A Study On Stress Analysis Of Intze Water Tank And Foundation Soil On Sloping Ground Using Critical Angle Of Seismic Load

[1]Kaushik I. Patadiya,[2]Nedunuri Vishnuvardhan,[3]Hemal J. Shah,
[1]P. G. Student of structural Engineering HJD-ITER - Kutch,[2]Assistant professor of Civil Engineering Department HJD-ITER - Kutch,[3]Assistant professor of Civil Engineering Department GEC-BHARUCH

Abstract: Water tanks are the storage container for storing water. Providing elevated water tanks on sloping ground is quite typical and challenging job. Forces develop on structure resting on sloping ground are more severe than those resting on leveled surface. Detailed analysis is required in case of elevated storage reservoir (ESR) which is provided on sloping surface. In this research paper work the attempt has been made to study the behavior of the R.C.C. elevated water tank of capacity 10 lakh liters using SAP2000 software. The seismic analysis is carried out based on static and dynamic analysis consists of response spectrum and time history method. Time history of Bhuj earthquake is considered. Comparison of different parameters i.e. Maximum stress, displacement, base shear, shear forces & bending moment are studied for critical angle of seismic load by considering water level as full & empty in intze water tank. In this research special attention is taken for maximum stress analysis in water tank as well as in foundation soil.

***Index Terms*– ELEVATED WATER TANK, STRESS, CRITICAL ANGLE, SLOPING GROUND, RESPONSE SPECTRUM METHOD, TIME HISTORY METHOD, BASE SHEAR, BENDING MOMENT, SAP2000**

I. INTRODUCTION

An elevated water tank is a large water storage container constructed for the purpose of holding water supply at certain height to pressurization the water distribution system. Elevated tanks are supported on staging which may consist of masonry walls, R.C.C. columns braced together, counter walls subjected to water pressure. The liquid storage tanks are particularly subjected to the risk of damage due to earthquake-induced vibrations. A large number of overhead water tanks damaged during past earthquake. Majority of them were shaft staging while a few were on frame staging type Elevated water tanks consist of huge water mass at the top of a slender staging which are most critical consideration for the failure of the tank during earthquakes. Elevated water tanks are critical and strategic structures and damage of these structures during earthquakes may endanger drinking water supply, cause to fail in preventing large fires and substantial economic loss.

From the shape point of view water tank may be of several types:

1. Circular tanks
2. Intze tanks
3. Rectangular tanks

Objectives

- To study the behaviour of the water tank on seismic load using critical angle of load the behaviour is studied based on static and dynamic analysis. In dynamic analysis in SAP2000 software response spectrum and time history is considered.
- To study the analysis of water tank based on stress analysis of water tank and foundation soil
- To study the Intze water tank based on displacement , base shear , bending moment , shear force and stress.

II. LITERATUREREVIEW

[1]Dr. S. A. Halkude, A. A. Perampalli investigated that the elevated storage reservoir(ESR) on sloping ground, it is observed that both shear force and bending moment increases steeply in the column resting on the higher side of the sloping ground

[9]Mr. Sai Kala Kondepudi M.,K. S. K Karthik Redd, Harsha Kaviti investigated that the area of steel is observed to be 50% more at bottom of the column when compared to top of the column, this is because the strength should be increased as we go bottom of the structure since all the loads to be transferred to soil from the bottom part of structure.

[5]Dixitkumar. B. Patel is investigated that the principal stresses are same in Both staging of the various component of the tank for different type of homogeneous soil mass below the foundation or layered soil mass below the foundation of the tank.

[6]Mr.Sunilkumar Hiremath investigated that in all these cases there was not significantly change in axial force acting in model over the slope ground compared to level ground surface

III. METHODOLOGY

In the present work the analysis of water tank with different type of soil are carried out:

a) Soft Soil

b) Medium soil

c) Hard soil

The capacity of water tank, walls, domes , beam and column dimensions are kept constant. The materials such as Density of RCC, Density of Masonry, compressive strength of steel and concrete etc. are kept constant in all water tank. Poisson's ratio, Modulus of elasticity, Unit weight of soil are different with different types of soil.

Comparison of the parameters considered in the study of water tank.

