International Journal of Scientific Research and Engineering Development-– Volume 5 Issue 4, July- Aug 2022

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Seismic Behavior of RC Frame Structure Using Various Types of Viscous Damping

Ms. Pallavi Chawale,[1] Prof. Mrs. Kariappa M.S.[2]

[1]Student, Department of Civil Engineering, M.S. Bidve Engineering College,Latur

[2] Assistant Professor Department of Civil Engineering, M.S. Bidve Engineering College,Latur

Abstract:

This is accomplished by engineering buildings to be ductile and allowing them to give in response to intense earthquake ground movements. Yielding results in a loss of stiffness and strength, an increase in interstory drifts, and irreversible drift damage, which renders the structure inoperable.

In this work, the influence of various capacities of FVD for step-back steel buildings is investigated using ETABs for analytical investigation. This research concludes that when the capacity of FVD grows, the response of RC frame buildings to base shear, top storey displacement, and storey drift increases.

linear viscous damping has the least harmful impact on the isolated structure when damping is required to lessen displacement demands in the isolation system. In addition, the research suggests that secondary system design must account for potential inaccuracies in the analytical prediction of peak floor accelerations and floor response spectra.

***Keyword: -* Dampers, Tall Building of Rc Frames, Storey Drifts, Lateral Displacements, Base Shear In The Building.**

I. INTRODUCTION

Buildings around the world is subject to various loading conditions. During the design of a buildings, the designer must estimate the loads related to the buildings itself, for example the static forces due to connections. However, the buildings would also possibly be affected by external excitations, such as earthquakes. These disturbances induce undesired vibrations in the buildings, make people uncomfortable, cause damage to the structure and the equipment, and reduce the life of the buildings. Because the disturbances is dynamic in nature and highly uncertain with respect to magnitude and arrival times, the uncertainties make the design challenging at times.

Design of conventional structures specified by the codes is based on the philosophy that the structure should withstand seismic loads while sustaining an acceptable level of damage. Structures is designed to prevent collapse but their serviceability and functionality in the aftermath of strong earthquake ground motion is not taken into consideration. This is achieved by designing structures to be ductile and letting them yield when subjected to strong earthquake ground motions. Yielding leads to stiffness and strength degradation, increased inter story drifts, and damage with permanent drifts, which render the structure non-functional.

A. Relevance

During an earthquake a finite amount of seismic energy enter into structure as input. This input energy must be either absorbed or dissipated through heat. If there were no damping, vibrations would exist for all time. Although structure have some inherent damping within it, which withdraw energy from structure and reduce amplitude of vibration. The structural performance can be improved if energy absorption within the structure is increased by means of adding an 'Energy Absorption Device'. All methods of response control come into practice have one or more disadvantages I) Active control system – requires continuous power supply along with real time data processing with increase the chance of failure in seismic event, II) Semi-Active control system- requires nominal power but real time feedback is must, III) Passive control system – no necessity of power supply and real time feedback but in some seismic response control parameters it shows ineffectiveness. To overcome these issues have led to the development in recent years of structural systems that incorporate the nonlinear characteristics of yielding structures and encompass self-centering properties allowing the structure to return to its original position after an earthquake.

Vibration control is having its ancestry initially in aerospace problems such as poking and tracking, and in space structures which is flexible, but the roots of technology rapidly moved to civil and infrastructure-related concern, such as the protection of bridges and buildings from severe loads of earthquakes and winds loadings. Many low-rise, medium rise and high rise buildings is constructed in the entire world which is beyond our imagination. Chiefly these structures have low natural damping. So today's world need is for increasing damping capacity of a structural system, or finding other mechanical means for increasing the damping capacity of a structure. But, now it should be made compulsory to design the damping system and incorporate in the structure to increase the overall effectiveness of the structure.

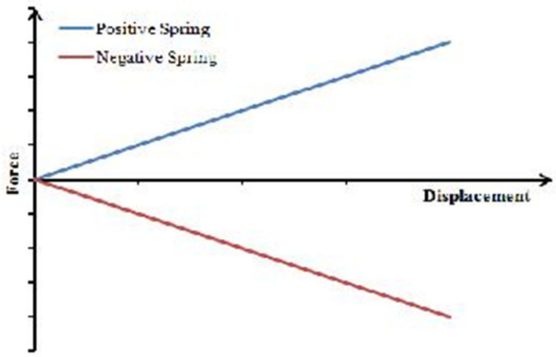


Fig 1. 1 Relation between Force and Displacement along with Stiffness.

