Analysis of Building with Baseisolation and Damper

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***Abstract*—This paper is about the seismic analysis of building. The aim of seismic design is to protect the buildings and reduce the damages occur through the seismic event. There were many studies are done to resist earthquakes. Providing base isolation and damper in building have greater impact to resist earthquake. The principle of base isolation is to alter the response of the building structure so that ground below can move easily without transmitting these motion forces to the building structure above. Using damper it dissipates a significant portion of induced energy so that damage to the building reduces. In the present study, afive story RCC building is analyzed according to IS Code for seismic analysis by ETABS software. In this study a several conditions are taken first considering a normal building, base isolated building, building with damper and building with base isolation and damper.**

Keywords:- Seismic, base isolation,damper,ETABS.

I. INTRODUCTION

Seismic is the factor which generate a lateral forces applied on the base of the structure. The objective of the seismic design is to protect important facilities such as hospitals museums and official buildings etc. In base isolated structure, the energy due to earthquake is dissipated by isolators before travelling through the structure from base to roof. Thus the lateral force resulting an earthquake which is applied on structural elements including nonstructural elements are low in base isolation system compared to conventional construction system. Base isolation define as structural elements that should separate a superstructure from its substructure. Damping also plays a vital role in Earthquake resistant design, which decreases the response of the building when they are exposed to lateral force. The fluid viscous dampers are the more applied tools for regulating responses and dissipating energy of the structures.

II. LITERATURE REVIEW

At first base isolation was registered as a patent in 1800’s, with Lead Rubber Bearing (LRB) providing high flexibility and damping. The natural rubber has been has been used for since 1840’s through the process of material development synthetic rubber or poly-tetra-fluoro-ethylene(PTFE)which is developed by DuPont was used, and designed for 50 years or more H.W.Shenton compared and analyzed relative results of fixed based and base isolated structure. The concrete fix base structure was designed by referring structural agencies association of California (SEAOC).The base isolated response was compared with fixed base response. The base shear was varying according to the SEAOC recommendation. Three different type of time history, post-earthquake record were selected to perform nonlinear dynamic analysis for fixed base and base isolated structure. Results were compared to 25% and 50%of the specified lateral force by SEAOC.The performance of building was checked for different lateral forces.

Todd W Erickson, presented response of the industrial structure under seismic forces, building was designed according to IBC Code. Theresults of superstructure under dynamic loading were found out for an elastic response. All problems related to design analysis, placement of isolator are comparatively discussed

Enrique Luco, determined the soil structure interaction effect on base isolated building .The results showed that the deformation of an inelastic structure is higher when the soil effect has taken into consideration

Vajreshwari Umachagi et.al presents an overview on applications of dampers for vibration control of structures. The review includes different types of dampers like metallic dampers, viscoelasticdampers, frictional dampers etc.it concludes that use of seismic control systems has increased but choosing best damper and installing it into a building is very important for reducing vibration in structures when subjected to seismic loading

III. LEAD RUBBER BEARING

A variety of isolation devices including elastomeric bearings (with and without lead core), frictional/sliding bearings and roller bearings have been developed and used practically for a seismic design of buildings during the last 25 years. Among the various base isolation system, the lead rubber bearing had been used extensively. Itconsists of alternative layers of rubber and steel plates with one or more lead plugs that are inserted into the holes. Due to lateral forces the lead core deforms, yields at low level of shear stresses approximately to 80 to 10 Mpa at normal temperature, so the lead bearing lateral stiffness is significantly reduced. One of the feature of lead core is that it can recrystallize at normal temperature and will not encounter the problems of fatigue failure under cyclic loadings

IV. FLUID VISCOUS DAMPER

Among the various energy dissipation devices, fluid viscous dampers have been widely used in the vibration control of various structural and mechanical systems. These dampers were widely being used in the military and aerospace industry for many years and recently been adapted for structural applications in civil engineering.FVDs have the unique ability of simultaneously reducing both deflection and stresses within the structure. A modern fluid viscous damper functions at a fluid pressure level of significant magnitude, thus making the damper small, compact and easy to install. This type of damper is generally less expensive to purchase, install and maintain compared to other types of damper.

V. METHODOLOGY

In the present study five storied reinforced concrete building is considered. In this building with various conditions such as analysis of regular building, building with LRB isolator, building with FVD and building with LRB and FVD are considered. The RC frame situated in zone IV of India having medium stiff soil is considered.

