Beam-Column Joint of Water Tank

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Abstract*-In areas with high probability of natural disasters, ability of lifeline systems to resist disaster related damages is one of the most important civil engineering challenges. Elevated water tanks are one of the most important lifeline structures. In this project an extensive computational study has been conducted to find out the performance of beam-column joint of elevated circular and Intze water tank under wind and seismic forces. Since these structures have large mass concentrated at the top of slender supporting structure, these structures are especially vulnerable to horizontal forces due to wind and earthquake.*

Beam-column joint of elevated Circular and Intze water tanks are analyzed with different parameters to study the effect of capacity, height of staging,. Findings of the present study shall lead us to better understanding of the behavior of beam-column joint under different staging and safer design of such structure.

Keywords*-*Intze Water Tank, Circular Water Tank, Seismic force, Staging.

I. INTRODUCTION

Stored water in raised tank is normally utilized for family unit exercises furthermore firefighting reason. Amid solid tremors safe operation of tank is a critical. The non-satisfaction of reason for these structures is scratch concern or genuine dangers to the lives as a result of shortage of water or inconvenience in firefighting at the season of quakes. The dynamic conduct of fluid stockpiling tank have been investigated in different reviews, however the majority of them have concentrated on ground level round and hollow tanks, and not very of them have endless supply of raised tanks. These are overwhelming structures with greatest part of their weight are accumulated at a rise about the bottom. Columns and Braces are the critical parts of these system through which the loads are passes to the groundwork. Because of the high affectability of raised water tanks to quake qualities, for example, recurrence substance, crest ground increasing speed and compelling length of the seismic tremor records, it appears to be important to consider the seismic tremor stacking as a non-stationary arbitrary example.

The most common types of elevated water tanks are.

- The circular tank
- The intze type tank
- The conical or funnel shaped tank.

1.1. Earthquake Damage to Liquid Storage Tanks

There are numerous reports regarding the damage to water storage tanks due to previous earthquakes in the literature. For instance, there were serious damages to both concrete and steel storage tanks during the strong seismic events such as (1933) Long Beach,(1964) Alaska, (1964) Niigata, (1966) Parkfield, (1978) Miyaage prefecture, (1979) Imperial County, (1983) Coalinga, (1994) Northridge, and (1999) Kocaeli earthquakes Rinne (1967), Shibata (1974), Kono (1980), Manos and Clough (1985), and Sezen and Whittaker (2006). Heavy damage levels were also observed in elevated water tanks during the (1960) Chilean as well as the (1997) Jabalpur and (2001) Bhuj earthquakes in India. At the time of Bhuj earthquake many elevated tanks suffered heavy damages in terms of flexural cracks in the circumferential direction in their supporting shafts near the base. Three elevated water tanks which were located in the highest intensity shaking zones also collapsed. Severe damages to cylindrical buried concrete tanks were observed in (1995) Kobe earthquake. An underground concrete tank was also damaged heavily in the form of the collapse of the wall during the (1971) San Fernando earthquake (Jennings (1971)). Failure mechanism of water storage tanks depends on different parameters such as construction material, tank configuration, tank type, and supporting mechanism. During past earthquakes reported damage to liquid containing structures (LCS) fall into one or more of the following categories:

1) Deformation in the form of buckling of the shell caused by excessive axial compression of the shell structure due to exerted overturning moment (elephant-foot buckling)
2) Deformation, cracks and leakage in side shell
3) Harm to the rooftop or the upper shell of the container, because of sloshing of the upper segment of the contained fluid in the tank with inadequate free space gave among the fluid free surface plane and rooftop.
4) Spillover of the stored water

5) Failure of piping and other accessories connected to the tank because of the relative movement of the flexible shell

6) Damage to the supporting structure in elevated water tanks

7) Damage to the anchor bolts and the foundation system

8) Failure of supporting soil due to over-stressing

1.2. Beam-column joints can be critical regions in reinforced concrete frames designed for inelastic response to severe seismic attack. As a consequence of seismic moments in columns of opposite signs immediately above and below the joint, the joint region is subjected to horizontal and vertical shear forces whose magnitude is typically many times higher than in the adjacent beams and columns. If not designed for, joint shear failure can result