- Dead load and Live load shall be considered as per IS 875 (Part-1 and Part-2).
- All models are analysed for seismic zone V.
- In Research work To make a models of Elevated Water Tank with sloping ground using critical angle of seismic load with consider different parameters like displacement, Base shear, Response Spectrum, Time history, Shear Force, Bending moment

Structure and Section details:

Storage Capacity = 10 Lakh Liters

Grade of Concrete = M20 and M30

Grade of steel = Fe415

Thickness of Top Dome = 100mm

The Rise of Top Dome (h1) = 2m

Radius of Top Dome (r1) = 15.06m

Size of Top Ring Beam = 400mm x 400mm

Diameter of Cylindrical Wall (D1) = 15m

Height of the Cylindrical wall (h2) = 5m

Thickness of Cylindrical Wall (t1) = 300mm

Size of Middle Ring Beam = 1200mm x 600mm

Height of Conical Dome = 2m

Thickness of Conical Dome = 300mm

Rise of Bottom Dome = 1.8m

Radius of Bottom Dome (r2) = 7.84m

Thickness of Bottom Dome = 250mm

Size of Bottom Ring Girder = 1200mm x 750mm

Plint Beam = 900mm x 600mm

No. of Columns = 8nos

Size of Bracing beam = 500mm x 500mm

Size of Columns = 900mm dia.