The application of negative-stiffness concept to massive structures, like buildings and bridges, requires modification of the existing mechanisms to reduce the demand for preload force and to "package" the negative stiffness device in a system that does not impose any additional loads on the structure, other than those needed for achieving the goal of seismic protection.

II. OBJECTIVES

1. To study the behavior of tall structures with dampers when subjected to along seismic loads with different zones.
2. To investigate behavior of Tall building of RC frames using viscous dampers (VD).
3. To interpret comparative seismic responses of the 18-story RC frames using the three types of zones.
4. Validation of results by software and literature.
5. To determine the effect of different dampers on various parameters like storey drifts, lateral displacements and base shear in the building.

III. LITERATURE REVIEW

1. M.C. Constantinou et. Al., 1993

This article discusses additional damping devices that are used to regulate the seismic response of structures. The mechanical features of these devices are reviewed, as well as design concerns for energy absorption systems. Retrofitted buildings with extra damping devices exhibit the behaviour of a moment-resisting frame rather than a braced frame. The forces generated by the devices result in the development of extra axial forces in the columns. This additional axial force occurs in phase with the peak drift in frictional, steel yielding, and viscoelastic devices, and thus affects the safety of loaded columns. This is a critical design factor that may put restrictions on the deployment of these devices in tall structures. A notable exception to this rule is a certain kind of fluid damper that shows basically linear viscous behaviour.

2. FABIO MAZZA et. Al., 2009

The nonlinear seismic response of base-isolated framed structures exposed to near-fault earthquakes is investigated in order to determine the influence of extra damping at the isolation system level, which is often used to avoid using excessively large isolators. A numerical research is conducted using two- and multiple-degree-of-freedom methods to simulate medium-rise base-isolated framed structures. A typical five-story reinforced concrete (RC) plane frame with complete isolation is constructed in accordance with Eurocode 8 under the assumption of ground types A (i.e., rock) and D (i.e., moderately soft soil) in a seismically active location. An analogous viscoelastic linear model is used to describe the total isolation system, which is composed of parallel high-damping laminated rubber bearings (HDLRBs) and supplementary viscous dampers. A bilinear model idealises the frame members' behaviour. Artificial pulse-type movements, artificially created accelerograms (according to the EC8 response spectrum for subsoil classes A.

3.D.G. Weng et. Al., 2012

In China, particularly in the aftermath of the Wenchuan earthquake, viscous dampers (VD), steel dampers (SD), and viscoelastic dampers (VED) are the most often used energy dissipation devices for seismic applications. To investigate the seismic impact of these three kinds of dampers, an eight-story reinforced-concrete (RC) frame structure is constructed using a damaged RC structure from the Wenchuan earthquake. The technique for retrofitting a building with dampers is briefly described. The specifications of the three kinds of dampers are chosen such that their maximum damping forces are equal during a mild earthquake.

4.O. Lavan et.al., 2015

This article investigates the sensitivity of ideally damped frames' reaction to structural and damping property uncertainty. To begin, viscous dampers are optimised for the nominal attributes of retrofitted buildings and a specified ensemble of recordings for each structure. The behaviour of the retrofitted buildings (in terms of the maximum envelope peak inter-story drift) is then evaluated using Monte Carlo simulations, taking into account uncertainty in their own and the dampers' characteristics. It is shown that uncertainties result in bigger mean drifts than predicted and that particular designs are more susceptible than others. The physical causes for this behaviour are explained, as well as some guidelines for which designs should be considered more sensitive.

IV. METHODOLOGY

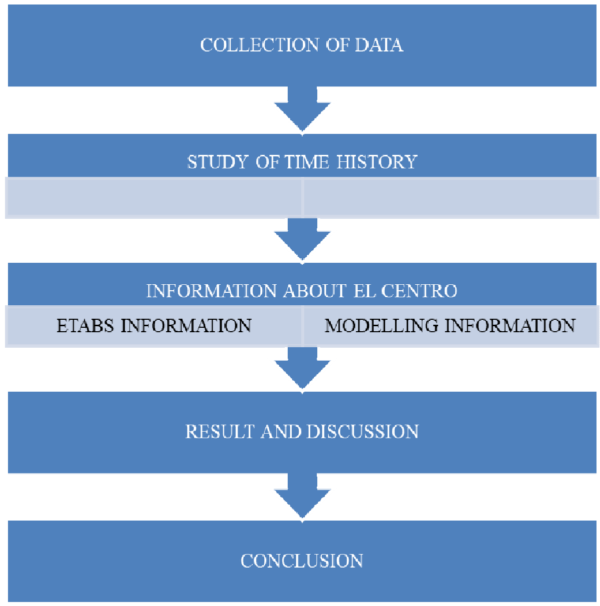


Fig: Flowchart

A) Mathematical Modeling as SDOF

1. Single Degree of Freedom Systems

The basic analytical model used in most blast design applications is the single degree of freedom (SDOF) system. A discussion on the fundamentals of dynamic analysis methods for SDOF systems is given below which is followed by descriptions on how to apply these methods to structural members.

