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Comparative Analysis Of STAAD Pro V8 Software And Manual Design For Elevated Circular Tank Design

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ABSTRACT

Water is necessary for all living things to live. In locations where water is scarce, water provision is critical. Water is used to supply water to those areas stored in a tank .These water tanks are built in public. Pipelines supply water to the tank's water storage folks. These tanks are available in a number of shapes, including circular, square, and rectangular etc. tanks can be built at various heights. In this project, an elevated circular water tank is created manually employing the IS working stress method IS 456-2000, 3370-2009 (parts I-IV), and completed with STAAD PRO V8. Finally, compare the two outputs both manually and through software.

Keywords: Circular tank, Staad Pro, Bending moment, Shear force, Axial force.

I. INTRODUCTION

Tanks for holding water for use are known as water storage containers. A water tank is as ancient as civilization itself. Water tanks are used for a variety of reasons, including irrigation, fire control, agricultural cultivation, livestock, and more. Throughout history, water tanks made of wood, pottery, and stone have been utilized. A handful of such tank still in use, while others are either natural or man-made. Granaries and water tanks were used by Indus Valley Civilization between 3000 and 1500 BC. The defenders of medieval castles relied on water tanks to keep them hydrated in case of an attack. In the Ao Nuevo State Reserve (California), an ivy-covered wooden water tank was restored to working order. When it was completed, it was in 1884. Water tanks may be made from a variety of materials, including plastic, polythene, fiber glass, and steel (welded or bolted carbon or stainless steel). Earthen ponds, often known as tanks, are used to store water. Carbon steel-lined "ground water tank" may collect water from wells or surface water, enabling for enormous volumes of water to be held in inventory and utilised during peak demand periods.

Increasing the elevation of huge tanks, which are often referred to as "Elevated water tanks," results in a rise in pressure in tank's distribution system.

Because of materials and designing of water tank are defined by application criteria, this is how water tanks start off in terms of its profile as:

- The water tank's location & positioning
- The capacity of the water tank.
- When and for what water is intended.
- Concerned of freezing in the storage area's temperature.
- Water delivery pressure is necessary aspect.
- The method of water delivery to tank.
- High-wind and earthquake-resistant water tanks are the result of careful design. Wood, porcelain, & stone have all been utilized as water storage containers throughout history. There are both natural &

man-made tanks that are still operational. Many other tank shapes, including rectangular cubes and cones, may be used in unique arrangements.

The water in a well functioning tank or container may be contaminated by a variety of environmental factors, like bacteria, algae, pH shifts, and mineral buildup. In order to counteract these detrimental impacts, water tanks that are properly built are essential.

Details of present project

Capacity of water tank	:	2 lakh liter capacity
Height of staging	:	12m
Diameter of cicular water tank	:	8m
No. of bays along length	:	4
NO. of bays along pheriphery	:	20
Column size	:	0.30mx0.30m
Beam size	:	0.23mX0.23m

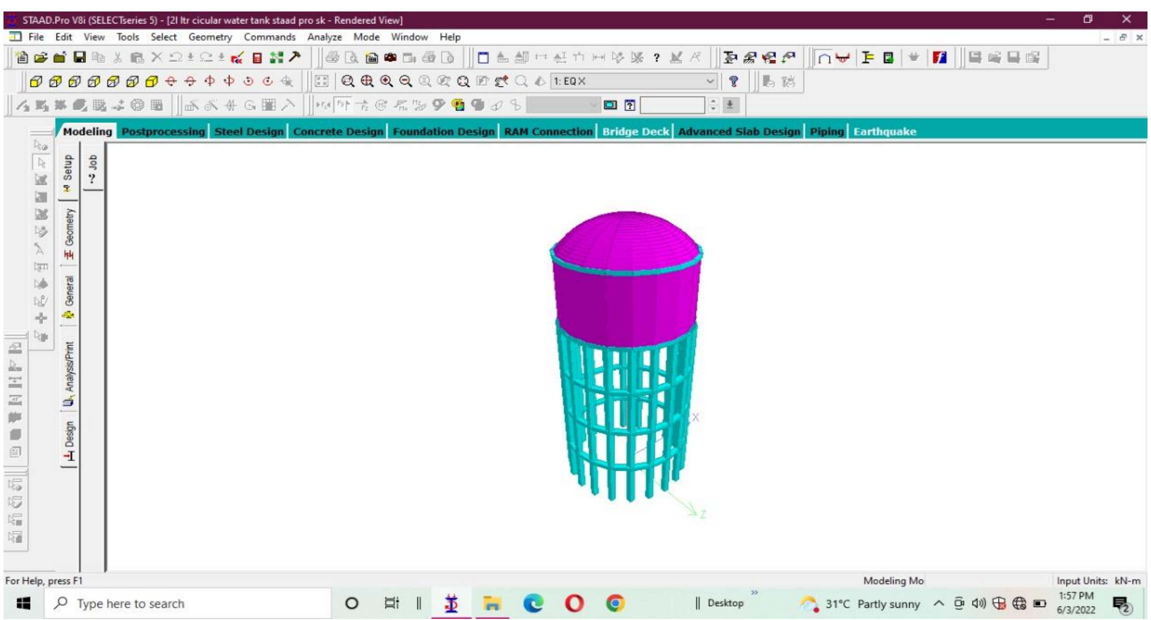

Fig 1: DESIGN OF ELEVATED CIRCULAR WATER TANK

II. LITERATURE OF REVIEW

An extensive amount of research is performed in process of examination & designing of water towers, according to a review of prior findings. Various designers and researchers have also made an effort to provide proportion of optimum geometrical constraintsin designing of containers to optimisedconstraintsin designingfir staging. Optimal foundation design for various sorts of soil conditions has not received much attention.

1] Issar Kapadia etal had carried out **"**DESIGNINGSTUDY& COMPARING OF UNDERGROUND RECTANGLE WATER TANK WITH STAAD PROVI8 SOFTWARE." This article examines UG Rectangle Tank, utilising STAAD Pro software to determine form deflection &which measures would generate whenever the tank was empty or full**.**

[**2**] **B.V. Ramana Murthy, M Chiranjeevi** performed "DESIGNING OF RECTANGLE WATER TANK WITH STAAD PRO". According to this report, he stated as 15-day mini-project was undertaken from May 21st, 2010 to June 7th, 2010 in order to get a thorough understanding of many strategies and challenges experienced in area. During the course of our little project, we've covered wide range of topics, from construction issues of designing parameters through formwork details to reinforcement to method of water treatment.

[3] Thalapathy.M et al "EXAMINATION&COST-EFFECTIVE DESIGNING OF WATER TANKS" have been carried out . He claimed in this study that the research provides a complete examination of the working stress method's design for a liquid-retaining structure. The notion for a safe design with a tank that costs the least is presented in this paper, along with designing relation curve among designing variables. Its essay aids into comprehending designing concept as water tank's secure and affordable construction.

