Pushover Analysis of Elevated Water Tank And Staging With Dampers

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Abstract- *The present study investigates the behaviour of an elevated circular water tank by Pushover Analysis. It is carried out by considering the seismic performance of elevated circular water tank for seismic zones IV of India for staging height of 20m for 500,000 liter capacity of elevated water tanks for H/D ratio 0.5 and number of columns are 10. Total eighteen models are made for analysis of elevated water tank.The tank has been modeled as 3D space frame model with six degree of freedom at each node using SAP 2000 software for stimulation of behavior under seismic loading. The support condition is considered as fully fixed. Complete analysis is carried out for dead load, water load & seismic load using SAP 2000. Response spectrum method is used. All load combinations are considered as per IS 1893:2016*

Keywords- SAP,Seismic, Water tank, 3D Space frame model, Base force, Displacement.

I. INTRODUCTION

The water is source of every creation. In day to day life one cannot live without water. The overhead liquid storing tank is the most effective storing facility used for domestic or even industrial purpose. Depending upon the location of the water tank, the tanks can be name as overhead, on ground and underground water tank. The tanks can be made in different shapes like rectangular, circular and intze types. The tanks can be made of RCC or even of Structural steel. Steel tanks are widely used in railway yards. Overhead tanks and storage reservoirs are used to store water, liquid petroleum and similar liquids. Reservoir is a general term used to liquid storage structure and it can be below or above the ground level. Reservoirs below the ground level are normally built to store large quantities of water. The overhead tanks are supported by the column which acts as stage. This elevated water tanks are built for direct distribution of water by gravity flow and are usually of smaller capacity. Most water supply systems in developing countries, such as India, depend on overhead storage tanks. The strength of these tanks against lateral forces such as those caused by earthquakes, needs special attention.
Elevated water tanks consist of huge water mass at the top of a slender staging which is most critical consideration for the failure of the tank during earthquakes. Elevated water tanks are critical and strategic structures; damage of these structures during earthquakes may endanger drinking water supply, cause to fail in preventing large fires and may cause substantial economic loss. Due to the lack of knowledge of supporting system some of the water tank were collapsed or heavily damaged. So there is need to focus on seismic safety of lifeline structure with respect to alternate supporting system which are safe during earthquake Because of large mass, especially when the tank is full, earthquake forces are more or less govern the lateral force design criteria in the zone of high seismic activity. In the extreme case, total collapse of tank shall be avoided. However, some damage repairable may be acceptable during severe shaking not affecting the functionality of tank. Whatever may be the cause of distress but water tanks should fulfill the purpose for which it has been designed and constructed with minimum maintenance throughout its intended life.

Damage Observed to Elevated Water Tanks in Bhuj Earthquake (2001) Most of the elevated water tanks undergo damage to their staging. Due to the lack of knowledge of supporting system some of the water tank were collapsed or heavily damages.

1.1 IS Codes provisions

The first seismic zone map was provided in 1962 by the Indian Standards, which was further revised in 1967 and once again in 1970. The map has been last revised in 2016, and it now has seismic zones – II, III, IV and V. The seismic zone I areas were merged with those of seismic zone II in 1970. Seismic Zone Map presents a large scale view of the seismic zones. Hence soil variations and variations in the geology cannot be represented at that scale. Therefore, for major projects, such as large scale dams or a power plant, the seismic danger is investigated specifically in detail for that particular site. In general, the methods of seismic analysis can be classified as

1. Static analysis and
2. Dynamic analysis.

1.2 Limitations of pushover analysis:

Although pushover analysis has advantages over elastic analysis procedures, underlying assumptions, pushover predictions are accuracy and limitations of current pushover procedures must be identified. Selection of lateral load patterns and identification of failure mechanisms for estimate of target displacement due to higher modes of vibration are important issues that affect the accuracy of pushover results. In a design earthquake target displacement are global displacement are expected. The mass center of roof displacement structure is used as target displacement. The estimation of target displacement accurate associated with specific performance objective affect the accuracy of seismic demand predictions of pushover analysis. Target displacement is the global displacement expected in a design earthquake. The estimate of target displacement, identification of failure mechanisms due to higher modes of vibration are important issues that affect, selection of lateral load patterns the accuracy of pushover results.

