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

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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.

Keywords- 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.

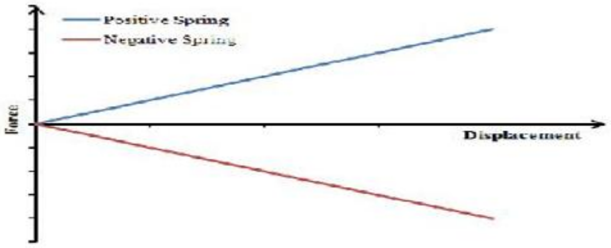


Fig 1. 1 Relation between Force and Displacement along with Stiffness.

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. Tribikram Kundu et. Al., 2019

Numerous single-span reinforced concrete (RC) frames have been severely damaged or collapsed in prior earthquakes due to insufficient lateral stiffness and structural redundancy. The current article describes an experimental investigation of the seismic performance of restored single-span RC frames. Four frames were reinforced utilising a variety of retrofit procedures, while one frame that was not retrofitted served as a reference specimen. All of these frames were constructed and subjected to cyclic stress. Each frame was examined for its failure modes, hysteretic behaviour, skeleton curve, energy dissipation, strength, and stiffness degradation. The validity of several strengthening techniques for enhancing the failure mechanisms and seismic performance of frames was established. The test findings revealed that the reinforced frames' strength, rigidity, and a variety of seismic properties were significantly enhanced**.**

2.Yao-Rong Dong et.al., 2019

To upgrade existing RC frame structure systems with insufficient seismic design and to improve the seismic design of RC frame structures, this study presents a novel and advanced frame structure system retrofitted with haunch viscoelastic damping braces (HVEDB) based on its superior energy dissipation performance, low cost, and non-invasive addition of viscoelastic dampers. To conduct a thorough and systematic investigation of this new structure system, the seismic behaviour of ten RC frames and ten additional RC frames added by HVEDB with an axial load ratio (ALR) of 0.1–1.0 is investigated under horizontal sinusoidal steady-state excitation loading, including hysteretic behaviour, load-bearing capacity, stiffness degradation, energy dissipation capacity, additional damping ratio, and rebar strain at key locations. On this premise, four plausible material-scale damage indicators are provided, and a comparison investigation of the material-scale damage progression for two different kinds of frames is conducted throughout the procedure**.**

3. Zeshan Alam et. Al., 2020

The fundamental objective of this study is to use viscoelastic (VE) dampers to enhance the seismic response of a complicated asymmetric tall building. Asymmetric structures have a detrimental effect on seismic performance because they introduce abrupt changes in stiffness or strength, which can result in unfavourable stress concentrations at weak points. Structural control devices are an effective method of mitigating seismic effects, especially in asymmetric constructions. VE dampers are regarded to be one of the most favoured energy dissipation devices for passive vibration control of buildings. Thus, in this research, VE dampers are installed strategically throughout a realistic case study building to maximise distributed damping without consuming significant architectural space and to reduce seismic vibrations in terms of storey displacements (drifts) and other design forces.

4. Alireza Shahriari et. Al., 2021

The performance of viscoelastic dampers intended for seismic loading was explored in this work for the purpose of protecting reinforced concrete special moment frame (RC-SMF) structures against blast loading. Additionally, the slow collapse of these buildings owing to an explosion has been investigated. This research used three reinforced concrete buildings with three, six, and fifteen levels. All three buildings are fitted with seismic viscoelastic dampers and use a specific moment frame as the lateral resisting mechanism. The obtained findings validated the effectiveness of seismic viscoelastic dampers d in dampening the response of buildings to blast loading, particularly in low-rise structures and lower floors of high-rise structures.

5. K. C. Chang et. Al.,

This article summarises the findings of a comprehensive investigation on the seismic behaviour of a viscoelastically damped structure subjected to moderate and severe ground movements during earthquakes. Shaking-table tests were performed on a two-story steel model with extra viscoelastic (VE) dampers for a range of ambient temperatures, damper placement scenarios, and earthquake intensities. Three distinct kinds of VE dampers were employed, each with a unique size and viscoelastic substance chosen to offer a comparable damping ratio at room temperature. Analytical investigations were conducted to anticipate the viscoelastically damped structure's equivalent damping ratios and seismic response.

