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Effect of Type of Earthquake Seismic Analysis of Concrete cube shaped Tanks Buried According to the Interaction of Soil Structure

R. Naderi[1], A. Yosefi Samangany [2], M. H. Talebpour [3]
[1]*Assistant Professor, Shahrood University of Technology, Shahrood, Iran*
[2]*MSc Student, Department of Civil Engineering,Islamic Azad University, Arak Branch, Iran*
[3]*PhD. Student, Department of Civil Engineering, Shahrood University of Technology, Iran*

Abstract

Tanks are generally buried structures to store and maintain large amounts of fluids are used. Therefore play an important role in systems engineering and should play a vital arteries. Failure and failure of such structures after the earthquake, Various losses such as loss of economic, environmental, etc. This search has led the design and analysis of important reservoirs are buried. In this paper, the influence of earthquake time history as the seismic behavior of buried tanks are considered. Thus the three dimensional reservoir modeling concrete cube to the software Abaqus، Effect of the Northridge earthquake, and Elcentro, Chi Chi Considering the interaction of soil and structure has been studied. The process for modeling the effect of soil structure interaction and wave propagation phenomena in the soil around the tank, and direct method of solving viscous absorbing boundary is used. Finally, draw diagrams tank wall deformation and stress, the effect of the earthquake record has been evaluated.

Key words: Time history analysis, buried tanks, and soil structure interaction, cube shaped tanks.

1. Introduction

Some structures are repositories for storage and maintenance of various liquids such as water, oil products and chemicals are used. Such structures and place to suit the application used, in various forms such as cylindrical, cubic, etc., are produced. Status of deployment of tanks, buried three general groups, land and air are divided. Meanwhile, buried tanks at the refinery due to the use and urban water supply networks have a particular importance. Therefore, failure of such structures due to lack of observation, the following general effects are irreparable. Buried oil tanks and damage caused chemical spill materials and environmental pollution, and some fires are vast. Destruction of water caused the buried tanks destroyed a large part of their environment due to phenomena such as earth, etc. will be settlment. Therefore, the design and analysis of such structures is important and must be given the most important factors influencing, the reservoir during the service carried out. One of them is the earthquake force in the design and analysis of buried tanks should play an important role to play. This issue has caused in the past years, many researchers analyzed the effect of tanks buried under the earthquake forces are considered. The researchers one of the oldest Jacobsan [1] Is. After Jacobsan, Housner researchers also one of the oldest reservoirs in seismic analysis is. Housner In 1954 extensive research in the field of simple dynamical model for the buried rectangular and cylindrical tanks start and noted [2]. Like other researchers after him Lysmer and Kuhlemeyer Epstein [4] Kausel [5] Buried tanks and so the modeling was investigated. But always in the process modeling point of reflection for buried tanks, tank and surrounding soil Interaction of soil and the tank is. Aaron valuable information into action in the field of soil and structures related to previous researchers and their experiments, the debate has gathered buried reservoir modeling [6] Most research in the field of soil structure interaction is based on the finite element analysis models based on two-dimensional tanks of various software are discussed [7-8] However, in some cases, modeling is also considered [10-12].

In this paper, the seismic behavior of buried concrete cube shaped tanks, according to several earthquakes, such as Chi Chi, and Northridge Elcentro discussed. Reservoir analysis in the process of three-dimensional models have been used To a more accurate assessment of earthquake-induced forces on the tank wall parameters such as stress and deformation is achieved. For this purpose, the software ABAQUS The appropriate computational capability based on finite element method has been used [13]. It is noteworthy that the present modeling of soil surrounding the reservoir is homogeneous and to perform analysis process, first under the environment of static force and the weight placed components Selected records earthquakes, the effect is given. Modeling software based on sex, body, floor and ceiling of reinforced concrete tank of the type of behavior is considered linear. Finally, draw diagrams concrete tank wall deformation and stress, influence earthquake analysis process has been studied.

