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Variation of Seismic Forces with Volume of Liquid for Elevated Tank

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ABSTRACT

Now a day's large storage capacity tanks are designed to facilitate need of human being, and as such the seismic analysis and design for these large storage tanks has become more important. Circular elevated water tank gives more economical results and performance in seismic region. Hence, circular water tank has been adopted for study. Performance of elevated water tank has been studied as per IS 1893-2002 (Draft) with IITK-GSDMA guidelines. The analysis is carried out for staging height ranging from 3m to 45m. Seismic forces on elevated water tanks are calculated and different parameters such as time period, base shear and base moment are presented. The objective of this paper is to study the influence of staging height on elevated water tank. Finite element software ETABS has been used.

KEYWORDS

Seismic forces, ETABS, Staging height.

1. Introduction

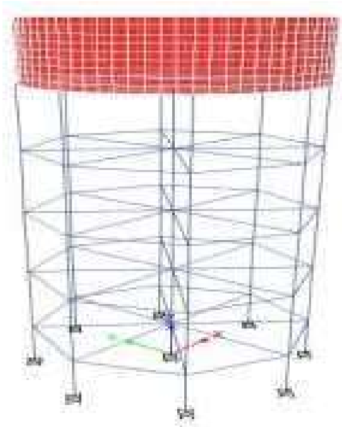
Elevated water tanks are mainly used for water supply and fire protection. One of the major problems that may lead to failure of these structures is earthquakes. Therefore the analysis of elevated tank must be carefully performed. Elevated water tanks consists of large mass of water at top of its staging which are the most critical consideration for failure of water tank structure. Due to faulty analysis and design of supporting system of elevated tanks some of them where collapse or damage. Framing system and staging height are the most important aspects of elevated water tanks as they differ as seismic zone changes. Staging height is governing factor as for as stability of elevated water tanks are concern. Present study is primarily focused on understanding seismic behavior and influence of staging height on the base shear characteristics of elevated circular water tank

2. Methodology

In the present paper different staging heights of elevated water tanks are used for analysis. Water tanks are model with the help of ETABS software. Spring mass model as per IS 1893:2002 (Draft) has been used to evaluate the seismic base shear, time period, base moment.

2.1 Model Description

Circular elevated water tank having capacity of 100 m3 is taken for the study. D/H ratios of tanks are kept as Considering M30 grade of concrete. Fifteen models are prepared having staging height ranging from 3m to 45m.



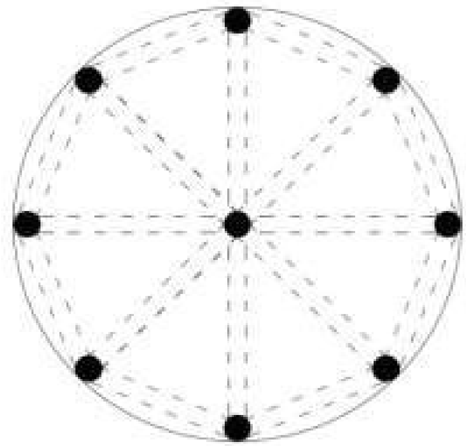


Fig No 1 Circular Model (Plan)

Preliminary Data

Details of sizes of various components and geometry are shown in table -3

Table No 1 Size of various components

Component size	mm
Roof slab- thickness	120
Wall- thickness	150
Floor slab- thickness	250
Floor beams	300 X 600
Braces 300	300 x 450
Columns	450 dia. (9 no.s)

Table No 2 Seismic data used for analysis

Zone factor (Z)	0.24
Importance factor (I)	1.5
Response reduction factor (R)	2.5
Soil type	Medium

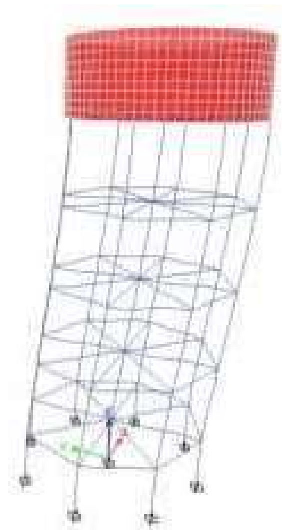
2.3 Analysis and Calculation

Equivalent static analysis, modal analysis and response spectra analysis was carried out on above models. Tanks are model in finite element software ETABS. The walls are modeled as shell element, slabs are model as

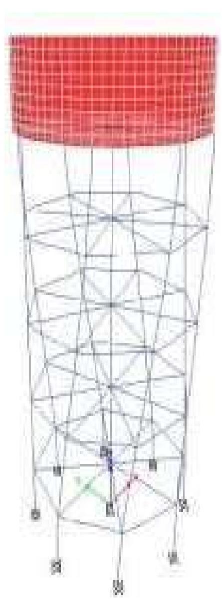
2.2 Modal Analysis

Modal analysis is used to determine natural mode shapes and frequencies of an object or structure during free vibrations. Followings are the mode shapes of circular elevated water tank having critical staging height 12m.

