IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 08-12

Seismic Response Control of Adjacent Building Using Fluid Viscous Damper

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Abstract: *The present paper informs that the study of seismic response control of two adjacent building structures of single degree of freedom system using with and without Fluid Viscous Damper. The study is also supports in the presence and absence of Fluid Viscous Damper (FVD) seismic excitation. The fluid viscous damper is considered for the particular study which is a passive device attached to the structural unit in the easy form as single storey at the top of the system. The main purpose of using of fluid viscous damper is to reduce the pounding forces in adjacent building structure. At the time of pounding, the displacement results show that the seismic response is more sensitive before proving of fluid viscous damper. Outcome of the present study informs that the using or providing of fluid viscous damper is very useful to decrease the displacement results of seismic response of adjacent structures. The present study is conducted to carry out the minimum seismic pounding gap between two adjacent building structure by using passive devices and found out the results of with and without using damper. In this paper, study of four real earthquakes ground motions found acceleration and displacement response results of adjacent structure. The goal of this paper is performing a study of structural dynamics of pounding response behavior between two adjacent structures by single degree of freedom system.*

Keywords: *Seismic Pounding, Single Degree of Freedom System, Adjacent Building Structure, Time History Analysis, Fluid Viscous Damper (FVD), Lump Mass System, SAP 2000*

I. Introduction

The earthquake with high magnitude is able to reason of sever damages. Due to the pounding of adjacent building structures could have bad damages as adjacent building with various dynamic characteristics that which is not sufficient gap distance to correspondent the relative motions of adjacent building structures. In the past seismic codes, didn’t gave proper guidelines to remove the possibility of pounding. Structural response control technology is very useful for the retrofitting of historical structures which is specially closed to earthquakes. The main reason is that the installation of such devices doesn’t need further house and also the free house out there between two adjacent building structures is effectively used for putting the devices pounding between adjacent buildings or between elements of constant building because of earthquakes has typically been recorded collectively of the causes of serious or perhaps sever structural injury. This drawback is especially common in several cities situated in seismically active regions, wherever because of varied socioeconomicfactors and land usage necessities the codes allow contact between adjacent buildings. Pounding might cause each as structural damages and, in some cases, it should cause collapse of the total structure. After that the several investigations are disbursed on pounding injury caused by the past earthquakes on mitigation of pounding hazards and on the modelling of pounding between structures.

Structural pounding refers to the lateral collisions of adjacent buildings throughout the earthquakes. Pounding happens once building separations area unit too little to accommodate the relative motions of adjacent building. In the study, the contributory factors embody obscure necessities from earlier codes that area unit predicted on inadequate drawback appreciation and knowledge. Pounding injury has been according from most major earthquakes poignantmetropolitan areas of the planet. Pounding of adjacent building has created injury worse and caused total collapse of the buildings. Attributable to seismic ground motion abstraction variation and completely different dynamic properties and dynamic characteristics. Adjacent buildings might vibrate laterally out of phase, which may cause collisions if the separation distance between them isn’t massive enough. The pounding between inadequately separated buildings has been determined in most previous major earthquakes.

The building structures can sustain short length massive impact force not specifically thought about in typical styles. These impacts typically cause damages round the pounding areas of adjacent structures and will amplify the dynamic response of structures. In those studies, structures were modelled either as single degree of freedom (SDOF) systems with objectives of providing realistic data on however the adjacent structures behave and to what extent the impact force by pounding will increase the structural response. The previous studies investigated that the pounding effects on adjacent structures with completely different separations, different heights, periods, damping ratios, pounding locations and models of non-linear pounding components. It is found that betting on the various structural conditions pounding may have useful or adverse effects on adjacent structures. The impact force functioning on structures because of pounding, that isn't thought about in a very traditional style, would possibly increase shear forces and overturning moments in structures. On the opposite hand adjacent structures offer constraints to every alternative thus pounding would possibly scale back displacement responses. Pounding responses area unit ruled by the relative structural properties and also the gap size between the adjacent building structures.