Pushover analysis yields insight into elastic and inelastic response of structures under earthquakes provided that adequate modeling of structures under earthquake provided that adequate modeling of structure, careful selection of lateral load pattern and careful interpretation of results are performed. However, pushover analysis is more appropriate for low to mid-rise buildings with dominant fundamental mode response. For special and high-rise buildings, pushover analysis should be complemented with over evaluation procedure since higher modes could certainly affect the response.

1.3 Necessity:

Indian sub-continent is highly vulnerable to natural disasters like earthquake, draughts, floods, cyclones etc. According to IS code 1893 (Part 1):2000, more than 60% of India is prone to earthquakes. The earthquake of 26 January 2010 in Gujarat was unprecedented for the entire country, then public learnt first time that the scale of disaster could have been far lower had the construction in the region compiled with codes of practice for earthquake prone regions. These natural calamities are causing many casualties and innumerable property loss every year. After an earthquake the loss which cannot be recovered are the life loss. Collapse of structures causes people to life loss. Hence badly constructed structures kill people more than earthquake itself. Hence it becomes important to analyze the structures properly. Seismic safety of liquid storage tanks is of considerable importance, as tanks storing highly concentrated liquids in industries, or in transporting vehicles, ships can cause considerable harm for human society if damaged. Water supply being the lifeline facility must remain functional following disaster to carter the need of drinking and fire fighting. These structures have large mass concentrated at the top of slender supporting structure hence these structure are especially vulnerable to horizontal forces due to earthquake as they act as the inverted pendulum like structure. Keeping these problems in consideration 'Bureau of Indian Standards' have published code especially for liquid retaining structures, 'Criteria for earthquake resistant design of structures' IS 1893(Part 2) : 2014 based on the guidelines and suggestions by IITK-GSDMA for seismic design of liquid storage tanks. This study will evaluate all the seismic analysis parameters using the recommended procedure in latest code as well as in IIT-GSDMA guidelines, and is concentrated mainly to the Sloshing effect that is happening in the water during earthquake. Sloshing is defined as the periodic motion of the free liquid surface in partially filled container. It is caused by any disturbance to partially filled containers. If the liquid is allowed to slosh freely, it can produce additional hydrodynamic pressure in case of storage tanks. Hence considerations of these forces are necessary, during analysis.

