Agenda Item: 650-1045

API SCAST SUBCOMMITTEE , SUBGROUP DESIGN

Agenda Item: **650-1045**
Date: **November ~~12~~17, ~~2018~~2020**

TITLE: 650-1045 Seismic Overturning at the Base of Each Shell Course
REVISION: ~~1~~3

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SOURCE: INQ-650-D77

PURPOSE: To clarify the extent to which the calculations are to be performed for vertical seismic effects on tank shell rings above the tub ring.

RATIONALE: There are currently requirements in paragraphs E.6.2.2.1 and E.6.2.2.2 to calculate the compressive stress at the base of the shell. It is then compared to the allowable value calculated in E.6.2.2.3. There is ambiguity as to whether this check is required to be performed for each shell course.

IMPACT: This change has potential to ~~increase~~ affect cost while also increasing reliability of upper shell courses. This change is most applicable in high seismic regions or lower seismic regions where roof loads are significant.

PROPOSED CHANGES: Additions to API 65~~2~~0 Ed ~~12~~ 13 ~~Addendum 3~~ are marked in green; deletions are struck through and marked in ~~red~~.

E.2.2 Notations

t~~s~~ Thickness of ~~bottom~~ shell course under consideration less corrosion allowance, mm (in.)

E.6.2.2.1 Shell Compression in Self-Anchored Tanks

The maximum longitudinal shell compression stress at the bottom of the bottom shell course when there is no calculated uplift, J≤0.785, shell be determined by the formula:

In SI units:

$$\sigma_c = \left(w_t(1 + 0.4A_v) + \frac{1.273M_{rw}}{D^2}\right)\frac{1}{1000t_s} \qquad \text{(E.6.2.2.1-1a)}$$

or, in USC units:

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$$\sigma_c = \left(w_t(1 + 0.4A_v) + \frac{1.273M_{rw}}{D^2}\right)\frac{1}{12t_s} \qquad \text{(E.6.2.2.1-1b)}$$

The maximum longitudinal shell compression stress at the bottom of the bottom shell course when there is no calculated uplift, J>0.785, shell be determined by the formula:

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In SI units:

$$\sigma_c = \left(\frac{w_t(1+0.4A_v)+w_a}{0.607-0.18667[J]^{2.3}} - w_a\right)\frac{1}{1000t_s} \qquad \text{(E.6.2.2.1-2a)}$$

or, in USC units:

$$\sigma_c = \left(\frac{w_t(1+0.4A_v)+w_a}{0.607-0.18667[J]^{2.3}} - w_a\right)\frac{1}{12t_s} \qquad \text{(E.6.2.2.1-2b)}$$

E.6.2.2.2 Shell Compression in Mechanically-Anchored Tanks

The maximum longitudinal shell compression stress at the bottom of the bottom shell course for mechanically-anchored tanks shall be determined by the formula:

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In SI units:

$$\sigma_c = \left(w_t(1 + 0.4A_v) + \frac{1.273M_{rw}}{D^2}\right)\frac{1}{1000t_s} \qquad \text{(E.6.2.2.2-1a)}$$

or, in USC units:

$$\sigma_c = \left(w_t(1 + 0.4A_v) + \frac{1.273M_{rw}}{D^2}\right)\frac{1}{12t_s} \qquad \text{(E.6.2.2.2-1b)}$$

E.6.2.2.3 Allowable Longitudinal Shell-Membrane Compression Stress in Tank Shell

The maximum longitudinal shell compression stress σ_c of the shell course under consideration must be less than the seismic allowable stress F_C, which is determined by the following formulas and includes the 33% increase for ASD. These formulas for F_C, consider the effect of internal pressure due to the liquid contents.

When GHD^2/t^2 is ≥ 44 (SI units) (10^6 USC units),

In SI units:

$$F_C = 83\ t_s / D \qquad \text{(E.6.2.2.3-1a)}$$

or, in USC units:

$$F_C = 10^6\ t_s / D \qquad \text{(E.6.2.2.3-1b)}$$

In SI units:

When GHD^2/t^2 is < 44:

$$F_C = 83t_s/(2.5D) + 7.5\sqrt{(GH)} < F_{ty}$$ (E.6.2.2.3-2a)

or, in USC units:

When GHD^2/t^2 is < 1 x 10^6:

$$F_C = 10^6 t_s/(2.5D) + 600\sqrt{(GH)} < F_{ty}$$ (E.6.2.2.3-2a)

If the thickness of the bottom shell course calculated to resist the seismic overturning moment is greater than the thickness required for hydrostatic pressure, both excluding any corrosion allowance, then ~~the calculated thickness of each upper shell course for hydrostatic pressure shall be increased in the same proportion, unless~~ an ~~special~~ analysis ~~is~~ shall be made to determine the seismic overturning moment and corresponding stresses at the bottom of each upper shell course (see E.6.1.5).

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