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DESIGN AND ANALYSIS OF INTZE TYPE WATER TANK FOR DIFFERENT WIND SPEED AND SEISMIC ZONES AS PER INDIAN CODES

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ABSTRACT

This project deals with the design and analysis and comparison of intze type water tank for different wind speed and seismic zones as per Indian codes. Any design of Water Tanks is subjected to Dead Load + Live Load and Wind Load or Seismic Load as per IS codes of Practices. The seismic load is also called as unstable load. Most of the day's tanks are designed for Wind Forces and not even analyze for Earthquake Load forward that the tanks are safe underneath unstable forces once designed for wind forces. During this study Wind Forces associate degreed unstable Forces working on an Intze kind storage water tank for Indian conditions are studied. The impact of wind on the elevated structures is of prime importance as Wind flows relatives with the surface of ground and generates masses (loads) on the structures standing on ground. Most of the designers contemplate the wind impact and neglect the unstable effect on the structure. The Indian Standard Code IS 875(Part-3) 2003 and IS 1893-2000 for Wind & unstable effect is used in this study. The Elevated Structure is meant for varied Wind forces i.e. 39 m/s, 44 m/s, 47 m/s & 50 m/s and also the same is cross checked with totally varying Seismic Zones i.e. Zone-II, Zone-III, Zone-IV, & Zone-V by 'Response Spectrum Method' and also the maximum governing condition from each the forces is more used for design & analysis of staging. It is found from the analysis that the overall load, Total moments and Reinforcement in staging i.e. Columns, Braces & also for Raft foundation varies for Case-1, Case-2, and Case-3 & Case-4.

Keywords: Wind Load, Intze Tank, seismic load and I. S. Codes etc.

I. INTRODUCTION

Storage reservoirs and overhead tank square measure wont to store water, liquid petroleum, fossil oil product. Tanks are concerning constant no matter the chemical nature of the merchandise. All tanks square measure designed as crack free structures to eliminate any run. Water or raw fossil oil holding block and walls can be of ferroconcrete with adequate cowl to the reinforcement. Water and fossil oil and react with concrete and, therefore, no special treatment to the surface is needed. Industrial wastes may also be collected. The petroleum product like gasoline, diesel oil, etc. square measure probably to leak through the concrete walls, thus such tanks want special membranes to prevent run. Reservoir may be a common term applied to

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liquid storage structure and it is below or higher than the bottom level. Reservoirs below the ground level square measure usually designed to store massive quantities of water whereas those of overhead sort square measure designed for direct distribution by gravity flow and square measure typically of smaller capability.

1.1 Preferences of Irrigation By Tanks

1. It is a modest and well known technique for watering system.
2. It keeps up level of groundwater.
3. Where development of wells is expensive because of hard shake surface, watering system by tank is less expensive.
4. Use is a great deal less when contrasted with channels.
5. Utilization of extra water from precipitation is conceivable through tanks.

1.2 Disservices of Irrigation By Tanks

1. Wellspring of water in tanks is just from precipitation. In the event that there is variety in precipitation, it affect sly affects farming.
2. Downpour water streaming towards tanks conveys residue likewise which lessens the profundity of tanks. It requires de-silting every now and then, which is exorbitant,
3. Taking water from tanks for watering system is expensive.
4. Tanks possess huge space in light of the fact that numerous characteristic tanks are exceptionally broad.

Different wellsprings of water for watering system incorporate lakes, earthen check dams, an cuts, check dams and so forth. In bumpy zones, for preservation of downpour water, amicus and check dams are built. Likewise, normal and simulated lakes and earthen check dams are for the most part built for neighborhood needs of water.

1.3 Types of Water Tank

Basing on the area of the tank in a building s tanks can be ordered into three classes. Those are:

- Underground tanks
- Tank lying on grounds
- Overhead tanks

Much of the time the underground and on ground tanks are roundabout or rectangular is shape however the state of the overhead tanks are affected by the aesthetical perspective of the environment and in addition the outline of the development. Steel tanks are likewise utilized uncommonly as a part of railroad yards. Basing on the shape the tanks can be roundabout, rectangular, square, polygonal, circular and tapered. An exceptional kind of tank named Intze tank is utilized for putting away extensive measure of water for a territory. The overhead tanks are bolstered by the segment which goes about as stages. This segment can be supported for expanding quality and also to enhance the stylish perspectives.