1. Seismic analysis of buried tanks

Different methods for seismic analysis of tanks, there are generally two categories, static and dynamic analysis are summarized. Meanwhile, the dynamic analysis of both spectral analysis and time history analysis is expressed. Time history analysis of two modes, one in Another time domain and frequency domain is performed on. In dynamic time history analysis, the effect of ground motion acceleration time history as a site to be determined. In this method, structural components directly affected by horizontal and vertical acceleration of ground motion is placed. So history analysis When required Geotechnical seismic studies at the site until this basis for site earth moving target, based on analysis of earthquake ground response should be determined. Based on analysis of earthquake ground motion profile can then records the required spectrum and can be calculated. This process Generally a complex process and requires knowledge of various parameters is [14]. In this paper time history analysis in frequency domain is used. Thus the equations of motion is expressed as follows:

$$[M][\ddot{U}]+[C][\dot{U}]+[K][U]=[M]\ddot{U}_g(t) \tag{1}$$

In relation to the above $[M]$ mass matrix, $[\ddot{U}]$ momentum matrix system, $[C]$ matrix depreciation $[\dot{U}]$ system matrix system speed, $[K]$ system stiffness matrix, $[U]$ the matrix displacement and $\ddot{U}_g(t)$ acceleration movement of the earth system [15].

To solve the equations of motion, there are different methods commonly associated with the damping factor is removed. But for most simulation models with actual depreciation system must be considered. Therefore, the total damping matrix of the system can be expressed as follows [12]:

$$[C]=\alpha[M]+\beta[K]+\sum_{n=1}^{m}[CF_i] \tag{2}$$

In relation to the above $[CF_n]$ matrix element n, fluid viscous damping and m is the number of fluid elements. Damping matrix for the extraction fluid, the relationship between strain rate and shear stress changes in time according to the viscosity coefficient is used. In relation (2) Coefficients can be α and β In the general case be calculated based on the following relationship:

$$\begin{bmatrix}\alpha\\ \beta\end{bmatrix}=\frac{2\omega_i\omega_j}{\omega_i^2\omega_j^2}\begin{bmatrix}\omega_j & -\omega_i\\ 1/\omega_j & 1/\omega_i\end{bmatrix}\begin{bmatrix}\xi_i\\ \xi_j\end{bmatrix} \tag{3}$$

In this regard ω_i and ω_j Two-mode frequencies, respectively, and the main reservoir and ξ_i and ξ_j Damping is related to it. With a choice of two main frequencies ω_1 and ω_2 Modal of analysis and consider a fixed percentage of damping, can be related based on the following two equations (3) and obtain relations dynamic analysis:

$$\xi=\alpha/2\omega_1+\beta\omega_1/2 \tag{4}$$

$$\xi=\alpha/2\omega_2+\beta\omega_2/2 \tag{5}$$

Finally, the above equation, we will:

$$\alpha=\frac{2\xi\omega_1\omega_2}{(\omega_1+\omega_2)} \tag{6}$$

$$\beta=\frac{2\xi}{(\omega_1+\omega_2)} \tag{7}$$

But the point discussed above reflect on the soil around the tank directly in the equations of motion is not observed. Soil around the tank constantly earthquake force on the structure and distribution of earthquake waves is effective. Therefore, the process must be buried reservoir seismic analysis of soil material reservoir and the surrounding soil structure interaction is considered.

