STRUCTURAL SOLUTIONS
ENGINEERING • CONSULTING, SE
2176 Esplanade, Chico, CA 95926
(530) 354-4160

JOB AMERIC BRAND

ENGINEER JP

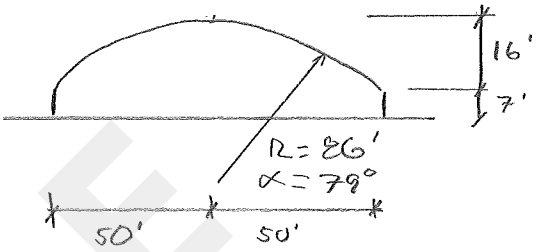
SHEET NO. 1

DATE 10.28.18

DESIGN OF 100' WIDE X 23' HIGH

CODE : ASCE 7-10
ACI 318-14

ASSUMPTIONS : FLAT TERRAIN
WIND SPEED = 80 MPH



WIND INFO : KD = .85
EXPOSURE C
Kzt = 1.0
G = .85
ENCLOSURE = ENCLOSED
GCpi = ± 0.18
Kz = KH = 0.90

WIND PRESSURES :

$q_z = 0.00256(.9)(1.0)(.85)(80)^2 = 12.5 psf$ ULT

$P = 12.5psf(.85)C_p - 12.5psf(\pm .18)$

$r = (16+7)/100 = .23$

	WINDWARD ¼	CENTER ½	LEEWARD ¼
C_p =	.045 -.72	-.93	-.5
P =	3psf ULT 2psf ASD -10psf ULT -6psf ASD	-12psf ULT -7psf ASD	-8psf ULT -5psf ASD

INFLATION PRESSURE:

ATMOSPHERIC PRESSURE = 1½" OF WATER HEAD

$= \frac{1.5'}{12}(62.4pcf) = 7.8psf$

DL = 12psf

SAY 8psf

10/28/18

STRUCTURAL SOLUTIONS
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2176 Esplanade, Chico, CA 95926
(530) 354-4160

JOB AMERI BRAND SHEET NO. 2

ENGINEER J DATE 10.26.18

DESIGN OF 100' WIDE X 23' HIGH

TENSION ON BOLTS:

$$T_A = 7psf(1')(2)(26)(\sin 79/4)/2 + 8psf(1')(50') + 6psf(100-52.5)/2 + (2+5)(\sin 30)(1')(16)(.67\times16'+7)/100$$

$$= 735plf$$

ANCHOR REQUIREMENTS

RED HEAD = 790# 1 5/8" EMBEDMENT
f'c = 2500 psi

HILTI = NO LIMIT IN UNCRACKED CONCRETE
3/4" EMBEDMENT
f'c = 2500 psi

FABRIC STRESS:

FABRIC CAPACITY = 300pli = 3600plf x.5 = 1800plf

DEMAND = 735pli < 1800plf OK

Summary:

Option #1:
3/8" Ramset/Red Head Multi-SET II Anchor @ 12oc x 1-5/8" embedment. Locate anchors 6" min from edge of slab. Concrete must be uncracked concrete (no cracks within 3" of anchor) with a compresive strength of 2,000psi min. Special inspection required.

Option #2:
3/8" Hilti HDI-P TZ Anchor @ 12oc x 3/4" embedment. Locate anchors 6" min from edge of slab. Concrete must be uncracked concrete with a compresive strength of 2,500psi min. Special inspection required.

ICBO Evaluation Service, Inc.

5360 WORKMAN MILL ROAD • WHITTIER, CALIFORNIA 90601-2299

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EVALUATION REPORT

ER-1372

Reissued March 1, 2000

Filing Category: FASTENERS—Concrete and Masonry Anchors (066)

ITW RAMSET/RED HEAD SELF-DRILLING, TRUBOLT WEDGE, AND MULTI-SET II CONCRETE ANCHORS

ITW RAMSET/RED HEAD
1300 NORTH MICHAEL DRIVE
WOOD DALE, ILLINOIS 60191

1.0 SUBJECT

ITW Ramset/Red Head Self-Drilling, Trubolt Wedge, and Multi-Set II Concrete Anchors.

2.0 DESCRIPTION

2.1 ITW Ramset/Red Head Self-Drilling Anchor:

2.1.1 General: The ITW Ramset/Red Head anchor is a self-drilling concrete expansion shell anchor with a single cone expander. Both elements are made from heat-treated steel. The steel for the body conforms to AISI C-12LI 4, and the steel for the plug conforms to AISI C-1010. The anchor has eight sharp teeth at one end and is threaded internally at the other end. The outer surface of the tubular shell at the toothed end has annular broaching grooves and four milled slits. At its threaded end, the anchor is provided with an unthreaded chucking cone that has an annular break-off groove at its base for flush mounting. Anchor shell and expander cone are electrodeposit zinc and chromate-plated.

2.1.2 Installation: Embedment, spacing, edge distance, and concrete requirements are shown in Tables 1 and 2. The anchors are installed by a Model 747 Roto-Stop Hammer, by air or electric impact hammer, or by hand. The anchor is used as a drill in forming the hole in normal-weight concrete. After the hole is formed, the anchor must be removed and the hole thoroughly cleaned. The hole depth is regulated by the drill chuck. A Red Head plug must be set into the bottom of the anchor prior to insertion in the hole. The concrete anchor must be driven over the plug, to cause expansion of the anchor in the hole. The chucking end of the anchor is broken off with a hammer blow. Verification that the anchor has been installed properly is evidenced by the fact that the anchor does not project above the surface of the concrete and the red plug is visible at the bottom of the hole.

