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Seismic Analysis of Double-Decker Elevated Water Tank

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Abstract: Double -Decker Elevated Water tank is used for storage of large quantity of water. Direct Source of water in water tank is from the rainfall. Taking water from tank for drinking, household & etc purpose is economical in that place where construction of well, bore well, etc is costly and area is less. Elevated water tanks are integrated part of lifeline facilities elevated water tank is storage container construction for the purpose of holding water supply. A large number of water tank is damage during past earthquake. So, there is need to focus on seismic safety.
The aim of this paper to propose a seismic analysis of double-decker elevated water tank in different zone and comparison with single elevated water tank in different soil condition (Hard, Medium, Soft). To study different types of load acting on it and compare it on basis of bending moment, shear force and its displacement if any after seismic load is applied on water tank by using staad-pro software.

Key Word: Double-decker Elevated Water tank, Comparison, Seismic analysis, Different soil Zone

1. Introduction

Double-decker elevated water tank it will allow more storage capacity than single water tank and the area needed for construction of both the tanks approximately same .The water pressure will be consistent in any type of situation so no more need for extra pressure machine for pumping water "With increasing concerns over earthquake resilience, this review explores the latest advancements in seismic analysis techniques applied to double elevated water tanks, aiming to identify critical factors influencing their structural analysis under seismic loading and propose effective design strategies for enhanced safety." Several studies have investigated the seismic analysis of elevated water tanks, including single and double-decker tanks. However, there is a need for a comprehensive review of the existing literature to identify the current state of knowledge, research gaps, and future research directions.

This research paper aims to provide a comprehensive overview of the seismic analysis of double-decker elevated water tanks and their comparison with single elevated water tanks. The paper also identifies research gaps and provides recommendations for future research directions. in this paper we will discuss the comparison between single elevated and double-decker elevated water tank as well as we going to find bending moment and shear force that going to acting on it and will find out the displacement happens if any.

2. Calculation

Assume Volume (V) =450 CUM (450000 lit)
Assume D=12M
$V=\pi XD^2XH$
$450=\pi X12^2XH$
H=3.47=4M

1. Design of top dome
A) Meridenial force (T1)
B) Hoop Tension (T2)

L.L=1.5KN/M^2 T1= wr/1+cos θ Assume dome thickness=100mm
W=0.1X25=2.5KN/M^2
W=2.5+1.5=4 KN/M^2

R=((D/2)^2+ h2) /2xh
H=0.2xD
H=0.2x12=2.4m
R=((12/2) ^2 +2.4 ^2)/2x2.4
R=8.7m
Sin θ = 6/8.7
θ =43.60'
Cos θ =0.724
T1=4x8.7/1+cos43.6
T1=20.18 KN/M
For M40 Grade=13N/MM^2
0.202<13 N/ MM ^2 ------Safe
For hoop Force T2
T2=WxR (Cosθ – 1/1+Cosθ)
=5KN/m
Hoop Stress=5x10^3/1000x100
=0.05<13 N/MM^2----------Safe
Assume for both tank
Beam=0.3x0.45 M
Column=0.45x0.6 M

Meri denial stress=Force/Area
=T1/Area
=20.18x103/1000x100
Meri denial stress=0.202 N/MM^2

3. Objective

1. To compare the bending moment for double-decker and single-decker elevated water tank.
2. To analyze the Single and double-decker water tank of zone III, IV, V.
3. To analyze the Single and double-decker water tank in Hard, Medium & Soft soil condition.
4. To calculate shear force & displacement for single-decker and double-decker elevated water tank.

4. Methodology

Data collection by reviewing the literature available on various journal.
Problem statement (assume all dimension and soil condition)

Linear dynamic analysis to get exact analysis of elevated double-decker tank. to use response spectrum analysis within a structural analysis software like STAAD Pro.

Analyzing both tank configurations under different seismic zone conditions, while focusing on key parameters like bending moment and shear force.

Modeling: Create detailed 3D models of both single and double elevated water tanks, accurately representing their geometry, support condition. Consider the different zone of seismic analysis and different forces that can damage the structure.

Comparison: Calculate and compare the following key structural responses between the single and double tank configurations: Bending moment at critical sections Shear force at critical sections Maximum displacement Code Compliance: Ensure that theanalysis is conducted according to relevant seismic design codes applicable to the region of study. Use of

Software: Analysis is conducted on staad-pro and all the results will and analysis will be achived by this software this methodology includes the comparison between single elevated & double-decker elevated water tank.

Analyzing it with linear dynamic analysis to get exact analysis of elevated double-decker tank.

To use structural analysis software like STAAD Pro, analyzing both tank configurations under different seismic zone conditions, while focusing on key parameters like bending moment and shear force.

Modeling:

`Create detailed 3D models of both single and double elevated water tanks, accurately representing their geometry, support condition.

`Consider the different zone of seismic analysis and different forces that can damage the structure.

