DESIGNING THREADED RODS WITH HILTI HIT-RE 500 V3 FOR DEEP EMBEDMENTS (>20d)
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Hilti has published data for the Hilti HIT-RE 500 V3 adhesive anchoring system which can be used for threaded rod and rebar installations for anchor design in accordance with ACI 318-14 Chapter 17 and CSA A23.3-14 Annex D. Current published data is based on testing in accordance with ACI 355.4 and ICC-ES AC308 and can be found in ESR-3814 and Section 3.2.4 of the Hilti North American Product Technical Guide Volume 2: Anchor Fastening Technical Guide, Edition 16.1 (PTG Ed. 16.1). The published values in ESR-3814 and the PTG Ed. 16.1 correspond to testing performed in accordance with the published Instructions for Use (IFU).

Hilti has not performed additional testing for deep embedment depths (> 20 * d_a where d_a is the nominal diameter of the anchor rod) for the installation of threaded rod with Hilti HIT-RE 500 V3. The design of these anchors is outside of the scope of ACI 318-14 or CSA A23.3-14 and requires engineering judgement by the design engineer. However, we offer the following recommendations:

Design using Rebar Development Theory:

Similar to a post-installed rebar with HIT-RE 500 V3, the anchor may be designed to develop the strength of the threaded rod using the provisions of ACI 318-14 Chapter 25 or CSA A23.3-14 Chapter 12. This theory assumes that threaded rods will behave similarly to rebar at deep embedment depths, if ductile threaded rods are used. ASTM F1554 and A193 B7 are both considered ductile and Hilti HAS rods are available in both materials. The following design equations from ACI 318-14 and CSA A23.3-14 should be used for this methodology:

ACI 318-14 equation 25.4.2.3a (f_y and d_b would be specific to the threaded rod chosen):

$$l_d = \left(\frac{3}{40} \frac{f_y}{\lambda\sqrt{f_c'}} \frac{\psi_t \psi_e \psi_s}{\frac{c_b + K_{tr}}{d_b}} \right) d_b$$

CSA A23.3-14 equation 12.1 (f_y and A_b would be specific to the threaded rod chosen):

$$l_d = \left(1.15 \frac{k_1 k_2 k_3 k_4}{c_b + K_{tr}} \frac{f_y}{\sqrt{f_c'}} \right) A_b$$

Additional information regarding the design methodology described above can be found in the [Hilti North America Post-Installed Reinforcing Bar Guide].

Design using Anchor Theory:

The anchor may be designed using ACI 318-14 Chapter 17 or CSA A23.3-14 Annex D and the published bond strengths in ESR-3814. However, the validity of the concrete breakout failure model in ACI 318-14 Chapter 17 and CSA A23.3-14 Annex D is questionable beyond 20 * d_a. However, at deeper embedment depths, fully developed reinforcement is often present and may allow for the concrete failure mode to be ignored in accordance with ACI 318-14 section 17.4.2.9 and 17.5.2.9 or CSA A23.3-14 Annex D Section D.5.2.9 and D.6.2.9.

Additionally, installation at embedment depths greater than 20*d_a is beyond the scope of testing and reductions in bond strength may occur due to various installation and hole cleaning concerns. Therefore, field testing is recommended to confirm the engineer's assumptions.

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Spacing and edge distance requirements will need to be considered. If splitting is a concern, Rebar Development Theory should be used.

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