

A COMPARATIVE STUDY ON SEISMIC ANALYSIS OF A RCC FRAMED REGULAR AND IRREGULAR STRUCTURES BY USING FLUID VISCOUS AND METALLIC DAMPERS

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Abstract: Among all the disastrous events, for example, flood, twisters, typhoons, earthquakes, and drought the least comprehended and the most damaging one is earthquake. They are typically affected when rock underground break down along a fault and these seismic events are the most important natural hazards and can cause dangerous destruction by increasing the energy inside the structure. Since the forces applied on a structure are dynamic in nature, they cause vibrations inside the composition and they also increase the energy within the structural system. The major job of a structure is to take the lateral loads and carrying them to the foundation. Such undesirable energy can be dissipated by presenting the few control systems, for example, active, hybrid, passive and semi active control systems. The current work incorporates one such dissipating device called dampers. Dampers are the energy dissipating devices which are utilized to resist lateral forces acting up on the structure. They also resist the displacement that occurred in reinforced Concrete buildings during an earthquake. Dampers are utilized to decrease the buckling of columns and deflection of beams and to expand the stiffness of structure and furthermore used to moderate the vibration and twisting of RCC framed structure during earthquakes. There are various kinds of dampers utilized in general. In this current study fluid viscous damper (FVD) and metallic damper are used to resist the energy from earthquakes. Regular and irregular Models will be created with two dampers .i.e. fluid viscous dampers and metallic dampers and to carry out results such as storey displacement, storey drift etc. Different types of analysis methods such as time history analysis and response spectrum method are adapted to study the storey displacement on a G+20 storey RCC framed structure with dampers by using ETABS software. Performance of structures will be found by comparing the reactions as storey displacement and storey drift for regular and irregular structures. The present study compares the performance and effects on RCC frame regular and irregular structural systems by using fluid viscous and metallic passive energy dissipating dampers. These dampers will be used for different regular and irregular modelled structures and at different locations in a building and also in seismic zone V.

Keywords: Natural hazards, undesirable energy, semi active control systems, fluid viscous dampers, storey displacements , regular and irregular structures

I. INTRODUCTION

Natural disaster like earthquake means the sudden vibration of earth by waves evolving from the source of intrusion in the earth by morality of release of energy in the earth's crust by naturally or manually. For the reason that of this, structures can experience a more deflection, depending on type of structure, magnitude of earthquake, zones of earthquake, severity of the earthquake and the structural characteristics. The breakdown of structures can lead to loss of life and property damage therefore structures are designed to resist earthquakes. Structural features such as materials, sectional properties, and also the structural systems have a major effect on horizontal load resisting capability of the structure. However, numerous codes have certain design specifications for seismically secure structures, yet there is yet much need of some changed standards for energy degeneracy protecting systems. The use of these structural control systems is extremely limited in India.

Structures may be regular and also irregular. Regularity of the structure deals with the symmetrical and compact shape of the structure. The importance of regularity of the building is for preventing unpredictable stress intensity that can cause local failures and revision of the vibrant performance. We know that various types of vertical irregular buildings are used in modern infrastructure. The irregular building cannot be avoided during the construction due to space out requirement in the construction field so the tall structure has more requirement. Asymmetrical structures, like structures having an L-shaped plan, that can be defined irregular according to both insightful norms and irregularity of rules

provided by strategies, show that, if the diaphragms are rigid and the columns are distributed according to the shape, size and also the irregularity is outward.

In the current study, an effort has been made for the different models with a RCC frame regular and irregular structural systems will be done by using fluid viscous and metallic passive energy dissipating dampers. These dampers will be used for different regular and irregular modelled structures and at different locations in a building and also in seismic zones like zone V.