IV. METHODOLOGY

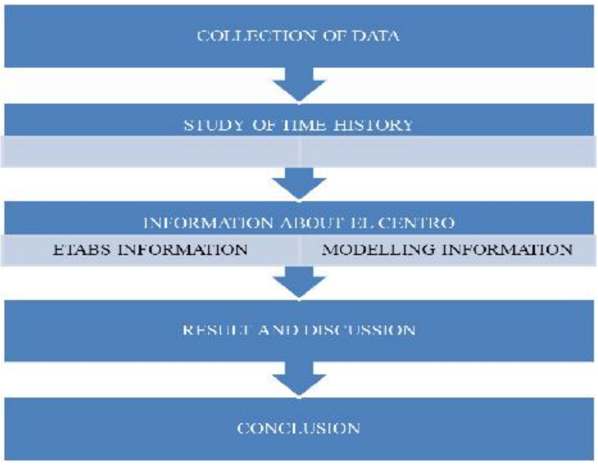


Fig: Flowchart

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

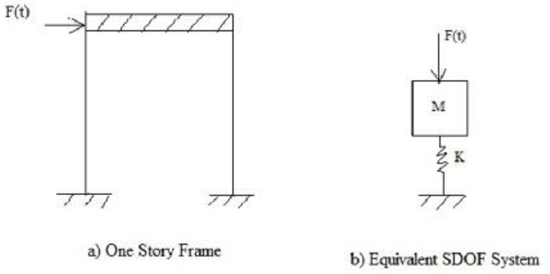
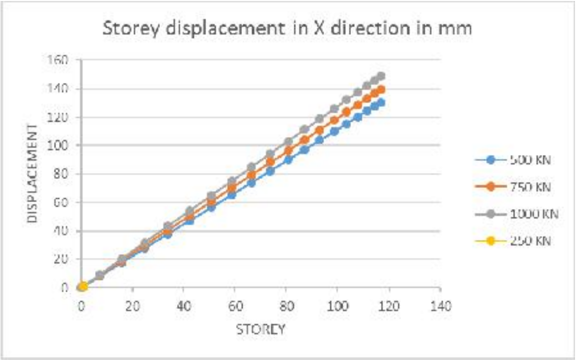
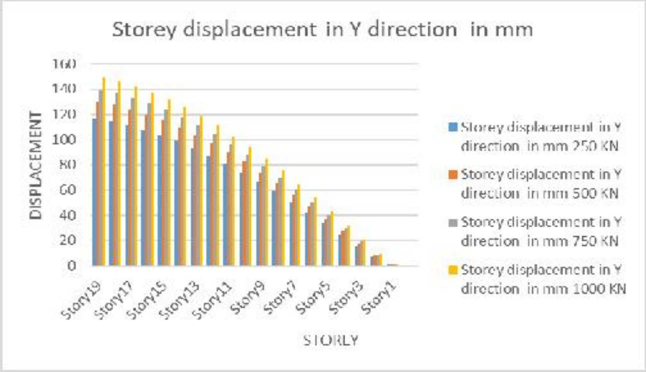