2.2 ITW Ramset/Red Head Trubolt Wedge Anchor:

2.2.1 General: The Trubolt Wedge anchor is a stud bolt type of drop-in anchor. The anchors are cold-formed or machined from zinc-plated and chromate-dipped carbon steel, hot-dipped galvanized carbon steel or stainless steel. Steel used to produce the anchors complies with AISI C-1015 to AISI C-1022 and AISI C-1213 carbon steels, Type 304 or Type 316 stainless steels. Hot-dipped galvanizing complies with ASTM 153 Class C requirements. The expander sleeves are fabricated from stainless steel or carbon steel meeting the requirements of Type 302 or AISI C-1010, respectively. Cold-formed anchor studs are available only for the $^1/_4$-inch-, $^3/_8$-inch-, $^1/_2$-inch-, $^5/_8$-inch- and $^3/_4$-inch-diameter (6.4, 9.5, 12.7, 15.9 and 19.1 mm) wedge anchors. The anchor stud is threaded at its upper end and has a straight cylindrical section reduced in diameter, around which the expander sleeve is formed. A straight-tapered section enlarging to a cylindrical base acts to increase the diameter of the expander ring as the stud is tightened in the concrete hold. The expander ring, which is formed around the stud bolt, consists of a split-ring element with a "coined" groove at each end. The expander ring is designed to engage the walls of the concrete hold as the tapered portion of the stud is forced upward against its interior.

2.2.2 Installation: Embedment, spacing, edge distance, and concrete requirements are shown in Tables 3, 4, 5 and 10. Holes must be predrilled in normal-weight or lightweight concrete with carbide-tipped masonry drill bits manufactured within the range of the maximum and minimum drill tip dimensions of ANSI B212.15-1994. The anchors must be installed in holes the same nominal size as the anchor size, with a greater depth than the length of embedment desired, but no less than the minimum embedment. The hole must be cleaned out prior to installation of the anchor. The anchor must be tapped into the hole to the embedment depth desired, but no less than the minimum embedment. A standard hexagonal nut and washer must be used over the material being fastened and the nut tightened until the minimum installation torque, as indicated in Tables 3 and 10, is reached.

2.3 ITW Ramset/Red Head Multi-Set II Anchor:

2.3.1 General: The Multi-Set anchors are designed to be installed in a predrilled hole equal to the anchor diameter. The anchor consists of a shell formed from carbon steel meeting the minimum requirements of AISI C-1213 and an expansion plug formed from carbon steel meeting the minimum requirements of AISI C-1010. The expansion end is divided into four equal segments by radial slots. The expansion plug is preassembled and is cylindrical in cross section.

2.3.2 Installation: Embedment, spacing, edge distance, and concrete requirements are shown in Tables 6, 7 and 9. Holes must be predrilled in normal-weight or lightweight concrete with carbide-tipped masonry drill bits manufactured within the range of the maximum and minimum drill tip dimensions of ANSI B212.15-1994. The anchors must be installed in predrilled holes, the hole depth and diameter for each anchor size being listed in Tables 6, 7 and 9. After the hole is drilled, it is cleared of all cuttings. The anchor is set by installing the expansion shell and then driving the cone expander with a setting tool provided with each anchor size. When the

cone expander is driven down into the anchor, the legs of the shell expand.

2.4 Design:

Allowable static loads are as set forth in Tables 1, 3, 6, 9 and 10. Allowable loads for anchors subjected to combined shear and tension forces are determined by the following equation:

$$(P_s/P_t)^{5/3} + (V_s/V_t)^{5/3} \leq 1$$

where:

P_s = Applied service tension load.

P_t = Allowable service tension load.

V_s = Applied service shear load.

V_t = Allowable service shear load.

The anchors cannot be subjected to vibratory loads. Sources of such loads include, for example, reciprocating engines, crane loads and moving loads due to vehicles.

2.5 Special Inspection:

When special inspection is required, compliance with Section 1701.5.2 of the code is necessary. The special inspector must be on the jobsite continuously during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, anchor spacings, edge distances, slab thickness, anchor embedment and tightening torque.

2.6 Identification:

The concrete anchors are identified by their dimensional characteristics, the anchor size, and by the length code stamped on the anchor. The conical-shaped expander plugs are colored red. See Figure 1 for additional details. Length codes are in Table 8. Packages are identified with the anchor type and size, the manufacturer's name and address, and the name of the quality control agency, PFS Corporation.

3.0 EVIDENCE SUBMITTED

Data complying with the ICBO ES Acceptance Criteria for Expansion Anchors in Concrete and Masonry Elements (AC01), dated January 1999.

4.0 FINDINGS

That the ITW Ramset/Red Head fasteners described in this report comply with the 1997 *Uniform Building Code*™, subject to the following conditions:

4.1 Anchor sizes, dimensions and installation are as set forth in this report.

4.2 Allowable shear and tension loads are as set forth in Section 2.4.

4.3 Calculations justifying that the applied loads comply with this report are submitted to the building official for approval.

4.4 Special inspection is provided as set forth in Section 2.5.

4.5 Anchors are limited to installation in uncracked concrete, which is concrete subjected to tensile stresses not exceeding 170 psi (1.2 MPa) as induced by external loads, deformations and interior exposures.

4.6 Anchors are limited to nonfire-resistive construction unless appropriate data is submitted to demonstrate anchor performance is maintained in fire-resistive situations.

4.7 Anchors are manufactured at Highway 12, Michigan City, Indiana, with inspections by PFS Corporation (NER-QA251).

4.8 Use of electroplated or mechanically plated carbon steel anchors is limited to dry, interior locations. Use of hot-dipped galvanized carbon steel is permitted in exterior-exposure or damp environments.

4.9 Except for ITW Ramset/Red Head Carbon Steel and Stainless Steel Trubolt Wedge anchors embedded in normal-weight concrete, as noted in Table 3, use of anchors in resisting earthquake or wind loads is beyond the scope of this report.

4.10 The anchors are not subjected to vibratory loads, such as those encountered by supports for reciprocating engines, crane loads and moving loads due to vehicles.

This report is subject to re-examination in two years.