[4]Mr.Manoj Nallanathel and colleagues had completed "Designing&examination of water tanks utilisingstaad pro." They studied the design of water tanks in that study, including overhead &subversive tanks with rectangle, cubical, & circle designs that were analysed using staad pro.

[5]Dubey.D,Dubey.S,Bajpai. Y.K's [8] The project uses the STAAD-Pro software tool to analyse wind effects on elevated water tanks of the INTZE type. They came to the conclusion that the designing of wind forces to zoneI are between 19 and 21 percent lower with those for zone II, 35 to 37 percent lower than those for zone III, 45 to 47 percent lower than those for zone IV, 55 to 57 percent lower than those for zone V, and 71 to 73 percent lower than those for zoneVI. EvenLateral displacingin zoneI are roughly 29 percent fewer as those for zone II, 45- 46 percent lesser than those for zone III, 50 to 52 percent less than those for zone IV, 56 - 58 percent less than those for zone V, and 63- 65 percent lesser than those for zoneVI.

III. OBJECTIVES

1. To carry out research on study and construction of an high placed circular water tank.

2. To be familiar with the design ethos for water tanks that are both secure and cost-effective.

3. To research IS: 3370 part 2-2009 and IS:456:2000 design specifications for liquid retention structures

4 In order to supply enough water and stop water shortages in the present and the future.

IV. METHODOLOGY

1) Set up new spatial framework in V8i using the units of length and force that you like.

2) Click on add beam and finish button.

3) Now grid view appears on screen and go to front view and then go to geometry, in geometry go to run structure wizard, now select frame model, select reverse cylinder option and enter length of staging as 12m,

radius as 8m, angle 360 degree, no. of bays along length as 4 and no. of bays along periphery as 20, now click on apply.

4) Now import the staging model to staad pro software.

5) Select all the beam section at the base and click on delete option click on ok

6) Now go to front view option and select the all the beam section copy option and paste it at a distance of 4m in Y direction.

7) Now to create the slant section select add 4 noded plates option and select the first ,second ,third and fourth point now copy the obtained 4 noded plates to remaining sections so select the plate cursor and select all the points and select the circular repeat option in y direction total angle of 360 degree and no. of steps as 20 now click on ok .

8) Now the plates are created

9) Now add the base to the tank go to front view click on cut section command select to view option and ok option

10) Now cut the respected portion, click on 3d view, go to generate surface option and select all the points.

11) Now mesh region opens and select ok option and add it automatically adds the mesh region to the water tank section.

12) To view the structure with mesh click on whole structure command and the respected entire section appears,.

13) Now to add cap go to geometry and run wizard command and select surface plate models and select spherical cap and enter the dimensions of the cap section click on apply option. The cap section appears on the screen and import the model to the software at a distance of 16m in y direction.

14) Now move the respected cap section by measuring the distance through node to node distanc now select the plate curser select the cap section move it at a distance which is measured through the node to node distance command click on ok button click on merge select delete the first node in all sets click on ok option.

15) Click on rendering view option

16) To assign supports click on supports, create option click on fixed supports and select supports option select all the node points assign to selected nodes assign option.

17) To assign beam and column size 1st we have to define the property , go to property option ,select rectangular option enter YD and ZD i.e .23m,0.30m as the dimensions of beam and click on add rectangle option enter YD &ZD option i.e,0.30m,0.30m as the dimensions of column. Now select the thickness option and enter the thickness as 150mm,add option .

18) Select t5he plate thickness option and select assign to selected plates option click n assign option.

19) Select the column size and go to select in that go to beams parallel top y axis ,now click on selected beams ,click on assign option.

20) Select the beam size go to select option in that go to missing attribute section missing property click on selected beams ,click on assign option yeas option.

21) To view the tank in 3d model click on rendering view option.

22) Now apply the load cases i.e DL, hydrostatic pressure,sesmic loading and wind loading condition.

23) Click on general option go to load and defnitions ,select defnitions click on sesdmic click on ok option and take as per in staad code is1893-2002/2005 Click on generate option select the zone and impact factor and response reduction factor etc click on generate option click on add now click on self wt click on add enter member wt as uniform load select the dimensions as 1.725Kn/m2 and element wt as 3.75Kn/m2 cl;ick on add option. Select uniform wt now select all the beam sections click on assign to selected beams click on assign yes opton.

24) Click on pressure click on assign to view click on assign option yes option.

25) Select wind Defn add select wind 1 add close and all the necessary data as per IS 875 code.

26) Now add exposure factor as 1 select assign to view option assign

27) Now apply load case details add seismic load as EQ X add and EQ Z add option.

28) Now select wind load option W X add option, W Z add option.

29) Now select dead load as DL add

30) Now select fluid load option s wp add close

31) Select EQ X add select seismic loads in x direction add close, same for the EQ Z .

32) Select wind X select wind load in x direction with factor as 1 add and -1 in opposite direction add close same for wind Z

33) Select DL add in y direction as factor of -1 add close select self wt assign to view option assign yes option.

34) Now select wp add select plate load select hydrostatic select all the plates by plate cursor click on done option add all the necessary data add close option.

35) Now analyze the model go to analysis and print option select no print option close and run analysis with zero errors and go to post processing mode click on done option.

36) Now the result setup icon appears on the screen then click on apply option and click ok option.

37) Now check the deflection of water tank due to presence to water pressure, u can change the deflections due to x& y direction seismic loading.

38) Now check the bending moment&shear forceillustration, axial force, and load because of water pressure on plates by selecting beam and respective dead loading condition.

39) Now select the plate load apply the stress type as Max absolute pressure click on apply option and click on ok option ,now it appears on the screen by selecting dead loading condition and earthquake load in x direction and z direction condition.

40) Now to design the respective water tank go to modelling option select the design option clickingupon concrete designing & select the code IS456,Select compressive strength, yield strength of primary reinforcement, yield strength of shear reinforcement, the maximal sizing of main reinforcement, & maximal size of secondary reinforcement by clicking ok option.

41) Now select the define parameters as we are using M30 grade concrete take compressive strength as 30000Kn/m2.

42) Now select FY main yield strength of main reinforcement as 600000KN/m2 click on add option and for section reinforcement i.e, FYsec as 600000KN/m2 click on add option.

43) Now select the maximum size of main reinforcement as 20mm and for secondary reinforcement as 16mm add option and close option.

44) Now select the commands option select design beam command add option now select the deign column command option add , design slab option add select take off command command option add and close.

45) Now assign the respective parameters ,select the FC30000 assign to view option

46) Select the FYMAIN 600000 assign to view option.

Select FYSEC 600000 assign to view option.

47) Select MAX MAIN 20 assign to view option.

48) Select MAX SEC 26 assign to view option.

49) Now select the design beam go to front view option select all the beams parallel to horizontal direction click on assign to selected beams click on assign option.

50) Now select the design column command and go to select option, now select beams parallel to y direction condition clicking on assigningfor selection beams assigning option yes option.

51) Now select the design element command using assign to view option yes option.

52) Now analyse the respective water for designing also go to analysis and print select no print option click on close option.

