

ABSTRACT

Spritzer IV, John M. M.S.C.E., Purdue University, May 2017. Design and Analysis of Aboveground Storage Tanks Subjected to Seismic Forces. Major Professor: Sukru Guzey.

This study investigates the seismic behavior of aboveground, welded, steel, flat-bottom storage tanks. Three different analyses were completed in order to review the seismic design provisions for these types of tanks provided by the American Petroleum Institute (API) document 650 in Annex E. A comparative analysis between Annex E of API 650 and other worldwide storage tank seismic design documents is carried out in order to identify possible differences in design philosophies. Two international documents in which seismic design is a critical aspect of the structure were chosen and include the document developed by the New Zealand Society of Earthquake Engineering, “Seismic Design of Storage Tanks: 2009,” and the Japanese document, “Design Recommendations for Storage Tanks and their Supports with Emphasis on Seismic Design (2010).” An elastic-plastic analysis was completed on aboveground, flat-bottom, open-top, unanchored storage tanks supported by a stiff soil medium taking into consideration wall and base deformations under the presence of seismic forces. This study was conducted in order to determine the difference in results when assuming a rigid base condition with undeformable walls, which is a key component in the development of the API 650 Annex E provisions, to a more realistic scenario where tanks deformations occur as load is applied. An elastic-plastic imperfection study was completed on aboveground, flat-bottom, open-top, unanchored storage tanks by comparing the behavior of perfect tanks to tanks with imperfections. This study allowed the effect of shell imperfections, which are ignored in the seismic design provisions of API 650 Annex E, to be evaluated with respect to perfect tank scenarios. This research delivers insight as to how API 650 Annex E was developed, its shortcomings, and an in depth analysis as to how the shortcomings are not crucial to the seismic design of aboveground storage tanks.