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Seismic Resistance and Buckling Strength of Cylindrical Steel Liquid Storage Tanks

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Extended Abstract

This paper presents the behaviour and design guidelines of cylindrical steel liquid storage tanks subjected to various strong earthquake excitations. Authors aim to develop practical design equations and charts estimating the buckling strength of the cylindrical steel liquid-filled tanks subjected to static and seismic loads. Numerical analysis is used to evaluate buckling strength of cylindrical steel liquid-filled tanks. Finite element analysis is performed using commercial computer program ANSYS. Both geometrically perfect and imperfect tanks are studied. The modelling method, appropriate element type and necessary number of elements to use in numerical analysis are recommended. The main phenomena addressed in this paper include pre- and post-buckling strength of the tanks with and without meridional and circumferential stiffeners subjected to base shear and overturning moment due to several seismic excitations.

Field observations during past earthquakes together with finite element analyses and published experimental results are used to substantiate the accuracy of employed finite element analysis. Based on extensive parametric study the accuracy of the current design guidelines is assessed. According to the results of the parametric study of the perfect tanks, the buckling strength decreases significantly as the diameter-to-thickness ratio increases, while it decreases slightly as the height-to-diameter ratio increases. The buckling strength of the tanks decreases significantly as the amplitude of initial geometric imperfection increases. Design equations and design curves for the cylindrical steel liquid-filled tanks of various geometries subjected different earthquakes are proposed and presented.