Fluid viscous damper is one of the energy degeneracy devices, FVD have been considerably used in the vibration control of various structural and also mechanical systems. These dampers have been commonly used in the military and aerospace industry for several years and have lately been adopted for structural applications in civil engineering. It has the rare ability to instantaneously reduce both deflection and stresses within the structure. A modern-day fluid viscous damper works in significant amounts of fluid pressure, making the damper small, compact and also very easy to install. This type of damper is normally less expensive to obtain, install and maintain than other types of dampers. FVD has a stainless-steel piston rod and a self-contained piston displacement accumulator unit with a bronze shield head. A viscous fluid damper consists of a hollow cylinder filled with a fluid. As the damper piston rod and piston head are stroked, the fluid flows at high velocities, resultant in the progress of friction. A damper repels the dynamic motion and dissipates energy from a structure during wind or seismic events and allows it to withstand dangerous input energy and reduce harmful deflections, forces and accelerations to structures. The damping fluid is silicone oil, which is inert, non-flammable, non-toxic, and stable for enormously long periods of time. These dampers decrease the response of structure which reduces the reaction to several vibration.

Metallic dampers are typically produced using steel. They are intended to distort so much when the building vibrates during an earthquake that they can't come back to their unique shape. This lasting disfigurement is called inelastic deformation, and it utilizes a portion of the seismic earthquake intensity which goes into the building.

In the last periods the problems of structural symmetry has been analysed in an exceedingly sizable amount of papers, which observed the undesirable effects of the dearth of regularity on the flexible and rigid seismic response of structures and suggested design methods ready to limit the risks associated to that. Almost all the seismic codes include common definitions of structural regularity and provisions take aim at regulating negative effects of irregularity. Nevertheless, in many the methodology appears to be generic and generalised, not taking into consideration the end result of research. The fundamental idea presented during this paper is that a building should be believed regular when its seismic response could also be predicted by means of normal geometric and mechanical models and standard methods of research. So as to debate regularity all the various problems connected to the definition of the model and to the choice of the tactic of research must be analysed. Every problem gives rise to specific criteria for regularity, which need to be encountered so as to permit a oversimplification of the model or of the tactic of research. Then it examines the methodologies used for estimating its elastic response, discussing the employment of static and modal analysis and therefore the use of restorative eccentricities for asymmetrical buildings. The third part tackles the matter of the inelastic response and also the effect of stiffness and strength allocation, both in plan and along the height of the building.

Irregular buildings represent an oversized part of the trendy metropolitan infrastructure. The alliance of individuals concerned in constructing the building accommodations, as well as owner, architect, structural engineer, contractor and native organizations, contribute to the general designing, choice of structural system, and to its structure. This could cause the structures with irregular allocations in their mass, stiffness and strength along the peak of the structure. When such buildings are located in an exceedingly high seismic zone, the structural engineer's role turn out to be tougher. Therefore, the structural engineer has to have an intensive knowledge of the seismic response of irregular structures. In the recent past, numerous studies are administered to gauge the response of irregular buildings work that has been previously done per the seismic response of vertically irregular building frames. Buildings with plan irregularities (e.g., individuals with re-entrant corners like L-shape plans on corner plots) and people with elevation irregularities (e.g., large vertical setbacks in elevation like a plaza-type pattern in commercial structures) are common within the impacted area. There are differing types of irregularities that are given in the code are mentioned below. Major disasters occurred because of irregularities like soft storey Failure, Mass Irregularity Failure, Plan Irregularity Failure, Shear Failure.

II. LITERATURE REVIEW

Prashanthi C Sudula and Dr. B. Shiva kumara Swamy (2014):In this undertaking they have examined and analysed the presentation and impacts on underlying frameworks with more metallic, friction, viscous and viscoelastic passive energy dampers for different earthquake zones. They have made an attempt to analyse the dynamic reaction of 2D RC bare frame and RC frame with dampers. Equivalent static examination is completed for all models and for all zones to

acquire static base shear. Of all seismic zones considered (Zone II, Zone III and Zone IV), zone IV is the basic zone with most noteworthy base shear, displacements, and axial force. They have arrived at the resolution that when the dampers are added further to the structures base shear increments because of the addition of self-weight, however displacements decrease because of growth in stiffness when the dampers are added to the framework it rises the stiffness to the frame thereby increasing the strength. Displacements and axial forces for RC frame with dampers are less compared to RC bare frame of the whole dampers utilized viscous damper is noticed to be effective because they have they have lower displacement, lesser drift, lesser axial force and reduced story shear and it very well may be utilized.