Fig: SDOF System

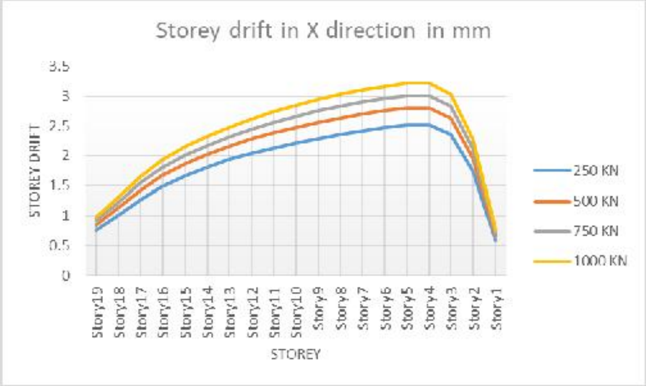
V. RESULT AND DISCUSSION



Graph: 1 Storey displacement in X direction in mm

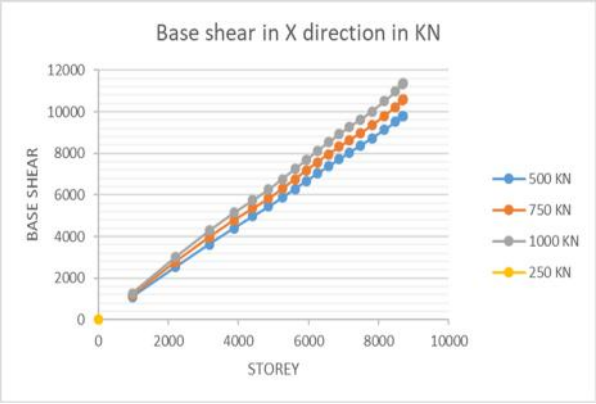


Graph: 2 Storey displacement in Y direction in mm

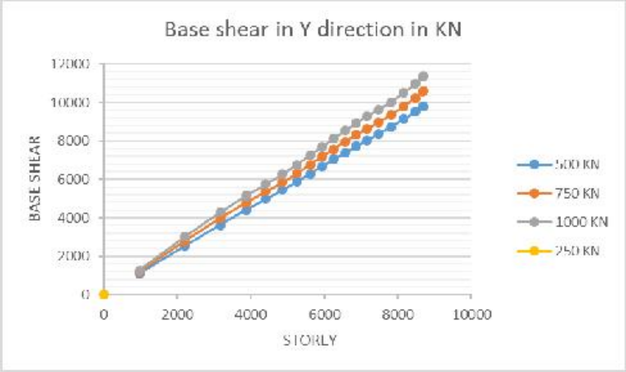


Graph: 3 Storey drift in X direction in mm

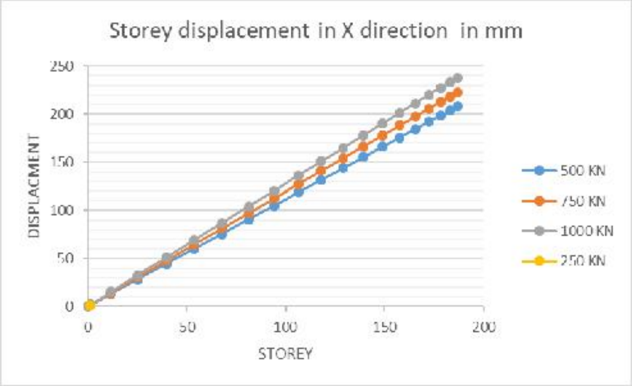
Graph: 4 Storey drift in Y direction in mm



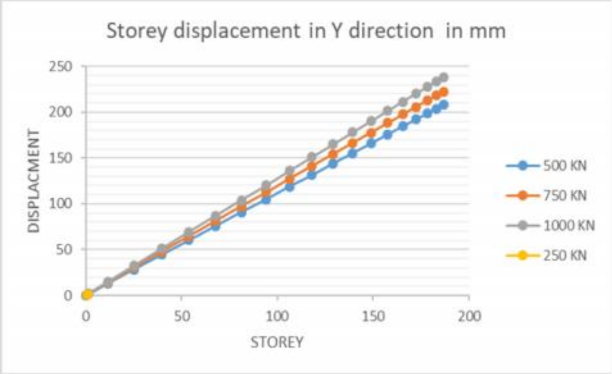
Graph: 5 Base shear in X direction in KN



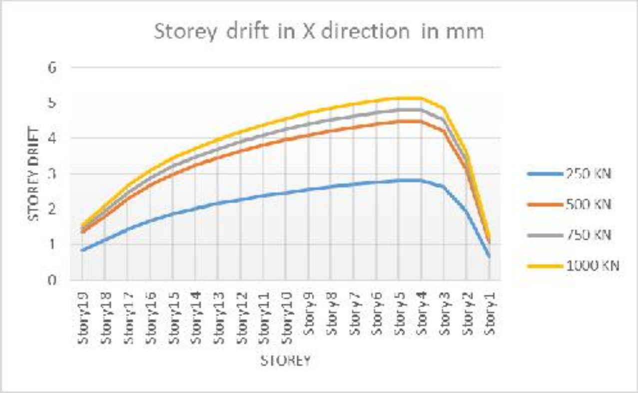
Graph: 6 Base shear in Y direction in KN



