ANALYSIS OF INTZE WATER TANK WITH DIFFERENT FRAME STAGING SYSTEM

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Abstract:* From the very upsetting experiences of few earthquakes, like Bhuj earthquake (2001) in India R.C.C elevated water tanks were heavily damaged or collapsed. This was might be due to the lack of knowledge regarding the behavior of supporting system of the tank and also due to improper geometrical selection of staging. The main aim of this study is to carry out the seismic analysis of RCC elevated tank using STAAD Pro Vi8. Using response spectrum analysis, compare the result of base reaction, joint displacement with different staging system. The table reveals displacement values of top node and bottom node of container of tank, though it is evident that alternate cross bracing pattern gives the minimum value of displacement, but from the construction point of view and economy of overall construction, the alternate diagonal bracing pattern can be suggested.

***Index Terms* – Intze Tank, Seismic Analysis, Response Spectrum, Elevated water tank, Frame Staging, Bracing.**

I. INTRODUCTION

India is the country which consist higher population of the world because of increasing population day by day. Primary requirement of increasing population is water, gas, electricity, etc. Water id Human vital needs for daily life by localities, industrial, rural, campuses, towns and cities etc. So, the liquid storage structure is required to storage chemicals, acids, petrol, hot liquids, etc. in industrial use. Water storage structure used to store the water to tide over the daily requirements of water by residential and rural areas. Throughout history, wood, ceramic and stone have been used as water tanks. These were all naturally occurring and manmade and some tanks are still in service. Based on the material of tanks, storage tanks are classified into two types, which is R.C.C. tanks and Steel tanks.

In this paper we will study about seismic behavior of intze tank with staging, in this paper the measuring parameters for staging pattern are top story displacement, time period, base shear is taken, the models are prepared and analyzed in Matrix based analytic software. To performed seismic analysis on model response spectrum method used.

To defined the different staging pattern, we used bracing system with 3 different plan patterns and 6 story staging.

II. CONCEPT OF FRAME STAGING AND SHAFT STAGING

In general, intze tank type structure staging is the bridge between the tank and soil, also the load transferring Earthquake resistance part of structure. In shaft staging the b bottom ring beam of container and footing are connected with shear wall, there no columns and beams are required, where in frame staging the supporting structure are the combination of beams and columns.

In this topic we study only about the frame staging, we use R.C.C. braces in frame structure to create truss system, in general study truss system are the most effective structural system.

Here we take 6 different type of bracing system as follows.

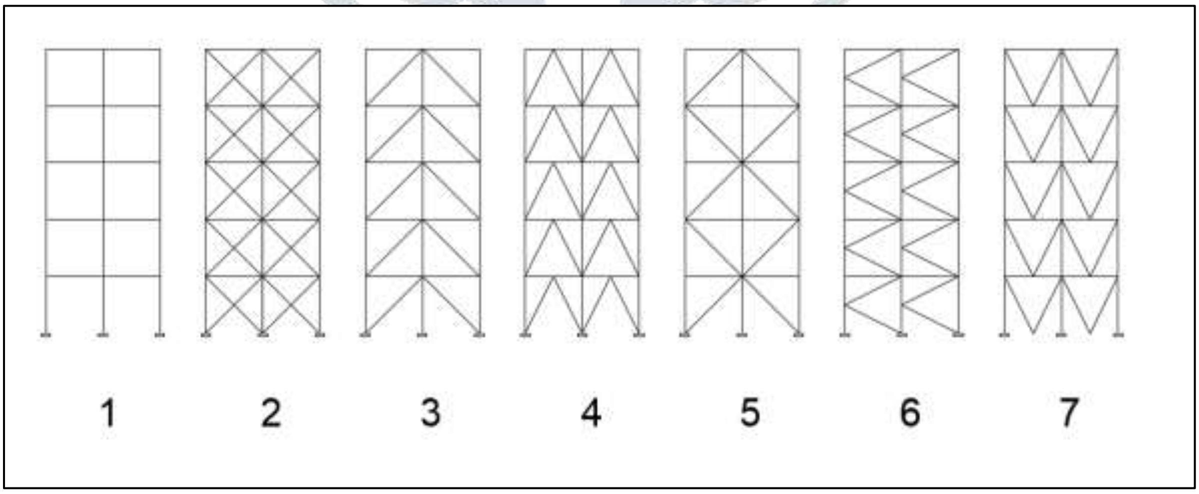

Figure 1 Different bracing system

From the figure types of bracing are: 1) Without bracing, 2) "X" type, 3) Diagonal type, 4) Chevron type, 5) Global type, 6) "K" type, 7) "V" type.

