Comparative Study of Elevated Service Reservoir (E.S.R.) with Dynamic Analysis for Earthquake Zone V in India

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ABSTRACT

The main aim of this study is to analyze the elevated water tank and comparing the forces created on elevated water tank in seismic zones V due to earthquake. Before design and analysis of structure first its impact on our economy based is to be fulfilled. The analysis of elevated water tank is performed on impulsive mode and convective mode using-(1) IS 456:2000, Plane and Reinforced9 Concrete-Code of Practice, (2) IS 1893 (PART- 1): 2016, Criteria for earthquake resistant design of structures,(3)- IS 3370 (PART-2):2009, Concrete structures for storage of liquids, (4)- (GSDMA GUIDELINES (GUJARAT STATE DISASTER MANAGEMENT AUTHORITY) &IS 11682-1985 Criteria for design of RCC staging for (o.h.t.) tanks. In this study with mention criteria to all above guidelines and codes, I have designed varying models of water tank (Rectangular and circular tank) using staad pro software V8i. By using all data and results I have compared results on following basis- Quantity estimation, Base shear, Base moment Time period, Plate stresses and moments value regarding our design.

KEYWORDS: Elevated Service Reservoir (E.S.R), GSDMA Guidelines, Equivalent static analysis

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1. INTRODUCTION

1011e1112344 Reservoir and Elevated service reservoir are used to store high amount of water and other things etc. All tanks are used to designed as crack free structure to deactivate or eliminate any type of leakage by taking high grade of concrete and steel. Sometimes industrial wastages are also collected in this types of tanks. In this one point is considered that underground water tank have higher capacities in reference to Elevated Service Reservoir.

From design point of view the tanks may be classified as per their shape such as (1)- rectangular tanks (2)circular tanks and Intz type of tanks. Rectangular tanks are provided are provided for smaller to big capacity. For small capacities circular tank proves uneconomical to some extent due to its formwork, has proved costly. The rectangular tank should be generally preferably square in plan from point of view of economy. In my project I have done complete analysis between both of the tanks i.e. (Rectangular & Circular tanks). In my project I have taken LSM method (LIMIT STATE OF DESIGN). It is important to point out here that a structure designed throughlimit state method when fails, so type failure could occur in elastic not in other stage. Tank height I considered 18 mts and 2 mts below ground level. In this first I have compared both the tanks (i.e.) Rectangular & Circular by taking 3-3 mts staging height with circular column dia, then I compared the results using staad and manually implementation is also applied. In second stage I have replaced the circular column dia with rectangular columns for modifying the results or to check what kind of changes isoccurs and lastly i.e. In third stage I have changed the staging height by 4.5 mts and now check the optimum results by above three cases, in third case by using above mention IS codes I have taken concept of staging height parameters mention in clause 7 & 7.1 Analysis of staging are taken under consideration.

In this water retaining structures due to its surcharge and heavily forces acted on tankbody heavy grade of concrete and steel is to be used in reference to IS 3370 and IS 456.

Grade of concrete is taken as M30, as minimum grade of concrete for RCC structures is M30 as per IS: 3370 (Part-1) 2009.The minimum quantity of cement in concrete mixshall not be less than 30 Kn/m³.

Methodology

In this six models are relatively study with its design calculations manually and its implementation on Staad pro software is carried out. Stage wise comparative study as mention in (Case study 3.4) is done and its result is been carried out. Comparisons is done according to earthquake zone V in India. Software used for design purpose is STAAD PRO SOFTWARE V8i. The methodology is to achieve what kind of variationsoccur as according to our comparative study in this type of Elevated Service Reservoir & which type of tank is feasible. Finally a comparative study on water tanks is doneaccording to point(3.1 Basics about project).

RESULTS AND DISCUSSIONS Overview on my work

In the present era of rapid development fast construction and quality work is always appreciated and also the need of the hour for construction is venuearable. In my projectI have designed E.S.R. of type Rectangular & Circular water tank. The main objective of this project/paper is Comparative study of (E.S.R) for earthquake zones V in India. The analysis is done by using STAAD PRO software and manually implementation is also done by using GSDMA guidelines and results being compared in seismic zone V in India. The comparison is made on the parameters such as Base shear, overturning moment, time periods, quantity estimation, plate stresses& moments, shear force, bending moment and reactions on column (on axis Global Y) are find out.

Result Analysis of Tanks

Comparisons on basis of Quantity (Concrete+Steel)

Stage wise- stage 1 (Mention in 3.5 Methodology)

Let's compare the value of in Zone V with respect to (4.2.1)







Figure 4.2- Comparisons of weight of steel in rectangular and circular tank.

In above tables we clearly seen that quantity wise circular tank is more preferable thanrectangular tank in today's field of economy.

Comparisons on basis of Quantity (Base shear, base moment & time period) Let's compare the value of in Zone V with respect to (4.2.2)



Figure 4.2 (a) Results showing comparisons in base shear.



Figure 4.2(b) Results showing comparisons in base moment/overturning moment



Figure 4.2 (c) Results showing comparisons in time period

Clearly in this reference by above comparisons we said that circular tank is feasible.

Comparisons on basis of stresses (Plate stress values)



Figure 4.3 Plate stresses value of rectangular tank in direction (sx local)-n/mm²





Figure 4.4 Plate stresses value of rectangular tank in direction (sy local)-n/mm²

Figure 4.5 Plate stresses value of circular tank in direction (sx local)-n/mm²





In this, we clearly see that stresses value are also getting lower for circular tank casetype.

