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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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IJTSRD52829

1. INTRODUCTION

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 heightwith 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/m^3.

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 venue-arable. In my project I have designed E.S.R. of type Rectangular & Circular water tank. The main objectiveof 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)

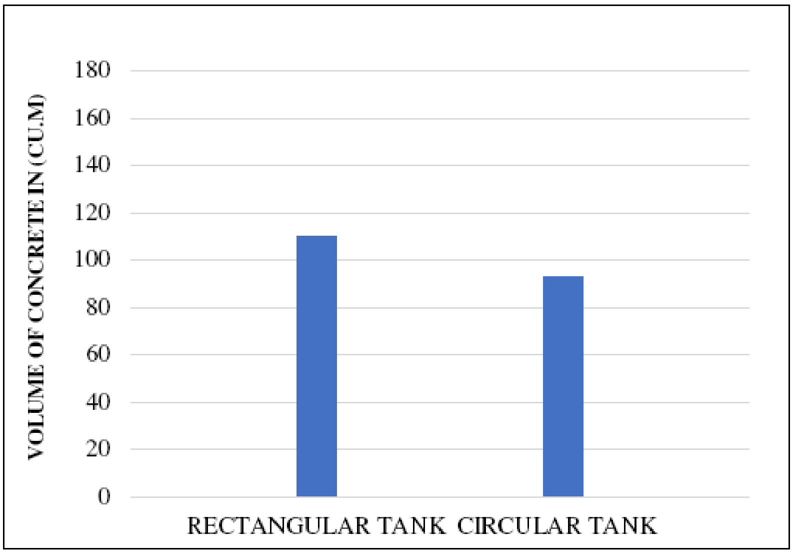


Figure 4.1- Comparisons of volume of concrete in rectangular and circular tank

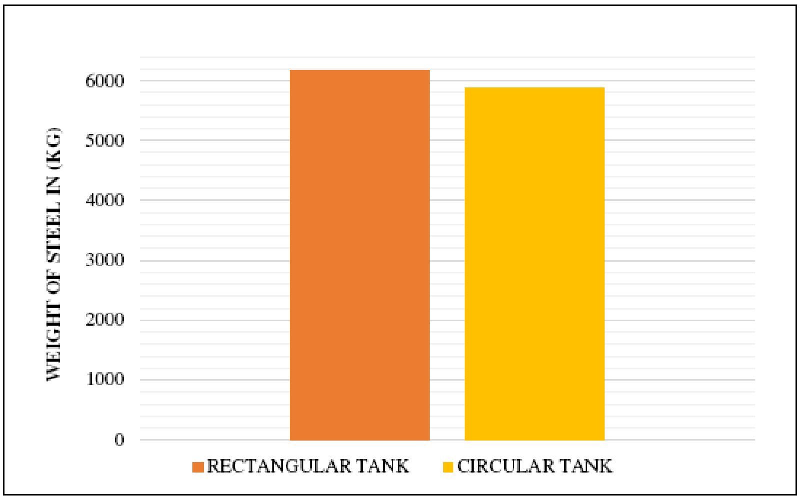


Figure 4.2- Comparisons of weight of steel in rectangular and circular tank.

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)

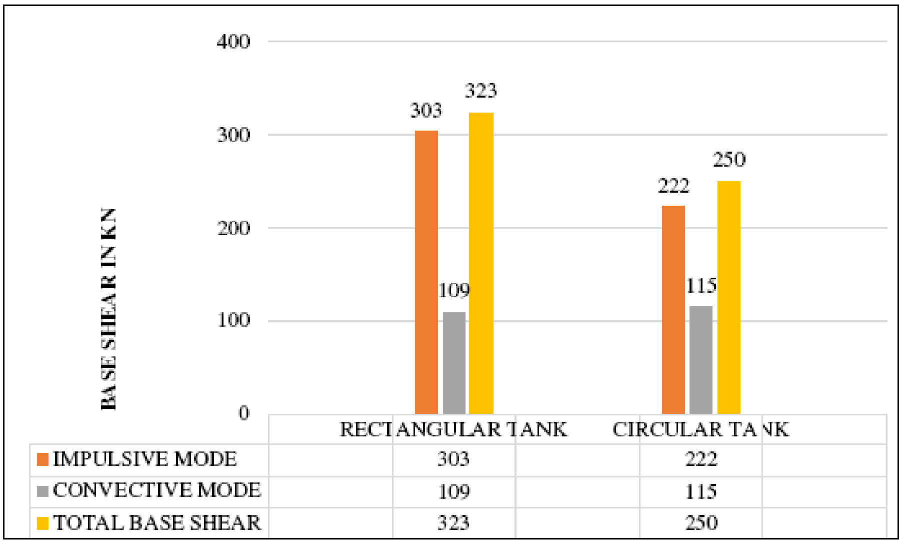


Figure 4.2 (a) Results showing comparisons in base shear.

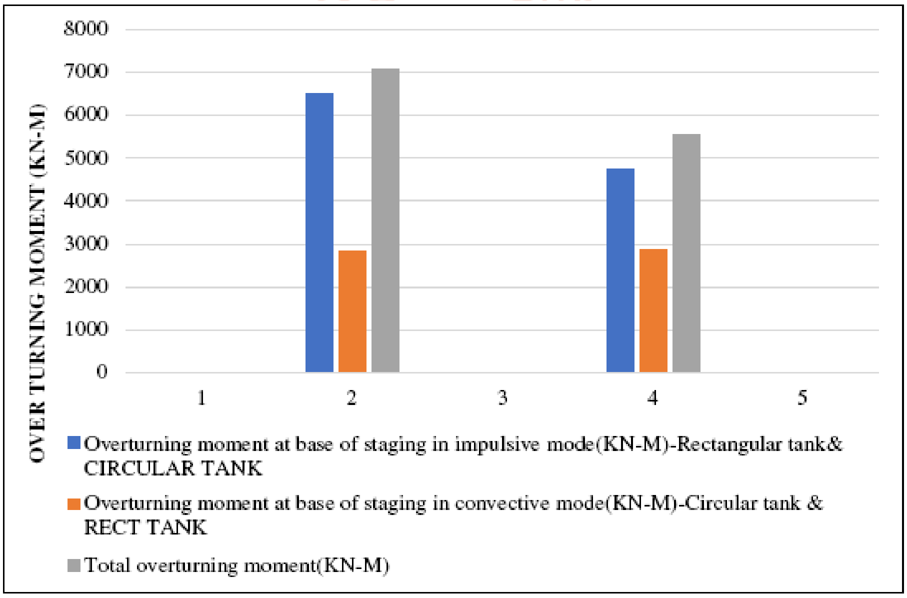


Figure 4.2(b) Results showing comparisons in base moment/overturning moment

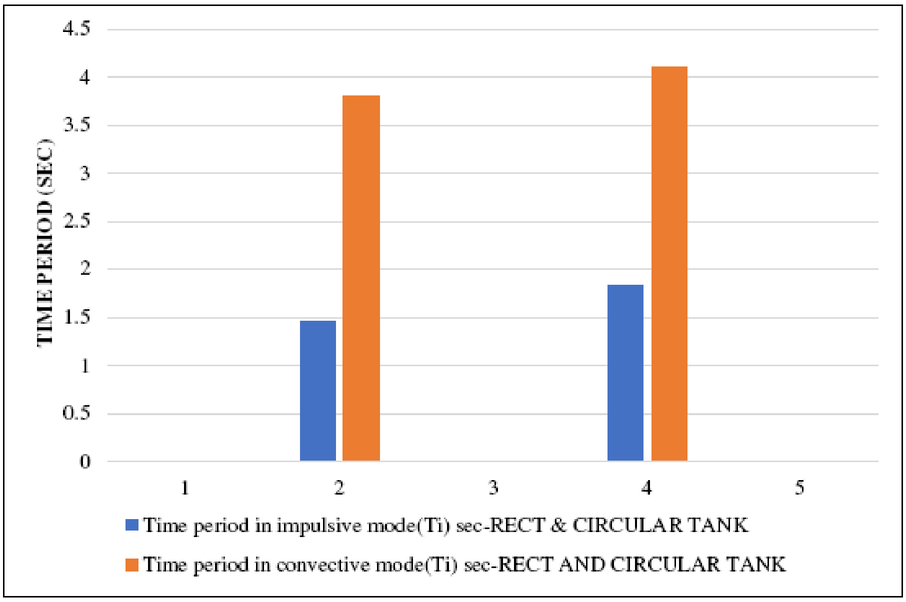


Figure 4.2 (c) Results showing comparisons in time period

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

Comparisons on basis of stresses (Plate stress values)

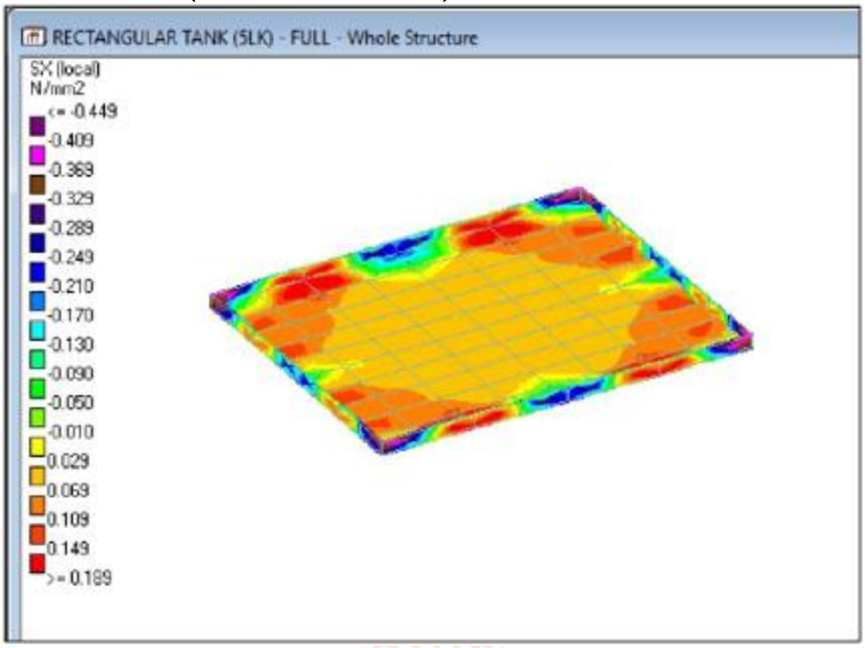


Figure 4.3 Plate stresses value of rectangular tank in direction (sx local)-n/mm^2

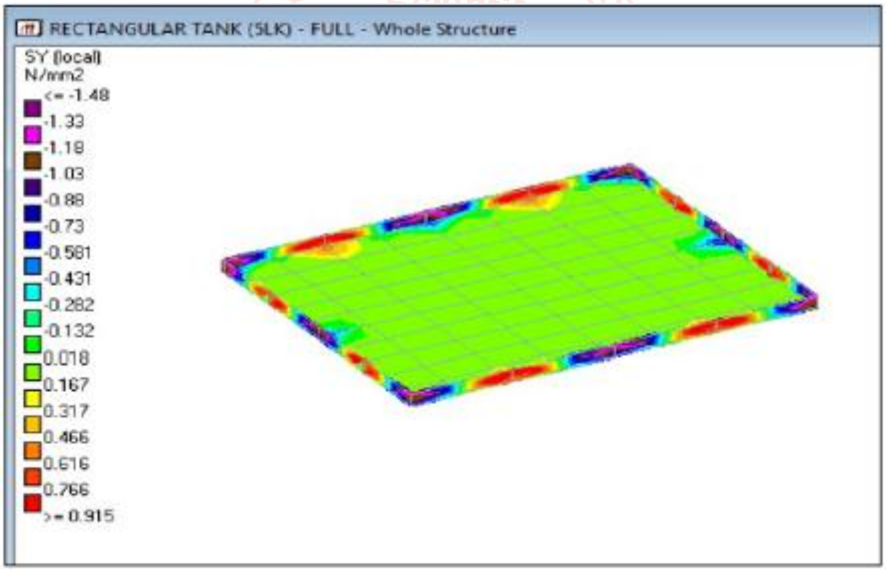


Figure 4.4 Plate stresses value of rectangular tank in direction (sy local)-n/mm^2

