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Necessity of Dynamic Analysis of Elevated Water Storage Structure Using Different Bracing in Staging

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ABSTRACT

Water tanks are very important for public utility and for industrial structure. 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. From the very upsetting experiences of few earthquakes in India, R.C.C elevated water tanks were heavily damaged or collapsed. This was might be due to the lack of knowledge regarding the proper behaviour of supporting system of the tank due to the dynamic effect and also due to improper geometrical selection of staging. The main aim of this study is to understand the behaviour of different staging, under different loading conditions and strengthening the conventional type of staging, to give better performance during earthquake. The aim of this study is to understand the necessity of analyse conventional staging system of elevated water tank with different type bracing in staging system for elevated water tank.

Keywords: Watertank, staging, Bracing

1. I 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. 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. In general there are three kinds of water tanks resting on ground, underground tanks and elevated tanks. The walls of these tanks are subjected to pressure and the base is subjected to weight of water and pressure of soil. From design point of view the tanks may be classified as per their shape rectangular tanks, Circular tanks, intze type tanks, spherical tanks conical bottom tanks and suspended bottom tanks .The liquid storage tanks are particularly subjected to the risk of damage due to earthquake-induced vibrations. A large number of overhead water tanks damaged during past earthquake. Majority of them were shaft staging while a few were on frame staging type 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 economic loss. Since, the elevated tanks are frequently used in seismic active regions also hence, seismic behaviour of them has to be investigated in detail .Due to the lack of knowledge of supporting system some of the water tank were collapsed or heavily damages. 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. Design of new tanks and safety evaluation of existing tanks should be carried out with a high level of accuracy because the failure of such structures, particularly during an earthquake, may be disastrous. Many elevated water tanks suffered damage to their staging (support structure) in the *Mw* 7.7Bhuj earthquake of January 26th, 2001 and at least three of them collapsed. These water tanks are located in the area of a radius of approximately 125km from the epicenter (USGS). The majority of these tanks are supported on cylindrical shaft type staging which developed circumferential flexural cracks near the base. These cracks pass through the thin section of the Staging and are clearly visible from inside too (figure 1.1). RC framed stagings are not very common for elevated tanks in this part of the country. Most of the elevated water tanks undergo damage to their staging. Due to the lack of knowledge of supporting system some of the water tank were

collapsed or heavily damages. 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. Hollow circular shaft is the most popular type of staging to support a tank container. Figure no.1.2.showing poor detailing of column-brace joints. The flexure cracks in stagings were observed from the level of the first lift to several fts reaching one- third the height of the staging, as shown in figure 1.3.

Figure: 1.1. Cracks are `through' the shell thickness as seen from inside the shaft of 1000 kL Anjar Nagar Palika Tank

Figure: 1.2. Poor detailing of column-brace joints for Manfera tank

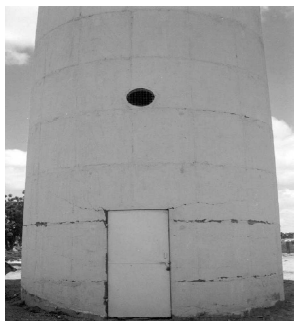

Figure: 1. 3. 200 kL Bhachau water tank which developed circumferential cracks up to one-third height of the staging. Severe cracking at the junctions of the first two `lifts'.

Figure: 1.4. Collapse of water tank in Bhuj

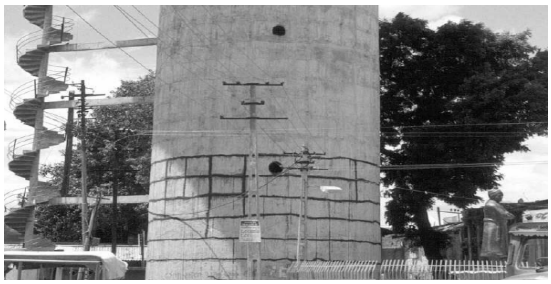

Figure: 1.5.Flexure cracks in staging

Figure: 1.6. Crack in soffit concrete under Side the staging beam of tank

Figure: 1.7.Crack in soffit concrete along the entire length of a staging

2. LITERATURE REVIEW

This chapter present the background to the need for the development of alternative staging with different bracing in elevated water tank. The available published literature on analysis of elevated water tank is also briefly reviewed.

