ANALYSIS AND BEHAVIOR OF RC FRAMED CIRCULAR INTZE TANK SUBJECTED TO SEISMIC LOADING USING STAAD PRO

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ABSTRACT: Raised water tanks are among the most crucial constructions in seismic tremor inclined regions. These designs have a high grouping of mass at the highest point of slim supporting constructions, making them especially powerless against even powers brought about by quakes and wind. They are fundamental parts in metropolitan water supply, firefighting frameworks, and numerous modern offices for water stockpiling. Accordingly, raised water tanks should keep on working even after the quake. In India, the Intze type tank is the most normally utilized overhead water tank. Right now, an enormous number of overhead water tanks are utilized to disperse water for public utilities. Most of the water tanks were underlying understanding with the old IS Code: 3370-1965, which didn't consider seismic tremor powers. Since raised tanks are every now and again utilized in seismically dynamic regions, their seismic conduct should be totally examined. A portion of the water tanks imploded or were seriously harmed because of an absence of information about the supporting framework. Accordingly, there is a need to zero in on seismic wellbeing of life saver structures as far as substitute supporting frameworks that are protected during tremors and can withstand higher plan powers. The objective of this exposition is to reveal insight into the Intze water tank planned in view of seismic tremor powers as indicated by Indian standard code 1893-Part 2, (2005) and to investigate the design with earth shudder powers.

Keyword's: Intze tank, Earth quake ,seismic analysis

1. INTRODUCTION

1.0 water tank

A water tank is a raised construction that upholds a water repository worked at tallness adequate to compress a water supply framework for the circulation of consumable water and to give crisis stockpiling to fire security. Water tanks are habitually utilized related to underground or surface assistance supplies, which store treated water near where it will be utilized. Different sorts of water pinnacles may just store crude (non-consumable) water for fire security or modern purposes, and could possibly be associated with a public water supply.

Water tanks can supply water in any event, during blackouts since they depend on hydrostatic strain created by water rise (because of gravity) to drive the water into homegrown and modern water appropriation frameworks; nonetheless, they can't supply water for a drawn out timeframe without power in light of the fact that a siphon is normally needed to top off the pinnacle. A water tower likewise works as a repository, providing water during top utilization periods. During top utilization hours, the water level in the pinnacle ordinarily drops, and a siphon fills it back up during the evening. Since the pinnacle is continually being depleted and topped off, the water doesn't freeze in chilly climate.

1.1 FACTORS AFFECTING PER CAPITA DEMAND:

- **Size of the city:** Per capita demand for big cities is generally large as compared to that for smaller towns as big cities have sewered houses.
- Presence of industries.
- Climatic conditions.
- Habits of economic status.
- Quality of water: Ifwater is aesthetically S people and their
- Medically safe, the consumption will increase as people will not resort to private wells, etc.
- Pressure in the distribution system.
- Efficiency of water works administration: Leaks in water mains and services; and un authorized use of water can be kept to a minimum by surveys.
- Cost of water.
- Policy of metering and charging method:Water tax is charged in two different ways: on the basis of meter reading and on the basis of certain fixed monthly rate.

1.2 Fluctuations in Rate of Demand:

Normal Daily Per Capita Demand
= Amount Required in 12 Months/(365 x Population)

Assuming that this normal interest is provided at every one of the occasions, it won't be adequate to meet the variances.

Occasional variety: The interest tops during summer. Firebreak outs bend commonly more in summer, expanding request. In this way, there is occasional variety.

Every day variety relies upon the movement. Individuals draw out more water on Sundays and Festival days, accordingly expanding request on nowadays,

Hourly variations they are vital in light of the fact that they have a wide reach. Most of the day by day prerequisite is devoured during dynamic family working hours, which are from six to ten a.m. furthermore four to eight p.m. During the remainder of the day, the prerequisite is insignificant. Besides, assuming a fire breaks out, a lot of water should be provided in a brief timeframe, requiring the requirement for a most extreme pace of hourly stock. Therefore, enough water should be accessible to satisfy top need. The inventory pipes, administration supplies, and conveyance pipes should be in every way appropriately proportioned to oblige the changes as a whole. Water is provided straight by siphoning, and the siphons and dissemination framework should be intended to fulfill top need. The impact of month to month variety impacts the plan of capacity repositories and the hourly varieties impacts the plan of siphons and administration supplies. As the populace diminishes, the change rate increments. .

