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Review Paper on Over Head Liquid Retaining Structures

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Abstract: ***This paper concerns on the study of dynamic analysis of RCC over head liquid retaining structure which is basically used to store water, chemicals, petrol and other liquids. So safety of liquid storage tank is important during earthquake, because due to earthquake there will be occurrence of heavy damage due to sloshing of liquid. So the study of dynamic analysis of structure is more important. In over head tank staging will play important role during earth quake, since the staging or bracing will help the overhead tank to maintain its CG and stiffness center. Since there is a lack of knowledge about staging pattern and cause of the failure of structure or damage in tank and due to serviceability and sloshing of liquid. So the main study of this paper is to understand the behavior of different staging pattern, seismic behavior of over head water tank and design method of the over headwater tank according to IS:3370 (Part I-IV) for liquid retaining structure.***
Keywords: W.S.M, L.S.M, seismic analysis, response spectrum analysis, tank staging.

I. INTRODUCTION

As we know water is a prime need for human life, so capacity of water tank also play important role which depends up on the number of population which it is intended for serving. We also know that there are different types of water tanks like underground, ground supported, and elevated which are available to full fill the demand of public and the demand of industries. An over head or elevated water tank has large capacity of storage of water of water which is capable for the supply of water to large population. So for sufficient supply of water or distribution of water by use of gravity, basically storage is done using elevated tank since it is easy to attain pressure head in the distribution pipe lines. During earth quake staging part of tank play very important role because staging helps to maintain CG and stiffness center of OHWT [5]-[8]. Due to lack of knowledge of load transfer mechanism the damage of OHWT will occur. Hence thorough analyses for earth quake with different bracing pattern tell us about design of water tank. In water storage tank WSM is generally adopted because to avoid the cracks.

II. RESPONSE SPECTRUM METHOD

This method is applicable for those structures where modes other than the fundamental one affect significantly the response of the structure [7]. In this method the response of MDOF system is expressed as the superposition of modal response, each modal response being determined from the spectral analysis of SDOF system, which is then combined to compute the total response [7].

III. TWO MASS MODEL

Two mass model for elevated tank was proposed by Housner (1963) most of the water tanks are never gets completely filled with water due to continuous supply of water. So basically two mass models is more appropriate than the one mass model. In two mass models elevated tank containing the liquid with free surface is subjected to horizontal earth quake ground motion. Due to this motion (ground motion) liquid get accelerated [1],[3]-[4]. The liquid in the water tank behave like impulsive and connective mass. The liquid in the lower region of tank behave like impulsive mass and which is accelerated along with wall and exerts impulsive hydrodynamic pressure on the base or wall of the tank. And the liquid in the upper region of tank also exerts connective hydrodynamics pressure on the base or wall of the tank.

IV. LITERATURE REVIEW

Various literatures has presented in the form of technical papers on the Seismic analysis of OHWT. Various issues and the points are covered in this review like seismic analysis of various cities as per seismic zones, hydrostatic pressure, and response spectrum method and tank with different staging pattern, depending on this study of design method of OHWT by LSM AND WSM as per IS:3370 code. Some of those are discussed below:

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M. Jabar, H. S. Patel; Issue III/April-June, (2012) This paper specify the behavior of supporting system or staging which is more effective in earth quake. In this paper two different type of bracing were used, they are cross and radial bracing. During earth quake water tanks become heavy damage or collapse due to sloshing of liquid since due to lateral force there is huge deflection and to avoid for frame to avoid sway we require a supporting system which will counteract the lateral deflection. So this paper help us to understand the behavior of supporting system under different staging type[2].

Jindal Bharat Bhushan, March (2012) The conclusion of this paper is that the size of member remain same for working stress method by both IS 3370(1965) or 3370(2009)and Requirement of area of steel increased in IS:3370(2009) as the allowable stresses in steel were lower. And the size of member or requirement of steel decreases for LSM by 3370:2009 as compare WSM by IS 3370:2009 or 3370:1965 [9].

Neeta K. Meshram, Dr.P.S.Pajgade, August(2014) The steel quantity is more for a reservoir by WSM as compare to LSM. And if we want to design a water tank by LSM, the crack width calculation is necessary. The recent introduction of the LSM of design in IS:3370 Part 2:2009 and IS 456 : 2000 with crack width limit of 0.2 mm and in line with international codes of practice is found to results in more rational and economical design method [10].

Mandar M. Joshi, April (2017) There are number of damages or collapse occurrences in water tank during earth quake so design or analysis of water tank is crucial. These structures must remain functional even duringand after the earthquake. Most elevated water tank are never completely filled with water. Hence, as per this paper a two- mass idealization of the tank is more appropriate as compared to one-mass idealization [11].

Sneha S. Shende, Sanjay Bhadke and Amey R. Khedikar, April(2016)In water storage structure, working stress method is generally adopted. As there is continues triangular variation in the pressure inside so there is need for high safety factor and more traditional approach to account for this variation. More over working stress method offers more serviceability when compared to L.S.M. which extends the life span of the structure. In the design of water tank strength and serviceability is the main factor. As far as serviceability is concerned the section has to be designed in such a way that no cracking is permitted which will otherwise upset its functionality. Thus to prevent the formation of crack and service load we need to be use WSM method in which permissible stresses are used. Cracking of concrete will occur when ever the tensile strength of the concrete is exceeded. Cracks affect the serviceability of the structure and for the design of the water tank by limit state method excessive crack width needs to be considered [12].

