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Parametric Study of Different Staging Pattern with Pushover Analysis of Water Tank

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ABSTRACT: The flow audit analyzes the enumerating of key components for the modifying variable of the seismic response of the RCC framed organizing of the raised water storehouse. The assessment revealed that three principal factors, called saved power, adaptability and clear tedium, impact the certifiable worth of the response change factor and thus ought to be considered while choosing the distinction in the appropriate response to be used during the seismic arrangement process. The evaluation of the response change factor is finished using a nonlinear static sissy assessment. Quitter examination is a general contraption for performing static nonlinear separates of framed structures. It is used to survey non-straight approach to acting and gives the progression and part to outlining the plastic turn. Here, movement controlled removing assessment is used to apply seismic powers in C.G. of compartment. The push twist, which is a fundamental cut graph relative with the removing of the housetop, gives the feasible furthest reaches of the development in the non-direct reach. This could be a direct result of the shortfall of data about the correct approach to acting of the tank genuinely strong organization because of the powerful effect and moreover in light of the lacking numerical assurance of the orchestrating. The objective of this study is to sort out the approach to acting of different stages, under different weight conditions and to develop the standard kind of getting sorted out, to gain better execution during a quake. This paper presents a seismic assessment of brought water tanks maintained up in different organizing models with different tank storing limits. Here we break down two different genuinely strong organizations, as extended help and get over help, with the central sincerely steady organization for various fluid level conditions. Eleven models are used to find out the shearing of the base and the nodal expulsions for getting sorted out with STAAD virtuoso. Ensuing to figuring out the base cut additionally, the nodal expulsions of eleven models for empty and complete conditions. Three unmistakable sorts of getting sorted out frameworks were researched.

KEYWORDS:Response reduction factor, Seismic design, Static nonlinear pushover analysis, SAP 2000, STAAD Pro

I. INTRODCTION

The important factors that affect the magnitude of earthquake forces are-

- Seismic Zone Factor, Z

India has been divided into four seismic zones as per IS 1893 (Part 1): 2002 for the Maximum Considered Earthquake (MCE) and service life of the structure in a zone. Different zone have different zone factor. Figure shows seismic zone map of India. India is divided into four seismic zones. There are three types of soil considered by IS 1893 (Part 1): 2002 i.e. soft medium and hard soil.

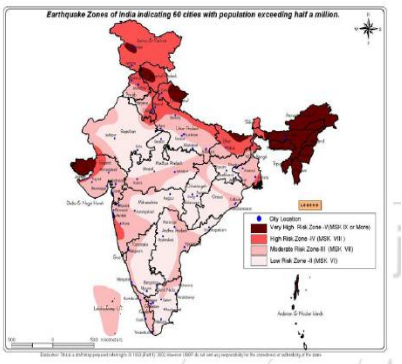

Fig. 1: Different Earthquake Zones of India [IS 1893:2002 (Part 1)]

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- Importance Factor, I

Importance factor depends upon the functional use of the structures, characterized by hazardous consequences of its failure, post-earthquake functional needs, historical value, or economic importance. Elevated water tanks are used for storing potable water and intended for emergency services such as fire fighting services and are of post earthquake importance. So importance factor is 1.5 for elevated water tank.

- Response Reduction Factor, R

Response reduction factor depends on the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations. R values of tanks are less than building since tanks are generally less ductile and have low redundancy as compared to building. R value is 1.8.

- Structural response factor, (Sa/g)

It is a factor denoting acceleration response spectrum of the structure subjected to earthquake ground vibrations, and depends on natural period of vibration and damping of the structure.

1.2 Provisions of IS Codes

Indian Standard IS: 1893-1984 provides guidelines for earthquake resistant design of several types of structures including liquid storage tanks. This standard is under revision and in the revised form it has been divided into five parts. First part IS: 1893(Part 1): 2002, which deals with the general guidelines and provisions for buildings has already been published. Second part, will deal with the provisions for liquid storage tanks. IS 1893-1984 has provisions for elevated tanks only; it does not have any provision for ground supported tanks. In the analysis of elevated tanks, the sloshing or convective component is not considered. These limitations in the provisions of IS 1893-1984 have been discussed by Jain and Medhekar. They have also suggested a set of modifications to be incorporated in the provisions of IS 1893-1984, on seismic analysis of tanks. Their suggestions were mainly focused on inclusion of convective component in the analysis of tanks. They suggested separate mechanical models for rigid and flexible tanks. Model of Haroun and Housner is used for flexible tank and approach of Veletsos and Yang is used for rigid tank. Impulsive mass calculation suggested by Jain and Medhekar is along similar lines as that of NZSEE guidelines (Priestley, 1986). Jain and Medhekar did not provide any suggestion on response due to vertical excitation.