Maximum daily demand = 1.8 x average daily demand

Maximum hourly demand of maximum day i .e. Peak demand

= 1.5 x average hourly demand

= 1.5 x Maximum daily demand 2^

= 1.5 x (1.8 x average daily demand)/24 — 2.7 x average daily demand24

= 2.7 x annual average hourly demand

1.3 Design Periods & Population Forecast

This amount ought to be worked out with due arrangement for the assessed prerequisites of things to come. The future period for which an arrangement is made in the water supply conspire is known as the plan time frame.

- Plan period is assessed dependent on the accompanying:
- Valuable existence of the part, thinking about oldness, wear, tears, and so on
- Expandability viewpoint.
- Expected pace of development of populace, including modern, business improvements and movement migration.
- Accessible assets,
- Execution of the framework during introductory period.

1.4 POPULATION FORECASTING METHODS

1. The different strategies used to gauge future populaces are recorded underneath. The specific strategy to be taken on for a particular case or for a particular city is to a great extent dictated by the elements examined in the techniques, and the determination is passed on to the creator's attentiveness and insight..
2. Incremental Increase Method
3. Decreasing Rate of Growth Method
4. Simple Graphical Method
5. Comparative Graphical Method
6. Ratio Method
7. Logistic Curve Method
8. Arithmetic Increase Method
9. Geometric Increase Method

In our design, the population is forecasted using Arithmetic, Geometric, Incremental and Decreasing Rate methods and the average value is taken as design population.

1.5 PROJECT SCOPE

- To make a study about the analysis and design of water tank.
- To make a study about the guidelines for the design of liquid retaining structures according to IS Code.
- To know about the design philosophy for the safe and economical design of water tank.
- To conduct case studies on the existing overhead water tank. * To know about the problems faced by the people in water supply around the areas of existing water tank.
- To find the possible solution and meet the daily requirements of water.
- To overcome the problem of low water pressure at all distribution ends.
- To choose a location around the area where water losses are minimum and good efficiency is maintained.
- To increase the design life period and serviceability of the structure.

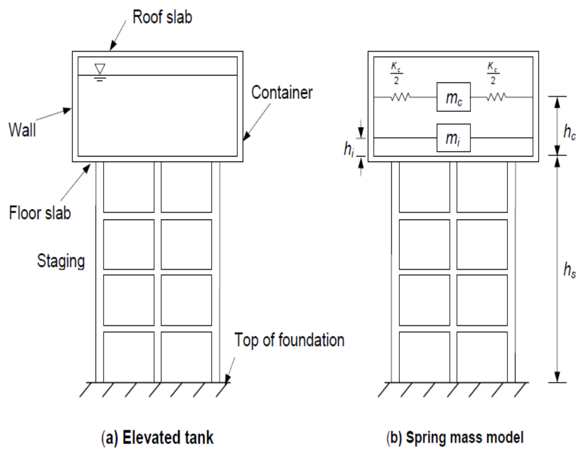


Figure 1. Rectangular tank

2. METHOD OF ANALYSIS

Code-based Procedure for Seismic Analysis

Main features of seismic method of analysis based on Indian standard 1893(Part 1):2002

Lumped Mass Model Method

1 MASS MODEL METHOD

MODELLING AND ANALYSIS for the analysis of Elevated Intze water tank following dimensions are considered which are elaborated below.

