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Report on the Applicability of the
Hilti HDA-P and HDA-T
Post-Installed, Undercut
Mechanical Anchor for use in
Components and Structural Supports in
Nuclear Facilities

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PURPOSE AND SCOPE

The Hilti HDA Undercut Anchor is for use in cracked and uncracked concrete to resist static and seismic loads and is intended for use in normal weight and lightweight concrete. The anchor is available in carbon and stainless steel in two configurations: “preset” (HDA-P and HDA-PR) and “through-set” (HDA-T and HDA-TR). The two types are shown in Figures 1 and 2 presented on pages 13 and 15.

The HDA anchors were previously evaluated for fit and purpose in accordance with ACI 355.2-01 and ACI 349-01 by Richard. E. Wollmershauser, P.E., FACI in his document entitled *Report on Applicability of the Hilti HDA Undercut Anchor for use in Components and Structural Supports in Nuclear Facilities* (Report WC 12-01) dated May 23, 2012.

The purpose of this present document is to evaluate the qualification testing performed on the HDA mechanical anchor system for compliance to the applicable requirements of the United States Nuclear Regulatory Commission as outlined in their USNRC Regulatory Guide, which is based on ACI 349-13.

REFERENCE DOCUMENTS:

- [1] Regulatory Guide 1.199 Revision 1, April 2020, *Anchoring Components and Structural Supports in Concrete*; U.S. Nuclear Regulatory Commission, Washington, D.C.
- [2] Regulatory Guide 1.199, November 2003, *Anchoring Components and Structural Supports in Concrete*; U.S. Nuclear Regulatory Commission, Washington, D.C.
- [3] *Code Requirements for Nuclear Safety Related Concrete Structures*, ACI 349-01; American Concrete Institute (ACI), Farmington Hills, MI.
- [4] *Code Requirements for Nuclear Safety Related Concrete Structures*, ACI 349-13; American Concrete Institute (ACI), Farmington Hills, MI.
- [5] *Evaluating the Performance of Post-Installed Mechanical Anchors in Concrete*, ACI 355.2-01; American Concrete Institute (ACI), Farmington Hills, MI.
- [6] *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary*, ACI 355.2-07; American Concrete Institute (ACI), Farmington Hills, MI.
- [7] *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary*, ACI 355.2-19; American Concrete Institute (ACI), Farmington Hills, MI.

- [8] *Acceptance Criteria for Mechanical Anchors in Concrete Elements*, AC193, Approved October 2017, Editorially Revised April 2018; ICC Evaluation Service, LLC, Brea, CA.
- [9] European Organization for Technical Approvals (EOTA) ETAG 001 (Edition 1997) *Guideline for European Technical Approval of Metal Anchors For Use in Concrete* (together with applicable Annex documents).
- [10] ISO / IEC 17025; *General Requirements for the Competence of Testing and Calibration Laboratories*; International Standards Organization; November 2017 (Corrected March 2018).
- [11] ASTM E488/E488M-15 *Standard Test Methods for Strength of Anchors in Concrete Elements*; ASTM International, West Conshohocken, PA.
- [12] *Evaluation Report on Evaluating the Performance of Post Installed Undercut Anchors Hilti HDA M10, M12, M16 and M20 in concrete in accordance with AC193 and ACI 355.2*, issued by Prof. Dr.-Ing R. Elighausen, Institut für Werkstoffe Im Bauwesen, Universät Stuttgart, Pfaffenwaldring 4. D-70550 Stuttgart, 23 December 2003
- [13] *Supplement 1 to the Evaluation Report on Evaluating the Performance of Post Installed Undercut Anchors Hilti HDA M10, M12, M16 and M20 in concrete in accordance with AC193 and ACI 355.2*, issued by Prof. Dr.-Ing R. Elighausen, Institut für Werkstoffe Im Bauwesen, Universät Stuttgart, Pfaffenwaldring 4. D-70550 Stuttgart, 23 December 2003
- [14] ICC Evaluation Report ESR-1546, Hilti HDA Carbon Steel and Stainless Steel Undercut Anchors for Cracked and Uncracked Concrete, current version re-issued March 2026, ICC Evaluation Service, LLC, Brea, CA.
- [15] *Report on Applicability of the Hilti HDA Undercut Anchor for use in Components and Structural Supports in Nuclear Facilities*, Report WC12-01, Issued March 23, 2012, Richard E. Wollmershauser Consulting.
- [16] Letter dated January 23, 2012 from Standard Testing and Engineering Company to ICC Evaluation Service, Inc. with attached Hilti Test Report No. 55-11 dated January 4, 2012 that includes documents pertaining to ductility testing of HDA and HSL-3 anchors.
- [17] *Building Code Requirements for Structural Concrete and Commentary*, ACI 318-08; American Concrete Institute (ACI), Farmington Hills, MI.
- [18] *Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets*, ASTM F606, ASTM International, West Conshohocken, PA.
- [19] Hilti Metric HDA Carbon Steel Undercut Anchor, Atlast Report No. 25H549 Rev 1, January 20, 2026 Rev. 1 March 26, 2026, Atlas Consulting Group, Oakland, CA.

PRODUCT QUALIFICATION SUMMARY

Hilti arranged testing with Prof. Dr.-Ing Rolf Eligehausen of the Institut für Werkstoffe Im Bauwesen, University of Stuttgart in Stuttgart, Germany to manage the testing of the HDA anchors as the Independent Test and Evaluation Agency (ITEA) in May 2002. Some of the tests were performed by Institut für Werkstoffe Im Bauwesen and some tests were subcontracted to several other testing laboratories (all in Europe). The evaluation report [12] lists the test reports included in the evaluation, which come from several test laboratories, all in Europe.