II. LITERATURE REVIEW

In Paper[1] presents dynamic analysis of elevated water tanks supported on RC framed structure with different tank storage capacities. Effects of hydrodynamic forces on tank walls are calculated. History of earthquake reveals that it have caused numerous losses to the life of people in its active time, and also post-earthquake time have let people suffer due to damages caused to the public utility services. Either in urban or rural areas elevated water tanks forms integral part of water supply scheme, so its functionality pre and post-earthquake remains equally important. These structures have heavy mass concentrated at the top of slender supporting structure hence these structures are especially vulnerable to horizontal forces due to earthquakes. Objective paper is to understand the dynamic behavior of elevated water tanks under earthquake loading using latest Indian code IS 1893(part 2):2014. Parameters from seismic analysis of elevated water tanks and their comparison within different capacities including sloshing effects are calculated, lateral stiffness of frame staging is calculated using latest STAAD Pro V8i SS6 software. Results state that there is more threat of destruction to the tanks with higher capacities as compared to the tanks with lower capacities in a given zone.Paper [2] explains current design of supporting structure of Elevated water tanks is tremendously vulnerable under lateral forces due to an earthquake. Water tanks and especially the elevated water tanks are structures of high importance which are considered as main lifeline elements that should be capable of keeping the expected performance i.e. operation during and after earthquakes. Thus researchers, in recent years, have focused on studying seismic behaviors of these tanks, particularly ground tanks, while only few of these researches have concerned with the elevated tanks and even less with the reinforced concrete elevated tanks. In this research, a sample of a concrete elevated water tank with 400 m3 have been studied and analyzed by linear dynamic method and seismic response such as base shear, tank displacement, max Bending Moment at the base of column under tank reinforced empty condition, tank full condition and tank half full condition for different type of bracing arrangements have been calculated and then results have been compared.In Paper [3] explains from past upsetting experiences, adequately designed elevated water tanks were heavily damaged or collapsed during earthquakes. This might be due to the lack of knowledge regarding the behaviour of supporting system of the tank; and also due to improper geometrical selection of staging patterns. For certain proportions of the tank and the structure, the sloshing of the water during earthquake may one of the dominant factor. In this paper, the seismic behavioural effect of elevated circular water tank is studied for constant capacity and constant number of columns; for various types of staging arrangement in plan, and variation in number of stages in elevation by using finite element method based software SAP2000. Two mass idealizations suggested by Gujarat State Disaster Management Authority (GSDMA) guideline are considered here. Total nine combinations were analysed using Response Spectrum Method (RSM) and results are presented. Radial arrangement with six staging levels is found to be best for ten numbers of columns.Paper [4]states that elevated water tanks were heavily damages or collapsed during earthquake. This was might be due to the lack of knowledge regarding the proper behavior of supporting system of the tank again dynamic effect and also due to improper geometrical selection of staging patterns. Due to the fluid-structure interactions, the seismic behavior of elevated tanks has the characteristics of complex phenomena. The main aim of this study is to understand the behavior of supporting system which is more effective under different response spectrum method with SAP 2000 software. In this Paper different supporting systems such as radial bracing and cross bracing.Paper[5] states that elevated tanks are structures of high importance which are considered as the main lifeline elements. i.e. operation during and after earthquakes. Many researchers have worked on the behaviour, analysis, and seismic design of tanks, particularly ground tanks, while only a few of these researchers have concerned with the reinforced concrete elevated tanks. From the very upsetting experiences of few earthquakes, like Bhuj earthquake (2001) in India R.C.C elevated water tanks were heavily damaged or collapsed. This might be due to the lack of knowledge regarding the proper behaviour of supporting system of the tank due to the dynamic effect and also due to improper geometrical selection of staging. The aim of this study is to understand the behaviour of different staging, under different loading conditions and strengthening the conventional type of staging, to give better performance during earthquake. This paper presents seismic analysis of elevated water tanks supported on different staging pattern with different tank storage capacities. Here two different supporting systems such as radial bracing and cross bracing are compared with basicsupporting system for various fluid level conditions. Eleven models are used for calculating base shear and nodal displacements for staging using STAAD pro. After calculating base shear and nodal displacements of eleven models for empty & full condition. Three different type of staging systems have been analyzed.Paper [6] discussed that 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 again dynamic effect and also due to improper geometrical selection of staging patterns. Due to the fluid-structure interactions, the seismic behaviour of elevated tanks has the characteristics of complex phenomena. The main aim of this study is to understand the behaviour of supporting system which is more effective under different earthquake time history records with SAP 2000 software. Here two different supporting systems such as radial bracing and cross bracing are compared with basic supporting system for various fluid level conditions. For later conditions water mass has been considered in two parts as impulsive and convective suggested by GSDMA guidelines. In addition to that impulsive mass of water has been added to the containerwall using Westergaard's added mass approach. Tank responses including base shear, overturning moment and roof displacement have been observed, and then the results have been compared and contrasted. The result shows that the structure responses are exceedingly influenced by the presence of water and the earthquake characteristics.

Paper [7] discussed about seismic performance of the elevated water tanks for various seismic zones of India with variation in staging heights and different types of staging configurations. Total 27 combinations were analyzed using Response Spectrum Method (RSM) in finite element based software SAP2000 by considering two mass idealization systems. Tank responses including base shear, overturning moment and roof displacement have been observed with the aim of recommendation of best staging arrangement for different earthquake zones in India. In Paper[8] states that elevated water tank are considered as one of the important structure as it is used to store water for drinking, firefighting etc. Seismic safety and performance of liquid tanks under strong earthquakes is of considerable importance as their serviceability after strong earthquakes is a matter of concern. As known from very upsetting experiences, elevated water tanks were heavily damages or collapsed during earthquake. Due to the high sensitivity of the elevated water tanks to the earthquake characteristics such as frequency contents, peak ground acceleration and the effective duration of the earthquake records. It is necessary to consider the earthquake loading as a non-stationary random process and hence Time history analysis is performed to predict the realistic behavior of elevated water tank and also the fluid-structure an interaction makes it more complex phenomenon under seismic ground motions. An attempt has been made in this paper to understand the dynamic behavior of Elevated reservoir under different earthquake recorded ground motions considering fluid structure interaction. In this paper time history analysis is carried out for elevated tank having different staging height under different eight earthquake ground motion records. SAP software is used to carry out time history analysis and tank responses obtained in form of Time period, Displacement, Drift, Base shear, Overturning moment have been observed, and then the results have been compared and contrasted.