Depth of Foundation (For sloping ground) = 7.2m

Response Reduction Factor = 2.5

Importance Factor = 1.5

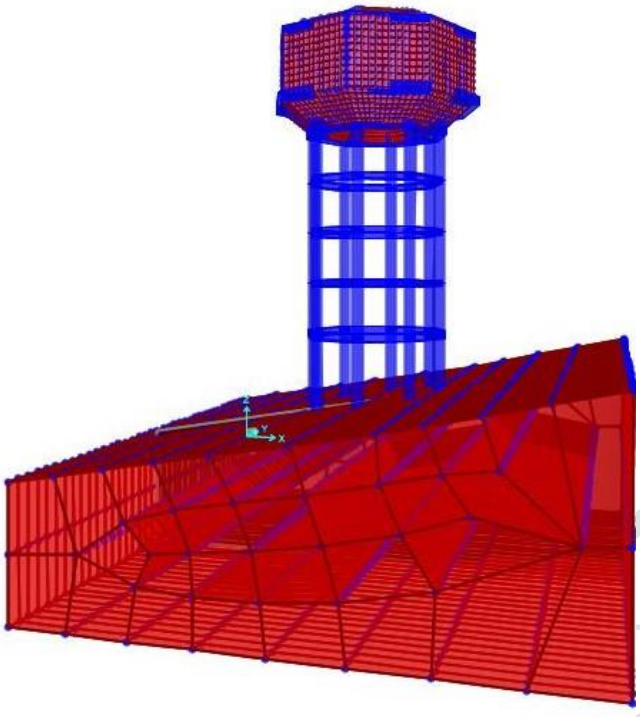


Fig:1 Slope of 10˚ water tank

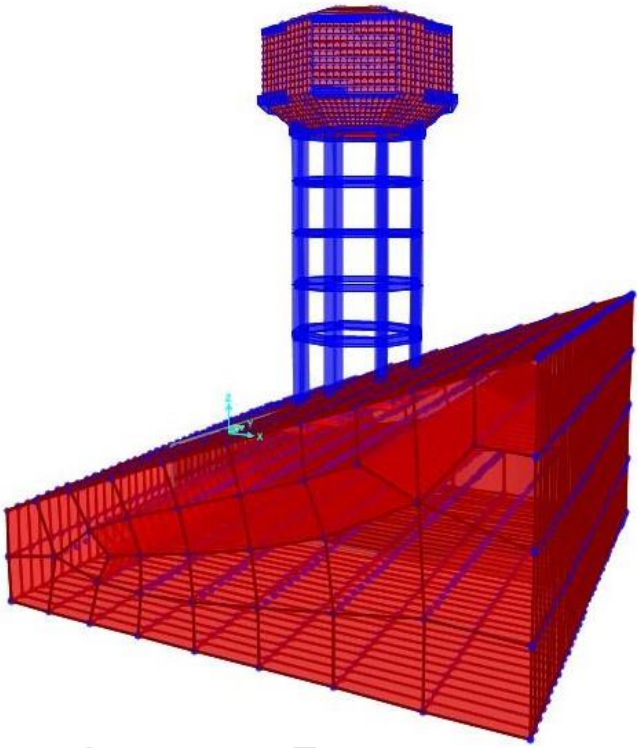


Fig :2 Slope of 20˚ water tank

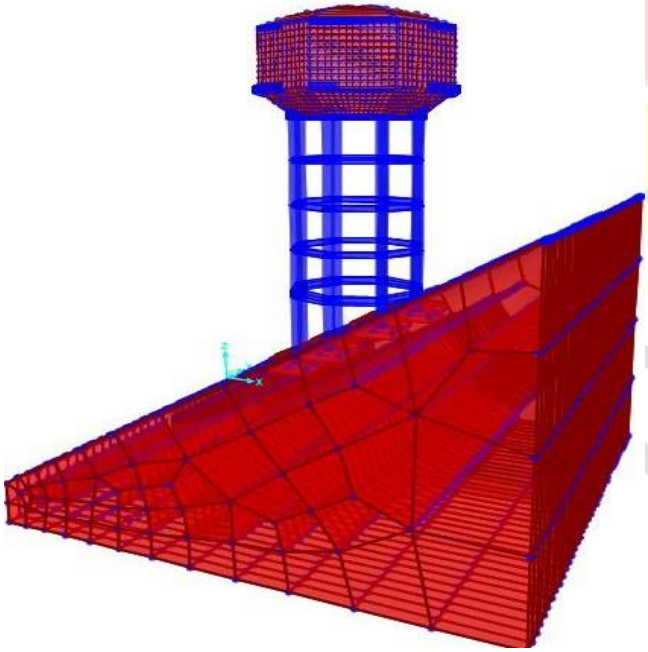
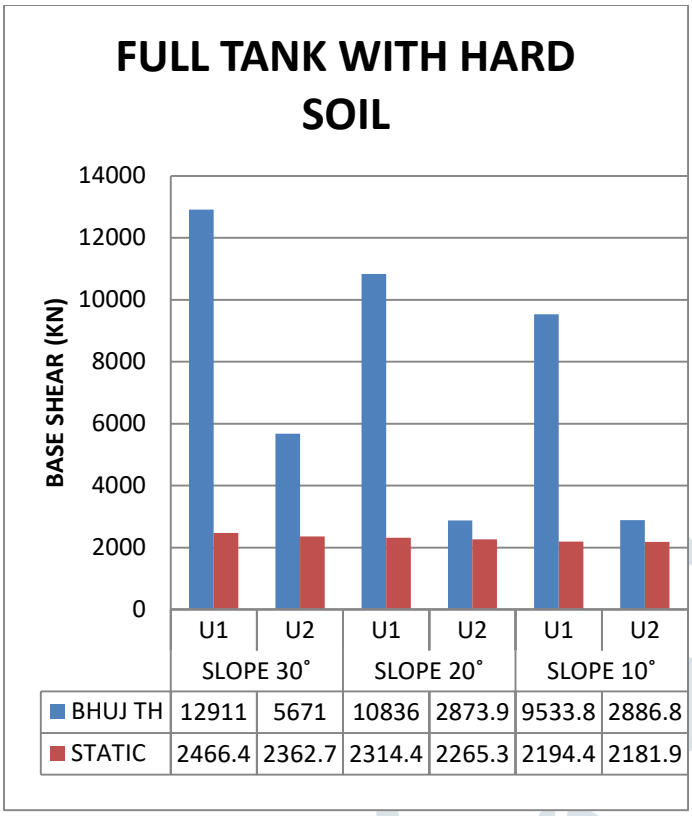


Fig:3 Slope of 30˚ water tank

IV. RESULTS

The analysis results of water tank on sloping ground subjected to seismic forces in Zone V are as below with different types of foundation soil.