Dr.-Ing Eligehausen was a distinguished professor at the University of Stuttgart (now retired) who conducted and directed numerous research projects on the testing and design of post-installed anchor systems and has contributed substantially to the development of ACI 355.2 from the beginning, as well as related anchor test standards in the United States and Europe. He is not a registered or licensed engineer as it is typically defined in the United States because there is no formal engineering registration system in Europe. However, in Europe, licensing of structural engineers is accomplished through accredited educational institutions. Dr.-Ing. Eligehausen's experience in the technology of fastening to concrete is substantial, with more than twenty-five years of experience conducting evaluation and approval of anchors in Europe. He has many more years of experience in research, testing, evaluation, and approval of anchors in Europe under the EOTA (European Organization for Technical Approvals (<http://www.eota.be>)) guidelines. He participated in the development of the criteria for qualification of anchor systems both in Europe and the United States. His recognized expertise and knowledge of anchor test and design is perhaps unparalleled in the anchor industry. Some of his work is referenced in ACI 349, ACI 355.2 and ACI 318.

The credentials of the contributing laboratories are discussed by Dr. Eligehausen in Section 4 of his Evaluation Report. As organizations accredited under ISO/IEC 17025 [10], the testing organizations are deemed valid and satisfactory, and the test data they reported is accepted.

In some cases, the tests originally performed were conducted according to ETAG 001 instead of ACI 355.2. This was particularly true of tests conducted prior to year 2000 before ACI 355.2 was published. In these cases, the test identification is based on ETAG 001 [9]. However, it is easy to correlate the ETAG 001 tests to the ACI 355.2 tests [5] (i.e., ETAG A1 to A4 correlate to Test Series 1 to 4 of ACI 355.2, and so on). The test procedures for the various tests defined under ETAG 001 are identical or equivalent to the pertinent test procedures defined in ACI 355.2 [5, 6, 7], since the ACI 355 documents were largely modelled after the ETAG requirements. The tests in ETAG001 correspond to the ACI 355 tests as shown in Table 1 (next page). The differences between the ETAG001 and ACI 355.2 tests are minor and of no concern.

The evaluation prepared by Dr.-Ing Eligehausen was the basis for the issuance of ESR-1546, *Hilti HDA Carbon Steel and Stainless-Steel Undercut Anchors for Cracked and Uncracked Concrete* [14] indicating the HDA anchors were suitable and acceptable for use according to the provisions of the International Building Code.

NUCLEAR REGULATORY REQUIREMENTS

For anchors used in facilities under the purview of the U.S. Nuclear Regulatory Commission (USNRC), the requirements outlined in Regulatory Guide 1.199 [1,2] must be satisfied, and it adopts the requirements of ACI 349 as the design basis for anchorage to concrete as the basis for anchor design. The current version of Regulatory Guide 1.199 (2020 [1], superseding the previous 2003 [2] version) adopts ACI 349-13 Appendix D [4]; along with ACI 355.2-07 [6] and ASTM E488/E488M [11]. The previous requirement referenced ACI 349-01 [3] Appendix B, ACI 355.2-01 [5] and ASTM E488-96 documents.

QUALIFICATION TESTING

As mentioned in the above, Regulatory Guide 1.199 adopts the requirements of ACI 349-13 [4], ACI 355.2-07 [6] and ASTM E488/E488-M [11]. Appendix D of ACI 349-13 pertains to the design of anchorage to concrete, and Section D.3.3 pertains to post-installed structural anchors. Section RD3.3 (commentary) indicates that post-installed anchors qualified to ACI 355.2 as Category 1 for use in cracked concrete are considered acceptable for use in nuclear power plants, applicable to normal weight concrete (Section D3.4) limited to a maximum of 8,000 psi strength (Section D.3.5). Note ACI 349-01 [3] and ACI 349-13 [4] do not explicitly refer to anchor categories. Also, according to Section RD3.3 of ACI 349, an anchor that has passed the simulated earthquake tests should function under impactive tensile loading in cracked concrete.

As mentioned above, some tests were conducted under the provisions of ETAG. Table 1, below, presents the correlation of the pertinent ETAG tests to the tests required under ACI 355.2-07 [6] Table 4.2.

Table 1: ETAG Test A1 Comparison to ACI 355.2-07 Table 4.2

ETAG001 Table Reference	Test Series	ACI 355.2 Table 4.2 Test Series	Test Type	Concrete Strength	Crack Width (mm)	Drill Bit
5.4	A1	1	Characteristic Strength	Low	-	d _m
5.4	A2	2	Characteristic Strength	High	-	d _m
5.4	A3	3	Characteristic Strength	Low	0.3	d _m
5.4	A4	4	Characteristic Strength	High	0.3	d _m
5.2	F1	5	Installation Safety	Low	0.3	d _m
5.2	F3	6	Function in Low Strength	Low	0.5	d _{max}
5.2	F4	7	Function in High Strength	High	0.5	d _{min}
5.2	F5	8	Crack-width Cycling	Low	0.1 - 0.3	d _{max}
5.4	A14	9	Critical Edge	Low	-	d _m
5.4	A20	10	Minimum Edge/Spacing	Low	-	d _m
5.4	A15	11	Shear	Low	-	d _m
Note 1	C1.1	12	Seismic Tension	Low	0.5	d _m
Note 1	C1.2	13	Seismic Shear	Low	0.5	d _m