Basics: -

All structures, regardless of how simple the construction, possess more than one degree of freedom. However, many structures can be adequately represented as a series of SDOF systems for analysis purposes. The accuracy obtainable from a SDOF approximation depends on how well the deformed shape of the structure and its resistance can be represented with respect to time. Sufficiently accurate results can be obtained for primary load carrying components of structures such as beams, girders, columns, wall panels, diaphragm slabs and shear walls.

The majority of dynamic analyses performed in blast resistant design is made using SDOF approximations. Common types of construction, such as single story plane frames, cantilever barrier walls and compact box-like buildingss is approximated as SDOF systems. Several examples of such structures is illustrated in Figure

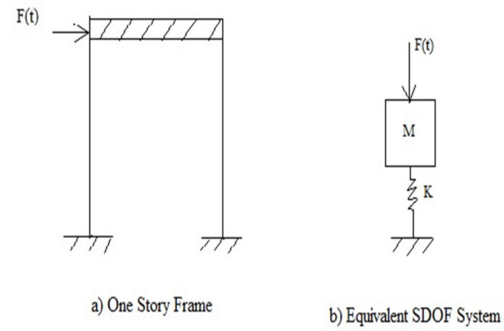


Fig: SDOF System

V. PROBLEM STATEMENT

Table:1. Parameters to Be Consider for Rectangular Geometry Analysis

Sr. No.	Parameter	Values
1.	Number of stories	G+18
2.	Base to plinth	1.5m
3.	Grade of concrete	M30
4.	Grade of steel	Fe 500
5.	Floor to Floor height	3 m
6.	Parapet Ht.	1m
7.	Total height of Building	58m
8.	Soil Types	Medium
9.	Floor Finish Load	1 Kn/m2
10.	Dead Load	Calculated By
11.	Wall Load	9 Kn/m2
12.	Imposed Load	3 Kn/m2
13.	Seismic zone	Zone III
14.	Terrain Category	Type II
15.	Frame size	18m X 18m building
16.	Grid spacing	6 m grids in X-
17.	Size of column	750mm x 750mm
18.	Size of beam	300mm x 500 mm
19.	Depth of slab	125 mm

Table:2. Software Development 3D FEM Model High Rise Structure Having Different Damper Conditions:

1.	g+18 damper model with viscous damper zone II (250 kn)
2.	g+18 damper model with viscous damper zone iii (250 kn)
3.	g+18 damper model with viscous damper zone iv (250 kn)
4.	g+18 damper model with viscous damper zone v (250 kn)
5.	g+18 damper model with viscous damper zone ii(500 kn)
6.	g+18 damper model with viscous damper zone iii (500 kn)
7.	g+18 damper model with viscous damper zone iv (500 kn)
8.	g+18 damper model with viscous damper zone v (500 kn)
9.	g+18 damper model with viscous damper zone ii (750 kn)
10.	g+18 damper model with viscous damper zone iii (750 kn)
11.	g+18 damper model with viscous damper zone iv (750 kn)
12.	g+18 damper model with viscous damper zone v (750 kn)
13.	g+18 damper model with viscous damper zone ii (1000 kn)
14.	g+18 damper model with viscous damper zone iii (1000 kn)
15.	g+18 damper model with viscous damper zone iv (1000 kn)
16.	g+18 damper model with viscous damper zone v (1000 kn)

