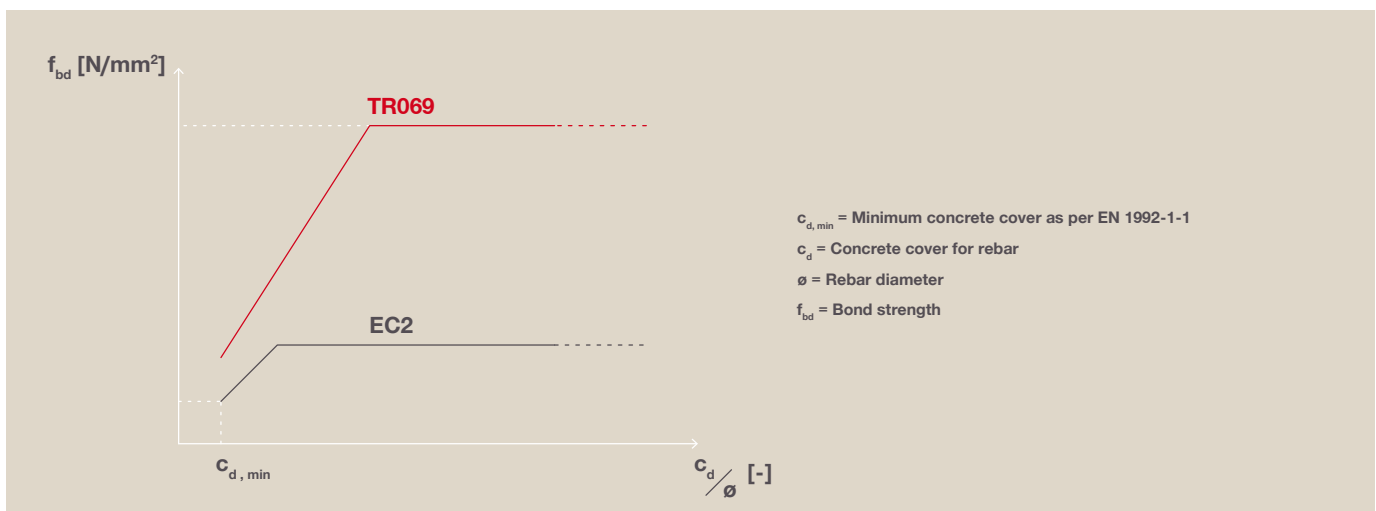
HIT-HY 200-R V3 injection mortar for post-installed rebar

A PERFECT COMBINATION

Optimized design through better bond strength

To determine the influence of concrete cover on cast-in rebar, numerous tests were performed by Elgehausen/Kreller/Langer (1989). When the concrete cover is thinner, the resulting bond strength is relatively small compared to the bond strength values with increased concrete cover. Post-installed rebar with thinner concrete cover may fail via splitting, while post-installed rebar with thicker cover can fail via pull-out.

In the below graph, the bond-slip curves of cast-in rebar and post-installed rebar using HIT-HY 200-R V3 for different thickness of concrete covers are shown. The test results with HIT-HY 200-R V3 show a significantly higher bond strength compared to cast-in rebar under the same conditions. This product-related behavior is reflected in the bond/splitting design in accordance with TR 069 and provides the possibility of utilizing this performance in post-installed reinforced concrete connections. As a result, the connection design system can be optimized.



Bond strength vs. concrete cover/diameter for post-installed rebar connection for a certain installation length and concrete strength, based on Eurocode 2 and TR 069 splitting model



Application conditions of the Hilti HIT-HY 200-R V3 injection system for post-installed rebar connections

