REVIEW STUDY ON DYNAMIC ANALYSIS OF RCC ELEVATED WATER TANK

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ABSTRACT: An elevated water tank is a water storage container constructed for the purpose of holding water at a certain height to pressurize the water distribution system. Water tanks are very important components of lifeline. They are critical elements in municipal water supply, fire fighting systems and in many industrial facilities for storage of water. Elevated water tanks are critical and strategic structures and damage of these structures during earthquakes may endanger drinking water supply, cause to fail in preventing large fires and substantial economic loss. A large number of overhead water tanks were damaged during the past earthquakes. Hence seismic behaviour of these structures during the earthquakes has to be investigated in detail in order to meet the safety objectives while containing construction and maintenance costs. So there is need to focus on seismic safety of lifeline structure using with respect to alternate supporting system which are safe during earthquake and also take more design forces.

Keywords: Elevated Water Tank, Kobe Earthquake, Modal Analysis

1. INTRODUCTION

Water is human basic needs for daily life. Sufficient water distribution depends on design of a water tank in certain area. An elevated water tank is a large water storage container constructed for the purpose of holding water supply at certain height to pressurization the water distribution system. Many new ideas and innovation has been made for the storage of water and other liquid materials in different forms and fashions. There are many different ways for the storage of liquid such as underground, ground supported, elevated etc. Liquid storage tanks are used extensively by municipalities and industries for storing water, inflammable liquids and other chemicals. Thus Water tanks are very important for public utility and for industrial structure. Elevated water tanks consist of huge water mass at the top of a slender staging which are most critical consideration for the failure of the tank during earthquakes. Elevated water tanks are critical and strategic structures and damage of these structures during earthquakes may endanger drinking water supply, cause to fail in preventing large fires and substantial economical loss.

Various steps involved in the present study are –

1. Static analysis by using Indian Standard codes (IS3370, IS11682, IS456, and IS875)
2. Dynamic analysis by Response Spectrum Method (IS1893 method)
3. Dynamic analysis by Displacement Coefficient method (FEMA 368 method)
4. Computational analysis
5. Comparison of results obtained by different methods.

Indian sub- continent is highly vulnerable to natural disasters like earthquake, draughts, floods, cyclones etc. Majority of states or union territories are prone to one or multiple disasters. These natural calamities are causing many casualties and innumerable property loss every year. Earthquakes occupy first place in vulnerability. Hence, it is necessary to learn to live with these events. According to seismic code IS: 1893(Part I): 2000, more than 60% of India is prone to earthquakes. After an earthquake, property loss can be recovered to some extent however, the life loss cannot. The main resign for life loss is collapse of structures. It is said that earthquake itself never kills people; it is badly constructed structures that kill. Hence it is important to analyze the structure properly for earth-quake effects.

2. LITERATURE REVIEW

To provide a detailed review of the literature related to dynamic analysis of elevated RCC circular liquid storage tank in its entirety would be difficult to address in this chapter. A brief review of previous studies on the application of the different methods to the dynamic analysis of liquid storage tanks is presented is this section. This literature review focuses on recent contributions related to dynamic analysis of liquid storage tanks, past efforts most closely related to the needs of the present work. Earthquakes represent an external hazard for industrial plants and may trigger accidents, i.e. fire and explosions resulting in injury to people and to near field equipments or constructions, if structural failures result in release of hazardous material. Quantitative Risk Analysis (QRA) [1] provides a guide for analysis of industrial risk; such an assessment may include the seismic threat if ground motion related malfunctioning (i.e. failure) rates are available for components [2]. From the structural perspective, steel tanks for oil storage are standardized structures both in terms of design and construction [3], [4], [5]. Review of international standards for the construction points out that design evolved slowly; therefore, a large number of postearthquake damage observations [6] are available and empirical vulnerability functions have been developed [7]. Liquid containing structures (LCS) as part of environmental engineering facilities are primarily used for water and sewage treatment plants and other industrial wastes. Normally, they are constructed of reinforced concrete in the form of rectangular or circular configurations. Currently there are few codes and standards available for seismic design of LCS in North America. In almost all of codes and standards, the Housner's model (Housner, 1963) has been adopted for dynamic analysis of LCS. The hydrodynamic pressures induced by earthquakes are separated into two parts of impulsive and convective components which are approximated by the lumped added masses. The added mass in terms of impulsive pressure is assumed rigidly connected to the tank wall and the added mass in terms of convective pressure is assumed connected to the tank wall using flexible springs to simulate the effect of sloshing motion. In this model, the boundary condition in the calculation of hydrodynamic pressures is treated as rigid. Although the Housner's model has been applied in the seismic design of LCS in the past, recent studies show that due to the assumption of the lumped added mass and the rigid tank wall, this method leads to overly conservative results. Chen and Kianoush (2005)

3. SCOPE OF THE STUDY

In this various methods of Dynamic analysis if water tank are studied. Following are the main scope of this study.

1. To study the different methods of analysis and design of water tanks.
2. To make a study about the guidelines for the dynamic analysis and design of liquid retaining structure according to IS Code.
3. To know about the design philosophy for the safe and economical design of water tank.
4. To check the computer software applicability and suitability for the dynamic analysis of RCC liquid storage tanks.
5. To check the Suitability of Displacement Coefficient method for the dynamic analysis of RCC liquid storage tanks.

4. OBJECTIVES OF THE STUDY

A RCC circular water tank of 50 m^3 capacities having following properties is selected for this study.

Internal diameter = 4.65 m
Height of circular water tank = 3.3 m (including freeboard of 0.3 m)
Lowest water level = 12 m above ground level
Density of concrete = 25 kN/m^3
Grade of concrete = M20
Grade of steel = Fe 415

It is supported on RC staging consisting of 4 columns of 450 mm dia with horizontal bracings of 300 x 450 mm at four levels. Staging conforms to ductile detailing as per IS13920. Staging columns have isolated rectangular footings at a depth of 2m from ground level. Tank is located on soft soil in seismic zone II.

The aim is to analysis this tank by using following methods.

1. Response spectrum method (IS 1893 method)
2. Displacement Coefficient method (FEMA method)
3. Computational analysis

5. CONCLUSION

From above mentioned detailed study and analysis some of the conclusions can be made as follows For same capacity, same geometry, same height, with same staging system, in the same Zone, with same Importance Factor & response reduction factor; response by Equivalent Static Method to Dynamic method differ considerably.

It also state that even if we consider two cases for same capacity of tank, change in geometric features of a container can show the considerable change in the response of elevated water tank. At the same time Static response shows high scale values that of the Dynamic response. It happens due to the different picks of time periods and hydrodynamic factors are ignored during the analysis they will affect vigorously and collapse of the structure can takes place.

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