# Design and Analysis of Water Tanks using STAAD Pro v8i

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**ABSTRACT -The increasing demand, water must be stowed & supplied accordingly to the needs of the people. Usage of water changes at different times of the day, and quanity utilised could vary from one hour to another. To make sure there is continually a steady supply, it is important to keep some water in reserve. For this reason, building water storage tanks is necessary to manage these changes and meet the daily needs of the community. One way to store water for later use is in a water tank. In some regions, it may also serve as reservoir for agricultural irrigation water, as well as a source of potable water for human use & industrial cooling. It is possible to construct water tanks in a variety of forms and locations, both above and below ground. In this study, we looked at how tank shape and position affect their strength and design. Using STAAD PRO V8i software, we learned how to model and analyze water tanks in shapes like rectangular, square, and circular. Outcomes portray as shape of a tank has a big impact on how loads are carried, how stresses are distributed, and how much the tank will cost to build. This project mainly explains designing and construction of an raised circular water tank with a domed roof.**

**Keywords- Water Tank, Staad pro,**

## I.INTRODUCTION

### 1.1 GENERAL

Liquids such as water, petroleum products, and other fluids are commonly stored in storage tanks or reservoirs. These tanks can be located above ground level or underground, depending on the purpose. Ground-level tanks are usually designed to store larger volumes, whereas elevated tanks are supported on structural frameworks or staging to supply water under the influence of gravity flow. When it comes to maintaining a constant supply of water for homes, businesses, and firefighting systems— even in the face of catastrophic events like earthquakes—elevated tanks are invaluable. Usage of high-quality reinforced concrete is essential for constructing durable water tanks. The water–cement ratio plays a major role in determination of strength, permeability, and durability of the concrete. Excess water in mix reduces strength and increases risk of cracks, while very lower water content might cause poor workability. To ensure proper compaction, usage of a mechanical vibrator is recommended. For durability and crack resistance, a cement content vacillating from 330 kg/m³ to 530 kg/m³ is considered suitable. In tank construction, the main objective is to minimize shrinkage cracks while achieving high strength and watertightness. Usage of thick timber shutters should be avoided, as it restricts the release of hydration heat from concrete and may lead to cracking. By allowing free thermal movement and proper curing, the risk of structural cracking can be significantly reduced, ensuring a safe and long-lasting liquid storage system.

## II. LITERATURE REVIEW

### 2.1 Introduction :

Tank construction has undergone extensive research for making them more efficient, cost-effective, and long-lasting. Researchers are looking at potential uses of various materials by individuals from all around globe. U sage of different

materials & size form foundation of test process.  Therefore, this insightful book review will have to do.

## 2.2 Literature Survey

### 2.2.1 Designing of Intze Tank in Perspective of Revision of IS: 3370 By, Pavan S. Ekbote and Dr. Jagadish .G. Kori (2013):

In an earthquake, high water tanks can cause significant damage or collapse. This could be because of understanding of response and dynamic action of water tank support system, & an inappropriate selection of tank stage geometric designs.

Because of contact of liquid structure, seismic behaviour of high water tanks is a feature of intricate occurrences. Goal of the research was to determine how a support system (or platform) that works better under a different SAP 2000 software response system operates.

### By, R.V.Prasad et.al (2012):

High water tanks being utilized for storing water. BIS amended IS 3370 (parts 1 & 2) in 2009, some years after the initial 1965 edition. This new code was built with a fluid storage tank in mind. In our research, the boundary condition technique must be used into constructing water tank. The idea behind construction of a circular water tank utilising WSM & LSM is presented in this paper. Water tank design with LSM is very cost effective since the equipment required is little compared to WSM. Because the water tank is such an important container for holding water, the crack width of the water tank must also be calculated.

### 2.2.2 OPTIMUM  DIAMETER OF TAPERED ELEVATED RC WATER TANK STAGING:

### By, Chirag N. Patel, H. S. Patel (2015) :

IS 1893: 1984 has a very limited stock of earthquake-resistant water tanks. These rules apply exclusively to high-water tanks; low-water tanks are not included. The impact of the sloshing vibration effect is not considered in IS 1893: 1984, even in high water tanks. Moreover, the standards of IS 1893: 1984 have several limitations as compared to current international practise in seismic tank design. As a result, one finds that India now has the appropriate level of design for earthquake-resistant water tanks. The current guidelines are designed to assist the designers of a water tank design project due to the lack of the Standard in the construction of an earthquake tank. These Guidelines are written in a format that is quite similar to the IS code, and the BIS may adopt it as IS 1893 in the future (Part 2). O. R. Jaiswal and colleagues (2006), The regulations of the 10 seismic codes on water tanks are reviewed and contrasted in this study article. This analysis demonstrates that the design of seismic stresses in various water tanks differs significantly between these codes. Causes are investigated thoroughly, and the importance of an integrated seismic designing for liquid storing tanks is emphasised. According to the 6 ° inclination, the stage size required to meet the 'No Differences in Column' criteria is 70% and 80% of the stage for the container container frame and shaft stage types, respectively.

### 2.2.3 FERROCEMENT  FLOOR  AND  ROOF  SYSTEM FOR BUILDINGS :

### By, Dr. T.S. Thandavamoorty and S.Durairaj (2016) :

Pre-sprayed with 1: 2 cement mortar and cured for 7 days, a ferro cement floor panel with a clear angle of 900 mm X 600 mm was installed. After that, it was sorted into the loading frame and put through a series of tests until it failed. The last load supported by a panel was 85 kN. Two layers of chicken match were used to make the Test Machine Program. As previously stated, the model is composed of cement mortar 1: 2 and reinforcement mesh. The full sample was given a 7-day treatment. In the upload frame, the template was sorted. The weight is delivered upwardly, and the readings of each dial are recorded as the force increases. The load was raised until the panel gave out.