TABLE 1—ITW RAMSET/RED HEAD SELF-DRILLING ANCHOR ALLOWABLE SHEAR AND TENSION VALUES (pounds)[1,3,4]

BOLT DIAMETER (inch)	ANCHOR DIAMETER (inch)	MINIMUM EMBEDMENT DEPTH (inches)	f'_c = 2,000 psi			f'_c = 4,000 psi		
			Tension		Shear	Tension		Shear
			With Special Inspection[2]	Without Special Inspection		With Special Inspection[2]	Without Special Inspection	
1/4	7/16	1 3/32	415	210	295	650	325	365
3/8	9/16	1 7/32	785	395	770	1,035	520	650
1/2	11/16	2 1/32	1,150	575	920	1,555	775	930
5/8	27/32	2 15/32	1,510	755	1,605	2,485	1,240	1,755
3/4	1	3 1/4	1,985	995	2,495	3,165	1,585	2,575

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 6.89 kPa.

[1]The tabulated shear and tensile values are for anchors installed in normal-weight concrete having the designated ultimate compressive strength at the time of installation. Values have been tabulated for both ASTM A 307 and A 449 bolts installed with the device.

[2]These tension values are applicable only when the anchors are installed with special inspection as set forth in Section 2.5.

[3]The minimum concrete thickness is 1 1/2 times the embedment depth, or the embedment depth plus three times the anchor diameter, whichever is greater.

[4]The anchors are illustrated as follows:

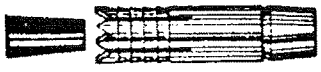

TABLE 6—ITW RAMSET/RED HEAD MULTI-SET II ANCHOR ALLOWABLE SHEAR AND TENSION VALUES (pounds)[1,2,4,5]

BOLT DIAMETER (inch)	ANCHOR DIAMETER (inch)	MINIMUM EMBEDMENT DEPTH (inches)	f'_c = 2,000 psi			f'_c = 4,000 psi			f'_c = 6,000 psi		
			Tension		Shear	Tension		Shear	Tension		Shear
			With Special Inspection[3]	Without Special Inspection		With Special Inspection[3]	Without Special Inspection		With Special Inspection[3]	Without Special Inspection	
1/4	3/8	1	420	210	270	590	295	300	745	375	325
3/8	1/2	1 5/8	745	375	790	950	475	625	1,560	780	465
1/2	5/8	2	825	415	1,145	1,460	730	875	2,075	1,035	600
5/8	7/8	2 1/2	1,375	685	1,860	2,160	1,080	1,385	2,755	1,375	910
3/4	1	3 3/16	2,070	1,035	2,620	2,370	1,185	1,920	3,065	1,530	1,215

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 6.89 kPa.

[1]The tabulated shear and tensile values are for anchors installed in stone-aggregate concrete having the designated ultimate compressive strength at the time of installation. Values have been tabulated for both ASTM A 307 and A 449 bolts installed with the device.

[2]The holes are drilled with bits complying with ANSI B212.15-1994. The bit diameter equals the anchor diameter.

[3]These tension values are applicable only when the anchors are installed with special inspection as set forth in Section 2.5.

[4]The minimum concrete thickness is 1 1/2 times the embedment depth, or the embedment depth plus three times the anchor diameter, whichever is greater.

[5]The anchors are illustrated as follows:

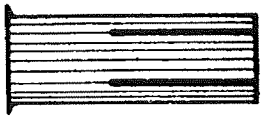

TABLE 7—RECOMMENDED SPACING AND EDGE DISTANCE REQUIREMENTS FOR ITW RAMSET/RED HEAD MULTI-SET II ANCHOR[1]

BOLT DIAMETER (inch)	ANCHOR DIAMETER (inch)	MIN. EMBEDMENT DEPTH (inches)	DESCRIPTION			
			Edge Distance Required to Obtain Max. Working Load (inches)	Min. Allowable Edge Distance (inches) Load Factor Applied = 0.80 for Tension = 0.70 for Shear	Spacing Required to Obtain Max. Working Load (inches)	Min. Allowable Spacing Between Anchors (inches) Load Factor Applied = 0.80 for Tension = 0.55 for Shear
1/4	3/8	1	1 3/4	7/8	3 1/2	1 3/4
3/8	1/2	1 5/8	2 7/8	1 7/16	5 11/16	2 7/8
1/2	5/8	2	3 1/2	1 3/4	7	3 1/2
5/8	7/8	2 1/2	4 3/8	2 3/16	8 3/4	4 3/8
3/4	1	3 3/16	5 5/8	2 13/16	11 3/16	5 5/8

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

[1]Linear interpolation may be used for intermediate spacing and edge distances.

[2]Spacings and edge distances shall be divided by 0.75 when anchors are placed in structural lightweight concrete in accordance with Table 9.

TABLE 8—LENGTH IDENTIFICATION CODES

CODE		LENGTH OF ANCHOR (inches)	LENGTH OF ANCHOR (mm)
A	Black	1 1/2 < 2	38 < 51
B	White	2 < 2 1/2	51 < 63
C	Red	2 1/2 < 3	63 < 76
D	Green	3 < 3 1/2	76 < 89
E	Yellow	3 1/2 < 4	89 < 102
F	Blue	4 < 4 1/2	102 < 114
G	Purple	4 1/2 < 5	114 < 127
H	Brown	5 < 5 1/2	127 < 140
I	Orange	5 1/2 < 6	140 < 152
J	N/A	6 < 6 1/2	152 < 165
K	N/A	6 1/2 < 7	165 < 178
L	N/A	7 < 7 1/2	178 < 191
M	N/A	7 1/2 < 8	191 < 203

CODE	LENGTH OF ANCHOR (inches)	LENGTH OF ANCHOR (mm)
N	8 < 8 1/2	203 < 216
O	8 1/2 < 9	216 < 229
P	9 < 9 1/2	229 < 241
Q	9 1/2 < 10	241 < 254
R	10 < 11	254 < 267
S	11 < 12	267 < 305
T	12 < 13	305 < 330
U	13 < 14	330 < 366
V	14 < 15	366 < 381
W	15 < 16	381 < 406
X	16 < 17	406 < 432
Y	17 < 18	432 < 457
Z	18 < 19	457 < 483

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ESR-4236

Issued 07/2018
This report is subject to renewal 07/2019.