A. Loadings

- Live load on floors =3kN/m²
- Live load on roof =1.5kN/m²
- Super imposed dead load on roof=0.75kN/m²
- Super imposed dead load on floor=1.5kN/m²

B. Geometric properties

- Column size=400*400mm
- Beam size=300*500mm
- Slab thickness=150mm

C. Material Properties

- Grade of concrete = M25
- Grade of steel =HYSD500

D. Soil type : Medium (Type II)

E. Zone factor :0.24

F. Importance factor :1

The work started with modeling and analysis of RC building for 4 cases. The first one is fixed base then base isolated then only providing damper and last one is the combination of base isolator and damper

TABLE1.LRB DIRECTIONAL PROPERTIES

Direction	Properties	
	Linear	***Nonlinear***
U1	Effective Stiffness =1103700 kN/m	Effective Stiffness =1103700 kN/m
	Effective Damping =0.1 kN-s/m	Effective Damping =0.1 kN-s/m
U2	Effective Stiffness =1103.7 kN/m	Effective Stiffness =11037 kN/m
	Effective Damping =0.1 kN-s/m	Post yield stiffness ratio =0.1
U3	Effective Stiffness =771200 kN/m	Effective Stiffness =11037 kN/m
	Effective Damping =0.1 kN-s/m	Post yield stiffness ratio =0.1

TABLE2. FVD WITH DIFFERENT CAPACITIES(kN)

Force(kN)	Weight(kg)
250	44
500	98
750	168
1000	234
1500	305
2000	600
3000	800
4000	1088
6500	1930
8000	2625

VI. RESULTS AND DISCUSSIONS

Fig I Storey displacement of a regular building

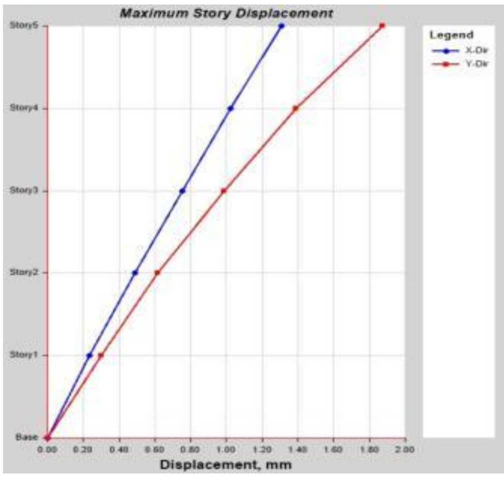

Fig 2 Storey displacement of building with damper

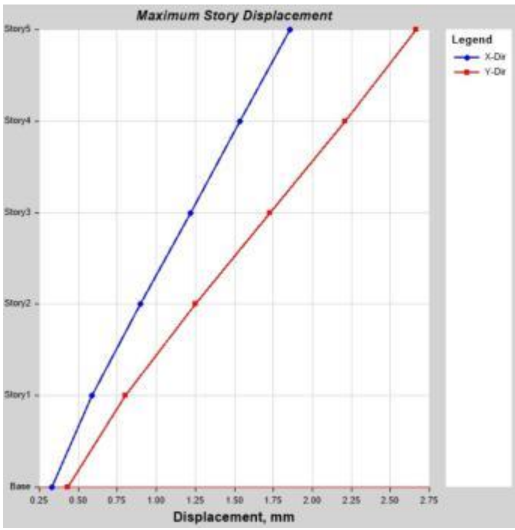

Fig 3 storey displacement of a building with LRB&FVD

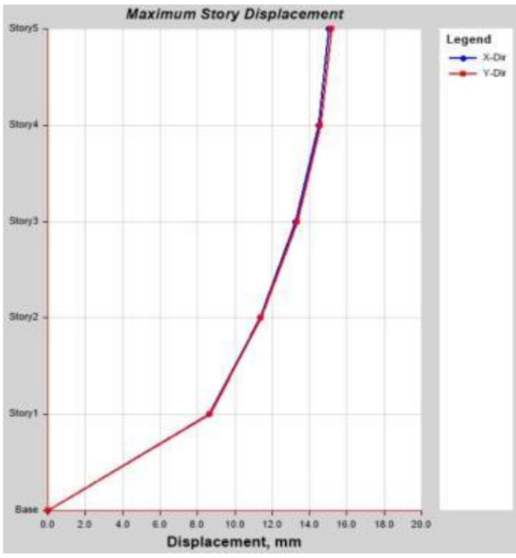

Fig 4storey displacement of a building with LRB

From figure 1 it is observed that maximum displacement occur at storey 5 with displacement 12.82mm.In figure 2 maximum displacements is at storey 5 with 1.874mm along direction. In figure3 maximum displacement is at storey 5with 2.6mm&minimum displacement 0.3313mm.In figure 4 displacements is maximum at storey 5 with 15.184mm minimum is at base 0.006953mm

