International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 05 | May-2016 www.irjet.net p-ISSN: 2395-0072

Performance of Intez Tank Under Near Fault And Far Field Earthquake Motion

Pankita L. Patel[1], Prof. Umang Parekh[2]

[1]P.G. Student Structure Engineering Department, L.J. Institute of engineering & technology, Ahmedabad, Gujarat, India
pankita.patel24@yahoo.com
[2]Assistant professor, Structure Engineering Department, L.J.Institute of engineering & technology, Ahmedabad, Gujarat, India
parekh61umang@gmail.com

---***---

Abstract -*Elevated water tank are one of the most important lifeline structures in the earthquake region. As water tanks required to provide water for drinking and fire fighting purpose. This type of structure has large mass concentrated at the top of slender supporting structure. So extremely vulnerable under lateral forces due to an earthquake. At near fault region water tank damages more during earthquake. Elevated water tanks collapsed or damaged during earthquakes because of unsuitable design and wrong selection of supporting system.*
The aim of the study is analyses seismic effect on different shape and types elevated water tank due to near fault and far field earthquakes. So it is very important to select proper supporting system and shape of tank according to codal provisions. For this purpose study, Intez types of elevated water tanks with different staging Height 12m , 16m , 20m and different capacity. Here model two different staging profiles such as shaft and frame and simulated to near fault and far field ground motion with STAAD.PRO. Software. Here analysis time history records from past earthquake ground motion records. Seismic responses including base shear have been observed under different earthquake time history records.
Key Words:*Elevated water tank, Staging, Seismic response, Time history, near fault far field earthquakes, Staad Pro.*

1.INTRODUCTION

In the 21st century, it is inconceivable to think of a water distribution system without water tank. Water being the basic need for humanity is required to store and distribute water to areas far away from water reservoirs with the expansion of cities and growth of populationElevated water tank is the only economical alternative available to distribute water under natural head to the maximum possible area. Elevated water tank should be located at the highest level and at the center of the pipeline system. It has been noted that, several elevated tanks are damaged or entirely collapsed during the past earthquakes in all over the world.So there is need to focus on seismic safety of lifeline structure is required.

Earthquakes pose a real threat to India with 59% of its geographical area vulnerable to seismic disturbance of varying intensities including the capital city of the country.

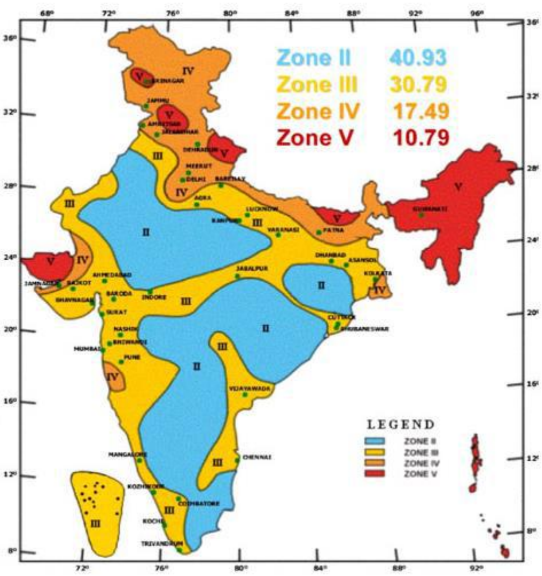


Figure 1 Seismic zones of India (Source: IS 1893:2002

1.1 Literature Survey

Tavakoli. H. R, Naeej. M, and Salari. A (2011) [7]Their objective for study was to investigate the effect of near fault and far fault earthquake motions on the response of reinforced concrete structures considering soilstructureinteraction. For this purpose, a series of linear time-history analysis wascarried out for three example buildings.For all buildings time-history analysis were performed under 3 example earthquake motions: Tabbas, Kobe and Loma Prieta. The main evaluated parameters were period of structure, base shear.

BabakAlavi and Helmut Krawinkler (2000) :The study done by them is concerned with the elastic and inelastic response of SDOFsystems and MDOF frame structures subjected to near-fault ground motions. Theglobal objective of the study is to acquire quantitative knowledge on near-fault groundmotion effects. Moreover they concluded that, equivalent pulses are capable of representing the salient response features of near-fault ground motion.

