ICC-ES Evaluation Report

ESR-2347

Reissued December 2015
Revised December 2016
This report is subject to renewal December 2017.

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DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings

REPORT HOLDER:

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EVALUATION SUBJECT:

HILTI LOW-VELOCITY POWDER-ACTUATED DRIVEN THREADED STUDS FOR ATTACHMENT TO STEEL

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012, 2009 and 2006 *International Building Code*® (IBC)
- * 2015, 2012, 2009 ~~and 2006~~ *International Residential Code*® (IRC)
- * ~~2013 *Abu Dhabi International Building Code* (ADIBC)†~~

~~†The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.~~

Property evaluated:

Structural

2.0 USES

The Hilti Powder-Actuated Driven Threaded Studs are used as alternatives to the welds and bolts used to attach materials to structural steel, which are described in IBC Sections 2204.1 and 2204.2, respectively. The fasteners may be used for structures regulated under the IRC, when an engineered design is submitted in accordance with IRC Section R301.1.3.

3.0 DESCRIPTION

3.1 General:

Hilti low-velocity powder-actuated threaded studs are fasteners with male threads for attachment of building materials on one end and a pointed- or blunt-tip shank on the other end for embedment into the supporting steel. The threaded studs are available with the thread designations, shank diameters, lengths and materials shown in Table 1.

3.1.1 X-EW6H and X-EW10H Threaded Studs: These pointed-tip studs are formed from carbon steel, hardened in accordance with the manufacturer's specifications, and zinc-plated in accordance with ASTM B633 SC 1, Type III. These studs are supplied with a plastic washer. See Figure 1 for a depiction of the fasteners.

3.1.2 X-CRM8 Threaded Studs: These pointed-tip studs consist of a threaded sleeve and a drive pin. The threaded sleeve is manufactured from SAE 316 stainless steel. These studs are supplied with a plastic washer. The drive pin is manufactured from a proprietary CrNiMo alloy complying with the requirements of SAE 316. See Figure 2 for a depiction of the fastener.

3.1.3 X-ST-GR M8 Threaded Studs: These pointed-tip studs consist of a threaded sleeve and a drive pin. The threaded sleeve is manufactured from SAE 316 stainless steel. These studs are supplied with plastic washers. The drive pin is manufactured from stainless steel conforming to specifications in the manufacturer's quality documentation. See Figure 3 for a depiction of the fastener.

3.1.4 X-BT Threaded Studs:

3.1.4.1 X-BT M8, X-BT W10 and X-BT M10: These blunt tip studs consist of a threaded sleeve and a drive pin, and may have a stainless steel/bonded elastomer sealing washer, designated SN12-R. The threaded sleeve and washer are manufactured from SAE 316 stainless steel. The drive pin is manufactured from a proprietary CrNiMo alloy complying with the requirements of SAE 316. See Figure 4 for a depiction of the fasteners.

3.1.4.2 X-BT M6 and X-BT W6: These blunt tip studs are formed as a single piece from a proprietary CrNiMo alloy complying with the requirements of SAE 316 stainless steel, and have a stainless steel/bonded elastomer sealing washer designated SN12-R. See Figure 5 for a depiction of the fasteners.

3.1.5 X-BT-MF: These blunt tip studs consist of a threaded sleeve and a drive pin, and have a combination stainless steel/bonded elastomer sealing washer designated SN4. They are also supplied with a plastic nut or a stainless steel nut. The drive pin is manufactured from a proprietary stainless steel conforming to specifications in the manufacturer's quality documentation. The threaded sleeve is manufactured from glass-fiber-reinforced polyamide material. See Figure 6 for a depiction of the fasteners.

