Advancements in Adhesive Anchor Technology

One giant leap for your next project.

What are the typical applications you design using post-installed anchors?

Post-installed anchors cover a complete range of fastening applications

Structural anchor bolts

Horizontal rebar dowels

Vertical rebar dowels

Replacing missing or damaged cast-in-place anchor bolts

Fastening metal fixtures to concrete or masonry

Broad range of anchoring solutions to meet your design needs

Mechanical Anchors

Concrete	Undercut	
	Wedge	
Masonry	Screw	
	Sleeve	

Adhesive Anchors

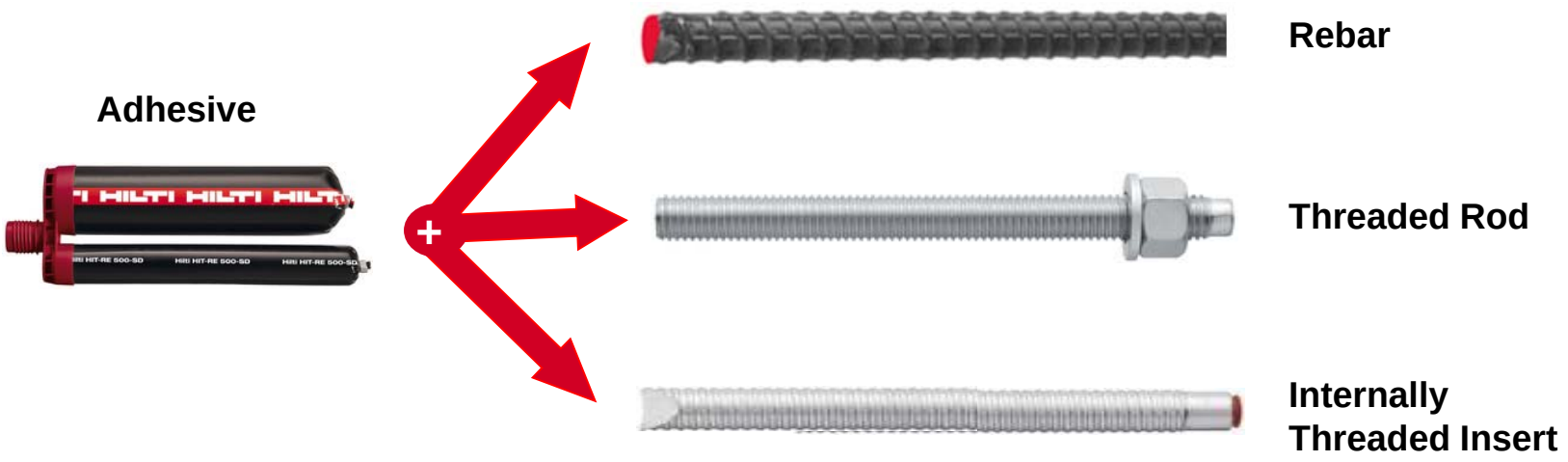
Concrete	Fast Cure	
	Slow Cure	
Masonry	Fast Cure	

What are the perceived differences between Adhesive and Mechanical Anchors?

Advantages of adhesive anchors

1 More flexibility vs. cast-in and post-installed mechanical anchors

- Wide variety of elements (rebar, rods, internally threaded inserts)
- Broader spacing and edge distance applications



Adhesives can be combined with a variety of anchor elements

Advantages of adhesive anchors

2 Suitable for multiple construction types and conditions

Adhesive + Rebar

Adhesive + Rod

Adhesive + Insert

Advantages of adhesive anchors

1. **More flexibility vs. cast-in and mechanical anchors**
2. **Suitable for multiple applications**
3. **Variable embedments**
4. **High loads**
5. **Edge distance and spacing are small**

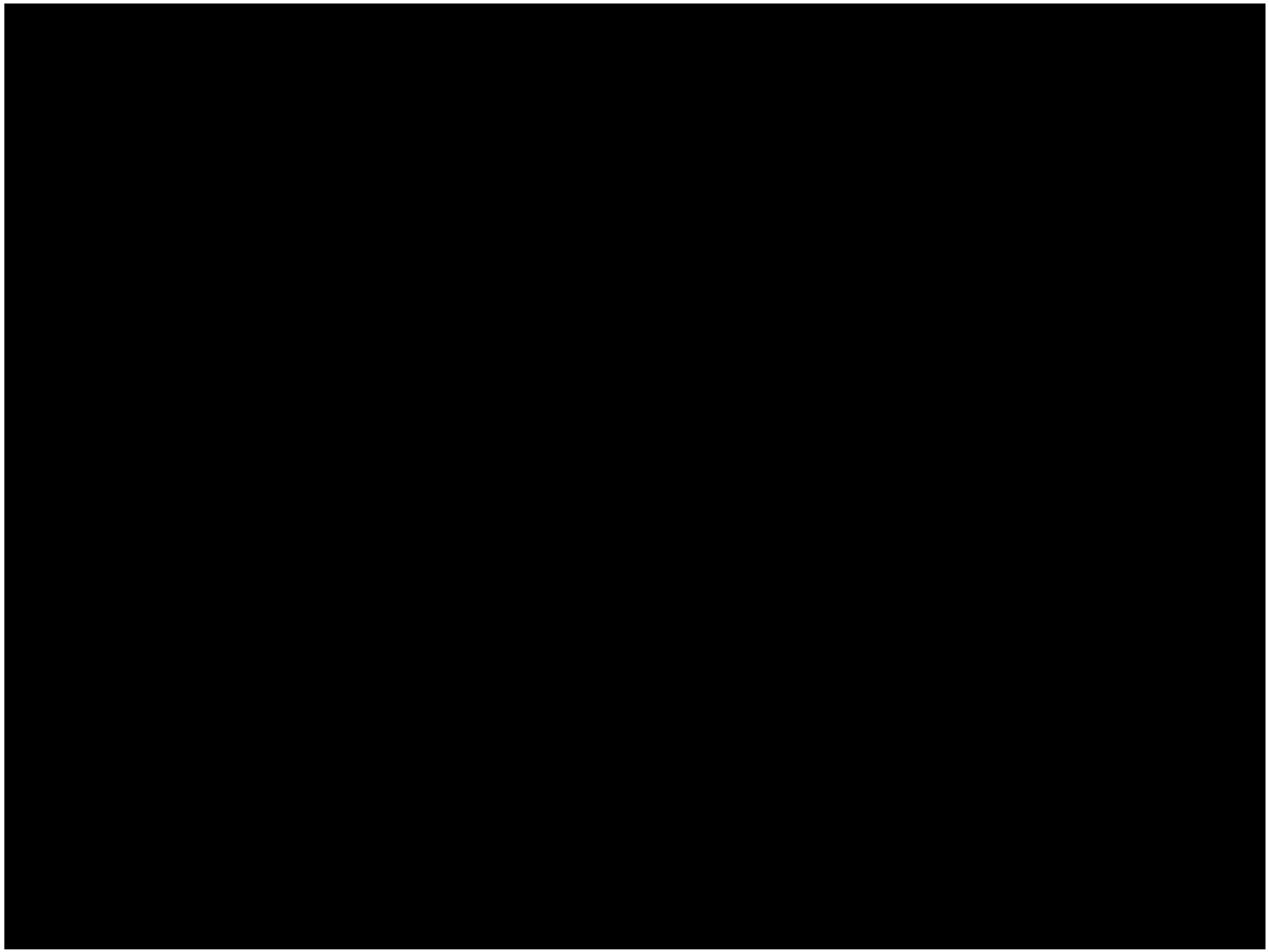
Adhesive Anchors are a well established technology

