LEGACY REPORT

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ICC Evaluation Service, Inc.
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Business/Regional Office ■ 5360 Workman Mill Road, Whittier, California 90601 ■ (562) 699-0543
Regional Office ■ 900 Montclair Road, Suite A, Birmingham, Alabama 35213 ■ (205) 599-9800
Regional Office ■ 4051 West Flossmoor Road, Country Club Hills, Illinois 60478 ■ (708) 799-2305

Legacy report on the 1997 *Uniform Building Code*™

DIVISION: 03—CONCRETE
Section: 03151—Concrete Anchoring

HILTI HDA METRIC SELF-UNDERCUTTING CONCRETE ANCHORS

HILTI, INC.
5400 SOUTH 122ND EAST AVENUE
TULSA, OKLAHOMA 74146

1.0 SUBJECT

Hilti HDA Metric Self-undercutting Concrete Anchors.

2.0 DESCRIPTION

2.1 General:

The HDA is a self-undercutting-type concrete anchor. The anchor is available in pre-set (HDA-P) and through-set (HDA-T) configurations and is fabricated from carbon steel. Figures 1 and 2 illustrate available configurations. All carbon steel parts are electroplated with a 5µm-thick zinc coating in accordance with DIN 50961. Both configurations include a cone bolt, sleeve, washer and hex nut. Specifications for the anchors are provided in Table 1.

2.2 Components:

2.2.1 Cone Bolt: Produced from carbon steel conforming to DIN 931, Grade 8.8, the cone bolt is cold-formed with rolled threads on one end and a cone on the other end. Within the threaded part of the bolt there is a small area without thread. This area without thread carries the setting mark (expansion control) of the anchor rod. The rod end is covered by a plastic cap to protect the thread during the setting process. On the tip of the rod, above the bolt end, a code letter is stamped, which permits establishing the total embedded length of the anchor, as described in Table 1.

2.2.2 Expansion Sleeve: The sleeve is machined carbon steel conforming to AISI 4130. The expansion area of the sleeve is subdivided into six sections by means of longitudinal slots. Two of these expansion sections have brazed tungsten carbide tips for undercutting. In the joint where the expansion sections transition to the body of the sleeve, there is a retention ring of plastic.

2.2.3 Washer: The washer is formed from carbon steel conforming to DIN 6796.

2.2.4 Hex Nut: The hex nut is formed from carbon steel conforming to DIN 934, Grade 8.

2.2.5 Concrete: Normal-weight concrete must conform to Sections 1903 and 1905 of the 1997 *Uniform Building Code*™ (UBC), with compressive strength in compliance with this report at the time of anchor installation.

2.3 Design:

2.3.1 Service Loads: Allowable service (allowable stress design) static shear and tension loads are described in Tables 3 and 4.

Service loads for anchors subjected to combined shear and tension forces are determined by the following equation:

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

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.

For anchors installed at edge distances less than critical edge distance, c_{cr}, and/or anchor spacing less than critical spacing, s_{cr}, the load capacity is reduced in accordance with reduction factors in Table 2.

2.3.2 Strength Design: Strength design static shear and tension loads are determined in accordance with Sections 1923.2, 1923.3.2, 1923.3.3 and 1923.4 of the UBC. For the purposes of design, A_b in Section 1923.3.2 of the UBC shall be taken as A_t in Table 1, and f_{ut} in Section 1923.3.2 of the UBC shall be taken as $f_{u,b}$ in Table 1. The limiting deflections used to determine the ultimate load in shear or tension are as follows:

M10: 0.39 inch (10 mm)

M12: 0.47 inch (12 mm)

M16: 0.63 inch (16 mm)

The design steel strength of the HDA-T in shear [pounds (N)] shall be calculated as follows:

$$V_{ss} = 0.60\, A_t\, f_{u,b} + 0.40\, A_{sl}\, f_{u,sl}$$

where:

t = Area of bolt as given in Table 1 (in^2/mm^2).

$f_{u,b}$ = Ultimate tensile strength of the bolt as given in Table 1 (psi/MPa).

A_{sl} = Cross-sectional area of the sleeve as given in Table 1 (in^2/mm^2).

$f_{u,sl}$ = Ultimate tensile strength of the sleeve as given in Table 1 (psi/MPa).

2.4 Installation:

Installation details for the HDA pre-set and through-set anchors are described in Tables 1 and 2 and in Figures 3, 4, 5 and 6. Stepped drill bits are supplied by Hilti, Inc., and are described in Table 1.