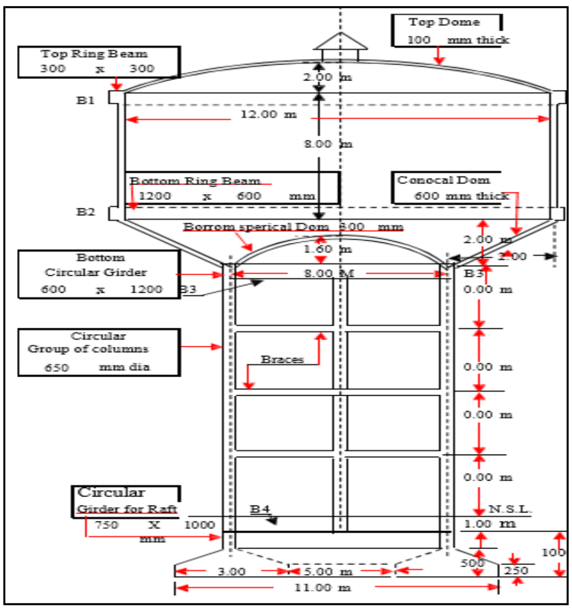


Figure 2. Design data of Elevated Intze Water tank

Table – 1 Design calculation

Components	Calculations	Weight (kN)
Top Dome	Radius of the dome=6.0m 2×π×6×2×(0.1×25)	188.5kN
Top Ring Beam	π(12+0.30)×0.30×0.30×25	86.94kN
Cylindrical Wall	π×12×0.15×8×25	1131kN
Bottom Ring Beam	π×12×1.2×0.6×25	678.5kN
Circular Ring Beam	π×0.6×1.2×8×25	452.38kN
Bottom Dome	2π×6×4×1.6×03×25	1809.55kN
Conical Dome	π×12×2×25×0.60	1130.97kN
Water	5655000+9810×(π/4)×8×8×10	10586kN
Columns	π×0.65×0.65×8×16×(25/4)	1081.85kN
Braces	π×3×8×25×0.65×0.65	796.38kN

2. Comparative Study: Lumped Mass Vs Two Mass Model Comparison of various seismic examination boundaries of intze tank upheld on outlines labeling is displayed in Table. In this table all boundaries for single mass modular also two mass modular with outline organizing are summed up

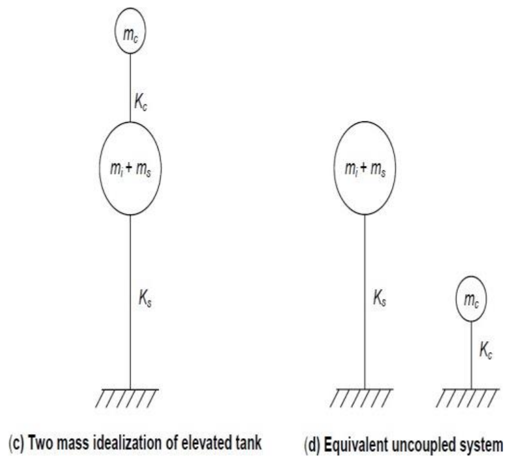


Figure 3. two mass idealized of elevated tank

Table - 4.2 Comparison of various parameters by two methods

Sl. No	Idealization of tank	Lumped-mass model	Two-mass model
1	Brace beam flexibility	Neglected	Considered
2	Lateral stiffness of staging	17457kN/m	17457 kN/m
3.	Time period		
4	Impulsive mode *a)*Tank Empty (T_i) *b)*Tank Full (T_i) Convective mode a) Tank Full (T_c)	 0.763 s 1.23 s ------	 1.18 s 1.80 s 3.705s
5	Design horizontal seismic coefficient: Impulsive mode Tank Empty $(A_h)_i$ Tank Full $(A_h)_i$ Convective mode Tank Full $(A_h)_c$	 0.019 0.010 -------	 0.025 0.165 0.033
6	Base shear (V) Tank Empty Tank Full	 117.818 kN 161.910 kN	 154 kN 241 kN
7	Overturning Moment (M) Tank Empty Tank Full	2321.05 kN-m 3189.43 kN-m	3084 kN-m 5311 kN-m