Owing to seismic ground motion abstraction variations and completely different structural dynamic properties and adjacent building structure may vibrate out of phase, which might cause collision if separation gap distance between them is not giant enough. Pounding between inadequately separated building structures has been ascertained in most of the previous major earthquakes. The adjacent building structure can sustain short length giant impact force not specifically thought of in typical styles when the pounding happens. These impacts sometimes cause damages and should amplify the overall structural dynamic responses. Previous investigations discovered thatpounding in structure may injure non-structural member like curtain walls and also causes equipment shifting loading to a large scale loss of building functions and it will result in collapse of building structure. It has been found that depending on various structural conditions that the pounding could have useful or adverse effects on adjacent structures. The mainly impact force performing on structures because of pounding, that isn't thought of in a very traditional style. On the opposite hand, adjacent structures give constraints to every alternative so pounding may decrease or reduce the displacement responses

1. Structural Properties of SDOF Model

Floor Mass:
$m_1 = 27.788$ ton, $m_2 = 28.636$ ton
Storey Stiffness:
$k_1 = 46285$ kN/m, $k_2 = 61713$ kN/m
Damping Ratio (ξ) = 5% = 0.05, Damping Coefficient (c) = $2m\omega_n\xi$
Where, $\omega_n = \sqrt{k/m}$
To find Time Period (T) = $2\pi/\omega_n$

Model 1 **Model 2**

Fig. 1.

Model 1: SDOF adjacent structure isn't subjected to pounding and with fluid viscous damper.

Model 2: SDOF adjacent structure is subjected to pounding with fluid viscous damper.

II. Fluid Viscous Damper

The fluid viscous damper (FVD) is hydraulic device that to drive away the kinetic energy of seismic occurrences and absorb the impact between adjacent structures. They have capable of moving freely and can be plot to allow free movement as well as restrained damping of structure to keep safe from wind load, thermal motion. Mainly in Indian context, mostly in older cities, there are large number of buildings are constructed very closely to each other without proper separation gap distance to keep clear or avoid the pounding incidences. For high rise building structure and low rise building structure like single storey building, a simple form of fluid viscous damper (FVD) is very much needed to be advance development, so that it should be feasible from economical as well as construction aspects. Fluid viscous damper does not require much more departure from present practice of construction and it is maintenanceless. So that is why the construction engineers and practicing designers will entertain or accept only such Fluid viscous damper.

2.1 Fluid Viscous Damper Properties

In the study, the FVD System is used to control the pounding response between the two adjacent building structure. The FVD has stiffness (k_k) of 100000 kN/m, Damping Coefficient (c_k) of 16 kN. Sec/m and Damping Exponent of 0.5. The impact force $F_c(t)$ is expressed as follows; $F_c(t) = k_k\delta(t) + c_k\dot{\delta}(t)$, Where $\dot{\delta}(t)$ is relative velocity between colliding bodies at time t.

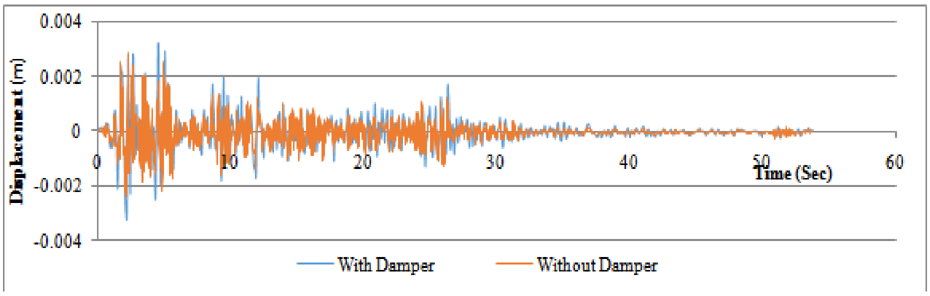
2.2 Fluid Viscous Damper Working

The fluid viscous damper system works when the external simulation such as wind vibration and seismic activity extend to the structure, so it will drive damper to move that means it will occur pressure difference. It is all that reaches the main purpose of control the structural vibration. The fluid viscous damper (FVD) has mostly used in structures like residential building, hospital building, school building, shopping malls, long span building, bridge structures, etc.

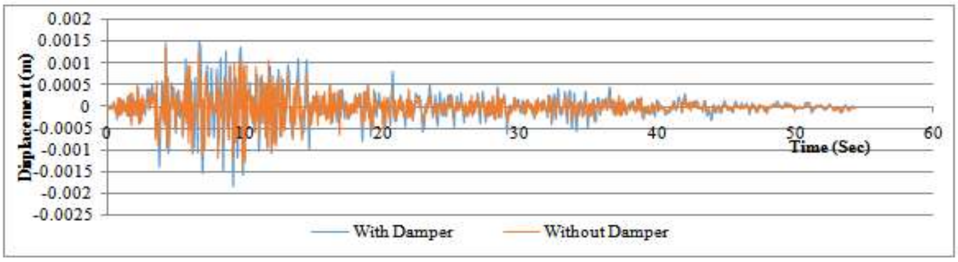
Table 1: Characteristics of real earthquake used for present study