- **BASE SHEAR:**



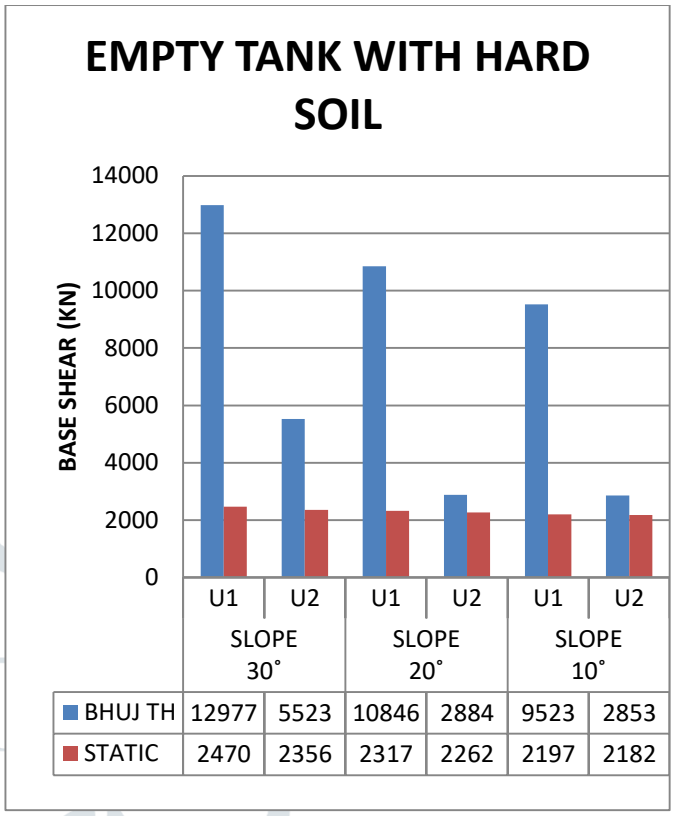
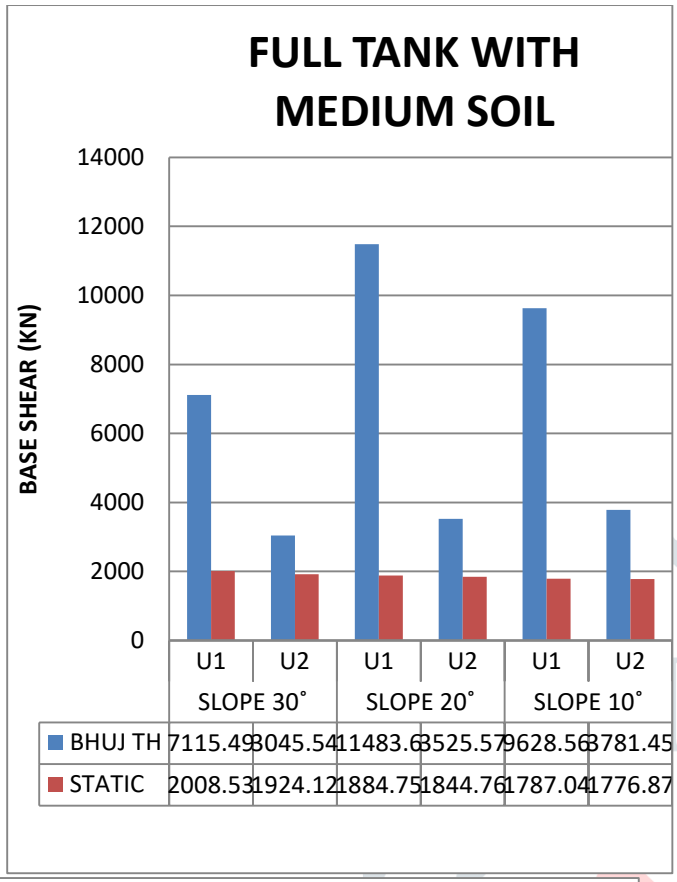


Fig:4 Base shear with hard soil (Zone V)