Table 4.1 Variation in plate stresses value								
S No	Type of Tank	Type of Tank SQX (N/MM ²)		SQY (N/MM ²)				
D• 140•	rype or rains	Minimum	Maximum	Minimum	Maximum			
1.	Rectangular	-0.402 ₅₀₂	0.190	-1.470	0.915			
2.	Circular	-2.856	0.697	-0.598	0.395			

Table 4.1 Variation in plate stresses value

Comparisons on basis of (Shear force and bending moment behave of wholestructure)



Figure 4.7 Rectangular tank behaviour as per shear force and bending moment

	Beam	LC	Node	EL I	17	FZ	Mx kilm	My Mm	kin i
	- 14	101 15DL+1	51	-99917	-19.213	-3.805	4.549	1.044	-57.60
			282	99917	23.285	3.805	4.549	1.043	46.157
	153	101 1 SOL+1	53	-70943	-14.544	-2.423	-5.078	0.292	-52.84
			254	70.943	19,017	2.423	5.078	1.038	43.52
	117	101 15DL-1	55	11.805	-16.133	4.347	-13.037	-1.350	-4756
			226	-11.805	20.202	-4.347	13.037	-1.035	37.95
	109	101 150L-1	50	+12.467	472.488	-0.001	-0.000	0.001	554.478
NN.			1488	12.467	-467.289	0.001	0.000	0.000	-235.29
	110	101 150L+1	57	0.000	T.422	0.000	0.000	-0.000	371
1 Alexandre			58	-0.900	-0.000	-0.000	-0.000	-0.000	-400
CAR VILL	111	101 1 SOL+1	57	181.471	272.368	-2,163	33.004	1.3%	149,270
			196	-181.471	-258.296	2.163	-33.004	-0.219	-455
	TOP								BB
	Eears	LC	lax Avial Fo	orces), Mar	Bending N	fz	Max Shear	Forces/	
K	Beam	UC	lax Avial Fo Dist m 0.000	Fa Marine	For Deniel Bending N Fy M M	fz KN 1805	Max Shear Ma kilim 4549	Forces/ My Him 104	Ht a kin 5785
	Hearn 19	UC 101 15DL-1	lax Axial Fo Dist m 0.000 0.137	Fi Max - 2000 - 100 - 100 - 100 - 100 - 100 - 100 - 10	FDende Bending N Fy KN -19213 -19213	Fz KN -3.805 -3.805	Max Shear Ma kilim 4549 4549	Forces/ My Mim 1.04 0.525	Hz *
	Bears	UC IDI 150L+1	lax Axial Fo Dest m 0.000 0.137 0.274	Fis Max Fis Max 489917 499917	rDead Bending N Fy M 49210 49210 49210	loments) Fz 48 -3.805 -3.805 -3.805	Max Shear Ma klim 4.549 4.549 4.549	Forces/ My Klim 1.04 0.523 0.001	Hr + 48m - 57518 - 5518 - 5254
	Hearn 10	UC 101150L-1	lax Avial Fo Dest m 0.000 0.137 0.274 0.411	Fi Beam From Fi Mi 489917 -86917 -86917 -86917 -86917	EDecid Bending N Fy M 49213 49213 49213 49213 49213	fz Fz 3.805 3.805 -3.805 -3.805 -3.805	Max Shear Ma kilm 4.549 4.549 4.549 4.549	Forces/ My Mm 1.04 0.525 0.001 -0.521	Hr 4 Hr 4 57515 5518 5518 5518
	10 00 000 000 000 000 000 000 000 000 0	UC 101 150L-1	lax Axial Fo Dest m 0.000 0.137 0.274 0.411 0.545	Fa Max Fa Max -86917 -86917 -86917 -86917 -86917 -86917	Fy H9210 49210 49210 49210 49210 49210 49210 49210 49210	fz Fz 43 -3.805 -3.805 -3.805 -3.805 -3.805 -3.805	Max Shear Mx klim 4.549 4.549 4.549 4.549 4.549 4.549	Forces/ My Him 1.04 0.525 0.001 -0.521 -1.045	H S H S S755 S519 S254 4859 4815
	10 CO	UC 101 150L+1	lax Axial Fo Dest m 0.000 0.137 0.274 0.411 0.546 0.000	Fill Have Fill H	Bending N Fy M 49210 49210 49210 49210 49210 49210 49210 49210 49210 49210 49210 4944	fz k8 -3.805 -3.805 -3.805 -3.805 -3.805 -3.805 -3.805 -2.423	Max Shear Ma klim 4.549 4.549 4.549 4.549 4.549 4.549 5.078	Forces/ My Mm 1.04 0.523 0.001 0.521 -1.043 0.292	E S kim 578% 5518 5518 489% 481% 5284
	10 00 00 00 00 00 00 00 00 00 00 00 00 0	UC 101 150L+1	lax Axaal Fo Dest m 0.000 0.137 0.274 0.411 0.546 0.000 0.137	Fit Market Street Fit Market Street Fit Market Street Stre	Provide Fy 49210 -49210	Ioments) F2 K8 3.805 3.805 3.805 3.805 3.805 3.805 3.805 2.423	Max Shear Mx ktim 4.549 4.549 4.549 4.549 4.549 4.549 4.549 4.549 4.549 4.549 4.549 4.549	Forces/ Ny Nm 1.04 0.001 -0.001 -0.001 -0.001 -0.001 -0.001 -0.001 -0.001 -0.001 -0.001 -0.001 -0.001 -0.0000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.0000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000	H 83 Mb 4 5725 5518 5254 4898 4815 5254 5254 5254 5254 5254 5254 5254 5254 5254 5254 5254 52555 5255 5255 5255 5255 5255 5255 5255 5255 5255
	1000 1000 1000 1000 1000 1000 1000 100	UC 101150L+1	lax Avial Fo Dist 0.000 0.137 0.274 0.411 0.546 0.000 0.137 0.274	Frame Max Frame Max 46917 46917 46917	Preset Bending IV Fy 49210 49210 49210 49210 49210 49210 49210 49210 49210 49210 49210 49210 49210 49210 49210 44544 44544	Ioments) Fz 88 3.005 3.005 3.005 3.005 3.005 2.423 2.423 2.423	Max Shear Na 4549 4549 4549 4549 4549 4549 4549 454	Eorces/ My Mm 1.044 0.525 0.001 0.521 -1.045 0.252 0.021 -0.041 0.255	Max Max Max 67501 5510 5510 4554 4390 4615 4254 4254 4375 4254 4375
	1000 1000 1000 1000 1000 1000 1000 100	UC 101 150L+1	lax Avail Fo Dist 0.000 0.137 0.274 0.411 0.546 0.000 0.137 0.274 0.411	50000000000000000000000000000000000000	Fp K Fy K -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49214 -4944	Ioments) Fz Mi 3.005 3.005 3.005 3.005 3.005 3.005 2.423 2.423 2.423 2.423	Nax Shear Na Alim 4549 4549 4549 4549 4549 4549 4549 454	Eorces/ My Hem 1.044 0.523 0.001 0.521 0.051 0.521 0.051 0.521 0.021 0.021 0.022 0.041 0.232 0.041 0.232 0.041 0.232 0.021 0.021	No. No. Max Max Max Max 5750 S518 5518 S518 4254 4898 4815 5284 4815 5284 4815 5284 4815 5284 4815 5284 4816 5178 4818 488
	10 C C C C C C C C C C C C C C C C C C C	UC 101 150L+1	lax Axial Fo Dest m 0.000 0.137 0.274 0.411 0.546 0.000 0.137 0.274 0.411 0.549	50000000000000000000000000000000000000	Fp K Fy K -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49213 -49214 -4944 -4944 -4944 -4944 -4944	Ioments) Fz Mi 3.805 3.805 3.805 3.805 3.805 3.805 2.423 2.423 2.423 2.423	Nax Shear Na Alim 4549 4549 4549 4549 4549 4549 4549 454	Eorces/ My Min 1.0H 0.525 0.001 -0.521 -1.040 0.252 -0.001 -0.521 -1.040 0.252 -0.041 -0.373 -0.718 -1.035	No No Max A STR STR STR STR A STR
	1000 1000 1000 1000 1000 1000 1000 100	101 150L-1	lax Axial Fo Dest m 0.000 0.137 0.274 0.411 0.545 0.000 0.137 0.274 0.411 0.545 0.000	Frank 1000 Frank 10000 Frank 1000 Frank 10000 Frank 1000 Frank 1000 Fran	Please Bending N 49213 49213 49213 49213 49213 49213 49213 49213 49213 49213 49213 49213 49214 49214 49214 49214 49214 49214 49215 4	Ioments) Fz Mi 3.805 3.805 3.805 3.805 3.805 3.805 2.423 2.423 2.423 2.423 2.423 4.347	Na Shear Na Kim 4549 4549 4549 4549 4549 4549 4549 454	Eorces/ My Min 1.0H 0.525 0.001 -0.521 -1.040 0.252 -0.011 -0.521 -1.040 0.252 -0.011 -0.521 -1.040 -0.521 -1.040 -0.525 -0.011 -0.525 -0.525 -0.525 -0.525 -0.525 -0.525 -0.525 -0.555	No No Max A 5525 5518 5525 5518 4525 4526 4515 4516 4515 4516 4515 4516 4515 4516 4515 4516 4515 4714
	14 4 1 Bears 39 103	101 150L+1	lax Axial Fr Dist m 0.000 0.137 0.274 0.411 0.546 0.000 0.137 0.274 0.411 0.546 0.000 0.137 0.274 0.411	Field Control of Contr	Please Bending N 49213 49213 49213 49213 49213 49213 49213 49213 49213 49213 49213 49213 49213 49214 49214 49214 49213 49213 49214 49214 49214 49213 49213 49213 49214 49213 49214 49213 49213 49214 49213 49215 4	Ioments) Fz k8 -3.805 -3.805 -3.805 -3.805 -3.805 -2.423 -2.423 -2.423 -2.423 -2.423 -2.423 -2.423 -2.423 -2.423 -2.423 -2.423 -2.423 -2.423 -2.437 -2.	Nax Shear Na 4549 4549 4549 4549 4549 4549 4549 454	Forces/ My Mim 1.044 0.525 0.001 -0.521 -0.05 0.232 -0.041 -0.05 0.235 -0.241 -0.05 -0.241 -0.05 -0.241 -0.05 -0.245 -0.2	No No Max A 5750 5750 5510 5254 4515 4515 4515 4514 4515 4514 4515 4514 4515 4514 4515 4514