Design considerations for real-world applications

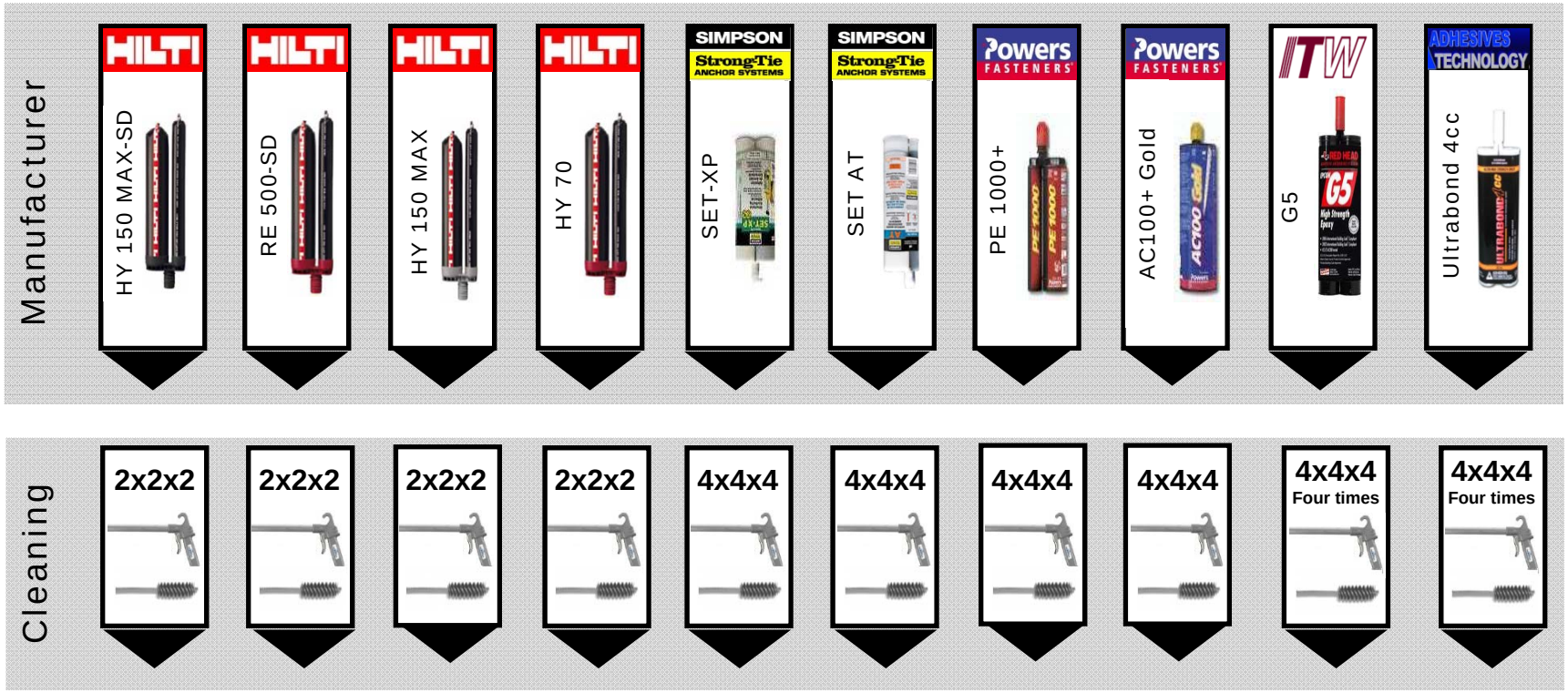
	Cause	Potential Effect
1	Cracked concrete	Increased displacement , variation, and cracking
2	Hole cleaning	Clean holes matter
3	Installation orientation	Anchor orientation can require different installation procedures
4	Temperature	Decrease in bond strength with increased variation
5	Diamond cored holes	Lower bond strength and larger displacement
6	Seismic	Reduced bond strength and increased variation

What does the contractor need to consider to properly install an adhesive anchor?

Standard cleaning procedures

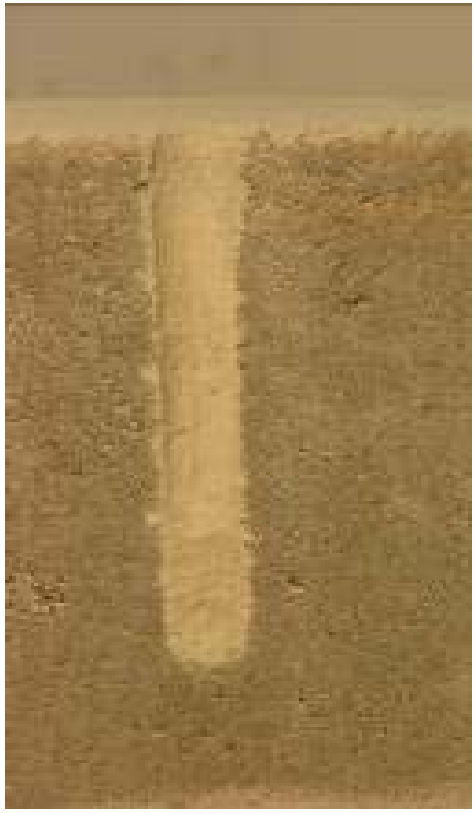


Cleaning method for different manufacturers vary



All adhesives are not created equal.
Clean holes matter for every installation

Clean holes matter!



Unclean Hole

Properly Cleaned Hole

How difficult is it to install an adhesive anchor consistently?
How often is it done?