DIVISION: 03 00 00—CONCRETE
SECTION: 03 16 00—CONCRETE ANCHORS
DIVISION: 05 00 00—DIVISION NAME
SECTION: 05 05 19—POST-INSTALLED CONCRETE ANCHORS

REPORT HOLDER:

HILTI, INC.

EVALUATION SUBJECT:

HILTI HDI-P TZ ANCHORS IN CRACKED AND UNCRACKED CONCRETE

ICC ES | ICC ES PMG | ICC ES LISTED

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ICC-ES Evaluation Report

ESR-4236

Issued July 2018

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DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors

REPORT HOLDER:

HILTI, INC.

EVALUATION SUBJECT:

HILTI HDI-P TZ ANCHORS IN CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2018, 2015, 2012, and 2009 *International Building Code®* (IBC)
- 2018, 2015, 2012, and 2009 *International Residential Code®* (IRC)

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS), see ESR-4236 LABC and LARC Supplement.

Property evaluated:

Structural

2.0 USES

The Hilti HDI-P TZ anchor is used as anchorage to resist static, wind, and seismic tension and shear loads in the underside (formed surface) of cracked and uncracked normal-weight concrete and lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi. Use of anchors is limited to supporting non-structural components.

The anchor is an alternative to cast-in-place anchors described in Section 1901.3 of the 2018 and 2015 IBC, Sections 1908 and 1909 of the 2012 IBC, and Sections 1911 and 1912 of the 2009 IBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 HDI-P TZ:

HDI-P TZ anchors are internally-threaded, displacement-controlled, mechanical expansion anchors. HDI-P TZ anchors consist of an internally-threaded anchor body with an expansion cone, a wedge (expansion element), and an internal setting plug which expands the anchor and activates the wedge when engaged with the HDI-P TZ setting tool. The HDI-P TZ is illustrated in Figures 1 and 2. The anchor components are manufactured from carbon steel and have a minimum 5 µm (0.0002 inch) zinc plating conforming to DIN EN ISO 4042 A2K.

The anchor is installed in a predrilled hole using a carbide-tipped hammer drill bit meeting the requirements of ANSI B212.15 or with a Hilti HDI-P TZ stop drill bit. The HDI-P TZ is inserted into the predrilled hole and the setting plug is engaged with the manual HDI-P TZ setting tool and a hammer, or the automatic HDI-P TZ setting tool and a hammer drill. See Figure 2 for the proper drilling and setting tools.

3.2 Steel Insert Elements:

A threaded steel insert element must be threaded into the Hilti HDI-P TZ anchor after the anchor is set in the concrete. The properties of the insert element must comply with ASTM A36 minimum, or equivalent. See Tables 3 and 4.

3.3 Concrete:

Normal-weight and lightweight concrete must conform to Sections 1903 and 1905 of the IBC. The minimum concrete compressive strength at the time of anchor installation is noted in Section 5.5 of this report.

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with the 2018 and 2015 IBC, as well as Section R301.1.3 of the 2018 and 2015 IRC, must be determined in accordance with ACI 318-14 Chapter 17 and this report.

Design strength of anchors complying with the 2012 IBC as well as Section R301.1.3 of the 2012 IRC, must be determined in accordance with ACI 318-11 Appendix D and this report.

Design strength of anchors complying with the 2009 IBC and Section R301.1.3 of the 2009 IRC must be determined in accordance with ACI 318-08 Appendix D and this report.

Design parameters provided in Tables 2, 3, and 4, of this report are based on the 2018 and 2015 IBC (ACI 318-14) and the 2012 IBC (ACI 318-11) unless noted otherwise in Sections 4.1.1 through 4.1.12.

The strength design of anchors must comply with ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Strength reduction factors, ϕ, as given in Tables 2 and 4 of this report must be used in lieu of ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, for load combinations calculated in accordance with Section 1605.2 of the IBC and Section 5.3 of ACI 318-14 or Section 9.2 of

ACI 318-11, as applicable. Use of load combinations calculated in accordance with ACI 318-11 Appendix C is beyond the scope of this report. The value of f'_c used in the calculations must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

4.1.2 Requirements for Static Steel Strength in Tension: The nominal static steel strength, N_{sa}, of a single anchor in tension must be calculated in accordance with ACI 318-14 17.4.1.2 or ACI 318-11 D.5.1.2, as applicable for the threaded steel element, $N_{sa,rod}$, as noted in Table 4 of this report. The lesser of $\phi N_{sa,rod}$ in Table 4 or ϕN_{sa} provided in Table 2 for the HDI-P Z anchor shall be used as the steel strength in tension.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: The nominal concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or N_{cbg}, respectively, must be calculated in accordance with ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, with modifications as described in this section. The basic concrete breakout strength in tension, N_b, must be calculated in accordance with ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of h_{ef} and k_{cr} as given in Table 2 of this report. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, must be calculated with k_{uncr} as given in Table 2 of this report and with $\Psi_{c,N} = 1.0$.

4.1.4 Requirements for Static Pullout Strength in Tension: The nominal pullout strength of a single anchor in accordance with ACI 318-14 17.4.3.1 and 17.4.3.2 or ACI 318-11 D.5.3.1 and D.5.3.2, respectively, as applicable, in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, respectively, is given in Table 2. For all design cases $\Psi_{c,P} = 1.0$. In accordance with ACI 318-14 17.4.3 or ACI 318-11 D.5.3, as applicable, the nominal pullout strength in cracked concrete may be calculated in accordance with the following equation where the specified concrete compressive strength, f'_c, exceeds 2,500 psi (17.2 MPa):

$$N_{p,f'c} = N_{p,cr} (f'_c / 2{,}500)^{0.35} \quad \text{(lb, psi)} \qquad \text{(Eq-1)}$$

$$N_{p,f'c} = N_{p,cr} (f'_c / 17.2)^{0.35} \quad \text{(N, MPa)}$$

Where values for $N_{p,uncr}$ are not provided in Table 2, the pullout strength in tension need not be evaluated.