Notes:

1. ETAG 001, 1997 Edition, "Guideline for European Technical Approval of Metal Anchors for Use in Concrete"
2. ETAG 001 Annex A: "Details of Test"
3. ETAG 001 Annex E: "Assessment of Metal Anchors under Seismic Action"
4. Installation Safety denotes reduced installation effort
5. Low Strength Concrete: 2,500 to 4,000 psi (17 to 28 Mpa) for ACI 355.2. For ETAG 001, C20/25 denotes 20 to 30 Mpa (2,900 to 4,300 psi) cylinder strength.
6. High Strength Concrete: 6,500 to 8,500 psi (46 to 60 Mpa) for ACI 355.2. For ETAG 001, C50/60 denotes 50 to 60 Mpa (7,250 to 8,700 psi) cylinder strength.

ASSESSMENT:

It is desirable to address certain specific requirements of ACI 349-13 [4] and the original testing and evaluation [12].

1. Test Laboratory and ITEA Credentials:

Section D.3.3 of ACI 349-13 [4] states *Post-installed structural anchors shall be tested before use, simulating the conditions of the intended field of application, to verify that they are capable of sustaining their design strength in cracked concrete under earthquake loads. These verification tests shall be conducted by an independent testing agency and shall be certified by a licensed design professional with full description and details of the testing programs, procedures, results, and conclusions. The corresponding commentary states ...all anchors are required to be qualified to resist seismic loads by satisfactory performance in simulated earthquake tests. The qualification should be performed consistent with the provisions of this appendix and should be reviewed by a licensed design professional experienced in anchor technology.... For a post-installed anchor to be used in conjunction with the requirements of this appendix, the results of tests have to indicate that pullout failures exhibit an acceptable load-displacement characteristic, or that pullout failures are precluded by another failure mode. ACI 349-13 requires that all post- installed anchors be qualified, by independent tests, for use in cracked concrete. Post-installed anchors qualified to the procedures of ACI 355.2 as Category I for use in cracked concrete are considered acceptable....*

According to the introduction of ACI 349-13, this requirement is based on the provisions of ACI 318-08. As it pertains to anchorage to concrete, ACI 318-08 references ACI 355.2-07 [6]. It is inferred, therefore, that the provisions in Section D.3.3 of ACI 349-13 allude to ACI 355.2-07.

Section 12 of ACI 355.2-07 [6] requires *[t]he testing and evaluation of anchors under ACI 355.2 shall be performed or witnessed by an independent testing and evaluation agency (ITEA) accredited under ISO/IEC 17025 [10] by a recognized accreditation body conforming to the requirements of ISO/IEC 17011. In addition to these standards, listing of the testing and evaluation agency shall be predicated on the documented experience in the testing and evaluation of anchors according to ASTM E 488 [11], including demonstrated competence to perform the tests described in ACI 355.2. Furthermore, [t]he testing shall be certified by a licensed engineer employed or retained by the independent testing and evaluation agency.*

As a matter of practice, and to satisfy the requirements of ICC Evaluation Service preliminary to issuing an Evaluation Report, *[t]est data obtained for the HDA evaluation according to Annex 1, Section 5.3, of AC193, was required to be performed in a laboratory accredited under the requirements of ISO/IEC 17025. Further, a listing, by an accredited listing agency, of the testing and evaluation laboratory was required to be based on the documented experience in the testing and evaluation of anchors according to ASTM E 488 (excerpt from Wollmershauser Report WC 12-01 [15], p. 3).*

The tests were conducted by several test laboratories, including CSTB: Centre Scientifique et Technique du Batiment, Marne-la-Vallee, France (accredited by COFRAC (full ILAC-member)); IWB: Institut für Werkstoffe im Bauwesen der Universität Stuttgart, Germany (accredited by ICC ES, IAS, and DAR (full ILACmember)); HTL: Bautechnische Versuchsanstalt an der HTL Bankweil, Austria (accredited by BMWA (full ILAC-member)); F: Forschungs- und Materialprüfungsanstalt Baden Württemberg Otto-Graf-Institut, Stuttgart, Germany (DIBt-accredited); Material Research and Testing Institute for Construction, Leipzig, Germany (DIBt-accredited); Institut für Bauforschung, Dortmund, Germany and Atlas Consulting Group,

Oakland, CA. All the laboratories who participated in the testing of the HDA anchors resulting in the publication of ESR were accredited by the International Laboratory Accreditation Cooperation (ILAC) under ISO/IEC 17025 [10], and all were deemed acceptable by ICC Evaluation Service.

The tests were primarily performed by the Institut Für Werkstoffe Im Bauwesen, and all test procedures and results were reviewed and accepted by Dr.-Ing Eligehausen, the ITEA for the project and evaluation [12]. Therefore, the provisions stipulated by ACI 349, ACI 355.2 and AC 193 pertaining to accreditation and supervision by licensed professional engineers are satisfied.

2. Concrete Compressive Strength: European Test Methods and Specified Compressive Strengths

Since the tests were conducted in Europe, the compressive strength of the concrete was typically derived according to European standards [9], which is based on testing 150 mm cubes instead of cylinders typical in the United States. For the evaluation performed, the cube strength was converted to cylinder compressive strength based on $f'_{cyl} = f_{cube,150} / 1.25$ for low strength concrete (i.e., $f_{cube,150} < 50 \text{ N/mm}^2$ or $f'_{cyl} = f_{cube,150} / 1.20$ for high strength concrete (i.e., $f_{cube,150} \geq 50 \text{ N/mm}^2$).