As a result, the most recent load measured 85 kN. This load is still distributed evenly throughout the panel, averaging 78.7 kN/m2. The minimum live load prescribed by IS 875 part 2 is only 2 kN/m2. It is reasonable, practicable, and feasible to contemplate this Ferro Cement panel

### 2.2.4 TRANSIENT ANALYSIS OF ELEVATED INTZEE WATER TANKFLUID- SOIL SYSTEM:

**Housner (2013)** Calculates the fast and evaporation fluid volume and its location above the base of the tank, as well as the convective weight of the spring, using a mild weightless model and enhanced statistics. For active construction, only one convective mass is usually considered.

**Haroun and Housner (2014)** developed a three-volume model that considers tank flexibility only.

**Ibrahim et al. (2015)** Introduced a comprehensive overview of sloshing flexibility, which includes both direct and non-linear analysis, with emphasis on cylindrical and rectangular thighs.

**Karamanos et al. (2016) and Patkas and Karamanos (2017)**

Ehanced scientific module for deliberating effects of direct sloshing on the flexible response of horizontal and circular cylinder containers during earthquake regeneration has been developed..

**Livaoglur. R. and Dogangun A. (2016)** The seismic behaviour of the foundation of a foundation-propelled fluid-based tank construction with a structural framework that supports the liquid-containing tank was explored. Six different earthquake-related soil kinds have been considered. The analysis included both the declining effects of fluid interactions and the soil composition of the high tanks lying on these six distinct soils.

**Karamanos et al. (2016)** Karamanos et al. (2016) developed a technique for the immersion analysis of immobile vessels in which seismic forces can be measured based on the "convective-impulsive" separation of a liquid vesseland a solution for the immersion analysis of immobile vessels in which seismic forces can be measured. The effects of the support structure's flexibility are also taken into account.

**Livaoglu et al. (2017)** They provide simplified earthquake analysis methods for high tanks that take into account the interaction of fluid, composition, and soil. Mechanical modelling approaches and a limited feature are used to analyse ten different models. The effectiveness of these 10 models in earthquake-proofing elevated tanks with four distinct subsoils is highlighted.

**Sezen et al. (2018)** A simple threemass model was used to do dynamic analysis. The activity of long-distance earthquake tanks damaged by the Kocaeli earthquake in Turkey in 1999 was investigated..

**Dutta et al. (2019)** The dynamic features of high RC tanks supported by a cylindrical shaft platform are deeply analyzed. A controlled trial test with limited testing validated the findings.

**Amani et al. (2016)** Using a water-based feature technique, study examined at resonant waves in a highly comparable RC-filled circular container and tested the results. The high-volume round tanks' horizontal base movement and free vibration, as well as their total flexibility, contain water at various levels. Consider how three distinct weight motions are necessary in a round tank: translation (structure), sloshing (vascular), and pipeline movement. As a result, in analysis, three degrees of freedom are required.

### III. METHODOLOGIES

**3.1 STAAD Pro design**



**Flow Chart of Steps Followed In Staad-Pro**

Design of an intz ee tank for a capacity of 675000 liters

Assuming height of tank floor above the G.L. is 24.67 m.

Safe bearing capacity of soil 200 kn/m2

Assuming M25 concrete

For which $\sigma_{cbc}$ = 8.5 N/mm2, $\sigma_{cc}$ = 6 N/mm2

Direct tension $\sigma_t$ = 1.3 N/mm2

Tension in bending = 1.8 N/mm2

Modular ratio m = 13

For Steel stress,

Tensile stress in direct tension =115 N/mm2

Tensile stress in bending on liquid face =115 N/mm2 for t < 225 mm And

125 N/mm2 for > 225 mm.
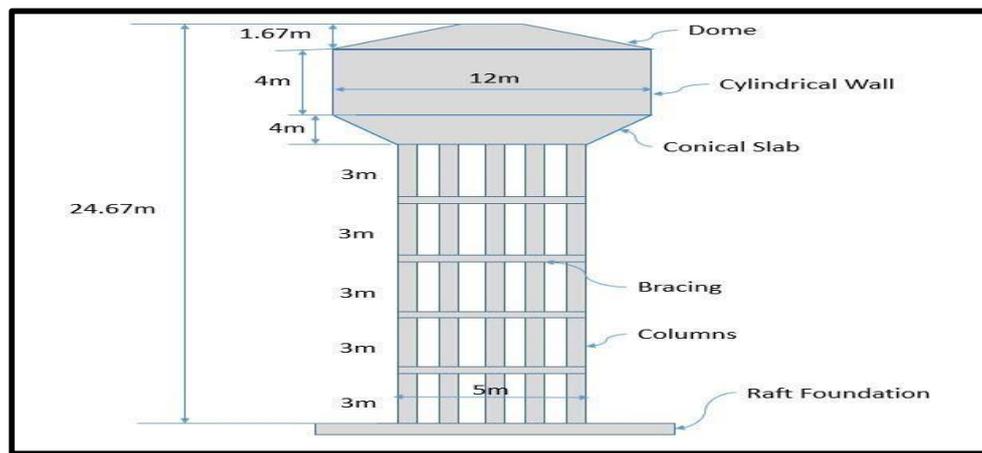
## 3.2 Design in STAADPro:

**Step 1: geometry design**

Put all nodal and connect beam
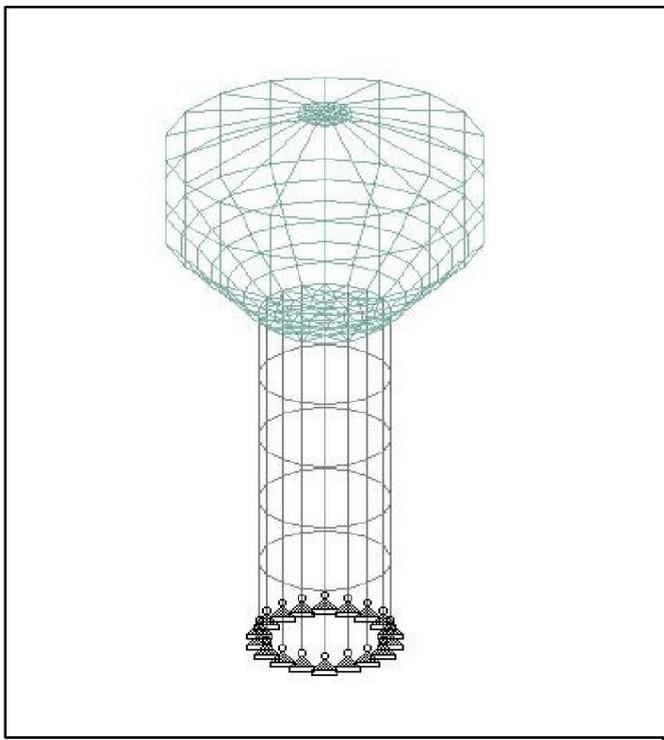


**Fig 3.2.1 : Geometry Design**

This is the structural image of awater tank without any load or support.