1.4 Classifications Of Water Tanks

Order bolstered underneath three heads:

1. Tanks laying on ground
2. Hoisted tanks bolstered on arranging

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3. Underground tanks.
4. Order bolstered shapes
5. Roundabout tanks
6. Rectangular tanks
7. Round tanks
8. Intze tanks
9. Roundabout tanks with cone like base

1.5 Earth Quakes

An Earthquake is a wonder that outcomes from and is controlled by the sudden arrival of put away vitality in the outside that engenders Seismic waves. At the Earth's surface, quakes may show themselves by a shaking or uprooting of the ground and once in a while tidal waves, which may prompt death toll and devastation of property. The word Earthquake is utilized to depict any seismic occasion whether a characteristic wonder or an occasion brought on by people—that creates seismic waves. Most normally happening seismic tremors are identified with the structural way of the earth. Such seismic tremors are called structural quakes. The Earth's lithosphere is an interwoven of plates in moderate however steady movement brought on by the warmth in the Earth's mantle and center. Plate limits grind past each other, making frictional anxiety. At the point when the frictional anxiety surpasses a basic worth, called neighborhood quality, a sudden disappointment happens. The limit of structural plates along which disappointment happens is known as the flaw plane. At the point when the disappointment at the shortcoming plane results in a brutal uprooting of the Earth's outside layer, the versatile strain vitality is discharged and seismic waves are transmitted, subsequently bringing on a tremor.

1.6 Introduction of General Design Requirements

1.6.1 Plain Concrete Structures

Plain solid individual from fortified solid fluid holding structure might be composed against auxiliary disappointment by permitting pressure in plain concrete according to as far as possible for strain in twisting. This will consequently deal with disappointment because of breaking. Be that as it may, ostensible fortification might be given, for plain cement basic individuals.

1.6.2 Admissible Stresses IN Concrete

(a) For imperviousness to breaking. For computations identifying with the resistance of individuals to splitting, the passable hassles in strain (immediate and because of twisting) and shear might affirm to the qualities determined in Table 1.The reasonable elastic anxieties because of bowing apply to the substance of the part in contact with the fluid. In individuals under 225mm. thick and in contact with fluid on one side these reasonable burdens in twisting apply additionally to the face remote from the fluid.

(b) For quality counts. In quality counts the allowable solid burdens should be as per Table 1. Where the ascertained shear stress in cement alone surpasses the allowable worth, fortification acting in conjunction with corner to corner pressure in the solid might be given to take the entire of the shear.

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1.7 Introduction of Design Loads

Burdens ought to be connected to the auxiliary configuration of a tank as indicated by its expected use, size, structure sort, materials, plan lifetime, area and environment, keeping in mind the end goal to guarantee life security and to keep up its fundamental capacities. The connected burdens ought to be as per the following, and their blends ought to be characterized considering the genuine likelihood of event.

- Dead loads
- Live loads
- Snow loads
- Wind loads
- Seismic loads
- Impulse and suction because of substance sloshing, and weight because of substance
- Thermal burdens
- Shock, e. g., by crane
- Fatigue loads
- Soil and water weights
- Others. e.g., load from mechanical gadget.

II. LITERATURE REVIEW

Different written works has exhibited as specialized papers till date on the Wind and Seismic examination of Elevated Water Tanks. Different issues and the focuses are secured in that analysis.i.e wind pace of different urban communities according to seismic zones, hydrodynamic weight, and element reaction of confined arranging and so forth. Some of those are talked about underneath:

2.1 Khaza Mohiddin Shaikh and Prof. Vasugi K (2014) infer that

Investigation and Design of lifted water tanks against seismic tremor impact is of extensive significance. These structures must stay utilitarian even after a seismic tremor. Most raised water tank are never totally loaded with water. Thus, a two-mass glorification of the tank is more proper when contrasted with one-mass admiration

2.2 R.K.Prasad and Akshaya B. Kamdi (2012)

BIS has drawn out the modified variant of IS 3370 (section 1 and 2) after quite a while from its 1965 adaptation in year 2009. This reexamined code is for the most part drafted for the fluid stockpiling tank. This paper gives in a nutshell, the hypothesis behind the configuration of roundabout water tank utilizing WSM and LSM. Outline of water tank by LSM is most practical as the amount of material required is less when contrasted with WSM. Water tank is the most vital compartment to store water in this manner, Crack width computation of water tank is additionally fundamental.