VI. MODELLING

Fig 5. 1Elevation view

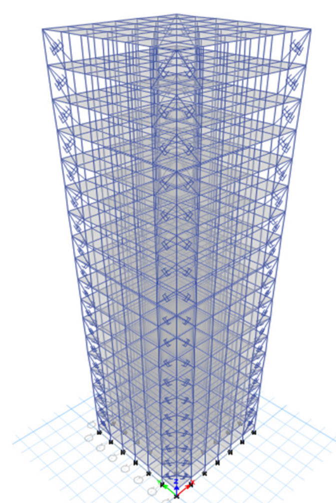


Fig 5. 2 3D view

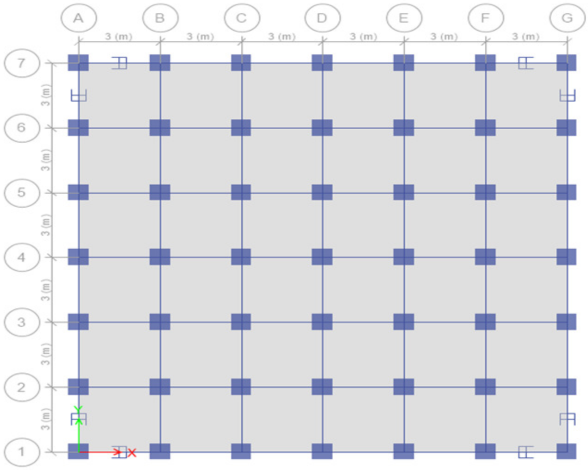
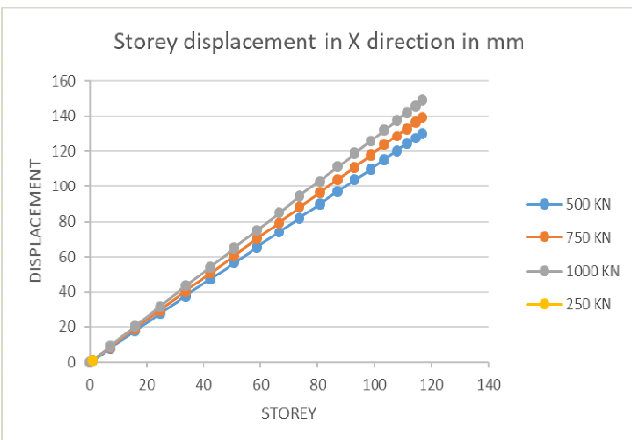
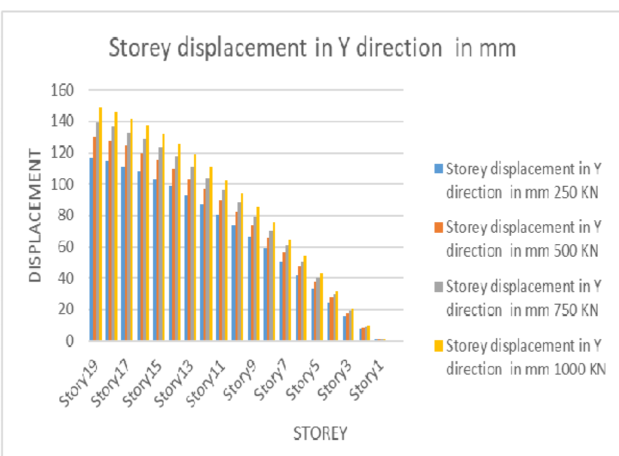


Fig 5. 3 Plan view

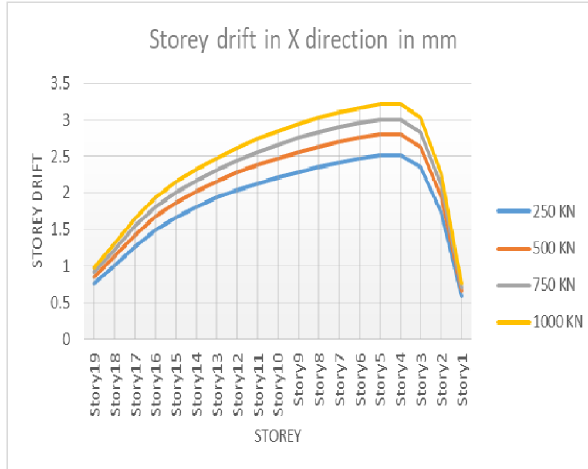
VII. RESULT AND DISCUSSION



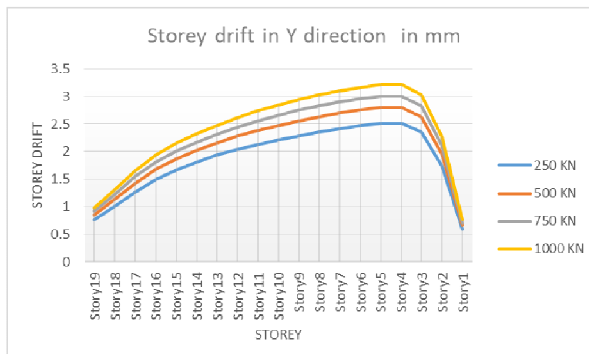
Graph: 1 Storey displacement in X direction in mm