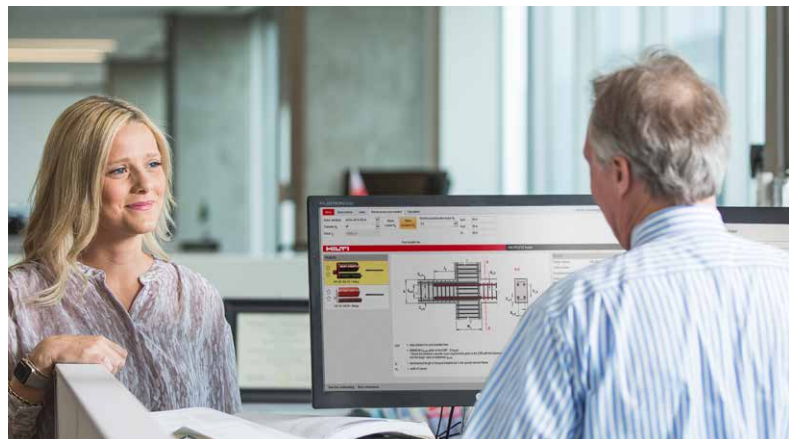
Application conditions	HIT-HY 200-R V3	HIT-RE 500 V3
Connection type	Anchorage, splice, moment resisting connection	Anchorage, splice
Standard / code / report	DIN EN 1992-1-1 / TR 069	DIN EN 1992-1-1
Anchor rod diameter	8 mm – 32 mm	8 mm – 40 mm
Maximum embedment depth	≤ 1 m	≤ 3,2 m
In-service temperature range	-10°C up to 40°C	-5°C up to 40°C
Working time	6 min – 3 h	10 min – 2 h
Curing time	1 h – 20 h	4 h – 168 h
Dry and wet borehole	Yes	Yes
Water-filled borehole / underwater application	No	Yes
Hammer drilled borehole	Yes	Yes
Diamond drilled borehole	Yes (14 mm – 32 mm)	Yes
Hilti SafeSet technology with roughening tool	Yes	Yes
Hilti SafeSet technology with hollow drill bit HDB and Hilti vacuum	Yes	Yes

► INTERESTED? REQUEST LIVE DEMO

SAFETY IN DESIGN AND EXECUTION

PROFIS Rebar: Planning, designing and documenting in one tool

Using the free Hilti PROFIS Rebar design software you can resolve every type of post-installed reinforced concrete connection: from simply supported to moment-resisting to splice. PROFIS Rebar offers you flexibility and efficiency, always according to the latest regulations and standards (TR 069, EC2). In addition, it generates an easy-to-use design report for your project documentation. For load cases which are not yet regulated, the Hilti Design Method can be assessed as an engineering judgement and provides additional engineering solutions e.g. post-installed reinforced concrete connections under fatigue loading.



[▶ LEARN MORE ABOUT PROFIS REBAR DESIGN SOFTWARE](#)

Tender templates

Design according to TR 069 (without splice)	Design according to EN 1992-1-1 (with splice)
Post-installed rebar connection Hilti HIT-HY 200-R V3 with B500B according to TR 069	Post-installed rebar connection Hilti HIT-HY 200-R V3 with B500B
Post-installed rebar connection with Hilti HIT-HY 200-R V3 fast-curing injection mortar (or equivalent) and concrete rebar (DIN 488-B500B)	Post-installed rebar connection with Hilti HIT-HY 200-R V3 fast-curing injection mortar (or equivalent) and concrete rebar (DIN 488-B500B)
Rod diameter: ... mm	Rod diameter: ... mm
Embedment depth in concrete: ... mm	Embedment depth in concrete: ... mm
Total length anchor rod: ... mm	Total length anchor rod: ... mm
Quantity and position of rebar are to be taken from execution planning or static attestation and to be observed	Quantity and position of rebar are to be taken from execution planning or static attestation and to be observed
Installation according to ETA-19/0665 & EAD 332402-00-0601 for design in accordance with TR 069 in concrete C20/25 to C50/60	Installation according to ETA 19/060 & EAD 330087-00-0601 in concrete C12/15 to C50/60
An assessment according to EAD 330499-01-0601 or EAD 330087-00-0601 or both is NOT sufficient.	

SafeSet: Consistent safety during installation

The load-bearing capacity of post-installed rebar connections can be influenced significantly by the installation process. A cleaned borehole is key to ensuring a void-free installation during the adhesive injection. Inserting the rebar up to the necessary anchorage length within the working time of the mortar is another crucial factor in your installation process.

To minimize installation errors, HIT-HY 200-R V3 injection mortar is compatible with the SafeSet system.

When hammer drilling, the Hilti SafeSet system relies on hollow drill bits (HDB) connected to a vacuum cleaner (e.g. Hilti VC 40-U or VC 20-U vacuums) to drill and clean the hole in one step. Hilti HDBs utilize the same state-of-the-art carbide drilling technology as Hilti TE-CX and Hilti TE-YX bits. The Hilti SafeSet system performs equally well in dry

and wet concrete and eliminates the most load-affecting and time-consuming step in the installation process: cleaning the hole before injecting the adhesive.

For diamond coring, Hilti SafeSet uses the TE-Y RT “Flex fork” roughening tool. This creates a rough surface within the diamond-cored hole – helping to increase the mechanical interlock between mortar and concrete. The result is much higher bond strength values with fewer, simpler cleaning steps.

Hilti SafeSet helps to minimize installation errors, contributing to a design which performs as you need it to on the jobsite.

[▶ LEARN MORE ABOUT SAFESET™](#)



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