2.5 Special Inspection:

Where special inspection is required, compliance with Section 1701.5.2 of the UBC is necessary. The special inspector shall verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, anchor spacing, edge distances, slab thickness, anchor embedment and anchor installation procedures (including the undercutting process and position of red setting mark).

2.6 Identification:

The label on packages of anchors includes the manufacturer's name (Hilti, Inc.) and address, the anchor name, the anchor size, the evaluation report number (ER-5608), and the name of the quality control agency (Underwriters Laboratories Inc.). Each anchor has the letters HDA-P or HDA-T, the anchor rod size, and the maximum fastened thickness embossed on the sleeve. As described in Section 2.2.1, on the tip of the rod, above the bolt end, a code letter is stamped, which permits establishing the total length of the anchor set in concrete.

3.0 EVIDENCE SUBMITTED

Reports of tension, shear and seismic load tests and mechanical properties tests; calculations; and quality control manual.

4.0 FINDINGS

That the Hilti HDA anchor system described in this report complies with the 1997 *Uniform Building Code*™ (UBC), subject to the following conditions:

4.1 Anchor sizes, dimensions and minimum embedment depths are as set forth in the tables of this report.

4.2 Loads applied to the anchors are adjusted in accordance with Sections 1909.2 and 1923.2 of the code for strength design and 1612.3 of the UBC for service design.

4.3 The anchors are installed in accordance with the manufacturer's instructions and this report.

4.4 Prior to installation, calculations and details demonstrating compliance with this report shall be submitted to the local building official for approval.

4.5 Design loads are as set forth in Section 2.3 of this report.

4.6 Special inspection is provided in accordance with Section 2.5 of this report.

4.7 Fire-resistive construction: Anchors are not permitted for use in conjunction with fire-resistive construction. Exceptions would be:

- **Anchors resist wind or seismic loading only.**
- **For other than wind or seismic loading, special consideration is given to fire exposure conditions.**

4.8 Fatigue and shock loading: 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 these conditions is beyond the scope of this report.

4.9 Cracked concrete or masonry: Since an ICC-ES acceptance criteria for evaluating the performance of anchors in cracked concrete or masonry is unavailable at this time, the use of anchors is limited to installation in uncracked concrete or masonry. Cracking occurs when $f_t > f_r$ due to service loads or deformations.

4.10 Use of the anchors is limited to dry, interior exposure.

4.11 Use of anchors in resisting earthquake or wind loads is permitted within the scope of this report. Section 4.2 references adjustments to the applied loads.

4.12 HDA self-undercutting anchors are manufactured by Hilti at their facilities in Schaan, Liechtenstein, with quality control inspections by Underwriters Laboratories Inc. (AA-637).

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

TABLE 1—SPECIFICATION TABLE

ANCHOR SIZE	HDA-T/HDA-P	M10 × 100/20	M12 × 125/30	M12 × 125/50	M16 × 190/40	M16 × 190/60
Stop drill bit for HDA-T		TEC-HDA-B 20 × 120	TEC-HDA-B 22 × 155	TEC-HDA-B 22 × 175	TEY-HDA-B 30 × 230	TEY-HDA-B 30 × 250
Stop drill bit for HDA-P		TEC-HDA-B 20 × 120	TEC-HDA-B 22 × 125	TEC-HDA-B 22 × 125	TEY-HDA-B 30 × 190	TEY-HDA-B 30 × 190
Setting tool		TEC-HDA-ST 20-M10	TEC-HDA-ST 22-M12	TEC-HDA-ST 22-M12	TEY-HDA-ST 30-M16	TEY-HDA-ST 30-M16
h: Thickness of base material, min.[1]	mm (in.)	150 (6)	188 ($7^3/_8$)	188 ($7^3/_8$)	285 ($11^1/_4$)	285 ($11^1/_4$)
ℓ: Total anchor length	mm (in.)	150 (5.90)	190 (7.48)	210 (8.27)	275 (10.83)	295 (11.61)
Length I.D. code[2]	letter	I	L	N	R	S
t_{fix}: Fastening thickness						
HDA-T, min.[3]	mm (in.)	10 (0.39)	10 (0.39)	10 (0.39)	15 (0.59)	15 (0.59)
HDA-T, max.	mm (in.)	20 (0.79)	30 (1.18)	50 (1.97)	40 (1.58)	60 (2.36)
HDA-P, max.	mm (in.)	20 (0.79)	30 (1.18)	50 (1.97)	40 (1.58)	60 (2.36)
d_{bit}: Nom. dia. of drill bit[4]	mm (in.)	20 (0.787)	22 (0.866)	22 (0.866)	30 (1.181)	30 (1.181)
h_1: Min. depth of drill hole	mm (in.)	107 (4.21)	134.5 (5.30)	134.5 (5.30)	203 (7.99)	203 (7.99)
h_{ef}: Effective anchoring depth	mm (in.)	100 (3.94)	125 (4.92)	125 (4.92)	190 (7.48)	190 (7.48)