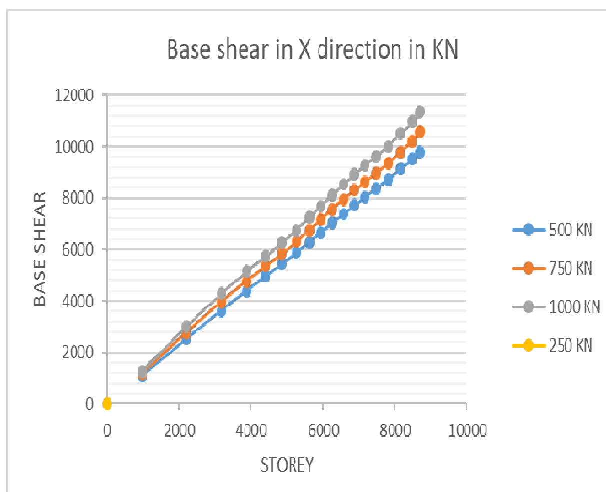
Graph: 2 Storey displacement in Y direction in mm



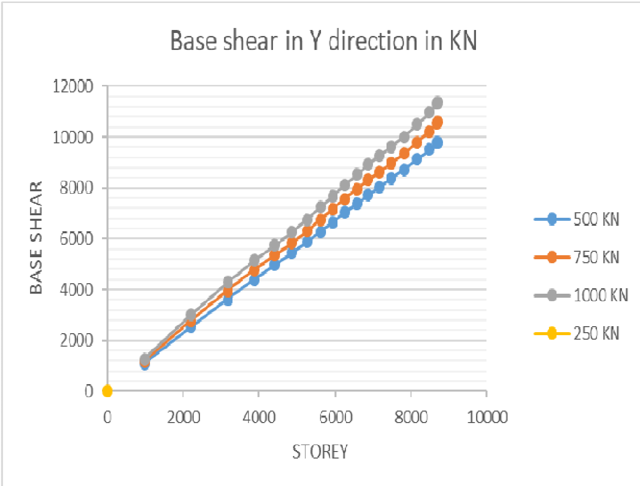
Graph: 3 Storey drift in X direction in mm



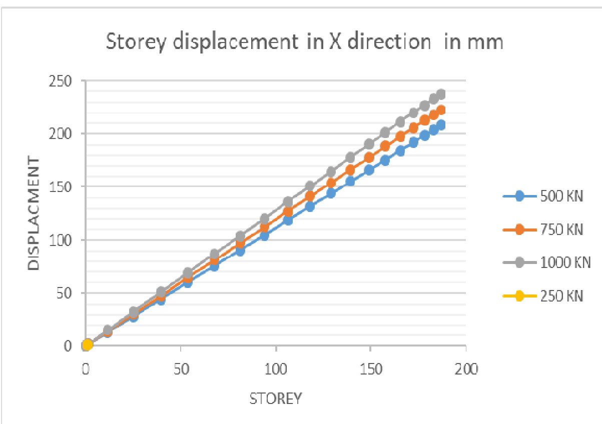
Graph: 4 Storey drift in Y direction in mm