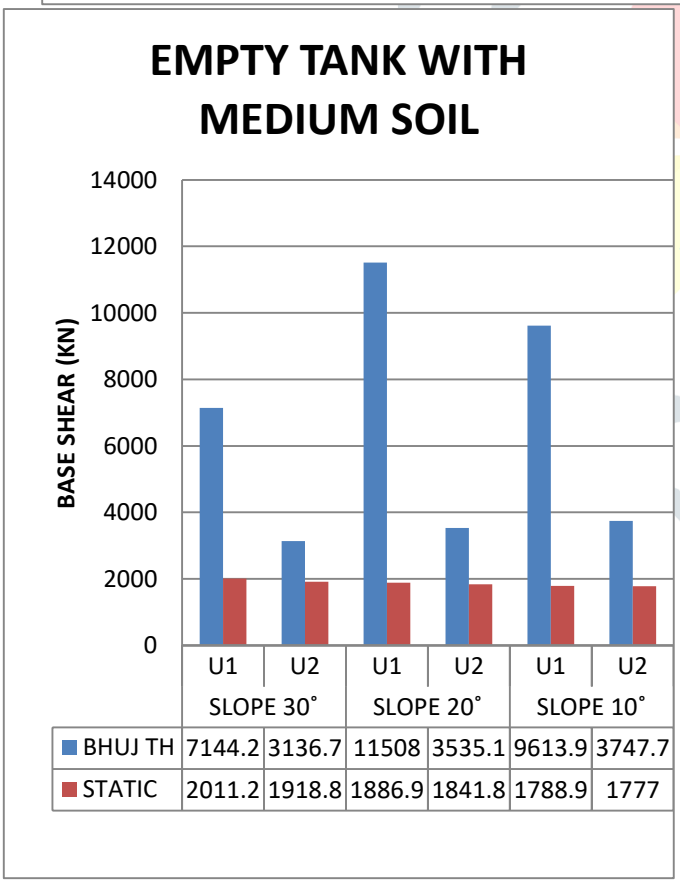
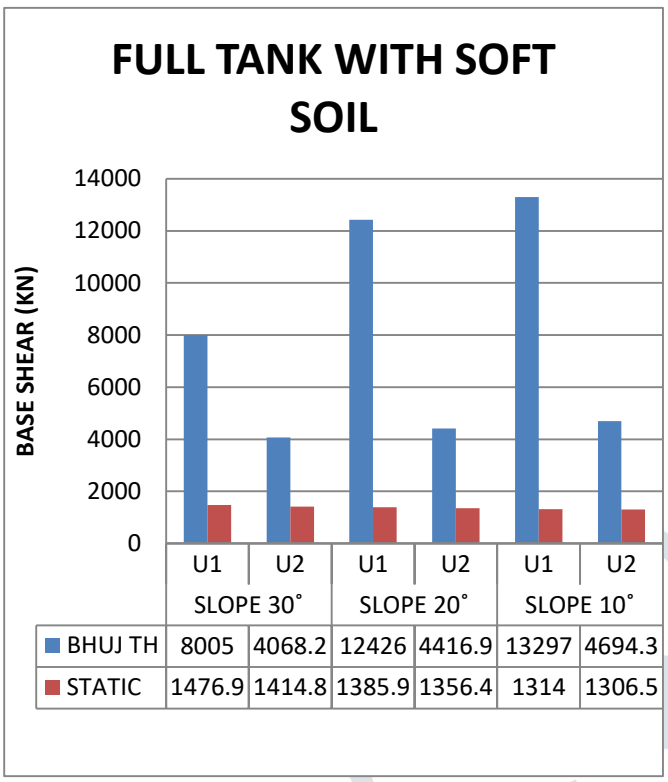


Fig:5 Base shear with medium Soil (Zone V)