Paper [9] presents dynamic analysis of elevated water tanks supported on RC framed structure with different tank storage capacities. Effects of hydrodynamic forces on tank walls are calculated. History of earthquake reveals that it have caused numerous losses to the life of people in its active time, and also post earthquake time have let people suffer due to damages caused to the public utility services. Either in urban or rural areas elevated water tanks forms integral part of water supply scheme, so its functionality pre and post earthquake remains equally important. These structures have heavy mass concentrated at the top of slender supporting structure hence these structures are especially vulnerable to horizontal forces due to earthquakes. Objective paper is to understand the dynamic behavior of elevated water tanks under earthquake loading using latest Indian code IS 1893(part 2):2014. Parameters from seismic analysis of elevated water tanks and their comparison within different capacities including sloshing effects are calculated, lateral stiffness of frame staging is calculated using latest STAAD Pro V8i SS6 software. Results state that there is more threat of destruction to the tanks with higher capacities as compared to the tanks with lower capacities in a given zone.Paper[10] studied the behavior of different staging pattern in bracing to strengthening the conventional type of staging, to give better performance during earthquake. Equivalent static analysis for staging with different types of bracing system applied to the staging of elevated circular water tank in zone V is carried out using STAAD Pro. Comparison of base shear and maximum displacement in X, Y &Z direction of circular water tank is done. Different model is used for calculating base shear and maximum displacement for staging with cross bracing, staging with diagonal bracing, staging with K-type bracing, staging with V- type bracing staging with chevron bracing and alternate cross bracing in staging, alternate K- type bracing in staging, alternate V-type bracing in staging alternate diagonal bracing in staging and alternate chevron bracing in staging.

Paper [11] The study investigates the effect of ViscoElastic (VE) dampers on the overall increase in damping ratio of RCC structure significantly and hence improving the global performance of dynamically sensitive structures. A parametric study is carried out on the proposed Hospital building located at Delhi using VE dampers. The building is chosen such that it is a life line structure and located in a highly seismic prone zone. Finite element analysis was employed using the program ETABS version 9.7.2. In order to show the effectiveness of damper a comparative study on the lateral load resisting behavior between bare(without damper) and damped structures has been studied analytically. The brace type damping mechanism has been modeled as a linear spring and dash-pot in parallel for the ViscoElastic damper. The earthquake events used in this study has been applied as response spectrum acceleration. A number of analyses were carried out to gain a comprehensive understanding of the effectiveness of strategic damper placement in this structure to achieve maximum damping ratio. This study indicates that the dynamic characteristics of ViscoElastic damper have improved the damping ratio additionally by 2% when compared to RCC structure. The effectiveness of adding the ViscoElastic damper reduced the seismic response (drift, displacement, shear and overturning moment) of the structures to about 4 to 20% and control of seismic responses facilitates the optimum design of shear wall without increasing the size of walls by which the net floor area increases about 0.5%. Paper[12] gives High rise building construction is adopted everywhere as we have sophisticated designing softwares, engineers and also due to advancement in the field on engineering and technology. As the structure height increases its response to seismic and wind loading also increases. Codes suggest that the forces and displacements of a structure is directly proportional to its height. A lot of research work is going on for reduction in responses during extreme loading condition due to wind and earthquake. Passive control devices like various types of dampers comes very handy as they can be easily installed, requires no operation cost and are easily replaceable. These devices become active only when loading is applied. This paper discusses the reduction in response of a G+35 RCC building located in Mumbai when Viscoelastic dampers are used considering seismic loading and wind loading (including gust factor). Best type of bracing configuration, its location and comparison of three different type of dampers is studied. The analysis is done on ETABS

2015 and special emphasis is laid on reduction of displacement and storey drift.Paper[13] describes the seismic and wind analysis of an R.C.C high rise structure with added viscoelastic dampers. It shows the results of the seismic and wind response of an R.C.C (G+42) storey structure with and without the use of viscoelastic dampers. When passive energy dissipating devices such as viscoelastic damper is provided to the structure, the seismic forces such as absolute displacement, absolute acceleration, storey drifts are considerably reduced. It also shows the comparison of viscoelastic damper with different stiffness and damping coefficient values. Analysis is carried out using ETABS.