Graph: 5 Base shear in X direction in KN

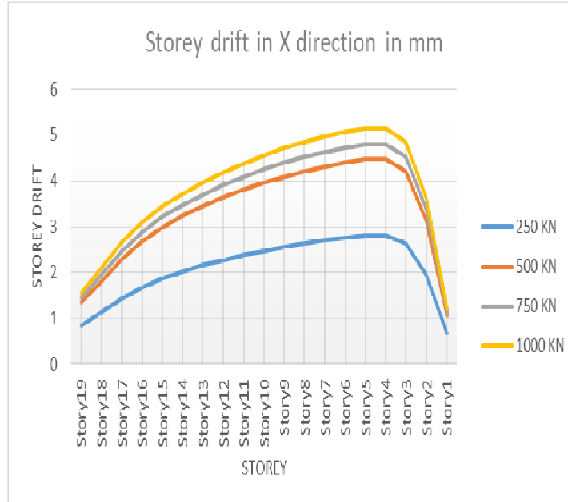


Graph: 6 Base shear in Y direction in KN

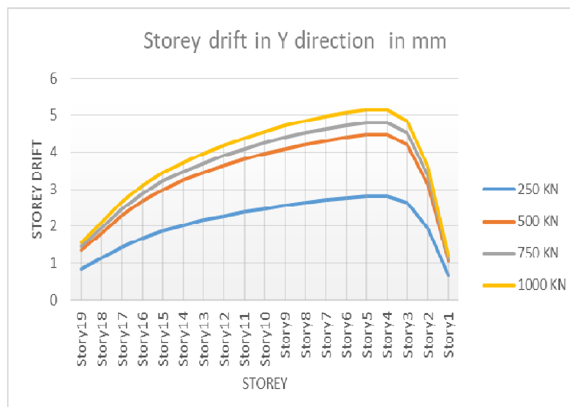


Graph: 7 Storey displacement in X direction in mm

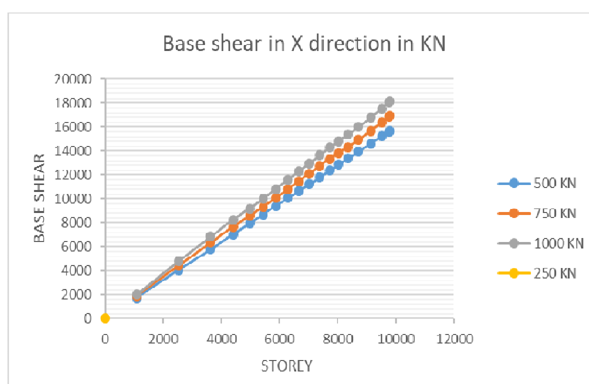
Graph: 8 Storey displacement in Y direction in mm



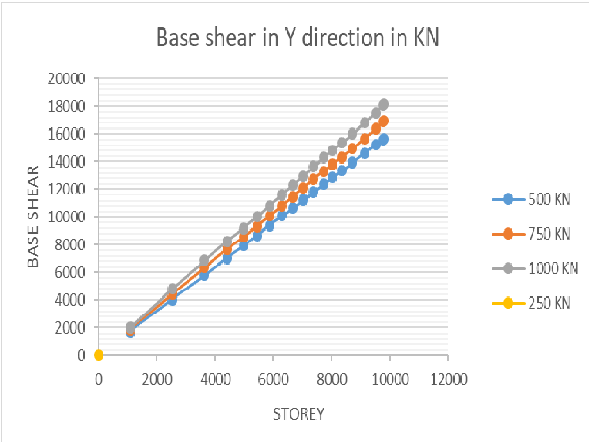
Graph: 9 Storey drift in X direction in mm



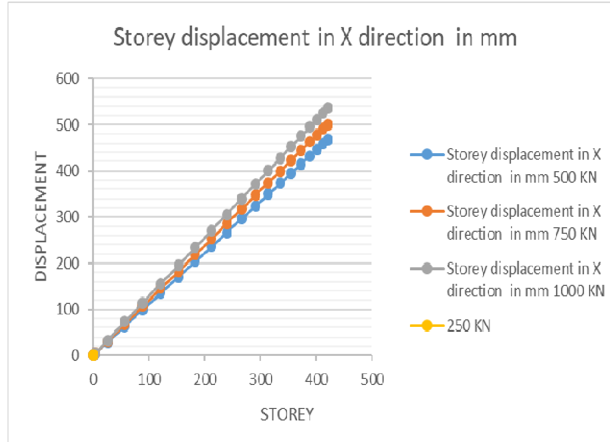
Graph: 10 Storey drift in Y direction in mm



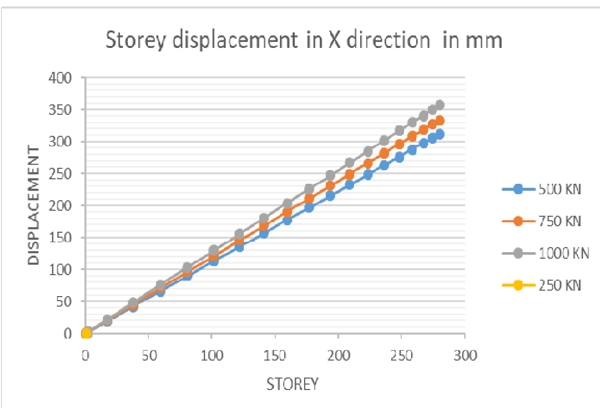
Graph: 11Base shear in X direction in KN



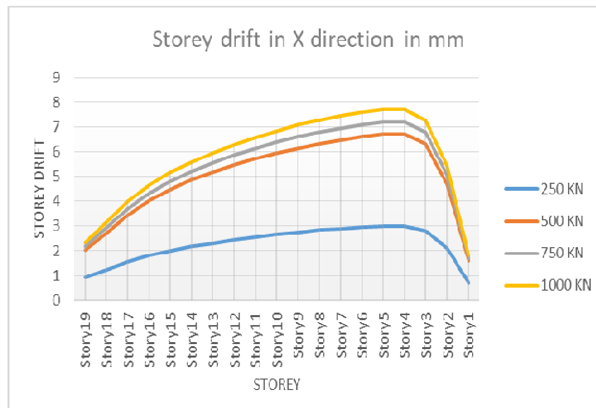
Graph : 12 Base shear in Y direction in KN