Figure 4.8 Circular tank behaviour as per shear force and bending moment

Design calculations of above comparisons by using GSDMAguidelines

RECTANGULAR TANK

DESIGN OF	F RECTANGULAR OVERHEAD WATER TA	NK	
	Volume calculation and sizing 500 KL		
Sizing of			
Tank:			
Volume of tank		500	cum
height of water stor	red as per Tender Development		
Clause		8 4	m
Dead Storage			
height		0	m
Height of free			
board		0.2	m
Total Height of			
Wall		4.2	m
Plan dimension	12.5 m x	10.0	m
Total Volume of			
Tank			
		500	Cum
		500000	Litres
ANALYSIS	AND STRUCTURAL DESIGN OF OVERHEA	AD TANK	FOR 500 KL
	CAPACITY WITH 18M STAGING		

BASIC DETAILS OF OHT INPUT DATA:

Plan dimension $(B * L)$	12.5	m x	10.0	m
Height of Cylindrical Wall			4.2	m
No of Columns At Periphery of Wall			8	Nos
No of Columns inside			1	Nos
Total No of Columns			9	Nos

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Spacing of Internal Columns Spacing of Peripheral Columns PRELIMINARY DATA				6.2 6.5	m m
Plan dimension (B * L) Staging height from ground level	12.	5	m x	10.0 18	m m
Bottom of Foundation Centre of Plinth Beam Width of Plinth Beam				2 0 0.25	m m m
wall Top Width of Wall Bottom Width of Wall				0.5 200 200	m mm mm
FLOOR SLAB				4.2	m
Thickness of Floor Slab FLOOR BEAM				250	mm
Width of floor Beam Depth of Floor beam				300 700	mm mm
WALKING GALLERY Thickness of Walking gallery				100	mm
Width of Walking Gallery Inner dia of Gallery				1 10.41	m m
Outer dia of Gallery				12.41	m
Bracing Level of Bracing Beam 1				3	m
Level of Bracing Beam 3				9	m
Level of Bracing Beam 4 Level of Bracing Beam 5				12 15	m m
Level of Bracing Beam 6				18	m
Depth of Bracing Beam				250 500	mm mm
No of Bracing Beam				6	Nos
ALL UNITS ARE IN KN					
External Columns Dia Weight of Various Components				500	mm
wall				945	kN
Floor Slab				782	kN
Floor Beam Gallery				312 123	kN kN
				125	KI V
External Columns upto GL Braces				764 1266	kN kN
Water				4910	kN
Weight of Staging				2030	kN
Weight of Empty container				2162	kN
Total Weight of full Container Weight of Container empty - 1/3	of staging			9102 2830	kN kN
1/5	or staging			2037	VT V

