Study on The Effect of Viscous Fluid Damper on Flat Slab Frame Structure

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Abstract*- T Structures are mainly subjected to various types of loading conditions such as earthquake, wind forces . For earthquake zone areas, the structures are designed considering seismic forces. The structure which are present in higher earthquake zone area are liable to get damaged or collapsed, hence to increase the safety of these structure few retrofitting techniques or addition of materials to stabilize the structures against the earthquake forces are done. if the retrofitting techniques are adopted then cost plays an important role and possibly few spaces will be compromised depend upon the type of methods adopted. Later the structure may be strengthened by adding materials externally to transfer the lateral loads i.e. some protective devices have been developed. In modern seismic design, damping devices are used to dissipate the seismic energy and control of the structural response of the structure to that earthquake excitation. For the present study, an 9-story structure which is L Shaped in plan is modelled and analyzed using the sap2000 software. The earthquake loads are defined as per IS1893-2002 (Part 1). SAP2000 nonlinear time history analysis program was applied to investigate the effects on building such as base shear, displacement and energy dissipation of damper element by varying different important parameters namely Earthquake time histories, location of dampers, damping coefficient, damper stiffness, no of story of building. Comparison study is also presented between building installed with dampers, building installed with single diagonal damper, cross damper, damper placed at mid frame & corner of frame to show importance of damping system for reduction of seismic quantities.he present study focuses on the analysis of material handling system with the help of discrete event simulation. The simple factory layout of packing system is considered and modeled with the queuing system based on time and the size delay function.it is found that the total system once modeled can helps in the improve modify or study the process in detail and helps to understand the system very effetely*

Keywords- Flat slab, Damper, Viscous fluid damper, Time history analysis

I. INTRODUCTION

The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load . Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large decrease the bending moments and shear forces in columns, they increase the axial compression in the columns to which they are connected. but this shear wall increases the weight of structure to need some alternatives system reduces lateral load. Bracing system and some damping devices need to control such types of forces. Structural design approach using seismic response control is now widely accepted and frequently applied in Civil Engineering. In recent years, much structural attention has been paid to the research and development of control techniques such as passive control system, active control system, and semi active control system giving special importance on improvement of wind and seismic responses of buildings and bridge The structural elements that includes all the individual damping devices, all structural elements or bracing required to transfer forces from damping devices to the base of the structure, and the structural elements required to transfer forces from damping devices to the seismic force resisting system.

1. Passive control system

The most mechanically simple set of control schemes is enclosed in the passive control category, which has been widely accepted for civil engineering application. Housner et al. have both provided brief overviews on structural control, including proper definitions for the various types of control practically implemented in structures. According to them a passive control system is one that does not require an external power source. All forces imposed by passive control devices develop as direct responses to the motion of the structure. Hence, sum of the energy of both the device and the primary system will be constant. The main purpose of these systems is to efficiently dissipate vibrational energy, and the various methods of achieving this can be categorized in two ways. The first method includes converting kinetic energy directly to heat, such as through the yielding of metals, the deformation of visco-elastic solids and fluids, or the implementation of friction sliders. The second method works on transferring energy among two or more of the vibrational modes of the building, generally achieved by adding a supplemental oscillator that absorbs the vibrations of the primary structures. Tune mass damper, tune liquid damper, base isolation are example of passive system.

2. Viscous Fluid Dampers

Fluid viscous dampers were initially used in the military and aerospace industry. They were adapted for use in structural engineering in the late 1980's and early 1990's (Makris and Constantinou, 1990,Constantinou and Symans, 1992). Fluid viscous dampers typically consist of a piston head with orifices contained in a cylinder filled with a highly viscous fluid, usually a compound of silicone or a similar type of oil. Energy is dissipated in the damper by fluid orificing when the piston head moves through the fluid (Hanson and Soong, 2001).The fluid in the cylinder is nearly incompressible, and when the damper is subjected to a compressive force, the fluid volume inside the cylinder is decreased as a result of the piston rod area movement. A decrease in volume results in a restoring force. This force is undesirable and is usually prevented by using a run-through rod that enters the damper, is connected to the piston head, and then passes out the other end of the damper. Another method for preventing the restoring force is to use an accumulator (Symans and Constantinou, 1998). An accumulator works by collecting the volume of fluid that is displaced by the piston rod and storing it in the make-up area. As the rod retreats, a vacuum that has been created will draw the fluid out. A damper with an accumulator is illustrated in .Experimental and analytical studies of buildings and bridges with fluid dampers is done & manufactured by Taylor devices Inc. The Taylor's device which has been filled with silicone oil consists of a stainless steel piston with a bronze orifice head and an accumulator.