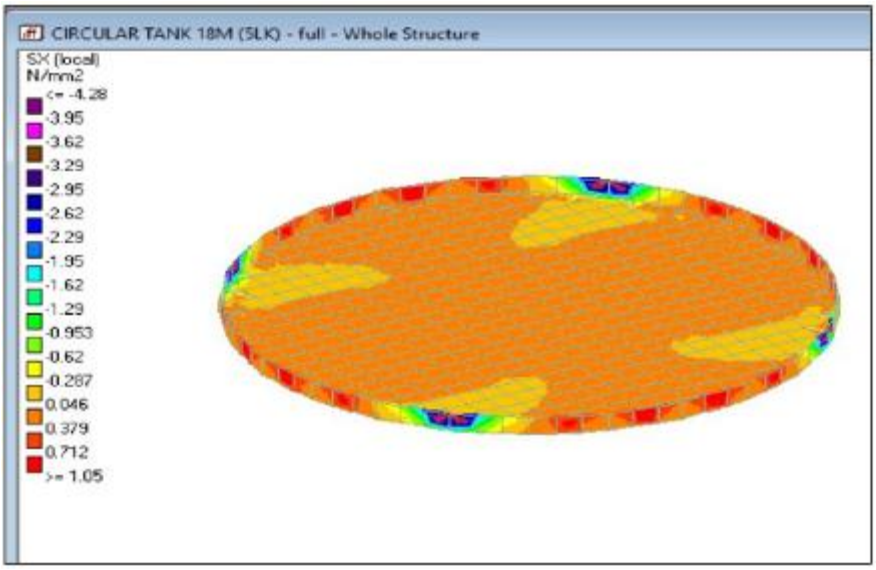


Figure 4.5 Plate stresses value of circular tank in direction (sx local)-n/mm^2

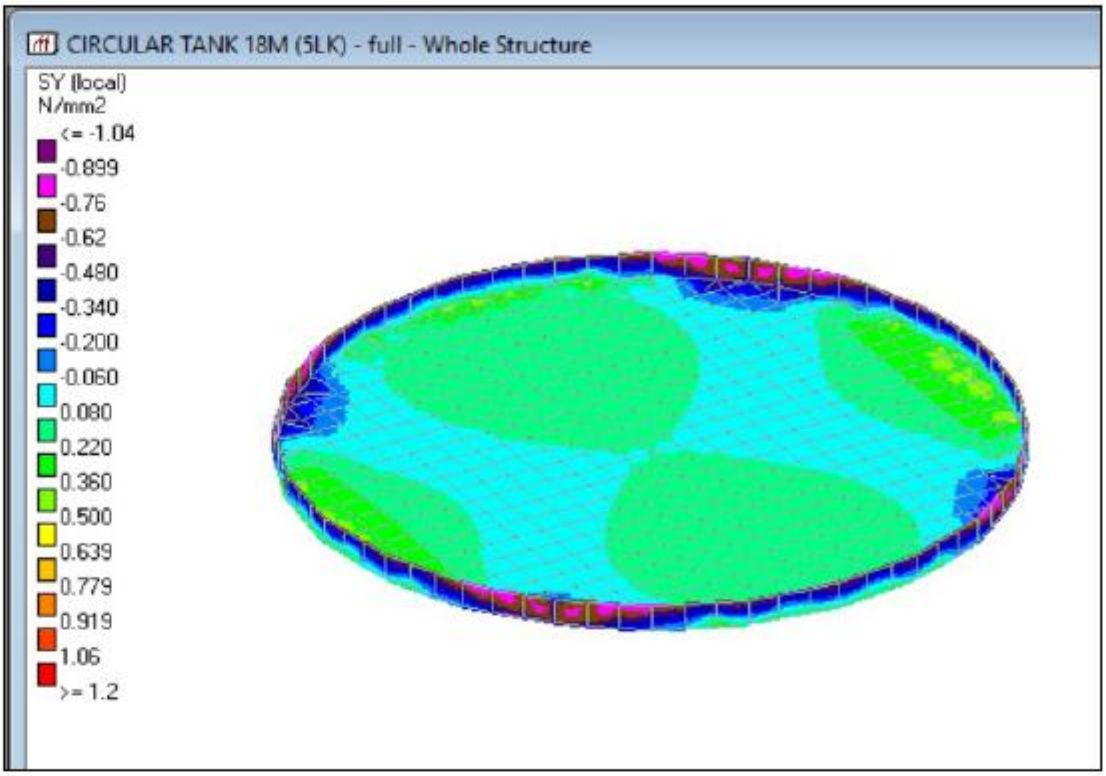


Figure 4.6 Plate stresses value of circular tank in direction (sy local)-n/mm^2

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 ofTank	SQX (N/MM^2)		SQY (N/MM^2)	
		Minimum	Maximum	Minimum	Maximum
1.	Rectangular	-0.402	0.190	-1.470	0.915
2.	Circular	-2.856	0.697	-0.598	0.395

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

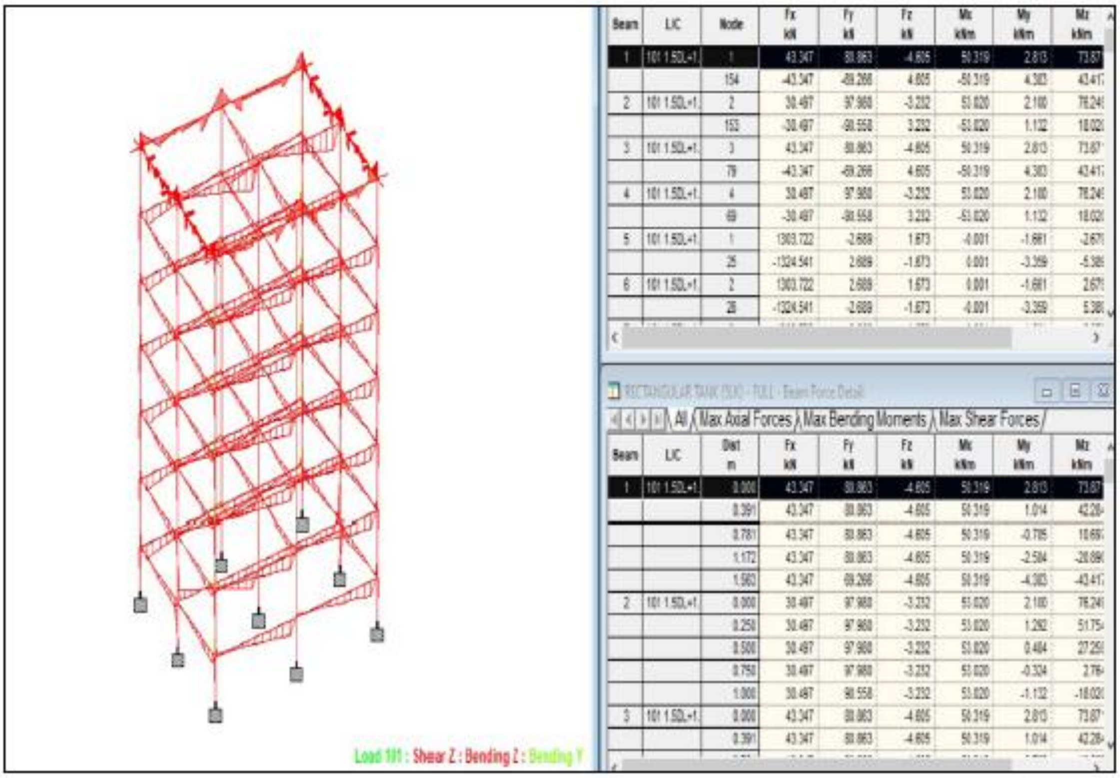


Figure 4.7 Rectangular tank behaviour as per shear force and bending moment

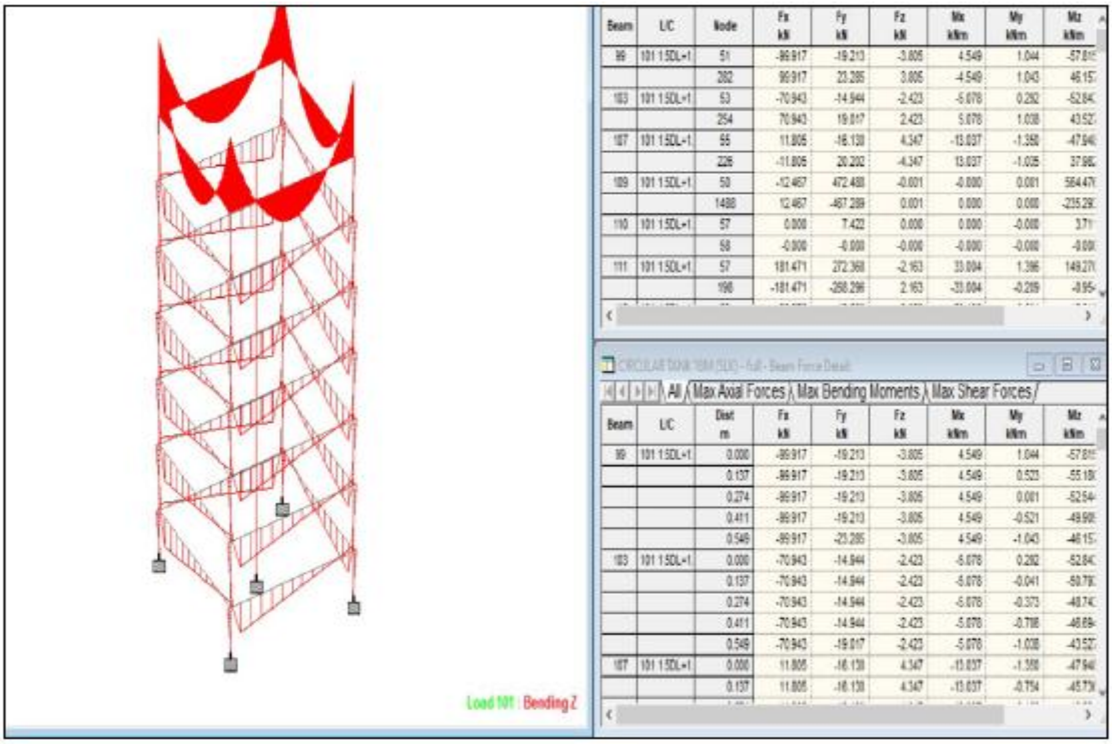


Figure 4.8 Circular tank behaviour as per shear force and bending moment

Design calculations of above comparisons by using GSDMAguidelines

RECTANGULAR TANK

DESIGN OF RECTANGULAR OVERHEAD WATER TANK

Volume calculation and sizing 500 KL

Sizing of Tank:

Volume of tank		500	cum
height of water stored as per Tender Clause		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 OVERHEAD 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

Spacing of Internal Columns			6.2	m
Spacing of Peripheral Columns			6.5	m
PRELIMINARY DATA				
Plan dimension (B * L)	12.5	m x	10.0	m
Staging height from ground level			18	m
Considering GL as 0 m				
Bottom of Foundation			2	m
Centre of Plinth Beam			0	m
Width of Plinth Beam			0.25	m
Depth of Plinth Beam			0.5	m
wall				
Top Width of Wall			200	mm
Bottom Width of Wall			200	mm
Total Height if Wall			4.2	m
FLOOR SLAB				
Thickness of Floor Slab			250	mm
FLOOR BEAM				
Width of floor Beam			300	mm
Depth of Floor beam			700	mm
WALKING GALLERY				
Thickness of Walking gallery			100	mm
Width of Walking Gallery			1	m
Inner dia of Gallery			10.41	m
Outer dia of Gallery			12.41	m
Bracing				
Level of Bracing Beam 1			3	m
Level of Bracing Beam 2			6	m
Level of Bracing Beam 3			9	m
Level of Bracing Beam 4			12	m
Level of Bracing Beam 5			15	m
Level of Bracing Beam 6			18	m
Width of bracing beam			250	mm
Depth of Bracing Beam			500	mm
No of Bracing Beam			6	Nos
ALL UNITS ARE IN KN				
External Columns Dia			500	mm
Weight of Various Components				
wall			945	kN
Floor Slab			782	kN
Floor Beam			312	kN
Gallery			123	kN
External Columns upto GL			764	kN
Braces			1266	kN
Water			4910	kN
Weight of Staging			2030	kN
Weight of Empty container			2162	kN
Total Weight of full Container			9102	kN
Weight of Container empty + 1/3 of staging			2839	kN

CG FROM TOP OF FLOOR BEAM

Component	Distance from Top of FloorBeam	Weight of Component	
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	2162

CG from Top of Floor Beam		1.017	m
CG from Centre of Floor Beam		1.367	m
Hence CG of Container from top of Footing will be		21.0	m

SEISMIC CALCULATION ON OHT AS PER IS 1893 PART 2 -2014

Weight of water		4910	kN
Hence mass of Water	m	500500	kg
	g	9.81	m2/sec
Depth of water	h	4	m
Length of Tank	L	10.0	m
Hence , h/L		0.3996	
Mi/m		0.44949	
Mi		224970	kg
Hi/h		0.375	
Hi		1.5	m
Hi*/h		0.13905	
Hi*		0.55619	m
Mc/m		0.56276	
Mc		281662	kg
Hc/h		0.55732	
Hc		2.22926	m
Hc*/h		1.0492	
Hc*		4.19679	m
Ms (mass of empty container + 1/3 of staging)		289387	kg
Kc		744581	
Refer STAAD MODEL OF SELFWEIGHT for Deflection of CG			
Deflection of CG in X direction as per STAAD model		1.054	mm
Hence Lateral Stiffness of STAGING	Ks	9487.67	KN/m

TIME PERIOD

Time period in Impulsive Mode	Ti	1.46	sec
Time period in Convective Mode	Tc	3.87	sec
Cc	Cc	3.83	

DESIGN HORIZONTAL SEISMIC COEFFICIENT

$$T_i = 2\pi\sqrt{\frac{m_i + m_s}{k_s}}$$

Design horizontal seismic coeficcient for Impulsive Mode

Earth Quake Zone	**V**	Soil Type	**Medium**
Zone Coeff., Z	0.36		
Imp. Factor, I	**1.50**		
Resp Red Fact, R	**4.00**	**RC Frame**	

Design Horizontal Seismic Coefficient

1. For Impulsive mode

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

Ti	=	1.46	sec
Damping=		**5.00**	%
Sa/g	=	0.93	
(Ah)i	=	**0.063**	

2. For Convective mode

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

Tc	=	3.87	sec
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	115	KN
Total Shear to be applied at the CG of tank	**337**	KN

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
Mc* = (Ah)c mc (hc* + hs) g

	2834	KN-m
Total Overturning Moment	**7320**	KN-m

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,

Φ = Circumferential angle,

Maximum Impulsive Hydrodynamic pressure will occur at Φ = 0 y = Distance of section from the base of wall

Qiw = Coefficient of Impulsive pressure on the wall

Max pressure will occur at base of wall,

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

Qiw (y =0) = 0.8385

Hence, piw = 2.168 kN/m^2

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)

= 0.974

Hence, pib = 2.399 kN/m^2

Convective Hydrodynamic Pressure, Cl. 4.9.2 GSDMA Guideline

Convective Hydrodynamic Pressure on wall:

pcw = Convective Hydrodynamic pressure on the wall

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

y = 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)

Qcw = 0.2180

Hence, pcw = 0.889 kN/m^2

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 * L

Where,

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 = 0.1963

Hence, pcb = 0.800 kN/m^2

Pressure due to Wall inertia

$$p_{ww} = (A_h)_i \, t \, \rho_m \, g$$

Where,

pww = Pressure on Tank wall due to its inertia

ρm = Density of wall material

Hence, pww = 3.078 kN/m^2

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

$$A_v = \frac{2}{3}\left(\frac{Z}{2} \times \frac{I}{R} \times \frac{S_a}{g}\right)$$

T	=	**1.46**	sec	As per GSDMA guidelines
Damping	=	**5.00**	%	
Sa/g	=	**0.93**		
Hence, A_V	=0.042			
Hence, pv	**=16.103**		**kN/m^2**	at the base of the wall (y = 0)

Maximum Hydrodynamic Pressure, p

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 = **16.96** **kN/m^2**

Check

Hydrostatic Pressure Acting on the wall, pst

= ρ g H

= 40.42 kN/m^2

Hydrodynamic pressure acting on the wall, p

= 16.96 kN/m^2

% Ratio (p / pst)*100

= 41.96 %

SEISMIC CALCULATION ON OHT AS PER IS 1893 PART 2 -2014

Weight of water		4909	kN
Hence mass of Water	m	500400	kg
	g	9.81	m2/sec
Depth of water	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 CG
Deflection of CG in X direction as per STAAD model 1.054 mm