	CG FROM TOP OF FLOOR BEAM	1			
Component	Distance from Top of FloorBeam	Weight of Co	mponent		
wall	2.1	945		1985.38	
Floor Slab	0.125	782		97.7539	
Floor Beam	0.35	312		109.302	
Gallery	0.05	123		6.125	
		2198.56	216	52	
CG from Top of	f Floor Beam	1.017	m		
CG from Centre	e of Floor Beam	1.367	m		
Hence CG of Co	ontainer from top of Footing will be	:	21	.0 m	
SEISMIC CAI	LCULATION ON OHT AS PER I	S 1893 PART	2 -2014		
Weight of water	r		4910) kN	
Hence mass of V	Water m		500500) kg	
	g		9.81	m2/sec	
Depth of water	h		4	m	
Length of Tank	I.		10.0) m	
Hence h/I	-		0 3996		
Mi/m			0.3770)	
Mi			>>/07/070) ka	
lvii Li/h			0 275	, Kg	
			0.373		
111 U;*/b			0.12005	· 111	
			0.13903)	
			0.55019	/ III :	
NIC/III Ma			0.30270)	
			281002	kg	
Hc/n			0.55752	-	
			2.22920) III	
HC*/n			91.0492		
Ma (mass of am	netro constainers + 1/2 of standard		200207		
Wis (mass of em	pty container + 1/3 of staging)		209307	ĸg	
			/44581		
Refer STAAD I	MODEL OF SELFWEIGHT for Det	flection of CG		1.071	
Deflection of C	G in X direction as per STAAD mod	del		1.054	mm
Hence Lateral S	tiffness of STAGING Ks			9487.67	KN/m
TIME PERIOD Time period in In	npulsive Mode		1.46		
Time period in C	'onvective Mode Tc		1.40	sec	
Cc	Cc		3.83	500	
DESIGN HORIZ	VONTAL SEISMIC COEFFICIE	NT			
Design horizontal	seismic coeficcient for Impulsive N	$T_i = 2 \pi$	$\frac{m_i + m_s}{k_s}$		
Farth Quake Zon	e V Soil Tur	ne Modir	ım		
Zone Coeff., Z Imp. Factor, I Resp Red Fact, R	0.36 1.50 4.00 RC Frame	inicult			

Design Horizontal Seismic Coefficient

1. For Impulsive mode

$$(A_h)_i = \frac{Z}{2} \frac{I}{R} \left(\frac{S_a}{g} \right)_i$$

2. For Convective mode

$$(A_h)_c = \frac{Z}{2} \frac{I}{R} \left(\frac{S_a}{g} \right)_c$$

Тс			
Damping	=	5.00	%
Sa/g	=	0.62	
(Ah)c	=	0.042	

BASE SHEAR

CALCULATION

Base shear at the bottom of the staging, in impulsive mode, Vi

		317 KN
Base shear in Convective Mode 🔤 🚦		
Vc g g		🗧 115 KN
Total Shear to be applied at the CG of tank	Development	337 KN
	ISSN: 2456-6470	e B

3.87

=

sec

BASE MOMENT

Overturning moment at the base of staging in impulsive mode		
$Mi^* = (Ah)i [mi (hi^* + hs) + mshcg]g$		
	6749	KN-m
hs	20.5	m
hcg	21.5	m

Overturning mode at the base of staging in Convective Mode		
$M_{c}^{*} = (A_{h})c m_{c} (h_{c}^{*} + h_{s}) g$		
	2834	KN-m

Total Overturning Moment

HYDRODYNAMIC PRESSURES

```
Impulsive Hydrodynamic Pressure, Cl. 4.9.1 GSDMA Guideline
Impulsive Hydrodynamic Pressure on wall:
piw = Impulsive Hydrodynamic pressure on the wall
piw = Qiw(y) * (Ah)i * g * H
Where,
\Phi = Circumferential angle,
Maximum Impulsive Hydrodynamic pressure will occur at \Phi = 0
```

7320 KN-m

y = Distance of section from the base ofwall Q_{iW} = Coefficient of Impulsive pressure on the wall Max pressure will occur at base of wall, Coefficient Qiw, at the base of wall (y = 0)0.8385 $Q_{iw} (y = 0) =$ Hence, piw 2.168 = kN/m² Impulsive Hydrodynamic Pressure on the base slab : at y = 0, pib = Impulsive Hydrodynamic pressure on the base slab l' = D at f = 0, Pib = Qib(x) * (Ah)i * g * hwhere, Qib(x) = sinh(1.732*x/h) / cosh(0.866*L/h)0.974 = Hence, pib 2.399 = kN/m² Convective Hydrodynamic Pressure, Cl. 4.9.2 GSDMA Guideline Convective Hydrodynamic Pressure on wall: $p_{CW} = Convective Hydrodynamic pressure on the wall$ pcw = Qcw(y) * (Ah)c * g * Ly = Distance of the section from the base of the wall At the base of the wall (y = 0)Coefficient Qcw, on the wall where, $Qcw(y) = 0.4165 * \cosh(3.162*y/L) / \cosh(3.162*h/L)$ 0.2180 Qcw 0.889 Hence, pcw At the top of the wall (y = h)Coefficient of Convective Hydrodynamic pressure on the wall Qcw 0.4398 = Hence, pcw 1.793 _ kN/m^2 Convective Hydrodynamic Pressure on the base slab: pcb = Convective Hydrodynamic pressure on the base slab pcb = Qcb(x) * (Ah)c * g * LWhere, $Q_{cb} = Coefficient of Convective Hydrodynamic pressure on the base slab$ $Qcb(x) = 1.125*(x/L - (4/3)*(x/L)^3) * sech(3.162 h/L)$ 0.1963 Qcb = Hence, pcb 0.800 kN/m² Pressure due to Wall inertia $p_{WW} = (A_h)_i t \rho_m g$ Where, p_{WW} = Pressure on Tank wall due to its inertia $\rho_{\rm m}$ = Density of wall material 3.078 kN/m² Hence, pww =

Pressure due to Vertical Excitation

Hydrodynamic Pressure on Tank wall due to vertical acceleration,

$$p_v = (A_v) \rho g h (1 - y/h)$$

Where,

 A_V = Spectral Acceleration Coefficient for Hydrodynamic Pressure on Tank wall due to vertical acceleration