A Field Study of Adhesive Anchor Installations

A Field Study of Adhesive Anchor Installations

Theory and practice

BY PHILIPP GROSSER, WERNER FUCHS, AND ROLF ELIGEHAUSEN

For every fastening application, the starting point is choosing the correct product. This requires understanding the loads to be resisted and following a defined design method. It also requires establishing the exact location of the fixing point, anticipating the environmental conditions during installation and service, and knowing the installation procedures for the fastener or anchor.

For adhesive anchors, the designer must select a product that is adequate for the conditions in service and that has been evaluated for compliance with code requirements.

Once an appropriate system has been selected and designed, the installation process has to be considered. To ensure correct installation, the installer must follow the manufacturer's instructions precisely. Furthermore, the installer must follow the requirements of the relevant evaluation service report (ESR)—refer to the sidebar. Detailed information on the installation and inspection of adhesive anchors is given by Wollmershauser and Mattis,[1] and information on factors influencing the behavior of adhesive anchors can be found in Reference 2.

In theory, the knowledge is available to ensure reliable fastenings with adhesive anchors and to give designers and installers confidence and flexibility in myriad applications. With the failure of adhesive anchors in Boston, MA, however, the installation and use of these types of anchors has been called into question. To figure out what can be improved with regard to the use of adhesive anchors, adhesive anchor installations with injection systems were monitored on 23 job sites in five locations scattered over the U.S. Critical aspects were examined to determine gaps between actual and recommended practice and to come up with proposals to improve installation practices.

FIELD RESEARCH PROJECT

The installation of adhesive anchor systems was investigated at construction sites in California, Florida, Illinois, New York, and Pennsylvania. In total, 23 sites were visited, 26 applications were monitored, and 31 installers were interviewed (Table 1). Thirteen different adhesive systems (either epoxy-based or hybrid mortars) were installed. Nine of these products had an ESR. The steel anchors were continuously threaded steel rods or deformed steel reinforcing bars. Anchors were used for strengthening bridge structures, seismic retrofits, connecting structural elements to structural walls, anchoring steel elements to existing concrete members, anchoring pavement dowels, installing hurricane protection, or anchoring façade elements. The anchors were installed downward in 13 applications, horizontally in 11 applications, and overhead in two applications.

All information relevant to the installation was monitored on site by the first author, and the detailed findings were recorded in a protocol. Installers were interviewed to determine their professional and educational backgrounds, training and experience levels with post-installed anchors, general anchor installation experience level, and general opinions concerning the pros and cons in regard to the installation of adhesive-bonded anchors.

TABLE 1:
DETAILS OF THE SURVEY

Location	Illinois	Florida	California	Pennsylvania	New York	Total
Job sites	6	7	5	2	3	23
Applications	7	8	5	3	3	26
Surveys	8	6	8	5	4	31

Magazine	Concrete International, V.33, No 1, pp. 57-63.
Date	January 2011
Authors	Grosser, P. ; Fuchs, W. and Eligehausen, R. University of Stuttgart

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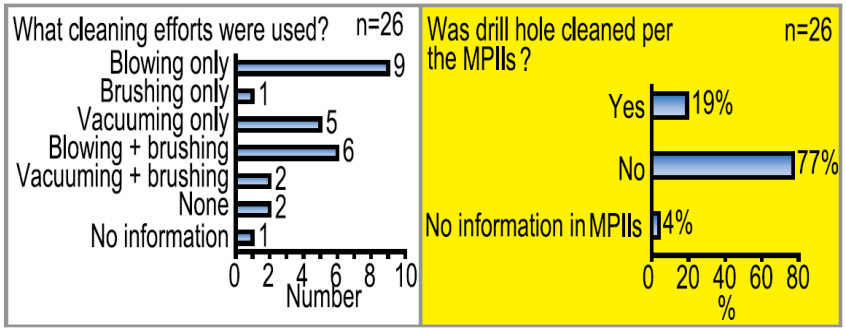

Fig. 2: Results of the field study of adhesive anchor installations. (n = number of observed applications)

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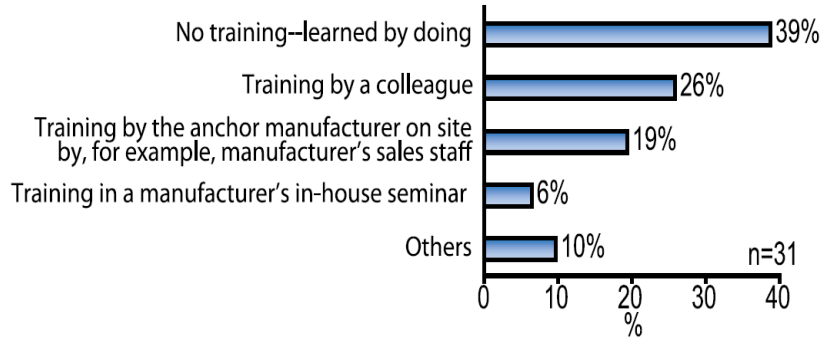

Fig. 12: Training of installers. Although the installers wanted to do a good job, their training was inadequate. (n = number of installers interviewed)

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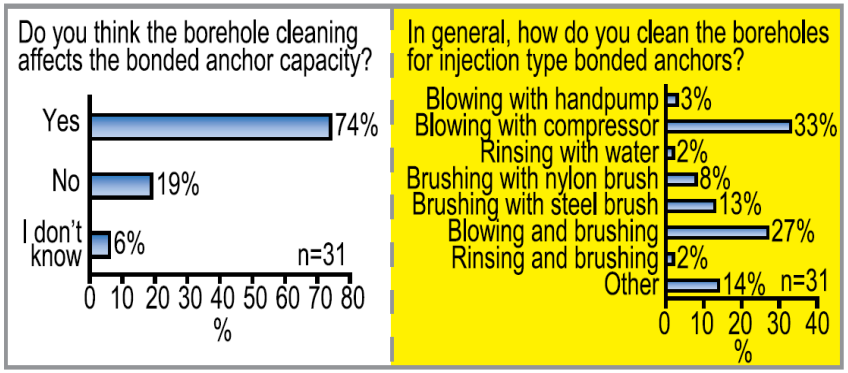

Fig. 13: Many installers were not aware of the influences of significant factors on anchor capacity: Although almost three out of four installers thought that the borehole cleaning method has an effect, less than a third were using blowing and brushing

