DESIGN AND ANALYSIS FOR SUPPORTING SYSTEM OF CIRCULAR ESR FOR DIFFERENT SEISMIC ZONE FOR SAME CAPACITY .

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Abstract - *Water tanks are very important for public utility and for industrial structure. As we know elevated water tanks were heavily damages or collapsed during earthquake. This was might be due to the lack of knowledge regarding the proper behaviour of supporting system of the tank against seismic effect and also due to improper geometrical selection of staging patterns . The study describes, design and analysis of supporting system of circular elevated water tanks having same capacity for different seismic zone (II , III and IV) . Shear force, Seismic Axial force , and seismic bending moment are calculated under each column by response spectrum method and compared for different seismic zone under peripheral and interior column of supporting system or staging .*

Key Words: Circular overhead tank, Staging system, R.S.M. , Bending Moment, seismic axial force, Shear Force, different zones.

1. INTRODUCTION: Water is essential to humans and other life. Sufficient water distribution depends on design of a water tank in certain area. An elevated water tank is a large water storage container constructed for the purpose of holding water supply at certain height to pressurization the water distribution system. Many new ideas and innovation has been made for the storage of water and other liquid materials in different forms and fashions. There are many different ways for the storage of liquid such as underground, ground supported, elevated etc. Liquid storage tanks are used extensively by municipalities and industries for storing water, inflammable liquids and other chemicals. Thus Water tanks are very important for public utility and for industrial structure. Elevated water tanks consist of huge water mass at the top of a slender staging which are most critical consideration for the failure of the tank during earthquakes. Elevated water tanks are critical and strategic structures and damage of these structures during earthquakes may endanger drinking water supply, cause to fail in preventing large fires and substantial economical loss. Since, the elevated tanks are frequently used in seismic active regions. Also hence seismic behaviour of them has to be investigated in detail. Due to the lack of knowledge of supporting system some of the water tank were collapsed or heavily damages. So there is need to focus on seismic safety of lifeline structure using with respect to alternate supporting system which are safe during earthquake and also take more design forces. The 3-D model of ESR is draft on AUTOCAD . The main aim of present study is to understand the behavior of staging for the same capacity of ESR for different seismic zone .

1.1. OBJECTIVES:

The followings are the main objectives of present study.

- To make a study about the analysis and design of elevated water tank.
- To know the design philosophy for the safe design of water tank.
- Understanding the behaviour of staging when tank is in full and empty condition.
- Comparison of seismic forces and seismic moments induced under peripheral and interior column of staging for different seismic zones.

2. TANK DATA AND MODELLING

In the present study the capacity of tank is considered as $300m^3$. The external diameter of tank is 9.8m. In full tank condition, the water level is 4.6m and free board is taken as 0.3. Circular column is considered of diameter 0.5m. The tank container is of circular type. Young's modulus and the weight of concrete per unit volume are taken as 25000MPa and $25kN/m^3$ .The container is filled with water of density 1000 kg/m^3.
Grade of concrete is M25.
Grade of steel Fe415.
SBC of soil is $130kN/m^2$ (medium soil).

capacity	300m^3
Internal Diameter of Tank	9.4m
Height of cylindrical wall	4.9m
Water depth	4.6m
THK of cylindrical wall	0.2m
THK of roof and base slab	0.120m & 0.2m
Roof beam	0.250×0.300m
Base beam	0.300×0.500m
Ring Beam	0.300×0.500m
Staging Height	15m
C/C braces distance	3m
Gallery Width	1m

2.1 Methodology

The methodology includes fixing the dimensions of components for the selected water tank by: 1893- 2002 (Part 2) draft code. This work proposes to study Circular tanks of same capacity and staging height and column configuration for seismic zone (*II , III and IV)*. The analysis is carried out for tank with full capacity and empty capacity by response spectrum method. If the tank is located in seismic prone areas , it should be analyse for both tank full and empty condition. The horizontal (W) and vertical forces on tank shall be dependent upon the total weight of tank which shall be computed by adding weight of tank proper and 1/3rd weight of staging .
The horizontal displacement of the top of the tank under seismic forces shall be cantilever member by assuming the columns acting as elastic spring each of stiffness (K)