These are ways to gain increased viscous damping force;

(1) Raise the viscosity of viscous material.
(2) Enlarge the area containing the viscous material.
(3) the velocity applied to the viscous material.
(4) Amplify the damping force of the viscous material.

Due to following characteristics Viscous Fluid Dampers (VFD) are widely used,

(1) VFD have relatively small size and self-contained as compare to other dampers.
(2) Only Fluid dampers are capable to reduce stress and displacement in a structure during a seismic event.
(3) VFD have stable and predictable performance at any temperature.
(4) Easily installed in structure as diagonal braces or a part of base isolation system.

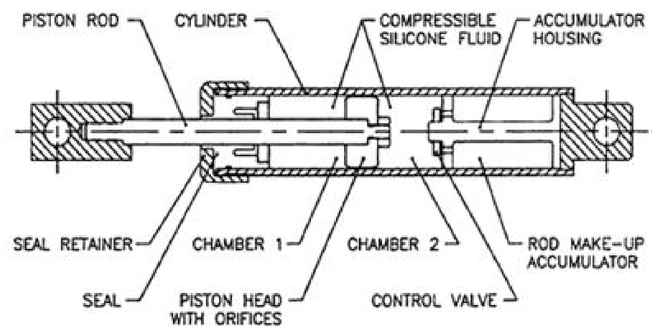

Figure 1. Fluid Viscous Damper

3. SAP2000v19

The SAP2000 has been identical with state-of-the-art analytical methods since its introduction over 30 years ago. SAP2000 works in the same convention featuring a very refined, instinctive and versatile user interface powered by unmatched analysis engine and design tools for engineers working on transportation, industrial, public works, sports, and other facilities. From 3-D objects based on graphical modeling environment to the wide varieties of analysis and design options completely incorporated across one powerful user interface,SAP2000 has verified to be the most integrated, productive and practical general purpose structural program on the market today. This spontaneous interface allows you to create structural models speedily and instinctively without long learning curve delays.

II. METHODOLOGY

Time History Analysis

Time history analysis is a step by step procedure of the dynamic response of the structure to a specified loading that may vary with time. The analysis may be linear or non linear. Time history analysis is used to determine the dynamic response to a structure subjected to arbitrary loading. The dynamic equilibrium equations to be solved are given by

$$Mx'' + Cx' + Kx = f(t)$$

Where M is the diagonal mass matrix, C is the damping matrix and K is the stiffness matrix and f(t) is the applied load x'', x' ,x, are the displacements, velocities and accelerations of the structure.

III. PROBLEM STATEMENT

The seismic response of G+9 storey flat slab structure with and without damper, single damper and cross damper ,damper placed at corner & mid frame of structure subjected to real ground motion.

Sap2000 Non linear time history of EL-Centro earthquake data (1940) used for analysis purposes and have compared flat slab structure with and without damper.

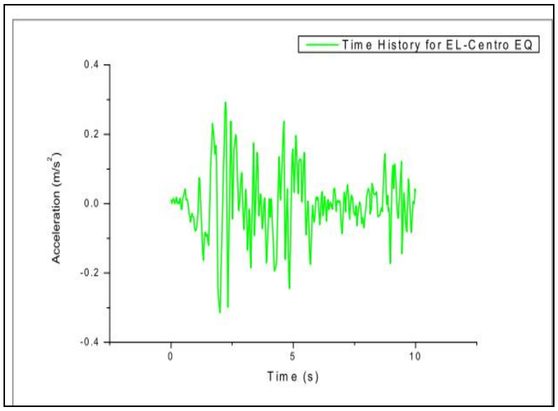

Figure 2. Graph. 1 Acceleration vs Time history of El Centro EQ

Table 1.

Type of Structural system	Parameters
Slab (mm)	160
Column (mm)	230X600
Material Properties	M25, Fe500
Height of floor(m)	3.2m
Density (KN/m^2)	25KN/m^2
Live load (KN/m^2)	4 KN/m^2
Floor finish (KN/m^2)	1 KN/m^2
Damper stiffness	2000KN/cm
Damping coefficient	350KN-s/m