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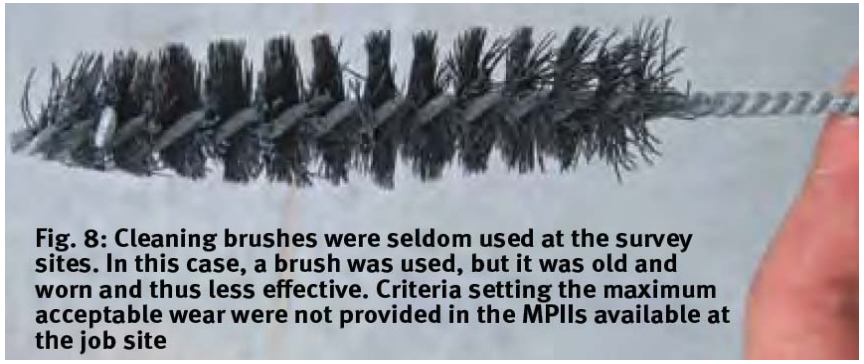
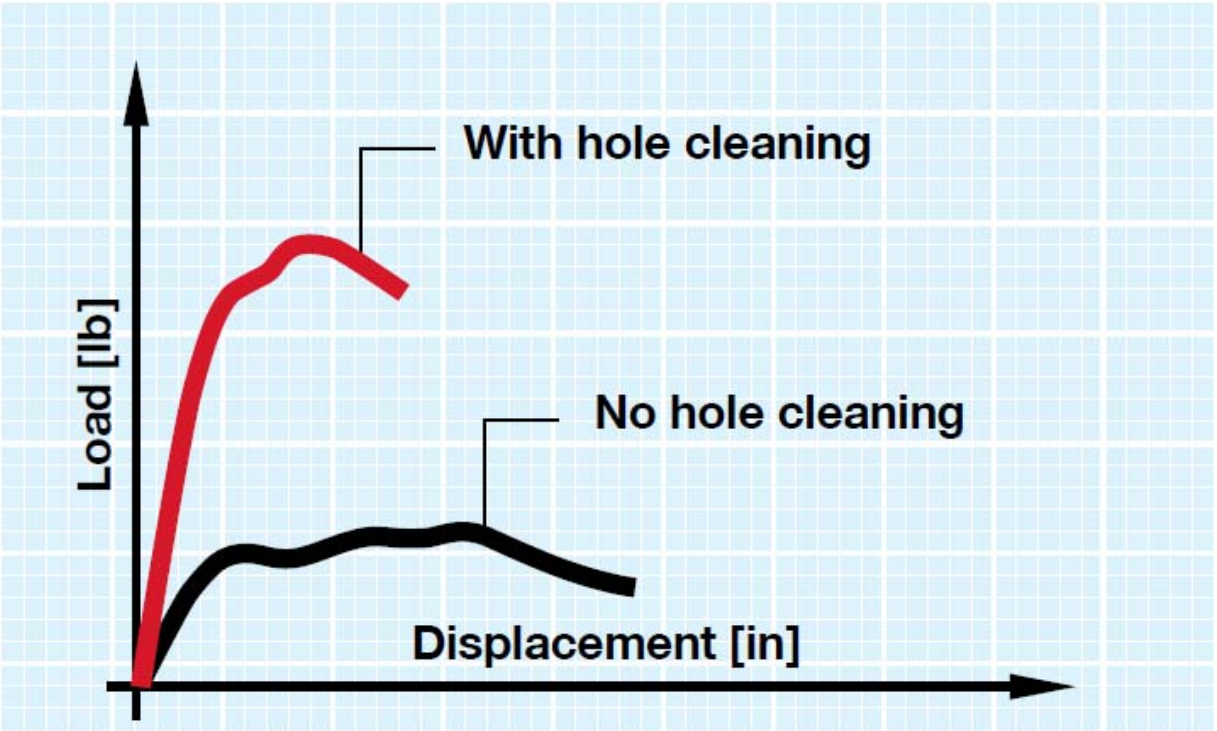


Fig. 8: Cleaning brushes were seldom used at the survey sites. In this case, a brush was used, but it was old and worn and thus less effective. Criteria setting the maximum acceptable wear were not provided in the MPIIs available at the job site

How critical is proper installation of the adhesive to achieve the design load capacity?

Improperly cleaned holes can have significant impact on design load capacity



How do you account for improper installation?

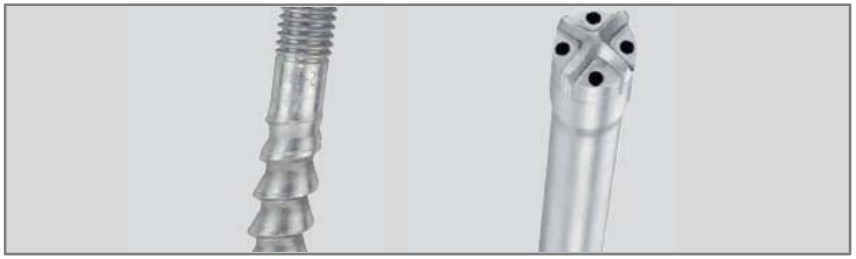
Field studies and testing indicates...

1	**Manufacturer's hole prep requirements vary**	▶	**All adhesives are not created equal**
2	**Special inspection can help ensure consistency**	▶	**Inspection requirements per ICC-ES Report**
3	**Contractor's need to be properly trained**	▶	**Specify adhesive anchor installation training by manufacturer or ACI AAI Certification program (IBC2012 req'd)**
4	**Need adhesive system with better reliability, consistency, and productivity**	▶	**Hilti has a better way…**

A small step...