Captions of Recorded Ground Motion	Year	Peak Ground Acceleration (g)
Imperial Valley Earthquake	1940	0.3483
Kern County Earthquake	1952	0.1556
Loma Prieta Earthquake	1989	0.2755
Parkfield Earthquake	1966	0.2371

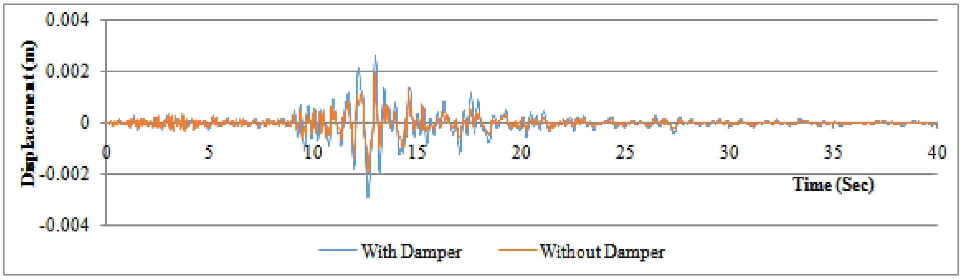
III. Results and Discussion



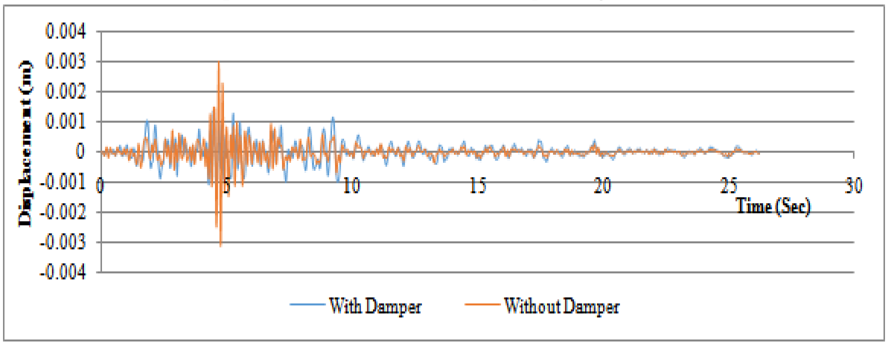
(a) Response for Imperial Valley Earthquake ground motion