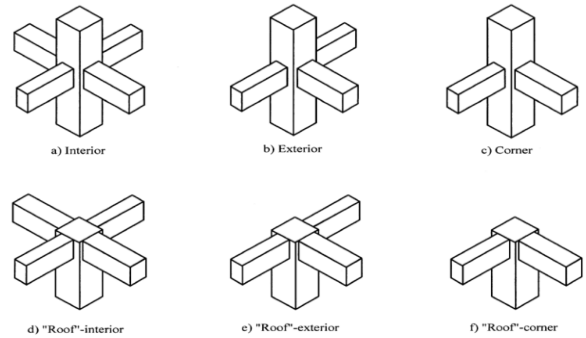
1.2.1. Design of joints

Joint types According to geometrical configuration Interior, Exterior, Corner According to loading conditions and structural behavior Type-I, Type-II

Interior joint: - As shown in Fig. An interior joint has beams framing into all four sides of the joint. To be classified as an interior joint, the beam should cover at least ¾ the width of the column, and the total depth of shallowest beam should not be less than ¾ the total depth of the deepest beam.

Exterior joint: - As shown in Fig. An Exterior joint has at least two beams framing into opposite sides of the joint. To be classified as an exterior joint, the widths of the beams on the two opposite faces of the joint should cover at least ¾ the width of the column, and the depths of these two beams should not be less than ¾ the total depth of deepest beam framing in to the joint.

Corner joint: **-** As shown in Fig. A Corner joint has at least one beam framing into the side of the joint. To be classified as a corner joint, the widths of the beam on the face of the joint should cover at least ¾ the width of the column.



According to loading conditions and structural behavior:-

Type1- Static loading Strength important, Ductility secondary A type-1 joint connects members in an ordinary structure designed on the basis of strength, to resist the gravity and wind load.

Type2-Earthquake and blast loading Ductility + strength, inelastic range of deformation, Stress reversal A type-2 joint connects members designed to have sustained strength under deformation reversals into the inelastic range, such as members designed for earthquake motions, very high wind loads, or blast effects.

1.3.Loading systems :- The structures are being imposed by many loads e.g. dead load, live load, imposed(wind) load, snow load, earthquake load etc. The structures have to be designed in such a way that they can bear these loads to overcome the collapse or failure of the structures. Today the earthquake resistant structures are being designed more widely. To understand the behavior of the structures in the earthquake, the researchers are applying cyclic loading to the building in the laboratory.

Types of Loading systems :- The behavior of building is studied with different types of loads.

1) 1) Static loading: - Static means slow loading in structural testing. Test of components:-Beams(bending),column (axial),beams and columns Purpose of testing:- Determine strength limits Determine the flexibility/rigidity of structures
2) Quasi-static loading:- Very slowly applied loading in one direction (monotonic)
3) Quasi-static reversed cyclic loading:-Very slowly applied loading in both direction (cyclic)
4) Dynamic (random) loading:- Shake at the base or any other elevation of the structure shaking similar to that during earthquakes.

Monotonic Loading:- The Monotonic loading can be defined as very slowly applied loading in one direction it may be in upward or downward direction. In Monotonic loading for the failure of the member the load is maximum. Therefore, the structures must be designed for monotonic loading. If the structures are designed as per monotonic loading, the structures are safe in other loading systems

II. OBJECTIVE OF WORK

The extent of present research work is restricted to taking after auxiliary contemplations:

- Elevated water tank is analyses for capacity of 9 lack liter.
- The analysis is carried out using STAAD-Pro. Software.
- Seismic analysis is carried out for intze and circular flat base water tank.
- Analysis of Beam- column Joint by IS 13920:1993.
- Comparison of design parameters