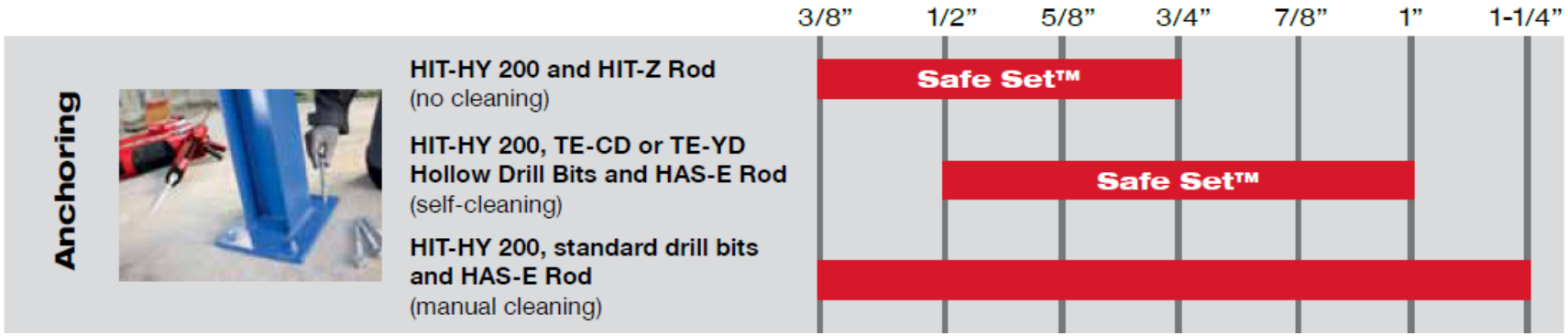
HIT-HY 200 Adhesive

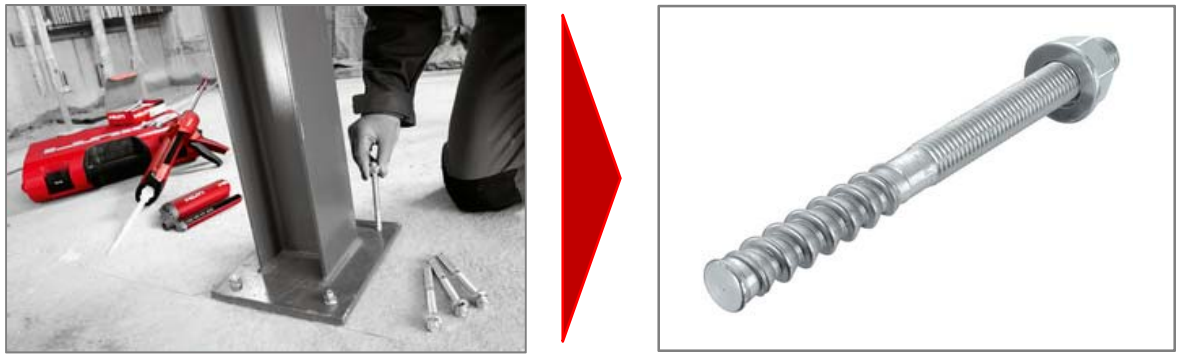
Safe Set™ Technology



1 Anchoring Application → HIT-Z Rods

HIT-HY 200 Application Ranges

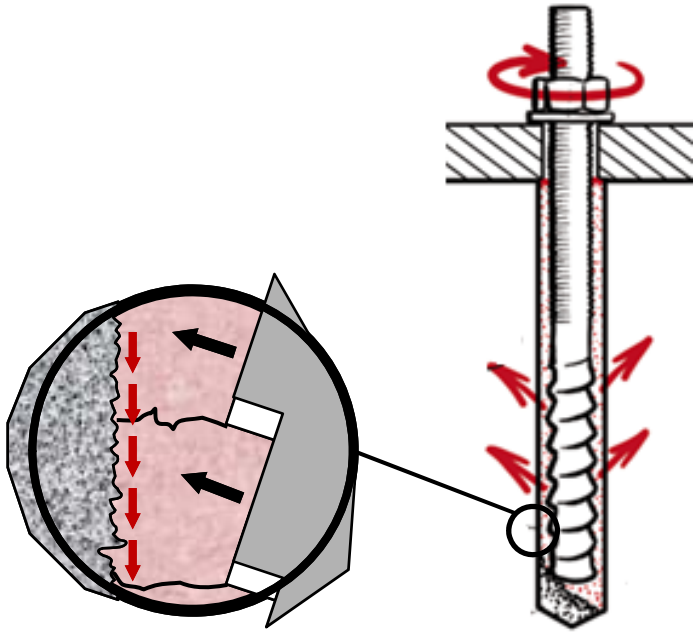




HIT-Z non-cleaning bonded expansion anchor

Functioning principal

- **Anchor coating prevents bond to HIT-Z surface**
- **Torque actuates expansion anchor characteristics and takes up initial minimal displacement**
- **Expansion forces increase friction to concrete significantly**



Special design of helix and expansion forces means that cleaning is not required

No cleaning required

3/4” HIT-Z Rod with HIT-HY 200 Safe Set System

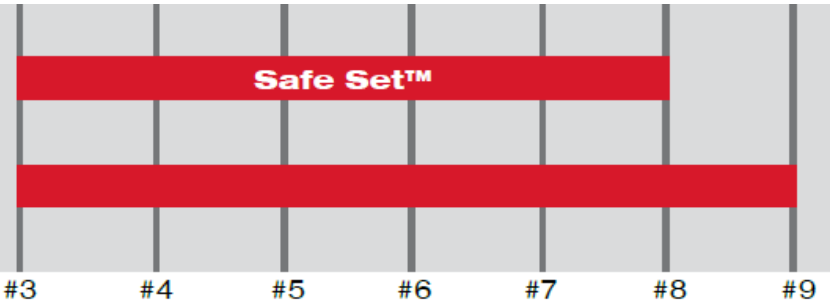
2 Rebar Applications → Hollow Drill Bit (HDB)

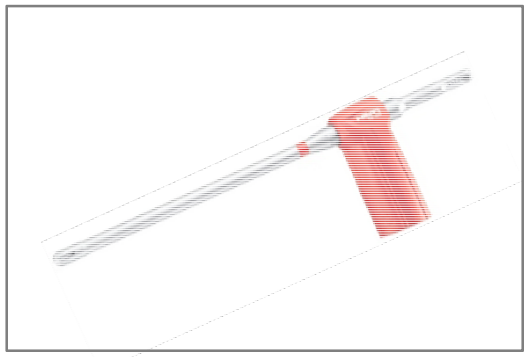
HIT-HY 200 Application Ranges

Rebar

HIT-HY 200, TE-CD or TE-YD Hollow Drill Bits and rebar
(self-cleaning)

HIT-HY 200, standard drill bits and rebar
(manual cleaning)

