Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 04, April -2018

MATERIAL OPTIMIZATION IN INTZE TANK BY USING 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.*

Keywords-*Intze Tank, Seismic Analysis, Bracing Patterns, Staging Patterns, Material Optimization, Response Spectra.*

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.

In Truss system axial force are the only force/moment that are to take in calculations for design, and the goal is to transfer all loads to the foundations, that also give the chance to optimization o0f the different tension and compression members, same thing here is going to use for R.R.C. members, using different staging system we optimize the beam and column dimensions and materials

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.

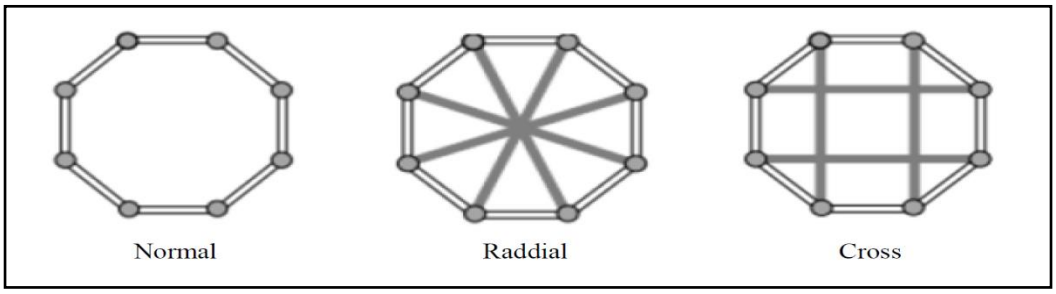

Figure 1 plan for different tie beam

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

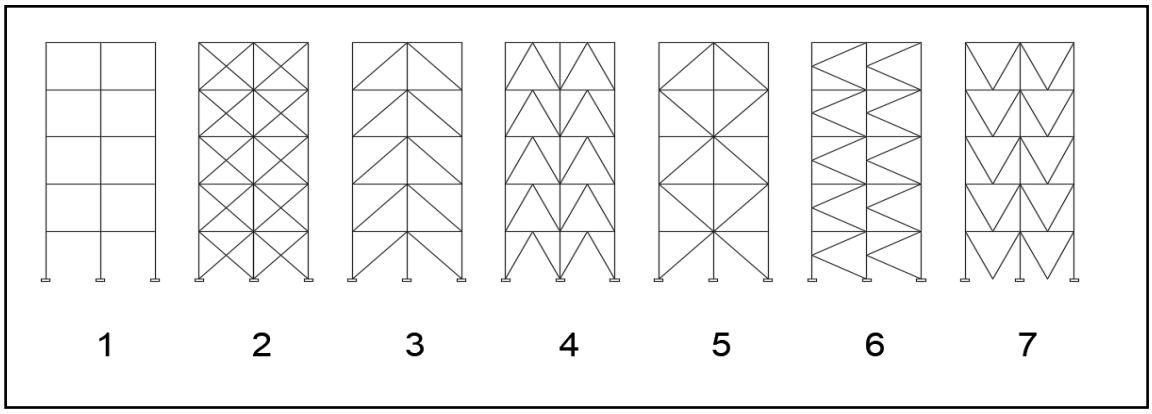

Figure 2 Different bracing system

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.

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 divisions 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 divisions 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

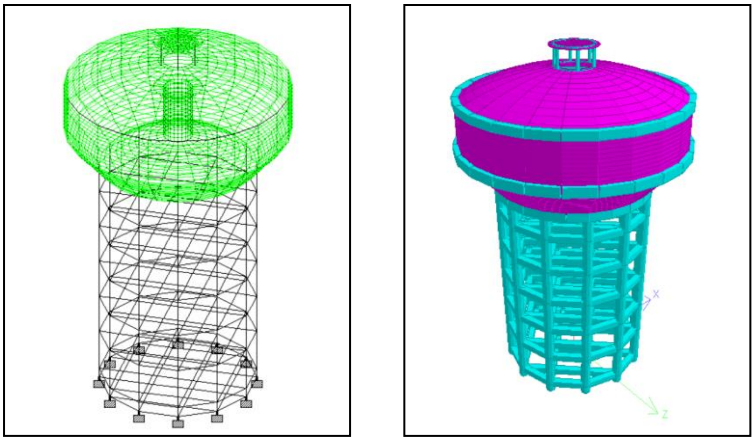

Figure 3: Existing tank model

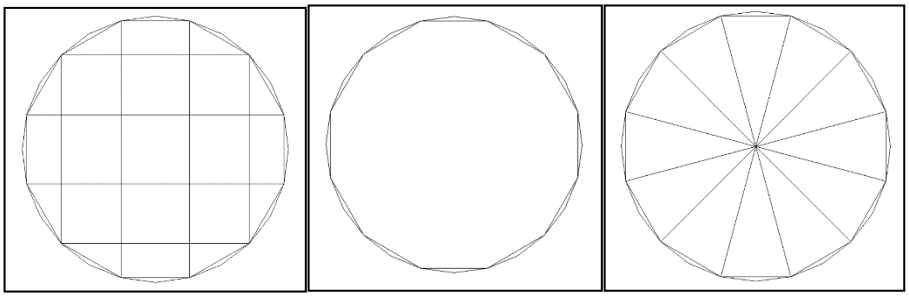

Figure 4: Different Plan Patterns

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 being 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 for earthquake response and economy both.

V. RESULTS

Here the results are compared after the code checking and material reduction for all member of staging system, for all results the top story displacement, base shear and time period are minted as per Indian standards, the results comparisons are made in use of cubic meter of concrete with the concrete use in existing, which is 888.2 cubic meter.

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

Table 6: Material difference using bracing for cross type

Bracing	Size of bracing	Size of column	Vol. of concrete	Difference
Without bracing	-	-	-	-
X	310x310	750	762.1	126.1
Diagonal	310x310	750	750	138.2
Chevron	300x300	750	727.2	161
Global	310x310	700	712.2	176
K	300x300	700	765.9	122.3
V	300x300	750	836.7	151.5

Table 7: Material difference using bracing for Radial type

Bracing	Size of bracing	Size of column	Vol. of concrete	Difference
Without bracing	-	1000	1011.9	-123.7
X	300x300	700	738.9	148.3
Diagonal	300x300	750	797.2	91
Chevron	320x320	750	728.4	159.8
Global	300x300	750	724.4	163.8
K	300x300	700	795.2	93
V	250x250	750	682.2	206

Table 8: Material difference using bracing for Normal type

Bracing	Size of bracing	Size of column	Vol. of concrete	Difference
Without bracing	-	1000	673.2	215
X	300X300	700	702.2	186
Diagonal	310X310	750	650.5	237.7
Chevron	300X300	750	675.9	212.3
Global	310X310	750	645.3	242.9
K	310X310	750	692.6	195.6
V	300X300	750	630.1	258.1

VI. CONCLUSIONS

For cross type, as per material consumptions Global type of bracings is most effective, which saves 176 cubic meters of concrete.
Least effective type of bracing for cross type is V type, which saves 51.3 cubic meters of concrete.
For Radial type, most effective pattern of bracing is also Global type, in radial type it saves 163.9 cubic meter of concrete.
For Normal type also Global bracing is most effective, in this case it saves 242.9 cubic meters of concrete.
In general X type and K type of bracing are also useful to resist seismic force and reduce materials, but for the prospective of construction we have to provide a joint in each story, which is not good for material quality control.
For all 21 cases Global type are the most material saved type.

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