53) Now go to analyse and run analysis save the model click on run analysis option. Now check for zero errors and after with no errors go to post processing mode click on done option.

54) Select the beam go to bending moment option double click on any one of the beams and it will show the respective beam design results and click on concrete design it will show the section of the beam and same follows for the column.

55) Click on output file option click on results option click on concrete option it will be consisting of each and individual calculation of beams, column sections as per IS456:2000 code.

4.1 LOADS ACTING ON THE WATER TANK

1. Dead load:
    - Dead load means the load due to the materials of the construction. i.e, unit weight of material x dimension or diameter of a section. Unit weight of concrete is 25 Kn/m^3.
2. Live load:
    - Load exerted by the living beings. In water tank load of water also consider as live load.
3. Wind load:

   Wind loading details by IS: 875 (part I-III),for the design
    - Basic wind speed (Vb) = 39m/sec
    - Terrain factor = 3

Earth quake load:

Earth quake load as per IS: 1893(part I-II), for the

- Design Seismic Zone = V
- Zone factor = 0.36
- Importance factor =1.0
- Response reduction factor =5

Design Seismic Zone	V
Zone factor	0.36
Importance factor	1.0
Response reduction factor	5

V. RESULTS

BENDING MOMENT

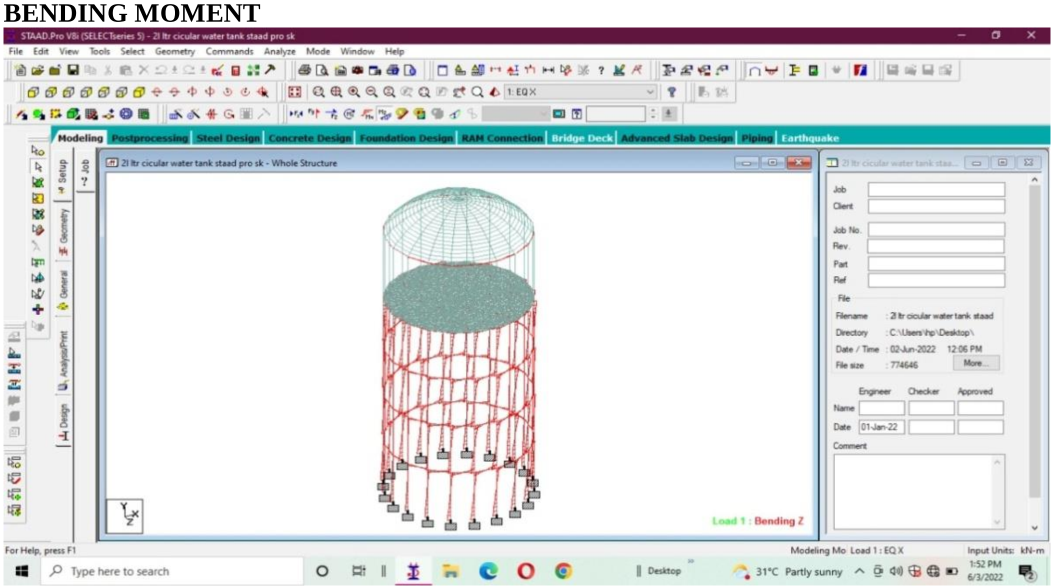

Fig 2 Bending moment

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SHEAR FORCE

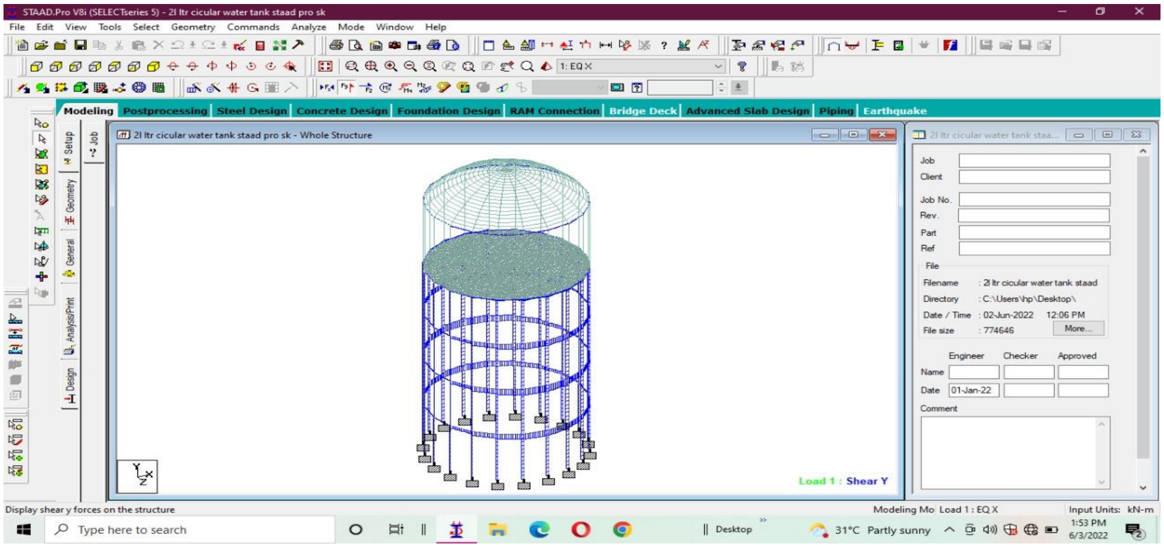

Fig 3 Shear force

AXIAL FORCE

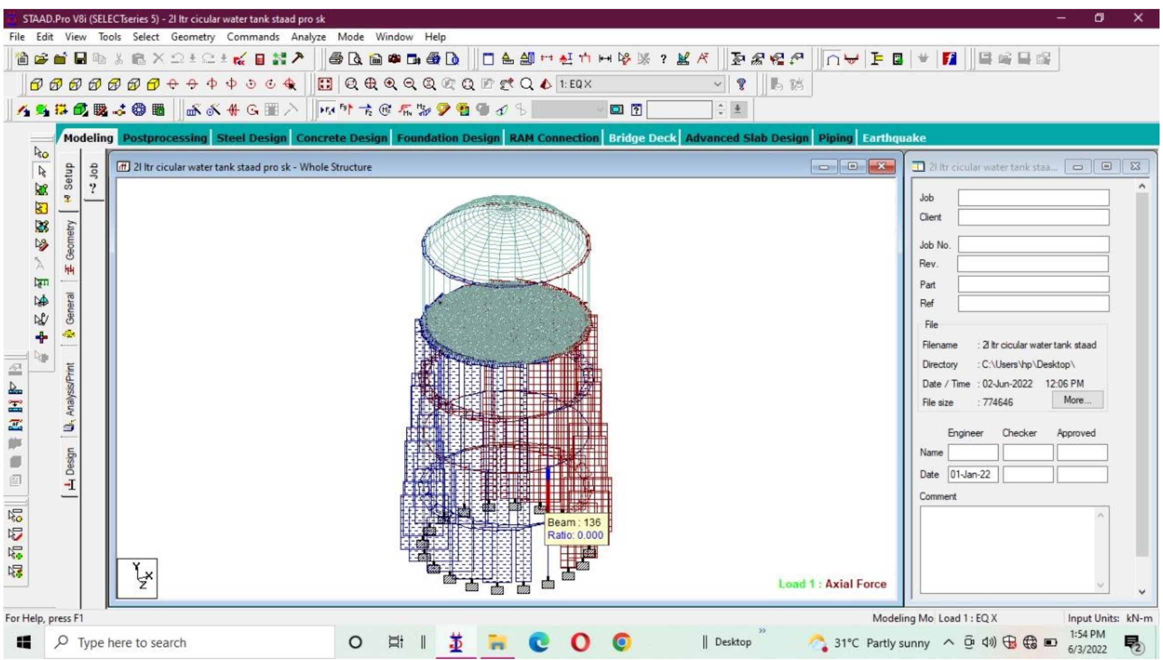

Fig 4 Axial force

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WATER PRESSURE

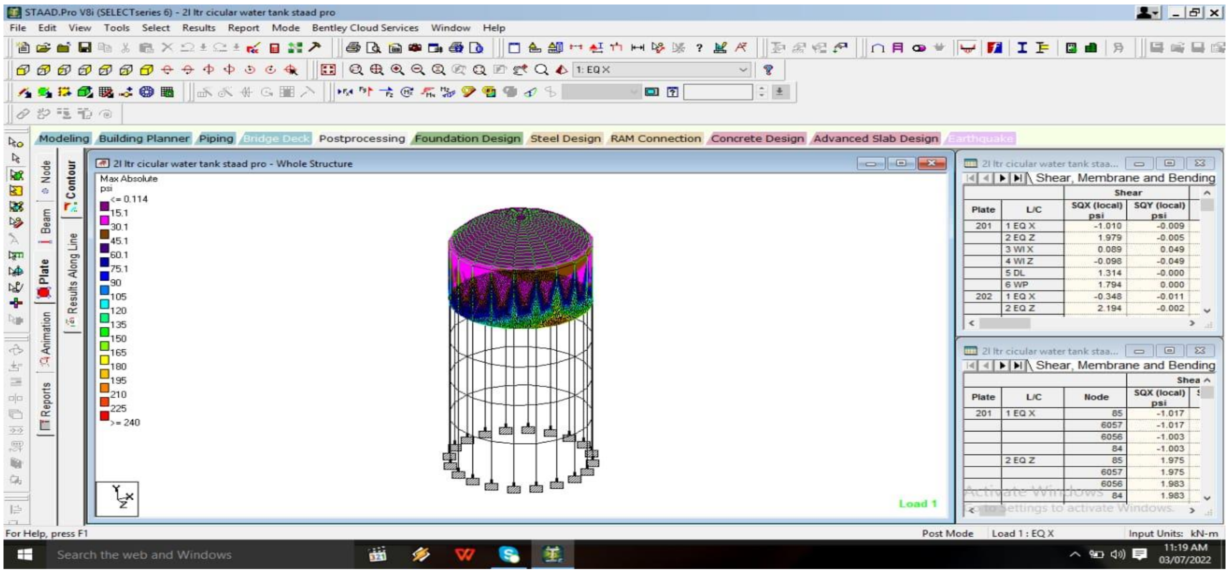

Fig 5 Water pressure

COLUMN DETAILS AND DEFLECTION

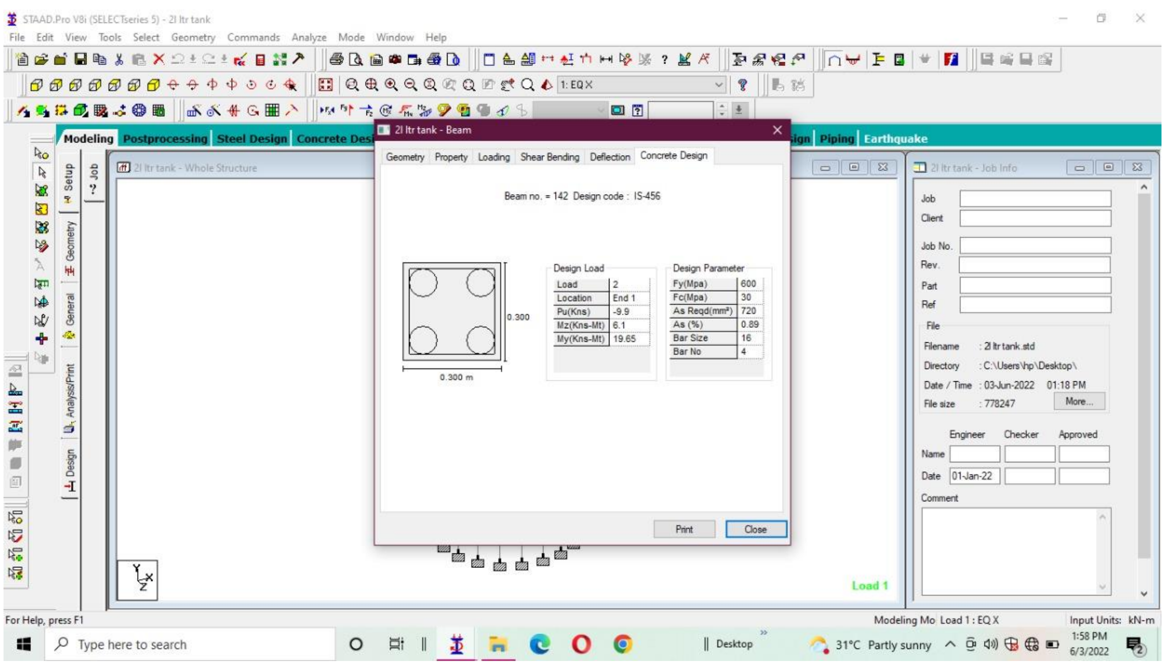

Fig 6 Column Details

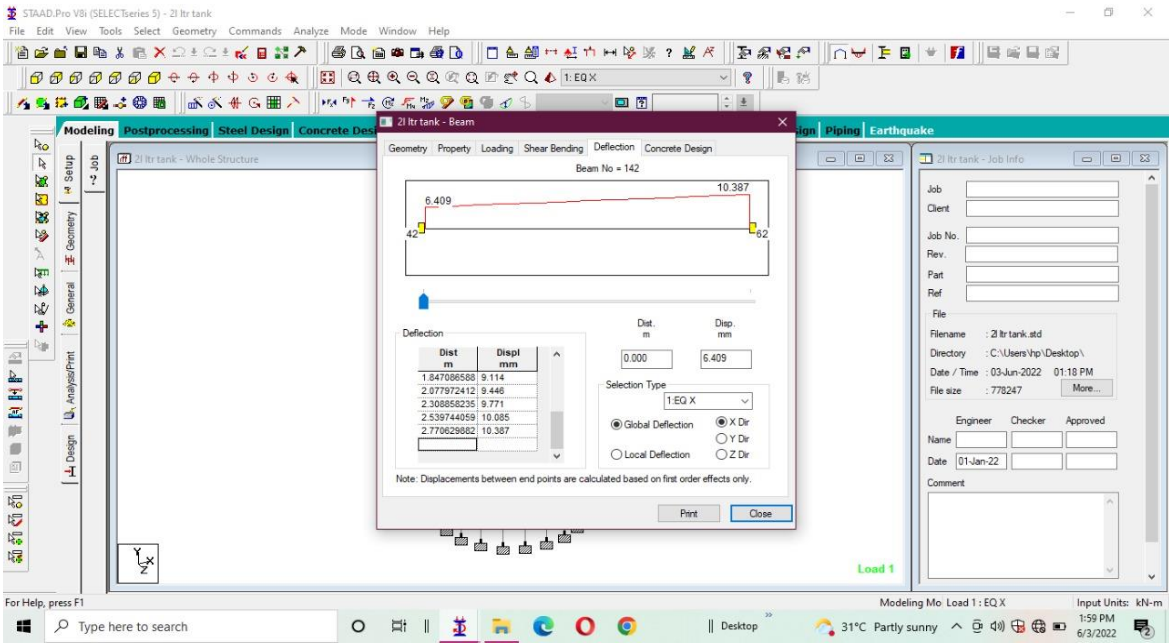

Fig 7 Deflection

BEAM DETAILS AND DEFLECTION

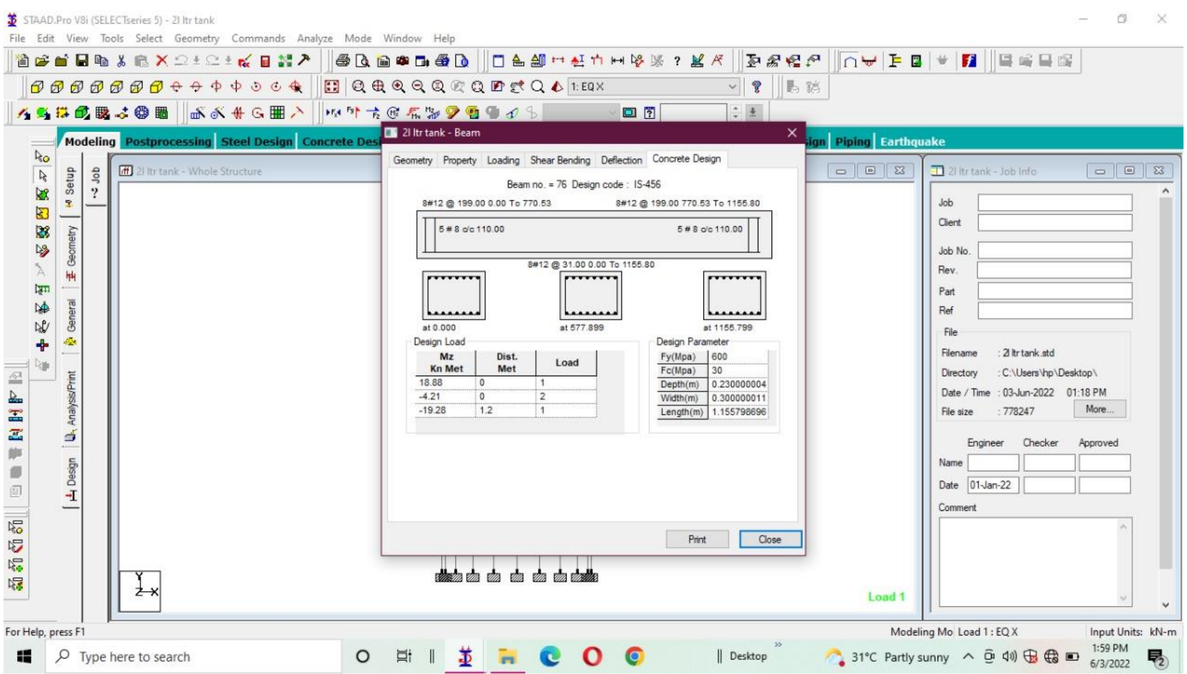