2.1 Soil Structure Interaction

Generally, soil structure interaction phenomena of two structural failure in adherence surrounding soil deformation and the effect on the structural dynamic motion around the soil is. Several methods of analysis and interaction of soil and structure are the most important of these methods in three main groups: Under structure methods, and methods of direct solution method to solve complex is seen. The most widely used methods, the direct solving method based on finite element method formulation is based. In other words, this method of soil and structural finite element method model to help and then are analyzed together. One of Basic weakness of this method is that the modeling of soil and structural finite element method requires the number of degrees of freedom are many. Another method of solving the major problems of direct, almost all modeling environment that is unlimited [16]. In other words, the reservoir and environment modeling, Displacement at infinity is zero and no energy reflected from the infinite reservoir reflected waves induced by the reservoir there. But virtually infinite modeling environment based on finite element methods and software is not possible. Therefore, the limit should be considered as infinite and Infinite boundary conditions established in the present model thus like to be reality. For this purpose, the direct method of solving the energy absorbing boundaries are used and the mechanism of energy dissipation by these boundaries are simulated. In this study, using spring and damper modeling, energy absorbing boundaries Extreme environment for simulation has been done. Accordingly, the lateral boundaries given environment model, each node of the three elements in the spring - damper orthogonal three directions perpendicular disruption has been used [10] Thus the waves return to the tank in the desired model lateral boundaries, to be amortized.

Other important issues involved in modeling the effects of soil structure interaction, the use of nonlinear soil behavior model that can simulate. The most general modeling method considering the effect of surrounding soil and soil structure interaction and wave propagation in soil is Alastvplastyk model. This model Include nonlinear behavior and can submit criteria for soil based on the submission form on the page level stress - strain considered. In this paper behavioral models have been used Dragr Pragr approximate Colomb the criteria in 1952 and is presented by Dragr Pragr. Yield criterion function Dragr Pragr is defined as follows:

$$F = \alpha J_1 + \sqrt{J_{2D}} - k = 0 \tag{8}$$

In relation to the above J_1 First constant stress tensor and the main J_{2D} The second constant is the stress tensor difference. Values α and k In relation (8), are model parameters; based on soil adhesion and friction to describe relations are calculated:

$$\alpha = \frac{2\sin\phi}{\sqrt{3}(3-\sin\phi)} \tag{9}$$

$$k = \frac{6C\sin\phi}{\sqrt{3}(3-\sin\phi)} \tag{10}$$

In relation to the above ϕ and C Internal friction angle and cohesion, respectively, the soil is. Based on these criteria provide the surface boundary, the approximate law of the mohair columb Dragr Pragr as amended by the von Misz criteria for submission to the hydrostatic stress effect has been. Advantages of standard Dragr Pragr can not duplicate the pattern of answers that are suggested columb mohair, cited.

Behavioral models are revealing the system can be detailed three-dimensional modeling reservoirs buried in the soil based software ABAQUS With Adoption of soil and structure interaction can be described [17].

2. System modeling software ABAQUS

In this paper, modeling tank and surrounding soil environment software ABAQUS Three-dimensional form and two separate classification has been defined and mesh. In this paper for modeling the reservoir model, the overall element Solid Homogeneous type is used. Gender setting specifications and based on the required tank (concrete) and other reservoir parameters is done. In this simulation, the type of concrete reinforced with a linear behavior is defined. For Modeling soil around the tank, the type of Homogeneous Solid Elements, but based on soil parameters settings are used. Elements of a Solid Homogeneous elements and eight knot is that each node there are three degrees of freedom. Based on these elements can be treated Elasto plastic Drakr Pragr through dynamic characteristics such as soil cohesion and soil internal friction angle, can be defined for nonlinear behavior. Thus to model the behavior, the actual behavior of the system is near. Models of three-dimensional finite element software ABAQUS For cubic tank in the following form is provided.