3.2 Steel Substrates:

Structural steel must comply with the minimum requirements of ASTM A36, ASTM A572 Grade 50 or

* Deleted by the City of Los Angeles

ASTM A992, and must have the minimum thicknesses, yield strength and tensile strength as shown in Tables 2 and 3, as applicable.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 Allowable Loads: The most critical applied loads, excluding seismic load effects, resulting from the load combinations in IBC Section 1605.3.1 or 1605.3.2 must not exceed the allowable loads given in this section. For fasteners which are subjected to seismic loads, see Section 4.1.3 for additional requirements. The allowable shear and tension loads for the threaded studs installed in steel are found in Tables 2 and 3. The stress increases and load reductions described in IBC Section 1605.3 are not allowed. Allowable loads listed in Tables 2 and 3 apply to the connection of the stud to the base material only. Other limit states applicable to the design of a connection, which are governed by the properties of the attached material, are outside the scope of this report. Design of the connection between the threaded stud and the attached material must comply with the applicable requirements of the IBC. When designing the connection of wood members to the base material, the bending yield strength of the threaded studs can be assumed to be the same as that of a nail with the same shank diameter as the stud.

4.1.2 Combined Loading: For fasteners subjected to both tension and shear loads, compliance with the following interaction equation must be verified:

$(p/P_a) + (v/V_a) \leq 1.0$

where:

p = Actual tension load on the fastener, lbf (N).

P_a = Allowable tension load for the fastener, lbf (N).

v = Actual shear load on the fastener, lbf (N).

V_a = Allowable shear load for the fastener, lbf (N).

4.1.3 Seismic Considerations: When the Hilti threaded studs (except for the X-ST-GR) are installed in steel and are subjected to seismic loads, the most critical load applied to each individual stud must be determined from the applicable equations in IBC Section 1605.3.1 or Section 1605.3.2, and must not exceed the allowable seismic load shown in Table 2 or 3, including the footnotes, as applicable. Recognition of the Hilti fasteners for use in the design of lateral force resisting systems, such as shear walls and diaphragms, is outside the scope of this report. The X-ST-GR fasteners may be used where the service load on any individual fastener does not exceed the lesser of 250 lbf (1112 N) or the published allowable load shown in Table 2.

4.2 Installation:

4.2.1 General: The powder-actuated threaded studs must be installed in accordance with this report and the Hilti, Inc. published installation instructions. A copy of these instructions must be available on the jobsite at all times during installation. Installation is limited to dry, interior locations, except for stainless steel fasteners, which may be installed in exterior or damp environments.

Fastener placement requires the use of a Hilti low-velocity powder-actuated tool in accordance with Hilti, Inc. recommendations. Threaded studs must be installed with stud stand-off, h_{NVS}, dimensions as defined in Figure 7 and Table 1. Minimum spacing between fasteners must be 1 inch (25.4 mm) and minimum edge distance must be $^1/_2$ inch (12.7 mm). Installers must be certified by Hilti and have a current, Hilti-issued, operator's license.

4.2.2 X-BT and X-BT-MF Blunt-tip Threaded Studs: The X-BT and X-BT-MF blunt-tip threaded studs require a pilot hole predrilled to the required depth with a Hilti TX-BT 4/7 step shank drill bit, in accordance with the manufacturer's published installation instructions. Installation instructions for the X-BT and X-BT-MF threaded studs are illustrated in Figures 9 and 10, respectively. In accordance with the manufacturer's instructions, the X-BT-MF threaded studs must be installed with the Hilti supplied flange nuts.

4.2.3 Use with Treated Lumber: Hilti stainless steel threaded studs may be installed in contact with preservative-treated wood or fire-retardant-treated wood, as set forth in the applicable code. Carbon steel threaded studs may be used in contact with fire-retardant-treated wood in dry, interior locations only, in accordance with 2015 IBC Section 2304.10.5.4 (2012 and 2009 IBC Section 2304.9.5.4) and Hilti's recommendations. Use of carbon steel threaded studs in contact with preservative-treated wood and with fire-retardant-treated wood in exterior applications is outside the scope of this report.

5.0 CONDITIONS OF USE

The Hilti Low-Velocity Powder-Actuated Driven Threaded Studs described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 The fasteners are manufactured and identified in accordance with this report.

5.2 Fastener installation complies with this report and the Hilti, Inc. published instructions. In the event of conflict between this report and the Hilti, Inc., published instructions, the more restrictive requirements govern.

5.3 Calculations demonstrating that the actual loads are less than the allowable loads described in this report must be submitted to the code official for approval. The calculations must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is constructed.