TABLE 1—SPECIFICATION TABLE (Continued)

ANCHOR SIZE	HDA-T/HDA-P	M10 × 100/20	M12 × 125/30	M12 × 125/50	M16 × 190/40	M16 × 190/60
d_h: Recommended clearance hole (min.)						
HDA-T	mm (in.)	21 ($^{13}/_{16}$)	23 ($^{3}/_{4}$)	23 ($^{3}/_{4}$)	32 ($1^{1}/_{4}$)	32 ($1^{1}/_{4}$)
HDA-P	mm (in.)	12 ($^{1}/_{2}$)	14 ($^{9}/_{16}$)	14 ($^{9}/_{16}$)	18 ($^{11}/_{16}$)	18 ($^{11}/_{16}$)
d_a: Anchor diameter						
HDA-T	mm (in.)	19 (0.748)	21 (0.827)	21 (0.827)	29 (1.142)	29 (1.142)
HDA-P	mm (in.)	10 (0.394)	12 (0.472)	12 (0.472)	16 (0.630)	16 (0.630)
d_w: Washer diameter	mm (in.)	27.5 (1.08)	33.5 (1.32)	33.5 (1.32)	45.5 (1.79)	45.5 (1.79)
S_w: Width across flats of the nut	mm (in.)	17 (0.669)	19 (0.748)	19 (0.748)	24 (0.945)	24 (0.945)
T_{max}: Max. tightening torque[5]	N-m (ft.-lb.)	50 (37)	80 (59)	80 (59)	120 (88)	120 (88)
Sleeve properties						
A_{sl}: Cross sectional area	mm^2 ($in.^2$)	196 (0.304)	223 (0.346)	223 (0.346)	445 (0.690)	445 (0.690)
S_{sl}: Elastic section modulus	mm^3 ($in.^3$)	596 (0.0364)	779 (0.0475)	779 (0.0475)	2110 (0.1288)	2110 (0.1288)
Bolt properties						
A_b: Bolt nominal area	mm^2 ($in.^2$)	78.5 (0.122)	113 (0.175)	113 (0.175)	201 (0.312)	201 (0.312)
A_t: Bolt tension area	mm^2 ($in.^2$)	58 (0.090)	84.3 (0.131)	84.3 (0.131)	157 (0.243)	157 (0.243)
S_b: Elastic section modulus	mm^2 ($in.^2$)	67 (0.0041)	117 (0.0071)	117 (0.0071)	293 (0.0179)	293 (0.0179)
A_{brg}: Undercut bearing area[6]	mm^2 ($in.^2$)	234.1 (0.363)	291.6 (0.452)	291.6 (0.452)	496.9 (0.770)	496.9 (0.770)
$f_{u,sl}$: Sleeve ultimate tensile strength	MPa (psi)	850 (123,250)	850 (123,250)	850 (123,250)	700 (101,500)	700 (101,500)
$f_{u,b}$: Bolt ultimate tensile strength	MPa (psi)	800 (116,000)	800 (116,000)	800 (116,000)	800 (116,000)	800 (116,000)

[1]Minimum concrete base material thickness as required to avoid splitting of concrete.
[2]Length code correlating to total anchor length, *l*.
[3]Minimum thickness of fastened part as required to ensure engagement of full sleeve cross section in shear.
[4]Metric drill bit supplied by Hilti must be used.
[5]Torque tightening of the anchor is not required for proper set. Torque tightening may reduce initial slip under load.
[6]Bearing area conforms to Section 1923.3.1 of the code.

HILTI RECOMMENDED HAMMER DRILLS FOR SETTING						
Anchor Size	HDA-T/HDA-P	M10 × 100/20	M12 × 125/30	M12 × 125/50	M16 × 190/40	M16 × 190/60
Drilling system for anchor setting		TE24, TE25 first gear			TE75 max. hammering power	
Single impact energy	Joules (ft.-lb.)	3.7 - 4.7 (2.7 - 3.5)			7.0 - 9.0 (5.2 - 6.6)	
Speed under load	rpm	250 - 500			150 - 350	