II. LITERATURE REVIEW

SnehalWankhede, Prof. P. J. Salunke, Prof. N. G. Gore

In the current review cost advancement of raised roundabout water tank is introduced. The goal is to limit the absolute expense in the plan cycle of the raised roundabout water tank thinking about the expense of materials. The plan factors considered for the expense minimization of the raised water tank, are thickness of the divider, floor piece profundity, floor pillar profundity (I. e. X1, X2, X3 resp.) Design limitations for the streamlining are viewed as agreeing Standard Specifications. The streamlining issue is described by having a blend of persistent, discrete and number arrangements of plan factors. For An enhancement reason Mat lab Software with SUMT (Sequential Unconstrained Minimization Technique) is utilized that is equipped for finding straightforwardly with high likelihood the base plan factors.

Ankush N. Asati, Dr.MahendraS.Kadu, Dr. S. R. Asati

As known from exceptionally disturbing encounters, inadequately planned raised water tanks were vigorously harmed or fallen during tremors. This may be because of the absence of information in regards to the way of behaving of supporting arrangement of the tank, and furthermore because of ill-advised choice of math of organizing designs. For specific extents of the tank and the construction, the sloshing of the water during quake might be one of the prevailing variables. Dynamic examination of tank containing fluid is perplexing including liquid design connection. In this paper, the seismic social impact of roundabout raised water tank is read up for explicit limit of tank for different organizing courses of action in plan, variety in number of outskirts sections and variety in number of stages in height. Two mass glorifications proposed by Gujarat State Disaster Management Authority are viewed as here. Under seismic tremor stacks; a convoluted example of stresses is produced in the tanks. Absolute 36 blends were dissected with SAP2000 utilizing Response Spectrum Method (RSM) and results are introduced. It is seen that expansion in number of segments, doesn't guarantee the expansion in that frame of mind of underlying reactions. Spiral course of action with six organizing levels is viewed as best for the quantity of segments utilized. To propose number of sections with appropriate width cost streamlining is finished the spiral organizing course of action with six arranging levels considering basic heading of seismic power, amount of cement and steel required. It is found that eight quantities of segments gives less expense when contrasted with six, ten and twelve with streamlined distance across of 300mm.

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Manish N. Gandhi, Prof. A. Rajan

Water tanks are vital for public utility and for modern design. Water tanks are vital parts of life saver. They are basic components in metropolitan water supply, putting out fires frameworks and in numerous modern offices for capacity of water. From the exceptionally disturbing encounters of not many quakes in India, R.C.C raised water tanks were vigorously harmed or imploded. This was may be because of the absence of information in regards to the appropriate way of behaving of supporting arrangement of the tank because of the powerful impact and furthermore because of ill-advised mathematical choice of organizing. The principal point of this study is to comprehend the way of behaving of various organizing, under various stacking conditions and reinforcing the customary sort of arranging, to give better execution during quake. The point of this study is to comprehend the need of dissect ordinary arranging arrangement of raised water tank with various kind supporting in organizing framework for raised water tank.

Ayazhussain M. Jabar and H. S. Patel

Has contemplated to comprehend the way of behaving of supporting framework which is more viable under various tremor time history is done with SAP 2000software. As known from extremely disturbing encounters, raised water tanks were intensely harms or fallen during seismic tremor. This was may be because of the absence of information with respect to the appropriate way of behaving of supporting arrangement of the tank again powerful impact and furthermore because of ill-advised mathematical determination of organizing designs.