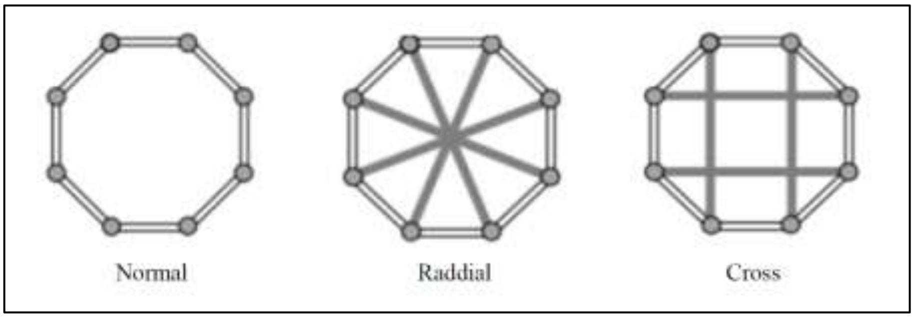

Figure 2 plan for different tie beam

Above picture shows the patterns for tie beams, which are no tie beams, radial type and cross type tie beams.

III. Problem Description

For knowing better staging system in intze water tank, I have taken a live model for comparison of different parameters, the tank is having a capacity of 34 lacks liters,12 column supported having a beam and column staging of 6 stories, there are no bracing were casted. We study about different 6 types of staging with bracing and 3 types of staging with tie beam patterns with 6 story staging, to reaches the conclusion there are different 21 models are made and analyzed in software.

Below table shows the Dimensional data of intze tank.

Table 1: Dimensional detail of intze tank from live structure (All dimensions are in mm.)

Dia. of column	1000	Top dome	125 thick
Tie beam	750x650		23644 Radius
Bottom ring beam	1000x2000	Internal circular wall	200 thick
Ring beam at top of conical	1350x1000	Outer circular wall	475 to 200
Top ring beam	600x825	Conical dome	800 thick
Top and bottom beam for cabin	200x200	Inspection slab	100
Bottom dome	250 thick	Cabin top slab	100
	10901 Radius	Radius at bottom	15600
Radius of Stair wall	2890	Radius for outer wall	22600
Height of Stair wall	5500	Height of outer wall	4900
Cabin Column	200x200 (6 nos.)	Height of top cabin	2100
Braces	350x450	No. of columns for top cabin	6

In this model inlet pipe, outlet pipe, overhead pipe, stair case is not taken as a structure member, hence those are not added in models.

The height of tank is 38.294 m at the top slab, in which frame staging are made up to 24.5 m and rest 13.794 m are the height of container.

Earthquake data are taken for Surat city in Gujarat, which are, R=5, Soil type is medium, Important factor is 1.5, zone is III, time period is manually calculated, which is 1.15 sec. and damping is 5% taken.

Tie beam are created at (from bottom) 0.987 m, 5.237 m, 9.237 m, 13.237 m, 17.237 m, 21.237 m, at 24.5 bottom ring beam is there.

The applied loads are Dead load, Self-weight and water load as live load, DL is 0.5 kN/m2 on top dome in gravity direction and the LL are as per under table.

Table 2: Hydrostatic load (LL) on Bottom dome (divide in 10 equal divisions along length)

Plate strip	Load in kN/m2	Plate strip	Load in kN/m2
1 (outer most)	99.0225	6	44.82
2	85.86	7	36.75
3	74.05	8	29.22
4	63.41	9	22.19
5	53.67	10 (inner most)	15.53

Table 3: Hydrostatic load on Conical dome (divide in 12 equal divisions along length)

Plate strip	Load in kN/m2	Plate strip	Load in kN/m2
1 (outer most)	44.40	7	51.18
2	45.89	8	51.82
3	47.23	9	52.32
4	48.42	10	52.66
5	49.49	11	52.85
6	50.41	12 (inner most)	52.92

Table 4: Trapezoidal load on Inner wall (divide in 12 equal division along Height)

Plate strip	Load in kN/m2	Plate strip	Load in kN/m2
1 (bottom most)	47.17 to 51.66	7	20.21 to 24.70
2	42.67 to 47.17	8	15.72 to 20.21

3	38.18 to 42.67	9	11.22 to 15.72
4	33.69 to 38.69	10	6.72 to 11.22
5	29.2 to 33.69	11	2.24 to 6.72
6	24.70 to 29.2	12 (top most)	0 to 2.24

Table 5: Trapezoidal load on Outer wall (divide in 12 equal division along Height)