III. OBJECTIVE OF THE PROJECT

An attempt is made in this thesis to evaluate the seismic response and pushover analysis of elevated water tanks with dampers and varying staging pattern. The main objectives of the report are

1. To study the seismic performance of circular elevated water tanks with varying staging height.
2. To study the seismic performance of staging pattern with dampers.
3. To study the pushover analysis of water tank.
4. To study hinge formation pattern in water tank.
5. To analyze the displacement of the structure along different direction.
6. To study base shear by using nonlinear static analysis.

IV. METHODOLOGY

Load Combinations:

Working combinations are considered for proper result interpretation. The following are the combinations

Tank empty: self-weight of structure + earthquake loads.

Tank full: Self weight of structure + Earthquake loads + water pressure + Sloshing force.

Method of analysis: Response spectrum analysis as per IS1893-2016 & IITK GSDMA guidelines, by using SAP2000.

Designing of structure with linear viscoelastic dampers (MDOF system)

The equation of motion of a multiple degree of freedom (MDOF) system attached with linear viscoelastic dampers can be expressed as,

Where, M, C, and K are the mass, damping, and stiffness matrices of the original structure,(xg)̈is the excitation, and the constant matrices (c)̅and represent the damping and k̅ stiffness contributed from the dampers. The stiffness k̅i and (ci)̅ fractional damping for the VE damper are defined as,

Where, G0 and G1 are the shear modulus of the materials of the VED, A is the shear area of cross section, h is the thickness of viscoelastic pad, θi is the angle of inclination of the viscoelastic dampers with the vertical walls for each storey of the structure.The damper properties in this study are taken from literature of “Comparative Study on Seismic Behavior of RC Framed Structure Using Viscous Dampers, Steel Dampers and Viscoelastic Dampers” by X.L. Lu, K. Ding, D.G Weng, K. Kasai & A.Wada and Design Guidelines by Trevor E Kelly, S.E Holmes Consulting Group.

Damper Name D3-K57-D12
Effective Stiffness 57000 (kN/m)
Effective Damping 12000 (kN-s/m)

The frame type is the most commonly used staging in practice. The main components of frame type of staging are columns and braces. In frame staging, columns are arranged on the periphery and it is connected internally by bracing at various levels. The staging is acting like a bridge between container and foundation for the transfer of loads acting on the tank. In elevated water tanks, head requirement for distribution of water is satisfied by adjusting the height of the staging portion. A reinforced elevated circular water tank having different staging arrangements, column sizes and staging levels has been considered for the present study. The storage capacity of water tank is 500 m3. The configuration of staging is the arrangements of columns and bracings in particular pattern. In the present study, three frame types of staging arrangements – normal, radial and cross have been considered as shown in Figure 3.Finite element model of tank is prepared in SAP2000.

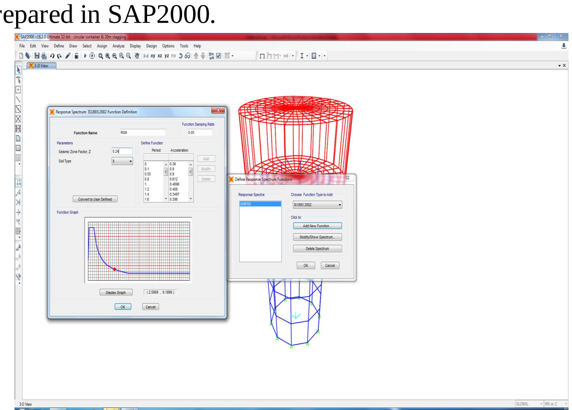


Fig 4.1 User Graphic Face of SAP 2000 while defining Response Spectrum function

Response spectrum method is used. All load combinations are considered as per IS 1893:2016.The earthquake load is considered as per IS:1893 (Part I):2016,for medium soil with importance factor 1.5 and Reduction factor for SMRF structure as 2.5.Seismic zone factor Z for Zone IV = 0.24

Scale factor = (Z/2)*(I/R)*g

The effect of vertical shaking should be considered as seismic zone of structure is considered to be IVFundamental time period of building are calculated as per IS 1893(Part 1):2016 by using response spectrum method.