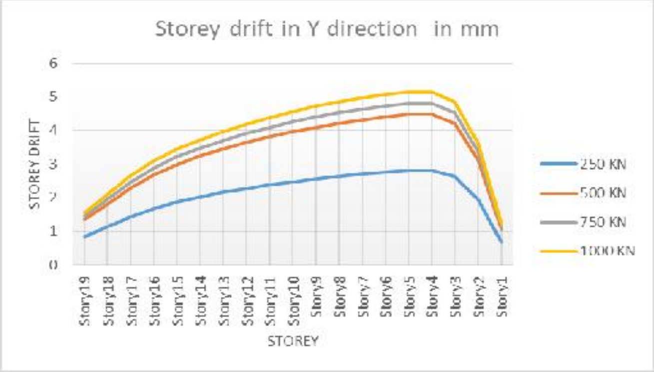
Graph: 7 Storey displacement in X direction in mm



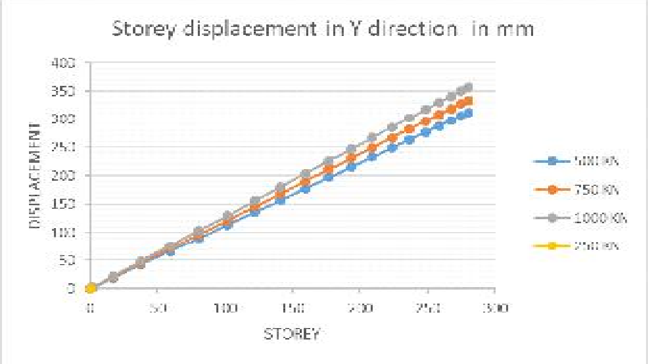
Graph: 8 Storey displacement in Y direction in mm



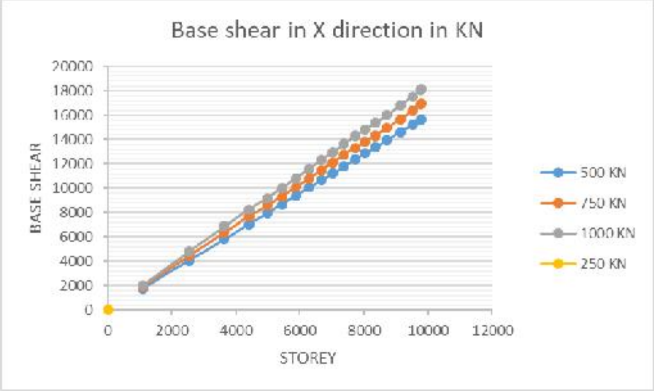
Graph: 9 Storey drift in X direction in mm



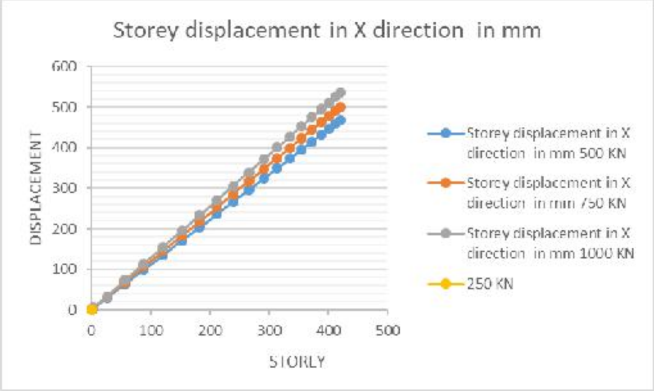
Graph: 10 Storey drift in Y direction in mm