Fig 8 Beam Details

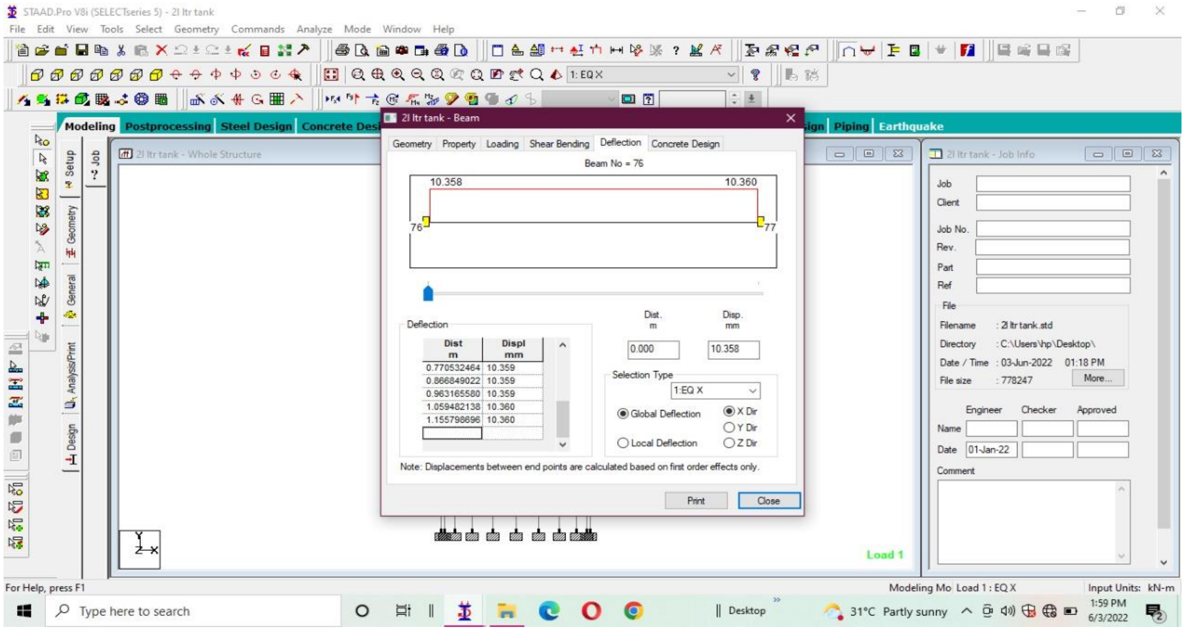

Fig 9 Deflection

PLATE LOAD

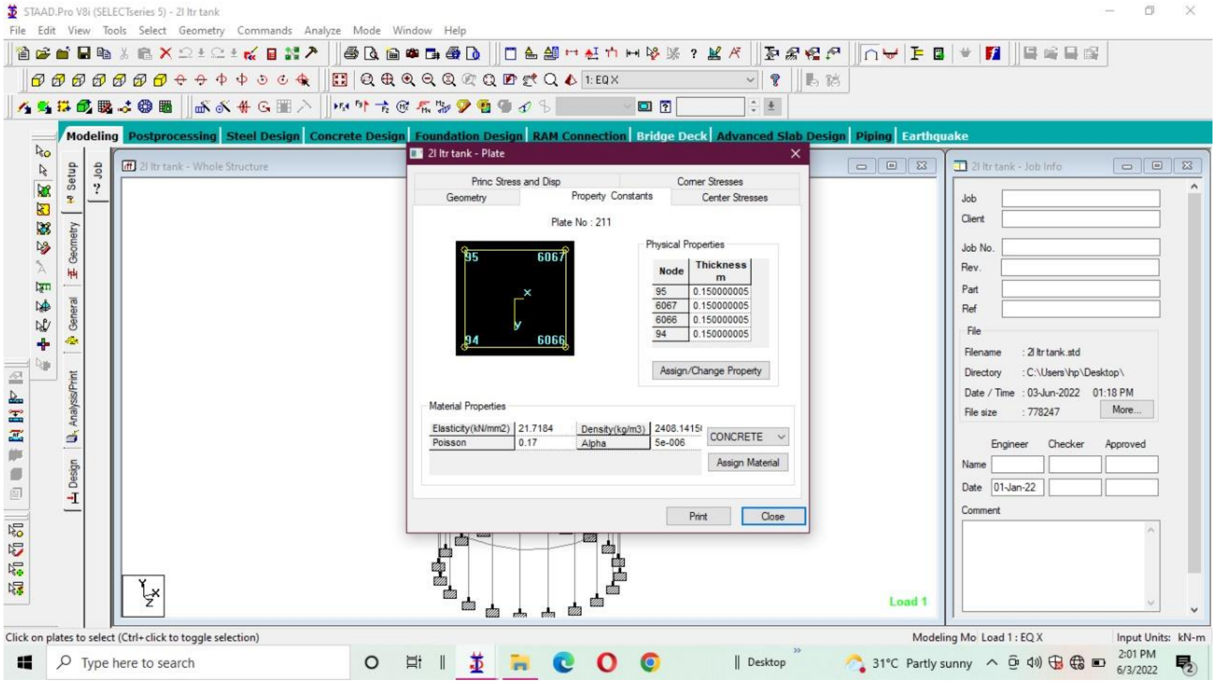

Fig 10 Plate load

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3-D MODEL

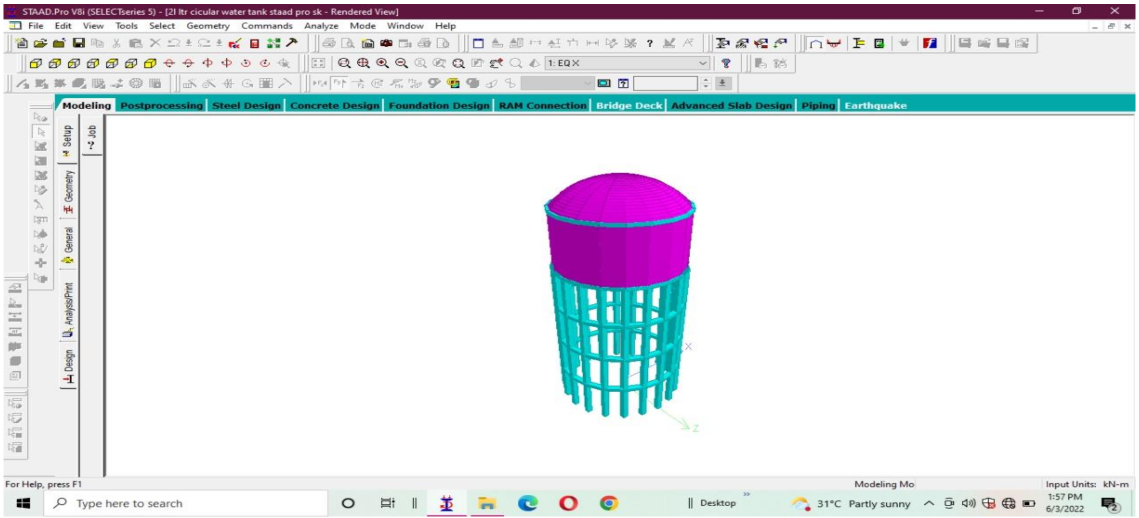

Fig 11 3-D Model

MANUAL DESIGN

1) Dimension of the tank:

$$D=\frac{\sqrt{4V}}{\sqrt{\pi XH}}$$

$$D=\frac{\sqrt{4X200}}{\sqrt{\pi X3.5}}$$

D=8.5=8m

Radius of the cylindrical portion = 4m.

1. Rise of the top dome = h1=0.2 X D=.2 X8=1.6m
2. Rise of the bottom dome=0.16XD=0.16X8=1.92=2m
3. Thickness of the wall (t) =150mm.
4. Diameter of cylindrical portion=8m.
5. Arc equation of top beam=r1

$$r1=\frac{\left(\frac{D}{2}\right)^2+1.6^2}{2Xh}=\frac{4^2+1.6^2}{2X1.6}=5.8m$$

6. Arc equation of bottom beam $r2=\frac{4^2+2^2}{2X2}$

7. Height of vertical wall =h3

8. Volume of cylindrical part$=\frac{\pi XD^2Xh3}{4}$ X (πh^2) X ($r2-h2/3$)

$$200=\left(\frac{\pi X D^2 X h3}{4}\right) X(\pi(h2)^2 X(r2-\frac{h2}{3})=7.42\text{m}$$