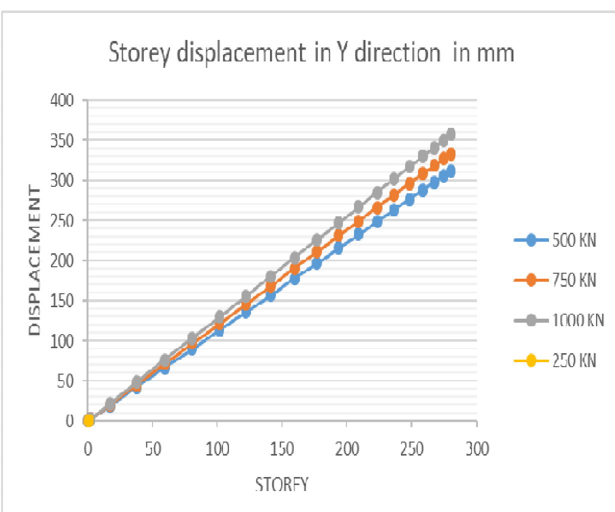
Graph: 15 Storey displacement in X direction in mm



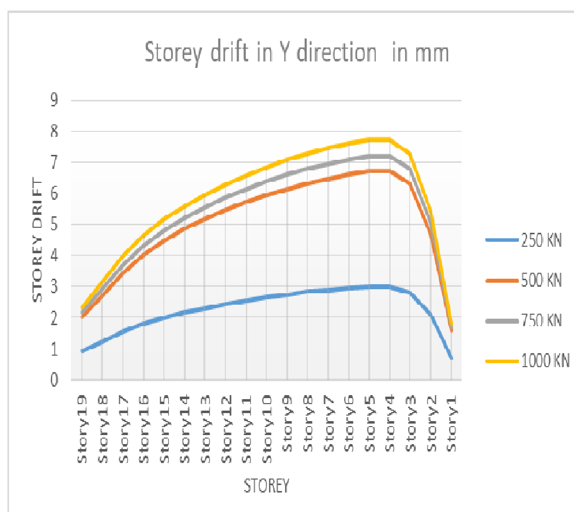
Graph : 13 Storey displacement in X direction in mm



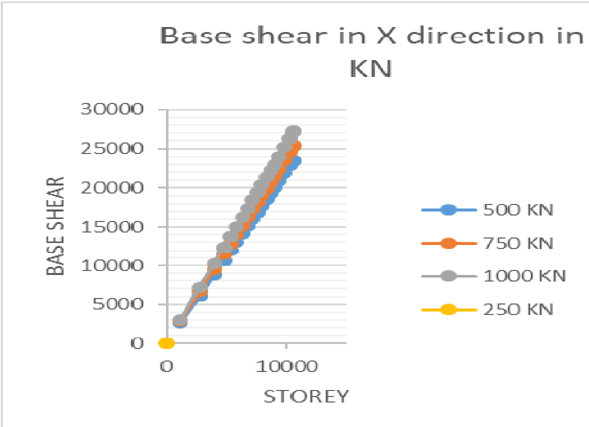
Graph : 16 Storey drift in X direction in mm



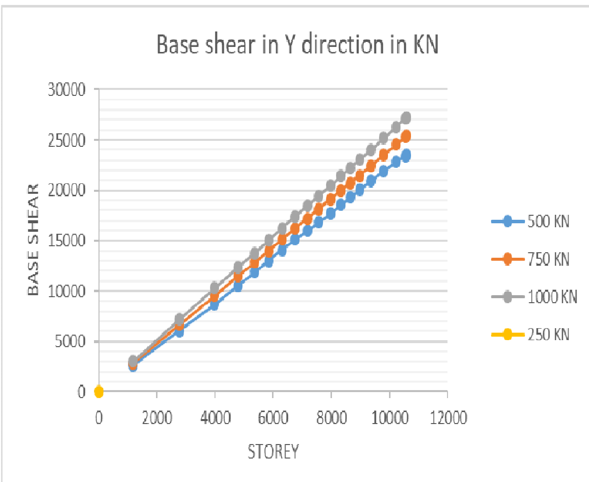
Graph: 14Storey displacement in Y direction in mm