**Step 2: Define an end property**

In this step we have to define the end properties with prpers supports
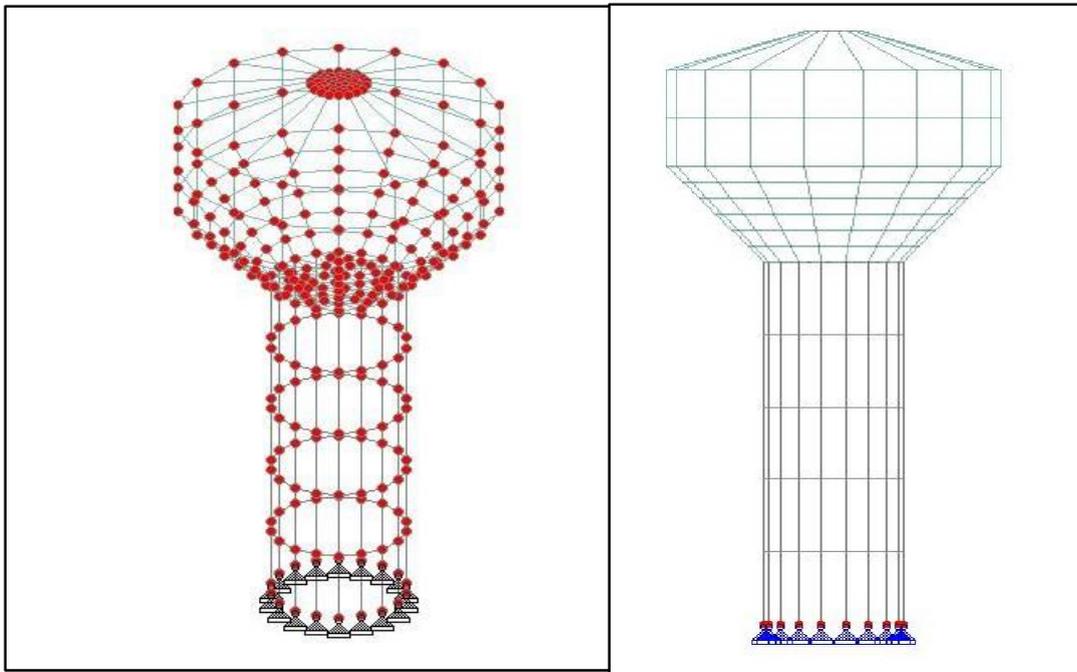
**Fig 3.2.2 : End Properties**

**Step 3: material**

Defining the     material  properties  like  young's  Modulus ,shear  Modulus, Critical damping etc .
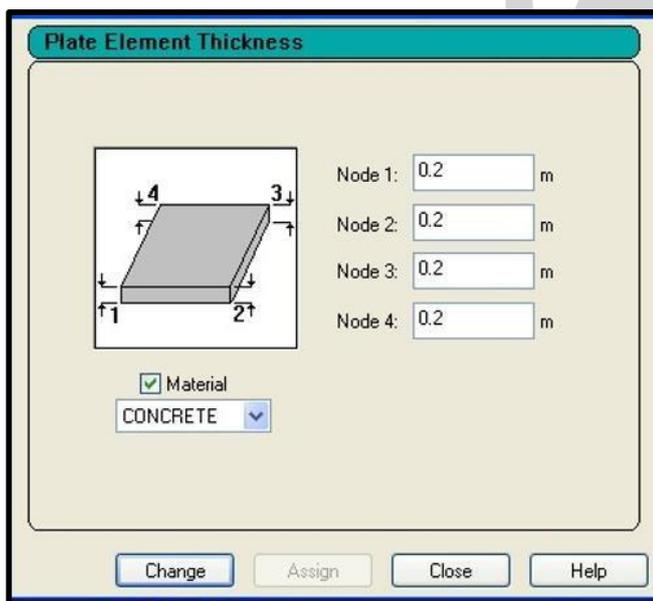


**Fig 3.2.3 : Plate Element**

**Step 4: Defining the properties and select all the members**

In this we have to define the properties like which one is the coloum which one is the beam and what type of loads are acting on that like Dead, Live, Wind loads, Earthquake load, Self weight etc.
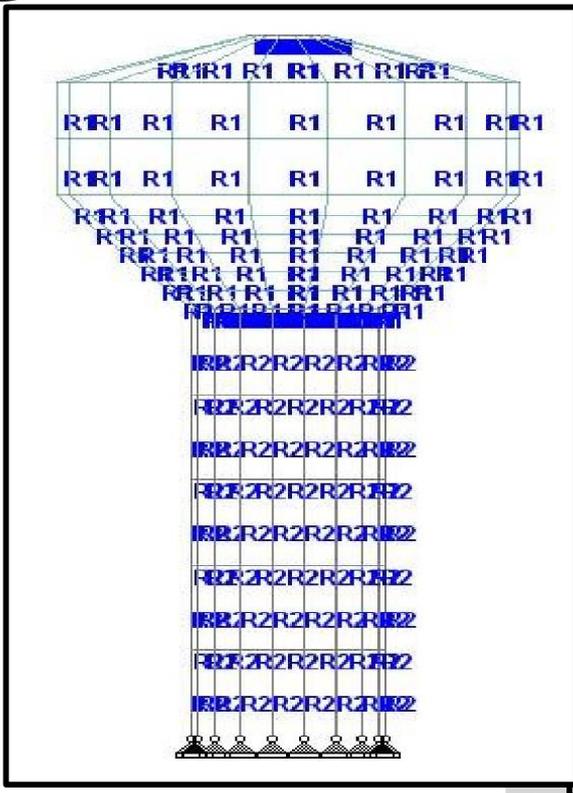
**Fig 3.2.4 : Selected Members**