(b) Response forKern County Earthquake ground motion

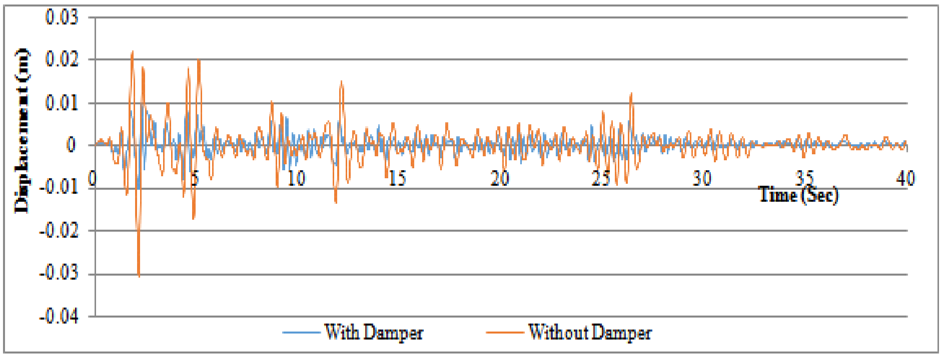


(c) Response for Loma Prieta Earthquake ground motion

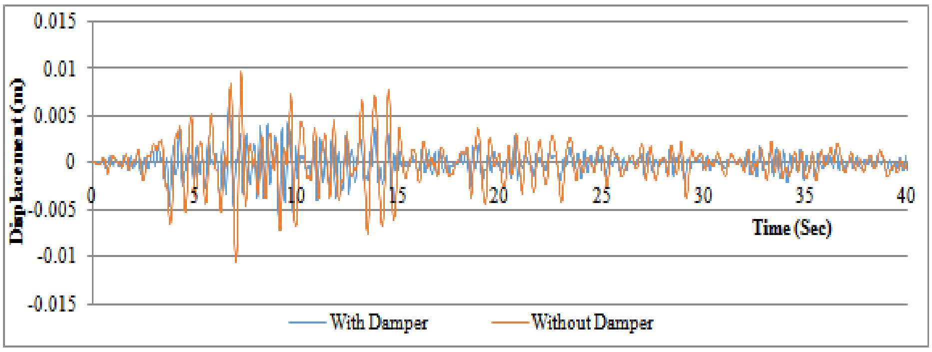


(d) Response for Parkfield Earthquake ground motion

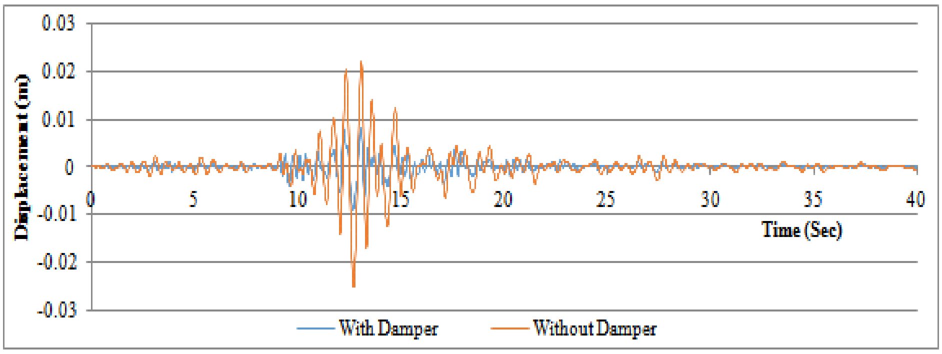
Fig. 2.(a)-(d) Displacement time history plots of all models for left structure under all ground motions.



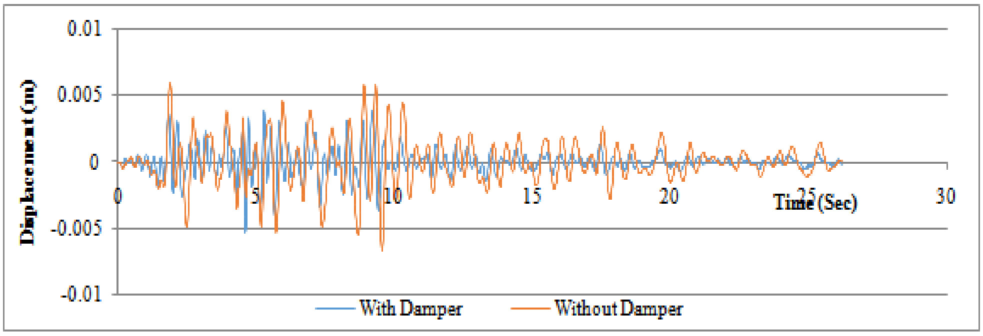
(a) Response for Imperial Valley Earthquake ground motion



(b) Response for Kern County Earthquake ground motion



(c) Response for Loma Prieta Earthquake ground motion



(d) Response for Parkfield Earthquake ground motion

Fig. 3.(a)-(d) Displacement time history plots of all models for Right structure under all ground motions.

The comparative study for the seismic response control of two adjacent building structures of single degree of freedom system using with and without Fluid Viscous Damper in the presence and absence of pounding presented in this section. The all plotted figures are the displacement time history for left structure and right structure under ground motion. The displacement time history plots for all the considered models in all input ground motions are given in Figs. 2 (a)-(d) and 3 (a)-(d). The tabulated results are mainly shows the peak values of displacements.

From displacement time history plot of figs.2 (a)-(d) and 3 (a)-(d) and Table 1 of peak accelerations, it is observed that the right structure suffers more deformation than the left structure due to its less rigidity.

Table 2: Displacement results of structures for recorded real ground excitations.

Displacement (m)					
Sr. No.	**Earthquake Type**	**With Damper**		**Without Damper**	
		Max.	**Min.**	**Max.**	**Min.**
1	Imperial Valley Earthquake				
1.A	Left Building	0.00323	-0.00323	0.00292	-0.00235
1.B	Right Building	0.0097	-0.01048	0.02174	-0.0307
2	Kern County Earthquake				
2.A	Left Building	0.001516	-0.00183	0.001357	-0.00137
2.B	Right Building	0.006595	-0.00606	0.009597	-0.01053
3	Loma Prieta Earthquake				
3.A	Left Building	0.002634	-0.00289	0.008014	-0.00193
3.B	Right Building	0.008014	-0.00894	0.02197	-0.02518
4	Parkfield Earthquake				
4.A	Left Building	0.001376	-0.00144	0.002993	-0.00308
4.B	Right Building	0.003872	-0.00524	0.005955	-0.00666

IV. Conclusions

In this study, it is found that the behavior of two adjacent SDOF system in the absence and presence of pounding with and without fluid viscous damper is investigated. The time history analysis is carried out by the considering the input of four real ground motions. The study is performed and solved using SAP 2000 program. The displacement of single storey adjacent building structure during pounding found to be more sensitive.The displacement response of structure is found to be very crucial which is considered of pounding with and without fluid viscous damper.

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