III. METHODOLOGY

3.1 Design of tank

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Intze tank plan capacity of 250,000 lts

Height of the tank over the ground level 24 m

Safe bearing limit of the dirt 100kn/m2

Wind weight 1200 N/m2

Accepting M20 grade concrete

For which σcbe = 7N/mm^2, σcc = 5N/mm^2

Direct strain σt = 5N/mm^2

Strain in twisting = 1.70 N/mm2

Particular proportion m = 13

For Steel stress,

Tractable anxiety in direct strain =115 N/mm2

Tractable anxiety in twisting on fluid face =115 N/mm2 for t < 225 mm

Furthermore, 125 N/mm2 for/> 225 mm

3.2 Design of Roof Dome

Considering an ascent of 1.50 m, sweep of the rooftop vault is given from

1.50(2R-1.50) = (3.75)2

R = 5.4375m.

Cos φ = (5.4375 – 1.50)/5.4375

= 0.7241

Also, φ= 43.602 < 51.8°

Likeness wind load inadvertent stacking and live load 2600 N/m2

Meridian anxiety at of edge of arch

Nφ = - wr (1+cosφ)

=-5000 (5.4375)/(1+0.7241)

=15769.10 N

Also, meridian anxiety = 15769.10/1000(100) = 1577 N/mm2

Most extreme loop stress at crown = wr/2t 5000(5.4375)/2(100)(1000)

= - 0.136 N/mm2

Use typical fortification 0.3% = 300 mm2

Utilize 8mm bars @ 160 mm c/c both ways

3.3 Design of Ring Beam at Top

Horizontal component Nφ= Nφcosφ

= 15769.10 (0.7241)

= 11418.41N

Hoop tension in ring = 11418 .41 (7.5/2)

=42819.10N

Steel required for hoop tension = 42819.10/115

= 372.33mm2

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Use 4 Nos.12 mm bars at corners.

Area of cross section of ring beam considering concrete only

= 42819.10/1.20

= 35682.58mm2

Use a ring beam 225mmX160mm

Area provided = 36000mm2 > 35682.58mm2

Use 6mm dia nominal stirrups @ 100mm c/c.

3.4 Design of Bottom Dome

Range of the arch = 4.70 m.

Ascent of the vault = 0.950 m.

Span of the vault from 0.950 (2R - 0.950) =(4.70/2)2

Thus R =3.3816m

Point subtended by the vault =2θ

Sinθ = (4.70/2)/3.3816 =0.695

What's more, θ = 44.02°; Cos θ = 0.71

Take thickness of vault as 200 mm

Stacking

D.L. of vault = 0.200 (24000) = 4800 N/m2

Wt. of water on vault = 10,000 [π/4(4.70)2 (6.40) –π/6(0.950) (3 x2.352 +0.9502)]

= 1023465.44 N

Territory of arch surface = 2 n (3.3816) (0.950) = 20.185 m2

= 2 π (3.3816) (0.950) = 20.185 m2

Load force = (1023465.44/20185) + 4800 =55504.26N/m2

Meridian push at springing level = wR/(1+cosθ) = 55504.26(3.3816)/1.719

=109187.43N/m

Loop stress = wR/t[cosθ-(1/1+cosθ)

Most extreme at θ=0, where

Max loop stress = 0.469N/mm2

Hassles are low and give 0.30 % steel.

Utilize 8 mm Ø bars @ 80 mm c/c.

3.5 Total loads

Load from Top = 3843667.62 N

Self wt. of 6 segments = 529300.00 N

Wt. of Bracing = 60000.00N

All out = 4432967.62 N

Load on every segment because of W = 738828 N

Pushed on every segment = 739567.50 N

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Vz =Vbk1k2k3 = 0.90Vbk2k3 taking k1 as

0.90 For 25 yrs. life

Taking k2 and k3 both as solidarity

pz = 0.60 v2 = 0.60 (45)2 =1215 N/m2

P1 = [7.5+0.450)(5.0(7.69)(2/3)(1.60)+(7.69+5.10)(1.60)/2]

(1215)(0.70) = 49915N

P2 = Due to segment, Bracing and roundabout Girder

= [(5.50) (0.600) + Vi (0.60) (4.0) (6.0)] (1215) (0.70) +(5.50) (0.300) (1215) (0.70)

= 10333.58N at l2m above G.L.