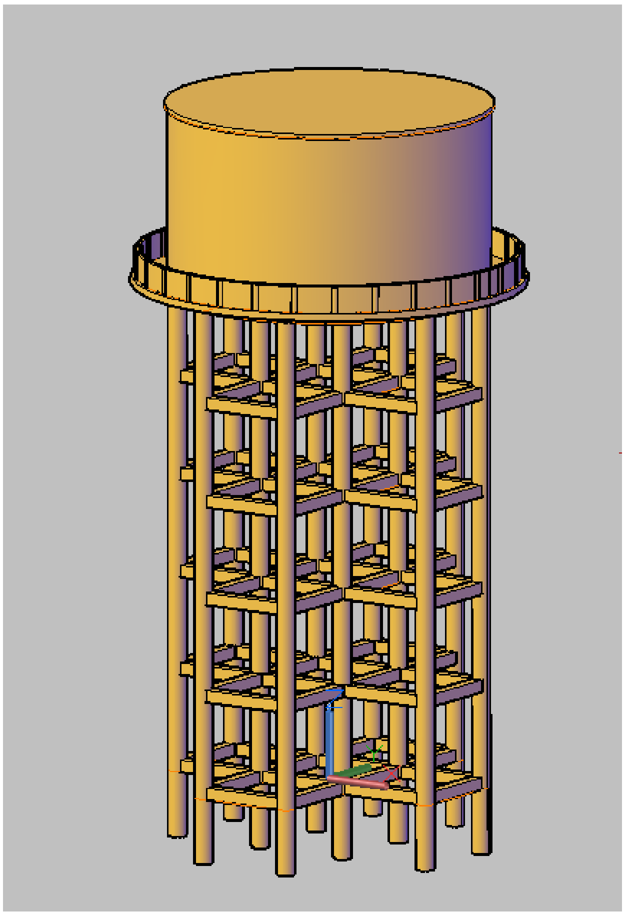

Fig1. AutoCAD 3D model circular ESR

$K=12EI/h^3$
Total stiffness of 'n' columns in any height 'h'
$12EIn/h^3$

Combined elastic stiffness 'k' of all columns for full height of staging is determine from ,

$1/K=1/K_1+1/K_2+1/K_3+1/K_4+1/K_5$

W = 5336.65kN (Full condition)
W = 2144.35kN (Empty condition)
check for column,
$(\sigma_{cc}'/\sigma_{cc}+\sigma_{cbc}'/\sigma_{cbc})<1$

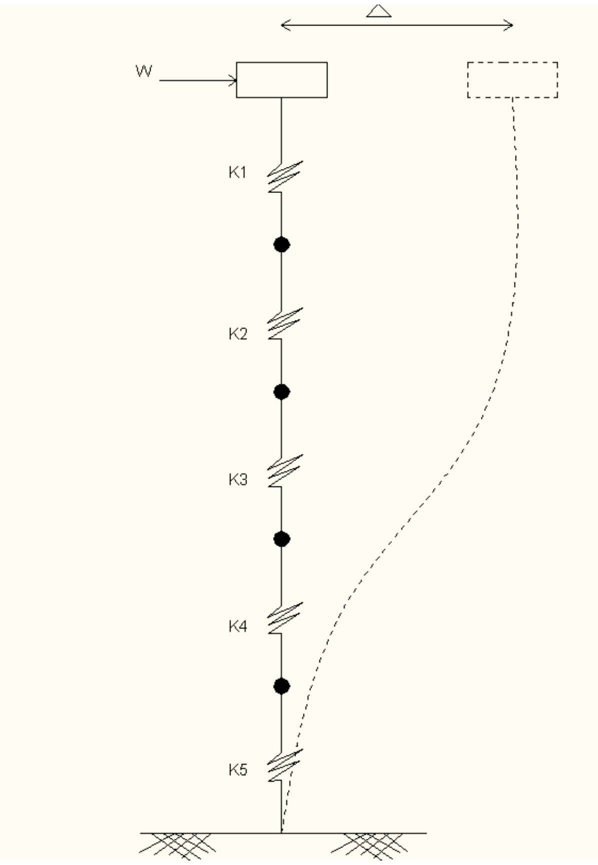

Fig2 Spring Model of ESR

3.RESULT AND DISCUSSION :

Response spectrum method is used to design and analyse circular ESR for tank with full of water condition and empty condition and following are the results. The results shown below are for per peripheral column and per interior column .

Note: All results tabulated in table is for each column i.e. for 3m height i.e. the distance between two consecutive braces .