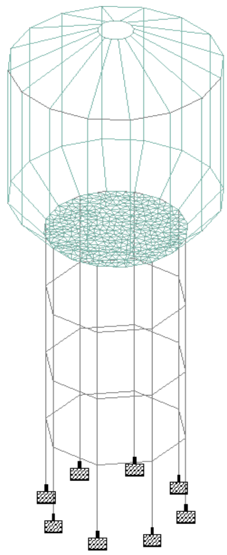


Figure 4. Plan of Intze water tank

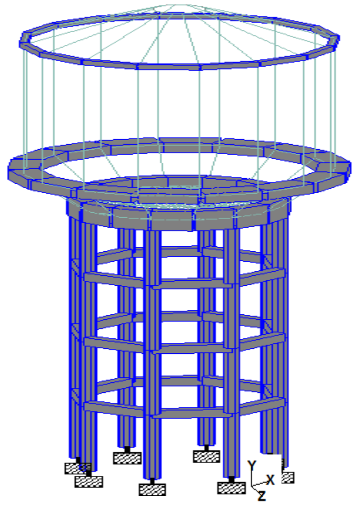


Figure 5. Model of Intze tank with sections

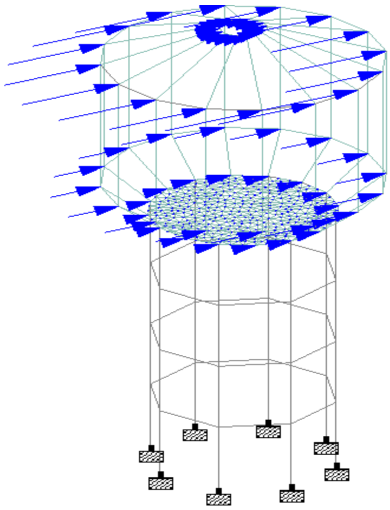


Figure 6. Earthquake loading in X(+)direction

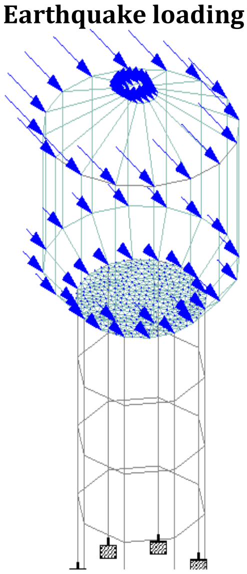


Figure 7. Earthquake loading in z(+)direction

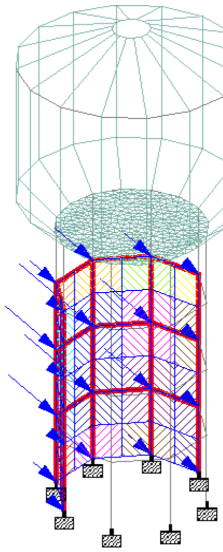


figure 8. Earthquake loading in z(-)direction