4.1.5 Requirements for Static Steel Strength in Shear: The nominal steel strength in shear, V_{sa}, of a single anchor must be taken as the threaded steel element strength, $V_{sa,rod}$, as noted in Table 4 of this report. The lesser of $\phi V_{sa,rod}$ in Table 4 or ϕV_{sa} provided in Table 2 for the HDI-P Z anchor shall be used as the steel strength in shear, and must be used in lieu of the values derived by calculation from ACI 318-14 Eq. 17.5.1.2b or ACI 318-11 Eq. D-29, as applicable.

4.1.6 Requirements for Static Concrete Breakout Strength in Shear: The nominal concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, respectively, must be calculated in accordance with ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, with modifications as described in this section. The basic concrete breakout strength, V_b, must be calculated in accordance with ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, based on the values of ℓ_e and d_a provided in Table 2 of this report.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear: The nominal concrete pryout strength of a single anchor or group of anchors, V_{cp} or V_{cpg}, respectively, must be calculated in accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, using the value of k_{cp} provided in Table 2 of this report and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

4.1.8 Requirements for Seismic Design:

4.1.8.1 General: For load combinations including seismic, the design must be performed in accordance with ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Modifications to ACI 318-14 17.2.3 shall be applied under Section 1905.1.8 of the 2018 and 2015 IBC. For the 2012 IBC, Section 1905.1.9 shall be omitted. Modifications to ACI 318-08 D.3.3 shall be applied under Section 1908.1.9 of the 2009 IBC.

The anchors comply with ACI 318-14 2.3 or ACI 318-11 D.1, as applicable, as brittle steel elements and must be designed in accordance with ACI 318-14 17.2.3.4, 17.2.3.5, 17.2.3.6 or 17.2.3.7; or ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6 or D.3.3.7; or ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6, as applicable. Strength reduction factors, ϕ, are given in Table 2 of this report. The Hilti HDI-P TZ anchors may be installed in regions designated as IBC Seismic Design Categories A through F.

4.1.8.2 Seismic Tension: The nominal steel strength and nominal concrete breakout strength for anchors in tension must be calculated in accordance with ACI 318-14 17.4.1 and 17.4.2 or ACI 318-11 D.5.1 and D.5.2, as applicable, as described in Sections 4.1.2 and 4.1.3 of this report. In accordance with ACI 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the appropriate pullout strength in tension for seismic loads, $N_{p,eq}$, described in Table 2 must be used in lieu of N_p, as applicable. The value of $N_{p,eq}$ may be adjusted by calculation for concrete strength in accordance with Eq-1 and Section 4.1.4 of this report.

4.1.8.3 Seismic Shear: The nominal concrete breakout strength and pryout strength in shear must be calculated in accordance with ACI 318-14 17.5.2 and 17.5.3 or ACI 318-11 D.6.2 and D.6.3, respectively, as applicable, as described in Sections 4.1.6 and 4.1.7 of this report. In accordance with ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, the appropriate value for nominal steel strength for seismic loads, $V_{sa,eq}$, described Table 2, must be used in lieu of V_{sa}.

4.1.9 Requirements for Interaction of Tensile and Shear Forces: For anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the design must be performed in accordance with ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

4.1.10 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318-14 17.7.1 and 17.7.3 or ACI 318-11 D.8.1 and D.8.3, respectively, as applicable, values of s_{min} and c_{min} as given in Table 1 of this report must be used. In lieu of ACI 318-14 17.7.5 or ACI 318-11 D.8.5, as applicable, minimum member thicknesses, h_{min}, as given in Table 1 of this report must be used.

4.1.11 Requirements for Critical Edge Distance: In applications where $c < c_{ac}$ and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated in accordance with ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, must be further multiplied by the factor $\Psi_{cp,N}$ as given by Eq-2:

$$\Psi_{cp,N} = \frac{c}{c_{ac}} \qquad \text{(Eq-2)}$$

whereby the factor $\Psi_{cp,N}$ need not be taken as less than $\frac{1.5\,h_{ef}}{c_{ac}}$. For all other cases, $\Psi_{cp,N}$ = 1.0. In lieu of using ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable, values of c_{ac} in Table 2 must be used.

4.1.12 Lightweight Concrete: For the use of anchors in lightweight concrete, the modification factor λ_a equal to 0.8λ is applied to all values of $\sqrt{f'_c}$ affecting N_n and V_n.

For ACI 318-14 (2018 and 2015 IBC), ACI 318-11 (2012 IBC) and ACI 318-08 (2009 IBC), λ shall be determined in accordance with the corresponding version of ACI 318.

4.2 Allowable Stress Design (ASD):

4.2.1 General: Design values for use with allowable stress design load combinations calculated in accordance with Section 1605.3 of the IBC, must be established as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \quad \text{(Eq-3)}$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha} \quad \text{(Eq-4)}$$

where:

$T_{allowable,ASD}$ = Allowable tension load (lbf or kN).

$V_{allowable,ASD}$ = Allowable shear load (lbf or kN).

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318-14 Chapter 17 and 2018 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Section 1908.1.9, and Section 4.1 of this report, as applicable (lbf or N).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter 17 and 2018 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Section 1908.1.9, and Section 4.1 of this report, as applicable (lbf or N).

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for nonductile failure modes and required over-strength.

The requirements for member thickness, edge distance and spacing, described in Table 1, must apply.

4.2.2 Interaction of Tensile and Shear Forces: The interaction must be calculated and consistent with ACI 318-14 17.6 or ACI 318-11 D.7, as applicable, as follows:

For shear loads $V \leq 0.2V_{allowable,ASD}$, the full allowable load in tension $T_{allowable,ASD}$, must be permitted.

For tension loads $T \leq 0.2T_{allowable,ASD}$, the full allowable load in shear $V_{allowable,ASD}$, must be permitted.