Kaviti Harsha, September (2015) In this paper the base shear, time period and base moment obtained by connective mode vibration which is more than the impulsive mode. Also results proved that in full tank condition base shear and base moment is more than in the empty condition. Also the results prevailed that lateral force is also more in full tank condition when compared with empty condition. Hence full tank condition is considered critical for seismic analysis and design [13].

V. CONCLUSION

As per the above review papers, it's been observed that WSM is an elastic method which gives safety in serviceability as compared to LSM which is plastic method; this method gives importance for strength and also extends the life span of the structure by limiting the crack width of the section. The WSM gives more area of reinforcement steel hence in WSM there is no need to check the crack width. But the LSM gives less area of reinforcement of steel and hence the check for crack width has to be done and the maximum limit as per IS:456-2000 is 0.2mm. The tank full is the critical condition for the seismic analysis and seismic resistant design is based on it, since water is not completely filled in tank hence as per Housner (1963) Two mass model approach is better suited for the dynamic analysis of OHWT. In the response of MDOF system which is expressed as the superposition of modal response and each modal response being determined from the spectral analysis of SDOF system, which is then combined to compute the total response. By this the dynamic analysis is completed. The papers suggests that by change in the staging pattern, the load transfer mechanism in the OHWT is different for different system.In case of Full condition, highest base shear is obtained for radial bracing as compared to cross bracing and for basic staging overturning moment is highest in half-full condition. Hence the staging pattern plays a vital role in the seismic prone area.

A. Notations

CG: Center of gravity
W.S.M: Working Stress Method
L.S.M: Limit State Method
OHWT: Over Head Water Tank
MDOF: Multi Degree of Freedom

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SDOF: Single Degree of Freedom

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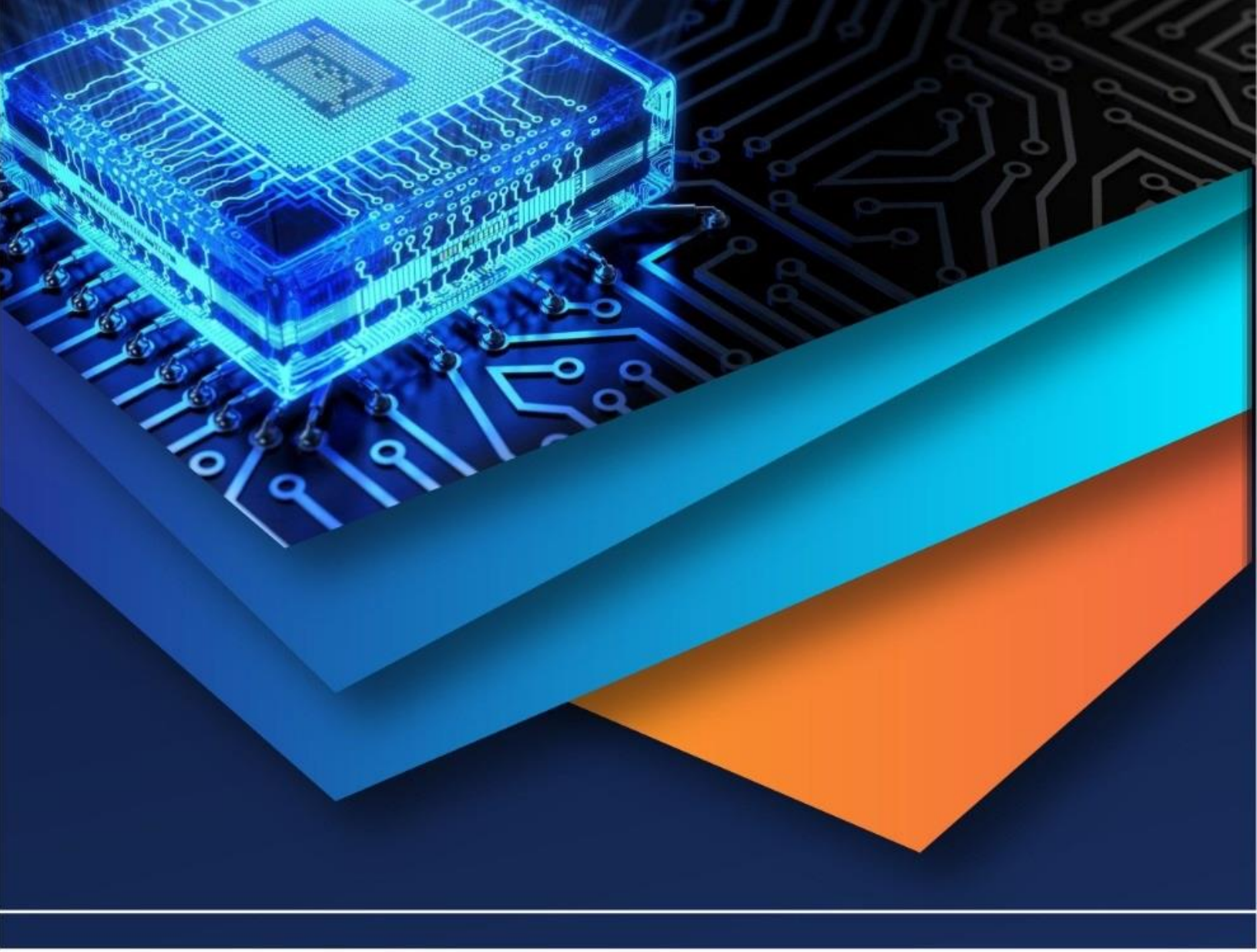

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