Prafful S, Naveen Kumar S (2018): This investigation considers, Performance of working of rectangular and square arrangement in horizontal load and seismic loads in seismic zone V, in light of soil type II (medium soil) and reduction factor 5 is taken from code for special RC moment-resisting frame. It is assessed by Static and Response Spectrum analysis for different load combinations according to: 1893:2002. Analysis of these structural systems is processed utilizing E-TABS 2015 software. To check the performance of the building by considering, storey displacement of both building with and without Fluid viscous damper (FVD). The object of the research is to analyse the outcomes achieved from static and response spectrum analysis of rectangular structure with square and rectangular column cross section and square structure with square and rectangular column cross section with and without FVD. It is also seen that in a square frame it is symmetric in both the directions, the response quantities are likewise identical in both the directions. Fluid viscous dampers can dissipate the maximum portion of the seismic energy and hence reduce the energy input in the primary structure. The FVDs are fit for decreasing the two forces and displacements of the structure under seismic loads and shear decrease in the structure is acquired by giving FVD it makes structure practical. It very well may be reasoned that the fluid liquid dampers can be viably utilized as one of the better options for the typical ductility-based design methods of earthquake resistant design of buildings.

S.Lakshmishireenbanu, Prathaushasri (2019): The project deals with the some kind of dissipating device namely fluid viscous damper are used to reduce seismic response of the structure in ETABS2016. A 10 storey structure with and without fluid viscous damper was analysed using ETABS2016 to get the seismic response of the structure. Nonlinear time history, which is calculated by fast nonlinear analysis of Bhuj earthquake records, is considered for the analysis. They have also considered the dampers position and enhancing their position at the height of the structure are studied as well. It inspects viscous damper systems and their effects on earthquake behaviour of multi-storey structures and determines impacts of damper system position on structure height. It is observed that there was 75% reduction in base shear due to time history analysis and also a considerable reduction in maximum storey displacement, maximum storey drifts and also storey shears when the damper is used in buildings.

Rajendra Kumar & Ranga Rao.V (2017): This project compacts with the comparison between different methods like equivalent static technique & response spectrum methods. They need adopted the equivalent static and response spectrum procedures to explore the model for this study and examine all the lateral displacements of the structure during the regular and irregular structure in various zones. The most important factors considered during the present study is to look at the seismic behaviour of varied zones i.e. zone-II, zone-III, zone-IV & zone-V and also the base shear, lateral displacements in various levels. From Linear Static Analysis and Linear Dynamic Analysis it's observed that there's a rise of lateral displacement in regular frame is a rise of zone-III, IV, and V respectively when put next with zone-II. From Linear Static Analysis and Linear Dynamic Analysis observed that there was a rise of lateral displacement in irregular frame is a rise of in zone-III, IV, and V respectively in comparison with zone-II. It absolutely was also observed that there was a rise in Base shear at corresponding to seismic Zones III, IV & V with compared to Zone II individually within the regular frame & Irregular frame.

Dr. k. Chandrasekhar Reddy & G. Lalith Kumar (2019): ETABS correspond to Extended Three Dimensional Analysis of Building Systems. ETABS combines every aspect of the engineering design procedure. Within the present situations of housing industry, the buildings that are being constructed are gaining significance, in general, those with the most effective possible outcomes which are mentioned members like beams and columns in multi storeys R.C structures. This software is mainly used for structures like high-rise buildings, steel and concrete structures. The paper aims to investigate a high-rise building of 30 floors (G+30) by considering seismic, dead and live loads. The look criteria for high-rise buildings are strength, serviceability and stability. The version of the software used is ETABS 2016. In the present study, we are mainly determining the results of lateral loads on moments, shear force, axial force, base shear, maximum displacement and tensile forces on structural system are subjected and also comparing the results of seismic zones 2, 3, 4 and 5. A high-rise building of 30 floors subjected to seismic, wind and live loads were analysed using ETABS 2016 software. Behaviour of the high rise building was shown clearly using the graphs and lateral displacements. It's found that the lateral displacements or drifts are more in zone 5 compared to the zones 4, 3 & 2.