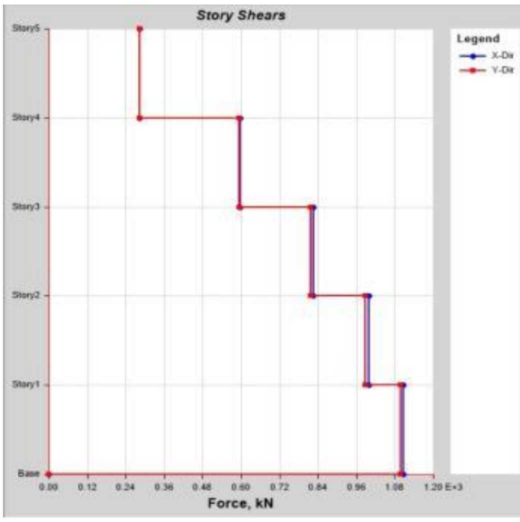

Fig 5 storey shear of regular building

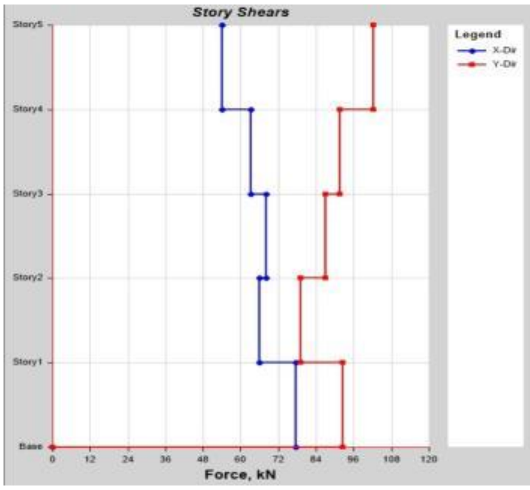

Fig 6 storey shear of building with damper

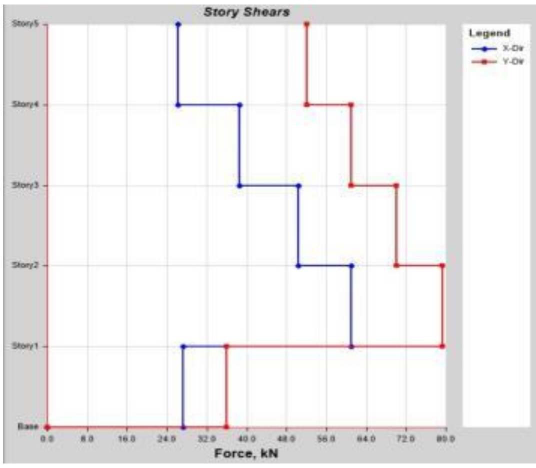

Fig 7 storey shear of building with LRB&FVD

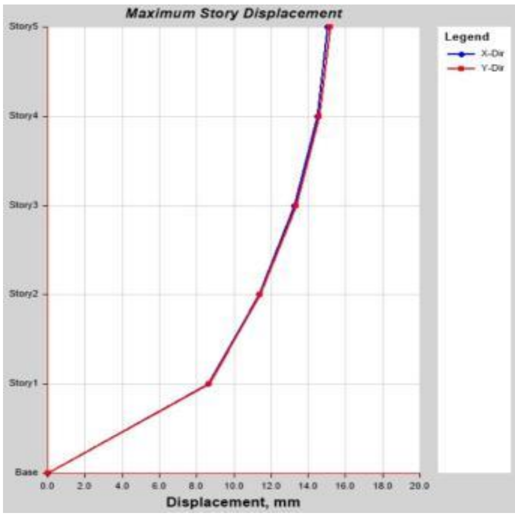

Fig 8 storey shear with LRB

In figure 5 maximum shear is at base .In figure 6 maximum shear is at storey 4.In figure 7 maximum shear is at storey 1 and In figure 8 maximum shear is at base. Comparing these graphs the shear is low at building with FVD&LRB