## Step 5: Combination and Loads

In this step we are going to assign the combinations and load
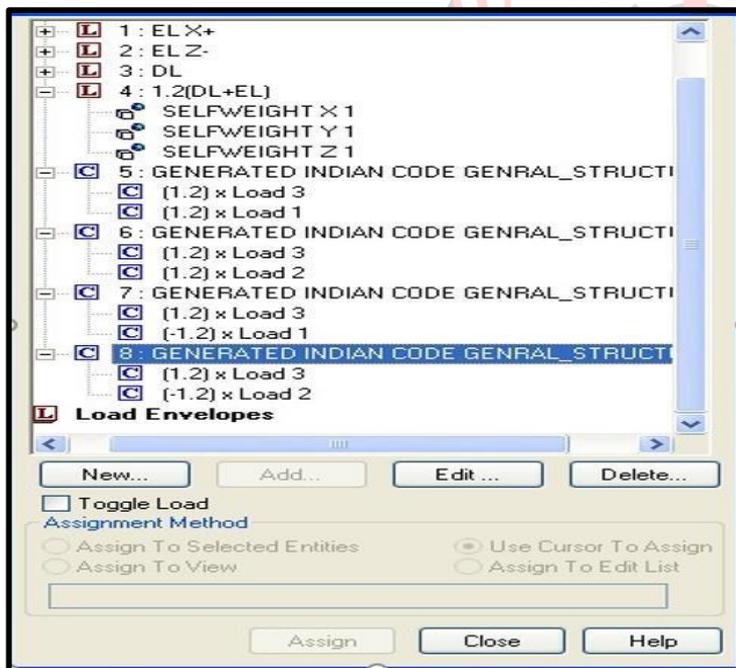


**Fig 3.2.5 : Combination and Load**

## Step 6: Analysis and print

Add IS code and specificationIS 456
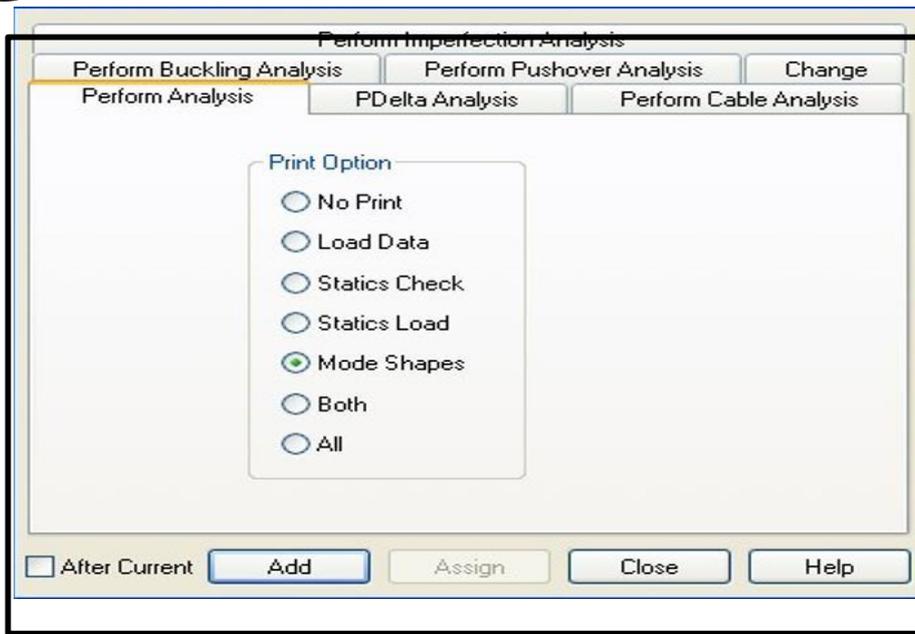
**Fig 3.2.6 : Analysis and Print**

**Step 7: Run program**

In this step we have to run the total program of analysis that analysis will give us the brief about the loads and the stresses how they effects the beams,column and the plates of the structure .
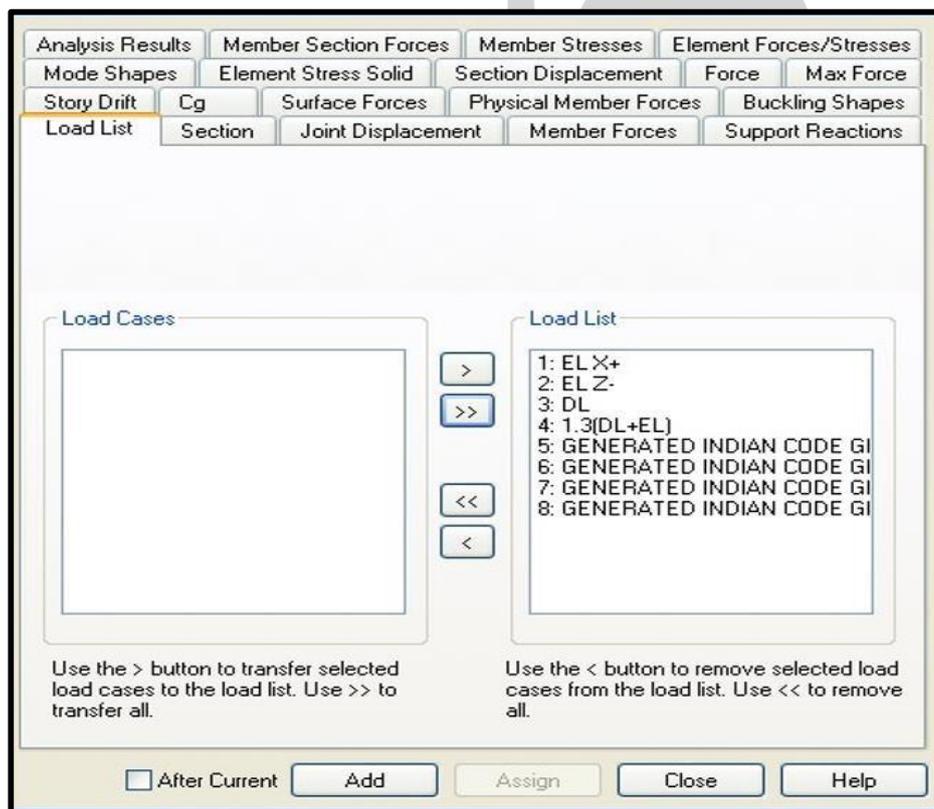