Setting Details

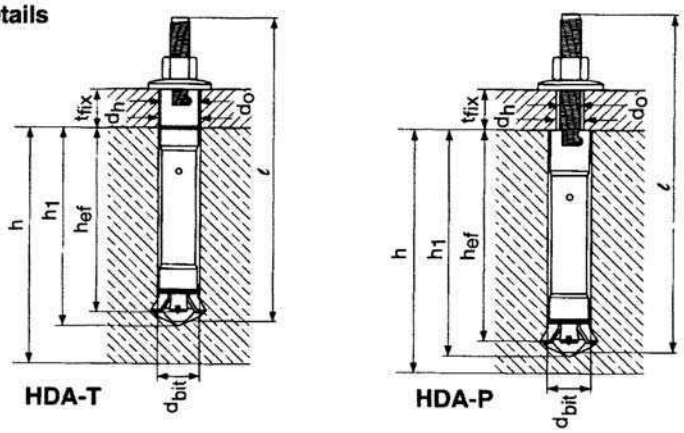

TABLE 2—HDA-P AND HDA-T ANCHOR SPACING AND EDGE DISTANCE GUIDELINES

GUIDELINE TYPE	LOAD CONDITION (Style)	CRITICAL (inches)			MINIMUM (inches)		
		M10	M12	M16	M10	M12	M16
Spacing (*S*)	Tension and shear	3.0 × h_{ef} = 11.81	3.0 × h_{ef} = 14.76	3.0 × h_{ef} = 22.44	1.0 × h_{ef} = 3.94	1.0 × h_{ef} = 4.92	1.0 × h_{ef} = 7.48
Edge (*C*)	Tension for HDA-P and HDA-T and shear for HDA-P	1.5 × h_{ef} = 5.91	1.5 × h_{ef} = 1.78	1.5 × h_{ef} = 11.22	0.8 × h_{ef} = 3.15	0.8 × h_{ef} = 3.94	0.8 × h_{ef} = 5.98
Edge (*C*)	Shear for HDA-T	2.0 × h_{ef} = 7.87	2.0 × h_{ef} 9.84	2.0 × h_{ef} = 14.95	0.8 × h_{ef} = 3.15	0.8 × h_{ef} = 3.94	0.8 × h_{ef} = 5.98

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

Notes:
1. When using minimum spacing and the load condition is either tension or shear, reduce the allowable service load by 13%.
2. When using minimum edge distance and the load condition is tension for HDA-P and HDA-T or shear for the HDA-P, reduce the allowable service load by 9%.
3. When using minimum edge distance and the load condition is shear for the HDA-T, reduce the allowable service load by 74%.

TABLE 3—HDA-P AND HDA-T METRIC ALLOWABLE SERVICE TENSION LOAD VALUES FOR NORMAL-WEIGHT CONCRETE (pounds)

ANCHOR SIZE (mm)	EMBEDMENT DEPTH (inches)	$f'_c \geq$ 2,500 psi		MAXIMUM DEFLECTION (inch)
		Special Inspection	Without Special Inspection	
M10	4	2,640	1,320	0.043
M12	5	3,988	1,994	0.052
M16	7.5	7,155	3,578	0.055

For **SI:** 1 inch = 25.4 mm, 1 psi = 6.895 × 10^{-3} MPa, 1 lbf = 4.45 N.

Notes:
1. The tabulated shear and tension loads are for anchors installed in structural normal-weight concrete having the tabulated ultimate compressive strength at the time of anchor installation.
2. Special inspection is provided in accordance with Section 2.5 of this report.
3. Minimum concrete thickness, *h*, must be in accordance with Table 1.

TABLE 4—HDA METRIC ALLOWABLE SERVICE SHEAR LOAD VALUES FOR NORMAL-WEIGHT CONCRETE (pounds)

ANCHOR SIZE (mm)	EMBEDMENT DEPTH (inches)	$f'_c \geq$ 2,500 psi		MAXIMUM DEFLECTION (inch)
		HDA-P	HDA-T	
M10	4	1,630	4,688	0.071
M12	5	2,378	5,113	0.071
M16	7.5	4,233	9,200	0.087

For **SI:** 1 inch = 25.4 mm, 1 psi = 6.895 × 10^{-3} MPa, 1 lbf = 4.45 N.

Notes:
1. The tabulated shear and tension loads are for anchors installed in normal-weight concrete having the tabulated ultimate compressive strength at the time of anchor installation.
2. Special inspection is provided in accordance with Section 2.5 of this report.
3. Minimum concrete thickness, *h*, must be in accordance with Table 1.