$A_{\rm v} = \frac{2}{2} \left(\frac{Z}{Z} \times \frac{I}{Z} \times \frac{S_a}{Z} \right)$						
`″ 3(2^R^g)				As per GS	DMA
Т		=	1.46	sec	guidelines	
Damping		=	5.00	%	C	
Sa/g		=	0.93			
Hence, Av		=0.042				
					at the base	e of the
Hence, pv		=16.103		kN/m ²	wall (y =	0)
Maximum Hydrodyna	mic Pressu	re, p				
of horizontal and vertic	cal excitation	on,				
- [()]	2	2				
$p = \sqrt{(p_{iw} + p_{ww})^2}$	$+p_{cw}^2 + p_{cw}^2$	Py - (ent				
At the base of wall,						
Hence, p	E	= 16.96	ernatikN/r	n^2 ournal		
Check			Trend in S	cientific		
Hydrostatic Pressure A	cting on th	e wall, pst				
	=ρgΗ	Te .				
	= <mark>40.42</mark>	kN/m ²				
Hydrodynamic pressur	e acting on	the wall, p				
	= 16.96	kN/m ²				
% Ratio	(p / pst)*	·100				
	=41.96	%				
SEISMIC CALCULA	TION ON	OHT AS F	PER IS 189	3 PART 2	2 -2014	1
Weight of water					4909	kN 1
Hence mass of Water		1	m		500400	кg
		٤	a da		9.81	m2/sec
Depth of water		1	h		4	m
Length of Tank]	L		12.5	m
Hence, h/L					0.31974	
Mi/m					0.36595	
Mi					183124	kg
Hi/h					0.375	·
Hi					1.5	m
Hi*/h					0.17079	

Hi*	0.68314	m
Mc/m	0.63239	
Mc	316449	kg
Hc/h	0.5386	
Hc	2.1544	m
Hc*/h	1.37769	
Hc*	5.51078	m
Ms (mass of empty container + 1/3 of staging)	289371	kg
Kc	601872	

Refer STAAD MODEL OF SELFWEIGHT for Deflection of CC
Deflection of CG in X direction as per STAAD model

mm

1.054

Hence Lateral Stiffness of STAGING Ks 9487.67/m

				$\sum T_i = 2 \pi$	$\frac{m_i + m_s}{r}$	
TIME PERIOD				iel	K_{s}	
Time period in Imp	ulsive Mode		T		140	600
Time period in Con	vective Mode				4.56	sec
Cc			InCenatio		4.039	bee
DESIGN HODIZO	NTAL SEISN		FFFICIE	in Scientific		
Design horizontal se	ismic coeficcie	ent for Ir	npulsive M	fode and		
Earth Quake Zone	V	Soi	il Type	lopment Mediui	n ? 8	
Zone Coeff., Z	0.36		ISSN: 2			
Imp. Factor, I	1.50					
Resp Red Fact, R 4.	00 RC Frame					
Design Horizontal	Seismic Coeffi	icient				
1. For Impulsive m	ode					
$(A_h)_i = \frac{Z}{2} \frac{I}{R} \left(\frac{S_a}{g} \right)_i$						
Ti	=	1.40	sec			
Damping	=	5.00	%			
Sa/g	=	0.97				
(Ah)i	=	0.065				
2. For Convective r	node					
$(A_h)_c = \frac{Z}{2} \frac{I}{R} \left(\frac{S_a}{g} \right)_c$						
Tc Damping Sa/g (Ah)c	= 4.56 sec = 5.00 % = 0.52 = 0.035	2				

BASE SHEAR CALCULATION

Base shear at the bottom of the staging, in impulsive mode, Vi 303 KN

Base shear in Convective Mode

Vc	109	KN
Total Shear to be applied at the CG of tank	323	KN

BASE MOMENT

Overturning moment at the base of staging in impulsive mode		
$Mi^* = (Ah)i [mi (hi^* + hs) + mshcg]g$	6490	KN-m
hs	20.5	m
hcg	21.5	m
Overturning mode at the base of staging in Convective Mode		
$Mc^* = (Ah)c mc (hc^* + hs) g$	2844	KN-m
Total Overturning Moment	7086	KN-m

HYDRODYNAMIC PRESSURES

Impulsive Hydrodynamic Pressure, Cl. 4.9.1 GSDMA Guideline

Impulsive Hydrodynamic Pressure on wall:

$$piw = Qiw(y) * (Ah)i * g * H$$

Where,

 $\Phi = Circumferential angle,$

Maximum Impulsive Hydrodynamic pressure will occur at $\Phi = 0y = Distance$ of section from the base of

wall

 Q_{iw} = Coefficient of Impulsive pressure on the wall

Max pressure will occur at base of wall,

Coefficient Qiw, at the base of wall (y = 0)

 $Q_{iW} (y=0) = 0.8561$

Hence, piw = 2.309 kN/m²

Impulsive Hydrodynamic Pressure on the base slab :

at y = 0,

pib = Impulsive Hydrodynamic pressure on the base slab

```
l' = D at f = 0,
```

Pib = Qib(x) * (Ah)i * g * h

where, Qib(x) = sinh(1.732*x/h) / cosh(0.866*L/h)

Hence, pib = 2.546 kN/m²

Convective Hydrodynamic Pressure, Cl. 4.9.2 GSDMA Guideline

Convective Hydrodynamic Pressure on wall:

 $p_{CW} = Convective Hydrodynamic pressure on the wall$

pcw = Qcw(y) * (Ah)c * g * L

y = Distance of the section from the base of the wall

International Journal of Trend in Scientific Research and Development @ www.ijtsrd.com eISSN: 2456-6470 At the base of the wall (y = 0)Coefficient Qcw, on the wall where, $Qcw(y) = 0.4165 * \cosh(3.162*y/L) / \cosh(3.162*h/L)$ Qcw 0.2676 = 1.157 kN/m² Hence, pcw At the top of the wall (y = h)Coefficient of Convective Hydrodynamic pressure on the wall 0.4332 Qcw _ 1.872 kN/m² Hence, pcw Convective Hydrodynamic Pressure on the base slab: pcb = Convective Hydrodynamic pressure on the base slab pcb = Qcb(x) * (Ah)c * g * LWhere, Qcb = Coefficient of Convective Hydrodynamic pressure on the base slab $Qcb(x) = 1.125*(x/L - (4/3)*(x/L)^3) * sech(3.162 h/L)$ Qcb 0.2410 Hence, pcb 1.042kN/m Pressure due to Wall inertia $p_{WW} = (A_h)_i t \rho_m g$ Where, pww = Pressure on Tank wall due to its inertia mational ρ_m = Density of wall material Hence, pww Pressure due to Vertical Excitation Hydrodynamic Pressure on Tank wall due to vertical acceleration, $p_v = (A_v) \rho g h (1 - y/h)$ Where, Av = Spectral Acceleration Coefficient for Hydrodynamic Pressure on Tank wall due to vertical acceleration Т 1.40 As per GSDMA sec guidelines Damping 5.00 % = 0.97 Sa/g = Hence, A_V 0.044 — 16.802 Hence, pv = kN/m^2