III. MODELLING AND ANALYSIS

The present study is conducted out to find out the behaviour of G+20 Storeyed Structures, Floor height provided as 3.5m for ground floor and others i.e. floor to floor height is taken as 3m and also then the properties are defined for the structure. The prototypical of buildings is created in ETABS computer software. The seismic zone taken as zone V and soil type is considered to be medium. Four prototypes of RC structures are prepared. Two varieties of geometry are adopted in this analysis: regular and irregular building. Two various structures are regular buildings such as square and rectangle. Two different vertical irregular buildings such as H shaped plan and L shaped vertical irregularity are modelled. The modelling of building is achieved for Indian standard Seismic Zone V, IS1893-2002. For certain structure, loads are applied which includes loads like live load, earthquake load, dead and wind load are corresponding to IS 875 part I, part II and IS1893-2002 respectively.

The seismic analysis will be carried out for the structures that have absence of resistance to tremor forces. Seismic analysis will be considered for the dynamic effects hence the precise study sometimes become complex. Though for easy regular structures the equivalent linear static analysis is sufficient one. This kind of research is allocated for normal and low rise buildings and this method will give good quality results for this kind of buildings. Dynamic analysis is allotted for the building as specified by code IS 1893-2002 (part1). Dynamic analysis is distributed either by Response spectrum method or site particular Time history method. Subsequent methods are adopted to hold away the analysis procedure. Approaches of study of structure: The seismic analysis must be allotted for the buildings that have shortage of resistance to earthquake forces. Seismic analysis will consider seismic effects hence the detailed analysis sometimes become complex. Dynamic analyses are going to be meted out either by Response spectrum method or site specific Time history method.

It includes modelling of RCC framed buildings of regular and irregular structures four models using ETABS software. Material properties which are used in the models are M30 ($f_{ck}=30\text{N/mm}^2$) grade concrete and HYSD415 ($f_y=415\text{N/mm}^2$) grade of steel. Beams of section used are 230mm x 300mm and column of section are 230mm x 425mm used for modelling of Regular models and Beams of section 230mm x 230mm and column of section 280mm x 280mm are used for modelling of Irregular models the Frame sections. The methods considered in the present project are equivalent linear static analysis and response spectrum analysis for the regular and irregular buildings with fluid viscous damper and metallic dampers for different locations in structure. The numerous structural systems used for the current study are four models and to determine the storey displacement, storey drift, storey stiffness and base reactions in zone V.