Plate strip	Load in kN/m2	Plate strip	Load in kN/m2
1 (bottom most)	42.02 to 46.02	7	18.00 to 22.01
2	38.02 to 42.02	8	14 to 18
3	34.01 to 28.02	9	10 to 14
4	30.01 to 34.01	10	6 to 10
5	26.01 to 30.01	11	2 to 6
6	22.01 to 26.01	12 (top most)	0 to 2

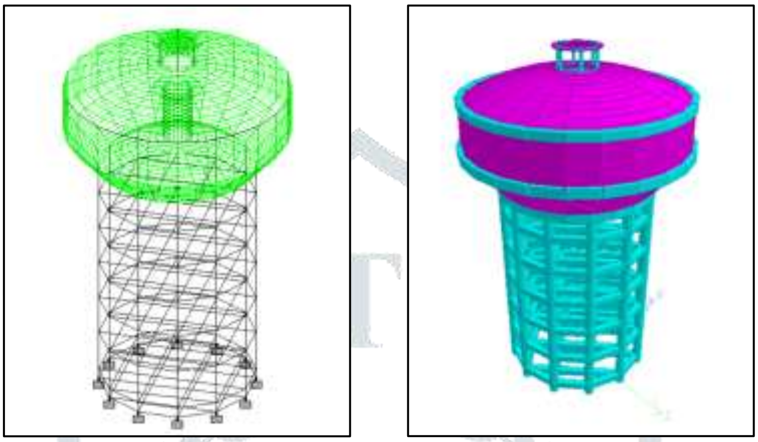

Figure 3: Existing tank model

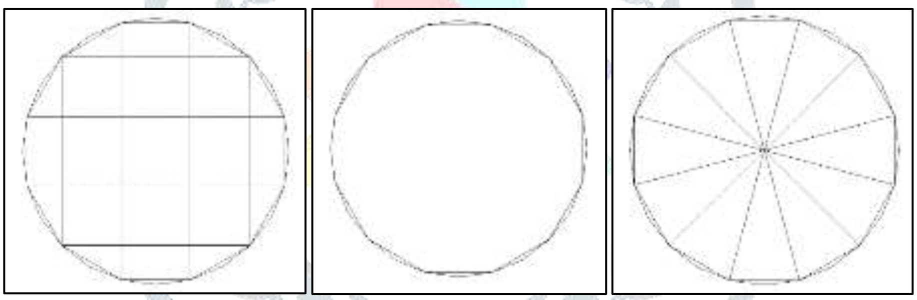

Figure 4: Different Plan Patterns

IV. WORK METHODOLOGY

There different 21 models are created with 7 types of elevation and 3 types of plan patterns, in those models load application and earthquake data are same, after applying response spectrum and analysis the scale factor is provided as per is code. To check all models 3 para meters are been taken, which are top story displacement, base shear and time period. After this the dimensions are been decrease as per the require capacity of different members for material and cost economy. From all these models the 1 pattern is conclude, which is best fir earthquake response and economy both.

V. RESULTS:

After the analysis of all models all are compared according to below parameters

Table 6: With cross tie beam

Parameters	**Top story Displacement (mm)**	**Base shear (kN)**	**Time Period (seconds)**
Without Braces	75.12	1716.56	2.59
X Braces	10.52	1897.22	0.69
Diagonal Braces	14.82	1799.54	1.07
Chevron Braces	18.82	1879.59	0.76
Global Braces	16.87	1752.42	1.02
K Braces	16.76	1776.50	1.02
V type	14.69	1776.05	1.03

Table 7: With no Tie beam

Parameters	Top story Displacement (mm)	Base shear (kN)	Time Period (seconds)
Without Braces	87.08	1572.66	2.97
X Braces	11	1689.36	0.84
Diagonal Braces	14.19	1651.01	1.07
Chevron Braces	13.01	1671.73	1.02
Global Braces	13.81	1610.64	1.04
K Braces	14.09	1633.62	1.04
V type	13.94	1632.16	1.07

Table 8: with radial Tie beam

Parameters	Top story Displacement (mm)	Base shear (kN)	Time Period (seconds)
Without Braces	69.87	1699.49	2.59
X Braces	10.40	1872.56	0.85
Diagonal Braces	14.37	1818.40	1.08
Chevron Braces	13.21	1854.93	1.03
Global Braces	13.22	1737.47	1.04
K Braces	15.07	1730.69	1.08
V type	14.58	1759.0	1.06

Table 2,3 and 4 shows the observation data from the software in which using different bracing top story displacement and time period are decreasing and base shear is increasing. The average value of these parameters is shown in below table.