M. Davoodi , M. Sadjadi& P. Goljahani and M. Kamalian(2012) : They addressed the influence of near-fault and far-fault earthquakes with consideringsoil-structure interaction on the maximum response of SDOF system. For thatpurpose, a simplified discrete model was used to represent the real soil-structuresystem,They concluded that at low stiffness ratios, the mean value of maximum dynamic responses of equivalent SDOF system subjected to far-fieldground motions are higher than fault normal component of near-field ground motionswith forward directivity effectand near-field ground motions with fling-step effect.

Durgesh c. Rai[9]Figure 1.4 shows the water tank in Bhachau pulleddown due to severe damage in staging. Brace and column members of tanks in Manfera and Bhachau do not meet the ductility and toughness requirements for earthquake resistance.

Figure 2 Collapsed water tank in Bhachau (Source: Rai, 2003)

1.2 Active fault region

After Loma Prieta 1989 earthquake, Mohraz has divided earthquakes in 3 groups:

- Near-field earthquakes: the distance between site and fault is less than 20 km
- Mid-field earthquakes: the distance between site and fault is between 20 km to 50 km.
- Far-field earthquakes: the distance between site and fault is larger than 50 km.

Near-field earthquakes have some characteristics that differs them from far-field ones.
i. These earthquakes have higher accelerations and restricted frequency content
in higher frequencies than far-field ones.
ii. Also their records have pulses in beginning of record with high period and high domain. These pulses are much considerable when the Forward directivity takes place, therefore the records change from Board-Band condition to Pulse-Like ones.

2.MODELLING OF STRUCTURE AND EARTHQUAKE RECORDS

In this study, models of Intez shape tank with 10 lac liters, 12.5 lac liters and 15 lac liters storage capacity have been investigated. Variations are made in tanks, staging, both in height and pattern. Adapted staging heights are 12 m, 16 m, 20 m and 24 m and for each height two staging pattern, frame and shaft are taken under consideration. All the structures are made of RCC and grade of concrete is M25. Tanks are designed with perfect accordance to the Indian Standard criteria for liquid retaining structure located in seismic zone IV. Other structural configurations are as per Table 1. Figure 3 shows the finite element models of the tanks prepared in STTAD-pro.

Table -1: Dimension of intez elevated water tank capacity of 1000 lac litter

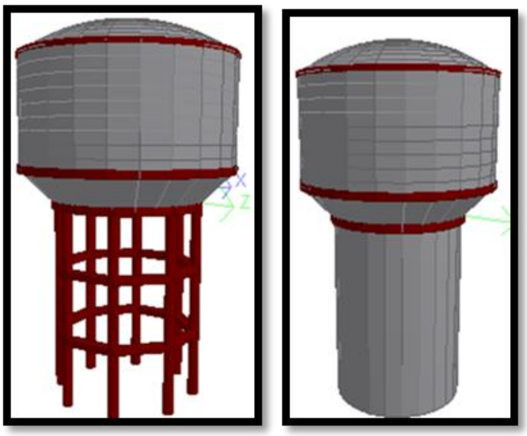
	Frame staging	Shaft staging
Diameter of top dome (m)	12.7	16.8
Thickness of top dome (m)	0.1	0.1
Dimension of top ring beam (m)	0.3×0.3	0.4×0.3
Height of cylindrical wall(m)	7.62 m	3.76
Thickness of wall (m)	0.3 m	0.2
Dimension of middle ring beam (m)	0.5×0.6	0.68×0.6
Thickness of conical dome (m)	2.6	0.4
Diameter of bottom dome (m)	0.5	12.73
Height of conical dome (m)	8.89	3.15
Thickness of bottom dome (m)	0.32	0.22
Dimension of bottom ring beam (m)	0.70×0.85	0.17×0.67
Column diameter (m)	0.7	------
Bracing beam dimensions (m)	0.4×0.55	-----
Shaft thickness (m)	----	0.17