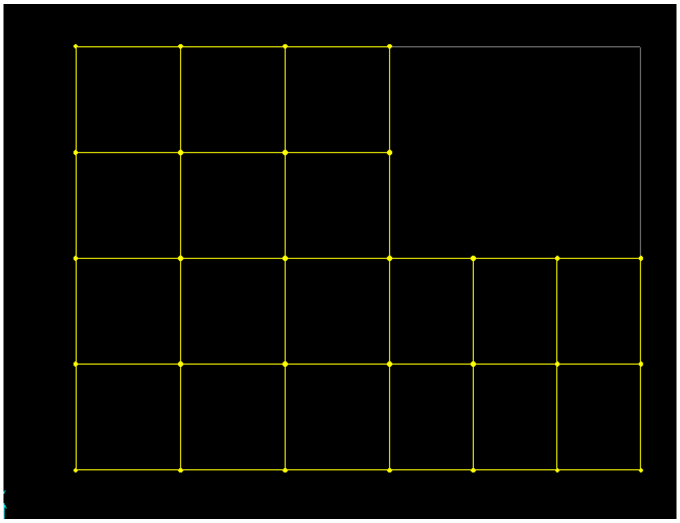

Figure 3. Plan of flat slab sap model

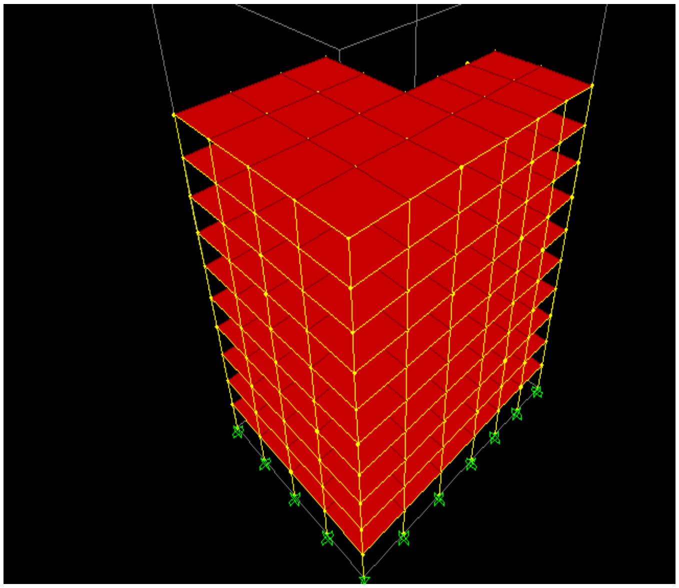

Figure 4. G+9 Flat slab structure without damper

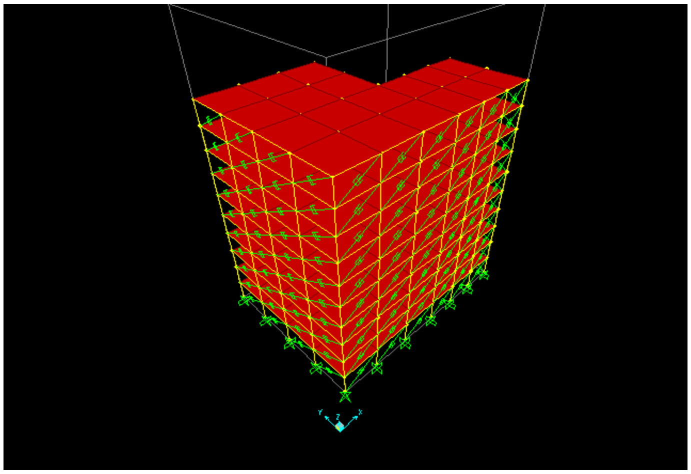

Figure 5. G+9 Flat slab structure with Diagonal damper

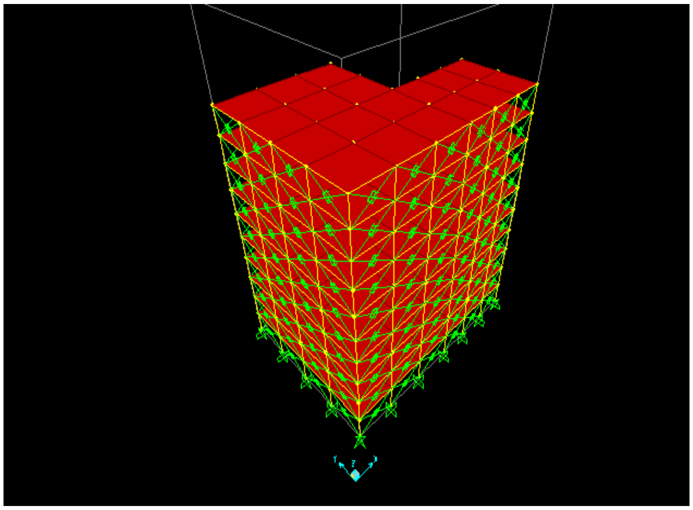

Figure 6. G+9 Flat slab structure with cross damper

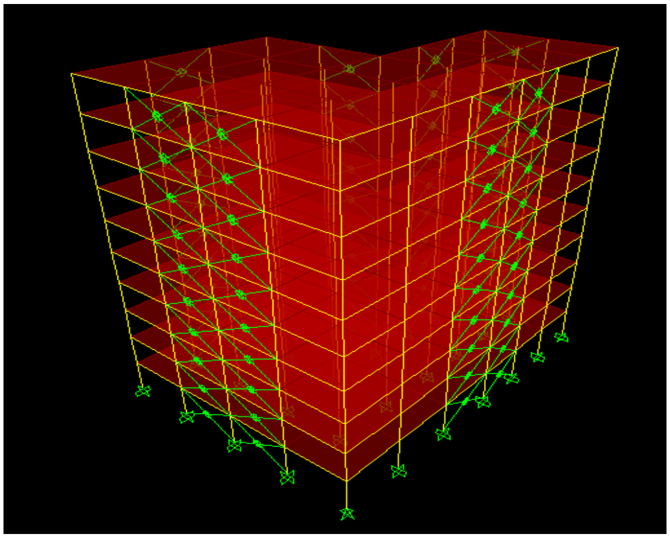