**Fig 3.2.7 :Run Program**
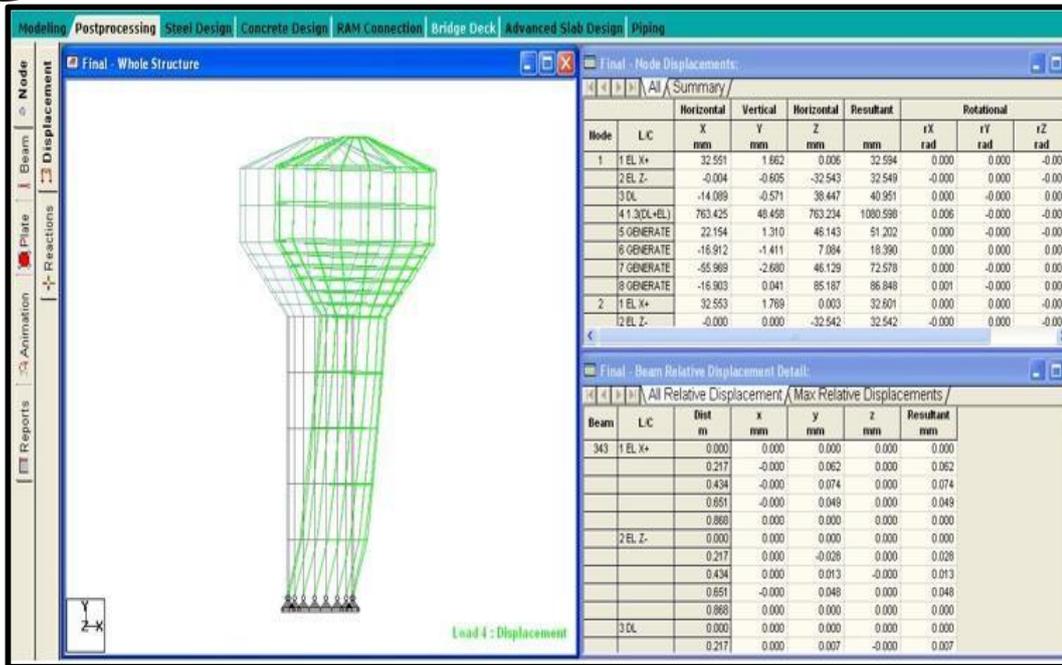
**Fig 3.2.8 : Bending Moment Diagram**

In this it shows about bending moment of the structure that if there is an extra stress and load acting upon Earthquake load, wind load in bad condition.

**Step 8: Main Pressures on Plates**

In this it shows the main stresses on the plates that is how the stress is acting on the plates .
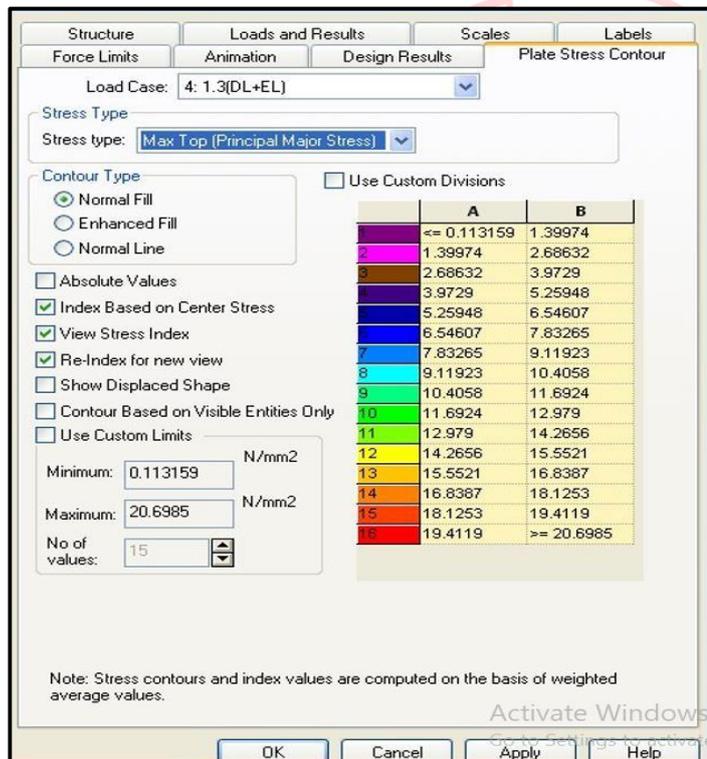