Seismic coefficient $A_h = (S_a/g)*(Z/2)*(I/R)$

Base shear $V_B = A_h*W$

For medium soil sites

Sa/g =1+15*T T≤0.10

=2.5 0.10≤T≤0.55

=1.36/T 0.55 ≤T≤4.00

=0.34 T>4.00

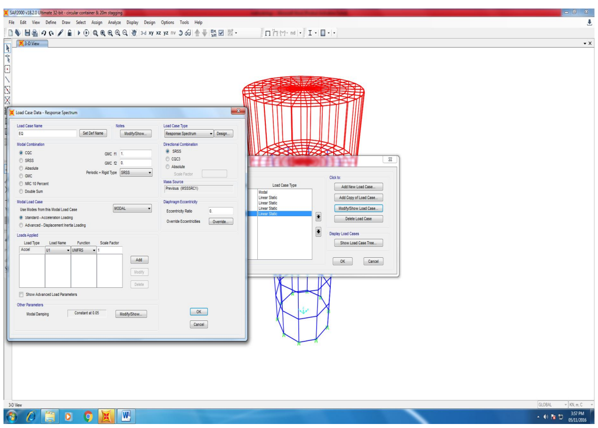


Fig4.2 User graphic face of SAP 2000 while assigning response spectrum load data.

Modelling:

The tank has been modeled as 3D space frame model with six degree of freedom at each node using SAP 2000 software for stimulation of behavior under seismic loading. The support condition is considered as fully fixed. Complete analysis is carried out for dead load, water load & seismic load using SAP 2000. Response spectrum method is used. All load combinations are considered as per IS 1893:2016.

Lateral stiffness of staging is defined as the force required to be applied at the CG of tank so as to get a corresponding unit deflection. As per Section 4.3.1.3(IITK), CG of tank is the combined CG of empty container and impulsive mass. However, in this example, CG of tank is taken as CG of empty container. Finite element software is used to model the staging (Refer Figure 4.1). Since container portion is quite rigid, a rigid link is assumed from top of staging to the CG of tank. From the analysis deflection is calculated at CG of tank due to an arbitrary 10 kN force. Thus, lateral stiffness of staging, Ks = 10 / deflection kN/m Stiffness of this type of staging can also be obtained using method described by Sameer and Jain (1992).

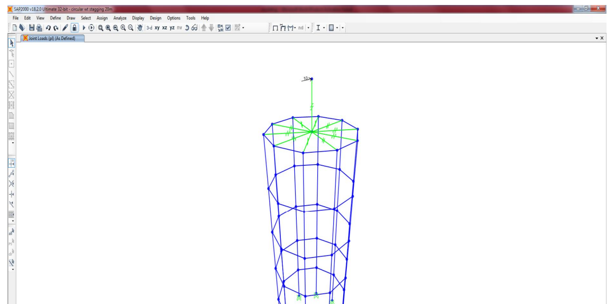
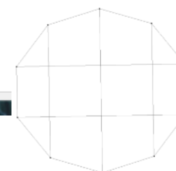


Fig. 4.3: Finite Element model of perimeter staging



(a) (b) (c)

Fig. 4.4: Staging Pattern

(a) -Perimeter staging

(b) – Radial Staging

(c) – Cross staging

V. RESULTS

5.1 Objective

The main aim of this exercise is to increase the general knowledge and proficiency in

Nonlinear analysis (pushover analysis) of water tank using structural analysis software. The expectation is that the results will provide enough information about structural vulnerabilities under earthquake actions and necessary retrofitting measures can be taken to increase seismic resistance.

Detailed seismic analysis is done using the software SAP 2000 based on the IITK guidelines based on codes IS 1893-2016 for seismic zone III. Two-dimensional Nonlinear Static Pushover Analysis was performed to evaluate load deformation characteristics of circular water tank with and without viscoelastic damper and examine the differences in strength capacity

Figure 5.1 shows base shear Vs. monitored displacement for circular water tank with perimeter, radial, cross, perimeter with VED, radial with VED and cross with VED bracing pattern for 2.5 m staging interval

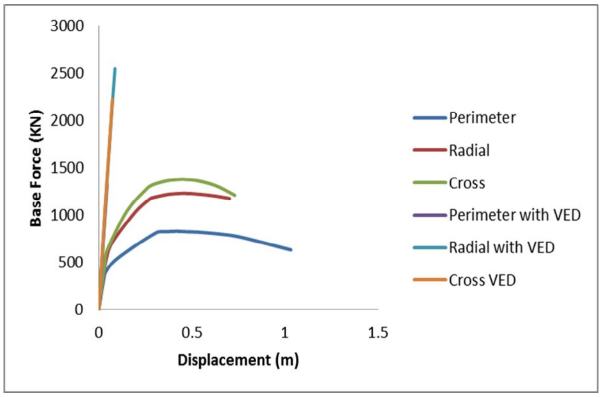


Fig. 5.1 Pushover Capacity Curve Base shear Vs. Monitored Displacement – Staging interval 2.5m

Figure 5.2 shows base shear Vs. monitored displacement for circular water tank with perimeter, radial, cross, perimeter with VED, radial with VED and cross with VED bracing pattern for 4 m staging interval.