Maximum Hydrodynamic Pressure, p

p is calculated by SRSS method combination of the hydrodynamic response of horizontal and vertical excitation,

$$p = \sqrt{(p_{iw} + p_{ww})^2 + p_{cw}^2 + p_v^2}$$

At the base of wall,

Hence, $p = 17.72 \text{ kN/m}^2$

Check

Hydrostatic Pressure Acting on the wall, pst

$$= \rho g H$$
$$= 40.42 \text{ kN/m}^2$$

Hydrodynamic pressure acting on the wall, p

$$= 17.72 \text{ kN/m}^2$$

% Ratio (p / pst)*100

= 43.85 %

Comparisons on basis of Quantity (CONCRETE+STEEL) STAGE WISE- STAGE 2 (MENTION IN 3.5 METHEDOLOGY) Let's compare the value of in Zone V with respect to (4.4)



Figure 4.9(a) (Results showing comparisons in concrete quantity)



Figure 4.9(b) (Results showing comparisons in steel quantity)

Comparisons on basis of Quantity (Base shear, base moment & timeperiod) Let's compare the value of in Zone V with respect to (4.4.1)



Figure 4.9 (C) (Results showing comparisons in base shear)



Figure 4.9(d) (Results showing comparisons in base moment/overturning moment)



Figure 4.9(e) (Results showing comparisons in time period)



Comparisons on basis of stresses (Plate stress values)

Figure 10 (a) Plate stress value for bottom plate of rectangular tank in SX (local)direction (N/mm²)



Figure 10 (b) Plate stress value for bottom plate of rectangular tank in SY (local)direction (N/mm²)



Figure 10 (c) Plate stress value for bottom plate of circular tank in SX (local)direction (N/mm²)



Figure 10(d) Plate stress value for bottom plate of circular tank in SY (local)direction (N/mm²) MOMENT VARIATION ALONG LOCAL AXIS IS SHOWN BELOW



Figure 11(a) Moments value for bottom plate of rectangular tank in mx (local) direction (KNm/m)



Figure 11(b) Moments value for bottom plate of rectangular tank in my (local)direction (KNm/m)



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Figure 11(c) Moments value for bottom plate of circular tank in mx (local)direction (KNm/m)



Figure 11(d) Moments value for bottom plate of circular tank in my (local)direction (KNm/m) Table 4.2 Variation in plate stresses value (Final value)

S.NO	TVDE OETANIK	SQX (N	N/MM^2)	SQY (N/MM ²)			
	I IFE OF IANK	Minimum	Maximum	Minimum	Maximum		
1.	Rectangular	-0.138	0.189	-0.018	0.159		
2.	Circular	-0.316	0.429	-0.57	0.60		

4.3 Variation in plate stresses value (With respect to moments alongmention axis)

SNO	TVDE OETANIZ	MX (K	Nm/m)	MY (KNm/m)			
5.NO	I IFE OF IANK	Minimum	Maximum	Minimum	Maximum		
1.	Rectangular	-103.2	94.1	-100	88.2		
2.	Circular	-90.3	58	90	57		

Comparisons on basis of (Shear force and bending moment behave of whole structure) RECTANGULAR TANK-

Contraction for which the second seco	T RECTANSALAR TANK OLD - FULL - Beam End Forcer								
	144	TEL AL	Summers)	Envelope /					
A	bun	US.	Reits	/1 145	ry kä	11	Ha kfm	My iden	W a
Alter A	- 13	10.150.41	40	1452-000	4100	3.800	2.010	4.391	476
N N			10	.442.50	4,000	1 909 1	6.010	4.307	-0.000
the second second	- 41	101122-1	- +1	1108.212	4300	3204	6.002	-4.320	0.000
The beaution of the	10.00	121.1.2.2.4	47	-1405/019	0.008	-1.054	6 800	-425	4.00
	- 44	101 13DL+1	41	1428-212	-0.000	-6.034	6.000	4.111	0.001
A state of the sta		0.000	-40	-1405.019	0.000	2.054	0.000	4,235	-0.0X
	前	(前1332-1)	77	0.022	10.044	1001	-6 800	-0.000	13.534
			41	-6402	13,407	4.001	6.000	0.801	-14.582
	Q4	1011304-1	30	0.004	10.905	-4.081	-6.900	0.000	0.751
1000 ALL ALL ALL ALL ALL ALL ALL ALL ALL			#80	- 4394	11.124	6.001	6-303	0.001	.4.12
	一些	前的加州	- 38	0.027	12.044	6.081	-0.000	-0.001	13.55
1 States I Log			- 12	482	0.07	4.001	6.005	0.001	18.26
102 Martin Constitution of the	4.00	1.1.1.1.1.1.1.1	eir in the						12
and the second sec		H+LALA	Max Asial F	orces à Max	Bending M	oments k	Max Shear	(a Forces/	m m
Land Contraction	ben	LC	Stat m	Fa	Fr bar	11	Ma	My	Mg a Man
WIR DATE	10	101102-1	6.900	1455-205	4333	-1 528	0.010	4.301	4.71
		1.1.1	0.750	14(2:90)	453	-2,028	6.010	2.191	-334
A Statistical A Martin			1.900	1403,200	-4500	-2.000	6.010	0.000	0.000
			2,210	1475.07	-4533	-2.528	6.010	2.18	348
Ren a series in the series of			3.800	14250	-4835	-2.500	0.010	-432	6.031
	140	101120-1	6.902	140.512	-0.000	2354	6.800	-6.328	0.011
A Line and the second			0.753	1465-009	-4000	2854	4,000	210	0.00
			1.500	1472.588	-0.000	1864	4,000	0.046	0.00
in the second se			2.265	1475 102	.0306	2.854	.0.60	2.04	0.050
			3,802	1465.819	4000	2.854	4.900	4,255	0.01
	62	*itt 1302-1	6.903	1465.012	-0.000	4364	6.000	4.321	0.01
1.8	a serie	1.1.1.1.1.1.1	0.740	1448.556	-0.000	2.854	4,000	2.107	0.01
2 Load 101 (Bending 7	10			10.00	- 100	110.7	110		- The