**Fig 3.2.9 : Pressures on Plate**
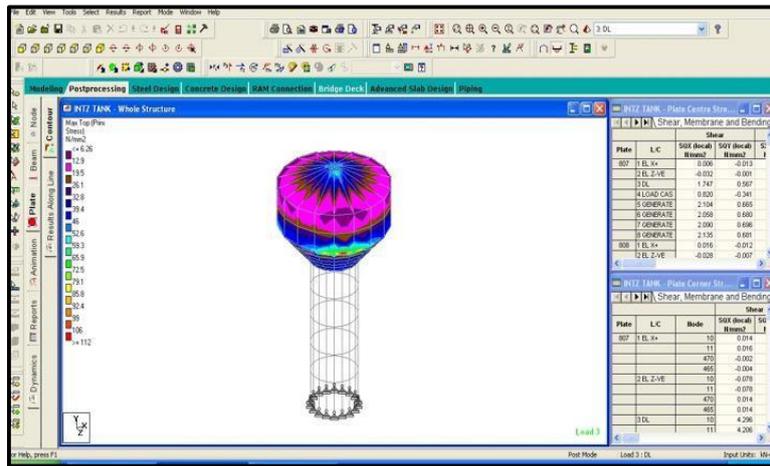
**Fig 3.2.10 : Pressure on Top Dome**

**Pressures in Beam:**
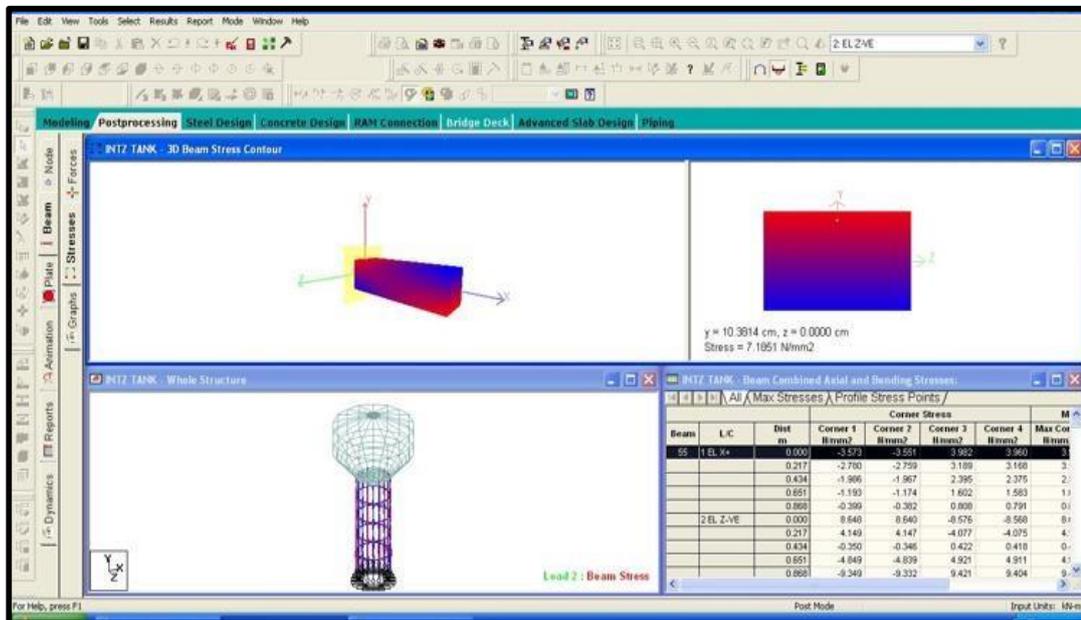


It shows about the the pressure acting on the Beam .

**Fig 3.2.11 Pressure in Beam**

**Pressures in Column:**

It shows about the pressure acting on the Column .
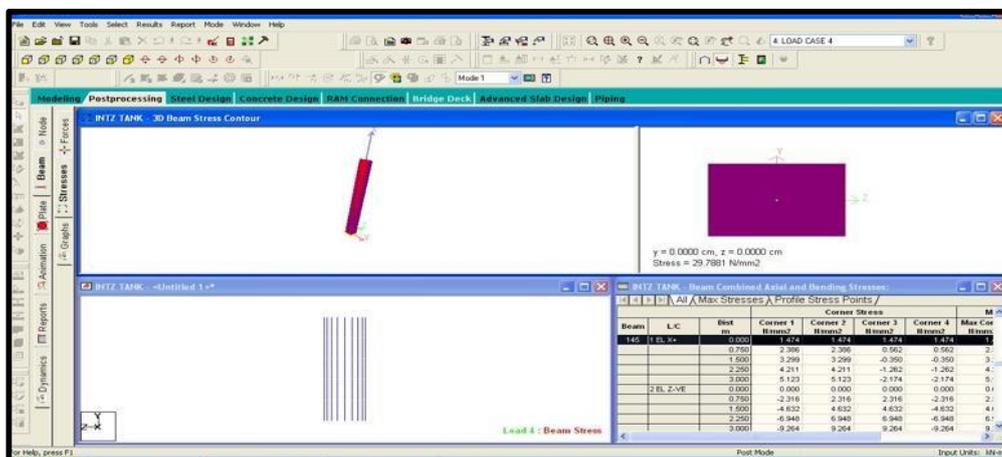


**Fig 3.2.12 : Pressure in Column**

**Final 3D View**

This is the final 3d view of the structure .
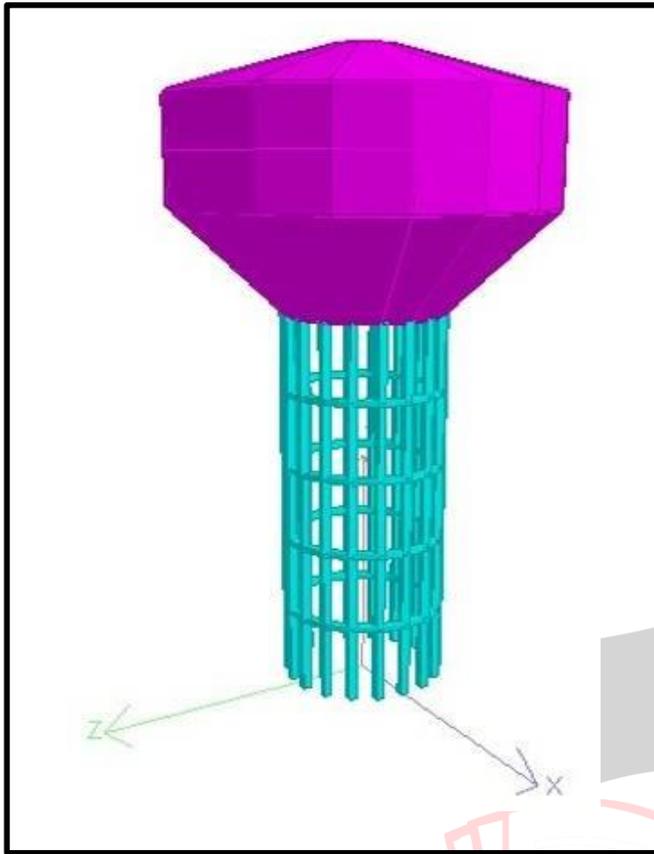