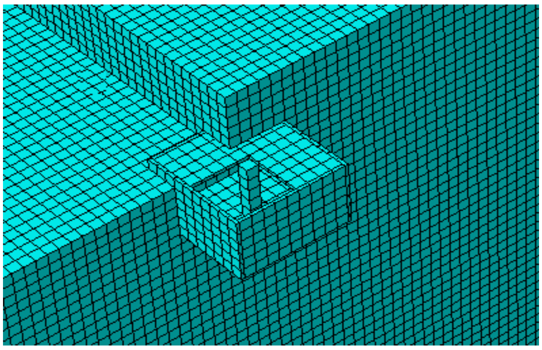

Figure 2 - Three-dimensional view of the tank and surrounding soil ABAQUS

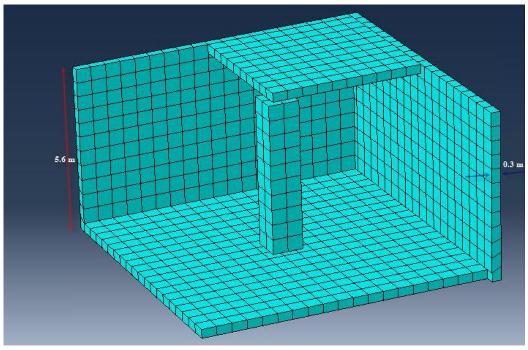

Figure 1 - Reservoir modeling element Classification in ABAQUS

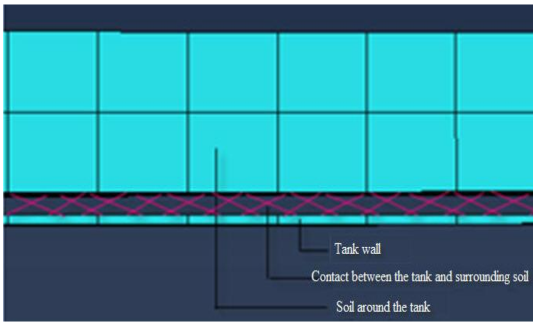

Figure 4 - Borders magnification and soil structure in Figure (3)

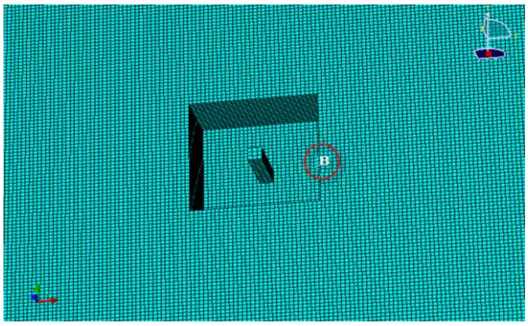

Figure 3 - Plan cubic tank in the vicinity of soil

3.1 Dissected specimens and model tanks

In this paper cubic tank model made of concrete, seismic analysis for the study based on soil structure interaction is used. Specific weight of concrete used in all the models $2400 kg / m^3$ And modulus and Poisson's ratio for concrete Elastsite the modol sequentially 0.2 and $2.1 \times 10^9 kg / m^2$ Been considered. In a given model, the tank dimensions $10_m \times 10_m$ External height 5.6_m Been considered. Middle column dimensions for the desired model, as the square $1_m \times 1_m$ Is assumed. Thickness of floor, walls and ceilings of the tanks 0.3_m Is considered.

As a single layer of soil around the tank and the length and transverse dimensions $60_m \times 60_m$ And the deep 40_m Defined that 30_m Below the floor level around the tank and almost 5_m Located on the overhead tank. Modeling soil surrounding the tank made of soft soil density $1900 kg / m^3$ Used. Angle of internal friction and adhesion for a given soil, respectively, against 26° and $1400 kg / m^2$ Been considered. On the other hand modulus and Poisson ratio respectively equal to the soil 0.25 and $1 \times 10^6 kg / m^2$ Is in order. Damping coefficient equal to 5 percent on selected models and values α and β According to calculations, respectively, against 0.13 and 0.016 Been considered.

On the soil bed is rocky and earthquake records from the lower boundary is applied to the system. Earthquake acceleration time history records as a basis Elcentro earthquake acceleration records, Northridge, and what the model of what actions will be given. Forms (5) to (7) of the earthquake acceleration records selected shows.

