



Faculty of Engineering

**3-D MODELING OF TANKS UNDER SEISMIC
LOADS CONSIDERING FLUID-STRUCTURE-
SOIL INTERACTION AND PROBABILISTIC SOIL
PROPERTIES**

By

Safaa AlySadek Mohammed

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Considering Fluid-Structure-Soil Interaction and
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A thesis submitted in partial fulfillment

Of

The requirements for the degree of

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In

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ABSTRACT

Many liquid storage tanks around the world have suffered different levels of damage during earthquakes. Seismic analysis of such tanks is much complicated due to the Fluid-Structure Interaction (FSI). Furthermore, when the soil properties are taken into consideration, the analysis with the Fluid-Soil-Structure Interaction (FSSI) becomes very complicated and tedious.

In this research, a 3-D Finite Element (FE) model for a shallow ground rested Reinforced Concrete (RC) rectangular tank and RC elevated tank are prepared using the FE software; ANSYS. Furthermore, a nonlinear dynamic time history analysis is carried out to investigate the behavior of these tanks during earthquake considering the FSSI. The vertical and the horizontal components of three ground motion records are used in this study with different frequency contents. The selected ground motion records have been scaled into 0.2, 0.4, 0.6, 0.8 and, 1 of the PGA of the earthquake to cover different peak ground accelerations. Moreover, two different soil types are considered. The effects of the FSSI and the ground motions on the straining actions at the tank's walls at the base for the rectangular tank, the straining actions of the column and the connecting beams for the elevated tank, and the fluid sloshing inside the tanks are obtained and discussed.

Based on the obtained results, the dynamic behavior of the ground rested rectangular and elevated tank systems are sensitive to the frequency content of the ground motion. The base shear and the base moment responses have not been affected by the frequency content of the applied ground motions. On the other hand, SSI has a great effect on the base shear and the base moment responses. Sensitivity of the sloshing response of the tank to the SSI, the ground motions frequency content and, the change of the PGA are observed.

The change of the PGA and the frequency content have no effect on the axial forces values of the elevated tank supporting system. However, the column displacement is affected by the ground motions frequency content and the PGA.

A probabilistic investigation the effects of SSI on the seismic response of RC elevated tank has been presented. A statistical analysis using Monte Carlo simulation was conducted using the mechanical model for the elevated tank and the soil using a developed MATLAB program which links ANSYS and MATLAB to perform the nonlinear analysis and the probabilistic analysis. By conducting the probabilistic analysis, the effect of soil properties as a random variables on the dynamic responses of the elevated tank has been investigated.

Keywords: Liquid storage tanks, fluid structure interaction, soil structure interaction, nonlinear seismic analysis, probabilistic analysis.