Table 9: Difference of observations using bracing in (%)

Bracings type	Top Storey Displacement (Decreased)	Time Period (Decreased)	Base Shear (Increased)
X	85.99	73.58	10.22
Diagonal	80.27	58.66	4.83
Chevron	74.95	70.88	9.49
Global	77.54	60.63	2.08
K	77.68	60.63	3.49
V	80.44	60.20	3.46

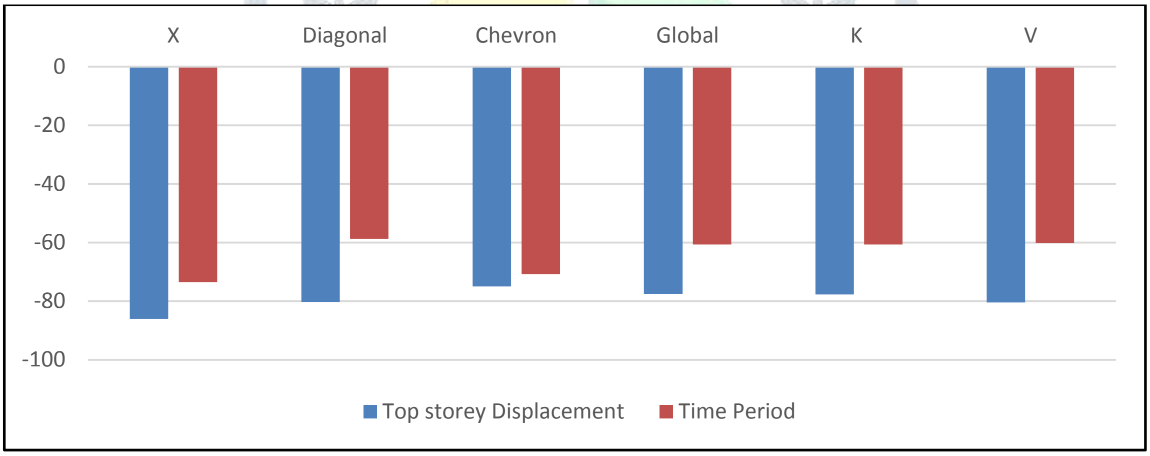

Figure 5: Decrement in parameters in (%)

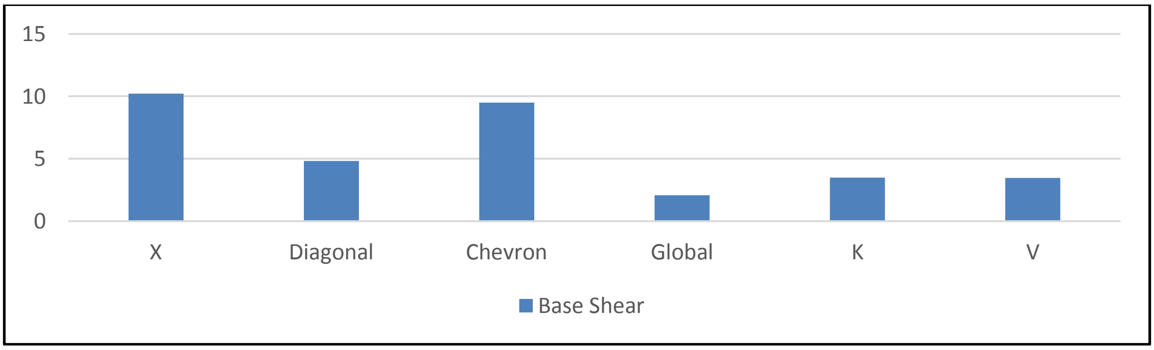

Figure 6: Increment in parameters in (%)

VI. CONCLUSIONS:

i) In parametric study for top storey displacement X type bracing system is most effective pattern among all 6 patterns, it reduces the displacement by 85.99 %.
ii) Using the bracing system all patterns are with in the permissible limit from IS 456 in terms of displacement, which is 144 mm for our case.
iii) From figure 5 and table 9, X type of bracing system have most increased base shear, which is 10.22 % because of the increase of volume of concrete, in other hand global type bracing system least increased base shear, which is 2.08.
iv) From table 2 to 4, K and V type of bracing system have almost same seismic behaviour in terms of all thee parameters.
v) X type of bracing are the most effective type as they reduced most displacement and time period.
vi) Global type bracings less effective compare to X type, but does not increase much volume of concrete, also effective response against earthquake, It be most effective and economical pattern among all 6 type.

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