The specified range for concrete compressive strength based on ETAG 001 [9] is somewhat higher than what is specified in ACI 355.2 [5,6,7]. Low strength concrete is defined as being 20 to 30 N/mm² (2,900 to 4,300 psi) and high strength is 50 to 60 N/mm² (7,250 to 8,700 psi). Under ACI 355.2, low strength is defined as 2,500 to 4,000 psi and high strength as 6,500 to 8,500 psi). Thus, in some cases, the concrete compressive strength was within the higher end of the specified ranges pursuant to ETAG 001 and over the range specified in ACI 355.2. There are also a few examples where the strength exceeded the ETAG 001 specification. However, based on the general performance of the HDA anchors wherein almost all the tests resulted in steel failure, it is apparent that the concrete compressive strength is not decisive to the anchor performance. Therefore, concrete compressive strength is not a factor in the evaluation of the HDA anchors, and tests conducted in concrete that were not within the strength range specified in ACI 355.2 are acceptable for the purpose of this evaluation.

3. Anchor Category: Section RD3.3 (commentary) of ACI 349-13 [4] stipulates the post-Installed anchor should be qualified as Category 1 for used in cracked as well as uncracked concrete, which is necessary in order for $\phi_{c,n}$ and/or $\phi_{p,n}$ to be 0.65. Testing according to ACI 355.2, Section 10.1 and amended by AC193 [8] are used to ascertain the anchor category. For designation as a Category 1 anchor, the requirements of ACI 355.2 and AC193 are identical. All the anchors were qualified as Category 1 in both cracked and un-cracked concrete, as listed in ICC-ES ESR-1546 [14] Table 5 and in Tables 10.1 (page 125), 10.2 (page 126), 10.3 (page 127) and 10.4 (page 128) of the original evaluation report.

4. Breakout Effectiveness Factors: Method used to calculate the breakout effectiveness factor, k (k_{cr} and k_{un-cr})

ACI 349 [4] (RD.5.2.2) indicates breakout effectiveness factor, k_c (that is, k_{cr} for cracked concrete or k_{un-cr} for uncracked concrete), for post-installed anchors are determined from product approval testing in accordance with ACI 355.2 [6]. ACI 355.2 (Section 7.3) prescribes a method for calculating the effectiveness factor directly from the 5% fractile of the test data, which is required to fall between a certain minimum and maximum value.

Starting with ACI 355.2-19 [7], and in other versions of the test criteria such as ICC-ES AC193 [8] beginning in 2005, the criteria was amended so that a value of k_m is calculated based on

mean test values with the result converted to a tabulated value for k . The threshold values for k for cracked concrete and for uncracked concrete, derived in this manner, are the same as those listed in ACI 355.2; however, the latest version of ACI 355.2 offers additional higher values possible for k if the test results justify it. The additional k values now allowed fall between the range of k factors allowed in ACI 349 (17 to 24 for cracked concrete and 24 to 30 for uncracked concrete).” It should also be noted ACI 355.2-19 [7] adopted the mean-based method for calculating k_m for deriving k and deleted the method outlined in ACI 355.2-01 [5] and ACI 355.2-07 [6]. Third-Party evaluation agencies never accepted the earlier method.

Calculating k based on the 5% fractile value is overly sensitive to the variability of possible test results and could vary significantly for different sets of reference tests of a given anchor. This could result in a value for k that is unconservative. Using the mean of the test data to derive k is not sensitive to the variability of the data and is therefore more indicative of the performance of a given anchor.

The tests in the late 1990’s and early 2000’s conducted on the HDA anchors were performed in accordance with ACI 355.2-01 [5], but incorporated some developments in that were eventually adopted in later revisions have some differences that primarily affects the derivation of the breakout effectiveness factors (difference of assessment only) and the derivation of the value by which the crack-width-cycling test is performed. The assessment by Dr. Eligehausen utilized a later method by which the breakout effectiveness factors in uncracked (k_{uncr}) and cracked (k_{cr}) were derived. The method he used is based on the average of the reference tests rather than the characteristic, as discussed above. The results derived by Dr. Eligehausen are widely used in the industry to date.

Breakout Effectiveness Factor, k_{uncr} and k_{cr} : Section 7.3.2 of ACI 355.2-01 [5] and ACI 355.2-07 [6] state “For steel failure in tension, cracked and uncracked concrete—When steel failure occurs for the embedment depth and steel strength reported in Table 11.1, 11.2, or 11.3, as applicable, report k as the minimum permissible value prescribed by Table 7.1. Alternatively, k shall be permitted to be determined by Eq. (7-1), using tests on the same anchor with a reduced embedment depth, a higher-strength steel, or both, to produce failure by concrete breakout”. Based on tests, including tests at shallower embedment depth to preclude steel failure, the HDA anchor indicated breakout effectiveness $k_{uncr} = 30$ and the $k_{cr} = 24$.