5.4 Refer to Section 4.1.3 for seismic considerations.

5.5 Stainless steel threaded studs may be installed in exterior, damp environments. Qualification of glass-fiber-reinforced polyamide material is outside the scope of this report. Use of carbon steel threaded studs is limited to dry, interior locations, which include exterior walls which are protected by an exterior wall envelope.

5.6 Installation must comply with Section 4.2.3 regarding fasteners in contact with preservative-treated and fire-retardant-treated wood.

5.7 Installers must be certified by Hilti, Inc., and have a current, Hilti-issued, operator's license.

5.8 The Hilti products addressed in this report are manufactured under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Power-Actuated Fasteners Driven into Concrete, Steel and Masonry Elements (AC70), dated February 2016, including seismic load test data in accordance with Annex A of AC70.

7.0 IDENTIFICATION

Each package of fasteners is labeled with the product designation, the manufacturer's name (Hilti), and the evaluation report number (ESR-2347). See Figure 8 for head markings.

TABLE 1—THREADED STUD DESCRIPTIONS

PRODUCT DESIGNATION	THREAD DESIGNATION	SHANK DIAMETER in. (mm)	NOMINAL THREAD LENGTH in. (mm)	NOMINAL SHANK LENGTH in. (mm)	MATERIAL	THREADED STUD STAND-OFF, h_{NVS}[1] in. (mm)
Pointed-Tip						
X-EW6H-11-9	UNC $^1/_4$-inch	0.145 (3.7)	$^7/_{16}$ (11)	$^3/_8$ (9)	Carbon steel	$^3/_8 – ^1/_2$ (9.5-12.5)
X-EW6H-20-9	UNC $^1/_4$-inch	0.145 (3.7)	$^3/_4$ (20)	$^3/_8$ (9)	Carbon steel	$^{23}/_{32} – ^{27}/_{32}$ (18.5-21.5)
X-EW6H-28-9	UNC $^1/_4$-inch	0.145 (3.7)	$1^1/_8$ (28)	$^3/_8$ (9)	Carbon steel	$1^1/_{16} – 1^5/_{32}$ (26.5-29.5)
X-EW6H-38-9	UNC $^1/_4$-inch	0.145 (3.7)	$1^1/_2$ (38)	$^3/_8$ (9)	Carbon steel	$1^7/_{16} – 1^9/_{16}$ (36.5-39.5)
X-EW10H-30-14	UNC $^3/_8$-inch	0.205 (5.2)	$1^3/_{16}$ (30)	$^9/_{16}$ (14)	Carbon steel	$1^3/_{32} – 1^7/_{32}$ (28.0-31.0)
X-CRM8-9-12 X-ST-GR M8/5	Metric 8 mm	0.157 (4.0)	$^3/_8$ (9)	$^1/_2$ (12)	Stainless steel	$^{15}/_{32} – ^{19}/_{32}$ (12.0–15.0)
X-CRM8-15-12 X-ST-GR M8/10	Metric 8 mm	0.157 (4.0)	$^5/_8$ (15)	$^1/_2$ (12)	Stainless steel	$^{21}/_{32} – ^{25}/_{32}$ (17.0–20.0)
Blunt-Tip						
X-BT W6-24-6 SN12-R	UNC $^1/_4$-inch	0.177 (4.5)	$^{15}/_{16}$ (24)	$^1/_4$ (6)	Stainless steel	$1 – 1^1/_{16}$ (25.7-26.8)
X-BT M6-24-6 SN12-R	Metric 6 mm	0.177 (4.5)	$^{15}/_{16}$ (24)	$^1/_4$ (6)	Stainless steel	$1 – 1^1/_{16}$ (25.7-26.8)
X-BT M8-15-6-R[2]	Metric 8 mm	0.177 (4.5)	$^5/_8$ (15)	$^1/_4$ (6)	Stainless steel	$^5/_8 – ^{11}/_{16}$ (15.7-16.8)
X-BT M8-15-6 SN12-R[2]	Metric 8 mm	0.177 (4.5)	$^5/_8$ (15)	$^1/_4$ (6)	Stainless steel	$^5/_8 – ^{11}/_{16}$ (15.7-16.8)
X-BT W10-24-6-R[2]	UNC $^3/_8$-inch	0.177 (4.5)	$^{15}/_{16}$ (24)	$^1/_4$ (6)	Stainless steel	$1 – 1^1/_{16}$ (25.7–26.8)
X-BT W10-24-6 SN12-R[2]	UNC $^3/_8$-inch	0.177 (4.5)	$^{15}/_{16}$ (24)	$^1/_4$ (6)	Stainless steel	$1 – 1^1/_{16}$ (25.7–26.8)
X-BT M10-24-6-R[2]	Metric 10 mm	0.177 (4.5)	$^{15}/_{16}$ (24)	$^1/_4$ (6)	Stainless steel	$1 – 1^1/_{16}$ (25.7–26.8)
X-BT M10-24-6 SN12-R[2]	Metric 10 mm	0.177 (4.5)	$^{15}/_{16}$ (24)	$^1/_4$ (6)	Stainless steel	$1 – 1^1/_{16}$ (25.7–26.8)
X-BT-MF M10/10 SN4	Metric 10 mm	0.177 (4.5)	$^{15}/_{16}$ (24)	$^1/_4$ (6)	Stainless steel pin/ plastic sleeve	$1 – 1^1/_{16}$ (25.7–26.8)
X-BT-MF W10/10 SN4	UNC $^3/_8$-inch	0.177 (4.5)	$^{15}/_{16}$ (24)	$^1/_4$ (6)	Stainless steel pin/ plastic sleeve	$1 – 1^1/_{16}$ (25.7–26.8)