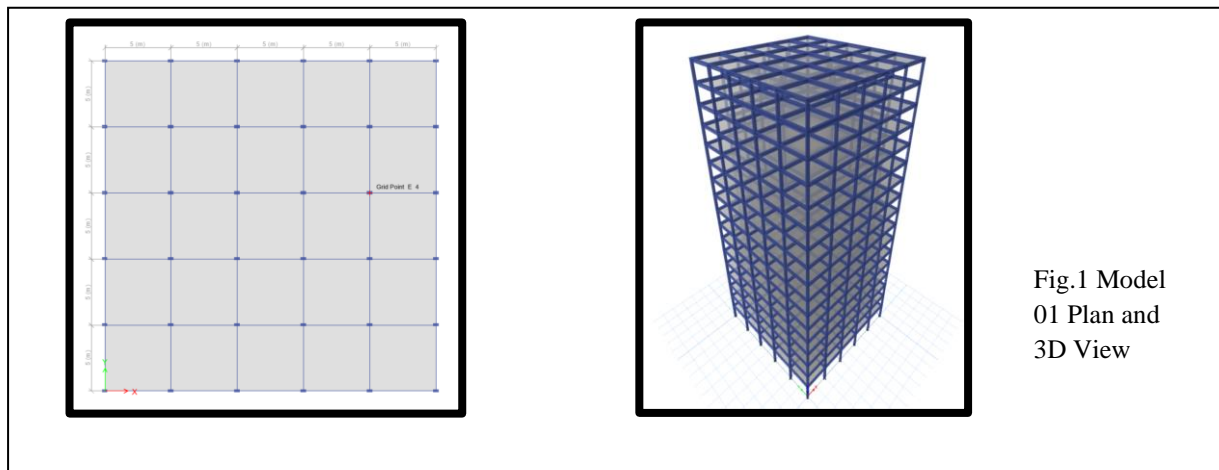
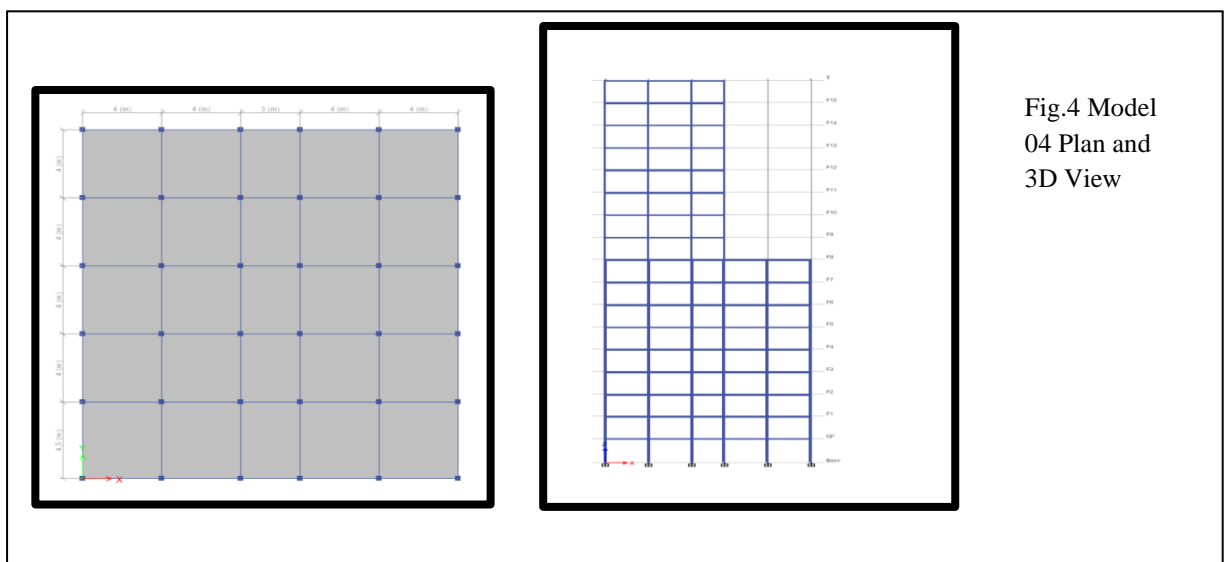