1) Design of top dome

a) Thickness of dome =100mm.

b) Meridional force (T1) =$\frac{wXR}{1+cos\theta}$

w=load of dome.

Live load =1.5KN/m²

Self-weight=thickness X density=0.10 X 25=2.5KN/m².

Total load=4KN/m²

Radius of curvature of dome

h=rise of dome

h=0.2XD=0.2x8=1.6m

R=5.8m

Sin ө =$\frac{\frac{D}{2}}{R}$=$\frac{4}{5.8}$=43˚60′

Cos ө =0.724

Meridional stress=$\frac{F}{a}$=$\frac{13.45X10^3}{1000X10}$=0.134N/mm²

Direct tension stress=σct

For M30 grade concrete =15kg/cm²

Permissible stress in concrete =8N/mm².

0.202$\ll 8N/mm^2$

Area of reinforcement

Provide 0.24% of minimum reinforcement

Ast =$\frac{0.24X1000X100}{100}$

Provide 8mm ϕ bar @ 200mm c/c.

(Ast=251mm²)

For hoop force (T2) = $wXR\left(cos\theta-\frac{1}{cos\theta}\right)$

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T2=$4X5.8X(.0724-\frac{1}{1.724}$=3.33kN/m

Hoop stress =$\frac{3.33X10^3}{1000X100}$=.033< $8\frac{N}{mm^2}$

Provide 0.24% of minimum reinforcement.