For **SI:** 1 inch = 25.4 mm.

[1]See Figure 7 for depiction of h_{NVS}.
[2]The suffix "Spec" may follow the M8, M10 and W10 designations, indicating the use of an alternate proprietary stainless steel specification.

TABLE 2—ALLOWABLE LOADS FOR POINTED-TIP THREADED STUDS DRIVEN INTO STEEL[1,2,3] (lbf)

Fastener	Shank Dia. (in.)	Steel Thickness (in.)									
		$^3/_{16}$		$^1/_4$		$^3/_8$		$^1/_2$		≥ $^3/_4$	
		Tension	Shear	Tension	Shear	Tension	Shear	Tension	Shear	Tension	Shear
X-EW6H	0.145	360	500	500	600	500	600	500	600	-	-
X-EW10H	0.205	-	-	970	1000	1100	1100	1100	1100	800	800
X-CRM8 X-ST-GR M8[4]	0.157	-	-	405	405	405	405	405	405	-	-

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.4 N, 1 psi = 6895 Pa.

Notes:
[1]Tabulated allowable load values based upon embedment in steel such that threaded stud stand-off, h_{NVS}, complies with Table 1.
[2]All allowable load capacities above are based on base steel with minimum yield strength (F_y) of 36 ksi and a minimum tensile strength (F_u) of 58 ksi.
[3]Unless otherwise noted, allowable loads are applicable to static and seismic loads in accordance with Section 4.1.
[4]Tabulated loads for the X-ST-GR fastener apply to static load conditions only. For seismic loading, allowable load must be limited in accordance with Section 4.1.3.

TABLE 3—ALLOWABLE LOADS FOR BLUNT-TIP (X-BT and X-BT-MF) THREADED STUDS DRIVEN INTO STEEL ≥ $^5/_{16}$ INCH THICK[1,2,3,4]

Fastener	Shank Dia. (in.)	Tension (lbf)	Shear (lbf)
X-BT M6, X-BT W6, X-BT M8, X-BT M10, or X-BT W10	0.177	405[5]	585[6]
X-BT-MF M10 or X-BT-MF W10	0.177	340[5]	500[6]

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.4 N, 1 psi = 6895 Pa.

Notes:
[1]Tabulated allowable load values based upon embedment in steel such that threaded stud stand-off, h_{NVS}, complies with Table 1.
[2]All allowable load capacities above apply to base steel with minimum yield strength (F_y) of 36 ksi and a minimum tensile strength (F_u) of 58 ksi.
[3]Installation of X-BT fasteners must be in accordance with Section 4.2.2 and Figure 9 of this report.
[4]Installation of X-BT-MF fasteners must be in accordance with Section 4.2.2 and Figure 10 of this report.
[5]Tabulated allowable tension load is applicable to static and seismic loads in accordance with Section 4.1.
[6]Tabulated allowable shear load is applicable to static and seismic loads in accordance with Section 4.1 and the following: For seismic loads for the X-BT M6 and X-BT W6 fasteners, multiply the tabulated shear load by 0.915; for seismic loads for the X-BT M8, X-BT M10 and X-BT W10 fasteners multiply the tabulated shear by 0.983. For the X-BT-MF M10 and X-BT-MF W10 fasteners, no adjustment is needed.