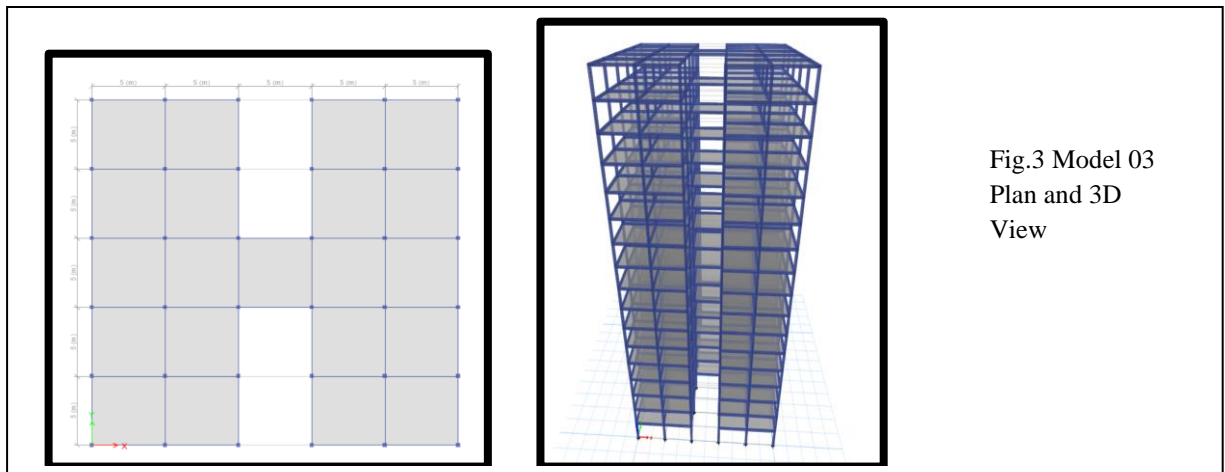
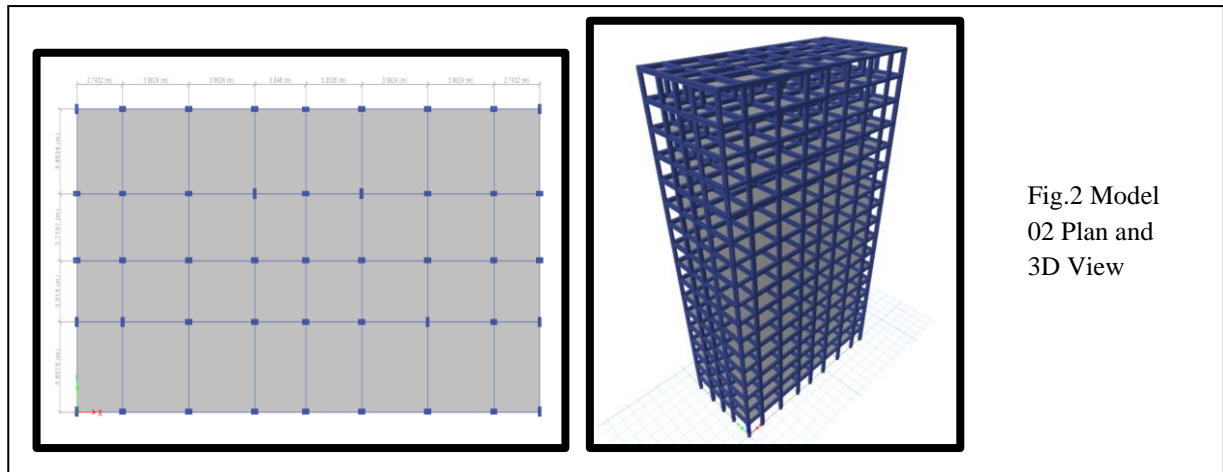