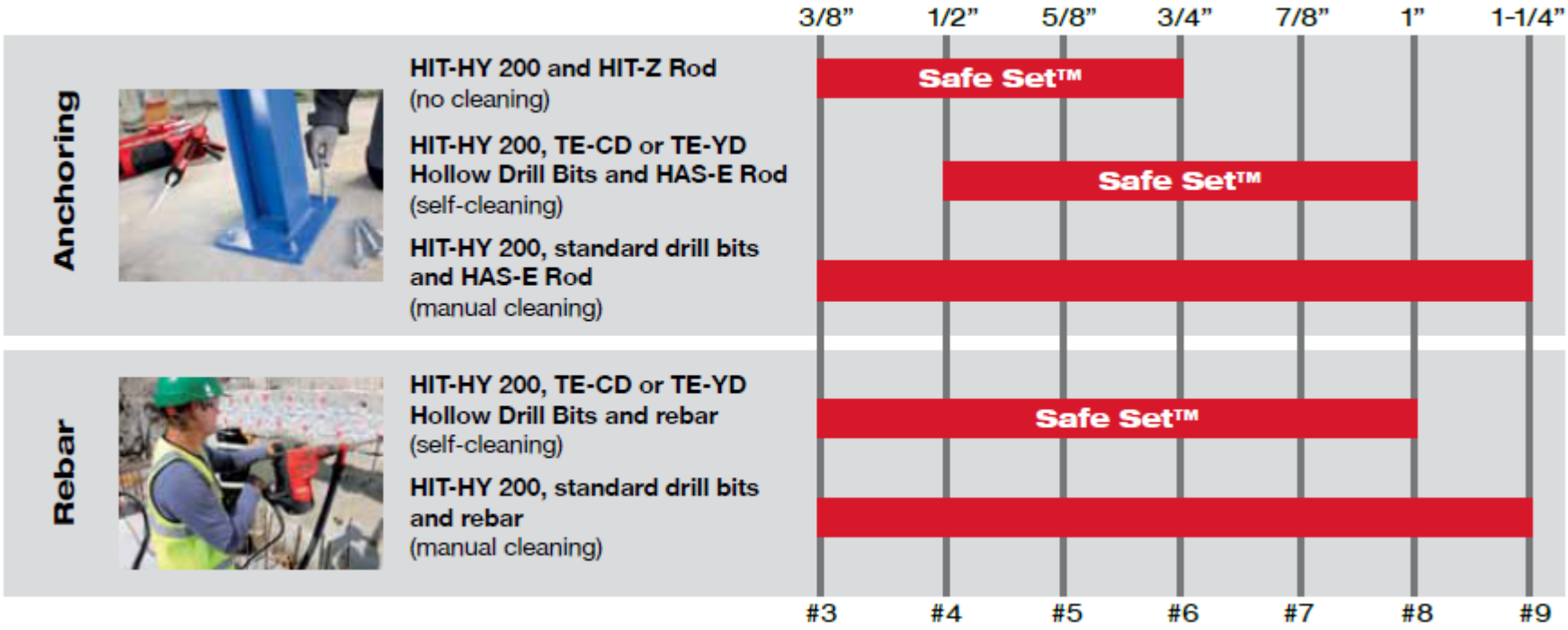




Holes that clean themselves

HIT-HY 200 with Hollow Drill Bit (HDB)

Wide Range of Applications with Safe Set™



1 No cleaning required.
HIT-Z Anchor Rods

The new Hilti HIT-Z Anchor Rod with its cone-shaped helix works as a torque-contolled bonded anchor. This means that because of their shape, HIT-Z Anchor Rods are not affected by uncleaned, hammer-drilled holes in dry or water saturated concrete in base materials above 41°F (5°C) when used with HIT-HY 200. The benefits are clear: fewer steps and extremely high reliability in anchoring applications.

2 Holes that clean themselves.
Hollow Drill Bits

Hilti TE-CD and TE-YD Hollow Drill Bits, in conjunction with HIT-HY 200, make subsequent hole cleaning completely unnecessary. Dust is removed by the Hilti VC 20/40 Vacuum System while drilling is in progress for more reliability and a virtually dustless working environment.

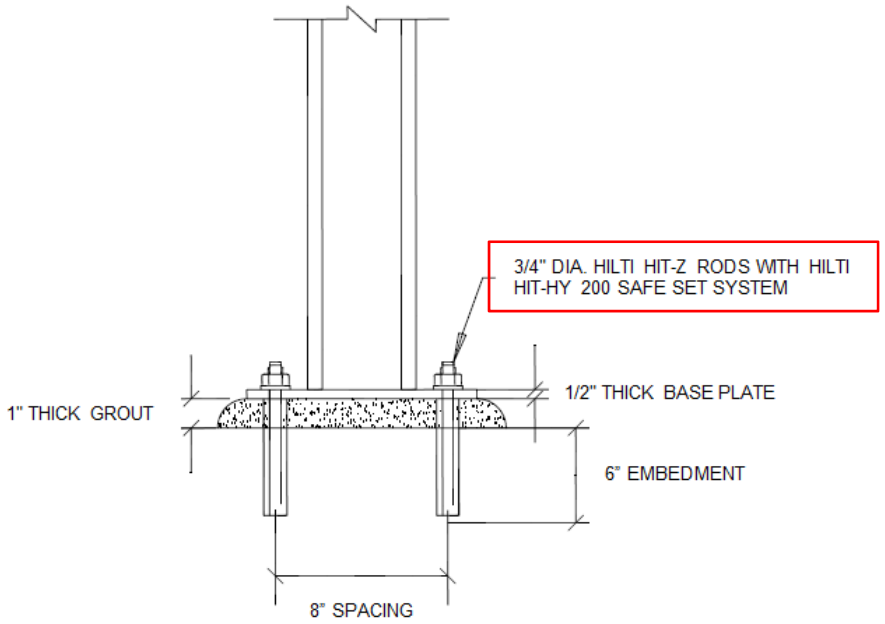
3 The traditional method.
Brush and blow

The current industry standard installation method uses compressed air and a wire brush to clean the drill hole. Like all Hilti adhesive anchors, HIT-HY 200 can be installed using the traditional blow-brush-blow method. Because HIT-HY 200 only requires two blows of compressed air, two brushes, and two more blows of compressed air when using the the traditional method, it is still faster to install than many other adhesives on the market. The blow-brush-blow cleaning technique maximizes the application range for HIT-HY 200.

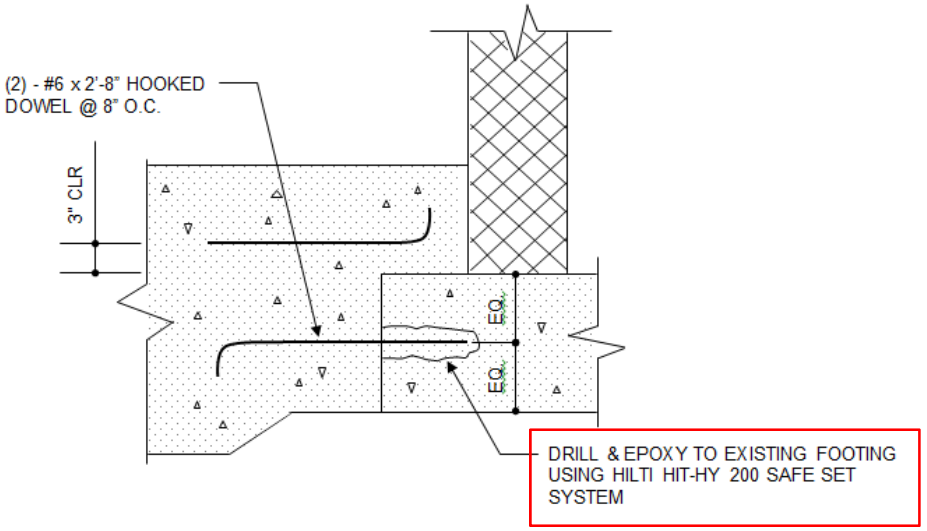
HY200 addresses many design considerations