Hence Lateral Stiffness of STAGING Ks 9487.67/m

$$T_i = 2\pi\sqrt{\frac{m_i + m_s}{k_s}}$$

TIME PERIOD			
Time period in Impulsive Mode	Ti	1.40	sec
Time period in Convective Mode	Tc	4.56	sec
Cc	Cc	4.039	

DESIGN HORIZONTAL SEISMIC COEFFICIENT
Design horizontal seismic coeficcient for Impulsive Mode

Earth Quake Zone	**V**	Soil Type	**Medium**
Zone Coeff., Z	0.36		
Imp. Factor, I	**1.50**		

Resp Red Fact, R **4.00 RC Frame**

Design Horizontal Seismic Coefficient

1. For Impulsive mode

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

Ti	=	1.40	sec
Damping	=	**5.00**	%
Sa/g	=	0.97	
(Ah)i	=	**0.065**	

2. For Convective mode

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

Tc	=	4.56	sec
Damping	=	**5.00**	%
Sa/g	=	0.52	
(Ah)c	=	**0.035**	

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 = Impulsive Hydrodynamic pressure on the wall

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

Where,

Φ = Circumferential angle,

Maximum Impulsive Hydrodynamic pressure will occur at Φ = 0y = Distance of section from the base of wall

Qiw = Coefficient of Impulsive pressure on the wall

Max pressure will occur at base of wall,

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

Qiw (y =0) = 0.8561

Hence, piw = 2.309 kN/m^2

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)

= 0.991

Hence, pib = 2.546 kN/m^2

Convective Hydrodynamic Pressure, Cl. 4.9.2 GSDMA Guideline

Convective Hydrodynamic Pressure on wall:

pcw = Convective Hydrodynamic pressure on the wall

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

y = 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)

Qcw	=	0.2676	
Hence, pcw	**=**	**1.157**	**kN/m^2**

At the top of the wall (y = h)

Coefficient of Convective Hydrodynamic pressure on the wall

Qcw	=	**0.4332**	
Hence, pcw	**=**	**1.872**	**kN/m^2**

Convective Hydrodynamic Pressure on the base slab:

pcb = Convective Hydrodynamic pressure on the base slab

pcb = Qcb(x) * (Ah)c * g * L

Where,

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	**=**	**1.042**	**kN/m^2**

Pressure due to Wall inertia

$$p_{ww} = (A_h)_i \, t \, \rho_m \, g$$

Where,

pww = Pressure on Tank wall due to its inertia

ρm = Density of wall material

Hence, pww	**=**	**3.211**	**kN/m^2**

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

T	=	**1.40**	sec	As per GSDMA guidelines
Damping	=	**5.00**	%	
Sa/g	=	**0.97**		
Hence, Av	=	0.044		
Hence, pv	**=**	**16.802**	**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 kN/m^2

Check

Hydrostatic Pressure Acting on the wall, pst

$= \rho\ g\ H$

$= 40.42\ kN/m^2$

Hydrodynamic pressure acting on the wall, p

$= 17.72\ kN/m^2$

% 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)

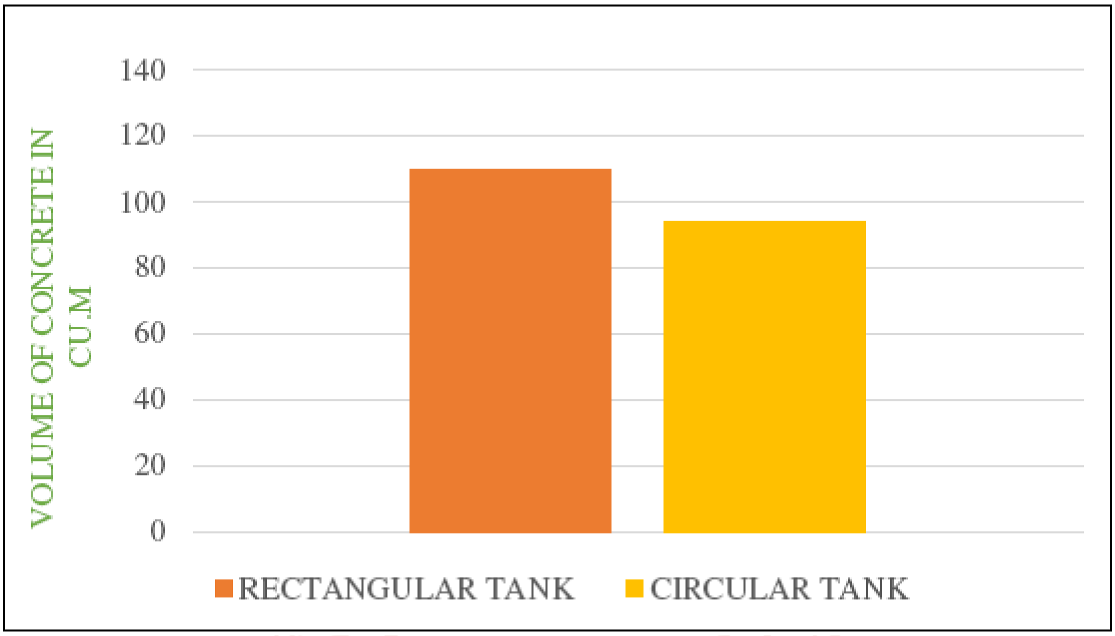


Figure 4.9(a) (Results showing comparisons in concrete quantity)

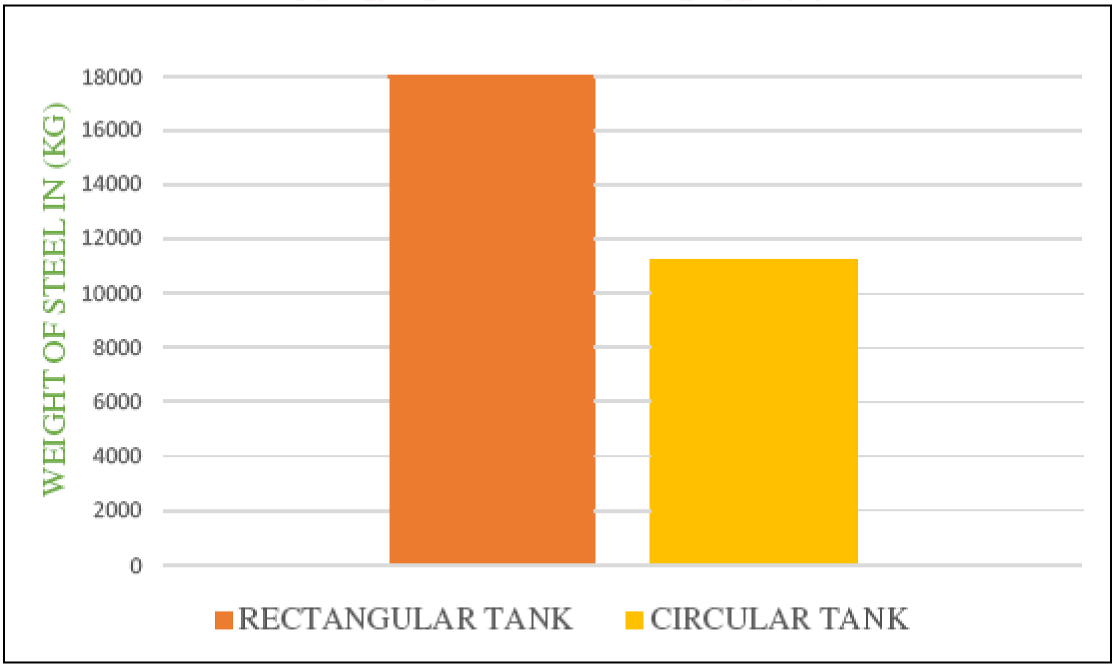


Figure 4.9(b) (Results showing comparisons in steel quantity)

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)

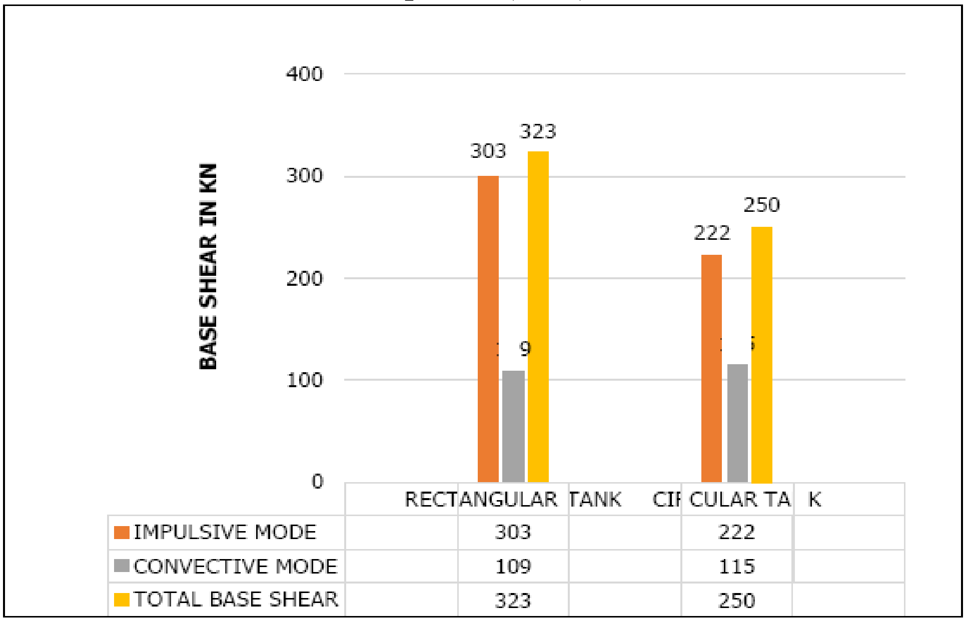


Figure 4.9 (C) (Results showing comparisons in base shear)

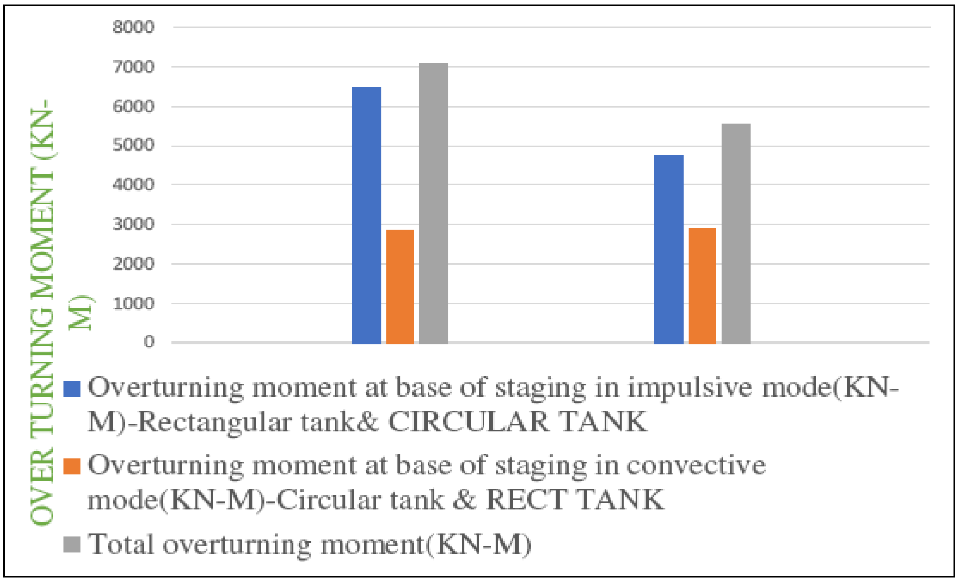


Figure 4.9(d) (Results showing comparisons in base moment/overturning moment)

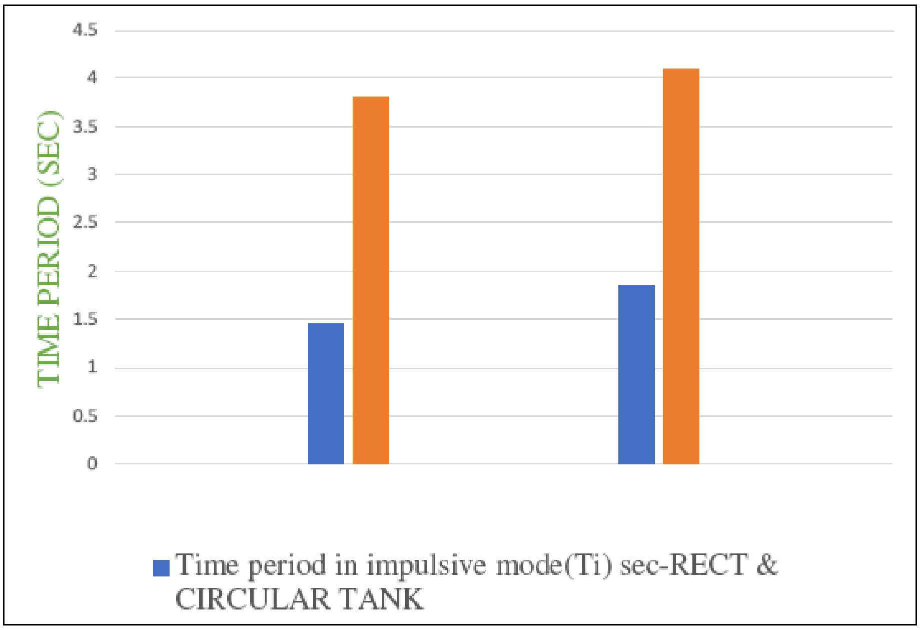


Figure 4.9(e) (Results showing comparisons in time period)

Comparisons on basis of stresses (Plate stress values)