For all other cases:

$$\frac{T_{applied}}{T_{allowable,ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \leq 1.2 \quad \text{(Eq-5)}$$

4.3 Installation:

Installation parameters are provided in Table 1 and Figures 1 and 3. Anchor locations must comply with this report and plans and specifications approved by the code official. The Hilti HDI-P TZ must be installed in accordance with manufacturer's published instructions and this report. In case of conflict, this report governs. Anchors must be installed in holes drilled into the concrete using carbide-tipped masonry drill bits complying with ANSI B212.15-1994 or with a Hilti HDI-P TZ stop drill bit. The minimum drilled hole depth, h_0, is given in Table 1. The HDI-P TZ is inserted into the predrilled hole and the setting plug is engaged into the anchor body using the manual HDI-P TZ setting tool and a hammer, or the automatic HDI-P TZ setting tool and a hammer drill. The setting plug must be driven until the shoulder of the HDI-P TZ setting tool is flush with the surface of the HDI-P TZ body. The minimum thread engagement of a threaded rod or bolt insert element assembly into the HDI-P TZ anchor must be the full internally threaded length of the anchor, however there is no specified installation torque required to set the anchor.

4.4 Special Inspection:

Periodic special inspection is required in accordance with Section 1705.1.1 and Table 1705.3 of the 2018, 2015 and 2012 IBC; or Section 1704.15 and Table 1704.4 of the 2009 IBC, as applicable. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, anchor spacing, edge distances, concrete member thickness, hole dimensions, anchor embedment and adherence to the manufacturer's printed installation instructions. The special inspector must be present as often as required in accordance with the "statement of special inspection." Under the IBC, additional requirements as set forth in Sections 1705, 1706 and 1707 must be observed, where applicable.

5.0 CONDITIONS OF USE

The Hilti HDI-P TZ anchors described in this report comply with or are suitable alternatives to what is specified in the codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Anchor sizes, dimensions, minimum embedment depths and other installation parameters are as set forth in this report.

5.2 The anchors must be installed in accordance with the manufacturer's published instructions and this report. In case of conflict, this report governs.

5.3 The anchors are limited to installation in the formed surface of cracked and uncracked normal-weight concrete and lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

5.4 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa).

5.5 The concrete shall have attained its minimum design strength prior to installation of the anchors.

5.6 Strength design values must be established in accordance with Section 4.1 of this report.

5.7 Allowable design values are established in accordance with Section 4.2 of this report.

5.8 Anchor spacing and edge distance as well as minimum member thickness must comply with Table1 and Figure 1 of this report.

5.9 Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.10 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of expansion anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.

5.11 Anchors may be installed in regions of concrete where cracking has occurred or where analysis indicates cracking may occur ($f_t > f_r$), subject to the conditions of this report.

5.12 Anchors may be used to resist short-term loading due to wind or seismic forces in locations designated as Seismic Design Categories A through F of the IBC, subject to the conditions of this report.

5.13 Where not otherwise prohibited in the code, anchors are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.
- Anchors are used to support nonstructural elements.

5.14 Use of carbon steel anchors is limited to dry, interior locations.

5.15 Use of anchors is limited to supporting non-structural components.

5.16 Anchors are manufactured under an approved quality-control program with inspections by ICC-ES.

5.17 Special inspection must be provided in accordance with Section 4.4.

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated October 2017, which incorporates requirements in ACI 355.2-07 for use in cracked and uncracked concrete.

6.2 Quality-control documentation.

7.0 IDENTIFICATION

7.1 The anchors are identified by packaging labeled with the company name (Hilti, Inc.) and contact information, anchor name, anchor size, and evaluation report number (ESR-4236).

7.2 The report holder's contact information is as follows:

HILTI, INC.
7250 DALLAS PARKWAY, SUITE 1000
PLANO, TEXAS 75024
(800) 879-8000
www.us.hilti.com
HiltiTechEng@us.hilti.com

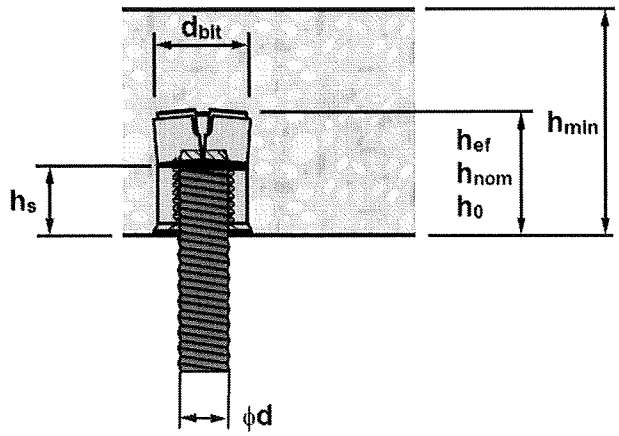


FIGURE 1—HILTI HDI-P TZ INSTALLATION PARAMETERS

TABLE 1—HILTI HDI-P TZ SETTING INFORMATION

Setting information	Symbol	Units	Nominal anchor size / internal thread diameter (in)
			$^3/_8$
Internal thread diameter	d	in.	$^3/_8$
Nominal bit diameter	d_{bit}	in.	$^9/_{16}$
Nominal embedment	h_{nom}	in. (mm)	$^3/_4$ (19)
Hole depth in concrete	h_0	in. (mm)	$^3/_4$ (19)
Effective embedment	h_{ef}	in. (mm)	$^3/_4$ (19)
Minimum concrete thickness	h_{min}	in. (mm)	2 ½ (64)
Thread engagement length	h_s	in. (mm)	$^3/_8$ (10)
Minimum edge distance	c_{min}	in. (mm)	6 (152)
Maximum installation torque for threaded element	T_{max}	ft-lb (Nm)	5 (7)
Minimum anchor spacing	s_{min}	in. (mm)	8 (203)