5. Ductility: Qualification of an anchor system as ductile or brittle.

Although ACI 355.2-07 [6] does not present a method or criterion for establishing the ductility of a post-installed mechanical anchor, both ACI 349 [3,4] and ACI 318 define ductility as tensile test elongation of not less than 14% and a reduction of area of not less than 30 percent. AC193 [11] presents a defined method for testing and evaluating the ductility of a post-installed mechanical anchor, which is presented in Section 6.6 and Tables 6.2 and 6.3 of Annex 1 (also adopted in Section 6.3.6 of ACI 355.2-19 [7]), which, similarly requires steel testing according to ASTM F606 to result in elongation of at least 14% and the reduction in area of at least 30% to be considered ductile.

Dr.-Ing. Eligehausen presented an analysis of the HDA anchor with regards to ductility in his supplemental evaluation report [13] based on provisions in Europe, which differ in some respects from the requirements in ASTM F606 [18], concluding the HDA anchors were ductile. In his report WC12-01 [15], Wollmershauser presented a discussion indicating the European ductility requirements correspond conservatively to the ASTM F606 method and stated that Eligehausen’s ductility assessment were sound, and likewise concluded the HDA anchors fulfill the ductility requirements of ACI 349.

The arguments above have further support, however, by tests conducted on the HDA anchors according to ASTM F606 [18], which reports tests of the carbon steel and stainless steel critical threaded rod component of all diameters of the HDA anchors were conducted by Standard Testing and Engineering Company, and the ductility was clearly and directly demonstrated. The elongation in all cases was ~18% for M10 CS and above 20% for all other sizes (>14% required) and the reduction of area was more than 60% for all sizes (>30% required).

Based on the conclusions presented by Eligehausen [13] corroborated by Wollmershauser [15] and clearly demonstrated by test [18], the HDA anchors are shown to be ductile.

6. Seismic Testing: Section D3.3 of ACI 349-13 [4] (B3.3 of ACI 349-01 [3]) requires “post-installed structural anchors shall be tested before use, simulating the conditions of the intended field of application, to verify that they are capable of sustaining their design strength in cracked concrete under earthquake loads. Sections 9.5 and 9.6 of ACI 355.2-07 [6] (Sections 9.6 and 9.7 of ACI 355.2-01 [5]) provide for optional seismic testing, which is adopted with amendment in AC193. The amendments in AC193 are essentially clarifications to the required procedure and evaluation.

Seismic Tension and Seismic Shear tests performed on HDA anchors are consistent with the requirements of AC193 [8] and ACI 355.2 [5,6]. Therefore, the HDA anchors satisfy the requirements of ACI 349 for seismic design.

CONCLUSION

The areas where ACI 355.2 and ACI 349 differ from ACI 193 are discussed above. Evidence is provided demonstrating that, while the language of the standards varies, the actual testing and evaluation met their intent and requirements. The remainder of ACI 355.2 and ACI 349 do not contain any other requirements that are functionally different from AC 193. Therefore, based on all pertinent data and evaluations, the testing performed on the Hilti HDA post-installed undercut anchors satisfies the intent and requirements of both ACI 355.2-07 and ACI 349-13.

The resulting design data conforming to the requirements of ACI 349 are presented in the **Design information for the Hilti HDA Undercut Anchors in Accordance with ACI 349** is attached hereto as Appendix A to this report. This data is accurate and complies with the intent and requirements of ACI 355.2-07, ACI 349-13, and USNRC Regulatory Guide 1.199 (as well as ACI 355.2-01 and ACI 349-01).

APPENDIX A: DESIGN INFORMATION FOR HILTI UNDERCUT ANCHORS (HDA)

1.0 SCOPE: This document is intended to provide guidance on the design of anchorages with Hilti Undercut Anchors HDA in accordance with ACI 349-13 Appendix B. Note this design varies from current general industry practice following ACI 318 Appendix D. It is the responsibility of the engineer of record to verify the accuracy and suitability of all design calculations, methodologies, capacities and code compliance. Information contained in this document was current as of July 30, 2026, and is subject to change. Updates and changes may be made based on subsequent testing. If verification is needed that the data is still current, please contact Hilti Technical Services at 1-877-749-6337.

2.0 USES: The Hilti HDA Undercut Anchor is used to resist static, wind, and seismic tension and shear loads in cracked and uncracked normal-weight concrete having a specified compressive strength $2,500 \text{ psi} \leq f'_c \leq 8,500 \text{ psi}$ ($17.2 \text{ MPa} \leq f'_c \leq 58.6 \text{ MPa}$). The values of f'_c used for calculations in this guide shall not exceed 8000 psi (55.2 MPa).

3.0 INSTALLATION: Installation shall be in accordance with Hilti's printed installation instructions as included in the anchor packaging.

