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A Parametric Study on Geometric Optimization of Intze Tank

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Abstract *— In this paper the original approach to the parametric study on geometric optimization of intze tank is investigated considering the draft code (IS-3370). The main focus of studying this topic is to identify the major parameter affecting the storage of intze type water tank. The intze tank shape was optimized based on different parameters like diameter, slope, height, top dome and bottom dome. The basic parameter like height of water tank from ground, capacity of intze tank are tacking constant here. A mathematical model and excel sheet is develop, and the model result were validates using available data from advanced reinforced concrete design by Krishna Raju. The algorithms of different parameters are created to get optimum geometric design*

Keywords*-Optimization, Parametric study, Geometric optimization, Intze tank, Optimization*

I. INTRODUCTION

The elevated water tank are public utility structures and considered as important city services in major cities and villages. An elevated water tank is a large water storage container constructed for the purpose of holding water supply to pressurization water distribution system. Now a day's intze tank are considered as most stable geometric configuration due to its shape. Since the intze type tank container has an optimal load balancing shape and it is widely preferred. This type of container and supporting structure has been extensively used in India since last few decades. The most common types of elevated water tanks are.

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

Circular tanks with a horizontal or flat floor slab is economical for smaller storage capacity of up to 200,000 liters and diameters in the range of 5 to 8 m. depth of the storage is between 3 to 4 m generally. The side walls are designed for circumferential hoop tension and bending moment since the walls are fixed to the floor slab at the junction. The design forces are determined using coefficients recommended in IS:3370 (part IV).

In case of large diameter elevated circular tanks, thicker floor slabs are required resulting in uneconomical domes. In such cases, Intz type tank with conical and bottom spherical domes provides an economical solution. As all of we know that measure of good civil engineering structure is economy in its design. Design of a intze tank involves proportioning and structural design, in which proportioning part mainly depends upon geometric aspects. Optimum cost design of such a structure needs several trial design. In present study, an optimum cost design of intze tank considering geometric and structural design aspects. The cost of the intze tank has been considered as the objective function and the geometric parameters have been considered as constraints.

Referring to Figure 1 the various structural elements of an intz type tank comprises of the following

- Top spherical dome
- Top ring beam
- Circular side walls
- Bottom ring beam
- Bottom spherical dome
- Conical dome
- Bottom circular girder
- Tower with columns and braces
- Foundations.

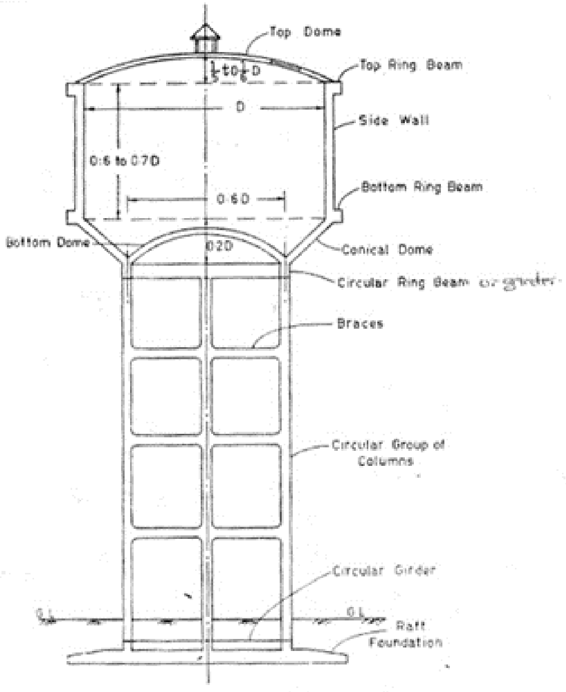

Figure 1: Structural elements of intze type tank

II. LITERATURE SURVEY ON DIFFERENT ELEVATED TANK'S CONFIGURATION

2.1. SEISMIC RESPONSE OF LIQUID-FILLED ELEVATED TANKS BY M. MOSLEMI, M.R. KIANOUSH, W. POGORZELSKI (2011)

The focus of the current study is to evaluate the performance of elevated loading. In this study, the finite element (FE) technique is used to investigate the seismic response of liquid filled tanks with seismic tanks. In this study complexities deals with modelling of the conical shaped tanks are discussed. This study shows that the proposed finite element technique is capable of accounting for the fluid-structure interaction in liquid contain structures. Using this method, the study of liquid sloshing effects in tanks with complex geometries such as conical tanks is made possible.

The computed FE time history results were also compared with those obtained from current practice and a good agreement was observed. This verifies the validity of the current practice in estimating the seismic response of liquid filled elevated water tanks. It should be noted that this study was validate to only one elevated tank subjected to a specific ground motion. As a continuation of this research study, a parametric study can be carried out to determine the effect of various tank and shaft dimensions as well as different ground motions on response.

2.2. SHAPE OPTIMIZATION OF RC FLEXURAL MEMBERS BY D. P. RATH, A. S. AHLAWAT, AND A. RAMASWAMY

The shape optimization of reinforced concrete flexural members a natural velocity field method has been demonstrated here. The objective function is the total cost, of material, fabrication, and placement costs. Material and formwork cost of concrete is directly depended to the volume of concrete. Consider two different diameters of bars to provide the same area of steel. One gives the required number of bars, providing an area of steel very close to the required, and the other provides a much higher area than that required one. so that, selection of a bar diameter affects the cost of the design. The required area of steel varies section due to change in the shape and dimension of the section, but different bar diameters at different sections cannot be used to provide a practical design. It makes optimization of the diameter and number of bars more complex. Genetic algorithms (GA) has been used to optimize the diameter and number of bars, as the available standard bar diameter is a discrete design variable. Example problems, viz, a simply supported beam, a cantilever beam, and a two-span continuous beam, have been solved to demonstrate the approach. The results show a significant saving in material. The demonstrated possibility of considerable saving in material by full shape optimization. The self-weight has not been updated in the revised design, although it decreases as shape approaches an optimal. It is expected that the consideration of self-weight would result in a further saving in material.