Figure 12 (a) Bending moment and shear force behaviourCIRCULAR TANK-



Figure 12 (b) Bending moment and shear force behavior

Design calculations of above comparisons by using GSDMAguidelines RECTANGULAR TANK-

As Shown In Stage 1 (Note Only Data Changed)

CIRCULAR TANK-

As Shown In Stage 1 (Note Only Data Changed)

Comparisons on basis of Quantity (Concrete+Steel)

Stage wise- stage 3 (mention in 3.5 methodology) Let's compare the value of in Zone V with respect to (4.6)







Table 4.13(b) Results showing comparisons in steel quantity

Comparisons on basis of Quantity (Base shear, base moment & timeperiod) Let's compare the value of in Zone V with respect to (4.6.1)



Figure 4.13 (C) Results showing comparisons in base shear

Figure 4.13(d) Results showing comparisons in base moment/overturning moment

Figure 4.13(e) Results showing comparisons in time period

Comparisons on basis of stresses (Plate stress values)

Figure 14 Plate stress value for bottom plate of rectangular tank in SX (local)direction (n/mm²)

Figure 15 Plate stress value for bottom plate of rectangular tank in SY (local)direction (N/MM²)

Figure 16 Plate stress value for bottom plate of circular tank in SX (local)direction (N/mm²)

Figure 17 Plate stress value for bottom plate of circular tank in SY (local)direction (N/mm²)

MOMENT VARIATION ALONG LOCAL AXIS IS SHOWN BELOW

Figure 18 Moments value for bottom plate of rectangular tank in mx (local)direction (KNm/m)

Figure 19 Moments value for bottom plate of rectangular tank in my(local)direction (KNm/m)

Figure 20 Moments value for bottom plate of circular tank in mx (local) direction(KNm/m)

Figure 21 Moments value for bottom plate of circular tank in my(local) direction(KNm/m)

Table 4.4 Variation in plate stresses value (Final value)								
S NO	TVDE OETANK	SQX (N	N/MM^2)	SQY (N/MM ²)				
5. NU	I I FE OF I ANK	Minimum	Maximum	Minimum	Maximum			
1.	Rectangular	-0.138	0.189	-0.018	0.159			
2.	Circular	-0.316	0.429	-0.57	0.60			
	40.							

Table 4.5 Variation in plate stresses value (With respe mention axis)									
S NO	TYDE OFTANIZ	MX (K	Nm/m)	MY (KNm/m)					
5. NO	I I PE OF IANK	Minimum	Maximum	Minimum	Maximum				
1.	Rectangular	-103.2 ar	^{ch a} 94.1	-100	88.2				
2	Circular	-90.300	omer58	90	57				

	Table 4.5 Variation in	plate stresses value (Wit	h respe mention axis)
--	------------------------	---------------------------	-----------------------

In above figures or table we can clearly see that even after changed bracing from 3 to 4.5 mts there is no change in stresses or moment along axis, reason behind it is that staging/bracing height has no connections regarding bottom of slab of tank it is connected or regarded with columns positions and total height of the tanks, so its final implementation doesn't affect the stresses or moment behaviour of tank.

Comparisons on basis of (Shear force and bending moment behave ofwhole structure) **RECTANGULAR TANK-**

Figure 22 (a) Rectangular tank Bending moment and shear force behaviourCIRCULAR TANK-

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	34	4 1	AL/S	iummary A	Envelope/					
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and the second se		28	101100.41	- 21	48497	+12213	-3.546 2	1540	1.044	-07-01
AND THE PARTY OF T				202	887.	20.20	100	4.548	1.00	6.15
ARCHIELE AND A CONTRACT OF A C		60	1-1001-1	63	-70.947	14.34	-240	-0.870	0.282	-200
				254	10.00	10.017	2.620	0.970	1.000	612
		67	01100-1	00	11.003	10.138	4.947	-10.807	1.331	47.24
				225	(1.00	29.232	-4347	10.807	1.000	235
		CE .	11.100L/L	00	0.47	172.438	-0.001	-0.800	2.000	008.471
				1400	12.427	-67.208	6.281	6.000	0.000	216.200
	15	10	中山山村	- 52	0.003	7.422	8.200	6.000	-8.000	377
				- 64	4.80	-0.008	-6.300	-6.800	-8.000	8.001
	-12	111	世(語)(- 12	101471	172.508	-2.10	11.004	1.392	148.271
And Andrews				198	-101-071	309.298	2.10	-25.804	-8,220	416
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		15	0100.4	\$165	4517	-15.20	-1.00	1545	1.04	47.01
and the second sec				0.117	-02217	10.21	-3.00	+56	0.525	41.00
Carrier D. 1				0,774	-0207	(10.21)	-5.00	+56	0.05	-0254-
I I THERE				0.01	40.07	1920	-5.00	156	-4.52	-40101
				5340	-0017	-20.20	-1.98	+545	-1.040	-415
1 Variation		\$3	D 150.1	0.000	-70.940	.14.54	-2.42	-5378	0.292	-88
d V .				\$157	-70.940	.1454	-2.42	-6.878	-0.041	-870
a 1				0,514	-70.940	-14.94	-2.425	-6.878	-0.370	-4874
				\$475	-70.940	-14.94	-2.42	-6.878	-4.78	-68-
				\$549	-70.940	-19.017	-2.42	-6.878	-1.036	-48.52
1 (L)	4	67	1111102-1	0.003	11.805	10.00	4347	-11.437	1.30	-47.04
4	Last Mr. Perding 7			8/07	11.000	10.01	4347	-41,427	-8.75×	-679.

Figure 22 (b) Circular tank Bending moment and shear force behavior

Comparisons on basis of reactions acting on columns end after appliedloading condition (GLOBAL Y) STAGE WISE-STAGE- 1

CIRCULAR TANK-

STAGE-2 RECTANGULAR TANK-RECTANGULAR TANK-

STAGE-3 RECTANGULAR TANK-

CONLUSIONS

In this study we have studied the behaviour of (Elevated Service Reservoir) of type Rectangular & Circular tank in earthquake Zone V in India. Now in this after analysedtank with above mention stages i.e. (Stage1-2-3). In this dynamic analysis is done and various comparison is been carried out by software and manual implementation by using GSDMA guidelines showed in section(Chapter 4) and maximum cases are takenfor comparisons. The results were analysed in earthquake zone V. Now according to above analysis and results we found some basics and important conclusions shown below

STAGE WISE – STAGE 01

- In this acc. To 1st stage results by using circular column, we compare it firstby quantity estimation, we get concrete and steel quantities obtained in case of rectangular water tank were more than those needed for circular tank in this case.
- Secondly by comparison on basis of Base shear, overturning moment and time period, we get lesser values in circular tank with respect to rectangulartank.
- Next is by comparing most critical section of water tank i.e. at bottom of baseslab, here we analyzed it

by plate stresses concept of minimum and maximum conditions, we get the least stresses and moments in circular tank with respect to rectangular tanks in corner stages.