For **SI:** 1 inch = 25.4 mm, 1 ft-lb = 1.356 Nm

TABLE 2—DESIGN INFORMATION, HILTI HDI-P TZ

Setting information		Symbol	Units	Nominal anchor size / internal thread diameter (in)
				$^3/_8$
Anchor O.D.		d_a	in. (mm)	0.561 (14.25)
Effective embedment		h_{ef}	in. (mm)	$^3/_4$ (19)
Strength reduction factor for steel in tension [1]		$\phi_{sa,N}$	-	0.65
Min. specified yield strength		f_{ya}	psi (N/mm^2)	70,400 (484)
Min. specified ult. strength		f_{uta}	psi (N/mm^2)	88,000 (605)
Effective-cross sectional steel area in tension		$A_{se,N}$	in^2 (mm^2)	0.071 (45.8)
Nominal steel strength in tension		N_{sa}	lb (kN)	6,250 (27.8)
Anchor category		-	-	1
Strength reduction factor for concrete failure in tension [2]		$\phi_{c,N}$	-	0.40
Effectiveness factor for uncracked concrete		k_{uncr}	in-lb (SI)	24 (10.0)
Effectiveness factor for cracked concrete		k_{cr}	in-lb (SI)	17 (7.1)
Modification factor for anchor resistance, tension, uncracked conc. [3]		$\psi_{c,N}$	-	1.0
Critical edge distance		c_{ac}	in. (mm)	6 $^1/_2$ (165)
Pullout strength in uncracked concrete [4]		$N_{p,uncr}$	lb (kN)	NA
Pullout strength in cracked concrete [4]		$N_{p,cr}$	lb (kN)	470 (2.1)
Pullout strength in cracked concrete, seismic [4]		$N_{p,eq}$	lb (kN)	465 (2.1)
Strength reduction factor for steel in shear [1]		$\phi_{sa,V}$	-	0.60
Nominal steel strength in shear		V_{sa}	lb (kN)	975 (4.3)
Nominal steel strength in shear, seismic		$V_{sa,eq}$	lb (kN)	975 (4.3)
Strength reduction factor for concrete breakout failure in shear [2]		$\phi_{c,V}$	-	0.45
Effectiveness factor for pryout		k_{cp}	-	1.0
Mean axial stiffness [5]	Uncracked concrete	β_{uncr}	lbf/in.	164,365
	Cracked concrete	β_{cr}	lbf/in.	48,895

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 N/mm^2.

[1] The HDI-P TZ is considered a brittle steel element as as defined by ACI 318-14 2.3 or ACI 318-11 D.1, as applicable.

[2] All values of ϕ are applicable with the load combinations of IBC Section 1605.2, ACI 318-14 section 5.3, or ACI 318-11 Section 9.2. For concrete failure modes, no increase for ACI 318-14 17.3.3 or ACI 318-11 D.4.3 Condition A is permitted.

[3] For all design cases, $\psi_{c,N}$ = 1.0. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) must be used.

[4] For all design cases, $\psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,500 psi (17.2 MPa). Pullout strength for concrete compressive strength greater than 2,500 psi (17.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}500)^{0.35}$ for psi or $(f'_c / 17.2)^{0.35}$ for MPa. NA (not applicable) denotes that pullout strength does not need to be considered for design.

[5] Mean values shown. Actual stiffness varies considerably depending on concrete strength, loading, and geometry of application.

TABLE 3—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON CARBON STEEL THREADED ROD ELEMENTS

Threaded rod specification	Units	Min. specified ultimate strength f_{uta}	Min. specified yield strength, 0.2 percent offset, f_{ya}	f_{uta} / f_{ya}	Elongation, min. percent	Reduction of area, min. percent	Specification for nuts [2]
Carbon steel: ASTM A36 / A36M [1]	psi (MPa)	58,000 (400)	36,000 (248)	1.61	23	40	ASTM A194 or ASTM A563

For **SI:** 1 inch = 25.4 mm, 1 psi = 0.006895 N/mm^2.

[1] *Standard Specification for Carbon Structural Steel.*
[2] Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable.

TABLE 4—STEEL DESIGN INFORMATION FOR THREADED ELEMENTS USED WITH HDI-P TZ ANCHORS [1,2,3]

Setting information	Symbol	Units	Nominal anchor size / internal thread diameter (in)
			3/8
Nominal rod diameter	d_{rod}	in. (mm)	0.375 (9.5)
Rod effective cross-sectional area	$A_{se,rod}$	in^2 (mm^2)	0.0775 (50)
Strength reduction factor for steel in tension, ASTM A36 steel material [4]	$\phi_{sa,rod,N}$	-	0.75
Nominal steel strength in tension ASTM A36 steel material	$N_{sa,rod}$	lb (kN)	4,495 (20.0)
Nominal steel strength in tension, seismic ASTM A36 steel material	$N_{sa,rod,eq}$	lb (kN)	4,495 (20.0)
Strength reduction factor for steel in shear, ASTM A36 steel material [4]	$\phi_{sa,rod,V}$	-	0.65
Nominal steel strength in shear ASTM A36 steel material	$V_{sa,rod}$	lb (kN)	2,695 (12.0)
Nominal steel strength in shear, seismic ASTM A36 steel material	$V_{sa,rod,eq}$	lb (kN)	1,885 (8.4)

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 N/mm^2.

[1] Values provided for steel element material types, or equivalent, based on minimum specified strengths and calculated in accordance with ACI 318-14 Eq. (17.4.1.2) and Eq. (17.5.1.2b); or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. $V_{sa,eq,rod}$ must be taken as $0.7V_{sa,rod}$.
[2] ϕN_{sa} shall be the lower of $\phi N_{sa,rod}$ or ϕN_{sa} for static steel strength in tension; for seismic loading, $\phi N_{sa,eq}$ shall be the lower of $\phi N_{sa,rod,eq}$ or $\phi N_{sa,eq}$.
[3] ϕV_{sa} shall be the lower of $\phi V_{sa,rod}$ or ϕV_{sa} for static steel strength in tension; for seismic loading, $\phi V_{sa,eq}$ shall be the lower of $\phi V_{sa,rod,eq}$ or $\phi V_{sa,eq}$.
[4] All values of ϕ are applicable with the load combinations of IBC Section 1605.2, ACI 318-14 Section 5.3, or ACI 318-11 Section 9.2. Values correspond to a ductile steel element.