**Fig 3.2.13: Final Structure**

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## Materials

| Mat | Name | E (kN/mm²) | v | Density (kg/m³) | α (1/°K) |
|---|---|---|---|---|---|
| 1 | STEEL | 205.000 | 0.300 | 7.83E+3 | 12E -6 |
| 2 | STAINLESSSTEEL | 197.930 | 0.300 | 7.83E+3 | 18E -6 |
| 3 | ALUMINUM | 68.948 | 0.330 | 2.71E+3 | 23E -6 |
| 4 | CONCRETE | 21.718 | 0.170 | 2.4E+3 | 10E -6 |

## Basic Load Cases

| Number | Name |
|---|---|
| 1 | EL X+ |
| 2 | EL Z- |
| 3 | DL |
| 4 | LOAD CASE 4 |

## Combination Load Cases

| Comb. | Combination L/C Name | Primary | Primary L/C Name | Factor |
|---|---|---|---|---|
| 5 | GENERATED INDIAN CODE GENRAL_S' | 3 | DL | 1.20 |
| | | 1 | EL X+ | 1.20 |
| 6 | GENERATED INDIAN CODE GENRAL_S' | 3 | DL | 1.20 |
| | | 2 | EL Z- | 1.20 |
| 7 | GENERATED INDIAN CODE GENRAL_S' | 3 | DL | 1.20 |
| | | 1 | EL X+ | -1.20 |
| 8 | GENERATED INDIAN CODE GENRAL_S' | 3 | DL | 1.20 |
| | | 2 | EL Z- | -1.20 |

## Load Generators

*There is no data of this type.*

## Seismic Loading : 1 EL X+

| Code | Direction | Factor |
|---|---|---|
| | X | 1.000 |

## Seismic Loading : 2 EL Z-

| Code | Direction | Factor |
|---|---|---|
| | Z | -1.000 |

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**Step 9: Report**

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## Plate Loads : 3 DL

| Plate | Type | Direction | Fa | Fb | X1 (m) | Y1 (m) | X2 (m) | Y2 (m) |
|---|---|---|---|---|---|---|---|---|
| 1 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 2 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 3 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 4 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 5 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 6 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 7 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 8 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 9 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 10 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 11 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 12 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 13 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 14 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 15 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 16 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 17 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 18 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 19 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 20 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 21 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 22 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 23 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 24 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 25 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 26 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 27 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 28 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 29 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 30 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 31 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 32 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 33 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 34 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 35 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 36 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 37 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 38 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 39 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 40 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 41 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 42 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 43 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 44 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 45 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 46 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |

Activate Windows

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## Plate Loads : 3 DL Cont...

| Plate | Type | Direction | Fa | Fb | X1 (m) | Y1 (m) | X2 (m) | Y2 (m) |
|---|---|---|---|---|---|---|---|---|
| 47 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 48 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 49 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 50 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 51 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 52 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 53 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 54 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 55 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 56 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 57 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 58 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 59 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 60 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 61 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 62 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 63 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 64 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 65 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 66 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 67 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 68 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 69 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 70 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 71 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 72 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 73 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 74 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 75 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 76 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 77 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 78 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 79 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 80 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 81 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 82 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 83 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 84 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 85 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 86 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 87 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 88 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 89 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 90 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 91 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 92 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |

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| Job Title | | Ref | | |
| | | By | | Chd |
| Client | | File Final.std | | |

## Plate Loads : 3 DL Cont...

| Plate | Type | | Direction | Fa | Fb | X1 (m) | Y1 (m) | X2 (m) | Y2 (m) |
|---|---|---|---|---|---|---|---|---|---|
| 93 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 94 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 95 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 96 | TRAP | N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 97 | TRAP | N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 98 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 99 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 100 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 101 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 102 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 103 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 104 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 105 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 106 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 107 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 108 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 109 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 110 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 111 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 112 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 113 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 114 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 115 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 116 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 117 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 118 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 119 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 120 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 121 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 122 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 123 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 124 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 125 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 126 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 127 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 128 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 129 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 130 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 131 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 132 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 133 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 134 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 135 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 136 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 137 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 138 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |

| | | Job No | Sheet No | Rev |
|---|---|---|---|---|
| | | | 5 | |
| Software licensed to | | Part | | |
| Job Title | | Ref | | |
| | | By | Chd | |
| Client | | File Final.std | | |

## Plate Loads : 3 DL Cont...

| Plate | Type | Direction | Fa | Fb | X1 (m) | Y1 (m) | X2 (m) | Y2 (m) |
|---|---|---|---|---|---|---|---|---|
| 139 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 140 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 141 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 142 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 143 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 144 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 145 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 146 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 147 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 148 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 149 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 150 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 151 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 152 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 153 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 154 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 155 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 156 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 157 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 158 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 159 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 160 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 161 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 162 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 163 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 164 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 165 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 166 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 167 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 168 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 169 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 170 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 171 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 172 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 173 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 174 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 175 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 176 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 177 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 178 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 179 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 180 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 181 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 182 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 183 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 184 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |

| | | | | | Job No | | Sheet No 6 | | Rev |
|---|---|---|---|---|---|---|---|---|---|
| Software licensed to | | | | | Part | | | | |
| Job Title | | | | | Ref | | | | |
| | | | | | By | | | | |
| Client | | | | | File Final.std | | | | |