- According to reactions acting on column (4.6.4), \geq one change is occur in caseof comparisons here in circular case acc to our arrangements and design we have 5 columns and in rectangular 9 columns, so due to distribution of loadacting on columns, here rectangular tank has less no od reactions with respectto circular tanks.
- Finally whole part of both the tanks, we compared it according to Shear force and bending moment diagram, here we get less behaviour of shear and bending in case of circular with respect to rectsngular tanks

STAGE WISE – STAGE 02

- \blacktriangleright In this acc. to 2nd stage results by replacing circular column to rectangular columns, we compare it first by quantity estimation, we get concrete and steel quantities needed for the rectangular water tank were more than those needed for circular tank in this case.(NO CHANGE)
- Secondly by comparison on basis of Base shear, onal J rectangular tanks. \geq overturning moment and time period, we get lesser values in circular tank with respect to and rectangulartank.
- Next is by comparing most critical section of water \geq tank i.e. at bottom of baseslab, here we analyzed it by plate stresses concept of minimum and maximum conditions, we get the least stresses and moments in circular tank with respect to rectangular tanks.
- According to reactions acting on column (4.6.4), \geq one change is occur in caseof comparisons here in circular case acc to our arrangements and design we have 5 columns and in rectangular 9 columns, so due to distribution of loadacting on columns, here rectangular tank has less no od reactions with respectto circular tanks(Same as shown in stage 01)
- \geq Finally whole part of both the tanks, we compared it according to Shear force and bending moment diagram, here we get less behavior of shear and bending in case of circular with respect to rectangular tanks.

STAGE WISE – STAGE 03

In this acc. to 3rd stage results by replacing 3.5 \geq mtzs bracings to 4.5 mts using circular columns, we compare it first by quantity estimation, we get concrete and steel quantities needed for the rectangular water tank were more than those needed for circular tank in this case.

- Secondly by comparison on basis of Base shear, \geq overturning moment and time period, we get lesser values in circular tank with respect to rectangulartank.
- Next is by comparing most critical section of water tank i.e. at bottom of baseslab, here we analyzed it by plate stresses concept of minimum and maximum conditions, we get the least stresses and moments in circular tank with respect to rectangular tanks in corner stages.
- \triangleright According to reactions acting on column (4.6.4), one change is occur in caseof comparisons here in circular case acc to our arrangements and design we have 5 columns and in rectangular 9 columns. so due to distribution of loadacting on columns, here rectangular tank has less number of reactions with respect to circular tanks(Same as shown in stage 03)

Finally whole part of both the tanks, we compared it according to Shear force and bending moment diagram, here we get less behavior of shear and bending in case of circular with respect to

FUTURE SCOPE Permeable

Develop The objective of taking comparative study of water tanks (E.S.R) is to check or provide which tank is feasible according to todays need. Water tanks are useful for various purposes like resorts, villages, society scheme and many more etc. During my internship period I have also designed a tank in khawasa (M.P.) in resort for tourism activity, which I shown below. And as we seen in most of the earthquake prone areas there is lot of destruction due to higher ritcher scale, so to sort out this problems complete analysis is done by mention software and manually with guidelines mention above.

Future Scope

- Design is done by STAAD PRO software V8i and complete analysis is donewith respect to IS codes(relevant)
- ▶ In this I have considered zone V so in future it could be compared for otherearthquake zone and check it feasibility.
- Replacing earthquake with wind zone is also a check for future optimistic.
- Different approach to study done.
- > Again different position of bracing beams, sizes and varying height and capacity should be

taken in future scope to check what kind of changes occur.

Bring innovation in systems for the analysis and design of structures.

REFERENCES

- [1] A.D.V.S. Uma Maheshwari, B. Sravani, "Performance of Elevated Circular Water Tank in Different Seismic Zones." International Journal For Technological Research In Engineering" Volume 3, Issue 5, January-2016
- [2] Ayaz Hussain M. Jabra, H. S. Patel "Seismic Behavior of Elevated Water Tank Under Different Staging Pattern and Earthquake Characteristics". International Journal of Advanced Engineering Research and Studies ISSN2249–8974.
- [3] B.V. Ramana Murthy, M Chiranjeevi "Design Of Rectangular Water Tank by Using Staad Pro Software". International Journal of Pure and Applied Mathematics Volume 119 No. 17 2018, 3021-3029 ISSN: 1314-3395 http://acadpubl.eu/hub/International Journal of Advanced Science and Technology Vol. 29, No. 7, (2020), pp. 3674-3679 ISSN: 2005-4238 IJAST Copyright © 2020 SERSC 3679

- [4] GSDMA Guidelines "(Gujarat State Disaster Management Authority) for seismic design of liquid storage tanks". 5. IS 1893 PART-2 (2014).
- [5] IS 3370 (Part-2); 2009, "Concrete Structures for Storage of Liquids", Bureau of Indian Standard New Delhi.
- [6] Dona Rose K J, Sreekumar M, Anumod A S. (A Study Of Overhead Water Tanks Subjected TO Dynamic Loads, IJETT, Vol-28) (Oct-2015) (Page no 344-348).
- [7] IS 456:2000, "Plane and Reinforced Concrete Code Of Practice", Bureau Of Indian Standard, New Delhi 56-59
- [8] Manoj Nallanathel, B. Ramesh, L. Jagadeesh Professor, "Design and Analysis Of Water Tanks Using Staad Pro". Volume 119 No. 17 2018, 3021-3029 ISSN: 1314-3395 (on-line version) url: http://acadpubl.eu/hub/
 - Pradnya V. Sambary, D.M. Joshi, "Seismic Analysis of Elevated Service Reservoir".
 International Journal Of Scientific And Engineering Research, Volume 6, Issue12, December-2015 ISSN 2229-551

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