NONLINER SEISMIC ANALYSIS OF STEEL ANKS UNDER HORIZONTAL AND VERTICAL BASE EXCITATIONS

Saeed SOBHAN
PhD Candidate, School of Civil Engineering, Sharif University of Technology, Tehran, Iran.
sobhan@mehr.sharif.edu

FayazR. ROFOOEI
Professor, Civil Engineering Department, Sharif University of Technology, Tehran, Iran
rofooei@sharif.edu

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ABSTRACT

In this study the dynamic buckling behaviour of anchored cylindrical steel tanks with different aspect ratios (H/D) under tri-directional seismic input is investigated using finite element method. Two anchored steel tank with different height to diameter (H/D) ratios is considered that are subjected to tri-directional ground excitations. The effect of aspect ratio of the tank models, type of seismic ground motions and importance of simultaneous 3-directional action of seismic ground motion on the seismic behaviour and formation of elastic and plastic buckling of steel tanks is investigated.The results obtained indicate the dominant effect of the aspect ratio and the type of ground motion on seismic response of steel tanks.

INTRODUCTION

The on grade cylindrical steel tanks are the type of lifeline structures extensively used in water supply facilities, oil and gas refineries and nuclear power plants for various purposes.Extensive failures and damages observed in the on grade cylindrical steel tanks have persuaded the engineers and the researchers to investigate the seismic behavior of these structures. Housner (1963) in a pioneering work divided the hydrodynamic response of a rigid tank into two liquid impulsive and sloshing modes of vibration. The part of the liquid that vibrates with the tank's rigid body, produces the impulsive mode of response, while the rest of the liquid generates the sloshing mode and is identified with a long period of vibration.

The primary buckling modes of steel tanks wall observed in the past earthquake events are called elaso-plastic buckling and elastic buckling. The elasto-plastic failure mechanism of steel tank wall is known as the elephant foot buckling and is characterized by plastification and outward bulge of tank wall in the vicinity of its base. One type of the elastic buckling modes of steel tank is diamond shape buckling that usually occurs in the upper part of the tank wall (ALA 2001).

Experimental investigation on the buckling behavior of a small tank model constructed of Mylar A sheet, is reported by Shih and Babcock (1980). The tank model was subjected to a single horizontal harmonic and simulated seismic base excitation. They reported elastic-plastic buckling near the tank base and the elastic buckling at the top of tank wall.

Virella et al. numerically investigated the dynamic buckling of anchored steel tanks with conical roof, having aspect ratio (H/D) of 0.40, 0.63 and 0.95, using finite element method (2006). The tank models were subjected to the horizontal component of two real earthquake ground motions. Using added mass approach to model the liquid inside, they assumed that the whole liquid contributes to the impulsive response of the system. They observed two types of seismic behavior for steel tanks and determined the critical peak ground acceleration of the earthquake records causing material plasticity and elastic buckling of the tank. It was