	Consideration	HY200 advantage
1	Cracked concrete	ICC-ES approval for performance in cracked and uncracked concrete
2	Hole cleaning	HY200 Safe Set™ System with Hollow Drill Bit or HIT-Z rod improves reliability
3	Installation orientation	Applicable for vertically down, horizontal, or overhead orientations
4	Temperature	Installation temperature range from 14°F to 104°F. Very high in-service temperature ranges
5	Diamond cored holes	HY200 with HIT-Z rod is only approved adhesive anchor solution in cracked concrete with diamond cored holes
6	Seismic	ICC-ES approval for performance in seismic design

Specifying the HIT-HY 200 Safe Set System



2 / S4 COLUMN BASE PLATE ATTACHMENT TO CONCRETE
SCALE 1/4" = 1"



3 / S4 TYPICAL NEW TO EXISTING FOOTING DETAIL
SCALE 1/4" = 1"

Specifying the HIT-HY 200 Safe Set System

POST-INSTALLED ANCHORS

1) EXCEPT WHERE INDICATED ON THE DRAWINGS, POST-INSTALLED ANCHORS SHALL CONSIST OF THE FOLLOWING ANCHOR TYPES AS PROVIDED BY HILTI, INC. CONTACT HILTI AT (800) 879-8000 FOR PRODUCT RELATED QUESTIONS.

   a) **ANCHORAGE TO CONCRETE**

      i) ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE USE:
         (1) **HILTI HIT-HY 200 SAFE SET SYSTEM WITH HILTI HIT-Z ROD** PER ICC ESR-3187
         (2) **HILTI HIT-HY 200 SAFE SET SYSTEM WITH HILTI HOLLOW DRILL BIT SYSTEM** WITH HAS-E THREADED ROD PER ICC ESR-3187.
         (3) **HILTI HIT-RE 500-SD EPOXY ADHESIVE ANCHORING SYSTEM** WITH HAS-E THREADED ROD PER ICC ESR-2322 FOR SLOW CURE APPLICATIONS

      ii) MEDIUM DUTY MECHANICAL ANCHORS FOR CRACKED AND UNCRACKED CONCRETE USE:
         (1) **HILTI KWIK HUS EZ AND KWIK HUS EZ-I SCREW ANCHORS** PER ICC ESR-3027
         (2) **HILTI KWIK BOLT-TZ EXPANSION ANCHORS** PER ICC ESR-1917
         (3) **HILTI KWIK BOLT 3 EXPANSION ANCHORS** (UNCRACKED CONCRETE ONLY) PER ICC ESR-2302

      iii) HEAVY DUTY MECHANICAL ANCHORS FOR CRACKED AND UNCRACKED CONCRETE USE:
         (1) **HILTI HDA UNDERCUT ANCHORS** PER ICC ESR 1546
         (2) **HILTI HSL-3 EXPANSION ANCHORS** PER ICC ESR 1545

   b) **REBAR DOWELING INTO CONCRETE**

      i) ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE USE:
         (1) **HILTI HIT-HY 200 SAFE SET SYSTEM WITH HILTI HOLLOW DRILL BIT SYSTEM** WITH CONTINUOUSLY DEFORMED REBAR PER ICC ESR-3187.
         (2) **HILTI HIT-RE 500-SD EPOXY ADHESIVE ANCHORING SYSTEM** WITH CONTINUOUSLY DEFORMED REBAR PER ICC ESR-2322.

   c) **ANCHORAGE TO SOLID GROUTED MASONRY**

      i) ADHESIVE ANCHORS USE:

2013 Hilti Adhesive Anchor Portfolio

Concrete

HIT-HY 200 *
Fast Cure Hybrid

HIT-RE 500 SD
Slow Cure Epoxy

Masonry

HIT-HY 70
Fast Cure Hybrid

HIT-HY 150 MAX and MAX-SD were phased out in 2013

Hilti Simplified Design Tables

New

1 Single anchor capacity table

Table 1 - Hilti KWIK Bolt TZ Carbon Steel Design Strength (Factored Resistance) with Concrete / Bond Failure in Uncracked Concrete [1,2,3,4,5]

Anchor Diameter in. (mm)	Effective Embed. Depth in. (mm)	Tension - ϕN_n or N_r				
		f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)	f'_c = 250((17.2 M lb (kN
3/8 (9.5)	2 (51)	1,635 (7.3)	1,790 (8.0)	2,070 (9.2)	2,535 (11.3)	2,37 (10.6
1/2 (12.7)	2 (51)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,37 (10.6
	3-1/4 (83)	3,585 (15.9)	3,925 (17.5)	4,535 (20.2)	5,555 (24.7)	9,84 (43.8
5/8 (15.9)	3-1/8 (79)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	6,675 (29.7)	9,28((41.3
	4 (102)	5,945 (26.4)	6,510 (29.0)	7,520 (33.5)	9,210 (41.0)	13,44 (59.8
3/4 (19.1)	3-3/4 (95)	5,380 (23.9)	5,895 (26.2)	6,810 (30.3)	8,340 (37.1)	12,20 (54.3
	4-3/4 (121)	6,940 (30.9)	7,605 (33.8)	8,780 (39.1)	10,755 (47.8)	17,39 (77.4

* See Technical Supplement for complete details

2 Reduction factor table

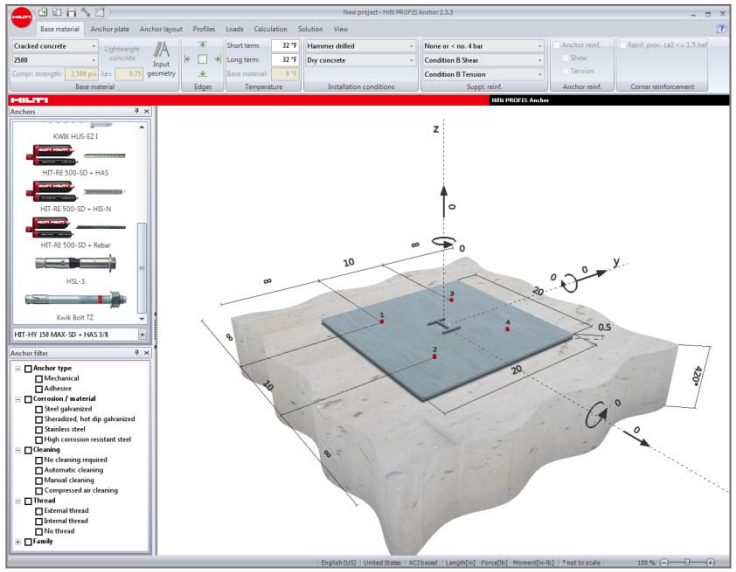
Table 3 - Load Adjustment Factors for 3/8-in. Diameter KWIK Bolt TZ in Uncracked Concrete

