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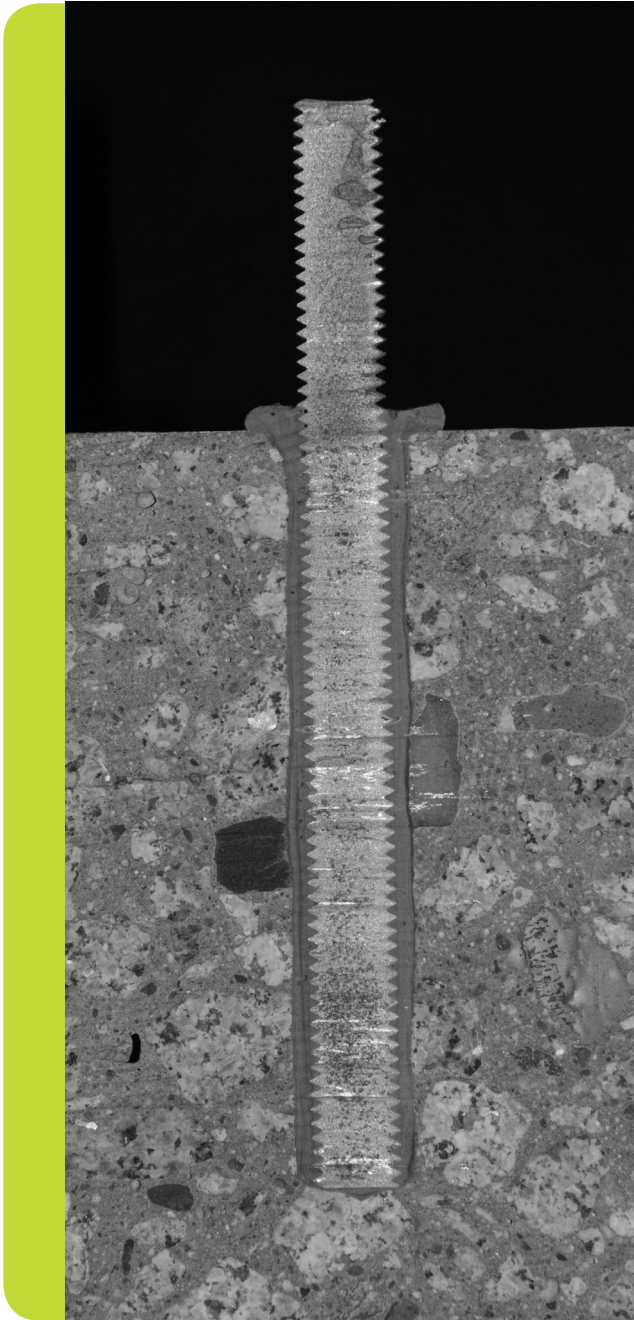
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ACI-CRSI Certification

Adhesive Anchor Installer

Installer Workbook
Publication CP-80 (12)



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INSTALLER WORKBOOK

ACI-CRSI Certification Program for
Adhesive Anchor Installer

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TECHNICIAN WORKBOOK

Foreword

Adhesive Anchors are recognized by the structural design profession as an important structural connection in many applications, with design and installation interdependent in achieving proper performance. The American Concrete Institute's 2011 Building Code Requirements for Structural Concrete, which is referenced by the 2012 International Building Code, recognizes the role installation plays in proper performance of anchors and now requires certification of installers when installing adhesive anchors in specific orientations. To respond to this need for certification, the American Concrete Institute and Concrete Reinforcing Steel Institute have partnered to develop and maintain a program to certify Adhesive Anchor Installers.

The ACI-CRSI Certification Program for Adhesive Anchor Installer identifies Installers who have demonstrated the ability to read, comprehend, and execute instructions to properly install

adhesive anchors in concrete. The Adhesive Anchor Installer must also possess the knowledge to properly assess ambient conditions, the condition of the concrete, materials, equipment, and tools for installing adhesive anchors and determine when it is appropriate to proceed with installation or when additional guidance from a supervisor/foreman/project engineer is needed.

Although written for Installers, much of the information in this Workbook will be of value for Concrete Construction Special Inspectors as continuous inspection of adhesive anchor installation grows in frequency, and may also subject to future credentialing.

This Installer Workbook (CP-80) describes the operation of the ACI-CRSI Certification Program and provides the resource materials and directions needed to prepare for the examinations.

