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Review for Comparative Study on Dynamic Behavior of Different Lateral Load Resisting System

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ABSTRACT

During April 2015 Nepal Earthquake, many elevated buildings in urban areas collapsed and suffered wide spread damages. After the earthquake observations shows many deficiencies in these structures including non-adoption of seismic engineering practices and lack of seismic resistant features. By adopting energy absorbing devices the seismic performance of building can be improved, which may be active or passive in nature. Active controls do not found much application due to its high cost and large instrumentation set up. Whereas, passive control systems for example, base isolation, dampers, bracing systems etc, are found to be easy to install and cost effective as compared to first one. Use of passive dampers is now a day becoming cost effective solution for improve seismic performance of existing as well as new buildings. This review paper is focussed on Energy dissipation system provided by fluid Viscous Dampers (FVD). In this paper, an attempt has been made for review comparative study on dynamic behaviour of different lateral load resisting system. For that the past papers related to the dynamic behaviour of the structure with passive dampers and other lateral load resisting structure has been studied and the fruitful conclusion has been made.

Keywords: Dynamic Analysis, Passive Dampers, Fluid Viscous Dampers, Energy Dissipation, Lateral Load Resisting System

I. INTRODUCTION

In the structure during seismic event large amount of energy is transmitted. For seismic design of building structures, the traditional method, which is by strengthening the stiffness, strength, and ductility of the structures, has been in common use for a long time. That design practice is to prevent collapse by permitting structural members to absorb and dissipate the transmitted earthquake energy by inelastic cyclic deformations. Therefore, the size of structural members and the use of material are expected to be increased, which leads to higher cost of the buildings as well as larger seismic responses due to larger stiffness of the structures. Thus, the efficiency of the traditional method is limited. To overcome these disadvantage associated with the traditional method, many vibration-control measures, namely as structural control, have been studied and remarkable advances in this respect have been made over recent years. Structural Control is a diverse field of study. These unconventional techniques enhance the energy dissipation capacity of the system. Therefore, significant reduction of structural and non-structural damage could be achieved through a efficient use of passive energy dissipaters which reduces the inelastic demand on primary structural members [2].

In a structure to limit damaging deformations in structural components mainly use passive energy dissipation devices. The degree to which a certain device is able to accomplish this goal depends on the inherent properties of the basic structure, the properties of the device and its connecting elements, the characteristics of the ground motion [9]. Device that have most commonly been used for seismic protection of structures include viscous fluid dampers, viscoelastic solid dampers, friction dampers and metallic dampers. Semi-active dampers have also been used for seismic response control in other countries, notably Japan but not in India [7].

Structural control can be categorized into as follow

- Passive energy dissipation,
- Active control systems,
- Semi-active control systems,
- Hybrid control.

II. METHODS AND MATERIAL

Literature Review

Thus the modal analysis of framed Structure is of great technical importance for understanding the behavior of the framed Structure under applied dynamic loading. The study of response analysis methodology of a SMRF with bracing and SMRF with damper and bracing with different height and in different EQ load is essential to conclude effectiveness of passive dampers on building.
As per Ras A. et. Al. [1] when it comes to removing unwanted energy such as instability, earthquake and wind Energy dissipation Systems in civil engineering structures are sought. Among many systems, there is the combination of structural steel frames with passive energy dissipation provided by Fluid Viscous Dampers (FVD). After analysis of 12-storey 3 D structure in SAP 2000 the result show a decrease values for reinforced cross brace and FVD models with a net benefit to the dissipative device model. This decrease is due to the additional stiffness provided by the reinforcing elements and due to the increase of damping rate for the FVD model. The dampers induced a resisting forces so that in damped model the damped braced transmit a less axial force to its near column as compare to cross braced structure. Among these advantages the damped model has the fundamental period decreases by 220% compared to the unbraced structure. As compared to the cross-braced structure reduction of the maximum displacements 32% of FVD model. The reduces values of base shear forces and its time loading due to reduction of the maximum acceleration is 50%. In bending moment and shear force reducing efforts by more than 40% in the most loaded member. The damper generate it viscoelastic behaviour which permit it greater capacity to dissipate the dynamic loading energies that induced restoring force.

Prashanthi C Sudula et. al. [6] give concluding remark after comparative study on the performance and effects on structural systems with added metallic, friction and viscous passive energy dissipating dampers for different earthquake zones for three seismic zones as per IS 1893(part 1) is that, Base shear is higher in zone IV compared to zone II and zone III, because they increases with increase in zone factor and zone IV have higher zone factor value. Higher values of base shear in RC bare frame (BF) are compared with RC frame with the dampers because of energy dissipation by the dampers. They also give three major differences between Viscous Dampers to other devices like metallic damper, friction damper, etc. The first difference is that the Viscous Dampers do not increase column stresses due to their inherent out of phase response output, where constant force output of another dampers increases maximum column or pier stress under any deflection of the structure. Normally dampers put out an essentially constant force when deflected, independent of velocity these causes continual stress in the structure during all thermal expansion and contraction of the structure but Viscous Dampers put out nearly zero force at the low velocities associated with thermal motion. The third difference is that Viscous Dampers allow the structure to re-center itself perfectly at all times where other dampers restrict a structure from restoring itself to its original position after seismic events. From the all the dampers used, viscous dampers show significant results because viscous damping reduces stress and deflection because the force from the damping is completely out of phase with stresses due to flexing of the columns. This is only true with viscous damping, where damping force varies with stroking velocity. Other types of damping such as friction devices, metallic etc., do not vary their output with velocity.

