The following excerpt are pages from the Hilti North America Post-Installed Reinforcing Bar Guide.

Please refer to the publication in its entirety for complete details on this topic including data development, product specifications, general suitability, installation, corrosion and spacing and edge distance guidelines.


To consult directly with a team member regarding our post-installed rebar products, contact Hilti’s team of technical support specialists between the hours of 7:00am – 6:00pm CST.

US: 877-749-6337 or [HNATechnicalServices@hilti.com](mailto:HNATechnicalServices@hilti.com)
CA: 1-800-363-4458, ext. 6 or [CATechnicalServices@hilti.com](mailto:CATechnicalServices@hilti.com)
Jobsite constraints should be taken into consideration while designing and installing post-installed reinforcing bars.

Note: In addition to state-of-the-art adhesive anchoring systems, Hilti offers best-in-class detection and drilling equipment to facilitate the installation of post-installed reinforcing bars over a wide range of bar diameters and embedments.

3.1 Location of existing reinforcement and other embedded items

The location of existing reinforcement is generally accomplished with one or more scanning methods. These may be generally categorized as:

a) Scanners that locate ferrous materials using magnetic fields (ferrous scanners, see Figure 21),

b) Scanners that utilize GPR (ground-penetrating radar technology), and

c) X-ray scanning equipment.

For reinforcing bars located within 8-10 inches of the concrete surface, ferrous scanners provide both bar location and size. For location of both ferrous and non-ferrous embedded items (e.g., aluminum conduit), GPR-based scanners are appropriate. For areas of heavy congestion or where existing reinforcing is too deep for ferrous or GPR systems, x-ray scanning methods may be necessary. Where available, it is generally preferable to supplement scanning results with as-built or original design documents.

3.2 Roughening the existing concrete surface

Surface roughening prior to casting new concrete against existing provides not only for increased adhesion, but also increases the ability of the joint to transfer shear through shear friction. Where new concrete is to be applied to an existing concrete surface, roughening of the existing concrete surface is typically specified\textsuperscript{10}. In cases where the surface layer of existing concrete is carbonated, the carbonated layer should be removed in areas that are to receive post-installed reinforcing bars. A rule of thumb is to remove the carbonated concrete over a circular area given by the diameter of the bar plus 2-1/2 inches.

ACI 318-11 Section 11.6.9 requires roughening "...to a full amplitude of approximately 1/4 in." This may be accomplished by mechanical means (e.g., using a Hilti TE 76 ATC equipped with a bushing tool, see Figure 22), sand-blasting or water-blasting. It should be ascertained that the resulting surface does not contain loose material prior to placing new concrete.

Figure 21 — Using a Hilti PS 200 hand-held Ferroscan scanner to locate and map existing reinforcing prior to beginning drilling.

Figure 22 — Roughening a concrete surface with a Hilti TE 76 Combihammer.

\textsuperscript{10} See ICRI Technical Guideline No. 310.2 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings and Polymer Overlays or ASTM E965 Standard Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique.
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3.3 Installation of post-installed reinforcing bars with small cover

As with cast-in bars, post-installed reinforcing bars must be provided with sufficient concrete cover to prevent corrosion. If the bar has been properly installed with adhesive surrounding the bar over its entire length, additional protection against corrosion is provided by the adhesive. Qualification of post-installed reinforcing bar systems under ICC-ES Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC308) includes verification (through an accelerated aging test) that the adhesive provides adequate corrosion resistance.

In addition, sufficient distance must be provided from the concrete face to facilitate drilling without splitting and/or spalling the existing concrete, particularly where hammer- or rock-drilling equipment is used. Hilti drilling alignment aids can be employed with Hilti hand-held hammer drills to improve drilling accuracy (Figure 24). In the absence of other guidance, and where alignment aids or other techniques to maintain drilling accuracy are not used, the following relationships may be used to account for possible deviation of the drilled hole from its intended path:

\[ c_{\text{req(min)}} = 1.2 + 0.06 \ell_d \geq 2d_b \] (in.) [2]

\[ c_{\text{req(min)}} = 2.0 + 0.08 \ell_d \geq 2d_b \] (in.) [3]

\[ c_{\text{req(min)}} = 1.2 + 0.02 \ell_d \geq 2d_b \] (in.) [4]

where,

- \( \ell_d \) is the hole length in inches; and
- \( d_b \) is the diameter of the reinforcing bar in inches
- \( c_{\text{req(min)}} \) is the distance from the concrete edge to the face of the drill bit (Figure 23).

Figure 23 — \( c_{\text{req(min)}} \) is intended to increase the probability that the end of the installed bar will remain within the minimum required concrete cover \( c_{\min} \).

Clearance requirements for core-drilled holes vary according to the type, diameter and length of core bits being used.

Regardless of the drilling method used, embedded items may cause drill bits to deviate from the intended path.