Fig.1 Model
01 Plan and
3D View



IV. RESULTS AND DISCUSSIONS

The results for equivalent static were represented for the load combination for lateral load ($0.9DL+1.5EQX$) calculated according to IS1893(Part1):2002. This study work is conducted out to compare the Equivalent static response of RCC

frames of regular and irregular models. Four models are considered for the equivalent static analysis with fluid viscous damper and metallic dampers. The results of storey displacement, storey drift and base reactions are calculated below. Dampers can reduce the external loads that occurred from the Earthquake. This RC framed structure is designed by the Properties of the structure can be explained in this work. The seismic behaviour of RC framed structure is observing the Parameters such as absolute displacement, story drift, Base reactions.

Maximum Storey Displacement: Displacement is a parameter which is subjected to a failure pattern of the building. In this current study, the displacement of the given building with and without damper and for regular and irregular structures is observed and the main objective is to arrange the dampers of the structure so that the displacement of the building is reduced..Comparison of displacement parameters as shown in fig.5 .

Storey Drift :Storey drift is defined as difference between the lateral displacements of two adjacent floors of the surface is called storey drift. In this analysis the Equivalent static linear analysis has been used. The storey Drift analysis values are shown in Table. Comparison of storey drift values as shown in fig.6

Storey Stiffness: The lateral stiffness (K_s) of a storey is usually defined as the ratio of story shears to storey drifts and however, storey drift is defined as the variation within the lateral displacements of floors bounding a storey is plagued by vertical distribution of horizontal loads, i.e., there is a singular dislocated profile for every form of horizontal load distribution. Comparison of storey stiffness values as shown in fig.7

Base reactions: Base shear reactions are the estimates of the maximum required lateral force on base of the structures due to seismic movement and were calculated shown in table 1.