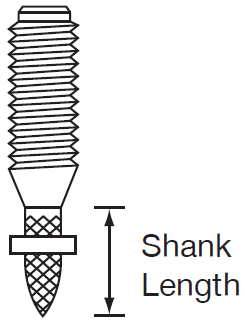


FIGURE 1—HILTI X-EW6H AND X-EW10H THREADED STUDS

FIGURE 2—HILTI X-CRM8 THREADED STUDS

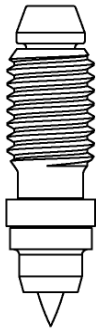


FIGURE 3—HILTI X-ST-GR M8 THREADED STUDS

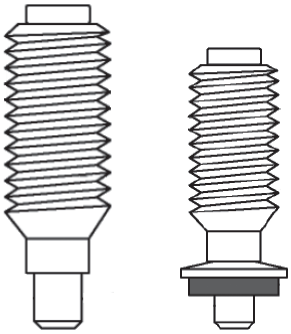


FIGURE 4—HILTI X-BT BLUNT-TIP THREADED STUD WITH AND WITHOUT SN12-R SEALING WASHER

FIGURE 5–HILTI X-BT M6 AND W6 THREADED STUDS WITH SN12-R SEALING WASHER

FIGURE 6—HILTI X-BT-MF BLUNT-TIP THREADED STUD WITH SN4 SEALING WASHER

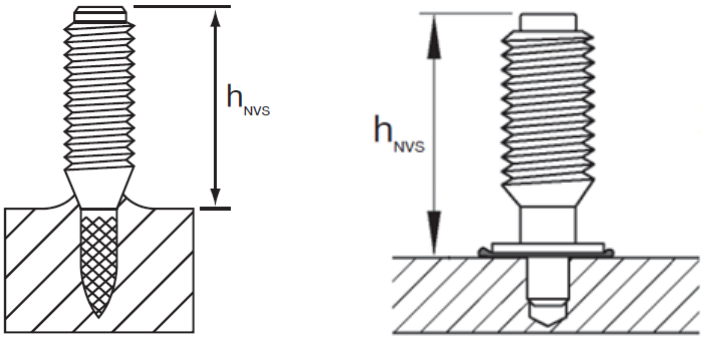


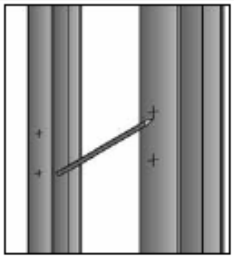
FIGURE 7—DEPICTION OF THREADED STUD STAND-OFF, h_{NVS}, FOR POINTED-TIP AND BLUNT-TIP THREADED STUDS

Carbon steel studs

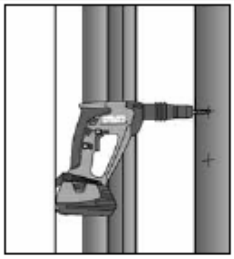
Stainless steel pointed tip studs and X-BT blunt tip studs

X-BT-MF blunt tip studs

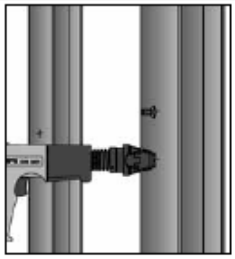
FIGURE 8—DEPICTION OF IDENTIFYING HEAD MARKINGS FOUND ON TOP OF THREADED STUDS



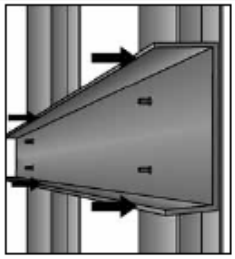
1. Mark location for each fastening



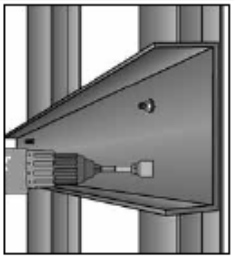
2. Pre-drill with TX-BT 4/7 step shank drill bit



3. Drive fastener into drilled hole only with DX351-BT/ BTG tool and Hilti 6.8/11M High Precision brown cartridge. High Precision cartridge is a cartridge with a specific energy level and a narrow energy band.