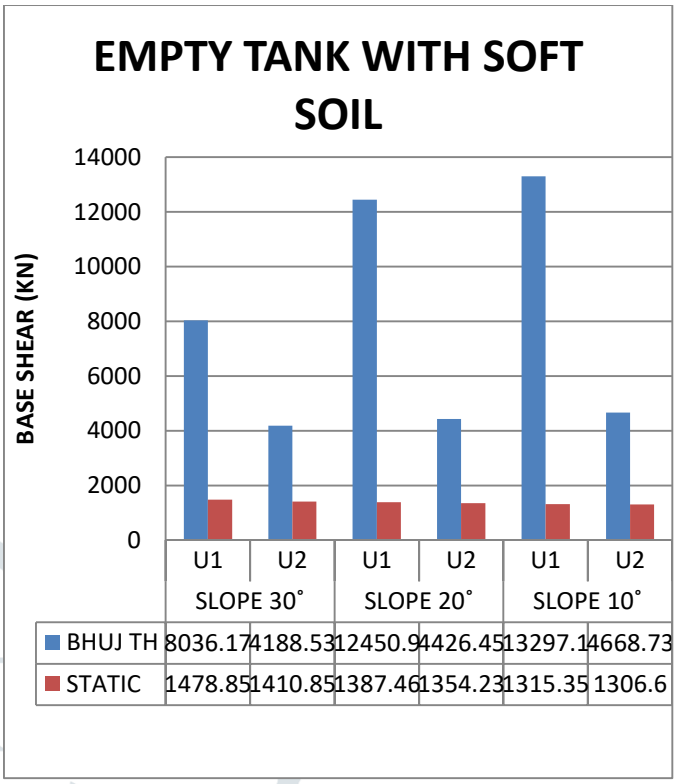
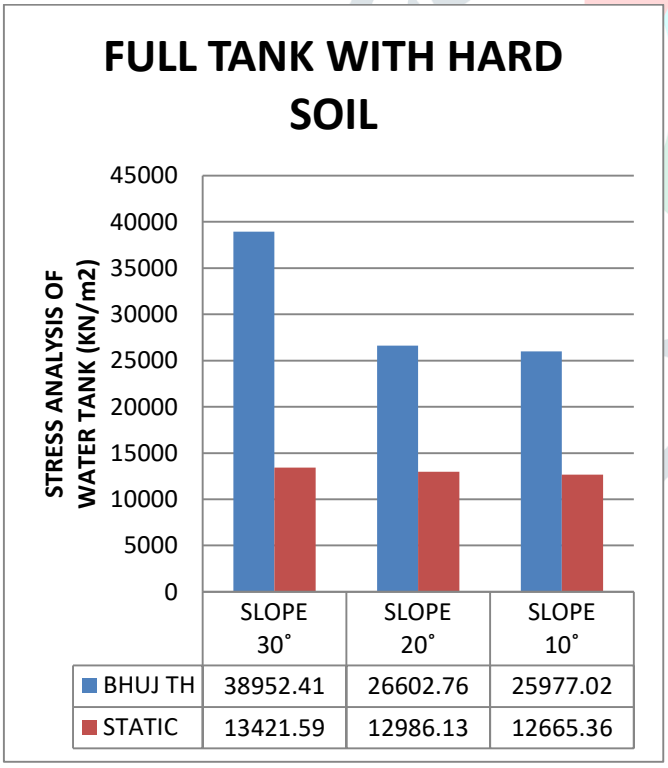


Fig:6 Base shear with soft Soil (Zone V)

- **STRESS ANALYSIS OF WATER TANK:**



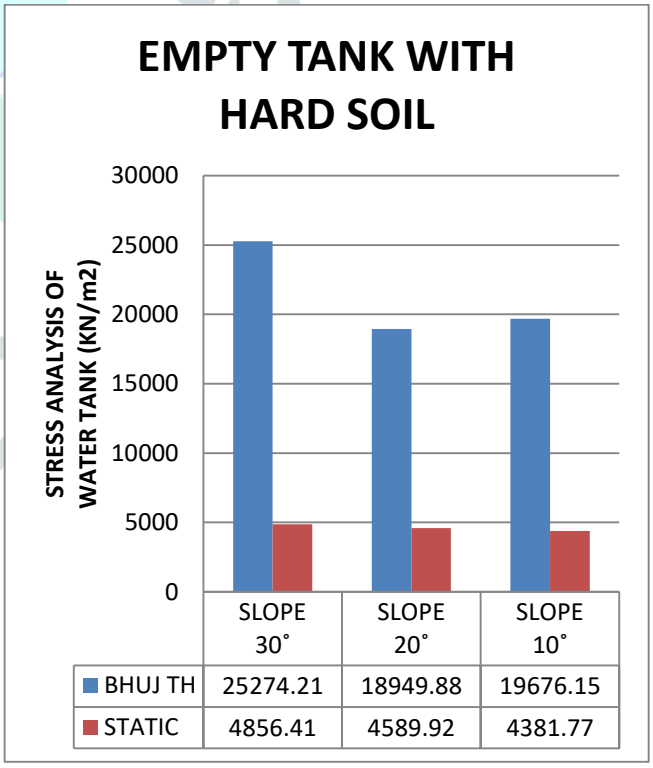
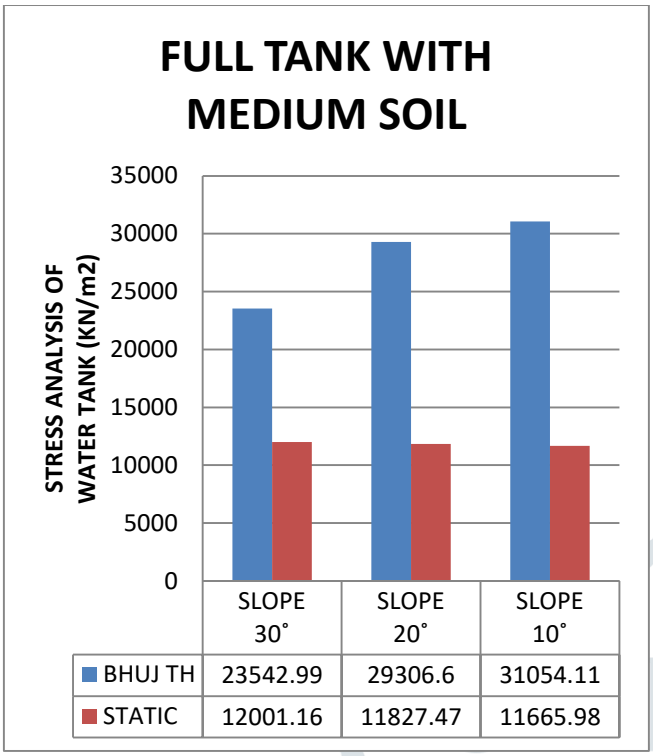