As a matter of practicality, spacing of adjacent post-installed reinforcing bars should in general be maintained at 4 bar diameters or greater. Where applicable, ACI provisions for cover and bar spacing should be observed.

3.4 Drilling method

To satisfy development length requirements, post-installed reinforcing bars are usually associated with deeper embedments, and therefore longer drilled holes, than adhesive anchors. As noted previously, one of the following three drilling methods is typically employed:

- rotary-impact drills (hammer drills) equipped with standard or cruciform carbide bits or with Hilti Hollow Drill Bits (HDB)
- percussive rock drills
- diamond core drills utilizing either wet or dry coring technology

Each method is associated with advantages and disadvantages. See section 3.3. Hammer drills (Figure 25) are readily available and are the preferred approach for most applications given their portability and ease of use. Hilti hammer drills produce a non-uniform hole surface especially suitable for enhancing bond (provided correct hole cleaning procedures are used). For longer holes, hammer drills may not be practical; they are also not always suitable for drilling through embedded steel where this is required.

The Hilti SafeSet™ system consists of Hollow Drill Bits (HDB) used in combination with Hilti Vacuum Cleaners (VC 40-U or VC 20-U). Hilti HDBs utilize the same state-of-the-art carbide drilling technology as Hilti TE-CX and Hilti TE-YX bits and they

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12 Hilti Hollow Drill Bits automatically remove concrete dust during drilling as part of the HIT-HY 200 SafeSet™ System.
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comply with the ANSI B212.15 standard for carbide drill bit dimensions. The Hilti SafeSet system performs equally well in dry and wet concrete.

Figure 25 — Drilling with a Hilti rotary-percussive drill equipped with Hilti SafeSet™ technology.

Rock drills offer speed and efficiency and produce a rough hole surface that is suitable for bond, but the larger impact energy associated with rock drills may increase the tendency for damage in the concrete member, particularly if used in applications with small edge distance or reduced backside cover. Rock drills typically require larger edge distances/member thickness (see Section 3.3). For applications involving rock drilled holes, contact Hilti.

For longer embedment depths, core drills are generally the preferred option (Figure 26 and Figure 27).

Figure 26 — Core drilling with a hand-held Hilti wet core drill with water-capture technology.

In contrast to hammer drills, which fracture the concrete with impact energy, core drill bits utilize a sacrificial matrix containing diamond fragments to abrade the concrete. Hilti diamond core bits with laser-welded segments offer long life and exceptional drilling efficiency. Using extensions, core drills can produce very long, straight holes. The stiffness of the core barrel permits holes to be drilled with less deviation from the intended path, and they are capable of drilling through embedded steel without great effort. On the other hand, where the existing reinforcing must be protected (e.g., as in the case of prestressing tendons), this feature of core drilling may be a liability. More importantly, core drills typically produce a very smooth hole that is usually covered with a thin film deleterious to bond. Accordingly, core drilled holes must be thoroughly cleaned prior to injecting adhesive. Note also that some adhesive systems are not suitable for use with core drilled holes. For qualified systems, specific hole cleaning procedures have been developed to optimize bond under these conditions, and are detailed in the Hilti Instructions for Use (generically, these instructions are known as the Manufacturer's Printed Installation Instructions, or MPII).

Note: Drilling through existing reinforcing or other embedded objects should in general not be undertaken prior to consultation with the engineer of record or other authority having jurisdiction.

Note: Correct hole drilling and cleaning are critical for the performance of post-installed reinforcing bars. Detailed instructions, referred to by Hilti as Instructions for Use, accompany all Hilti anchoring products. For questions regarding correct installation Hilti offers expert advice through Hilti field representatives, nationwide Hilti Centers, Hilti Customer Service, and online at www.us.hilti.com (USA), or www.hilti.ca (Canada).

Figure 28 illustrates the potential influence of drilling method on the load-displacement behavior of a post-installed reinforcing bar at shallow embedment. Where the drilling method to be used has not been predetermined, it is advisable to use an adhesive that is suitable for all drilling methods (e.g., Hilti HIT-RE 500 V3).
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Figure 28 — Example of the influence of drilling method on the bond-displacement behavior of a post-installed reinforcing bar installed with an adhesive not suitable for diamond drilled holes.

3.5 Hole cleaning

Bond between adhesive and concrete is directly influenced by the condition of the hole wall at the time of adhesive injection. The concrete in which the post-installed reinforcing bar is to be installed may be dry, saturated or even partially or completely submerged at the time of installation.

**Note:** Where installation in water-saturated or submerged concrete is required, check that the adhesive system to be used is qualified for these conditions.

Wet diamond core drilling will necessarily result in a damp environment in the drilled hole. Hole cleaning generally involves a water-cleaning process, followed by sequential blowing out the hole with compressed air (Figure 29 and Figure 33) to remove debris and water, and the use of a wire brush (Figure 30) to mechanically scour the hole wall.

All cleaning procedures finish with the use of compressed air. (It is important to note that the use of compressed air may produce flying debris — eye protection should be worn at all times.)

