Seismic Design of Storage Tanks: November 2009 Notes

A pdf copy of the NZSEE document "Seismic Design of Storage Tanks – November 2009" can be downloaded from the Dropbox link

https://www.dropbox.com/s/v3xtuysnlfl1a0r/2009%20Final%20including%20Figures2.pdf

We have not as yet fully developed an addendum, but the following notes on errors identified will form an addendum for the next issue of the guidelines.

1. Page 144, First example: Total impulsive mass mr = 4.98E+06 not 4.98E+0.6

2. Page 145, 1st value of Kx = 4.08E+09 not 1.08E+10?

3. Page 145, 1st value of K theta = 5.71E+11 not 1.5E+12?

4. Page 145. 2nd value of Kx =3.96E+09 not 1.04E+10?

5. Page 145, 2nd value of K theta = 4.89E+09 not 1.89E+12?

6. Page 146, Kv = 4.99E+09 not 1.07E+10?

7. Page 146, for alpha v = 0.78, Kv = 3.97E+09 not 1.05E+10?

8. Page 146, Tbar b = 0.34 not 0.24?

9. 2 to 8 above: What has occurred is that the values of Young's Modulus and the Shear Modulus were transposed in the final editorial changes (but not in the underlying working equations of the spreadsheet). The overall outcomes of the examples are correct but some of the working along the way now has incorrect values. Amends the values of equations involving Es and Gs plus following on equations will provide a basis to compare results.

10. Page 152, sigma axial SW = (mw + mt) g/(2 pi R tw) not (mw + mr) g/(2 pi R tw)

11. Page 157, How to assume the available freeboard height of 2.0m in roof pressure calculations?

The freeboard is just a design assumption for the example, i.e. for this case the designer has a wall height 2m greater than the required fill level.

12. Page 157, How to find the maximum pressure distribution that will extend inwards of 9.85m in roof pressure calculations? Use/follow the graphical procedure on pages 81 to 83.

13. Page 164, Importance Level for AS/NZS 1170 =1 should only used for tanks that do not have a life risk if faliure occurs and no significant economic value.

14. Page 171, 7th line up from bottom line of text: Delete “Increase r as MR is greater than MOT”. Substitute “Decrease r as MR is less than MOT”.

15. Design example 1 in the design guide. It would appear on page 146, when working out the vertical mode period, the formulae for a flexible tank (equations C3.27 and C3.32, rather than C3.33) have been used when the tank in the example is considered rigid? Could you please confirm which are the correct formulae for Tb when considered a 'rigid' tank, as in this case?

The comment in the example about the tank being considered as rigid is probably incorrect. The comment follows the use of figure C3.17 where the H/R ratio leads to a mf=0 and thus a mass and lever-arm distribution the same as a rigid tank and then does flow onto the impulsive period equations. The rigidity of a tank is a function of more than just the H/R ratio including parameters like the wall thickness. Essentially a fully rigid tank has an impulsive period of 0 seconds implying PGA input. By way of comparison the impulsive period of the tank in example 2 is actually smaller than that of example 1 while this has been checked as a flexible tank. This is something we can clear up when the document is updated.

The difference from the vertical period equation used is essentially nothing as in each case the vertical period falls on the hazard plateau of the design spectra (which is the case typically for most tanks unless very flexible). The same normally also applies to the impulsive period.

Checking as a flexible tank will generally be conservative by way of inclusion of the flexible lever-arms and where the H/R ratio is less than 1 as in Example 1 the resulting demands will be the same whether the rigid or flexible approach is used.

If you have found other errors we would be very pleased to know of them. Thank you.