Durgesh C Rai

Portrays about the presentation of raised tanks in bhuj tremor of January 26th 2001. The flow plans of supporting designs of raised water tanks are very weak under sidelong powers because of a quake and the Bhuj tremor gave another outline when a large number water tank organizing's endured harm and a couple fell.

AsariFalguni and Prof. M.G.Vanza

has illuminated the consequences of an insightful examination of the seismic reaction of raised water tanks utilizing fiction damper. In This paper, the way of behaving of RCC raised water tank is examined with utilizing rubbing damper (FD). For FD framework, the fundamental advance is to decide the slip load.

III. METHODOLOGY

The tank has been modelled as 3D Space frame model with six degrees of freedom at each node using STAAD-pro software for stimulation of behaviour under gravity and seismic loading. The isometric 3D view and elevation of the tank model is shown as figure. The support condition is considered as fully fixed.

Complete analysis is carried out for dead load, live load & seismic load using STAAD-pro. All combinations are Considered as per IS 1893:2016 part-II.

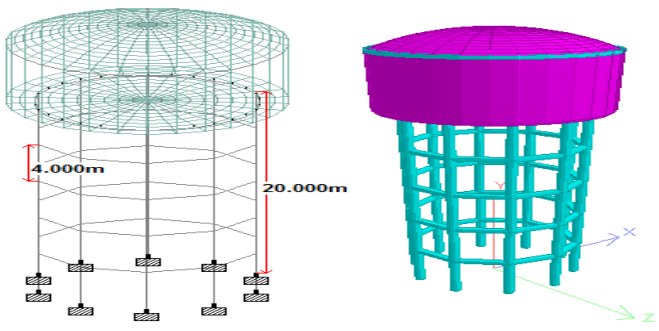

Fig. 4.1: Model with Frame Type of Staging

Above figure shows that model having frame type of staging with staging height of 20 m.

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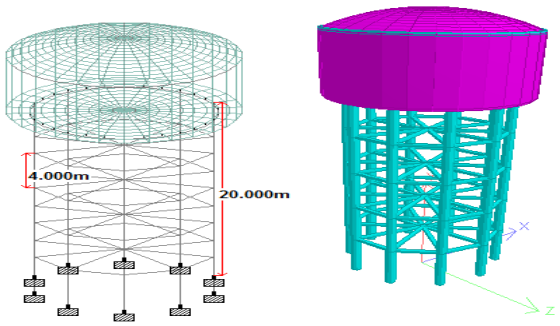

Fig. 4.2: Model with Radial Type of Staging

Above figure shows that model having radial type of staging with staging height of 20 m.

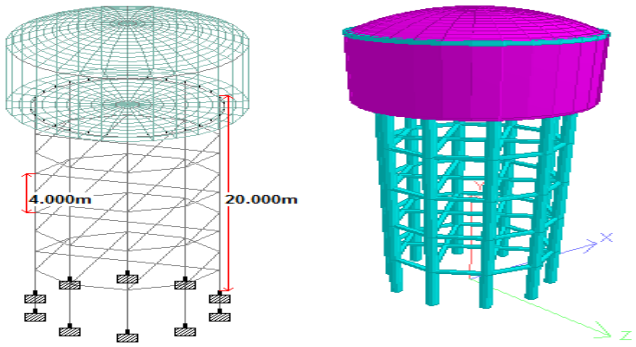

Fig. 4.3: Model with Cross Type of Staging

Above figure shows that model having cross type of staging with staging height of 20 m.

The parameters of an elevated circular water tank are shown below in table no. 4.1

Sr No.	Parameters	Values		
1	Volume of Tank	500 m3	800 m3	1000 m3
2	Diameter of Tank	10.84 m	12.68 m	13.20 m
3	Height of Tank	5.7 m	6.6 m	7 m
4	c/c Diameter of Tank	11.1 m	12.94 m	13.91 m
5	Size of Top Slab	100 mm thick		
6	Size of Bottom Slab	450 mm thick		
7	Size of Top Ring Beam	300x300 mm		
8	Size of Bottom Ring Beam	300x600 mm		
9	Size of Braces	300x300 mm		
10	Density of Concrete	25 kN/ m3		
11	Height of Staging	20 m		
12	Number of Columns	10		
13	Zone	III		
14	Response Reduction Factor	1.8		
15	Importance Factor	1.5		
16	Type of Soil	Medium Soil		
17	Grade of Concrete & Steel	M25 & Fe415		