P3 = on segment and Bracing

= [6 (0.600) (4) + (5.80) (0.300)] (1215) (0.70)

= 13727 Nat 4 m. above G.L

P4 = [6(0.600) (4) + (6.20) (0.300)](1215) (0.70)

= 13829 N at 4 m above G.L.

3.6 Design of Bottom Slab

Utilize 400 mm thick chunk

Projection =1.60(0.450/2) = 1.375 m

Intended for variety of bearing weight considering impact of Moment Downward load from top due to Section and soil = 40 kN/m2 Referring to Fig.

Maximum = [(104.81-40)(1.375)2/2]+13.297[(1.375)2/3] =69.4556kNm

Saying. SF at separation d = 3 50 from face of bar

= [½(108.20 +118.107) - 40] (1.375 - 0.350)

= 74.982 KN

τv = 1.5(74.962)(10)3/1000(350) = 0.321 N/mm2

J = 0.948 and Ast =869.67mm2

Utilize 12mmφ @125 c/c

3.7 Check for Stability

Sliding - Due to seismic stacking

V= 244237.52 N

W=4193494.15 + Wt. of base + Circular Bear

=4193494.15 + 617662.25 + 65144.06

=4876300.56 N

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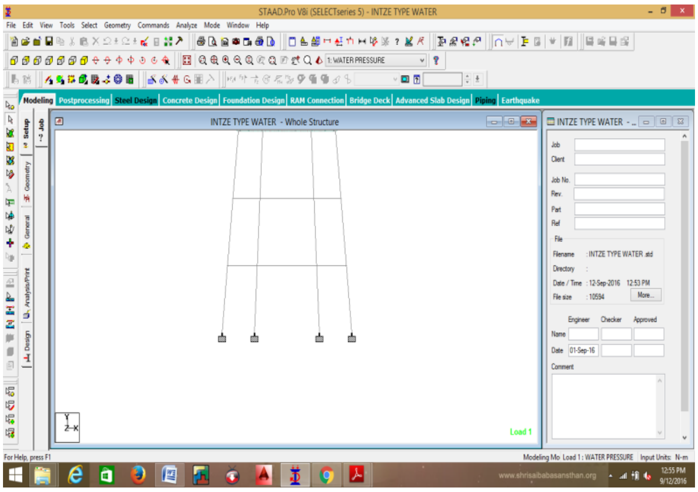
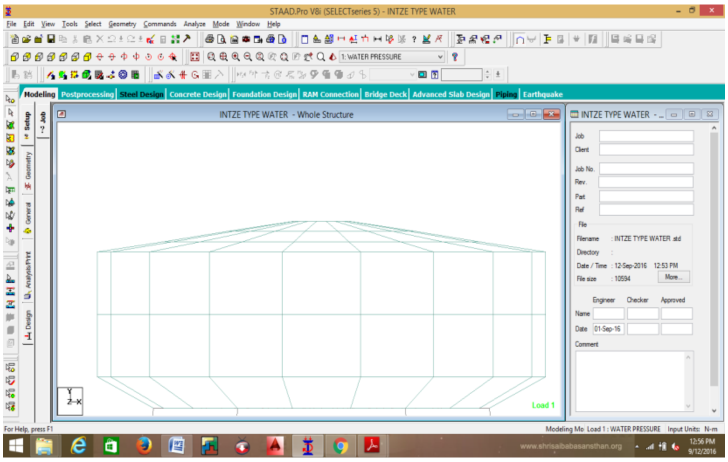
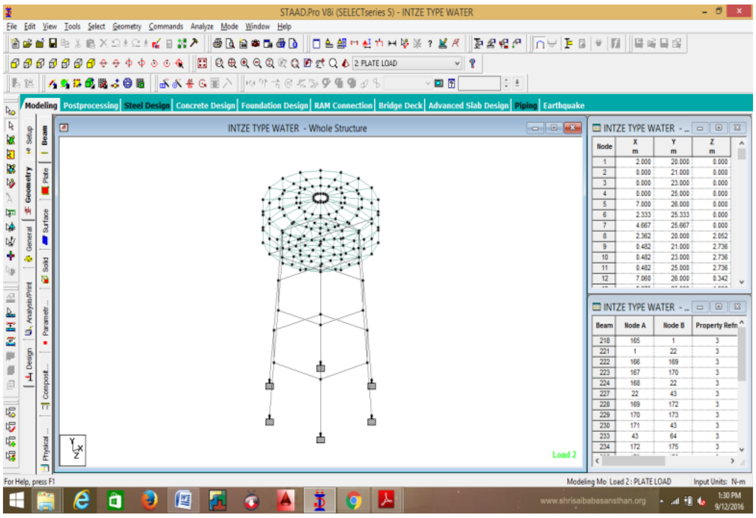
IV. RESULT