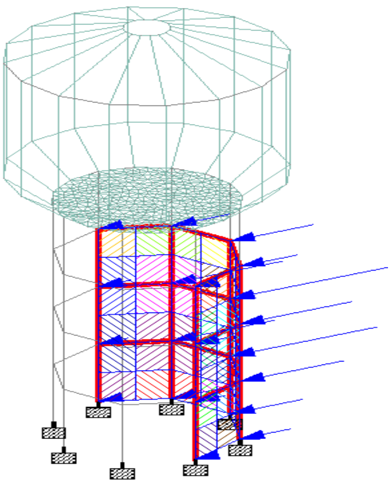


Figure 8. Wind loading in x(-)direction

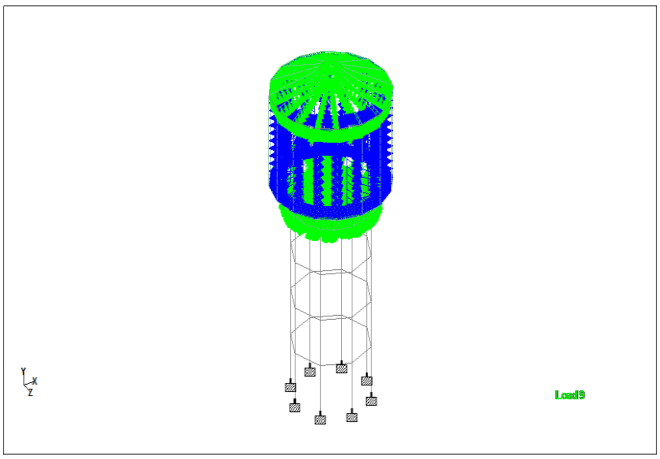


Figure 9. Trapezoidal load on cylindrical wall

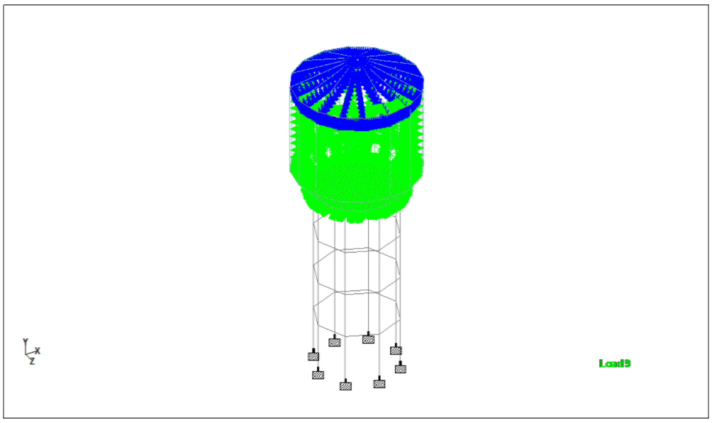


Figure 10. Trapezoidal load on top ring beam

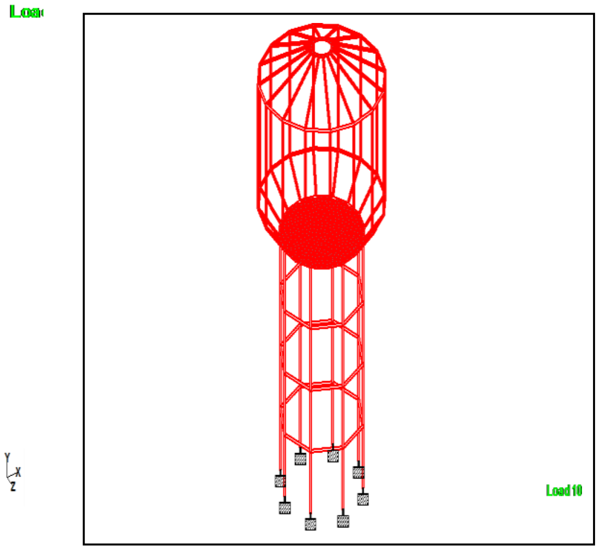


Figure 11.Self weight of the structure

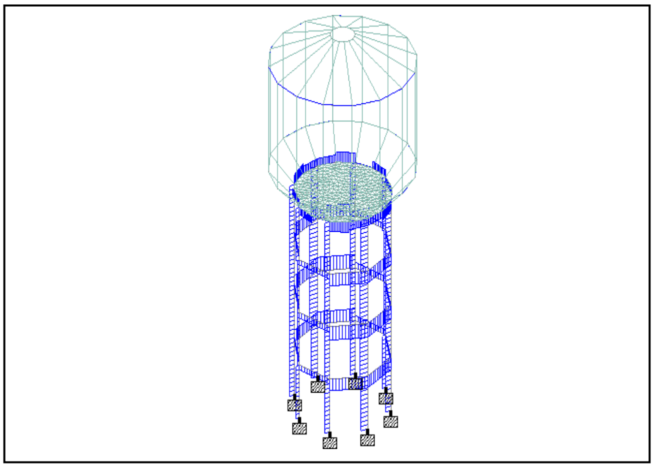


Figure 12. Shear force diagram

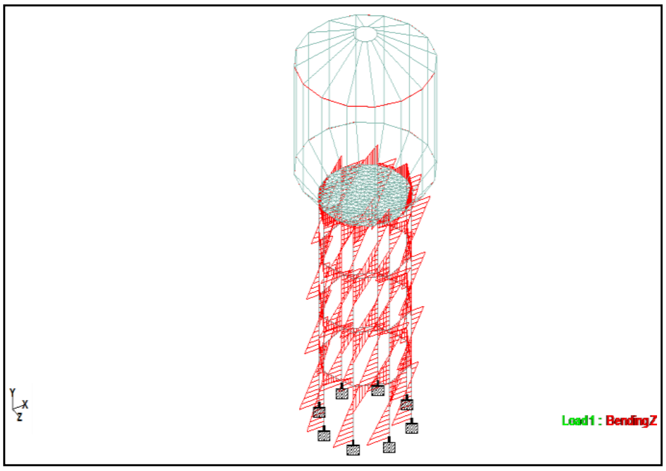