FULL CONDITION :

Seismic Zone - *II*

Pos^n of column	Seismic axial force (kN)	Seismic moment (kN.m)	Shear force (kN)	Ast req. (mm^2)
Peripheral	461.79	37.52	25.01	490.87
Interior	618.64	75.045	50.03	589.04

Seismic Zone - *III*

Pos^n of column	Seismic axial force (kN)	Seismic moment (kN.m)	Shear force (kN)	Ast req. (mm^2)
Peripheral	469.42	60.02	40.02 5	490.87
Interior	636.65	120	80.05	736.31

Seismic Zone - *IV*

Pos^n of column	Seismic axial force (kN)	Seismic moment (kN.m)	Shear force (kN)	Ast req. (mm^2)
Peripheral	479.3	90.045	60.03	490.87
Interior	656.667	180.105	120.7	1963.4

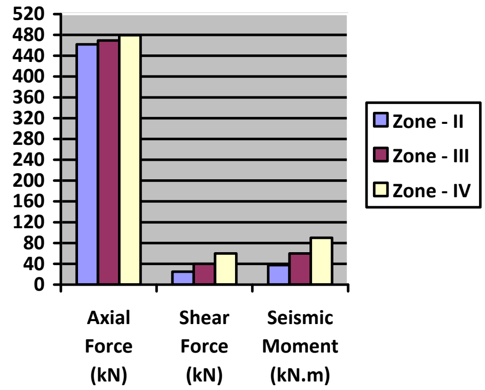

Chart 1. Axial , shear and moment for peripheral column

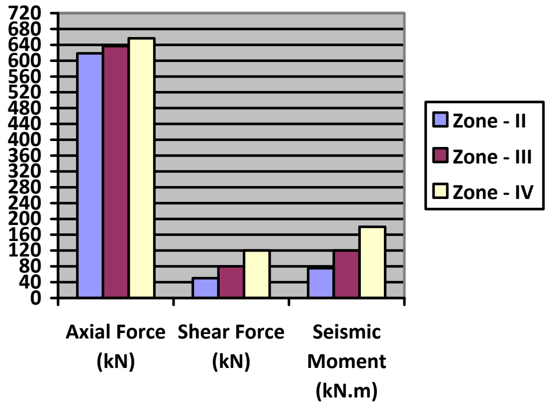

Chart 2.Axial , shear and moment for interior column

EMPTY CONDITION :

(Ast_{pro} will be same as in case of full cond^{n})

Seismic Zone - *II*

Pos^{n} of column	Seismic axial force (kN)	Seismic moment (kN.m)	Shear force (kN)
Peripheral	454.31	15.075	10.05
Interior	603.68	30.16	20.105

Seismic Zone - *III*

Pos^{n} of column	Seismic axial force (kN)	Seismic moment (kN.m)	Shear force (kN)
Peripheral	457.33	24.12	16.08
Interior	609.71	48.24	32.16

Seismic Zone - *IV*

Pos^{n} of column	Seismic axial force	Seismic moment	Shear force (kN)

	(kN)	(kN.m)	
Peripheral	461.35	36.18	24.12
Interior	617.75	72.37	48.24

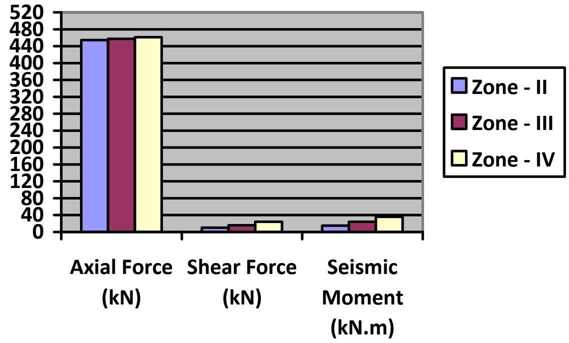

Chart 3. Axial , shear and moment for peripheral column

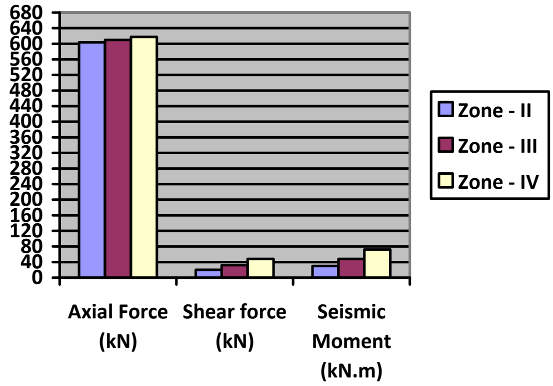

chart 4.Axial ,shear and moment for interior column

conclusion : From the above results it is concluded that for different zones, axial force , shear force and bending moment under peripheral and interior column of staging varies . But area of steel req. under peripheral column come out same for all zone and it is varies for interior columns.

From the check equation available, it is also concluded that, the direct stresses and bending moment induced under peripheral and interior column are within the permissible limit for Zone - II and Zone - III and for Zone - IV interior column fail in bending so therefore there is a need to increase the size of column for safety in flexure.

From the above tabulated result it is physically observed that, the axial force, shear force and bending moment for interior columns comparatively more than peripheral columns for both the conditions i.e. Full and Empty.

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