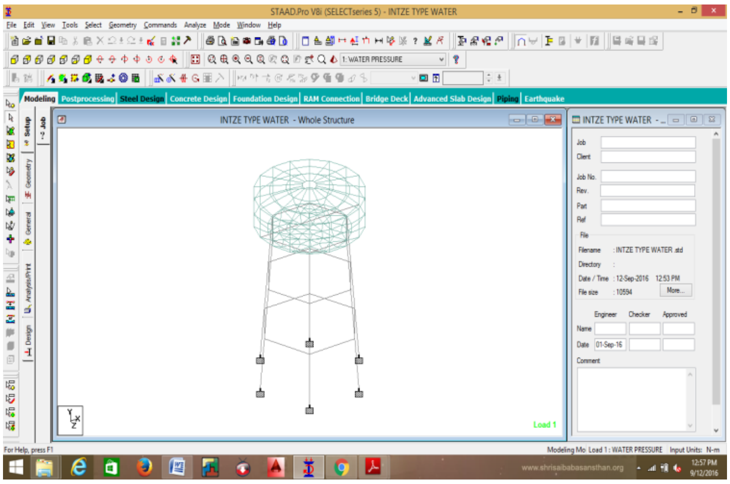
STRUCTURE WITH COLUMNS



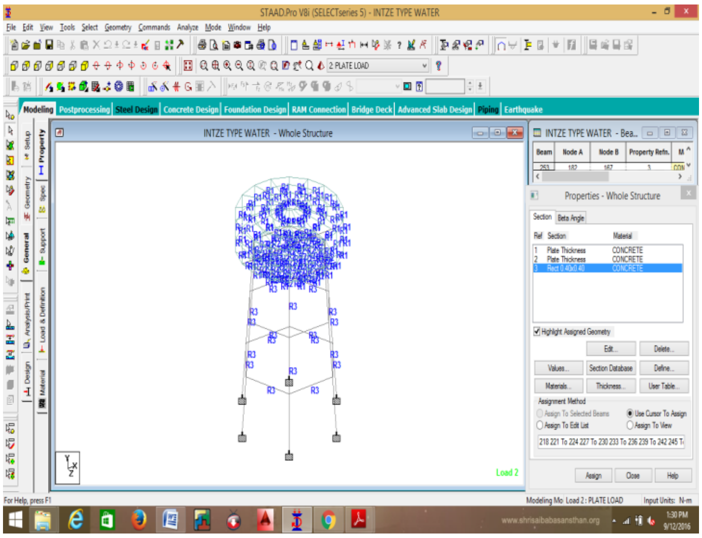
Structure with Dome



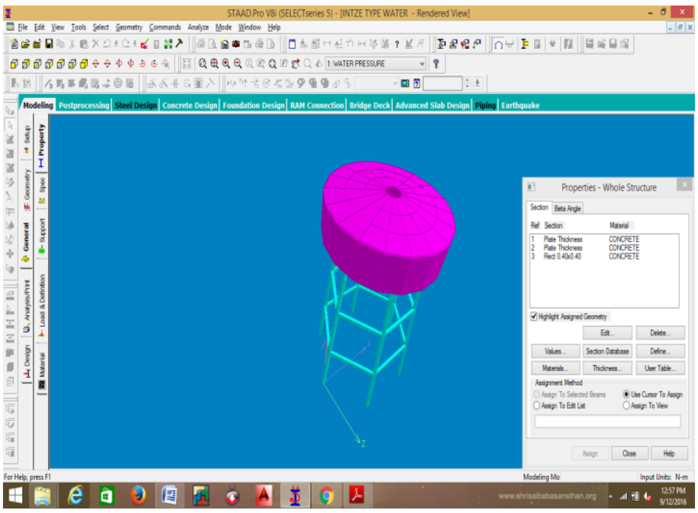
Structure with Nodes View



Structure Profile with Isometric View