Figure 13.Bending moment diagram

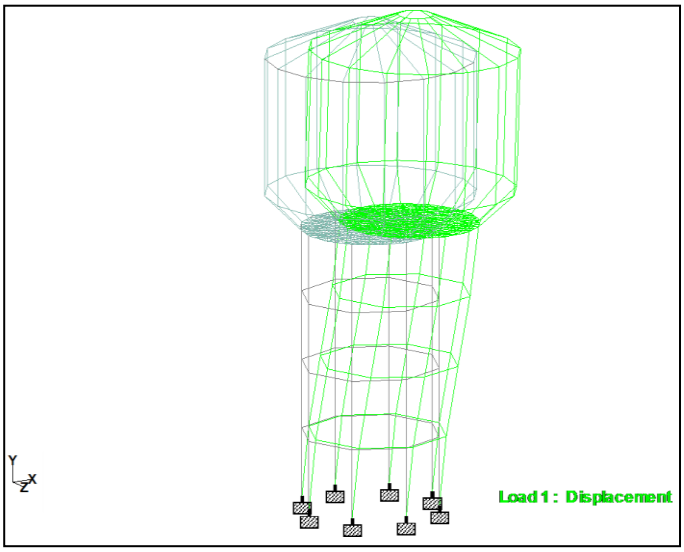


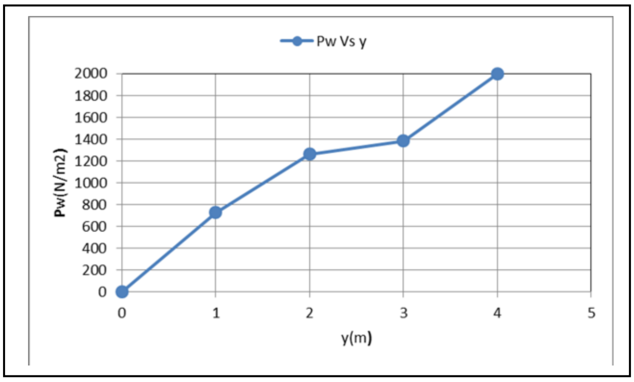
Figure 14.Displacement diagram of Intze tank

3. RESULTS AND DISCUSSIONS

Lumped Mass Model Graphical Representation

y (m)	y/h	Pb (N/m^2)
0	0	0
1	0.2	361.26
2	0.4	750.08
3	0.6	1187.63
4	0.8	1412.23
5	1.0	1789.62

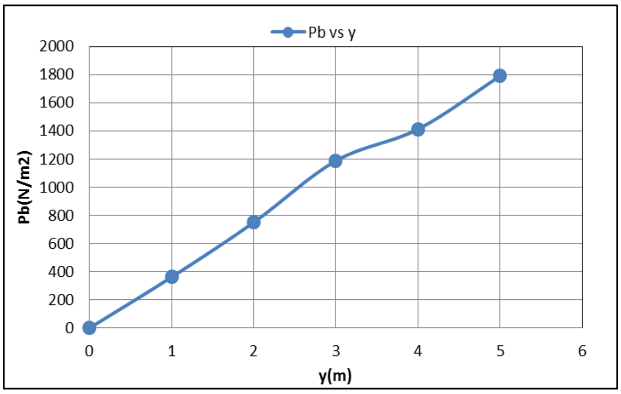
Table 3. Lumped Mass Model Graphical Representation