## Plate Loads : 3 DL Cont...

| Plate | Type | | Direction | Fa | Fb | X1 (m) | Y1 (m) | X2 (m) | Y2 (m) |
|---|---|---|---|---|---|---|---|---|---|
| 185 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 186 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 187 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 188 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 189 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 190 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 191 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 192 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 193 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 194 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 195 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 196 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 197 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 198 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 199 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 200 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 201 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 202 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 203 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 204 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 205 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 206 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 207 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 208 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 209 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 210 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 211 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 212 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 213 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 214 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 215 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 216 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 217 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 218 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 219 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 220 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 221 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 222 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 223 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 224 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 225 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 226 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 227 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 228 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 229 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 230 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Job No | | | | | Sheet No | | | 7 | | Rev |
| Part | | | | | | | | | | |
| Job Title | | | Ref | | | | | | | |
| | | | By | | | Date 11- | | Chd | | |
| Client | | | File Final.std | | | | | | | |

## Plate Loads : 3 DL Cont...

| Plate | Type | | Direction | Fa | Fb | X1 (m) | Y1 (m) | X2 (m) | Y2 (m) |
|---|---|---|---|---|---|---|---|---|---|
| 231 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 232 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 233 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 234 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 235 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 236 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 237 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 238 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 239 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 240 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 241 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 242 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 243 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 244 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 245 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 246 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 247 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 248 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 249 | TRAP | N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 250 | TRAP | N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 251 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 252 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 253 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 254 | TRAP | N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 255 | TRAP | N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 256 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 257 | TRAP | N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 258 | TRAP | N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 259 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 260 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 261 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 262 | TRAP | N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 263 | TRAP | N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 264 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 265 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 266 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 267 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 268 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 269 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 270 | TRAP | N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 271 | TRAP | N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 272 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 273 | PRE | N/mm2 | Z | -0.020 | - | - | - | - | - |
| 274 | TRAP | N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 275 | TRAP | N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 276 | TRAP | N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Job No | | | | | Sheet No | **8** | | Rev |
| Part | | | | | | | | |
| Job Title | | | Ref | | | | | |
| | | | By | | | ... | ... | |
| Client | | | File Final.std | | | DL ... .. | | |

## Plate Loads : 3 DL Cont...

| Plate | Type | Direction | Fa | Fb | X1 (m) | Y1 (m) | X2 (m) | Y2 (m) |
|---|---|---|---|---|---|---|---|---|
| 277 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 278 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 279 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 280 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 281 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 282 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 283 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 284 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 285 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 286 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 287 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 288 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 289 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 290 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 291 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 292 | PRE N/mm2 | Z | -0.020 | - | - | - | - | - |
| 293 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 294 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 295 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 296 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 297 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 298 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 299 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 300 | TRAP N/mm2 | Z | 0.020 | 0.020 | - | - | - | - |
| 301 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 302 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 303 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 304 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 305 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 306 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 307 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 308 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 309 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 310 | TRAP N/mm2 | Z | 0.019 | 0.017 | - | - | - | - |
| 311 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 312 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 313 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 314 | TRAP N/mm2 | Z | 0.003 | 0.003 | - | - | - | - |
| 315 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 316 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 317 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 318 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 319 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 320 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 321 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |
| 322 | TRAP N/mm2 | Z | 0.017 | 0.016 | - | - | - | - |

| | | JOB NO | Sheet No | Rev |
|---|---|---|---|---|
| | | | **9** | |
| Software licensed to | | Part | | |
| Job Title | | Ref | | |
| | | By | | |
| Client | | File Final.std | | |

## Plate Loads : 3 DL Cont...

| Plate | Type | Direction | Fa | Fb | X1 (m) | Y1 (m) | X2 (m) | Y2 (m) |
|---|---|---|---|---|---|---|---|---|
| 323 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 324 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 325 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 326 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 327 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 328 | TRAP N/mm2 | Z | 0.016 | 0.014 | - | - | - | - |
| 329 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 330 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 331 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 332 | TRAP N/mm2 | Z | 0.014 | 0.013 | - | - | - | - |
| 333 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 334 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 335 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 336 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 337 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 338 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 339 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 340 | TRAP N/mm2 | Z | 0.012 | 0.012 | - | - | - | - |
| 341 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |
| 342 | TRAP N/mm2 | Z | 0.008 | 0.008 | - | - | - | - |

## Selfweight : 3 DL

| Direction | Factor |
|---|---|
| Y | -1.000 |

## Selfweight : 4 LOAD CASE 4

| Direction | Factor |
|---|---|
| X | 1.000 |
| Y | 1.000 |
| Z | 1.000 |

## IV. RESULTS

1. We used three various structures of spherical water tanks in the process, and we first created water tank manually using IS 3370-2009. We use this information to construct and analyse the structure using STAAD. Pro Circular water tank structures were designed using specific dimensions for the same capacity.

2. As we all know, beams and columns contribute nearly all of the building's load through transferring dead and live loads. As a result, we began designing the structure in STAAD. Pro..

3. As the structure's capacity grows, so does the amount of materials required. However, a less-than-perfect proportionality finding was observed, i.e., a proportional increase in capacity did not always imply a comparable upsurge in materials required.

4. A report was created for all kinds of water tanks after this thorough examination:

5. All members of construction appear to be secure. STAAD.Pro calculates the total volume of concrete for beams and plates.

6. In addition, in the case of steel STAAD. Only for beams and plates does Pro provide the total weight of reinforcement steel.

## V. CONCLUSION

A 675,000-liter elevated Intze water tank with a 15-meter staging was designed with M25 concrete in mind. Nonetheless, M30 is reserved for containers, whereas M25 is reserved for staging.

We have completed the detailed structural design. Utilizing STAAD Pro v8i, we were able to compute data on nodal displacement, forces, staging stress, and other relevant aspects.

Tank remains steady during hydrostatic testing, however it becomes unstable whenever sloshing is considered and values of essential elements go over the limits.

It is reasonable to say that the inzte-type raised water tank design is complete after using both the manual approach and STAAD Pro v8i.

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