Water Tank Structure with Properties



Structure in 3d View with Properties

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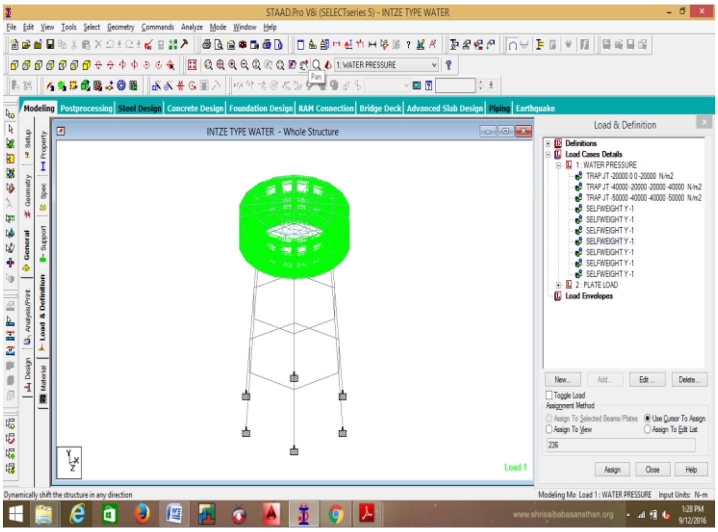


Self Weight of Dome

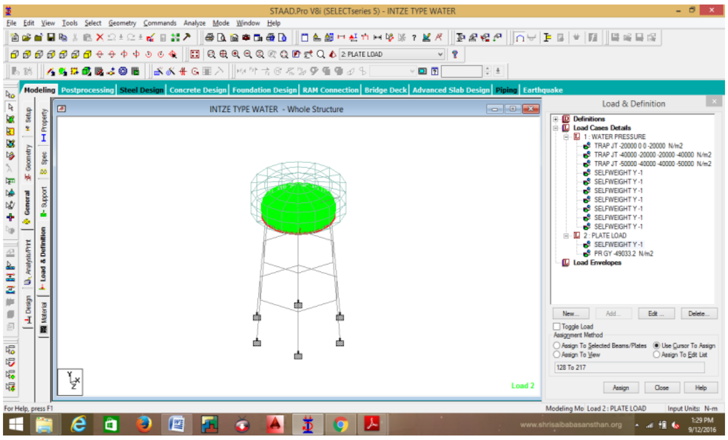
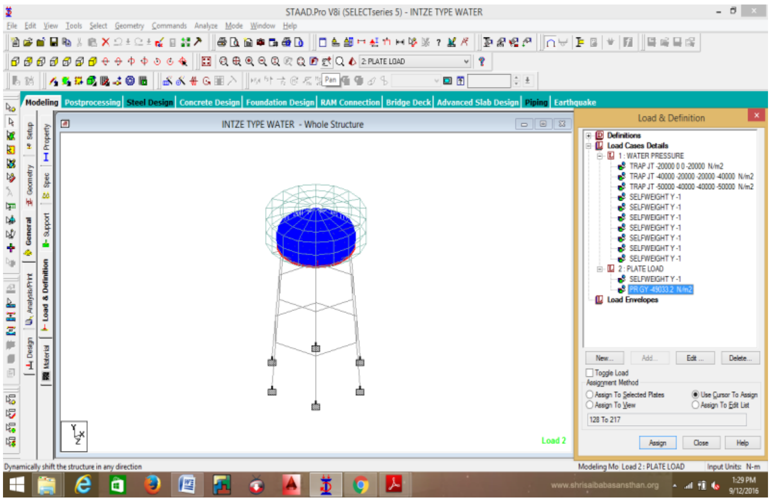