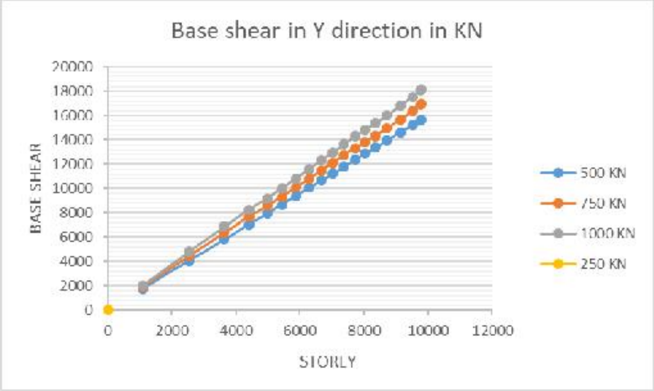
Graph: 14Storey displacement in Y direction in mm



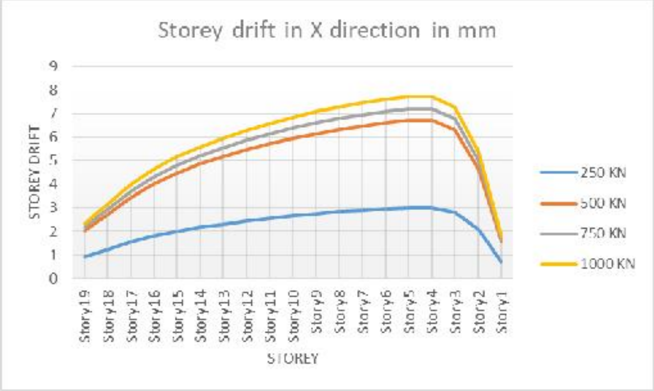
Graph: 11Base shear in X direction in KN



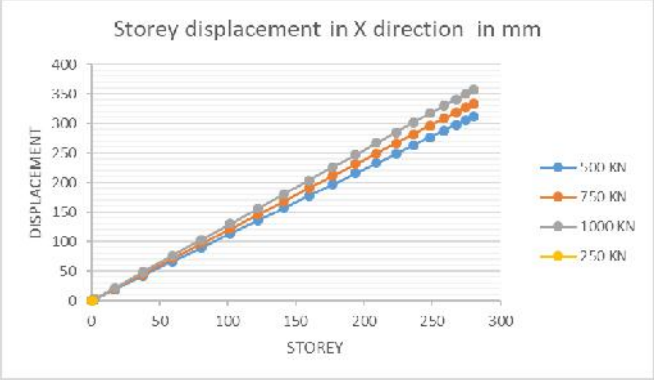
Graph: 15 Storey displacement in X direction in mm



Graph : 12 Base shear in Y direction in KN

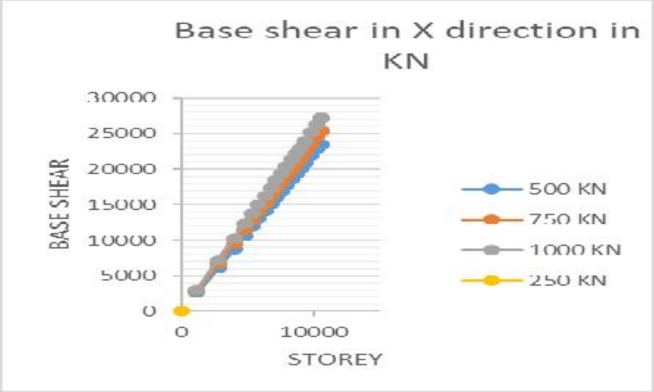


Graph : 16 Storey drift in X direction in mm

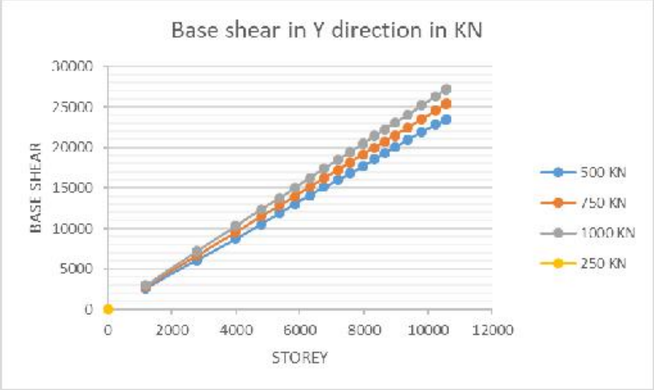


Graph : 13 Storey displacement in X direction in mm

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

VI. 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.

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