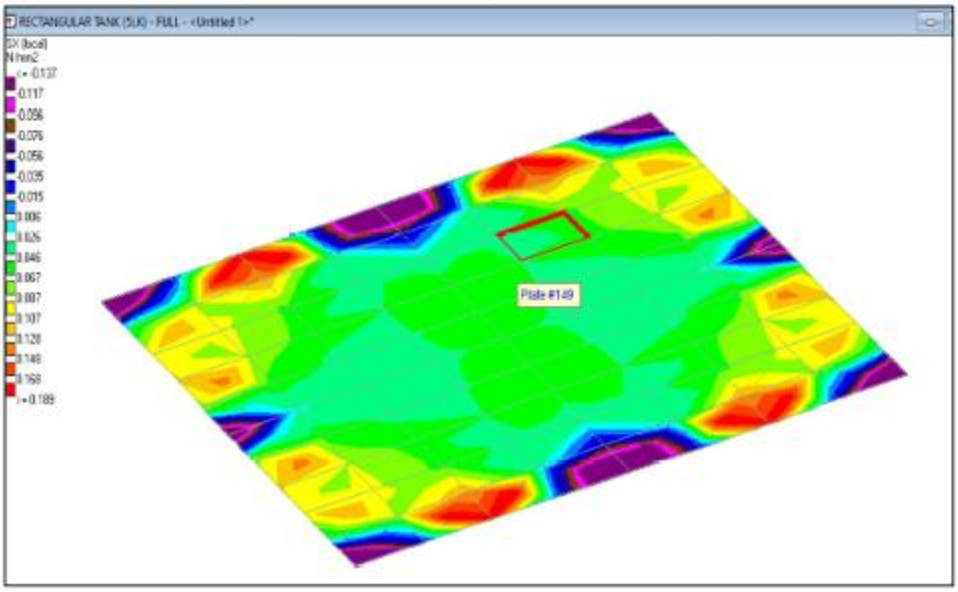


Figure 10 (a) Plate stress value for bottom plate of rectangular tank in SX (local)direction (N/mm^2)

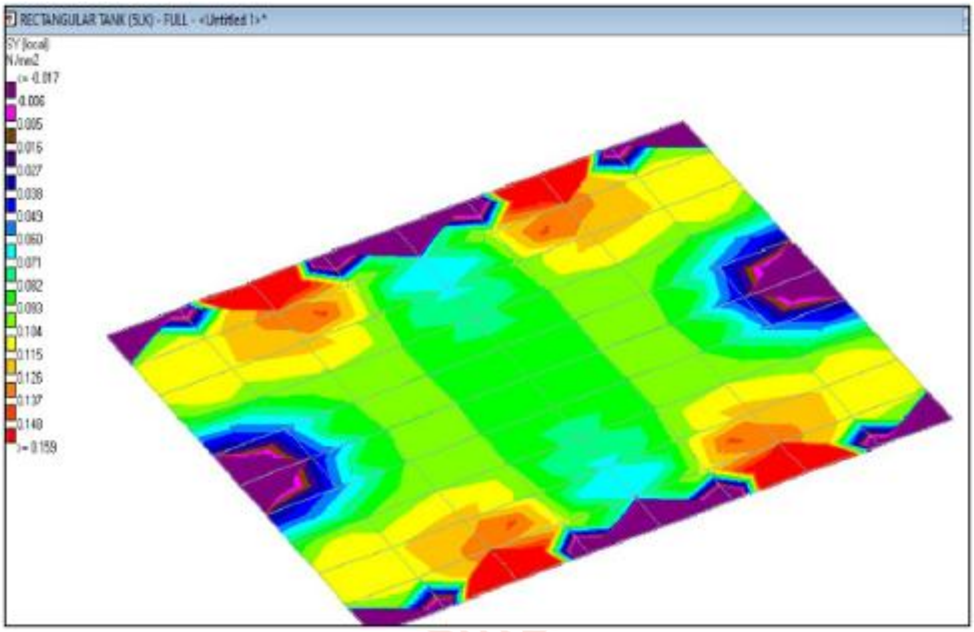


Figure 10 (b) Plate stress value for bottom plate of rectangular tank in SY (local)direction (N/mm^2)

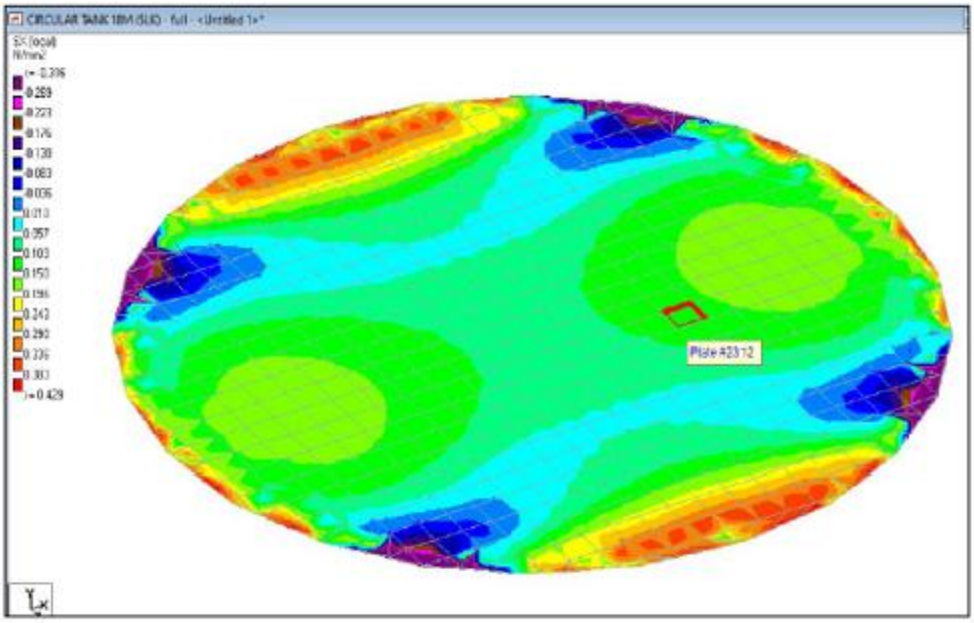


Figure 10 (c) Plate stress value for bottom plate of circular tank in SX (local)direction (N/mm^2)

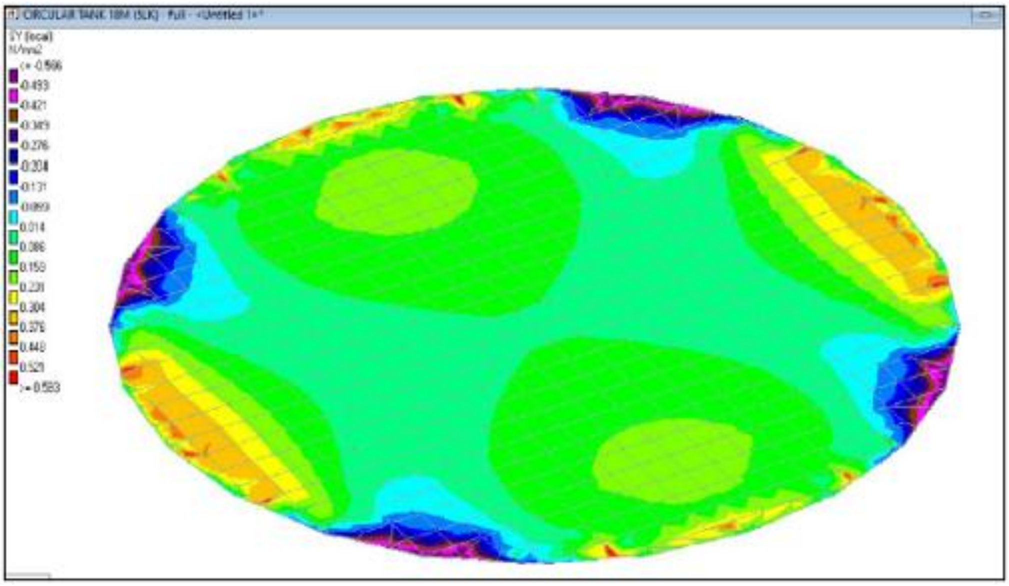


Figure 10(d) Plate stress value for bottom plate of circular tank in SY (local)direction (N/mm^2)

MOMENT VARIATION ALONG LOCAL AXIS IS SHOWN BELOW

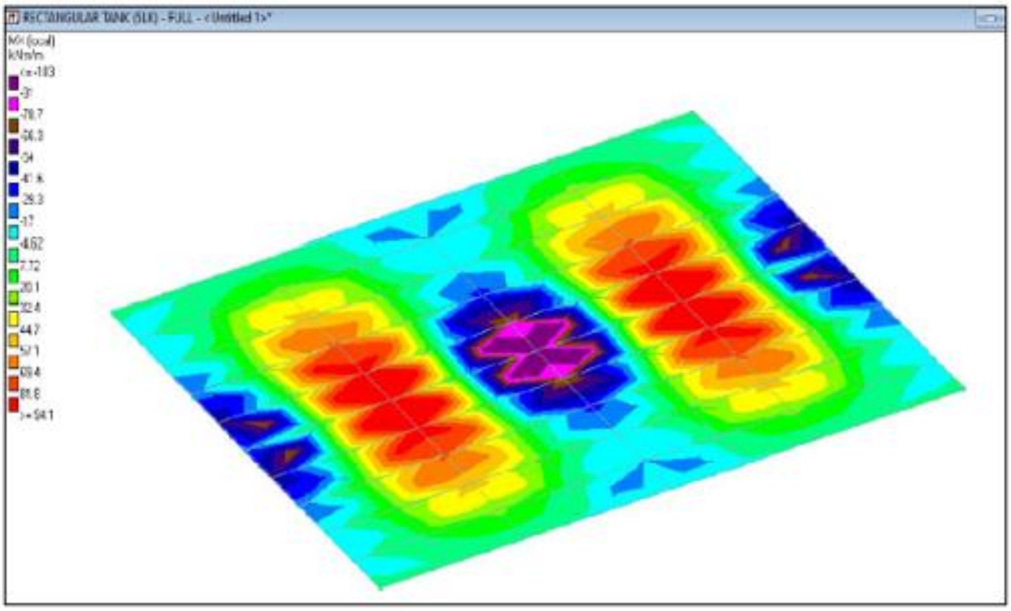


Figure 11(a) Moments value for bottom plate of rectangular tank in mx (local) direction (KNm/m)

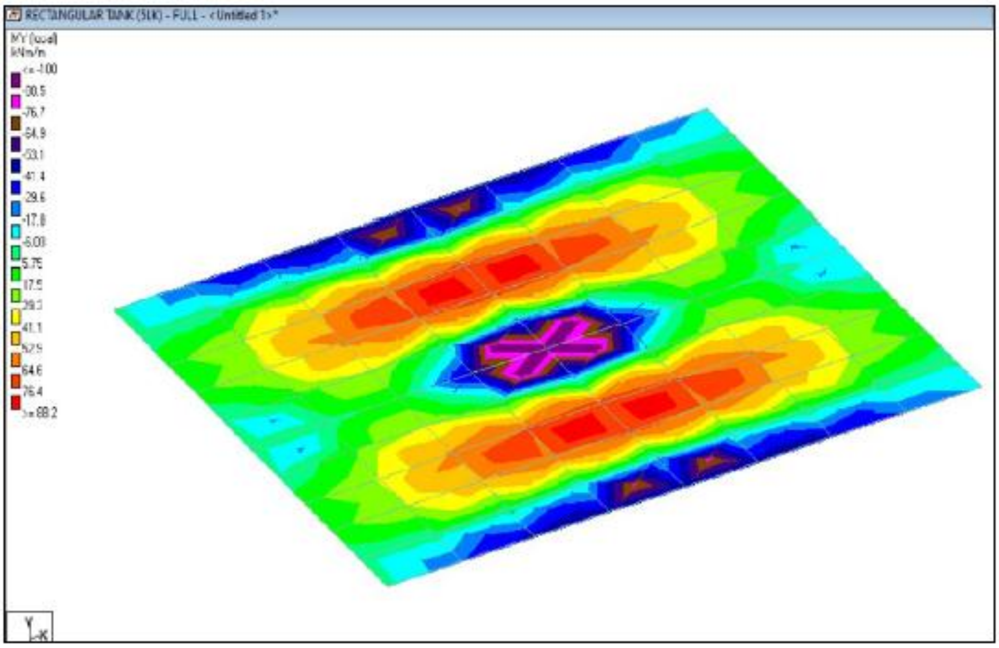


Figure 11(b) Moments value for bottom plate of rectangular tank in my (local)direction (KNm/m)

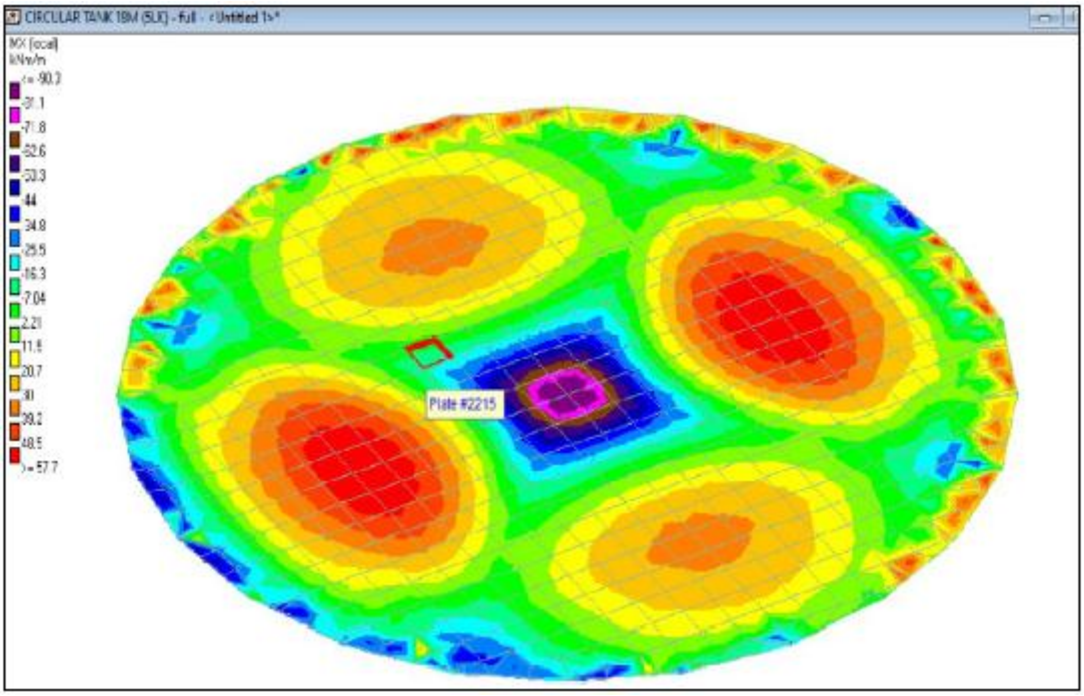


Figure 11(c) Moments value for bottom plate of circular tank in mx (local)direction (KNm/m)