2) Designing of top ring beam

It's designed for hoop tension

W=T1Xcosθ=13.45 X cos (43˚60′)=9.74KN/m

Total hoop tension in beam

WX$\frac{D}{2}$=9.74X4=38.96KN

Ast for hoop tension

$$\frac{T}{\sigma st}=\frac{38.96X10^3}{150}=259.53mm^2$$

Provide 12mmϕ @150mm c/c (Ast=753)

To find dimension R.B

$$\sigma ct=\frac{T}{Ag+(m-1)Ast}=\frac{38.96X10^3}{250XD+(9.33-1)X753}<1.5$$

Ag=b X d

m=$\frac{280}{3X\sigma cbc}=\frac{280}{3X10}=9.33$

$$\sigma ct=29551.27<375D=78.84$$

Consider D=300

Size of beam =230X230mm

Provide minimum shear reinforcement

8mm ϕ bar -2 legged vertical stirrups

Sv =$\frac{0.87XfyXAsv}{.4Xb}=362.96mm^2$

Asv=$\frac{\pi Xd^2}{4}=\frac{\pi X8^2}{4}=100.53mm^2$

Spacing limit

1) 0.75XD=0.75X230=172mm

2) 230mm

Provide 8mm ф bar -2 legged vertical stirrups @225 c/c.

3) Design of tank wall

T=$\frac{wXHXD}{2}=\frac{10XHX8}{2}=40H\frac{kn}{m}$

Ast =$\frac{\text{T}}{\sigma\text{st}}=\frac{40\text{H}}{13}$

Ft=$\left(\frac{\text{wXHXD}}{2}\right)=\left(\frac{10\text{X}3.5\text{X}8}{2}\right)=140\,\frac{\text{kn}}{\text{m}}$

Ast$\left(\frac{140\text{X}10^3}{150}\right)=933\,\frac{\text{mm}^2}{\text{m}}$

Provide 12mm diameter bars @ 150mm c/c at tank bottom (Ast=1000mm²).

If t= thickness of the tank wall at bottom of tank then

$$\left(\frac{T}{Ac+(m-1)Ast}\right)=\sigma ct$$

$$\left(\frac{140X10^3}{100t+(9.3-1)Ast}\right)=1.6$$

T=79.21≈ $80mm.$

Adopt 100mm thick walls uniform up to top of the tank.

Minimum reinforcement =0.24%=$\left(\frac{0.24X100X1000}{100}\right)=240\,\frac{mm^2}{m}$.

Provide 12mm dia hoops at 300mm center for the top one meter .For the middle one meter adopt a spacing of 225mm c/c.

Distribution steel Ast=$\left(\frac{0.2X1000X100}{100}\right)=200mm^2.$

Provide 12mm dia ф @n300mm center in vertical direction.

3) Diagonal tank floor slab:

The tank floor slab is circular and fixed at periphery to the circular ring beams.

Load on circular slab= (wt. of water) + (s.wt of slab Ast 300mm)

W=10 X 3.6+.3 X 24

W=43.2kn/m

a) Max radical and circumferential moments

+ve moment at center of span is

Mrp = $\frac{3XwXr^2}{16} = \frac{3}{16}X43.2X4^2 = 129knm.$

-ve moment at support is

Mrp=$\frac{wXr^2}{8} = \frac{43.2X4^2}{8} = 86.4knm.$

Circumferential moment is given by relation

Mc=$\left(\frac{wXr^2}{16}\right) = \left(\frac{43.2X4^2}{8}\right) = 43.2knm.$

Effective depth of slab is given by

D=$\frac{\sqrt{M}}{\sqrt{Q.b}} = \frac{\sqrt{129X10^3}}{\sqrt{2.57X1000}} = 224mm$

Adopt d=270mm, overall depth =300mm.

a) Reinforcement in circular slab

Ast (center of span) =$\left(\frac{129000X10^3}{190X0.89X270}\right) = 2825mm^2.$

Ast (supports) =$\left(\frac{86400X10^3}{150X0.88X270}\right) = 1212.24mm^2$

Provide 16mm dia bars @120mm center both ways at bottom and for a length of 1.2m from supports and circumferentially.

4) Design of bottom ring

Loads of ring beam

a) Load due to top dome=241.30kn

b) Load due to ring beam=1.322kn

c) Load due to cylindrical wall=12.5kn

d) Self-weight of ring beam=1.322kn

e) Total load =256.44kn

Horizontal force = H = V1 cos (45)=256.44Xcos(45)=181.3kn/m

Hoop tension due to vertical load

Hg=$\frac{HXD}{2} = \frac{181.3X8}{2} = 725.2kn$

Hoop tension due to water

Hw=$\frac{wXdXDXhs}{2} = 72kn$

Total hoop tension =Hg + Hw =$725 + 72 = 797kn$

Ast=$\frac{797000X10^3}{150} = 5314.6mm^2$

Assume 18-22mm ф bar (Ast=5314.2mm²)

Maximum tensile stress=$\frac{797000X10^3}{(230X230)+(18X5655.6)} = .05153\,\frac{N}{mm^2}$

Provide ring beam of 230X230 with 18 bar of 20mm ф distribution bar of 10mm ф from cylindrical wall taken round the main bars s stirrups at 180mm c/c.

f) Supporting tower

Total load from ring beam =1618KN

Load on each column =80.9KN

Self- weight of braces = (300X300) = 0.3X0.3X12X25=27KN

Self-weight of braces = (230X230) = 0.23X0.23X4X25X2=10.58KN

Total load on each column (tank full) =80.9+27+10.58=118KN

Total axial load = $\left(\frac{1618-1000}{20}\right) + 27 + 10.58 = 68.48KN$

b) Wind force

Intensity of wind pressure =1.5Kn/m².

reduction coefficient form circular shape =0.7

1) Wind force on top of dome & cylindrical wall

$$(\,0.7X1.5X5.35X6.2) = 35KN$$

2) Wind force on one column=$(20X0.3X12X1.5 = 108KN$

3) Wind force on braces =$(2X6.2XX4.5X1.5)$ =8.2KN

4) Total horizontal wind force =35+108+8.2=151.2 KN

Assuming contra flexure points at mid height of columns and fixity at the bars to raft foundation the moment at the bars of column is obtained

$$M=(0.5X151.2X4) = 302.4KNm$$

If M1= moment at the base of column due to wind force

M1=$(35X14.67) + (108X20) + (8.2X20) = 2837.45KN - m$

If V = reaction developed at base of exterior column

M1=$\Sigma M + \frac{V}{r1} X \Sigma r^2$

r1=4 X cos (30) = 3.46m

r2=4$(3.46)^2$=47.88m

$2837.45 = 302.4 + \left(\frac{V}{3.46} X47.88\right)$

∴V = 183.19KN

∴ Total load on leeward column at base

$$P = (332 + 183.19) = 515KN$$

Moment in each column =$\frac{302}{20} = 15.1KN$

Eccentricity =e= (MIP) = ($\frac{15100X10^3}{515X10^3} = 29.32mm$

Since eccentricity is small direct stress are predominant, using 8mm bars of dia equally spaced on all faces

Ast = (8X20) =1608mm^2.