Check the ACI website for updated information and/or errata/addendums:
www.concrete.org/certification/cert_errata.htm

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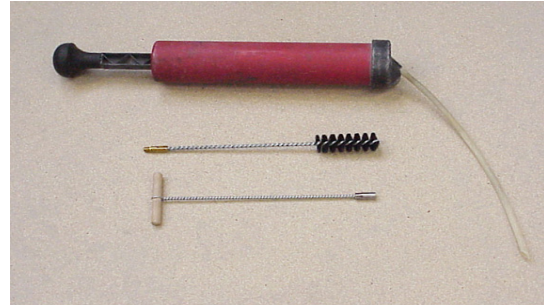


Fig. 4.1: Adhesive anchor system consisting of foil cartridge, mixing nozzle, dispensing tool, brush and hand pump (the MPII is not shown) (Courtesy of IWB, University of Stuttgart)



Fig. 4.2: Cut sections of installed adhesive anchors. The image on the right has a visible layer of drill dust that interferes with the bond between the epoxy mortar and the concrete. (Courtesy of IWB, University of Stuttgart)

Chapter 4: Preparing the Hole

Hole cleaning instructions vary by product and the relevant product-specific cleaning equipment is given in the MPII. The cleaning equipment for each product might vary for different diameters and embedment depths. The primary requirement is to evacuate the drill fines from the hole. An example of an injection type adhesive anchor system is given in Fig. 4.1.

It is imperative to remember, however, that the care and time spent creating a clean, roughened surface onto which the adhesive can bond will help ensure a successful installation. As shown in Fig. 4.2, a layer of dust left in the hole can prevent the adhesive from securely bonding to the concrete. The layer of dust can be compared to using flour on a baking tray to prevent cookies from sticking. Not cleaning the hole properly, as shown in Fig. 4.2, can reduce the bond strength significantly. Poor hole cleaning will reduce the performance of the overall installation (Fig. 4.3).

Cleaning procedures almost always include blowing and brushing the hole with product specific equipment. Specific products or applications may also require vacuuming or flushing with water. The number of times and the order in which these operations are performed may differ based on the MPII. For most adhesive anchor systems the brushing operation is an important step within the hole cleaning procedure.

Condition of Concrete

Provided that the adhesive was properly stored, the concrete temperature and moisture content will have a more significant impact on the bonding characteristics of the adhesive than the air temperature, to which it will have limited exposure. An inexpensive tool that can be used to check the temperature of the hole is a hand-held infrared temperature gun (Fig. 4.4). It is a highly recommended tool for an installer to use prior to injecting adhesive into the hole.

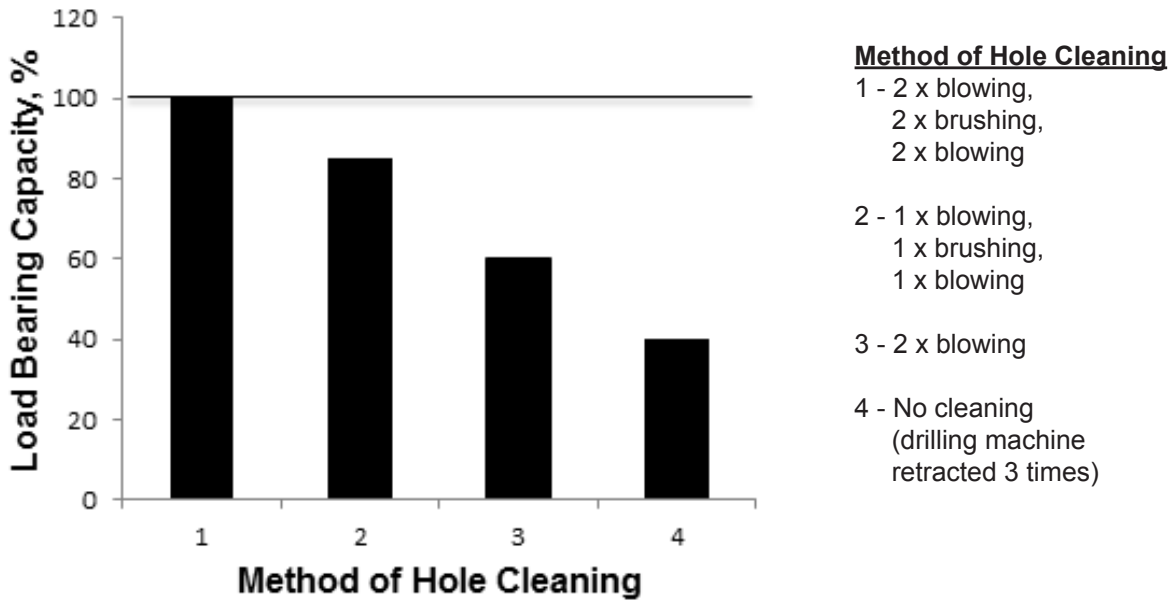


Fig. 4.3: Unclean holes can reduce bond strength up to 60% and more depending on the condition of the hole, ambient conditions (dry or humid) and the level of cleaning and the type of product. Data shown is an example valid only for dry concrete (Data for graph from Anchorage in Concrete Construction⁶)



Fig. 4.4 Infrared thermometer

The concrete should be clean, dry (unless this is a wet or submerged application), and free of surface contaminants (Fig. 4.5). The ambient conditions should meet the requirements stated in the MPII. Dry concrete, per ACI 355.4-11, is concrete that is at least 21 days old and has not been exposed to water for the preceding 14 days. ACI 318-11 requires a minimum concrete age of 21 days for installation of adhesive anchors. This is to allow the concrete time to hydrate (react with

water), reducing the presence of excess moisture in the concrete. This is important for adhesive anchor installations because many adhesives do not bond well in water-saturated concrete, when moisture is present, or when the adhesives are not tolerant of moist environments.