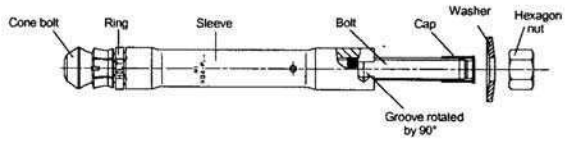

FIGURE 1—"PRE-SET"

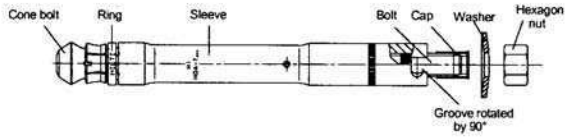

FIGURE 2—"THROUGH-SET"

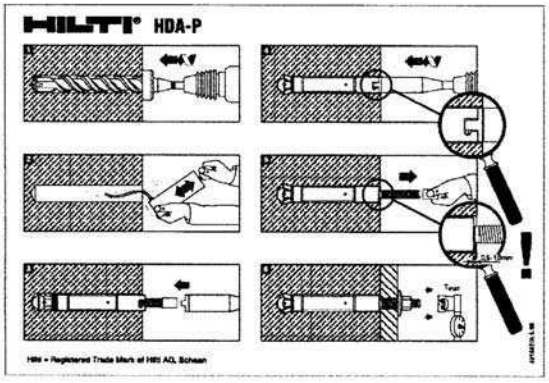

FIGURE 3—INSTALLATION INSTRUCTIONS FOR HDA-P

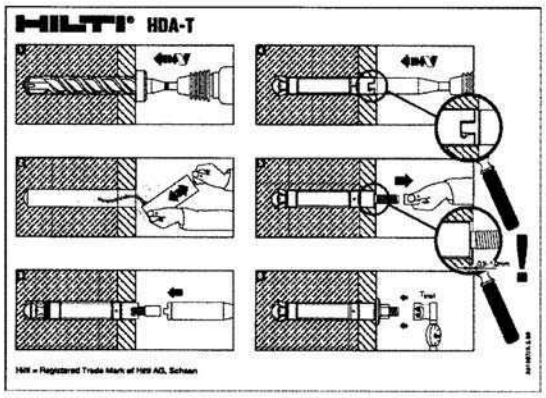

FIGURE 4—INSTALLATION INSTRUCTIONS FOR HDA-T

Description of the setting procedure for the HDA-P (pre-setting) and HDA-T (through-fastening) anchors.

Pictogram 1:
With a stop drill bit assigned to the anchor (tables 2 and 5), a hole with defined depth is produced.

Pictogram 2:
The hole has to be cleaned with a pump.

Pictogram 3:
The anchor is placed in the hole, so that the cone sits on the bottom of the bore hole. Then the setting tool assigned to the anchor (tables 2 and 6) is attached to the rotary hammer drill, which has been used for drilling the hole. The setting tool is guided over the anchor rod, so that the noses on the end of the setting tool catch the groove in the sleeve.

Pictogram 4:
The anchor is set rotating and hammering analogously to the drilling procedure. During the setting procedure, the sleeve shifts axially to the anchor rod and at the same time the undercut is made in the concrete. On the setting tool, there is a red ring as a first setting mark. This mark can give the user a clue, how far the setting procedure has progressed. If this marking is flush with the concrete surface for the pre-setting style and with the connected part for the through-fastening, the setting procedure should be finished soon.

Pictogram 5:
Mandatory for a correct setting procedure is the setting marking on the anchor rod. The anchor is set and the undercut is completely produced, as soon as the red setting marking on the anchor bolt is visible above the top edge of the sleeve.

Pictogram 6:
The part to be fastened is secured by tightening the torque.

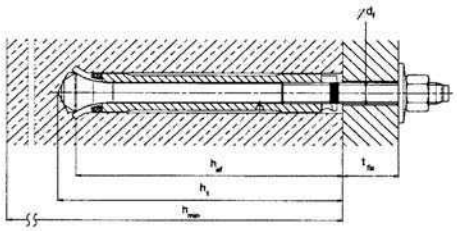

FIGURE 5—PRE-SETTING ANCHOR HDA-P (PREPOSITIONING)

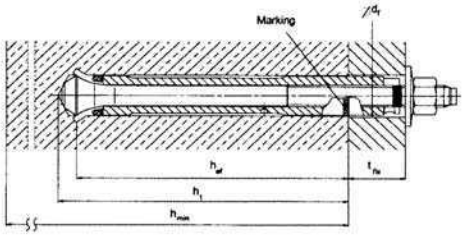

FIGURE 6—THROUGH-SETTING ANCHOR HDA-T (POSTPOSITIONING)