4.0 DESIGN: The design shall be in accordance with this document and ACI 349-13 Appendix B.

Table 2: Design Information, Hilti HDA Undercut Anchors

Design Parameter	Symbol	Units	Nominal anchor diameter						
			M10		M12		M16		M20
			HDA	HDA-R	HDA	HDA-R	HDA	HDA-R	HDA
Anchor O.D.	d_a	mm (in.)	19 (0.75)		21 (0.83)		29 (1.14)		35 (1.38)
Effective minimum embedment depth ¹	$h_{ef,min}$ $\ell_e^{(2)}$	mm (in.)	100 (3.94)		125 (4.92)		190 (7.48)		250 (9.84)
Minimum edge distance	c_{min}	mm (in.)	80 (3.15)		90 (3.54)		120 (4.72)		150 (6.00)
Minimum anchor spacing	s_{min}	mm (in.)	80 (3.15)		90 (3.54)		120 (4.72)		150 (6.00)
Critical edge distance	c_{ac}	-	$\psi_{cp,N}$ shall be taken as 1.0 for all cases. $c_{ac} = 1.5 h_{ef}$.						
Minimum thickness of concrete member	h_{min}	-	See Tables 5 and 6						
Strength reduction factor for tension, steel failure modes ^{3,4}	ϕ	-	0.75						
Strength reduction factor for shear, steel failure modes ^{3,4}	ϕ	-	0.65						
Strength reduction factor for tension, concrete and pullout failure modes ^{3,5}	ϕ	Cond. A	0.75						
		Cond. B	0.65						
Strength reduction factor for shear, concrete and pryout failure modes ^{3,5}	ϕ	Cond. A	0.75						
		Cond. B	0.70						
Yield strength of anchor carbon steel	f_{ya}	lb/in ² (N/mm ²)	92,800 (640)						
Yield strength of anchor stainless steel	f_{ya}	lb/in ² (N/mm ²)	87,000 (600)						
Ultimate strength of anchor carbon and stainless steel	f_{uta}	lb/in ² (N/mm ²)	116,000 (800)						
Tensile stress area	A_{se}	in ² (mm ²)	0.090 (58.10)		0.131 (84.50)		0.243 (156.80)		0.380 (235.20)
Steel strength in tension	N_{sa}	lb (kN)	10,440 (46.40)		15,196 (67.60)		28,188 (125.40)		44,080 (196.10)
Effectiveness factor uncracked concrete	k_{uncr}	-	30		30		30		30
Effectiveness factor cracked concrete	k_{cr}	-	24		24		24		24
Modification factor for tension, uncracked concrete	$\psi_{c,N}$	-	1.0		1.0		1.0		1.0
Pullout strength uncracked conc. ⁶	$N_{p,uncr}$	-	N/A		N/A		N/A		N/A
Pullout strength cracked conc. ⁶	$N_{p,cr}$								
Pullout strength, seismic ⁶	$N_{p,eq}$								
Coefficient for pryout	k_{cp}	-	2		2		2		2
Steel strength in shear static ⁷ HDA-P/PR	V_{sa}	lb (kN)	5,013 (22.3)	6,070 (27.0)	7,284 (32.4)	8,992 (40.0)	13,556 (60.3)	16,861 (75.0)	20,772 (92.4)
Steel strength in shear, seismic ⁷ HDA-P/PR	$V_{sa,eq}$	lb (kN)	4,496 (20.0)	5,620 (25.0)	6,519 (29.0)	8,093 (36.0)	12,140 (54.0)	15,062 (67.0)	18,659 (83.0)
Axial stiffness in service load range in cracked / uncracked concrete	β	10 ³ lb/in	80 / 100						

For in-lb units: 1mm = 0.03937 inches, 1 Nm = 0.7376 ft-lb

¹ See Figure 1 and 2.

² To calculate the basic concrete breakout strength in shear, V_b , ℓ_e equals h_{ef} . In no cases shall ℓ_e exceed $8d_a$.

³ The strength reduction factor applies to ACI 349-13 Section D.4.4 when the load combinations from the ACI 349-13 Section 9.2 are used.

⁴ The HDA(-R) anchors are considered ductile steel elements.

⁵ Condition A applies where supplementary reinforcement is present except for pullout and pryout strengths. Condition B applies where supplementary reinforcement is not present, and for pullout and pryout strength.

⁶ In cracked or uncracked concrete, or in seismic conditions, pullout failure does not control and therefore does not need to be evaluated.

⁷ For HDA-T/TR see Table 3.

Table 3: Design Information: Steel Strength in Shear, HDA-T & HDA-TR

Anchor Designation		Thickness of fastened part(s), t_{fix}		Steel Strength in Shear Static V_{sa}	Steel Strength in Shear, Seismic $V_{sa,eq}$
		(mm)	(in.)	(lb)	(lb)
Carbon Steel Anchors	HDA-T M10x100	$15 \leq t_{fix} \leq 20$	$5/8 \leq t_{fix} \leq 13/16$	13,940	12,590
	HDA-T M12x125	$15 \leq t_{fix} \leq 20$	$5/8 \leq t_{fix} \leq 13/16$	16,635	15,060
		$20 \leq t_{fix} \leq 50$	$13/16 \leq t_{fix} \leq 2$	18,660	16,635
	HDA-T M16x190	$20 \leq t_{fix} \leq 25$	$13/16 \leq t_{fix} \leq 1$	30,575	27,425
		$25 \leq t_{fix} \leq 30$	$1 \leq t_{fix} \leq 1-3/16$	34,620	31,250
		$30 \leq t_{fix} \leq 35$	$1-3/16 \leq t_{fix} \leq 1-3/8$	38,220	34,395
		$35 \leq t_{fix} \leq 60$	$1-3/8 \leq t_{fix} \leq 2-3/8$	41,365	37,095
	HDA-T M20x250	$25 \leq t_{fix} \leq 40$	$1 \leq t_{fix} \leq 1-9/16$	45,185	40,690
		$40 \leq t_{fix} \leq 55$	$1-9/16 \leq t_{fix} \leq 2-1/8$	50,805	45,635
		$55 \leq t_{fix} \leq 100$	$2-1/8 \leq t_{fix} \leq 4$	54,630	49,235
Stainless Steel Anchors	HDA-TR M10x100	$15 \leq t_{fix} \leq 20$	$5/8 \leq t_{fix} \leq 13/16$	15,510	13,940
	HDA-TR M12x125	$15 \leq t_{fix} \leq 20$	$5/8 \leq t_{fix} \leq 13/16$	20,235	17,985
		$20 \leq t_{fix} \leq 50$	$13/16 \leq t_{fix} \leq 2$	22,255	20,010
	HDA-TR M16x190	$20 \leq t_{fix} \leq 25$	$13/16 \leq t_{fix} \leq 1$	35,745	32,150
		$25 \leq t_{fix} \leq 30$	$1 \leq t_{fix} \leq 1-3/16$	37,770	33,945
		$30 \leq t_{fix} \leq 35$	$1-3/16 \leq t_{fix} \leq 1-3/8$	39,565	35,520
		$35 \leq t_{fix} \leq 60$	$1-3/8 \leq t_{fix} \leq 2-3/8$	40,915	36,870