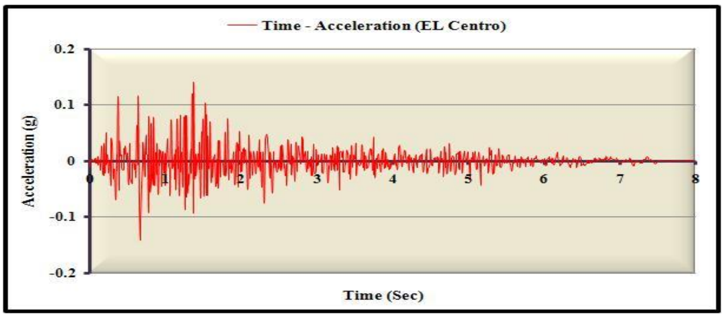

Figure 5 - acceleration Elcentro earthquake records

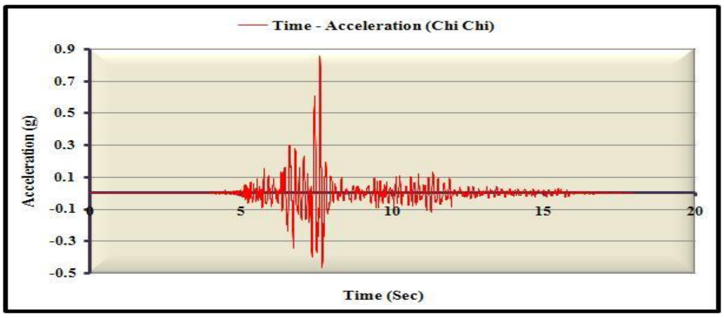

Figure 6 - acceleration Chi Chi earthquake records

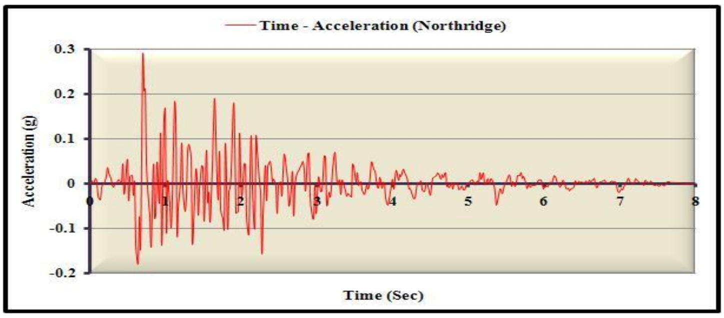

Figure 7 - Acceleration Northridge earthquake records

Considering the time being, and analysis of large models, for the calculation of the area of severe fluctuations present earthquake record is used. This profile earthquakes and time of choice in modeling software ABAQUS Table (1) is visible.

Table 1 - Profile of earthquake actions

Earthquake	Year earthquake	Time Used
Chi Chi	1999	8.5_s تا 6.5_s
Elcentro	1940	2.4_s تا 0.4_s
Northridge	1994	2.5_s تا 0.5_s

As can be seen in Table 1, for all time used the momentum mapping given by 2_s Considered is thus equal to compare the effect of earthquake actions, be provided.

4. Analysis of seismic vessels

After the reservoir based on analysis of seismic acceleration records of earthquakes, the results described diagrams form (8) has been made. The charts have been tried, stress and deformation values at specific points according to changes in the height of the reservoir, to be evaluated, thus changes in earthquake types for values Stress and deformation of the tank wall according to the soil structure interaction must be examined. Thus the form (8) graph deformation and stress changes in the concrete tank wall according earthquakes, Chi Chi, Elcentro, Northridge shows.