Graph 1. Variation of hydrodynamic pressure with the depth of the cylindrical wall for lumped mass condition

Table 4. Hydrodynamic pressure on the wall

y (m) (from top)	Pw (N/m^2)
0	0
1	727.784
2	1262.066
3	1384.963
4	1996.134
5	2202.998



Graph 2. Hydrodynamic pressure on the bottom of the tank

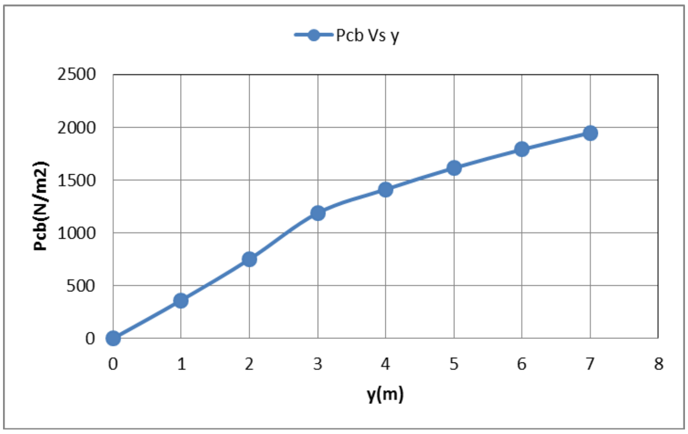
Hydrodynamic pressure on the bottom of the tank

Convective Hydrodynamic Pressure

y (m)	y/h	Pcw (N/m^2)
0	0	0
1	0.083	1986.43
2	0.166	2102.69
3	0.250	2523.40
4	0.333	2598.62
5	0.416	3691.69
6	0.500	4498.92

Table 3. Convective hydrodynamic pressure on the wall

y(m)	Pcb (N/m^2)
0	0
1	361.26
2	750.08
3	1187.63
4	1412.23
5	1614.45
6	1789.76
7	1948.62



Graph 4. Variation of Convective hydrodynamic pressure on base slab

4.CONCLUSIONS

- From the examination of rash and convective method of vibration it was seen that Time Period, Base shear, Base second got by convective method of vibration is more noteworthy than hasty method of vibration.
- All out base shear and base second acquired for tank full condition are more than tank void condition by 47% and 51% separately. Subsequently configuration will be administered by tank full condition.
- Parallel power is more in tank full condition when contrasted with tank void condition and subsequently tank full case is considered for seismic examination.
- Base shear acquired by two mass model is viewed as expanded by 36% when contrasted with lumped mass model strategy.
- Upsetting second acquired by two mass model strategy is viewed as more noteworthy than the second gotten in lumped mass model technique by 41%.
- Results from the review recommend to think about convective and incautious parts in seismic investigation of tanks.
- The convective tensions during seismic tremors are extensively more in size when contrasted with imprudent tensions and its impact is a sloshing of the water
- The hydrodynamic strain acquired by two mass model is more than that got by lumped mass model.
- For raised tanks, the two level of opportunity admiration of tank ought to be utilized for investigation as opposed to utilizing single level of opportunity of romanticizing of tank as the impact of convective hydrodynamic strain has been remembered for the examination of the tanks.
- The most extreme worth of powers and minutes acquired from STAAD Pro tells the greatest burden to which the tank is oppressed and subsequently basic. The check for basic individuals from STAAD Pro additionally uncovers that the tank is steady for most extreme powers and minutes.

REFERENCE

1. IS CODE 456:2016
2. IS CODE 10262:2000
3. IS CODE 1893:2002