Table 4: Characteristic Values of Anchors and Installation

HDA M10 to M20 and HDA-R M10 to M16			M10		M12		M16		M20	
			P	T	P	T	P	T	P	T
Nominal drill bit diameter ¹	d_{bit}	mm	20	20	22	22	30	30	37	37
Minimum hole depth ^{1,2}	h_{hole}	mm (in.)	107 (4.21)	107 (4.21)	133 (5.30)	133 (5.30)	203 (7.99)	203 (7.99)	266 (10.47)	266 (10.47)
Maximum clearance hole diameter in fastened part	d_h	mm (in.)	12 (0.47)	21 (0.83)	14 (0.55)	23 (0.91)	18 (0.71)	32 (1.26)	22 (0.87)	40 (1.57)
Min. thickness of fastened part	t_{min}	mm (in.)	0 (0.00)	10 (0.39)	0 (0.00)	10 (0.39)	0 (0.00)	15 (0.59)	0 (0.00)	20 (0.79)
Sleeve recess ³	h_s	mm (in.)	$2 \leq h_s \leq 6$ (0.08 $\leq h_s \leq 0.24$)		$2 \leq h_s \leq 7$ (0.08 $\leq h_s \leq 0.28$)		$2 \leq h_s \leq 8$ (0.08 $\leq h_s \leq 0.31$)		$2 \leq h_s \leq 8$ (0.08 $\leq h_s \leq 0.31$)	
Installation torque	T_{inst}	Nm (ft-lb)	50 (37)	50 (37)	80 (59)	80 (59)	120 (89)	120 (89)	300 (221)	300 (221)

For in-lb units: 1mm = 0.03937 inches, 1 Nm = 0.7376 ft-lb

¹ Use required stop drill bits only. See Table 5 and 6.² Actual hole depth for HDA-T is provided by minimum hole depth + ($t_{fix,max}$ - t_{fix}) where $t_{fix,max}$ is provided in Table 6 and t_{fix} is the thickness of the part(s) being fastened.³ Sleeve recess after setting of the anchor:

- a) Pre-setting anchor HDA-P(R): distance from surface of the concrete member to top edge of the anchor sleeve (see Figure 1).
b) Through-fastening anchor HDA-T(R): distance from top edge of the fixture to top edge of the anchor sleeve (see Figure 2)

Table 5: Minimum thickness of concrete member, HDA-P and HDA-PR

Anchor type			HDA-P M10	HDA-P M12	HDA-P M16	HDA-P M20
			HDA-PR M10	HDA-PR M12	HDA-PR M16	
Minimum thickness of concrete member	h_{min}	mm	180	200	270 ¹	350
		(in.)	7.1	7.9	10.6	13.8

For inch units: 1mm = 0.03937 inches

¹ With TE 70 $h_{min} \geq 300\text{mm}$ (11.8 in) for HDA-P(PR) M16.

Table 6: Minimum thickness of concrete member, HDA-T and HDA-TR¹

Anchor type			HDA-T M10	HDA-T M12		HDA-T M16		HDA-T M20	
			HDA-TR M10	HDA-TR M12		HDA-TR M16			
Maximum fastenable thickness	$t_{fix,max}$	mm	20	30	50	40	60	50	100
Minimum thickness of concrete member ¹	h_{min}	mm	$200-t_{fix}$	$230-t_{fix}$	$250-t_{fix}$	$310-t_{fix}^{(2)}$	$330-t_{fix}^{(2)}$	$400-t_{fix}$	$450-t_{fix}$
		(in.)	$(7.9-t_{fix})$	$(9.1-t_{fix})$	$(9.8-t_{fix})$	$(12.2-t_{fix})^{(2)}$	$(13.0-t_{fix})^{(2)}$	$(15.7-t_{fix})$	$(17.7-t_{fix})$

For inch units: 1mm = 0.03937 inches

¹ h_{min} is dependent on the actual fixture thickness t_{fix} (use of a stop drill bit) e.g. HDA-T M12*125/50: $t_{fix} = 20\text{mm} \rightarrow h_{min} = 250 - 20 = 230\text{mm}$; $t_{fix} = 50\text{mm} \rightarrow h_{min} = 250 - 50 = 200\text{mm}$.

² With TE 70 $h_{min} = 340\text{mm} - t_{fix}$ for $t_{fix,max} = 40\text{mm}$ and $h_{min} = 360\text{mm} - t_{fix}$ for $t_{fix,max} = 60\text{mm}$ when using HDA-T(TR) M16.