TABEL I
BASE SHEAR FOR EQX DIRECTION [6]

Base Shear			
Model	**Zone II**	**Zone III**	**Zone IV**
Bare frame	39.25	62.8	94.2
Metallic damper	45.761	73.217	109.826
Friction damper	46.701	74.722	112.083
Viscous damper	55.994	89.591	134.386

Nitendra G Mahajan et al. [5] make table, that showing reduction in Base shear is mainly depending on

Earthquake acceleration and No of story. The percentage reduction in base shear is different for different no of story. The input type of Earthquake and no of story is clearly affecting the characteristics of base shear. The buildings behave as they are rigidly connected by bracing at very high stiffness of dampers. As a result, the damper totally loses its effectiveness and the relative displacements and the relative velocities of the connected floors become almost zero. In contrary, the buildings return to the unconnected condition like building without dampers or un-damped condition, if the stiffness of dampers is reduced to zero, as a result dampers again losses its effectiveness. As no of story decreases the overall stiffness of building increases to counter act this thing damper stiffness was to be reduce relative to higher no of story as per their investigation, So it is clear that effectiveness of damper is also depend on no. of storey. Increase in story drift as well as increased base shear are results of Continuous reduction in effective stiffness of dampers. Which clearly indicate that optimum effective stiffness for particular no of story exists. They concluded that dampers are more significant to reduce seismic quantities with same direction of placement as brace. Dampers placed in the upper levels had little to no effect on the structural response. They comes to the point that significant reduction in structure acceleration, deformation and Base shear can be achieved by strategically placing the dampers within the periphery of structure.

TABEL II
PERCENTAGE REDUCTION IN BASE SHEAR DUE TO DAMPERS [5]

Earthquakes	12-story	17-Story	22-Story
Koyna, 1967	18	43	25
El Centro, 1940	8	5	5
Bhuj, 2001	16	28	30
Tohoku, Japan, 2011	17%	5%	26%

The analysis result of 5 storey structure with soft storey at ground of Yuvraj Bisht et. al. [9] show that Due to loss of stiffness at the ground storey there is a sudden rise in drift and displacements at 2nd storey. So that, the building can undergoes soft storey failure if exposed to seismic conditions. As per Table III , it can be interpreted from the results that the use of Viscous Dampers has improved the performance of the building to great extent. Sudden change in normal frame at storey 2 indicates sharp change in stiffness due to soft storey. The drift behavior of soft storey with viscous Damper shows considerable reduction in this soft storey problem of excessive drift. Also the maximum drift of building is within the maximum permissible limits. The maximum drift is reduced from 3.7 % to 0.86 % By the provision of viscous dampers up to five stories.

TABEL III
DRIFT OF DIFFERENT STOREY [9]

Displacement of different storey		
Storey Number	**Normal frame**	**With Damper**
1st	10.98	6.12
2nd	584.48	139.42
3rd	595.42	143.40
4th	604.34	146.94
5th	612.66	150.27

After the analysis of regular building with Tuned Mass Dampers, with Viscous Fluid Dampers and without any damping device by the G.S. Balakrishna et al**.** [4] come to some useful conclusion that, To control vibration of the structure the TMDs and VFDs can be successfully used. Amongst 2%, 3% and 5% TMD's, 3% TMD is found to effectively reduce base shear by about 10-35% and top storey displacement by about 10-25% for the regular building frame. VFD with damping exponent value 0.5 is found to be effective in reducing the top storey displacement by about 90% and base shear by about 89-93% as compare VFD with damping exponent value of 0.75. But The TMDs are easy to construct and implement on top of buildings compared to implementation and placing of VFDs of particular stiffness on buildings.

III. CONCLUSION

From, the above study it can be conclude that,

- The performance of building structure in seismic loading is improved to great extent after application of damped system as compare to bare frame and braced structure.

- Passive energy dissipaters usually relatively in expensive. It consumes no external energy, inherently stable and works even during a major earthquake.
- It prove that the use of viscous dampers ensures an effective displacements and base shear force control, generally, achieving reductions between 60% to 90%.
- Due to the passive nature of devices and the random nature of earthquake events the effectiveness (amount of control) of passive devices is always limited.

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