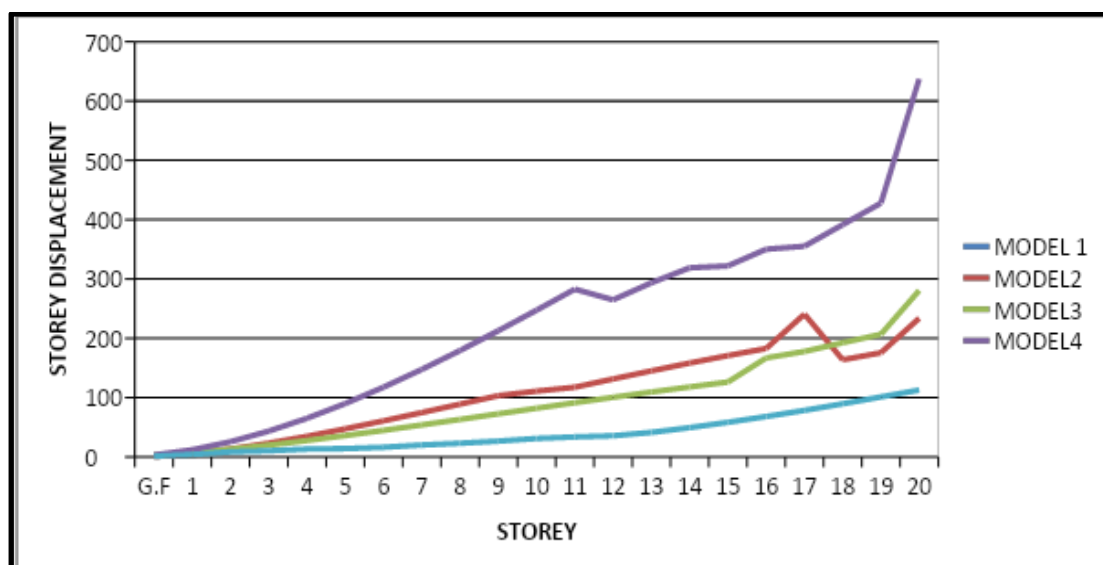


Fig. 5 Maximum storey displacements in different models

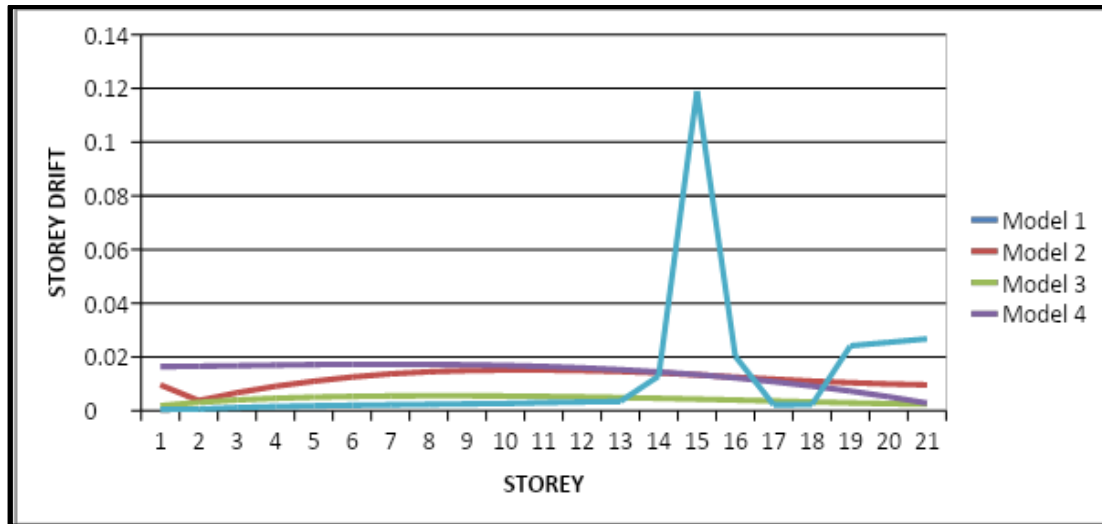


Fig. 6 Maximum storey drifts in different models

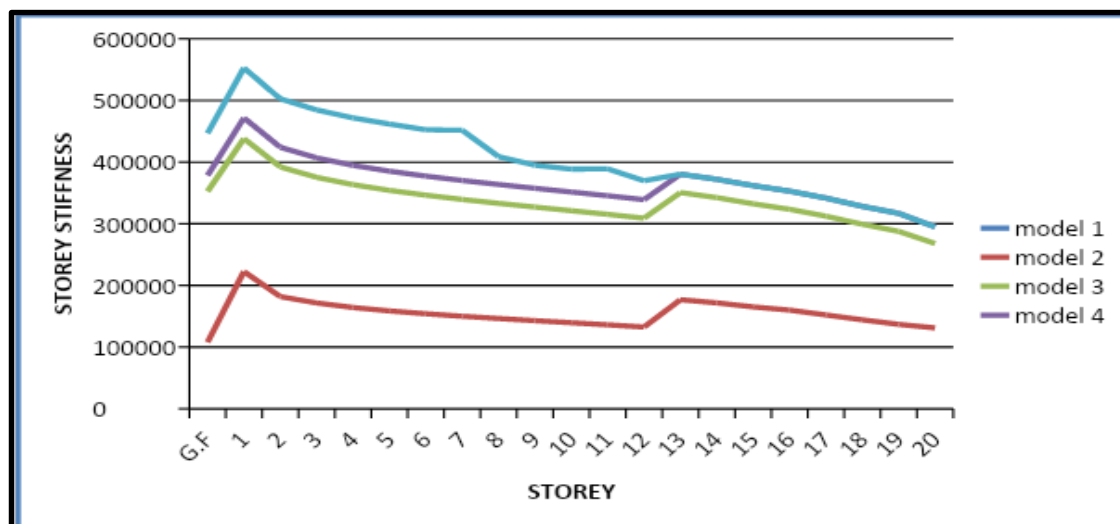


Fig. 7 Maximum storey stiffness in different models

Table : 1 Maximum base reactions for models

Reactions	Model 1	Model 2	Model 3	Model 4
FX-kN	264.0663	-689.4627	-84.5654	221.3682
FY-kN	328.4681	-9.8083	0	208.9339
FZ-kN	143909.0612	79092.8211	90558.2586	75254.642
MX-kN/m	1789139.0731	490852.2772	1131978.2326	778788.2194
MY-kN/m	-1970940	-1198914	-1255425	-664770.0083
MZ-kN/m	1534.7225	3966.2709	1057.0679	-501.6707

V. CONCLUSIONS

In this analysis result are carried out by using ETABS software for RC framed structures in order to find out the various parameters like maximum displacement, storey drifts, storey stiffness which will be compared further.

- Maximum storey displacements and storey stiffness was found to be more in metallic dampers which are placed in middle of structure than fluid viscous damper in zone V in H shaped plan irregular structure .
- Maximum storey drifts are more in fluid viscous dampers which are placed in corners of the structures than metallic dampers which are placed in different positions in zone V.

3. Maximum storey displacements are more in H shape irregular plan model than the other three models.
4. Maximum storey drifts and storey stiffness are more in L shaped vertical irregular model than the other three models.
5. Fluid viscous dampers placed in middle effectively reduce lateral displacements and drifts of the RC building than the metallic dampers.
6. From the study it is proved that regular structures are more effective to sustain the seismic loads even with dampers.

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