III. LITERATURE SURVEY ON DIFFERENT ELEVATED TANK'S BEAM-COLUMN JOINT

1. *M. MOSLEMI, M.R. KIANOUSH, W. POGORZELSKI (2011)* The concentration of the present review is to assess the execution of raised stacking. In this review, the limited component (FE) strategy is utilized to examine the seismic reaction of fluid filled tanks with seismic tanks. In this review complexities manages displaying of the tapered formed tanks are talked about. This review demonstrates that the proposed limited component method is fit for representing the liquid structure association in fluid contains structures. Utilizing this strategy, the investigation of fluid sloshing impacts in tanks with complex geometries, for example, cone like tanks is made conceivable. The registered FE time history results were additionally contrasted and those acquired from current practice and a decent understanding was watched. This confirms the legitimacy of the momentum hone in assessing the seismic reaction of fluid filled lifted water tanks. It ought to be noticed that this review was approve to just a single hoisted tank subjected to a particular ground movement. As a continuation of this examination consider, a parametric review can be done to decide the impact of different tank and shaft measurements and also unique ground movements on reaction.

2.*FALAK PARIKH AND VIMLESH AGARAWAL [2013]*the conduct of fortified solid minute opposing casing structures in late seismic tremors everywhere throughout the world has highlighted the results of poor execution of reinforcement section joints. Substantial measure of research did to comprehend the unpredictable components and safe conduct of reinforcement section joints has gone into code proposals. This manuscript gives basic survey of proposals of settled codes with respect to outline segment profundity and shear quality parts of shaft section joints

3. *HARSHAL NIKHADE, AJAY DANDGE, ANSHUL NIKHADE*In this paper a Seismic constrain on water tank is computed by IS 1893-1984 code. The new draft code is broadly coursed however it is not yet embraced. There are numerous parameters normal in both the codes while the draft codes take estimations of even shear compel, shear minute, sloshing wave stature, day and age and so on in imprudent and convective modes with expansion to different parameters. In this paper arrangements of existing codes are contrasted and the draft code. A portion of the discoveries of the examination are likewise exhibited. The draft code considers different parameters like convective and indiscreet loadings, it is observed to cover numerous aspects identified with seismic stacking. keeping in mind the end goal to Study the outline of raised roundabout water tank the organizing framework seismic compel figuring 3 tanks of 1000m3 ,2000m3 ,3000m3 limit where plan according to arrangement of IS 3370(Draft codes) two diverse design i,e, tube shaped and Intze sort were picked. From the concentrate this paper i see the conclusion is Time Period if there should arise an occurrence of Convective mode is observed to fluctuate between 4 sec to17sec.For medium soil condition Sa/g is computed utilizing recipe 1.36/T , bringing about low estimations of Sa/g. For structures there is impediment on day and age on 4 sec according to 1893-2002 section II However these constraints are expelled from code for tank. The over the top lower estimations of Sa/g result in exceptionally bring down estimation of base shear in convective mode which require reevaluation.

IV. METHODOLOGY

In this paper the study is carried out on reinforced cement concrete of intz and circular flat base water tank which are commonly used in practice. With a specific end goal to look at the seismic reaction of different models have been modeled using STAAD- PRO software. For each case response spectrum method has been discussed. Review of cement and steel utilized are M30 and Fe415. In analysis special moment resisting frame (SMRF) are considered. Elevated water tanks having 900000 liter capacity with staging heights of 3m @ 4Nos.of each panel are considered for study. Complete analysis is carried out for dead load, tank full and tank empty condition & seismic load. All combinations are Considered as per IS 1893:2002.

The Structure is designed by IS 13920:1993, ACI 318-05 and EN 1998:2004. Breaking down section to shaft minute limit proportion (MCR) at most extreme minute, at zero hub stack and at plan hub stack.

Reinforcement section joints in a strengthened solid minute opposing casing are essential zones for exchange of burdens viably between the associating components (i.e., pillars and segments) in the framework and hence shear strength checked and design by Draft provisions in IS 13920:1993,ACI 318-05.

V. CONCLUSION

Thorough study is necessary for comparing beam-column joint of intz water tank and circular water tank and form studying it is found that:-

1) As load increases displacement, minimum stress and maximum stress also increases.

2) For fixed support condition for corner and exterior joint the displacement, minimum stress and maximum stress values are minimum as compare to hinge support condition.

3) The behavior of corner beam column joint is different than that of the exterior beam column joint

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