Figure 7. G+9 Flat slab structure with diagonal damper at Mid frame

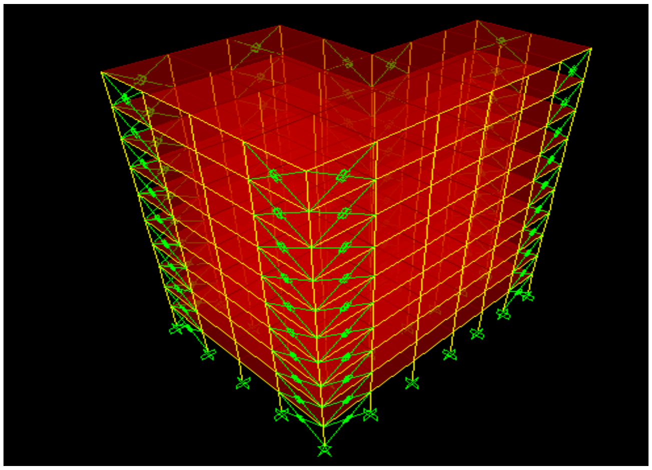

Figure 8. G+9 Flat slab structure with Diagonal damper at Corner frame

IV. RESULTS

After analyzing the building frame structure with flat slab in sap2000, results of base shear, displacement & force-displacement loops with and without damper are graphically represented below.