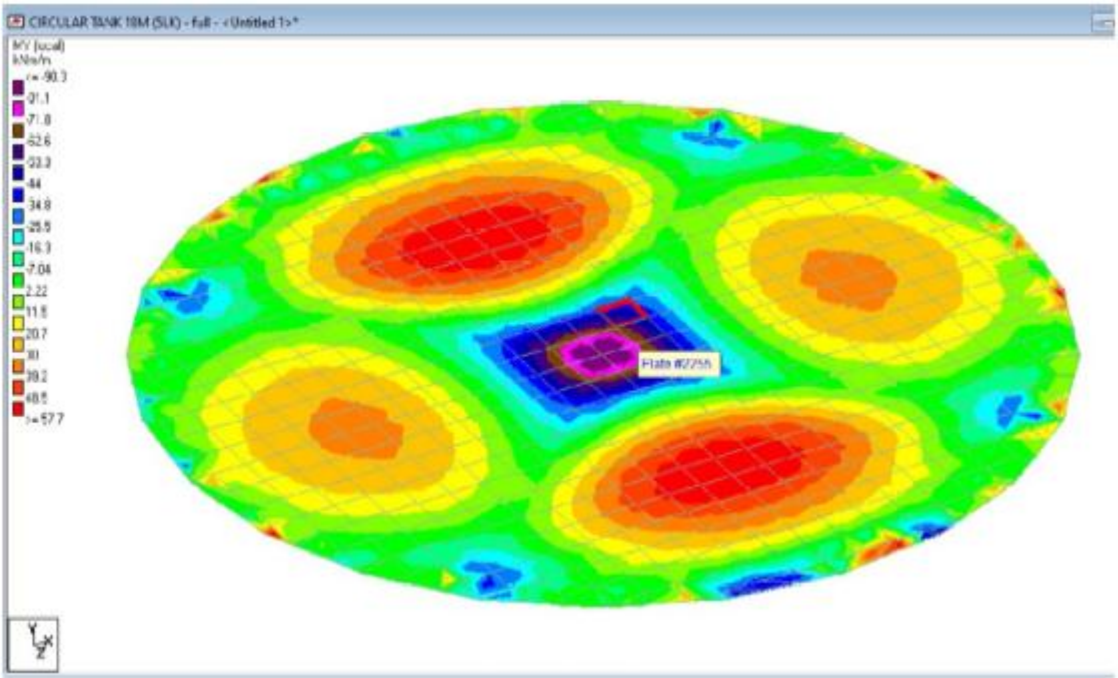


Figure 11(d) Moments value for bottom plate of circular tank in my (local)direction (KNm/m)

Table 4.2 Variation in plate stresses value (Final value)

S.NO	TYPE OFTANK	SQX (N/MM^2)		SQY (N/MM^2)	
		Minimum	Maximum	Minimum	Maximum
1.	Rectangular	-0.138	0.189	-0.018	0.159
2.	Circular	-0.316	0.429	-0.57	0.60

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

S.NO	TYPE OFTANK	MX (KNm/m)		MY (KNm/m)	
		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 ofwhole structure)
RECTANGULAR TANK-

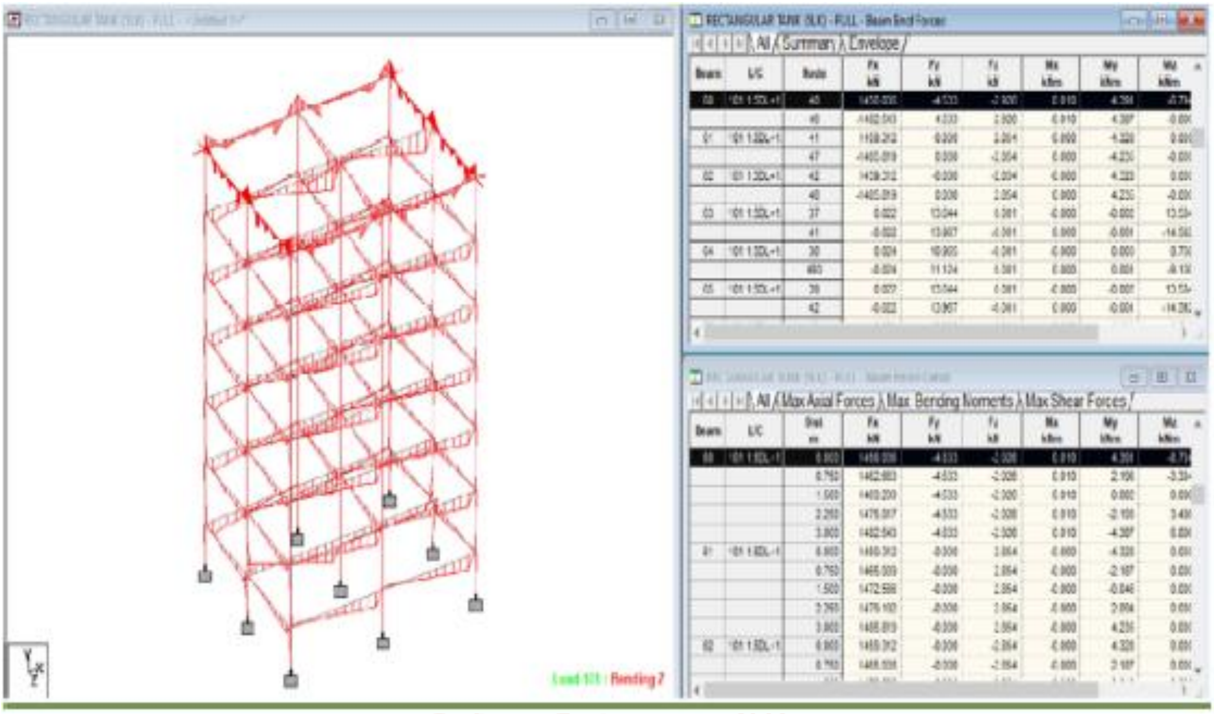


Figure 12 (a) Bending moment and shear force behaviourCIRCULAR TANK-

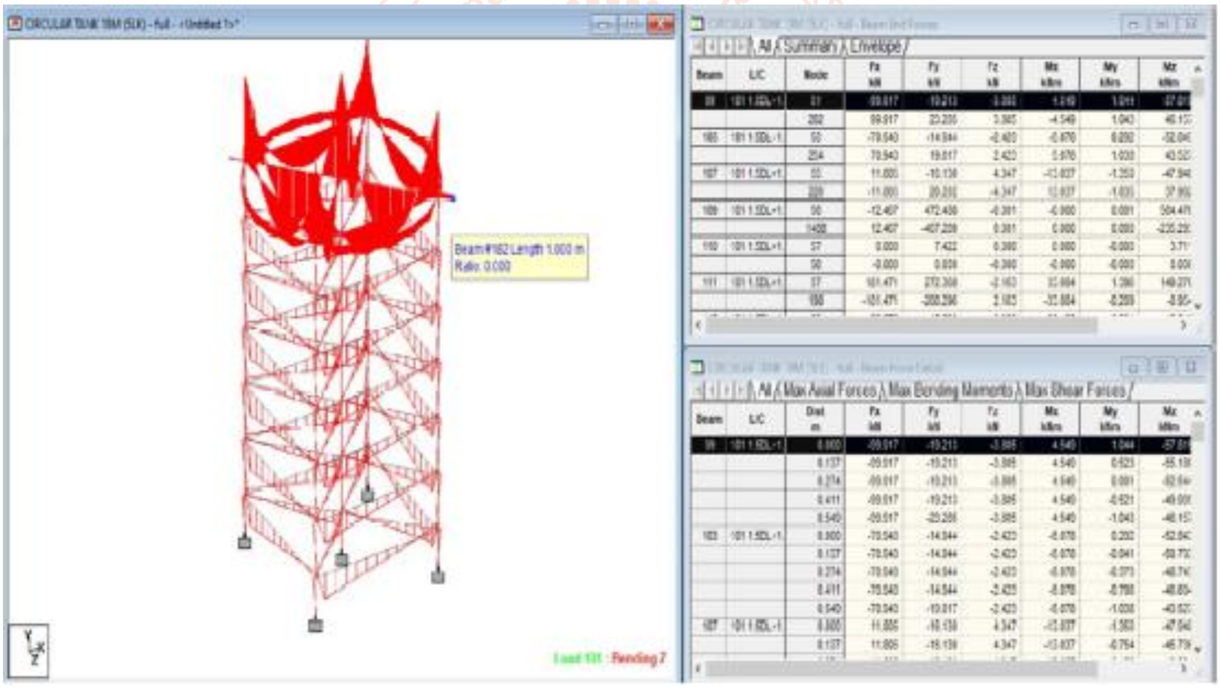


Figure 12 (b) Bending moment and shear force behavior

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)

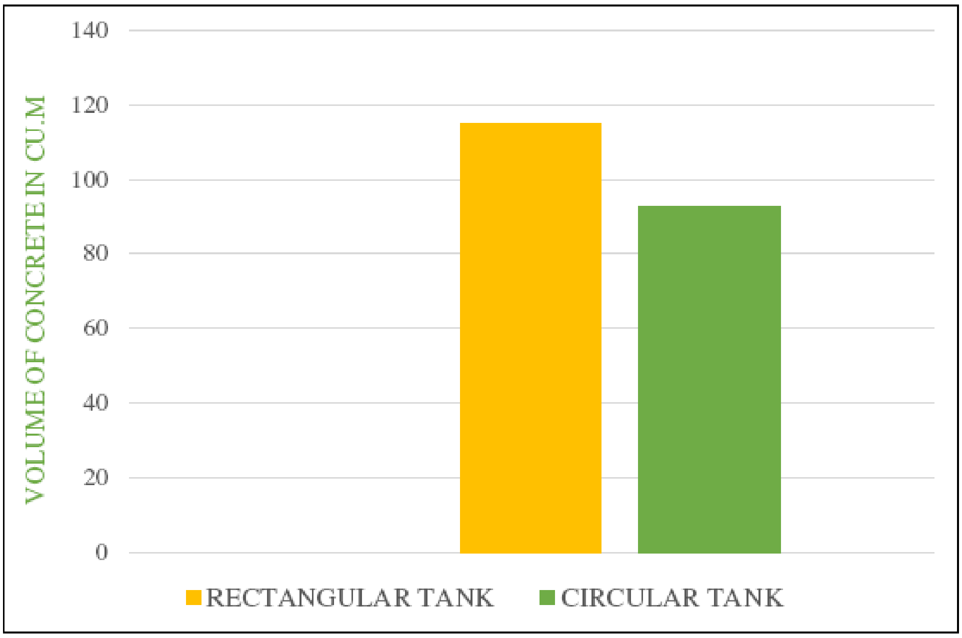


Table 4.13(a) Results showing comparisons in concrete quantity

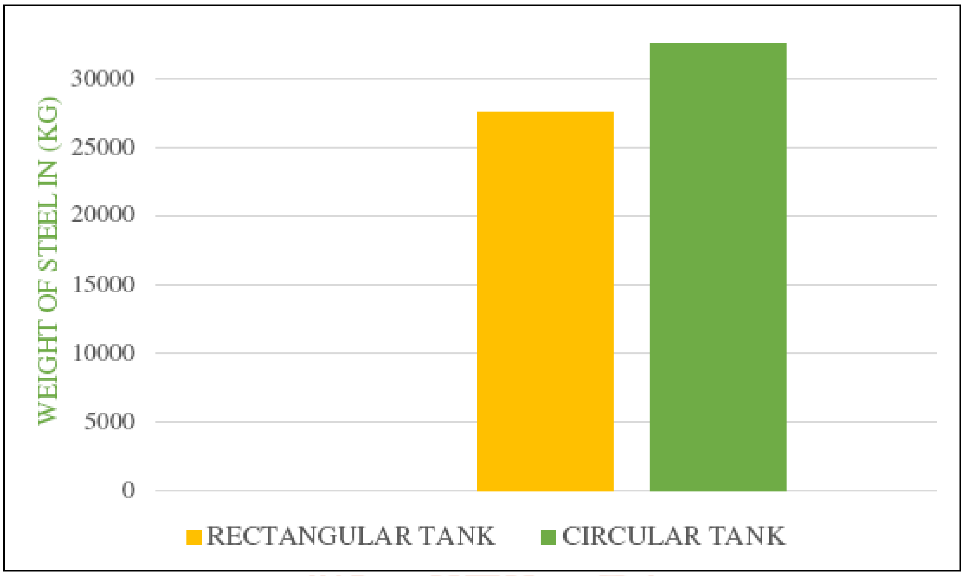


Table 4.13(b) Results showing comparisons in steel quantity

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)