Seismic Analysis:

Utilize the Staad-pro to analyze the tanks under different seismic zones, using design specific to each zone.

Comparison:

Calculate and compare the following key structural responses between the single and double tank configurations: Bending moment at critical sections Shear force at critical sections Maximum displacement.

Code Compliance:

Ensure that the analysis is conducted according to relevant seismic design codes applicable to the region of study.

Use of Software:

Analysis is conducted on staad-pro and all the results will and analysis will be achived by this software.

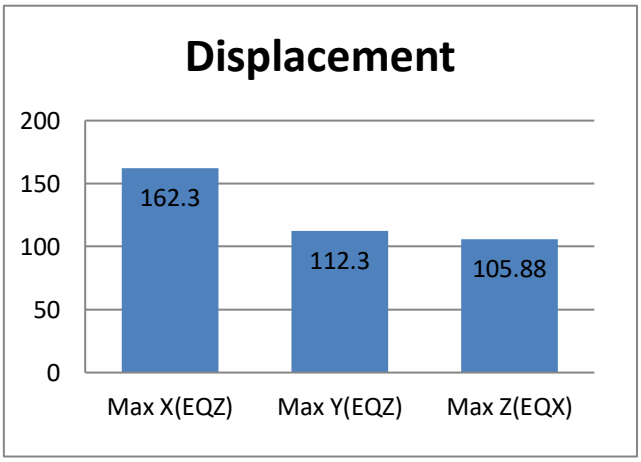
5. Results

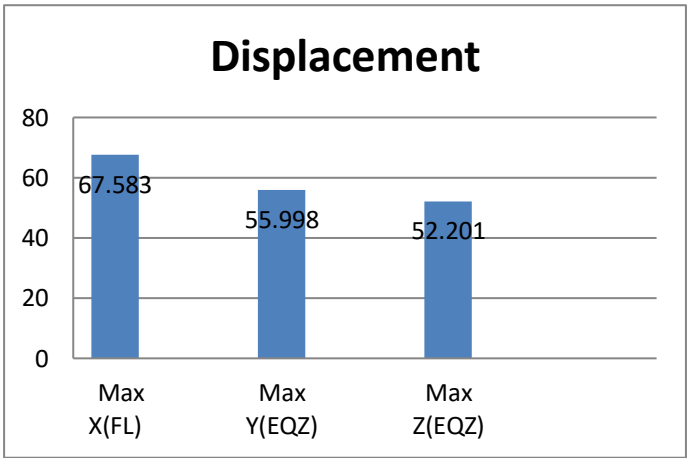
Zone III Double tank displacement in Hard soil

DIRECTION	LOAD	MAX. Displacement in (MM)
Max X	EQZ	162.946
Max Y	EQZ	112.275
Max Z	EQX	105.886

Zone III Single tank displacement in Hard soil

DIRECTION	LOAD	MAX. Displacement in (MM)
Max X	FL	67.583
Max Y	EQZ	55.998
Max Z	EQZ	52.201



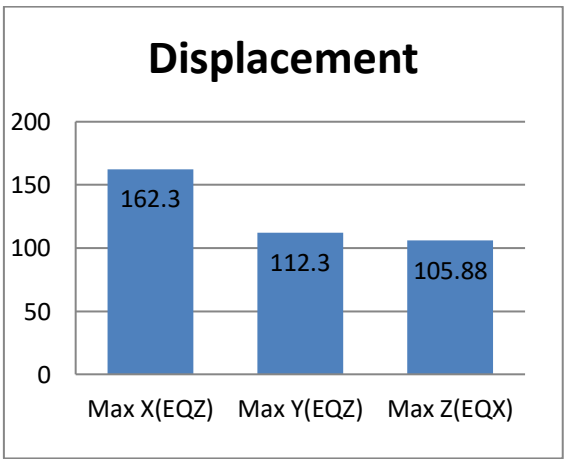


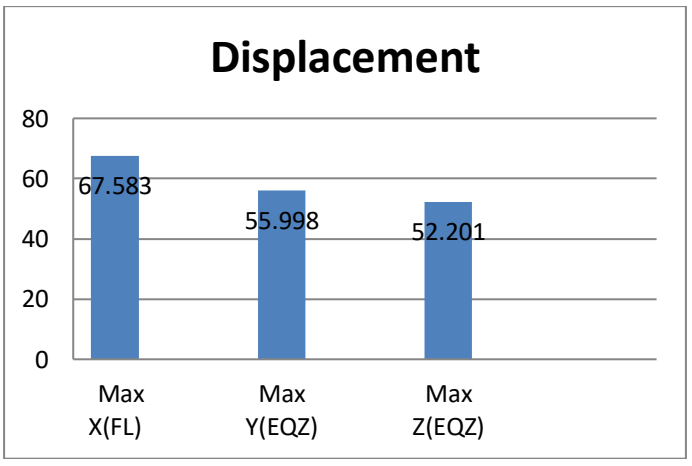
Zone IV Double tank displacement in Hard soil