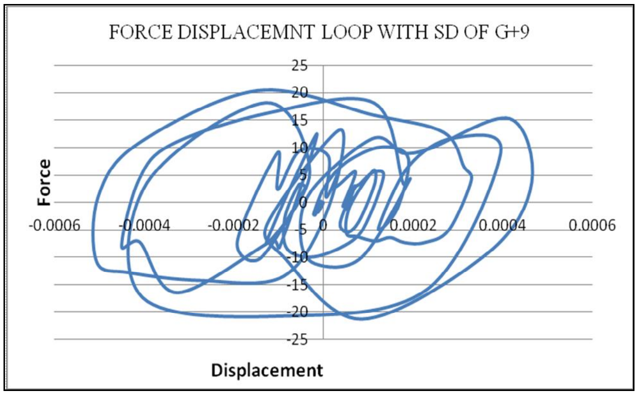

Figure 9. Force-displacement graph NLVD for SD of G+9

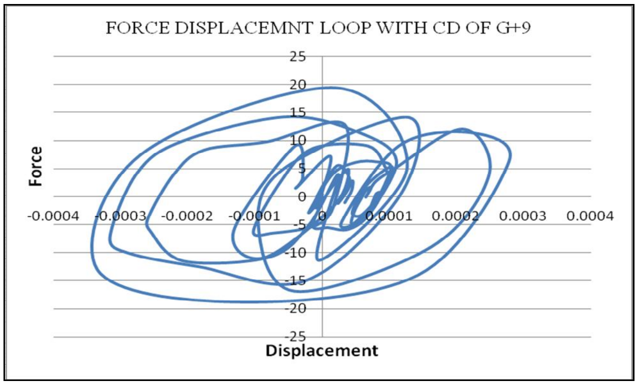

Figure 10. Force-displacement graph N LVD for CD of G+9

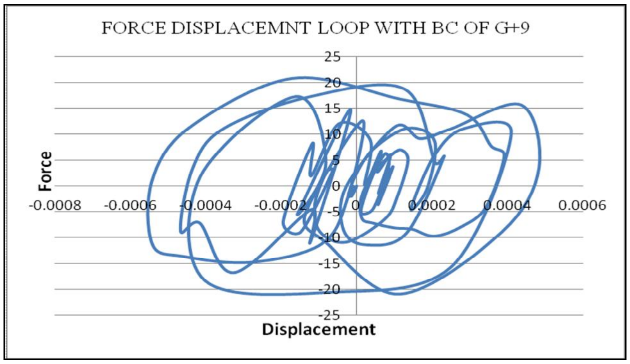

Figure 11. Force-displacement graph NLVD for BC of G+9

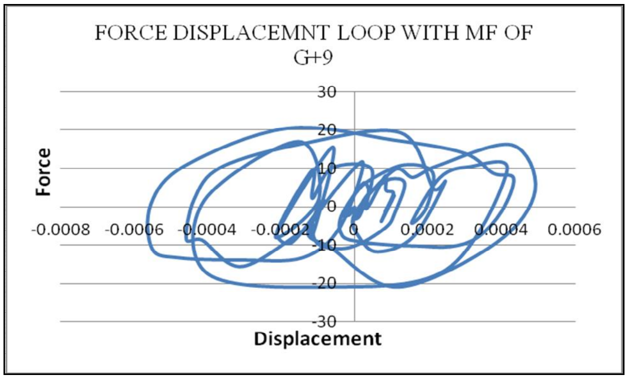

Figure 12. Force-displacement graph NLVD for BC of G+9

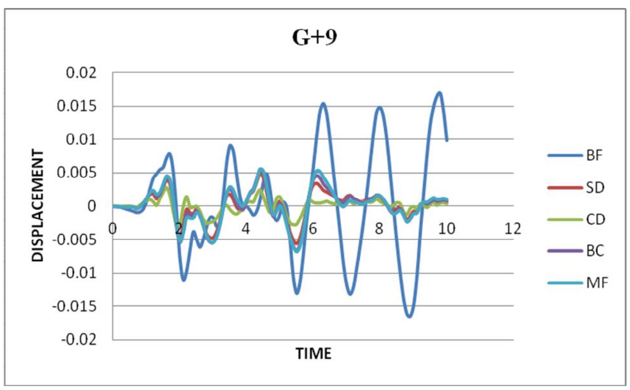

Figure 13. Disp. Vs Time G+9

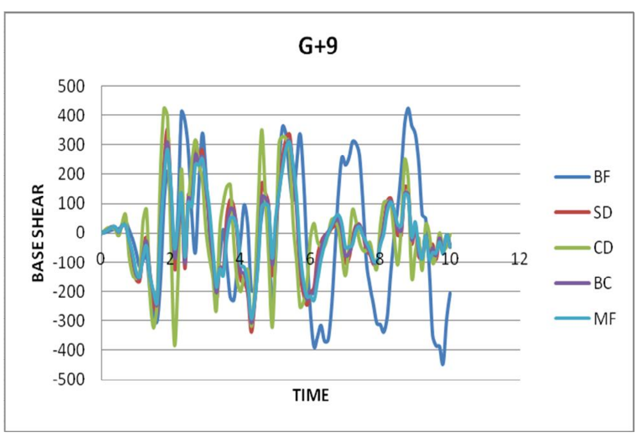

Figure 14. Base shear Vs Time G+ 9.

Table 2. Maximum Base Shear of G+9

Description	Base shear KN
Bare Frame (BF)	423
Single diagonal Damper (SD)	336
Cross Damper (CD)	382
Damper placed at building corner (BC)	304
Damper placed at mid frame of sides (MF)	290

Table 3. Maximum displacement of G+9

Description	Displacement m
Bare Frame (BF)	0.0169
Single diagonal Damper (SD)	0.0056
Cross Damper (CD)	0.0029
Damper placed at building corner (BC)	0.0066
Damper placed at mid frame of sides (MF)	0.0068

V. CONCLUSION

After studying all the models with and without damper, it is concluded that the use of damper is more effective for controlling the vibration produced due to earthquake excitation.

It could be concluded that use of damper in G+9 model, percentage reduction of base shear is increased up to 20.56%, 9.70%, 28.13% and 31.44% for single diagonal, cross diagonal, damper placed at corner of frame & damper placed at mid frame .

It could be concluded that use of damper in G+9 model, percentage reduction of Displacement is increased up to 66.8%, 82.8%, 60.9% and 59.7% for single diagonal, cross diagonal, damper placed at corner of frame & damper placed at mid frame .

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