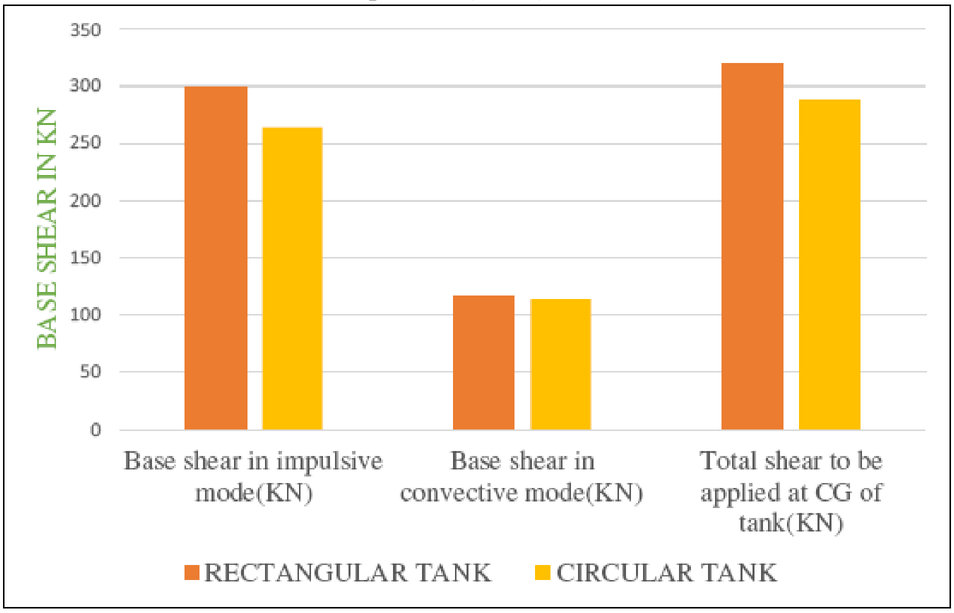


Figure 4.13 (C) Results showing comparisons in base shear

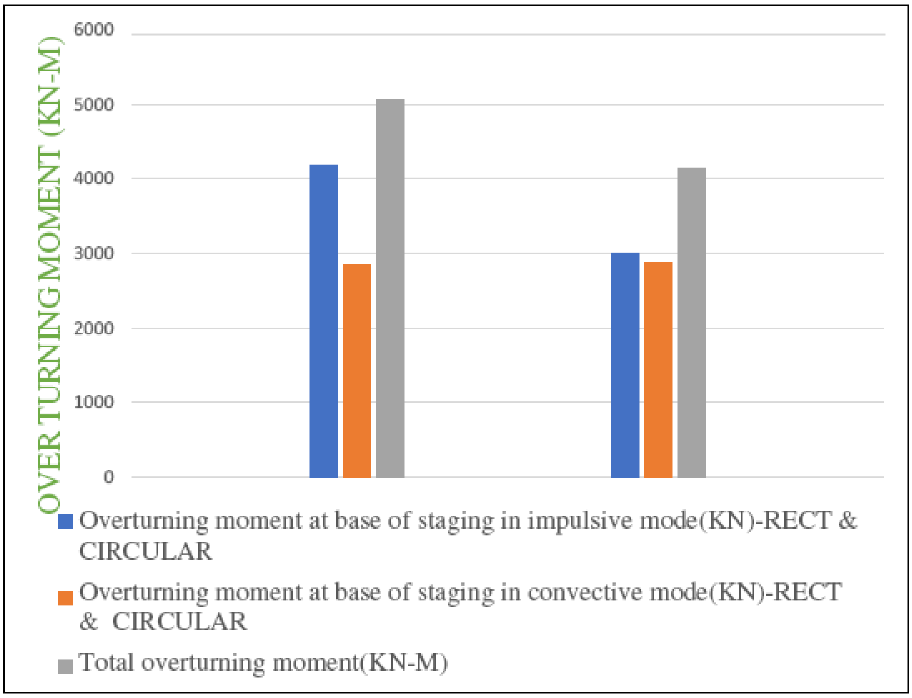


Figure 4.13(d) Results showing comparisons in base moment/overturning moment

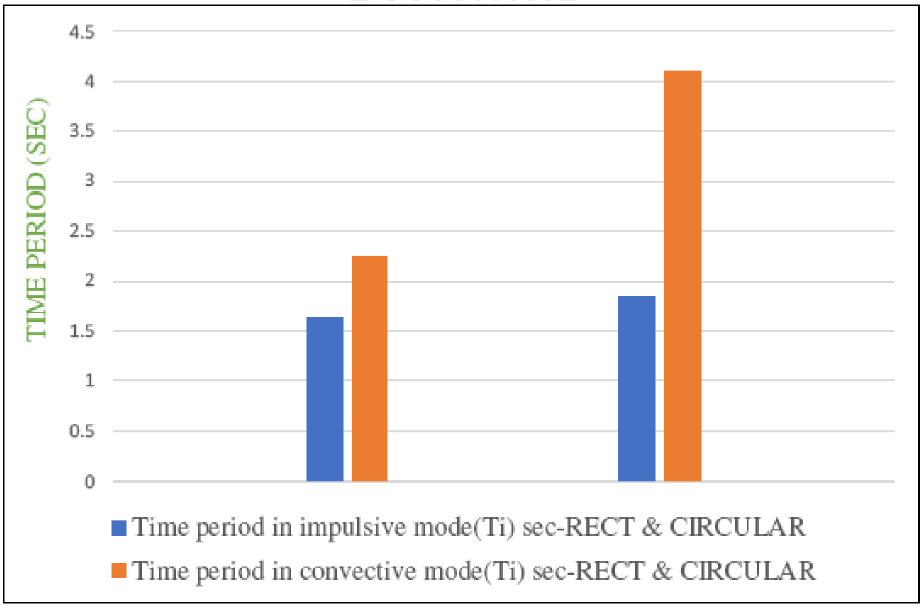


Figure 4.13(e) Results showing comparisons in time period

Comparisons on basis of stresses (Plate stress values)

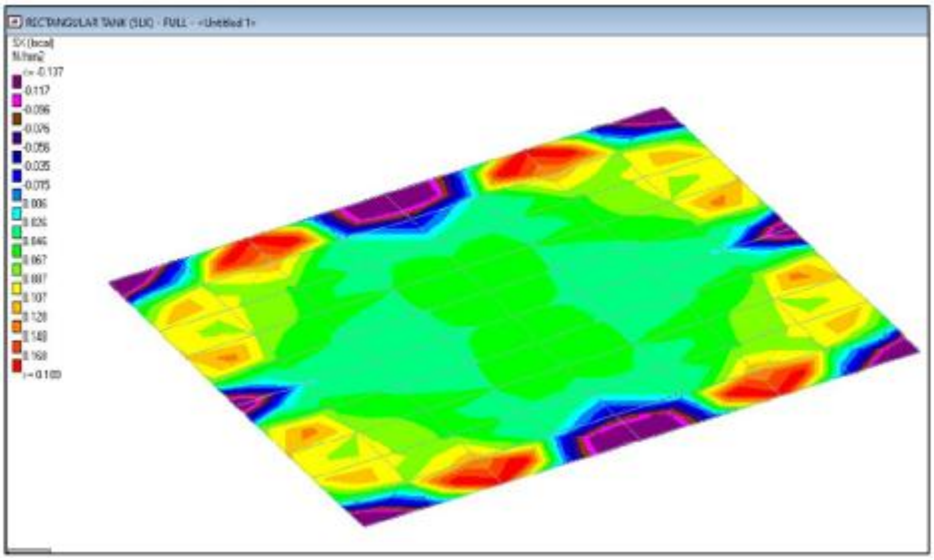


Figure 14 Plate stress value for bottom plate of rectangular tank in SX (local)direction (n/mm^2)

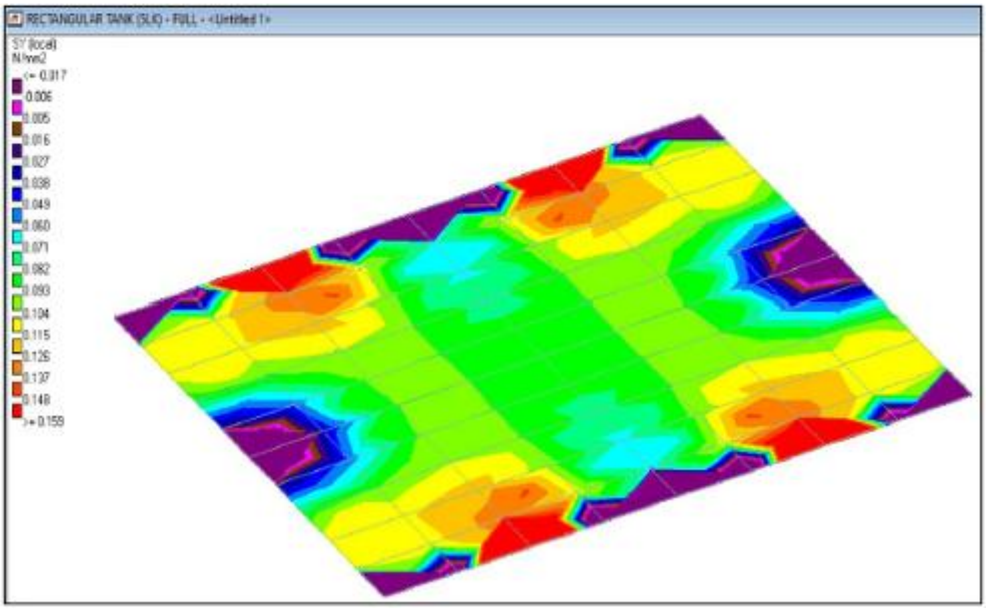


Figure 15 Plate stress value for bottom plate of rectangular tank in SY (local)direction (N/MM^2)

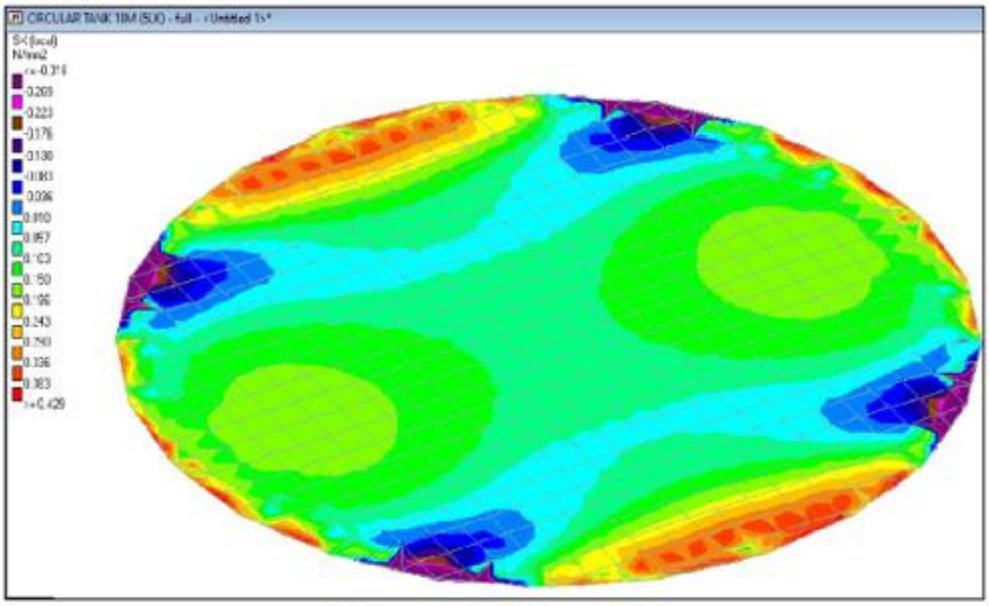


Figure 16 Plate stress value for bottom plate of circular tank in SX (local)direction (N/mm^2)

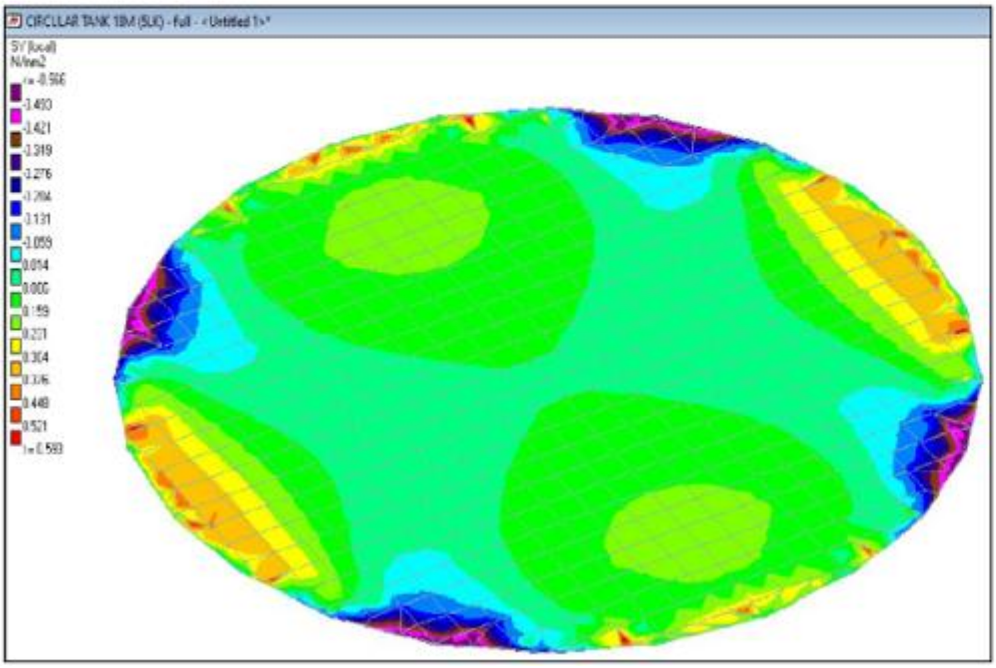


Figure 17 Plate stress value for bottom plate of circular tank in SY (local)direction (N/mm^2)

MOMENT VARIATION ALONG LOCAL AXIS IS SHOWN BELOW

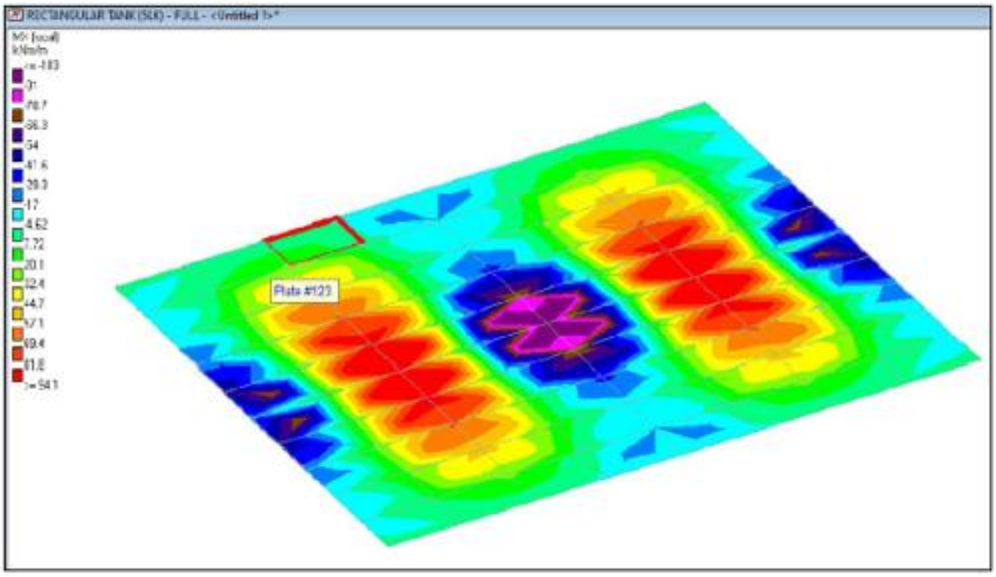


Figure 18 Moments value for bottom plate of rectangular tank in mx (local)direction (KNm/m)