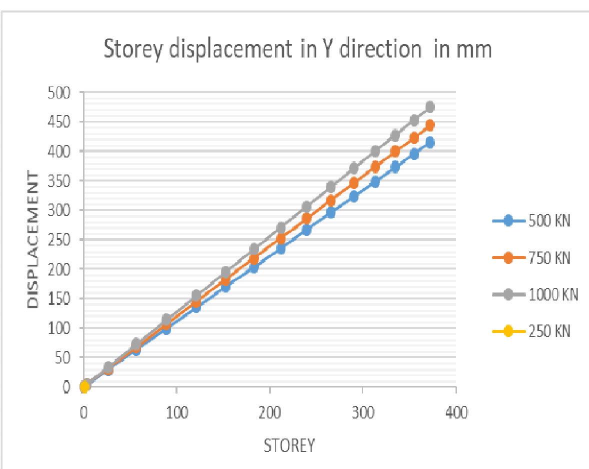
Graph : 17 Storey drift in Y direction in mm



Graph: 18 Base shear in X direction in KN



Graph :19 Base shear in Y direction in KN



Graph : 20 Storey displacement in Y direction in mm

VIII. CONCLUSION

There are various types of dampers available in the market as per their capacities and weights. For present study viscous dampers with different capacities are used for reducing the response of building.

- The viscous damper is applied as link property in ETABS. The damper is modelled only along diagonal direction.
- In the present study, the effect of different capacities of FVD for step-back steel building is studied for an analytical research approach in ETABs for analysis.
- From this study, is concluded that, the response of RC frame building for base shear, top storey displacement and storey drift is increases when capacity of FVD increases. Hence for different seismic events, it is found that the response of building under horizontal ground motion is critical for seismic event.
- Therefore, the RC frame building should be design separately for the seismic event of maximum peak ground acceleration. Also, it is observed that the higher capacity dampers can be used to improve the performance of RC frame buildings.

REFERENCES

1. Alam, Z., Zhang, C., & Samali, B. (2020). The role of viscoelastic damping on retrofitting seismic performance of asymmetric reinforced concrete structures. Earthquake Engineering and Engineering Vibration, 19(1), 223–237. https://doi.org/10.1007/s11803-020-0558-x

2. Chang, K. C., Soong, T. T., Oh, S.-T., & Lai, M. L. (1995). Seismic Behavior of Steel Frame with Added Viscoelastic Dampers. Journal of Structural Engineering, 121(10), 1418–1426. https://doi.org/10.1061/(asce)0733-9445(1995)121:10(1418)

3. Constantinou, M. C., & Symans, M. D. (1993). Seismic response of structures with supplemental damping. The Structural Design of Tall Buildings, 2(2), 77–92. https://doi.org/10.1002/tal.4320020202

4. Dong, Y. R., Xu, Z. D., Li, Q. Q., Xu, Y. S., & Chen, Z. H. (2019). Seismic behavior and damage evolution for retrofitted RC frames using haunch viscoelastic damping braces. Engineering Structures, 199(July), 109583. https://doi.org/10.1016/j.engstruct.2019.109583

5. Habib, A., Yildirim, U., & Eren, O. (2021). Seismic Behavior and Damping Efficiency of Reinforced Rubberized Concrete Jacketing. Arabian Journal for Science and Engineering, 46(5), 4825–4839. https://doi.org/10.1007/s13369-020-05191-1

6. Hu, B., Lv, H. L., & Kundu, T. (2019). Experimental study on seismic behavior of reinforced concrete frame in primary and middle schools with different strengthening methods. Construction and Building Materials, 217, 473–486. https://doi.org/10.1016/j.conbuildmat.2019.05.040

7. Lavan, O., & Avishur, M. (2013). Seismic behavior of viscously damped yielding frames under structural and damping uncertainties. Bulletin of Earthquake Engineering, 11(6), 2309–2332. https://doi.org/10.1007/s10518-013-9479-7

8. Lu, X. L., Ding, K., & Weng, D. G. (2012). Comparative Study on Seismic Behavior of RC Frame Structure Using Viscous Dampers , Steel Dampers and Viscoelastic Dampers. 15th World Conference on Earthquake Engineering, Lisbon Portugal.

9. Mazza, F., & Vulcano, A. (2009). Nonlinear response of RC framed buildings with isolation and supplemental damping at the base subjected to near-fault earthquakes. Journal of Earthquake Engineering, 13(5), 690–715. https://doi.org/10.1080/13632460802632302

10. Shahriari, A., Birzhandi, M. S., & Zafarani, M. M. (2021). Seismic behavior, blast response and progressive collapse of RC structures equipped with viscoelastic dampers. Soil Dynamics and Earthquake Engineering, 143(January), 106643. https://doi.org/10.1016/j.soildyn.2021.106643