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IV. RESULTS

Stiffness Variation

Table 5.1: Stiffness Variation

Series of Models	Tank Type (m3)	Stiffness (kN-mm)
Model I	500 Frame	7770000
Model II	500 Radial	5140000
Model III	500 Cross	5140000
Model IV	800 Frame	4400000
Model V	800 Radial	6900000
Model VI	800 Cross	7490000
Model VII	1000 Frame	6710000
Model VIII	1000 Radial	5280000
Model IX	1000 Cross	5370000

Above table shows that stiffness variation for different tank capacities with different staging pattern. Total nine combinations are observed and analysis is carried out by seismic coefficient method.

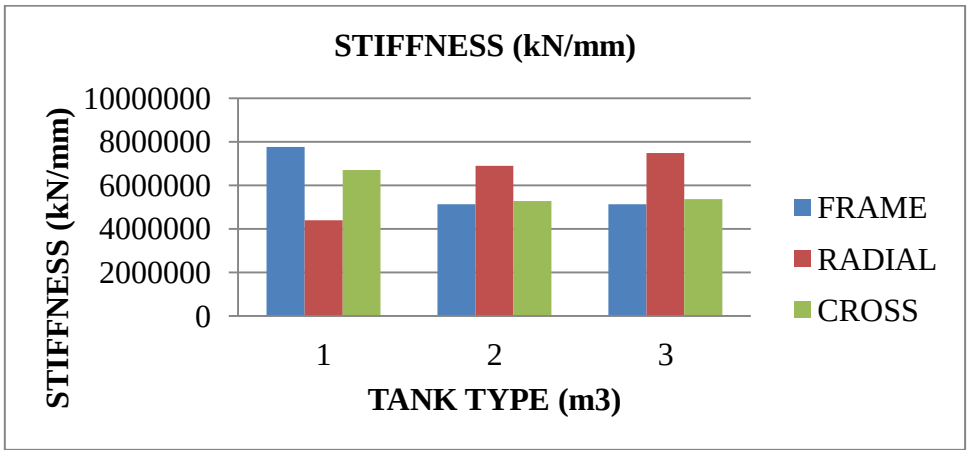

Fig. 5.1: Stiffness Variation

In above graph, stiffness (kN/mm) is given on x-axis and tank type (m3) i.e. tank having different capacities with different staging pattern. Variation of stiffness along various types of tank is shown in graph. From graph, it is concluded that 500 m3 tank with frame staging having maximum stiffness and least in 800 m3 tank with frame staging. Tank with radial and cross staging is having nearest same values for all tank capacities.

Absolute Maximum Displacement Variation for 500 m3 Capacity

Table 5.2: Abs Max Displacement

Tank Type (m3)	Staging Height	Abs Maximum Displacement (mm)
500 Frame	0	0
	4	7.205
	8	19.747
	12	33.286
	16	46.15
	20	53.968
500 Radial	0	0
	4	4.039
	8	12.452
	12	22.09
	16	30.657
	20	34.983

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500 Cross	0	0
	4	6.644
	8	21.036
	12	37.701
	16	52.275
	20	59.263

Above table shows that absolute maximum displacement variation for various tank staging height. Total nine combinations are observed and analysis is carried out by seismic coefficient method. As the height of staging increases absolute maximum displacement increases.