Plate Load



Pressure on Plates

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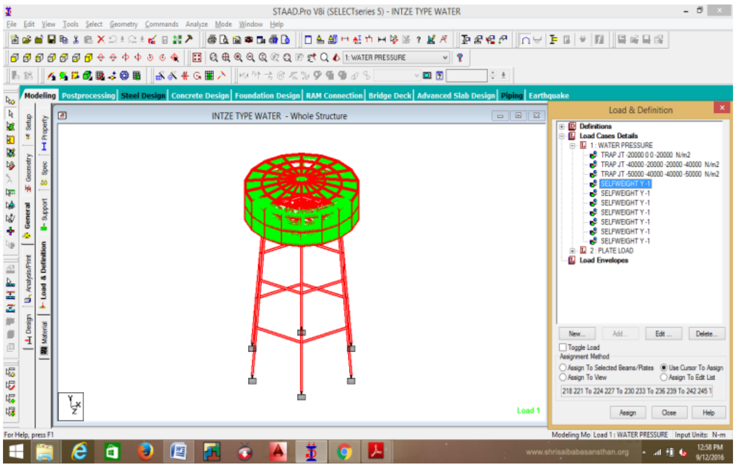
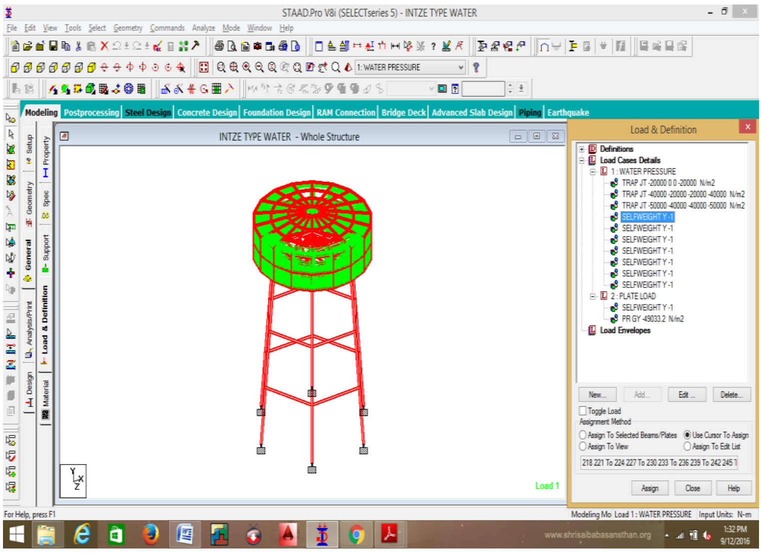


Tank with Water Pressure



Overall Loads on Structure

V. CONCLUSION

There is no consistency in kind of tanks depicted in different archives. All reports propose thought of Convective and Impulsive Components in seismic investigation of tanks. Ratio of Base Shear of tank and building is 6 to 7 for low flexibility tanks and 3 to 4 for high malleability tanks.

Most of the reports don't give lower bound utmost on unearthly values for tanks. Suitable arrangements for lower bound cutoff on ghostly values for tanks are fundamental. Just ACI 371, managing lifted tanks and IBC 2000 have such arrangements. Convective Mode Base Shear values got from API 650 and Euro Code 8 are comparable yet those got from ACI 350.3 is 2.5 times more prominent than that of ACI 370. Few irregularities among various AWWA benchmarks should be determined. Indian Code needs to incorporate arrangements on lower bound point of confinement on unearthly estimations of structures and tanks furthermore Convective Mode of vibration in the seismic examination of tanks. Based on the survey of different International Codes, it is suggested that IS 1893 ought to have estimations of R in scope of 1.1 to 2.25 for various sorts of tanks. R Value taken in IS 1893:1984 is no place in the extent comparing to that worth in various universal codes. Base Shear and Base Moment increments from Zone 3 to Zone 4 to Zone 5. With the expansion in R esteem Base Shear and Base Moment diminishes. The seismic powers stay consistent in a specific Zone gave the dirt properties stay same. In beach front locale Wind power is overwhelming, yet in inside seismic tremor powers are more prevalent lying in the same Zone.

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