Ac= [(300X300)-1608] + (1.5X13X1608)=119746mm^2

Ic=$\left(\frac{300X300^2}{12}\right) + (2X1.5X13X3X201X150^2) = 3.3\frac{N}{mm^2}$

Bending stress $\sigma cb = \left(\frac{15100X10^3}{531X10^7}\right) = 0.56\frac{N}{mm^2}$

Hence,

$$\left(\frac{\sigma cc'}{\sigma cc} + \frac{\sigma cb'}{\sigma cb}\right) < 1$$

$$(\frac{33}{5X1.33} + \frac{0.56}{7X1.33}) < 1$$

∴ The stress are within safe permissible limits adopt 6mm dia ties at 250mm c/c.

5) Design of bracings:

Moment in brace =2XMoment in column X sec (30)

Moment in brace = (2 X15.1X1.15) = 34.73KN-m

Section of brace = (230X230) mm.

b=230mm

d=230mm

Moment of resistance of section is given by:

M1=$\left(\frac{0.897X230X230^2}{100}\right) = 10.91KN - m$

Balance moment =M2= (M-M1)=(34.73-10.91)=23.82KN-M

Ast₁=$\left(\frac{10.91X10^6}{230X230X0.9}\right) = 230mm^2$

Ast₂=$\frac{23.82X10^6}{230X0.9X230}$=500mm²

Ast=(Ast₁+Ast₂)=$(230 + 500) = 730mm^2$

Provide 3 bars of 20mm dia at top and bottom since wind direction is reversible (Ast=942mm²)

Length of brace =$(2X4Xsin(30)) = 4m$

$$= \left(\frac{Moment\ in\ brace}{½length\ of\ brace}\right) = \left(\frac{34.73}{0.5X4}\right) = 17.36KN$$

$$\tau_v = \left(\frac{17.36X10^3}{230X230}\right) = 0.32\frac{N}{mm^2}$$

From table no.23 of is: 456 code,$\tau c = 0.33\ N/mm^2$

Since $\tau c \gg \tau_v$ provide nominal shear reinforcement.

Using 6mm dia 2-legged stirrups

Spacing = S_v=$\left(\frac{AsyXfy}{0.4Xb}\right) = \left(\frac{2X28X415}{0.4X230}\right) = 252.60mm$

Adopt 6mm dia 2-legged stirrups at 150mm c/c

6) Design of foundation:

a) Circular girder:

A circular girder with a raft slab is provided for the tower foundation.

Total load on foundation =$118X20 = 2360KN$

Self-weight of foundation at 10% = $236KN$

Total load = 2596KN

S.b.c of soil = 100$\frac{KN}{m^2}$

$$\therefore Area\ of\ foundation = \left(\frac{2596}{100}\right) = 25.96m^2$$

If b= width of footing required

$$(\pi X8Xb) = 25.96$$

$$\therefore b = \frac{25.96}{\pi X8} = 1.03m$$

Adopting footingwidth =1.5m & circular girder having width of 500mm

Total loadingupon ring girder=2596KN

Load/m run of girder=$\left(\frac{2596}{\pi X8}\right) = 41\frac{KN}{m}$

Maximum –ve moment at support =$0.0148XwXR = 0.0148X2596X4 = 153\frac{Kn}{m}$

Maximum +ve moment at mid span =$0.0075XwXR = 0.0075X2596X4 = 77.88\frac{Kn}{m}$

Maximum torsional moment =$0.0015XwXR = 0.0015X2596X4 = 15.56\frac{Kn}{m}$

S.F at support section is obtained as

V=$\left(Total\frac{load}{2Xno.of\ column}\right) = \left(\frac{2596}{2X20}\right) = 64.9\frac{Kn}{m}$

S.F at section of maximum torsion

V=$\left(64.9 - \frac{41}{180}X3.142X4X12.73\right) = 28.45\frac{Kn}{m}$

The support section is designed for a maximum –ve moment of M=153 Kn/m and S.F of 64.9Kn-m assuming a width b=500mm.

Effective depth

D=$\sqrt{\frac{153X10^6}{2.5X500}} = 349.85mm.$

Adopt d=500mm and overall depth = 550mm

Ast=$\left(\frac{153X10^6}{230X0.9X500}\right) = 1478.26mm^2$

Provide 4 bars of 22mm dia bars (Ast=1520.72mm².

τ_v=$\left(\frac{100Ast}{bd}\right) = \left(\frac{64.9X10^3}{500X500}\right) = 0.259\frac{N}{mm^2}$

=$(100Ast/bd) = (\frac{100X1520}{300X300}) = 1.68$

$$\tau_v = 1.68\frac{N}{mm^2}$$

From table 23 of is: 456 $\tau c = 0.30\frac{N}{mm^2}$

Since $\tau_v > \tau c$ shear reinforcement is required.

Balance shear = (64.9-$\frac{0.30X300X300}{1000}$) =37.9 Kn

Using 10mm dia 2-legged stirrups spacing

S_v= ($\frac{230X2X78.5X500}{107.5X10^3}$)=167mm.

Adopt spaceof 160mmc/c.

Steel needed for mid span segment is

Ast = ($\frac{77.8X10^6}{230X0.9X230}$) =1634mm².

But minimum steel = ($\frac{0.85X230X230}{415}$) =108mm².

Provides 2 bars of 20mm dia (Ast=628mm²).

Equivalent shear is obtained as

Ve=$\left(V+\frac{1.6T}{b}\right)=\left(28.45+1.6\left(\frac{5}{0.5}\right)\right)=38.45Kn.$

$$\tau_v=\left(\frac{38.45X10^3}{300X300}\right)=0.427mm^2.$$

=$\left(\frac{100Ast}{bd}\right)=\left(\frac{100X628}{300X300}\right)=0.69$

From table 23of IS:456 code

$$\tau c=0.22\frac{N}{mm^2}$$

Since $\tau_v > \tau c$ shear reinforcement is required.

Balance shear =$\left(38.45-\frac{0.22X300X300}{1000}\right)=18.65Kn$

Using 10mm dia-2 legged stirrups the spacing is given by

S_v= ($\frac{230X2X78.5X500}{12X10^3}$) =220mm.

VI. CONCLUSION

In this project a study is made to compare designing of elevated circular water tank by manual method and software method. To know about the area of steel required for the water tank.
From the study it is finally conclude that.

1) The amount of steel required for the whole structure is less for software design compare to manual design.
2) While comparing with manual design software design saves 10% of steel in whole structure.
3) Manual design method require more time and complicated. Whereas the design done in STAAD PRO software require less time and easy**.**

SCOPE OF THE WORK

- We conducted a survey of 250 families with an average of four members to determine the water consumption in the area. A typical person needs 200 litres of water every day.
- Based on this, there is a need for water of (200x4x100) = 200000 liters.
- So, in order to meet these families' daily water needs and ensure that there won't be a water shortage in the future as the population grows, we are building a water reservoir.

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