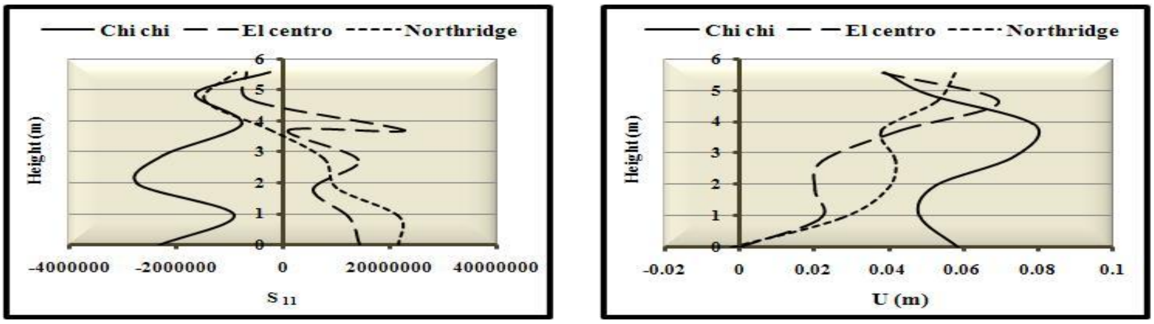

Figure 8 - Graph maximum deformation and maximum stress on the tank wall

As the chart form (8) can be seen, stress and deformation in the wall of the tank based on what what other earthquake earthquakes are more selective. The reason can be discussed in maximum acceleration and proposed for discussion. As you know the main characteristics of ground motion in three Sector overall scope, frequency content and duration of motion is seen. Dynamic range of criteria common ground, which is based on the maximum acceleration of research done in 1973 (Avkamvtv) And 1975 (Brad and Tryfvnak) intensity earthquakes are related. As the momentum mapping presented in forms (5), (6) and (7) is observed, the maximum acceleration in the acceleration of earthquake records from the Chi Chi accelerated the other peak acceleration of the mapping is more selective. Of On the other hand grab the base period of earthquake records of other earthquakes of Chi Chi is more selective. These factors caused the earthquake to effect what amounts of what the concrete tank wall deformation and stress of the other earthquakes are given more. Term basis in accordance with the definition, the first and last time exceed a value Threshold acceleration is generally equal to the threshold momentum $0.05g$ Be considered. Of course, other definitions by different researchers, the debate move the earth for long-term basis are presented.

After the Earthquake Chi Chi, Accelerated examination given by the mapping, which can receive a maximum acceleration of earthquake Northridge Elcentro earthquake is higher But the base period for the acceleration of earthquake records Elcentro Northridge earthquake is higher. This is due to the maximum deformation and maximum values of stress for the concrete tank wall Elcentro earthquake Northridge earthquake is higher. In other words, comparing the maximum amount of deformation and stress for the concrete tank wall and the Northridge earthquake Elcentro important issue can be realized for earth moving. Term effects of earthquake motion has the effect of frequency. Many physical processes such as reducing hardness, strength and so the number of cycles applied load or stress during an earthquake depends. A short-term move, even if Scope and magnitude is the maximum acceleration may cycle times to achieve a sufficient number of structures is not the final level. On the other hand a range of motion and acceleration and maximum average long-term loading cycle, can be considerable damage to the structures created. Research criteria for the effect of frequency in the earth moving is done. Mc Gyvr and Hanks in 1981 for a term relationship and magnitude of earthquake ground motion are presented. According to this relationship, duration of strong ground motion with the third root of seismic moment are related. Therefore, with increasing duration of receiving strong ground motion, earthquake effects increase. It is worth noting however that other factors like the frequency content of the earthquake and its effects are involved.

5. Conclusion

- maximum acceleration of ground motion generally used to describe domain Gzfth be an effective impact on the extent and effects of earthquakes, according to the other main characters are strong ground motion.
- The base period usually is defined based on the acceleration threshold, the role and effects of the earthquake is. Effects of a large range of motion with a short term much of an average range of motion, but with enough time, is less.
- dynamic response of buried tanks in addition to structural profile, the actions will depend on factors such as earthquake, primarily based on the main characteristics of ground motion (amplitude, duration and frequency content) is described.
- dynamic response of buried tanks in the soil, many dependent on site characteristics and soil around the tank, so it is recommended in the seismic analysis of buried tanks, and soil structure interaction effects are considered.

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