The importance of hole cleaning as specified in the Hilti Instructions for Use for the performance of post-installed reinforcing bars is indicated in Figure 32. For cases where adherence to multi-step hole cleaning procedures may not be possible, use of Hilti SafeSet™ technology with Hilti Hollow Drill Bits (HDB) is recommended.

Figure 29 — Hilti accessories for compressed air hole cleaning operations (partial).

Figure 30 — Hilti extension rod and Hilti HIT-RB matched-tolerance steel brushes for hole cleaning.

Figure 31 — Hilti Profi Rebar Accessory Set.

Figure 32 — Schematic representation of the potential influence of hole cleaning procedures on the measured bond and displacement of a post-installed reinforcing bar loaded in tension.
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Hilti provides a number of accessories for cleaning deep drilled holes in accordance with the Instructions for Use. These include matched-tolerance wire brushes, brush extensions for long holes, attachments to facilitate power brushing, air wands, hose extensions, couplers and air nozzles. Hilti Profi Rebar Accessory Sets (Figure 31) provide the necessary additional components for installation of post-installed reinforcing bars in a single package.

3.6 Selection of adhesive system

The suitability of Hilti adhesive systems for post-installed reinforcing bar applications has been verified for a wide variety of jobsite parameters. Nevertheless, the choice of the appropriate Hilti adhesive system (Figure 34) and injection equipment (Figure 35) for post-installed reinforcing bar installations is to a degree dependent on jobsite parameters; see Section 4.1.

Hilti HIT-RE 500 V3
Hilti HIT-HY 200-R

Figure 34 — Hilti anchoring adhesives suitable for post-installed reinforcing bar connections.

Note: Adhesives which have not been properly verified for post-installed reinforcing bar applications should not be used for structural or safety-related applications.

For example, if a rapid-cure adhesive is specified for a large and deep bar installation, the time required to inject the adhesive may exceed the working time of the polymer. In such cases it may be impossible to insert the bar fully into the hole and/or the adhesive may not reach full strength. In particular, when adhesives are delivered in bulk quantities into a large drilled hole, the exothermic reaction associated with polymerization can result in excessive temperature rise which in turn can result in accelerated cure, further complicating bar installation.

Hilti HIT-ED 3500 battery dispenser in combination with Hilti HIT-RE 500 V3 / Hilti HIT-HY 200 for smaller bar diameters.

Conversely, injection of adhesives under sub-zero conditions can result in elevated viscosity, likewise making manual adhesive injection and bar installation difficult or impossible.

Basic considerations associated with adhesive selection should include:

• Can the adhesive be injected and the reinforcing bar installed within the gel time of the adhesive?
• Is the appropriate injection equipment available, including all necessary accessories, to ensure correct dispensing and mixing?
• Is the adhesive suitable for the concrete temperature and moisture conditions, hole orientation and drilling method?
• What mechanical effort or equipment is required to inject the adhesive and to install the reinforcing bar into the adhesive-filled hole?
• How will the bar be held in place during adhesive cure?
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3.7 Injection of the adhesive

The objective of adhesive injection is to achieve a void-free installation. Aside from reducing bond area and inhibiting cure, air voids in the injected adhesive may lead to increased effort associated with bar installation and can cause uncontrolled ejection of the adhesive from the hole during bar installation as air is forced out of the adhesive matrix.

**Note:** Proper skin and eye protection should always be worn during injection of Hilti adhesives.

In order to inject the adhesive with minimal air voids in drilled holes, the Hilti injection system utilizes matched-tolerance piston plugs (Figure 36). The Hilti piston plug system provides positive feedback to the operator for controlling the injection process through the pressure of the adhesive on the plug and has been shown to dramatically improve injection quality and efficiency.

![Hilti HIT-SZ piston plugs](image)

**Figure 36** — Hilti HIT-SZ piston plugs, available in diameters appropriate for #3 through #18 reinforcing bars.

Dispensing equipment used for injection is generally selected as a function of bar size and orientation, ambient temperature conditions and accessibility (Figure 37).

![Dispensing equipment](image)

**Figure 37** — The Hilti HIT-P8000D pneumatic dispenser, appropriate for large volume installations and large bar diameters.

3.8 Bar installation

Smaller bar diameters can be inserted in a vertical downward direction with (relatively) minimal effort. Large-diameter bars in horizontal and upward-inclined orientations may require substantial effort to lift and insert the reinforcing bar into the adhesive-filled hole (Figure 38). In all cases, it is advisable to **test the fit of the bar in the hole prior to injecting adhesive**.

For overhead installations, particularly of larger diameter bars, provision must be made for securing the bar during adhesive cure. In addition, certification requirements for installers performing installation of bars to carry sustained tension loads, as well as additional special inspection requirements, may apply.

**Note:** Hilti dispensers provide efficient, void-free adhesive injection at all orientations, hole diameters and depths, and temperature conditions.