For installations where the substrate does not meet the requirements for dry concrete, check the MPII to see if the product is qualified for use in conditions where water or moisture is present.

Adhesive anchor products must be qualified per ACI 355.4-11 or ICC-ES AC308 for use in saturated, water-filled, or submerged conditions. A saturated installation is when the concrete is wet during the hole drilling and cleaning process, but there is no standing water in the hole during adhesive injection and anchor insertion. This condition can be observed during the drilling operation when the color of the drilling dust changes from grey in the beginning to a much darker grey the deeper the hole becomes. A water-filled installation is when the hole is drilled and cleaned without water present, but the anchor is installed when there is standing water in the hole. A submerged installation is when the drilling, cleaning, and installation processes are all performed with water present. Cleaning and injecting techniques may vary for the types of installations. Having a clear understanding of these situations and understanding the limitations of the product being used is the responsibility of the installer.

Weather Conditions

If the weather is dry (no rain or snow) and the concrete temperatures are within the conditions stated on the MPII, typically 30 to 100°F (-1 to 38°C), anchor installation can be performed.

If it is wet (raining or snowing) and the weather will adversely affect the condition of the hole, check with your supervisor prior to continuing the installation process. If water is present confirm that this is the intended application, check that the product to be used has been qualified for these conditions, and follow MPII cleaning instructions. If the product is not designated for use in the presence of water, do not use it under these conditions.

Equipment

The equipment to be used for the installation is product dependent and stated in the MPII. The following equipment could be mentioned:

Compressed Air: Oil-free compressed air is typically used for cleaning. This can be provided using an air compressor and wand or a hand pump. It's important to be sure that the wand (with extension if needed) can reach to the deepest part of the drilled hole. Check the wand to be sure it is free of contaminants including grease, dirt, dust, oil, and water. The MPII may state a minimum and maximum air pressure required when using an air compressor or, in the case of hand pumps, a minimum number of blows from the hand pump within a cleaning sequence.



Fig. 4.5: Image of drilled holes that need to be cleaned. The job conditions will vary on different projects. Here the installer has to work around reinforcement (Courtesy of Wiss, Janney, Elstner Associates, Inc.)



(a) Wire



(b) nylon

Fig. 4.6: Examples of a variety of brushes, (a) wire (Courtesy of Sterling Hardware) and (b) nylon (Courtesy of Bunzl), suitable for specific adhesive anchor products hole cleaning

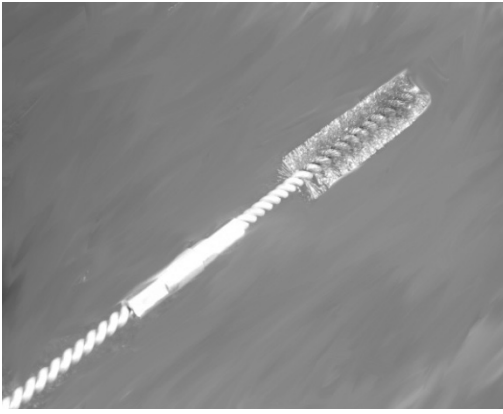


Fig. 4.7: Wire brush, example of a specific adhesive anchor product in good condition to be used for hole cleaning



Fig. 4.8: SDS chuck, with brush attachment (brush top extends beyond left side of photograph), designed to fit into a drill

Types of Brushes: In addition to blowing air into the hole, it is necessary to brush the hole out to remove dust that has adhered to the side and bottom of the drilled hole. The brushes (Fig. 4.6 and Fig. 4.7) used for cleaning may be stiff metal or nylon. To be most effective, the brush should be clean and free of dirt, dust, oil, and other contaminants. The bristles should be full, not twisted or bent.

The size of the brush used should be as stated in the MPII. To ensure contact with the sides of the hole, the minimum brush diameter is larger than the hole diameter. If the brush does not resist insertion into the hole, it is too small or worn and should not be used. Some manufacturers provide a gauge to ensure that worn brushes are not used for hole cleaning. If brush size is important, it will be stated in the MPII.