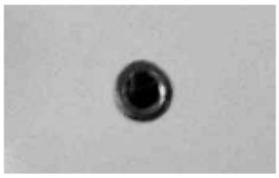
4. Install material to be fastened, washer and nut



5. Tighten nuts using an electric screw driver with torque clutch or torque wrench.

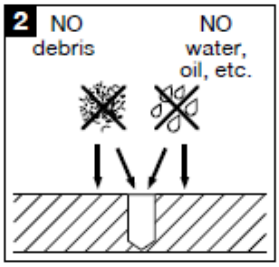
Installation Details

Pre-drill until shoulder grinds a shiny ring (to assure proper drilling depth).



Before fastener installation:

The drilled hole must be clear of liquids and debris. Area around drilled hole must be free from liquids and debris.



Adjust power on the **DX351-BT/BTG** so that the fastener stand-off, h_{NVS}, is:

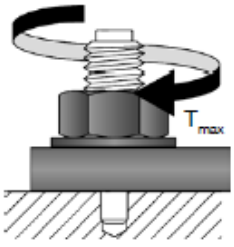
Fastener	h_{NVS}
X-BT W6 and W10	1.012"–1.055" (25.7–26.8 mm)
X-BT M8	0.618"–0.661" (15.7–16.8 mm)

Proper compression of the sealing washer must be achieved.

Power regulation guide to check fastener stand-off available from Hilti.

Tightening torque, T_{max} = 6 ft-lb (8 Nm)

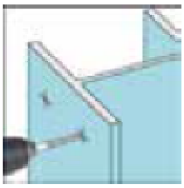
Hilti Tool	Torque Setting[1]
SFH 18-A	9-10
SF 18-A	9-10
SFH 144-A	9-10
SF 144-A	9-10



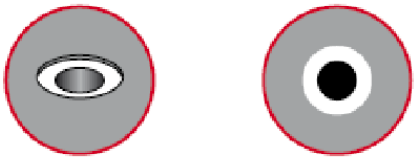
1 Tool torque settings are for guideline purposes. Tool wear and temperature as well as battery charge will influence torque characteristics.

FIGURE 9—INSTALLATION INSTRUCTIONS FOR HILTI X-BT THREADED STUDS

Pre-drill with **TX-BT 4/7** step shank drill bit

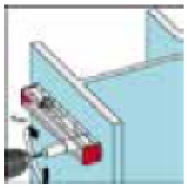


Pre-drill until the shoulder grinds a shiny ring (to ensure proper drilling depth)

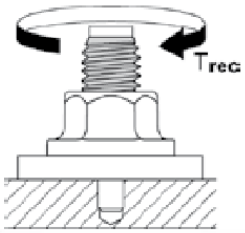


Before fastener installation:
The drilled hole and the area around the drilled hole must be clear of liquids and debris.

Tighten using a screwdriver with torque clutch



Tightening torque:
$T_{rec} \leq 8$ Nm (5.9 ft-lb)!



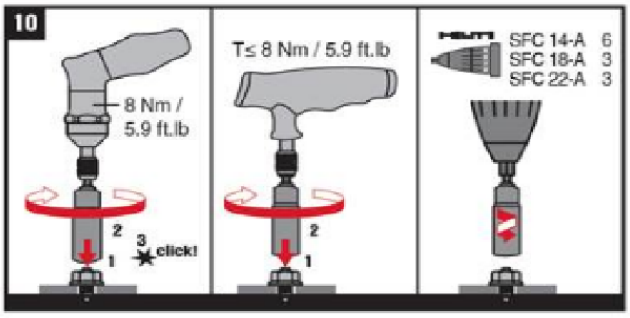


FIGURE 10—INSTALLATION INSTRUCTIONS FOR HILTI X-BT-MF THREADED STUDS