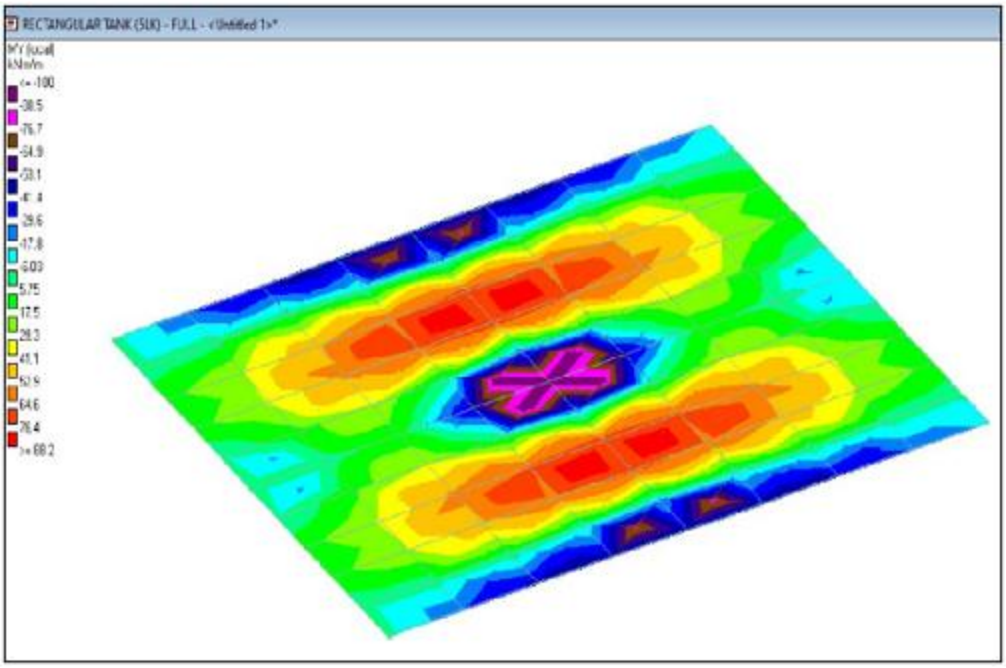


Figure 19 Moments value for bottom plate of rectangular tank in my(local)direction (KNm/m)

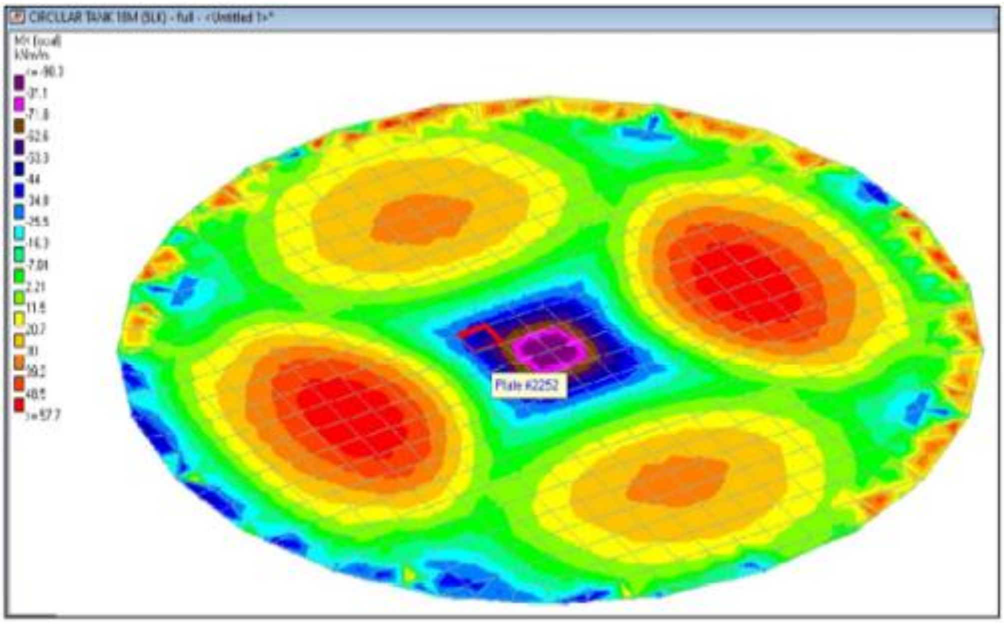


Figure 20 Moments value for bottom plate of circular tank in mx (local) direction(KNm/m)

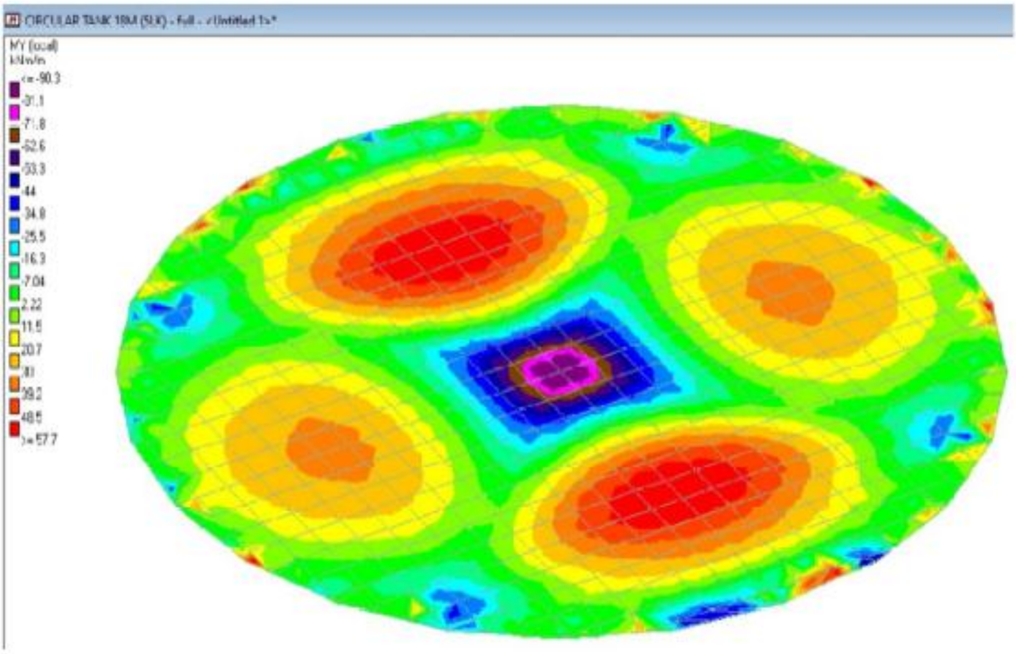


Figure 21 Moments value for bottom plate of circular tank in my(local) direction(KNm/m)

Table 4.4 Variation in plate stresses value (Final value)

S. NO	TYPE OFTANK	SQX (N/MM^2)		SQY (N/MM^2)	
		Minimum	Maximum	Minimum	Maximum
1.	Rectangular	**-0.138**	**0.189**	**-0.018**	**0.159**
2.	Circular	**-0.316**	**0.429**	**-0.57**	**0.60**

Table 4.5 Variation in plate stresses value (With respe mention axis)

S. NO	TYPE OFTANK	MX (KNm/m)		MY (KNm/m)	
		Minimum	Maximum	Minimum	Maximum
1.	Rectangular	**-103.2**	**94.1**	**-100**	**88.2**
2.	Circular	**-90.3**	**58**	**90**	**57**

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-

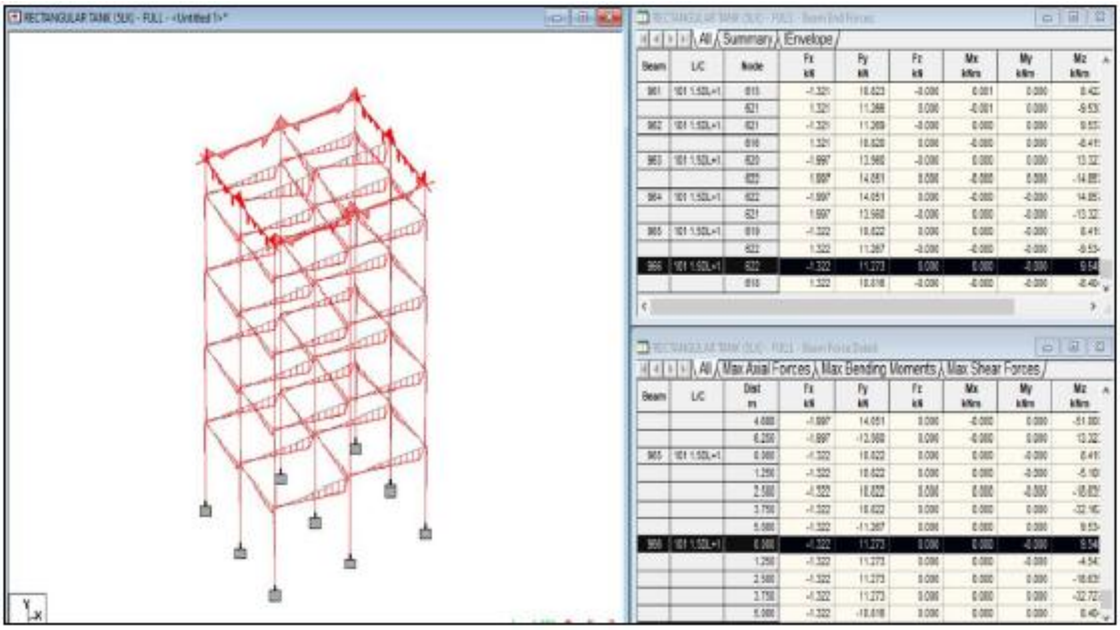


Figure 22 (a) Rectangular tank Bending moment and shear force behaviourCIRCULAR TANK-

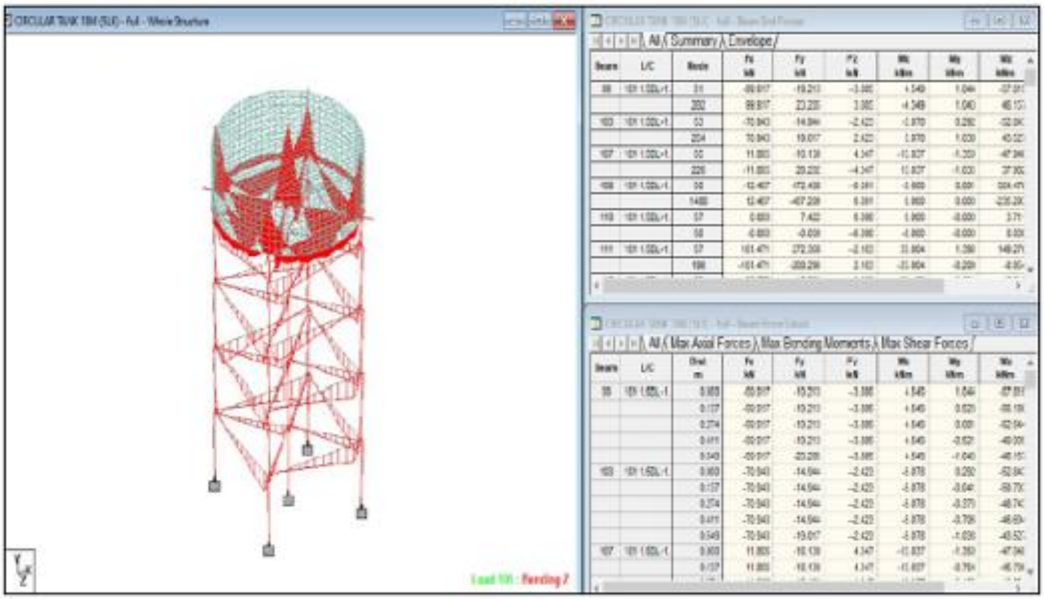
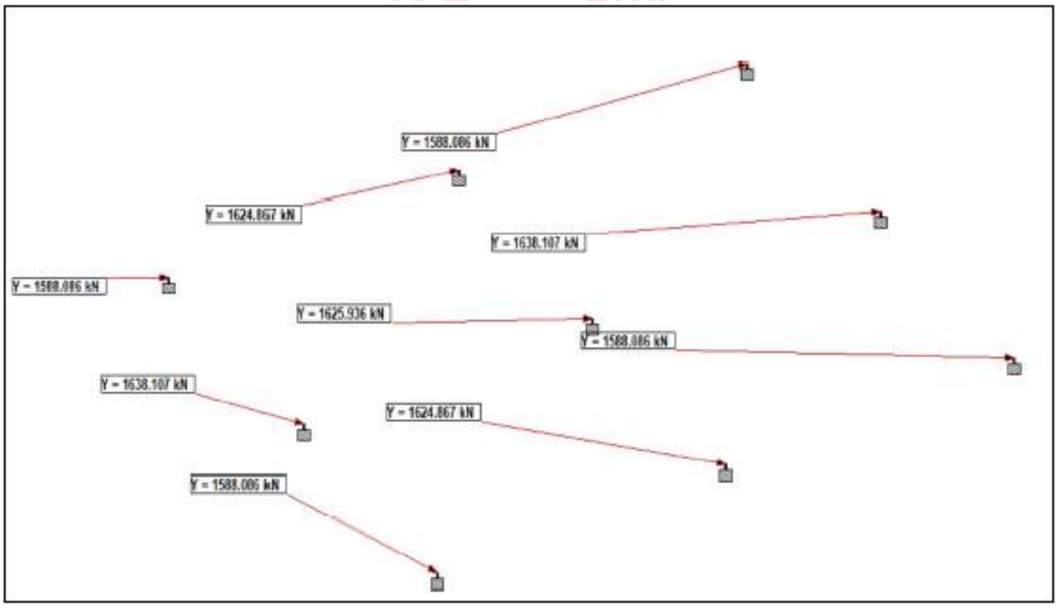


