

A Comparative Seismic Study on Elevated Storage Tank for different Frame conditions- Literature Review

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Abstract- Various formulaes and methods were formed to study the behaviour of Elevated water storage tanks. In dynamic analysis, the elevated water tank is analysed for time history analysis and response spectrum analysis. For time history analysis consider time acceleration values of past earthquake and for dynamic analysis, use seismic formulaes, magnitude, particular zone, damping, importance factor and reduction factors to study the behaviour of structures. Various staging patters were analysed to increase stiffness and to provide economy in structure. Cross bracings were provided to increase strength against lateral forces. Study number of models in different zones and in different soil conditions. Various time history ground motions were taken to study behaviour of structure and frame.

Index Terms- dynamic, elevated tank, seismic, time history, bracing, damping, stiffness etc.

I. INTRODUCTION

Storage tanks in different forms were widely used for storing water from ancient time but use of elevated tanks were not before, but now it's common to establish one elevated water tank in colonies and villages. When a particular area hit by an earthquake, these structures play an important role. Such structures hold water at some elevation, at ground and at under ground. Elevated tanks used to transfer water to longer distance under head. Housner described structure as single degree freedom system and two degree freedom system, where lumped mass is located at height. These structures require adequate cover to reinforcement to corrosion of steel and requires higher grade of concrete to avoid leakage. Water tanks are capable to handle situations before and after earthquake. Earthquake never kills people, it is structure that kills people.

II. LITERATURE REVIEWS

L. Kalani Sarokolayi et.al.

Kalani used FEM method to study the effect of six ground motions to check non-linear behaviour of structure. Different types of tanks were modelled by changing their shapes and geometries. He concluded that base shear is maximum for shorter tanks upto 6m. The structure is stiffer in lateral direction. Natural frequencies changes as elevation of water level in tank changes. It is clear that accidental torsion mainly depends on structural properties.

Y. Sonobe et.al.

Sonobe said that different vibratory characteristics present in elevated water tank. In the paper, the elevated water tank replaced with equivalent vibratory system for dynamic analysis of water tank. Sonobe took two models, one is cylindrical tank and another is spherical of same size. He performed free vibration test on both the structures and experimentally obtained the water depth and the exciting time periods of frame, then he performed vibration test on electro-magnetic vibration table. From response, it has obtained the height of water level in tank, maximum displacement and acceleration of frame.

Dr. Suchitra Hirde et.al.

Hirde presented seismic behavior of elevated water tanks for different heights and capacity for different soil conditions. The paper contains study on R.C.C elevated tanks commonly used. Paper includes 60 models for study purpose of 50000 liters capacity having full conditions and sixty models for empty condition. Then again 120 models for 100000 liter capacity. The objective of this paper is to study 240

models in seismic zones II, III, IV and V, having all three soil conditions i.e. soft, medium and hard.

Ankush N.Asati et.al.

Asati concluded that radial arrangements is best for six staging levels, then after cross and at last normal staging. The paper consist of 6, 8, 10 and 12 number of columns , but it is found that 8 columns give more economy in spite of 6, 10, and 12 number of columns. Hence, before increasing number of columns it's better to analyze after considering the structural behavior.

C. Pavithra et.al.

Pavithra concluded that the sloshing response directly depends on tank geometry, water depth and ground motions. Depth of water has big impact in finding the base shear. The displacement of tank linearly depends on depth of liquid. Soil characteristics are responsible in the behavior of the structure.

Ranjbar,M.M. et.al.

Ranjbar considered a 900 m³ capacity of water tank, the structure is analyzed for 3 records of previous earthquake in time history- using FEM techniques and mechanical. The liquid mass is taken as sloshing mass or impulsive mass. He concluded that the response of structure is always for empty, partially full and full. Earthquake properties are most important in reducing response of structure. The maximum displacement occurs in C type soil having supportive system with the joint, as per UBC – 97 classifications. The freeboard taken for the tank is 190 cm, but sloshing displacement recorded in Kocaeli record was 219cm, which is greater than the taken value.

Dr. Kamila Kotrasova et.al.

In this paper for fixed base and flexible soil elevated tank of single lumped mass model give overturning moments and base shears. It is found that subsoil conditions may groove the overturning moment and base shear. The paper concludes the total base shear and overturning moment at bottom of staging tank.

Srikanth S. et.al.

Srikanth said that roof displacement increases in frame with increase in height of staging frame. If PGA value increases, then base shear will decreases.

On increasing staging height and tank capacity the natural frequencies decreases. Earthquake ground motions highly influence structure. The paper states that high PGA value affects less as compared to low PGA value.

Dona Rose KJ et.al.

Dona concluded that using El Centro earthquake ground motions , the peak displacements are below permissible displacement. As staging height increases the nodal displacement increases. As capacity of tank increases the displacement increases. Half fill displacement values are lesser as compared to full tank capacity. For same staging condition, for half capacity of tank for the base shear is less as compared to full tank condition.

Mor Vyankatesh K .et.al.

Mor concluded that, in convective mode time period is greater as compared to impulsive mode and as structural mass increases, the time period also increases. As staging increases the horizontal forces increases with increases in capacity. Increasing capacity, changing pattern of staging and if increasing stiffness the vertical deflection in staging is reduced. For higher capacities the overturning moment is more.

Durgesh et.al.

Durgesh concluded that elevated tanks having thin walled, circular shaft behave as brittle at flexural strength. For thin walled sections the ductility is very small. Two mass idealization of Housner is more accurate as compared to one mass model of IS code. To increase ductility and lateral strength, concrete jacketing is required. Footing can be upgraded by adding extra piles to the pile cap and hence flexural strength can be enhanced by overlying of concrete.

Manish N. Gandhi et.al.

Manish considered number of bracing pattern like cross bracing pattern like cross bracing, conventional bracing, chevron bracing, diagonal bracing, k- type bracing, v-type bracing and checked displacement(mm) in every type of bracing. Base shear value decreases for alternate bracing pattern, this is because of reduction in stiffness of structure. Displacement of about 81.09% decreases in X- direction and 92.98% in Z- direction as compared to

structure without bracing. Cross bracing pattern provides less displacement as compared to other bracing pattern.

Nashigandha R.Patil et.al.

Nashigandha provided shear walls at central core for resisting lateral forces. For M1 model the base shear is minimum due to reduction in seismic weight. As bracings were provided, hence columns at the periphery stressed more.

III. CONCLUSIONS

All researchers have performed analysis by using various ground motions and past time histories to study the behavior of structure, when it is modified by means of cross bracings, staging height and staging pattern. The conclusions made by them for different modifications to frame of water tank were given as:

- It is concluded that nodal displacement increases as staging height increases.
- It is clear that subsoil conditions influence overturning moment and base shear.
- Base shear increases due to rotational components for short tanks. Kalani(2013) explained six rotational components.
- It is very important to check behavior of tank for empty, partially full and totally full tank, so that ground properties can be determined.
- On changing pattern and increasing stiffness, the vertical displacement reduced.
- for same staging condition, base shear for half tank is less as compared to full tank.
- as staging increases, the horizontal forces will also increase with increase in capacity.

Hence, it is clear that, determining behaviour of structure for different ground motions and magnitude in different time variaton, it is difficult to say that whether structure survive that earthquake. But, chances of deformations can be reduced.

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