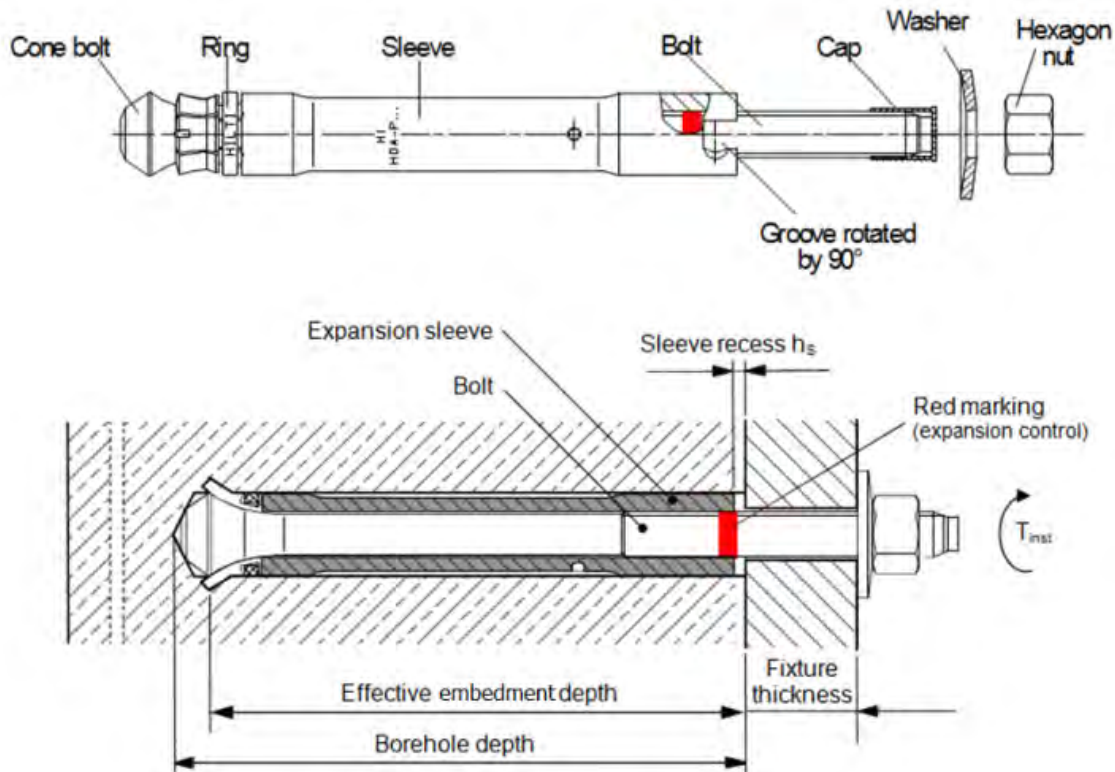


Figure 1: PRE-SETTING ANCHOR HDA-P AND HDA-PR (PRE-POSITIONING)

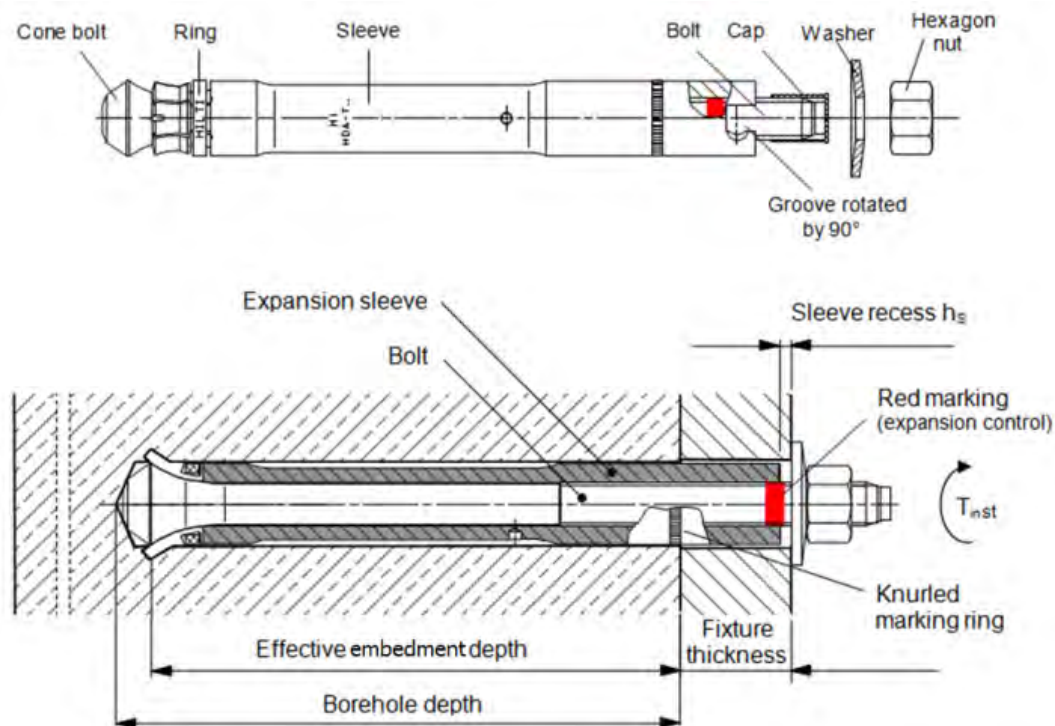


Figure 2—THROUGH-FASTENING ANCHOR HDA-T AND HDA-TR (POST-POSITIONING)