[1] Ayazhussain M. Jabar and H. S. Patel (2012), has studied to understand the behavior of supporting system which is more effective under different earthquake time history is carried out with SAP 2000software. As known from very upsetting experiences, elevated water tanks were heavily damages or collapsed during earthquake. This was might be due to the lack of knowledge regarding the proper behavior of supporting system of the tank again dynamic effect and also due to improper geometrical selection of staging patterns.

[2] Durgesh C Rai (2003), describes about the performance of elevated tanks in bhuj earthquake of January 26th 2001. The current designs of supporting structures of elevated water tanks are extremely vulnerable under lateral forces due to an earthquake and the Bhuj earthquake provided another illustration when a great many water tank staging's suffered damage and a few collapsed.

[3] Asari Falguni & Prof. M.G.Vanza (2012) has thrown light on the results of an

analytical investigation of the seismic response of elevated water tanks using fiction damper. In This paper, the behavior of RCC elevated water tank is studied with using friction damper (FD). For FD system, the main step is to determine the slip load

[4] Hasan Jasim Mohammed (2011), studied application of optimization method to the structural design of concrete rectangular and circular water tanks, considering the total cost of the tank as an objective function with the properties of the tank that are tank capacity, width and length of tank in rectangular, water depth in circular, unit weight of water and tank floor slab thickness, as design variables.

[5] Durgesh C. Rai and Bhumika Singh(2004), studied Reinforced concrete pedestal (circular, hollow shaft type supports) are popular choice for elevated tanks for the ease of construction and the more solid form it provides compared to framed construction. In the recent past Indian earthquakes, Gujarat (2001) and Jabalpur (1997), thin shells (150 to 200 mm) of concrete pedestals have performed unsatisfactorily when great many developed circumferential tension flexural cracks in the pedestal near the base and a few collapsed.

CONCLUSIONS

From the various sources of data there are a number of conclusions:

1. For basic staging overturning moment is highest as compare to the other staging pattern.
2. The slender staging that results from the low design forces is a very unfavorable feature for seismic areas for elevated water tanks
3. The current designs of RC shaft type circular staging (supporting structure) for elevated water tanks are extremely vulnerable to lateral loads caused by earthquakes. It is evident from the damages sustained to staging as far as 125km away from the epicentral tract of the Bhuj earthquake.
4. Supporting structures of elevated water tanks are extremely vulnerable under lateral forces due to an earthquake.
5. Looking to the above literature study only frame type staging with a single row of columns placed along the periphery of a circle, are not adequate to support container of elevated water tanks. Apart from that, it is required to identify suitable modified water tank staging system by determining what improvements or added features are necessary for staging part of water tank for better performance during earthquake

REFERENCES

[1]. Ayazhussain M. Jabar and H. S. Patel, (2012) "Seismic Behavior of RC Elevated Water Tank under Different Staging Pattern and Earthquake Characteristics". International journal of advanced engineering research and studies e-issn2249–8974, IJAERS/Vol. I/ Issue III/April-June, 2012/293-296

[2]. Durgesh C Rai, (2003) "Performance of Elevated Tanks in Mw 7.7 Bhuj Earthquake of January 26th, 2001" International journal of advanced engineering research Proc. Indian Acad. Sci. (Earth Planet. Sci.), 112, No. 3, September 2003, pp. 421-429

[3]. Asari Falguni, Prof. M.G.Vanza, (2012) "Structural Control System for Elevated Water Tank" International journal of advanced engineering research and studies e-issn2249–8974, IJAERS/Vol. I/ Issue III/April-June, 2012/325-328.

[4]. Hasan Jasim Mohammed,(2011) "Economical Design of Water Concrete Tanks" European journal of scientific research ISSN 1450-216x vol.49 no.4 (2011), pp. 510-520 Euro journals publishing, inc. 2011

[5]. Durgesh C. Rai and Bhumika Singh, (2004) "Seismic Design of Concrete Pedestal Supported Tanks"13th World Conference on Earthquake Engineering Vancouver, B.C, Canada August 1-6, 2004 Paper No. 230.

Codes.

1. Draft IS: 1893 (Part-II, Liquid Retaining Tanks) Criteria for Earthquake Resistant Design of Structures,Bureau of Indian standards, New Delhi, India.
2. IS-1893(Part-I), Criteria for Earthquake Resistance Design of Structures.