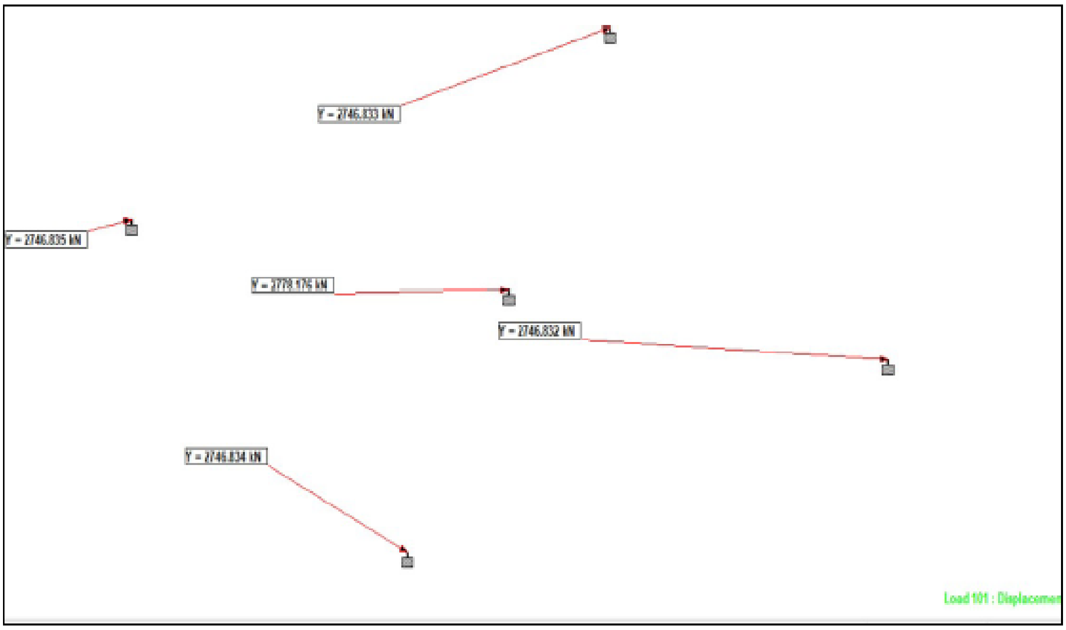
Figure 22 (b) Circular tank Bending moment and shear force behavior

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

RECTANGULAR TANK-

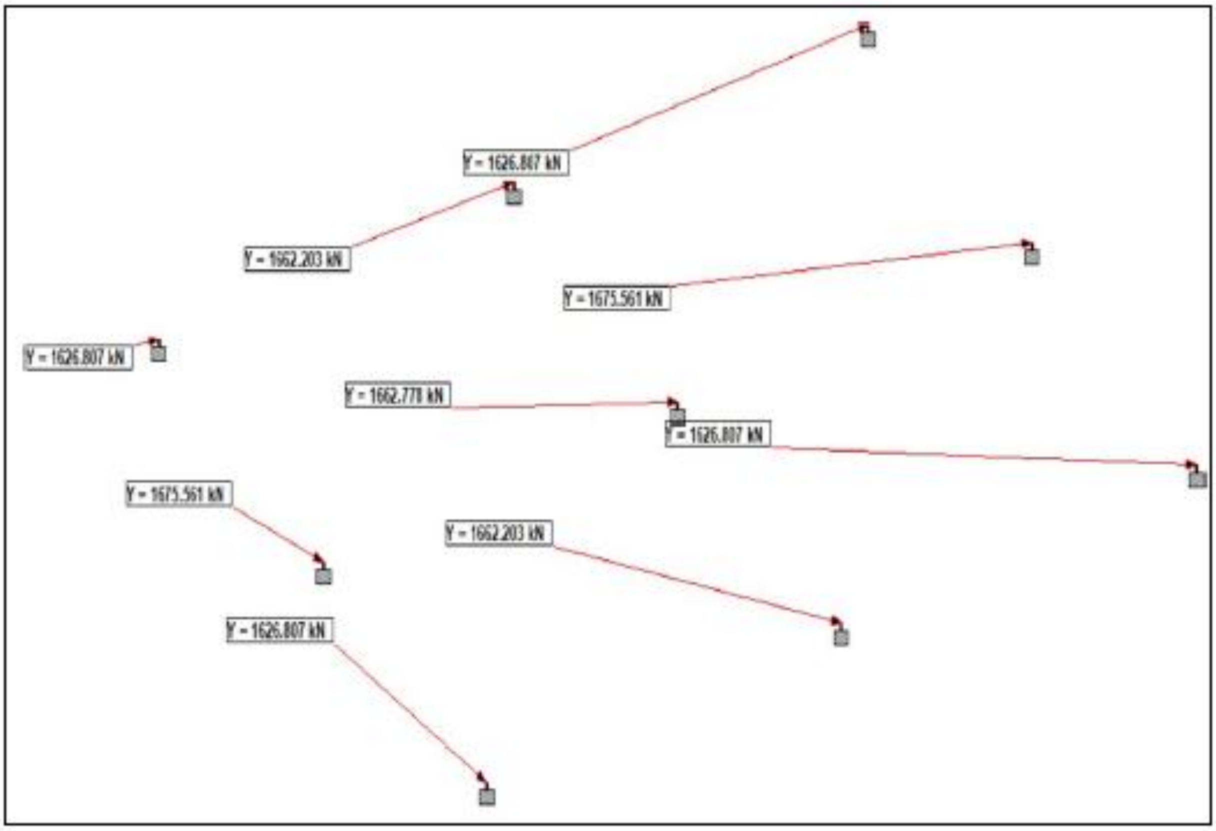


CIRCULAR TANK-

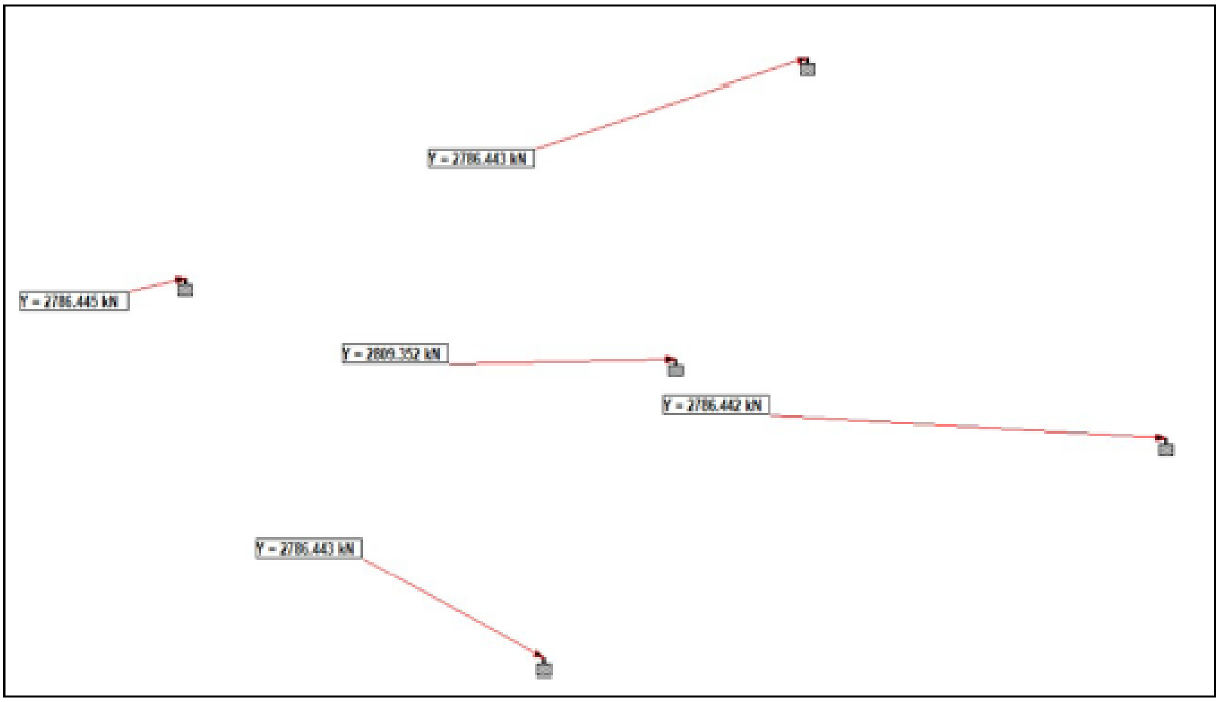


STAGE-2 RECTANGULAR TANK-

RECTANGULAR TANK-

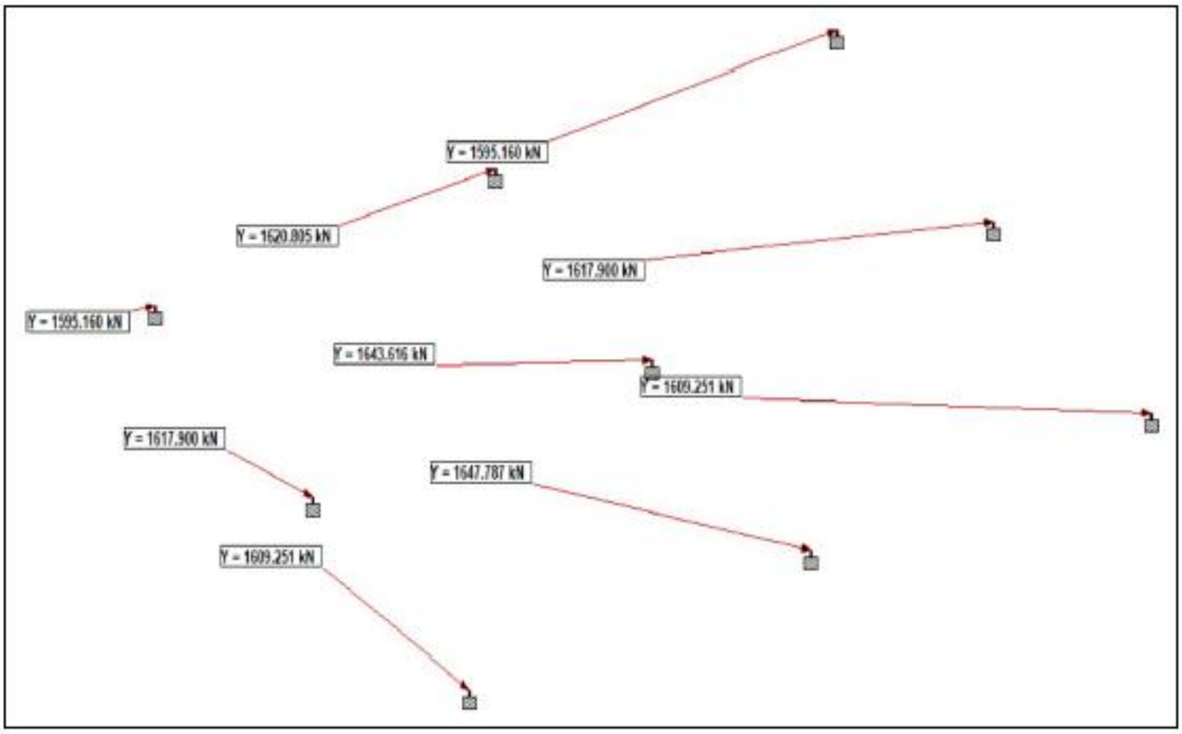


CIRCULAR TANK-

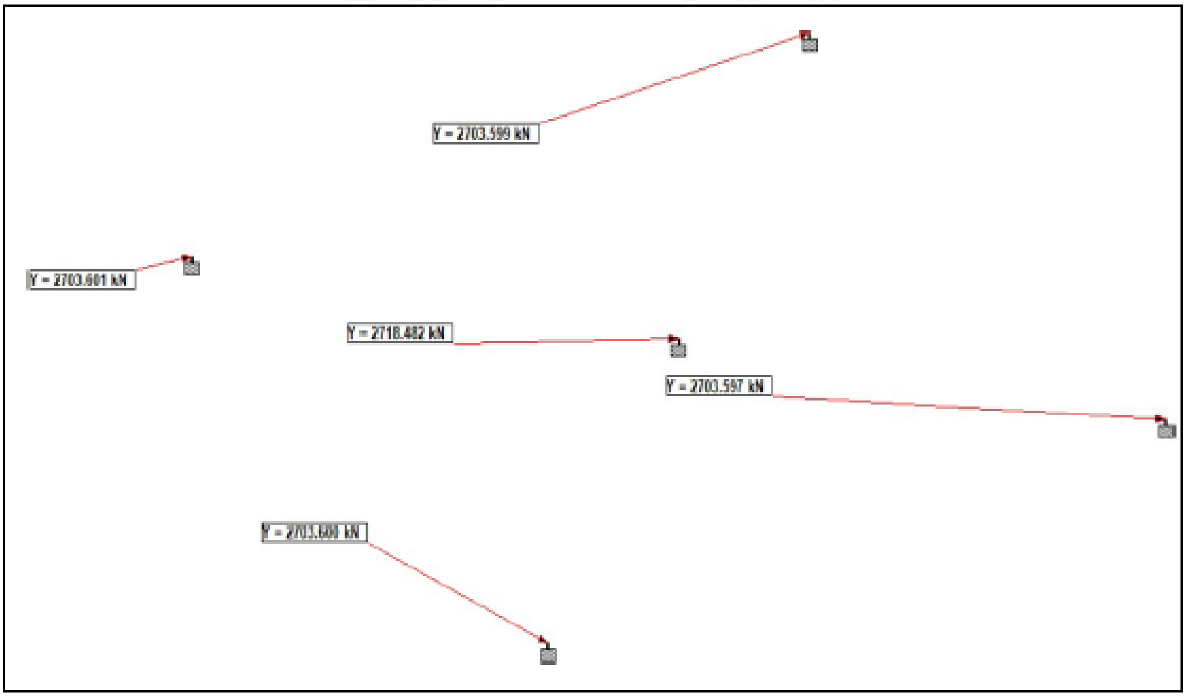


STAGE-3

RECTANGULAR TANK-



CIRCULAR 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), 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 forceand 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

- In this acc. to 2^{nd}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, 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.
- 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 no od reactions with respectto circular tanks(Same as shown in stage 01)
- Finally whole part of both the tanks, we compared it according to Shear forceand 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 mtzs bracings to 4.5 mts usingcircular 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, 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), 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 forceand bending moment diagram, here we get less behavior of shear and bending in case of circular with respect to rectangular tanks.

FUTURE SCOPE

Permeable

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 andcapacity should be

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

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

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