DIRECTION	LOAD	MAX. Displacement in (MM)
Max X	EQZ	162.946
Max Y	EQZ	112.275
Max Z	EQX	105.886

Zone IV Single tank displacement in Hard soil

DIRECTION	LOAD	MAX. Displacement in (MM)
Max X	FL	67.583
Max Y	EQZ	55.998
Max Z	EQZ	52.201





Zone V Double tank displacement in Hard soil

DIRECTION	LOAD	MAX. Displacement in (MM)
Max X	EQZ	162.946
Max Y	EQZ	112.275
Max Z	EQX	105.886

Zone V Single tank displacement in Hard soil

DIRECTION	LOAD	MAX. Displacement in (MM)
Max X	FL	67.583
Max Y	EQZ	55.998
Max Z	EQZ	52.201

6. Conclusion

Analysis of elevated water tank against earthquake using Staad-pro V8iis considerable importance. This is done to remain structure functional even after earthquake. After detailed study of all results following point are to be considered at the of time of seismic analysis of elevated water tank.

After analyzing all the results, we come to the conclusion that

In Zone III (Soft soil, Medium soil & Hard soil all the results are same)

The Max.M Bending moment in single elevated tank is 345.127 KN.M and for double elevated

Tank 1633.93 KN.M which is more than (78.85%) than single Elevated water tank.

The Max.M Displacement in single elevated tank is 65.72 MM and for double elevated

Tank 162.946 MM which is more than (58.52%) than single Elevated water tank.

The Max.M Shear force in single elevated tank is 660.904 KN and for double elevated

Tank 1696.41 KN which is more than (61.04 %) than single Elevated water tank.

In Zone IV (Soft soil, Medium soil & Hard soil all the results are same)

The Max.M Bending moment in single elevated tank is 345.127 KN.M and for double elevated

Tank 1633.93 KN.M which is more than (78.85%) than single Elevated water tank.

The Max.M Displacement in single elevated tank is 65.72 MM and for double elevated

Tank 162.946 MM which is more than (58.52%) than single Elevated water tank.

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In Zone V (Soft soil, Medium soil & Hard soil all the results are same)

The Max. M Bending moment in single elevated tank is 345.127 KN.M and for double elevated

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The Max. M Shear force in single elevated tank is 660.904 KN and for double elevated

Tank 1696.41 KN which is more than (61.04 %) than single Elevated water tank.

In all the zones tanks having L/B ratio 3.0 and 4.0 experiences maximum displacement values.

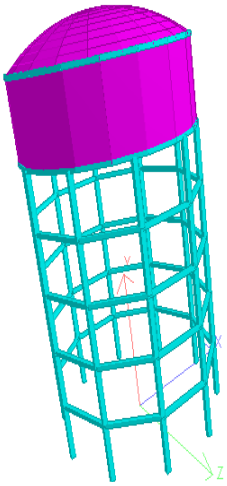
Shear force & bending moment in empty tank slightly less than full tank condition due to the absence of hydrostatic pressure.

7. Future Scope

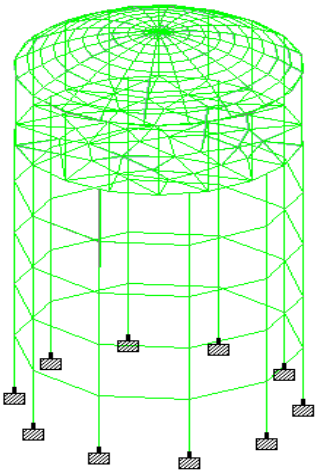
1. Further study shall be carried out using different Parameters (Diameter of tank, size of Tank elements).
2. Study is carried out using different material like Steel water tank.
3. Different capacity of tank according to requirement.
4. Future study will be carried out using different seismic zone.
5. Study will be carried out using different Height of elevated tank.

8. Modelling

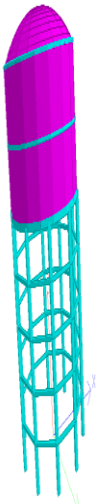
SINGLE DECKER ELEVATED WATER TANK



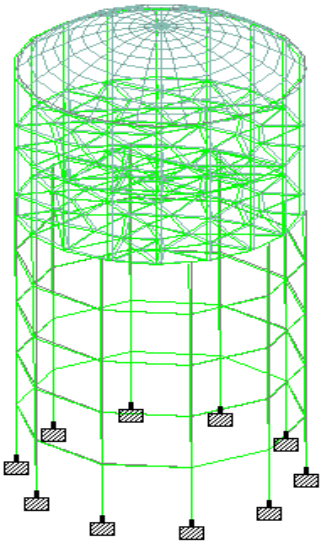
SINGLE DECKER DISPLACEMENT



DOUBLE-DECKER ELEVATED WATER TANK



DOUBLE-DECKER DISPLACEMENT



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