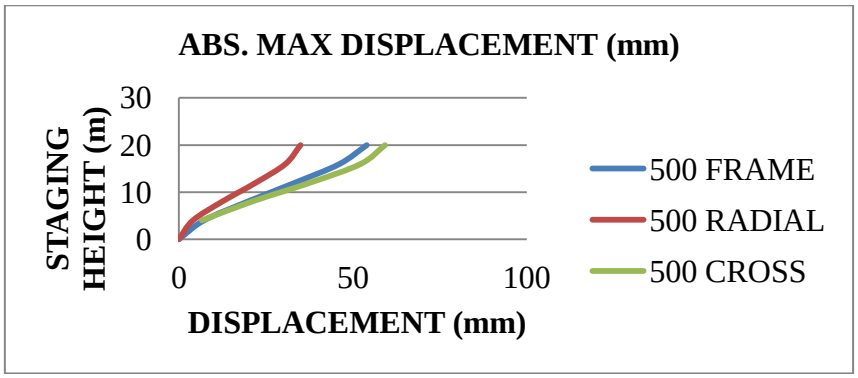

Fig.5.2: Abs Max Displacement

In above graph, displacement (mm) is given on x-axis and staging height (m) on y-axis. Variation of displacement verses staging height is shown in graph. From graph, it is concluded that as height of staging increases absolute maximum displacement increases. The maximum displacement occurs at staging height of 20 m in 500 m3 cross type of model and minimum displacement is in 500 m3 radial type of model at staging height of 4 m.

Absolute Maximum Displacement Variation for 800 m3 Capacity

Table 5.3: Abs Max Displacement

Tank Type (m3)	Staging Height	Abs Maximum Displacement (mm)
800 Frame	0	0
	4	6.27
	8	19.334
	12	34.303
	16	47.546
	20	54.079
800 Radial	0	0
	4	8.283
	8	26.765
	12	48.418
	16	67.084
	20	75.662
800 Cross	0	0
	4	15.245
	8	46.603
	12	82.191
	16	113.841
	20	129.622

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Above table shows that absolute maximum displacement variation for various tank staging height. Total nine combinations are observed and analysis is carried out by seismic coefficient method. As the height of staging increases absolute maximum displacement increases.

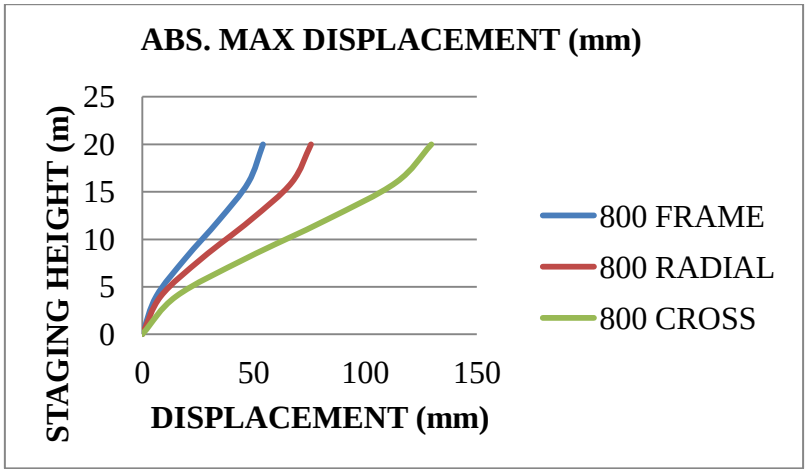

Fig. 5.3: Abs Max Displacement

In above graph, displacement (mm) is given on x-axis and staging height (m) on y-axis. Variation of displacement verses staging height is shown in graph. From graph, it is concluded that as height of staging increases absolute maximum displacement increases. The maximum displacement occurs at staging height of 20 m in 800 m3 cross type of model and minimum displacement is in 800 m3 frame type of model at staging height of 4 m.

V. CONCLUSION

- Parametric study is carried out by using different patterns of bracings in staging of an elevated water tank. From the table it is clear that the base shear value reduces for alternate bracing pattern in staging. This is apparent because of the reduction of overall stiffness of the structure.
- Cross type of arrangement has more deflection than frame and least in radial, and vice versa is the stiffness.
- Roof displacements of all models are within permissible limits as per IS 1893 (PartI): 2002.
- Parametric study is carried out by using different patterns of bracings in staging of an elevated water tank. Base shear for different bracing pattern it is clear that the base shear value, reduces for alternate bracing pattern in staging. This is apparent because of the reduction of overall stiffness of the structure.
- Tank with volume of 1000 m3 having cross staging has higher volume of concrete & least volume of concrete is in 500 m3 tank with frame type of staging. .
- High value of weight of steel is required for 800 m3 tank with cross staging and less for 500 m3 tank with frame staging.
- From above two conclusions it is concluded that 500 m3 tank with frame type of staging is best suited.

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