2.3. INELASTIC SEISMIC TORSIONAL BEHAVIOUR OF ELEVATED TANKS BY S. C. DUTTA, S. K. JAIN, C. V. R. MURTY

This paper studies the possibility of torsional behavior of elevated water tanks due to such small accidental eccentricity in inelastic range with detailed case studies, using two simple systems with two coupled lateral torsional degrees of freedom and, Strength-deteriorating and elasto-plastic hysteresis models. The systems are capable of retaining the characteristics of two extreme categories of water tanks namely, (a) tanks on staging with less number of columns and panels and (b) tanks on staging with large number of columns and panels. The study shows that the presence of a small eccentricity may lead to localized unsymmetrical yielding in some of the reinforced concrete staging elements. This may lead to progressive strength deterioration through successive yielding's in same elements under cyclic loading during earthquakes. Such localized strength drop may increasingly develop large strength eccentricity resulting in large localized inelastic displacement and ductility demand, leading to failure.

Small accidental eccentricity may cause asymmetrically localized yielding in the staging members due to unequal displacement of staging edges caused by coupled lateral torsional vibration. This large is placement and ductility demand cannot be accommodated in reinforced concrete members. Hence, this may result in a collapse due to torsion as observed in the elevated tank collapsed in 1993 Killari, India, earthquake

2.4. DYNAMIC ANALYSIS OF CIRCULAR WATER TANK AND STUDY OF RELEVANT CODAL PROVISION BY HARSHAL NIKHADE, AJAY DANDGE, ANSHUL NIKHADE

In this paper a Seismic force on water tank is calculated by IS 1893-1984 code. The new draft code is widely circulated but it is not yet adopted. There are many parameters common in both the codes while the draft codes take calculations of horizontal shear force, shear moment, sloshing wave height, time period etc. in impulsive & convective modes with addition to other parameters. In this paper provisions of existing codes are compared with the draft code. Some of the findings of the comparison are also presented. The draft code considers various parameters like convective and impulsive loadings, it is found to be covering many facets related to seismic loading. in order to Study the design of elevated circular water tank the staging system seismic force calculation 3 tanks of 1000m3,2000m3,3000m3 capacity where design as per provision of IS 3370(Draft codes) two different configuration i,e, cylindrical and Intze type were chosen.

From the studying this paper i notice the conclusion is Time Period in case of Convective mode is found to be varying between 4 sec to17sec.For medium soil condition Sa/g is calculated using formula 1.36/T , resulting in very low values of Sa/g. For buildings there is limitation on time period on 4 sec as per 1893-2002 part II However these limitations are removed from code for tank. The excessive lower values of Sa/g result in very lower value of base shear in convective mode which need reconsideration.

2.5 SIMPLIFIED SEISMIC ANALYSIS PROCEDURES FOR ELEVATED TANKS CONSIDERING FLUID–STRUCTURE–SOIL INTERACTION BY R. LIVAOGLU, A.DOGANGLIN

This paper presents a review of simplified seismic design procedures for elevated tanks and the applicability of general-purpose structural analyses programs to fluid–structure–soil interaction problems for these kinds of tanks. Ten models are evaluated by using mechanical and finite-element modelling techniques. An added mass approach for the fluid–structure interaction, and the massless foundation and substructure approaches for the soil–structure interactions are presented. The applicability of these ten models for the seismic design of the elevated tanks with four different subsoil classes are emphasized and illustrated. Designers may use the models presented in this study without using any fluid and/or special soil elements.

The seismic design of elevated tanks is using single lumped-mass models provides smaller base shears and overturning moment in both fixed-base with flexible soil conditions. These circumstances may lead to unsafe seismic design of R/C elevated tanks. The period values were estimated to be near to 2s for these models. The seismic design of the R/C elevated tanks, based on the rough assumption that the subsoil is rigid or rock without any site investigation, may lead to a wrong assessment of the seismic base shear and overturning moment. Three or more times larger base shears may be obtained, especially for subsoil of class D. Generally, small base shear and overturning moments are obtained for soft soils. Sometimes, lateral displacements are ignored in the design. However, they may reach three or more times larger values and these large displacements lead to instability of the elevated tank.

III. CONCLUSIONS

1. From the full shape optimization a demonstrated possibility of considerable saving in material. The self-weight has not been updated in the revised design, although it decreases as shape approaches an optimal one. It is expected that the consideration of self-weight would result in a further saving in material.
2. A Small accidental eccentricity may cause asymmetrically localized yielding in staging members due to unequal displacement of staging edges caused by coupled lateral torsional vibration.

3. Time Period in case of Convective mode is found to be varying between 4 sec to17sec.For medium soil condition Sa/g is calculated using formula 1.36/T , resulting in very low values of Sa/g. For buildings there is limitation on time period on 4 sec as per 1893-2002 part II However these limitations are removed from code for tank.
4. The period values were estimated to be near to 2 s for these models. The seismic design of the R/C elevated tanks, based on the rough assumption that the subsoil is rigid or rock without any site investigation, may lead to a wrong assessment of the seismic base shear and overturning moment.

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