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EXTENDED ABSTRACT

Modification of Equivalent Acceleration Relation of Horizontal and Vertical Earthquakes in Ground Elliptical Tanks

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1. Introduction

Modification of equivalent acceleration relation of horizontal and vertical earthquakes in ground elliptical tanks was done in the current study. The seismic analysis of the tank is highly important because by investigating the results obtained from this analysis, a useful recognition of the tank behavior quality can be obtained at the time of a real earthquake. The results of the seismic analysis include the impulsive pressure and the wave height of fluid on different points of the tank. In Housner theory, earthquake equivalent acceleration is a key parameter in calculation of impulsive vibration mode parameters such as impulsive pressure and impulsive force. US nuclear reactors and earthquakes code presented a simple relation to calculate earthquake equivalent acceleration. To obtain more calculation accuracy in the ground elliptical tanks, a suitable equation was provided in the current study for the earthquake equivalent acceleration, by the use of principles of statistical regression. Because of less average error, the use of the equation proposed by this study instead of the equation presented by US nuclear reactors and earthquakes code, provides more accuracy in the tank design applications. By the study of the conclusions of this research, it was revealed that the accuracy index of horizontal and vertical earthquake equivalent acceleration relations developed by this research is 16% and 26% more than that of the corresponding relations of US nuclear reactors and earthquakes code, respectively.

2. Methodology

In the current study, to obtain more calculation accuracy in the ground elliptical tanks, the impulsive pressure of fluid was obtained under 8 various earthquakes in the longitudinal and transverse directions by doing the seismic analysis on 5 elliptical tanks of the ground type with the clamped floor, in the Fluent software. Then, by the use of Housner theory equations, the earthquake equivalent acceleration was calculated for each of the cases. Finally, by the performing of nonlinear statistical regression by Mathematica software, 2 equations with an acceptable precision were obtained for the horizontal and vertical earthquake equivalent acceleration.

3. Results and discussion

In Housner theory, earthquake equivalent acceleration is a key parameter in calculation of impulsive vibration mode parameters such as impulsive pressure and impulsive force. US nuclear reactors and earthquakes code presented a simple relation to calculate earthquake equivalent acceleration as follows:

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$$a_e = S_a \tag{1}$$

In the above equation, S_a is the impulsive spectral acceleration in terms of m/s^2.

The target of the current study was providing a more comprehensive equation for the horizontal and vertical earthquake equivalent accelerations, to obtain more calculation accuracy in the ground elliptical tanks, by the use of principles of statistical regression.

The plan of elliptical tank under horizontal earthquake equivalent acceleration is presented in Figure 1.

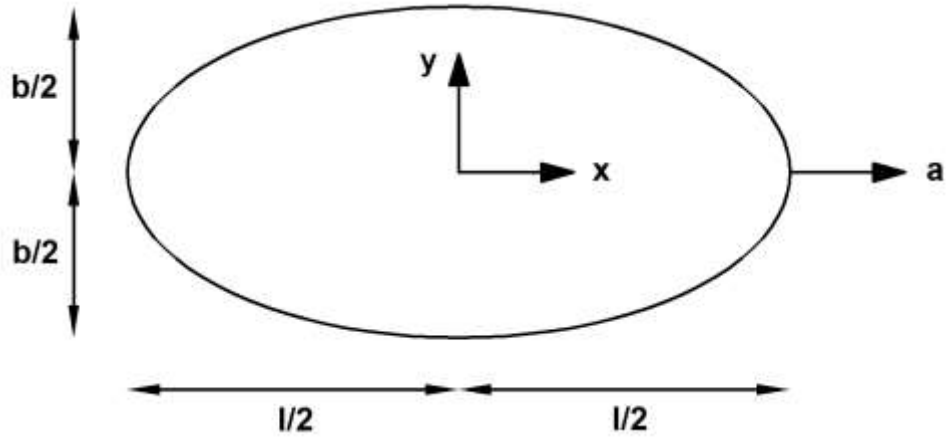

Fig. 1. Elliptical tank plan

By using the statistical regression method, the following equation was suggested for horizontal earthquake equivalent acceleration:

$$a_h = \frac{1.247 a_{des}^{1.771} (\frac{l}{b})^{0.09}}{a_{max}^{0.97}} \tag{2}$$

In the above equation, b and l are the width and length of the elliptical tank in terms of meters, respectively. Also, a_{max} and a_{des} are the earthquake maximum acceleration and earthquake design acceleration, respectively in terms of m/s^2.

Also, by using the statistical regression method, the following equation was suggested for vertical earthquake equivalent acceleration:

$$a_v = \frac{1.815 a_{vdes}^{1.48}}{a_{vmax}^{0.87}} \tag{3}$$

In the above equation, a_{vmax} and a_{vdes} are the vertical earthquake maximum acceleration and vertical earthquake design acceleration, respectively in terms of m/s^2.

The comparison of average error of US nuclear reactors and earthquakes code equivalent acceleration relation and relation (2) and relation (3) is presented in Table 1.

Table 1. Comparison of average error of relation (1) and relation (2) and relation (3)

Equation	Average Error (%)	
	horizontal	vertical
Eq. (1)	21	40
Eq. (2)	5	
Eq. (3)		14

4. Conclusions

By the use of the equations obtained from the current study, the horizontal and vertical earthquake equivalent acceleration values in the ground elliptical tanks were calculated with a higher precision. By having the earthquake equivalent acceleration value, the fluid's maximum impulsive pressure on the tank can be obtained from the Housner theory for tank loading. Because of less average error, the use of the equations proposed by this study instead of the equation presented by US nuclear reactors and earthquakes code, provides more calculation accuracy in the tank design applications.

Based on the investigations done in the current study, the following results were obtained:

1) The horizontal earthquake equivalent acceleration in elliptical tank, depends on the earthquake maximum acceleration, the earthquake design acceleration and the elongation of the elliptical tank.
2) The vertical earthquake equivalent acceleration in elliptical tank, depends on the vertical earthquake maximum acceleration and the vertical earthquake design acceleration.
3) The accuracy index of horizontal and vertical earthquake equivalent acceleration relations developed by this research is 16% and 26% more than that of the corresponding relations of US nuclear reactors and earthquakes code, respectively.

5. References

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