Brushes can be manually inserted or can be powered by a drill. When using a brush with a drill, many systems have a Special Direct System (SDS) chuck to connect the brush to the drill, as shown in Fig. 4.8.

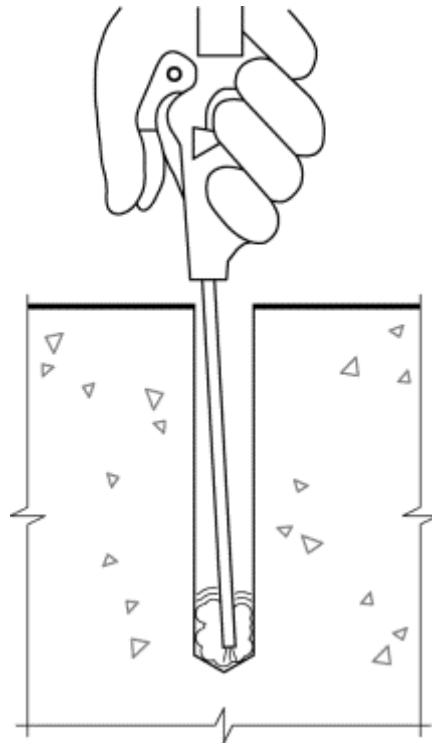


Fig. 4.9: Using compressed air to clean out a hole with a wand reaching to the deepest part of the hole

Dry Hole Cleaning Procedures

PPE recommended and sometimes required for this operation includes: safety glasses, dust mask, and gloves. Cleaning procedures for vertical down, horizontal, and overhead are the same. Care should be taken when cleaning overhead holes so debris does not drop in your face.

Determine the proper cleaning method from the MPII. In general, both cartridge and capsule adhesive anchor systems require cleaning of the hole. The following steps are based on typical instructions for dry hole cleaning.

Select the proper brush size (diameter and length) and air compression apparatus. Test the brush/drill and air compressor to be sure they are operational.

Blow out the hole using oil-free air, starting at the deepest part of the hole (add extensions if needed to reach the base of the hole) and slowly remove the wand from the hole. Perform this step as often as required by the MPII or until the air stream is free from noticeable dust.

Brush out the hole using a plunging/rotating motion as often as stated in the MPII. The brush should be inserted with a twisting motion until it makes contact with the deepest part of the hole, and then the brush should be pulled completely from the hole using a twisting motion. Some MPII

may require additional full turns of the brush when it reaches the deepest part of the hole, please refer to the product's MPII for details. Brushing can be done manually or with the use of a drill. Using a drill will provide a more uniform brushing to the hole surface.

Again, *blow* out the hole using oil-free air, starting at the deepest part of the hole and removing the wand from the hole (Fig. 4.9). Perform this step as often as required by the MPII or until the air stream is free from noticeable dust.

Although the *blow-brush-blow* technique is common to most adhesive anchor products, the number of times each operation is performed will vary. If the adhesive anchor is not going to be installed immediately after the cleaning procedure, take steps to protect the hole from contamination.

In some cases, an inspector may need to examine the hole before the adhesive is injected. If the inspector questions the cleanliness of the hole because they observe dust in it, the best resolution would be to repeat the cleaning procedures in accordance with the MPII.

Wet Hole Cleaning Procedures

Follow the procedures for cleaning as outlined in the MPII.

Generally, if the hole is filled with water, submerged, or was diamond-cored (wet), the hole should be cleaned by flushing it with a water hose pressed to the deepest part of the hole, until the water runs clear. Then perform the brushing operation and repeat the water flushing. Repeat these steps as required in the MPII. Extra care to remove water-concrete particle slurries that formed during drilling should be taken. Once the slurry hardens it will form a paste layer between the hole surface and the adhesive. This layer will significantly reduce the effectiveness of the adhesive bond if not removed.

If the hole is required to be dry for installation of the adhesive anchor, use a vacuum or compressed air to remove standing water, and then use compressed air to dry the hole. The hole is still defined as 'wet' after this installation step due to the moisture in the concrete.

Checklist for Typical Dry Hole Cleaning:

- Use PPE
- Select proper hole cleaning equipment
- Blow (see MPII for number of times)
- Brush (see MPII for number of times)
- Blow (see MPII for number of times)
- Protect hole.

Checklist for Typical Wet or Submerged Hole Cleaning:

- Use PPE
- Select proper hole cleaning equipment
- Flush (see MPII for number of times)
- Brush (see MPII for number of times)
- Flush (see MPII for number of times)
- Vacuum (unless this is a submerged installation)
- Protect hole

Cited References

⁶ Data for graph from: Eligehausen, R.; Málée, R.; and Silva, J.F., *Anchorage in Concrete Construction*, Ernst & Sohn, Berlin, Germany, 2006, pp. 181-210.