

Agenda Item: 650-1112

Title: API 650 Anchor Embedment Design

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Purpose: To align API 650 with ASCE 7 regarding anchorage embedment design. Also, add in the requirement that anchors have a minimum gauge length of eight diameters to ensure an adequate length of bolt is provided to stretch during a seismic event.

Source: Justin Kline

Revision: 1

Impact: Slight increase in embedment reinforcement.

Rationale: ASCE 7 (15.7.5) was revised in the 2010 edition to modify the design of anchorage embedment to develop the steel strength of the anchor in tension. Previous editions had specified the design of anchor embedment to develop the minimum specified yield strength of the anchor.

ASCE 7-05 (15.7.5): "Where anchorage is required, the anchor embedment into the foundation shall be designed to develop the minimum specified yield strength of the anchor."

ASCE 7-10/16 (15.7.5): "Anchorage shall be in accordance with Section 15.4.9, whereby the anchor embedment into the concrete shall be designed to develop the steel strength of the anchor in tension. The steel strength of the anchor in tension shall be determined in accordance with ACI 318, Appendix D, Eq. D-3." (Note: this is equation 17.6.1.2. in the latest edition of ACI 318).

ACI 318 (16.6.1.2): $N_{sa} = A_{se,N} f_{uta}$

ACI Commentary R17.6.1.2 indicates the nominal strength of anchors in tension is best represented as a function of the anchor bolt tensile strength rather than yield strength as most anchor materials do not exhibit a well-defined yield point.

Proposal: 5.12.13 When required for seismic, the embedment strength of the anchor in the foundation shall be sufficient to develop the specified minimum steel tensile strength of the anchor in tension. The steel strength of the anchor in tension shall be equal to the minimum specified tensile strength multiplied by the uncorroded tensile stress area of the bolt. Hooked anchor or end plates may be used to resist pullout. See E.6.2.1.2 restrictions for hooked anchors for Annex E tanks. When mechanical anchorage is required for seismic, the anchor embedment or attachment to the foundation, the anchor attachment assembly and the attachment to the shell shall be designed for anchor attachment design load. The anchor attachment design load shall be the lesser of the load equal to the minimum specified yield strength multiplied by the nominal root area of the anchor or three times seismic design uplift load per anchor, T_b , defined in 5.12.2. When mechanical anchorage is required for seismic, one of the following provisions shall also be met:

- a) In the case of anchor bolts, the anchor shall have a minimum gauge length equal to eight times the bolt diameter, or
- b) In the case of anchor straps, the strap shall have a minimum gauge length equal to eight times the diameter of an equivalent bolt having the same cross-sectional area as that of the strap.

Gauge length is the length of bolt or strap above the foundation that is allowed to stretch.

Notes: Companion agenda item with 620-1027.