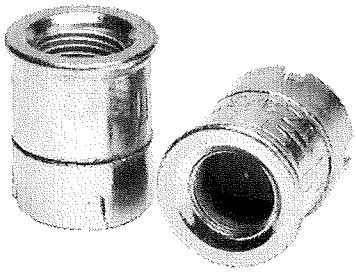
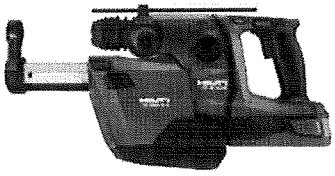
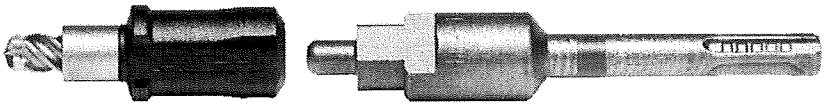
Hilti HDI-P TZ anchor	
Optional Dust Removal (DRS) module for drilling for use with Hilti hammer drills	
Hilti HDI-P TZ stop drill bit with automatic setting tool combination for use with hammer drill	
Hilti HDI-P TZ manual setting tool for use with hammer	

FIGURE 2—HILTI HDI-P TZ ANCHOR AND HDI-P TZ DRILLING AND SETTING TOOLS

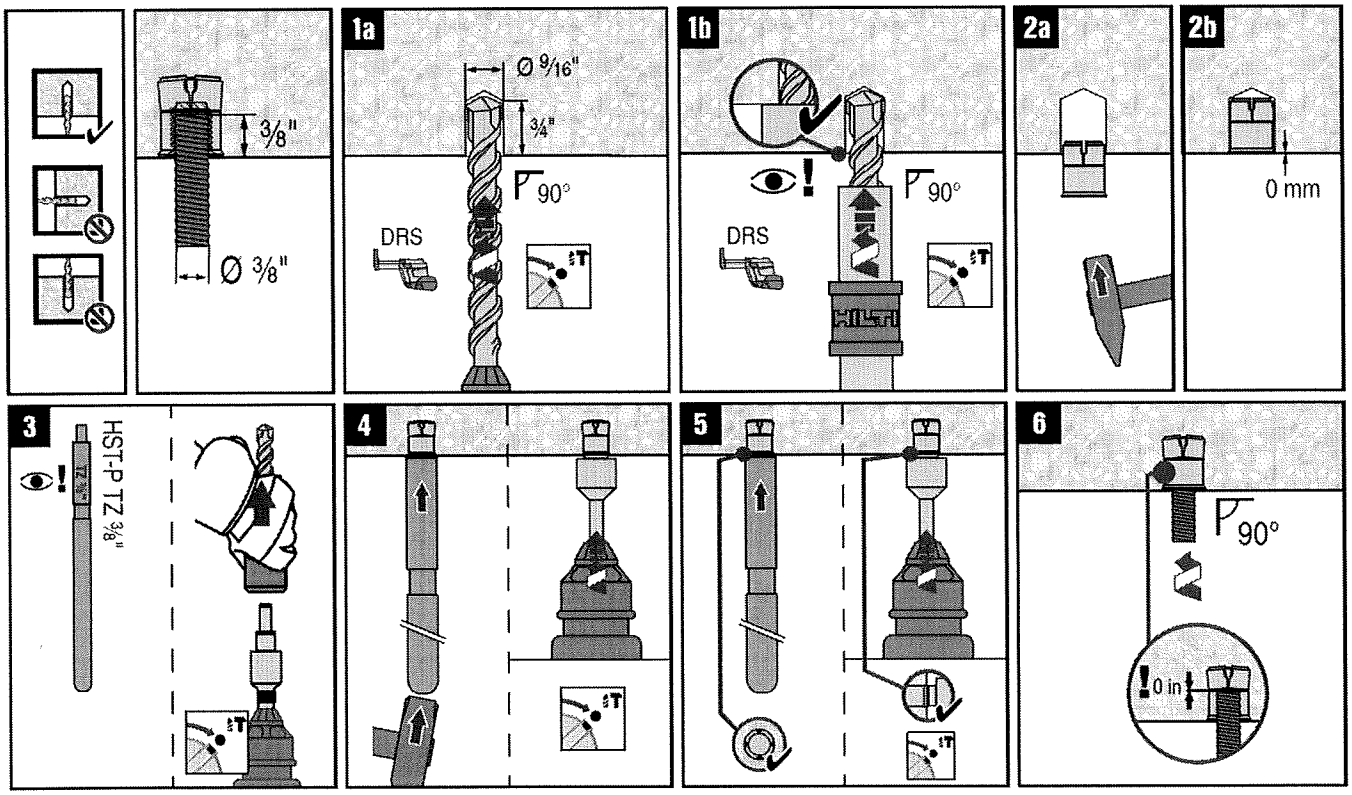


FIGURE 3—INSTALLATION INSTRUCTIONS

seattle textile COMPANY
3434 2ND AVENUE SOUTH SEATTLE, WA 98134
(206) 233-0595 FAX (206) 233-0536
e-mail: sales@seatex.com

61" F/R 18oz VINYL TEX

PVC Coated Polyester
STC Item #: VI-ST18-061-XXM

- SPECIFICATIONS -

Width	61 inches
Base Fabric (100% Polyester)	1000D x 1300D / 18 x 17
Weight (FS-191-5041)	18 oz / yard²
Tensile Strength (Grab) (FS-191-5100)	410 lbs x 410 lbs
Tensile Strength (Strip) (FS-191-5102)	300 lbs x 300 lbs
Tear Strength (Tongue) (FS-191-5134)	100 lbs x 100 lbs
Adhesion Strength (FS-191-5970)	12 x 10 lbs / inch
Abrasion Resistance (FS-191-5306)	400 cycles
Hydrostatic Resistance (FS-191-5512)	At least 600 lbs / inch²
U.V. Resistance (Weather-O-Meter)	Not excessive fading after 300 HRS
Cold Crack Resistance (FS-191-5874)	-40° F
High Temperature Resistance (FS-191-5872)	180° F (Does not Block)
Flame Resistance	NFPA 701 Large & Small Scale - PASS
Special Treatment(s)	U.V. Inhibitors