Table -2: Dimension of intez elevated water tank capacity of 1250 lac litter

	Frame staging	Shaft staging
Diameter of top dome (m)	13.7	18
Thickness of top dome (m)	0.1	0.1
Dimension of top ring beam (m)	0.35×0.3	0.35×0.45
Height of cylindrical wall(m)	8.2	3.9
Thickness of wall (m)	0.32	0.22
Dimension of middle ring beam (m)	0.55×0.65	0.65×0.75
Thickness of conical dome (m)	2.9	0.45
Diameter of bottom dome (m)	0.5	13.5
Height of conical dome (m)	9.59	3.375
Thickness of bottom dome (m)	0.45	0.24
Dimension of bottom ring beam (m)	0.90×0.75	0.15×0.75
Column diameter (m)	0.70	------
Bracing beam dimensions (m)	0.45×0.55	-----
Shaft thickness (m)	-----	0.18

Table -3: Dimension of intez elevated water tank capacity of 1500 lac litter

	Frame staging	Shaft staging
Diameter of top dome (m)	15	19
Thickness of top dome (m)	0.10	0.1
Dimension of top ring beam (m)	0.45×0.35	0.40×0.50
Height of cylindrical wall(m)	8.4	4
Thickness of wall (m)	0.42	0.27
Dimension of middle ring beam (m)	0.85×0.76	0.75×0.85
Thickness of conical dome (m)	3.7	0.57
Diameter of bottom dome (m)	0.75	13.9
Height of conical dome (m)	9	19
Thickness of bottom dome (m)	0.5	0.1
Dimension of bottom ring beam (m)	1.2×0.95	0.40×0.50
Column diameter (m)	0.75	------
Bracing beam dimensions (m)	0.45×0.55	-----
Shaft thickness (m)	-----	0.19



(a) frame type staging (b) shaft type staging

Figure 3 Staad pro model of elevated intez type tank

2.1 Kobe earthquake record

Table -4: Seismic Characteristics Of Kobe Earthquake

Seismic Characteristic	Near fault	Far feild
Magnitude (Mw)	6.90	
Station	Nishi-Akashi	Kakogawa
EpicentralDistanc(km)	8.70	24.20
PGA (g)	0.4865	0.27
PGV (cm/sec)	35.73	21.66
PGD (cm)	10.75	7.60

To study the effect of far-field and near-fault earthquake on elevated water tank, hereKobe earthquake (1995) are taken intoconsideration. Acceleration time histories for these earthquakes are collected fropmPEER NGA database for two stations, i.e. one located in near-fault region and the other in far-field region.

Table 4 shows the seismic characteristics of Loma Prieta (1989) time history data,regarding location of the record station, Peak Ground Displacement (PGD), PeakGround Velocity (PGV), Peak Ground Acceleration (PGA).

3. RESULT AND CONCLUION

In this research attempts are made to study the seismic behavior of Elevated water tank of different storage capacity and staging system, subjected to far-field and near fault ground motion. Tanks of four different capacities have been taken to enhance the insight regarding the behavior regarding the storage capacity.Time history analysis is performed for all the models taking three KOBE earthquake records.

3.1 Base shear results

For all the water tanks considered here base shear value for time history analysis is high in case of near-fault earthquake than far-field earthquake. Figures shows the base shear values for intez type frame and shaft supported water tank of different staging height and capacity.
From graph shows that base shear value is more at near fault earthquake than far field once. Base shear value decrease as height decrease in frame staging water tank in both type of shape. But in shaft type staging base shear value increase as height of tank increase.