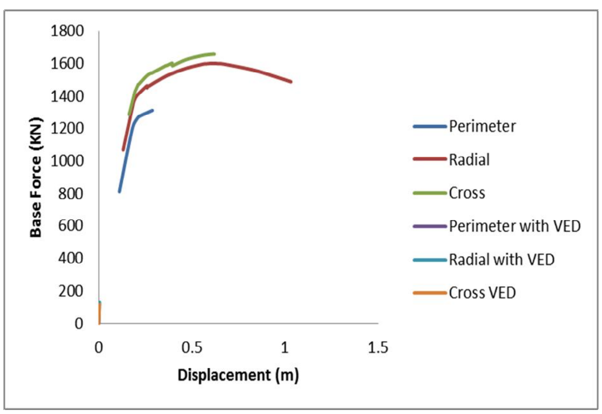


Fig. 5.2 Pushover Capacity Curve
Base shear Vs. Monitored Displacement – Staging interval 4m

Figure 5.3 shows base shear Vs. monitored displacement for circular water tank with perimeter, radial, cross, perimeter with VED, radial with VED and cross with VED bracing pattern for 5 m staging interval.

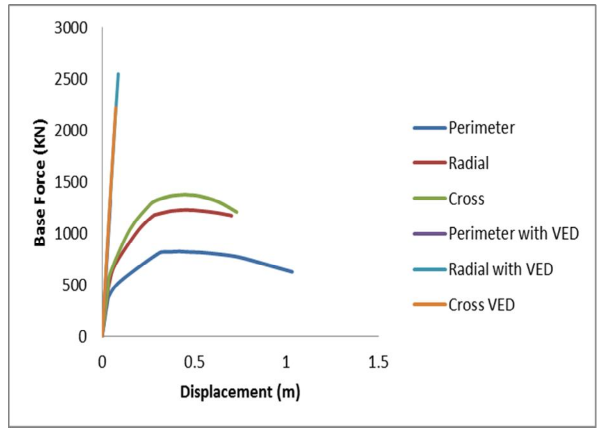


Fig. 5.3 Pushover Capacity Curve
Base shear Vs. Monitored Displacement – Staging interval 5m

VI. CONCLUSION

Detailed seismic analysis is done using the software SAP 2000 based on the IITK guidelines based on codes IS 1893-2016 for seismic zone III. Two-dimensional Nonlinear Static Pushover Analysiswas performed to evaluate load deformation characteristics of circular water tank with and without viscoelastic damper and examine the differences in strength capacity.

Following conclusions are made from study are:

1. Several techniques are available today to minimize the vibration of the structure, out of which concept of using of damper is the one among them. The results of this investigation shows that, the response of structure can be dramatically reduced by using damper without increasing the stiffness of the structure.
2. Comparison of base shear value by linear earthquake analysis and pushover analysis is done in which pushover analysis shows higher values due to hinge formation mechanism.
3. Comparison of lateral displacement by linear earthquake analysis and pushover analysis is done in which pushover analysis shows lower values in staging with damper due to hinge formation mechanism.
4. Base force versus targeted displacement curves are plotted for all models, staging without damper crosses more target displacement than staging with dampers.
5. Bar diagram shows base shear is high for staging without damper models and less for frame with damper model.
6. Maximum lateral displacement is maximum for frame without damper model. Frame with

viscoelastic damper reduces lateral displacement upto 60%. Hence response of structure is increased by combination of dampers.

Future Scope

1. The study can be further extended to analysis of irregular building.
2. Irregular buildings with different position of shear wall can be analysed.
3. Analysis can be done by using software ETAB 2016, STAAD- pro etc.
4. Analysis can be carried out using Time history method.
5. Comparison of Time history method and response spectrum method can be done.
6. Analysis can be doing with different soil conditions.
7. Analysis can be done with different ground slope.

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