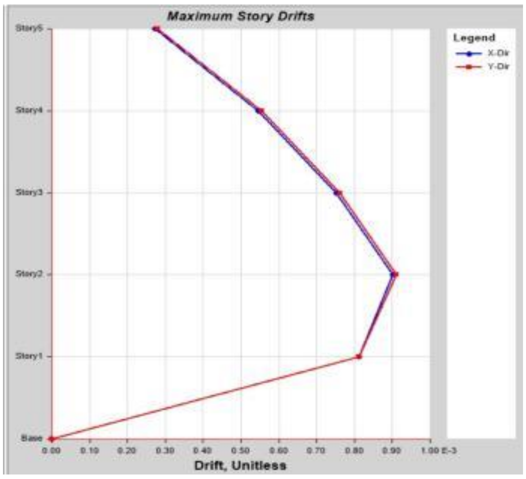

Fig 9 storey drift of regular building

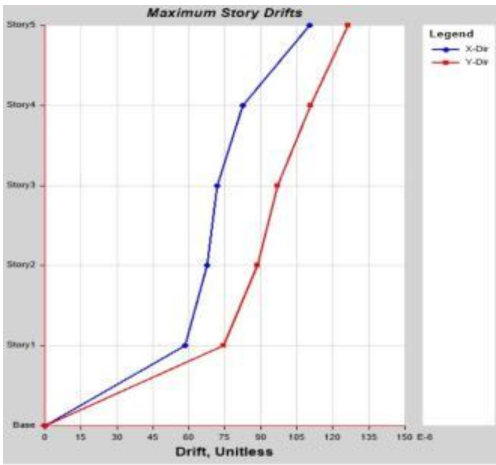

Fig 10 storey drifts of building with damper

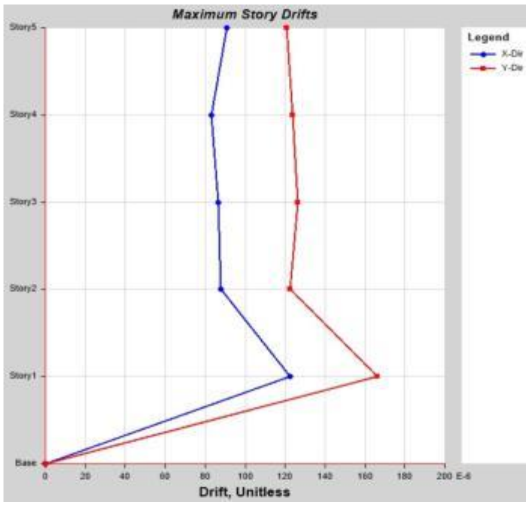

Fig 11 storey drifts of building with LRB&FVD

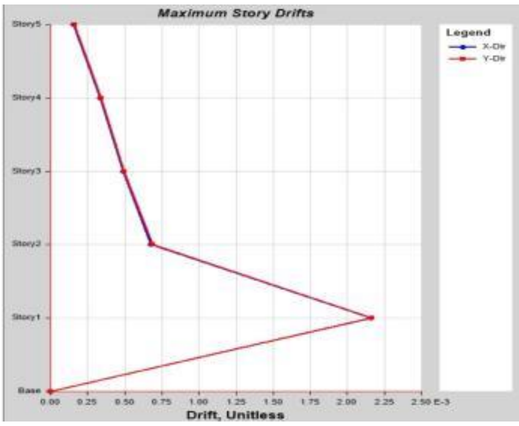

Fig 12 storey drifts of building with LRB

In figure 9 maximum storey drift is at storey 2 that is 0.000911 and minimum at base. In figure 10 maximum drift is 0.000126 and is at storey 5.In figure 11 maximum drift is 0.000166 and is at storey 1.In figure 12 maximum drift is at 0.002166 and is at storey 1

CONCLUSION

From the results of the linear dynamic analysis the following conclusions can be drawn.

A. Fluid viscous dampers can dissipate major portion of seismic energy and hence reduce the energy input on the primary structure. They are capable of reducing force and displacements
B. If we provide LRB only. Its displacement increases and it returns back to its original position with less damage and also it can remain without damage for a longer time periodof earthquake compared to building with damper
C. The displacement of building with LRB&FVD is slightly higher than the displacement of building with FVD only
D. Building with LRB&FVD can't remain for longer time period of earthquake

REFERENCES

[1] Dr. Hadi Nasir Ghadhban AL-Maliki, "Analytical Behavior of Multistoried Building with Base Isolation Subjected to Earthquake Loading", Journal of Engineering and Development, Vol. 17, No.2, [2013] ISSN 1813- 7822

[2] Abrishambaf, Amin, " Principles and Practices of Seismic Isolated Buildings". Masters. Cyprus: Eastern Mediterranean University. [2009.]

[3] S.M.Dhawade, "Comparative study for seismic performance of base isolated , fixed base RC frame structure" International journal of civil engineering research, [2014] vol.5, pp.183-190.

[4] Douglas P. Taylor, Fluid dampers for applications of seismic energy dissipation and seismic isolation, Eleventh World Conference on Earthquake Engineering, Paper no. 798.

[5] YuvrajBisht, SaraswatiSetia, Seismic behavior of a soft storey building with & without viscous dampers, International Journal of Engineering Research and Applications (IJERA), March 2014.

[6] A. Ras, N. Boumechra, Seismic energy dissipation study of linear fluid viscous dampers in steel structure design, Alexandria Engineering journal (2016) 55, 2821-2832.

[7] A.K. Sinha, Sharad Singh, Structural response control of RCC moment resisting frame using fluid viscous dampers, International Journal of Civil Engineering and Technology (IJCIET), Volume8, Issue 1, Jan 2017, pp. 900-910.