(a) Frame staging

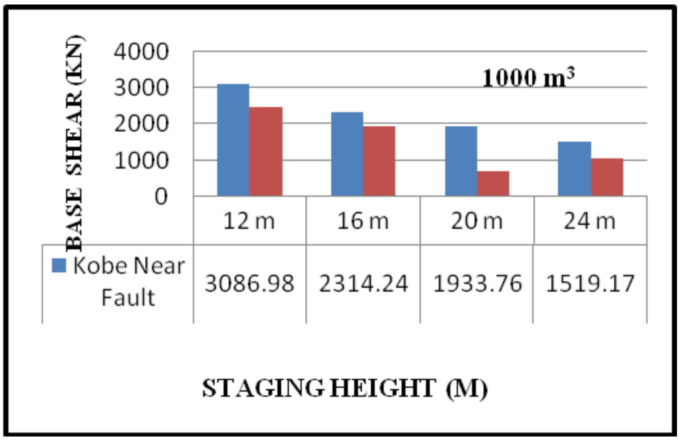


Figure 4. Base shear for 10 lac lire capacity frame type intez tank

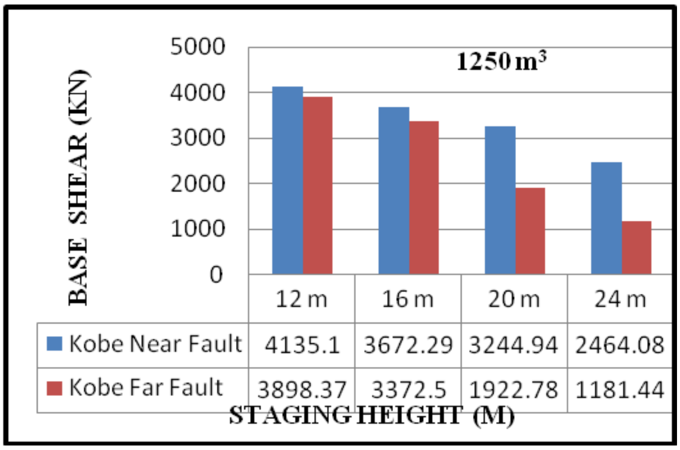


Figure 5. Base shear for 12.5 lac lire capacity frame type intez tank

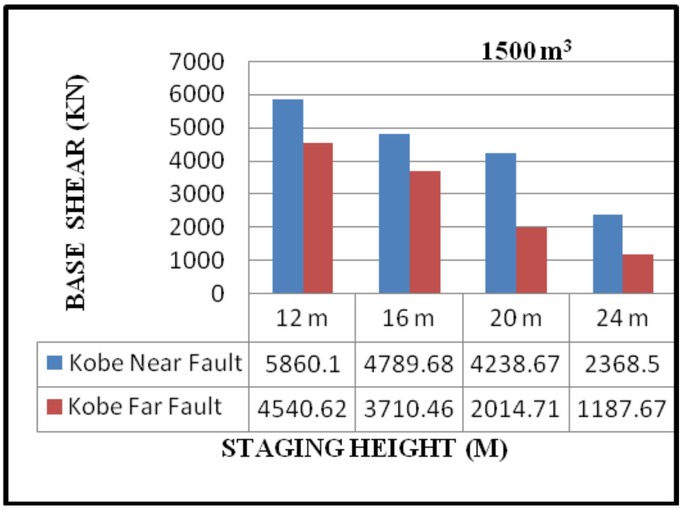


Figure 6. Base shear for 15 lac lire capacity frame type intez tank

(b) Shaft staging

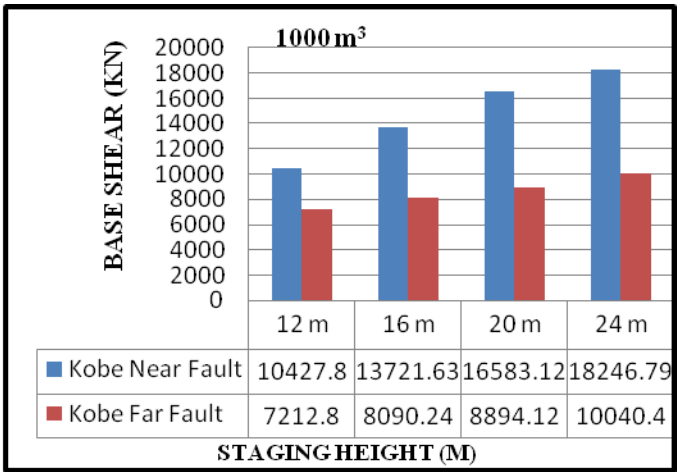


Figure 7. Base shear for 15 lac lire capacity shaft type intez tank

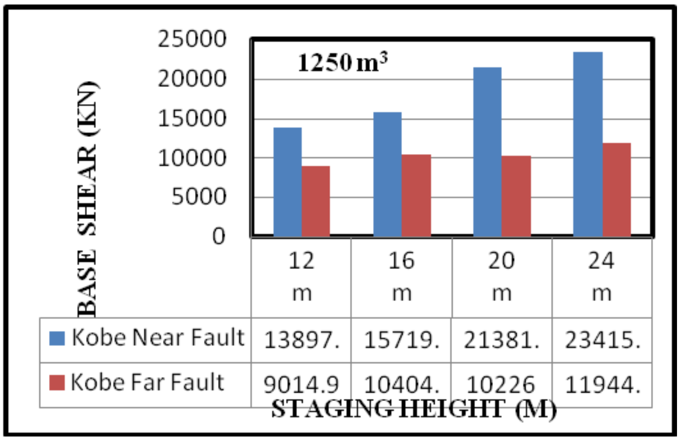


Figure 8. Base shear for 15 lac lire capacity shaft type intez tank

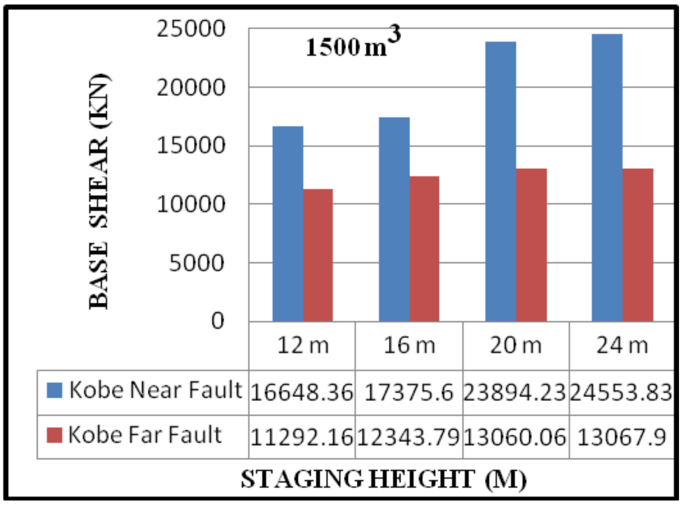


Figure 9. Base shear for 15 lac lire capacity shaft type intez tank

4. CONCLUION

STAAD.Pro analysis results are compared to do a parametric study for the structural responses of water tanks with change in staging type, shapes and staging Height. The conclusions are made based on the comparison of the results generated by time history analysis for three different types of earthquake motions.

- base shear increase with increase in storage capacity in shaft and frame staging for near fault and far field region earthquakes.
- With increase in Height for shaft type staging and both shape of water tanks base shear also increase. But in frame type staging base shear decrease with increase in Height generally. Only few cases it was increase.
- Response of the elevated water tank subjected to Near-Fault ground motion is very high as compared to Far-field ground motion for each model.
- Due to system frame type staging base shear value is more than shaft type staging.

REFERENCES