Fig:7 Stress analysis of water tank with hard soil (Zone V)



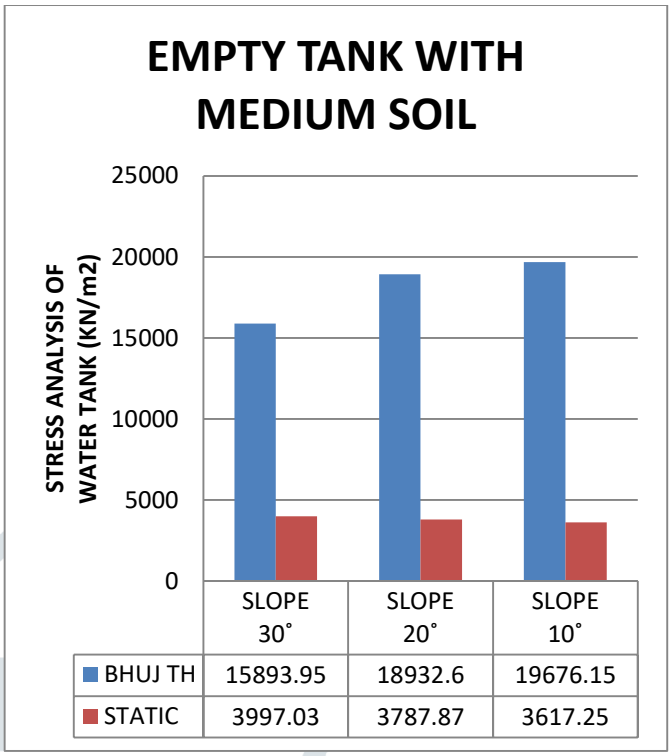
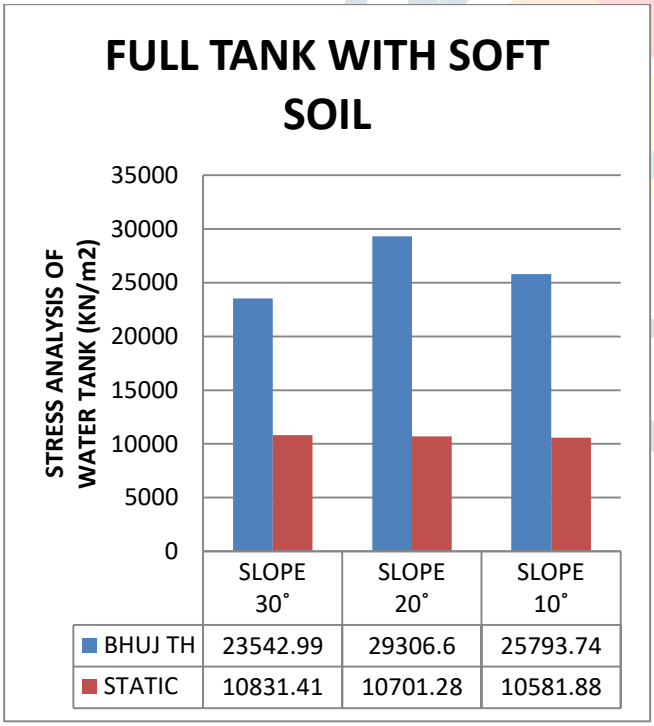


