

Agenda Item: 650 - Sliding and Overturning Resistance

Title: Sliding and Overturning Resistance

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Purpose: To clarify tank sliding shall not be resisted by a combination of friction and anchor shear. Additionally, tank overturning shall not be resisted by a combination of bottom uplift and anchors.

Source: Justin Kline

Revision: 0

Impact: None

Rationale: API 650 does not currently explicitly prohibit resisting tank sliding through a combination of friction and anchor bolt shear. For shear resistance, if the bolts are in contact with the bottom, the bottom movement cannot happen. If a gap is provided, the bottom must move (static friction reduces to dynamic friction). The bottom will then impact the bolts with a higher load (difficult to predict the magnitude) and likely shear off some of the bolts.

Similarly, API 650 does not currently explicitly prohibit resisting overturning through a combination of bottom and uplift and anchors.

Proposal: 5.11.4 Sliding Friction

Unless otherwise required, tanks that may be subject to sliding due to wind shall use a maximum allowable sliding friction of 0.4 multiplied by the force against the tank bottom. **For mechanically anchored tanks, sliding shall not be resisted by a combined action of friction and anchor shear.**

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E.6.2.1 Anchorage

Resistance to the design overturning (ringwall) moment at the base of the shell shall be provided by:

- The weight of the tank shell, weight of roof reaction on shell W_{rs} , and by the weight of a portion of the tank contents adjacent to the shell for self-anchored tanks. Tanks are permitted to be designed without anchorage when they meet the requirements for self-anchored tanks listed in E.6.2.1.1.

- Mechanical anchorage devices. **Overtuning shall not be resisted by a combination of bottom uplift and anchors.**

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E.7.6 Sliding Resistance

The transfer of the total lateral shear force between the tank and the subgrade shall be considered.

~~For self-anchored flat bottom steel tanks,~~ The overall horizontal seismic shear force shall be resisted by friction between the tank bottom and the foundation or subgrade. **Self-anchored** Storage tanks shall be proportioned such that the calculated seismic base shear, V , does not exceed V_s :

The friction coefficient, μ , shall not exceed 0.4. Lower values of the friction coefficient should be used if the interface of the bottom to supporting foundation does not justify the friction value above (e.g., leak detection membrane beneath the bottom with a lower friction factor, smooth bottoms, etc.).

$$V_s = \mu (W_s + W_r + W_f + W_p) (1.0-0.4A_v)$$

~~No additional lateral anchorage is required for mechanically-anchored steel tanks designed in accordance with this Annex even though small movements of approximately 25 mm (1in.) are possible.~~ In cases where the calculated seismic base shear, V , exceeds V_s , the tank shall be reportioned or some other means provided to transfer the shear to the subgrade.