[1] Tehrani Zade. M, Haj Najafi. L, “Assessing seismic behavior of eccentrically braced frames (ebfs) due to near-field ground motions”. The 14th World Conference on Earthquake Engineering, china, 2008.

[2] Gareane A. Algreane.“Dynamic behaviour of elevated concrete water tank with alternate impulsive mass configurations.”

[3] IITK-GSDMA guidelines (2007), “Seismic design of liquid storage tanks, provisions with commentary and explanatory examples”.

[4] I.S 1893:2002, “Criteria for earthquake resistant design of structures”, Bureau of Indian Standards, New Delhi.

[5] IS 3370 (Part II) : 2009, “Code of practice for concrete structures for the storage of liquids part II reinforced concrete structures”, Bureau of Indian Standards, New Delhi.

[6] IS 456:2000, “Plain and Reinforced Concrete, Code of Practice”, Bureau of Indian Standards, New Delhi.

[7] Tavakoli.H.R, Naeej.M, Salari.A “Response of RC structures subjected to near-fault and farfault earthquake motions considering soil-structure interaction, international journal of civil and structural engineering Volume 1, No 4, 2011”

[8] Dr. Suchita Hirde,Mr. Umesh L, Raygandhi-Shaha.”Effect of Staging Height on Seismic Performance of RC Elevated water G. P. Marvroeidis, A.S Papageorigion, Near-fault ground motion and its relation to the fault rupture process, 14WCEE

[9] Durgesh C Rai, Performance of elevated tanks in Mw 7.7 Bhuj earthquake of January 26th, 2001. Indian Acad. Sci. (Earth Planet. Sci.), 112, No. 3, pp. 421-429, (2003).

[10] Pavan .S. Ekbote, “Seismic Behavior of RC Elevated Water Tankunder Different Types of Staging Pattern” Journal of Engineering, Computers & Applied Sciences (JEC&AS) ISSN No: 2319-5606 Volume 2, No.8, August 2013.