Fig:8 Stress analysis of water tank with medium soil (Zone V)



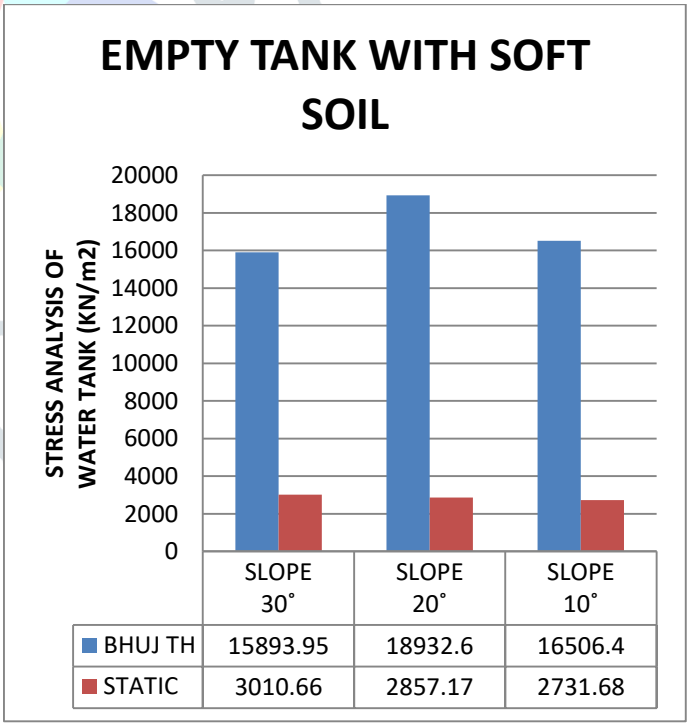


Fig:9 Stress analysis of water tank with soft soil (Zone V)

V. CONCLUSIONS:

According to static method,

- Maximum stress in water tank is observed at 30˚ slope for full and empty tank in soft , medium and hard soil.
- Maximum stress in water tank is observed at 30˚ slope for empty tank is greater than 5.10% according to 20˚ slope and 9.27% to 10˚ slope of water tank in soft soil.

- Maximum stress in water tank is observed at 30˚ slope for empty tank is greater than 5.23% according to 20˚ slope and 9.50% to 10˚ slope of water tank in medium soil.
- Maximum stress in water tank is observed at 30˚ slope for full tank is greater than 3.24% according to 20˚ slope and 5.63% to 10˚ slope of water tank in hard soil.
- Maximum stress in water tank is observed at 30˚ slope for empty tank is greater than 5.49% according to 20˚ slope and 9.77% to 10˚ slope of water tank in hard soil.
- Maximum base shear in water tank is observed at 30˚ slope for full and empty tank in soft , medium and hard soil.

According to time history method,

- Maximum stress in water tank is observed at 30˚ slope for full tank is greater than 31.70% according to 20˚ slope and 33.31% to 10˚ slope of water tank in hard soil.
- Maximum stress in water tank is observed at 30˚ slope for empty tank is greater than 25.02% according to 20˚ slope and 22.15% to 10˚ slope of water tank in hard soil.
- Maximum stress in water tank is observed at 10˚ slope for full tank is greater than 5.63% according to 20˚ slope and 24.19% to 10˚ slope of water tank in medium soil.
- Maximum stress in water tank is observed at 20˚ slope for empty tank is greater than 12.81% according to 10˚ slope and 16.05% to 30˚ slope of water tank in soft soil.
- Maximum base shear in water tank is observed at 30˚ slope for full and empty tank in hard soil and 10˚ slope in soft soil.

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