Mode 1



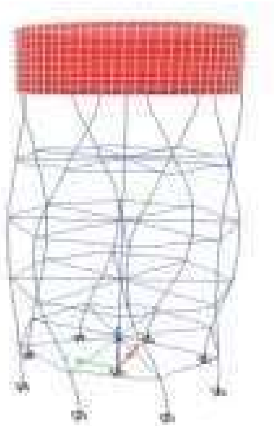
Mode 2



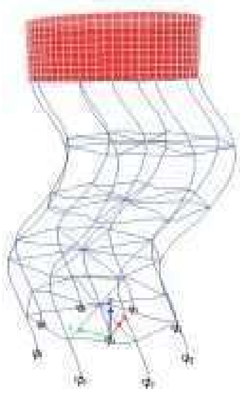
mode

Mode 3

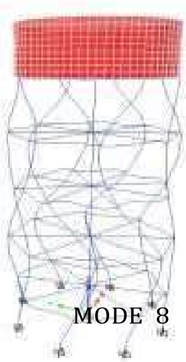
Mode 4



Mode 5 Mode 6



MODE 7 MODE 8

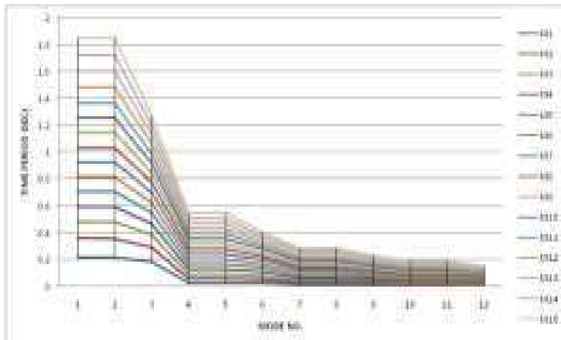


MODE 8 MODE 9

3. RESULTS AND DISCUSSION

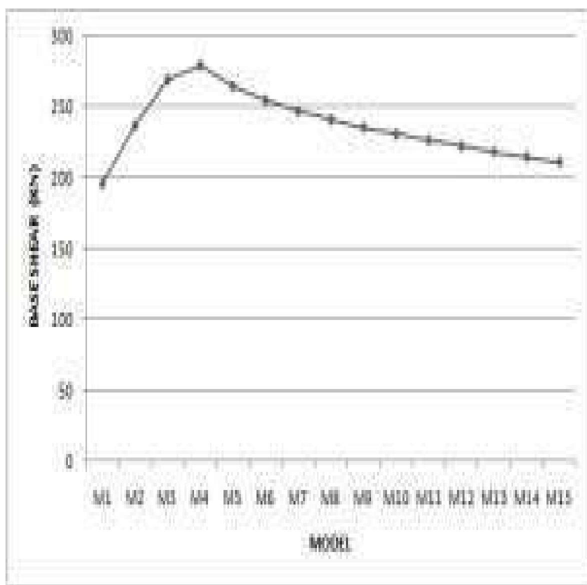
In this case we are going to consider elevated water tank having 200 m3 capacity with staging height 12m, 15m, 18m, 21m, 24m, considering 3m height of each panel for the study. We are finding out whether the height of staging has an influence on base shear characteristics and along with that we are interested to know about the critical height at which the increasing base shear start decreasing after certain height

3.1 TIME PERIOD



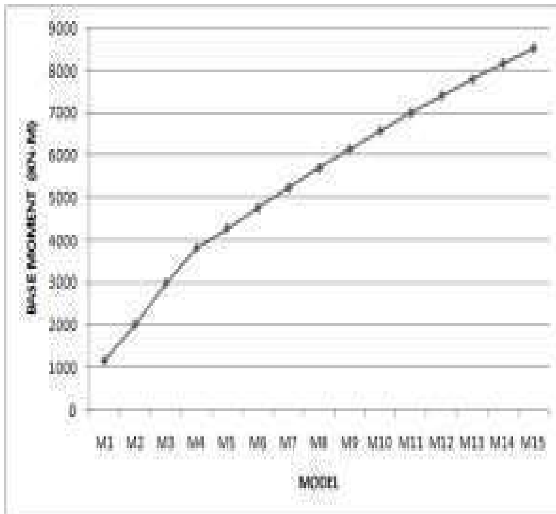
3. BASE SHEAR 2

Base shear increases until a critical staging height and then it start decreasing



3.2 BASE MOMENT

Base moment increases gradually until critical height and then it starts increasing linearl.



4. Conclusion

From the analysis it was found that the elevated water tank appears vulnerable for 12m height of staging. Base shear increases until a critical staging height and then it start decreasing. Base moment increases gradually until critical height and then it starts increasing linearly. Care should be taken in avoiding the critical height.

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