Adjustment Factor 3/8-in. Uncracked Concrete		Spacing Factor in Tension f_{AN}	Edge Distance Factor in Tension f_{RN}	Spacing Factor in Shear [2] f_{AV}	Edge Distance in Shear		Conc. Thickness Factor in Shear [3] f_{HV}
					⊥ Toward Edge f_{RV}	∥ To Edge f_{RV}	
Embedment h_{ef} in (mm)		2 (51)	2 (51)	2 (51)	2 (51)	2 (51)	2 (51)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/2 (64)	0.708	0.597	0.603	0.488	0.597	n/a
	3 (76)	0.750	0.686	0.624	0.642	0.686	n/a
	3-1/2 (89)	0.792	0.800	0.645	0.809	0.809	n/a
	3-5/8 (92)	0.802	0.829	0.650	0.853	0.853	n/a
	4 (102)	0.833	0.914	0.665	0.988	0.988	0.813
	4-1/2 (114)	0.875	1.000	0.686	1.000	1.000	0.863
	5 (127)	0.917		0.707			0.909
	5-1/2 (140)	0.958		0.727			0.954
	6 (152)	1.000		0.748			0.996
	7 (178)			0.789			1.000
	8 (203)			0.831			
	9 (229)			0.872			
	10 (254)			0.913			
	11 (279)			0.955			
	12 (305)			0.996			
	13 (330)			1.000			

Combines current state-of-the-art Strength Design testing standards with the ease of the Allowable Stress Design (ASD) calculation methodology

Design made easy...

1 PROFIS Anchor Software



- **Use for complex layouts and more precise analysis**

2 Hilti Simplified Design Tables

Table 1 - Hilti KWIK Bolt TZ Carbon Steel Design Strength (Factored Resistance) with Concrete / Bond Failure in Uncracked Concrete [1,2,3,4,5]

Anchor Diameter in. (mm)	Effective Embed. Depth in. (mm)	Tension - ϕN_n or N_r				
		f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)	f'_c = 250((17.2 M lb (kN
3/8 (9.5)	2 (51)	1,635 (7.3)	1,790 (8.0)	2,070 (9.2)	2,535 (11.3)	2,375 (10.6
1/2 (12.7)	2 (51)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,375 (10.6
	3-1/4 (83)	3,585 (15.9)	3,925 (17.5)	4,535 (20.2)	5,555 (24.7)	9,845 (43.8
5/8 (15.9)	3-1/8 (79)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	6,675 (29.7)	9,280 (41.3
	4 (102)	5,945 (26.4)	6,510 (29.0)	7,520 (33.5)	9,210 (41.0)	13,44 (59.8
3/4 (19.1)	3-3/4 (95)	5,380 (23.9)	5,895 (26.2)	6,810 (30.3)	8,340 (37.1)	12,20 (54.3
	4-3/4 (121)	6,940 (30.9)	7,605 (33.8)	8,780 (39.1)	10,755 (47.8)	17,39 (77.4

- **Use for simple layouts and quick reference of load capacities**

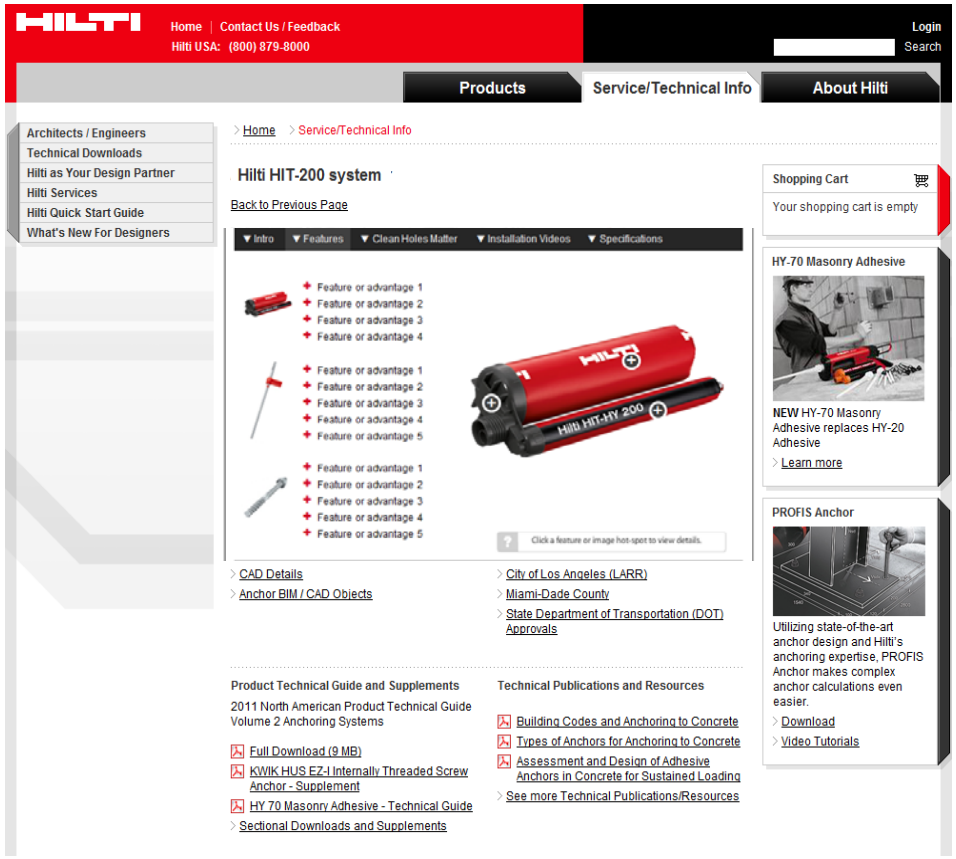
Online Resources for HIT-HY 200 Adhesive

www.us.hilti.com/hy200

Webpage will contain:

- **Interactive Demo**
- **Videos**
- **Brochures**
- **Technical Data**
- **Approvals**
- **Articles**
- **Sample Specifications**
- **BIM/CAD Details**

more…



Questions?

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