STUDY THE BEHAVIOUR OF FLAT, CONVENTIONAL AND GRID SLAB OF RCC STRUCTURES FOR REGULAR AND INREGULAR PLAN WITH SHEAR WALL AND VISCOUS DAMPER

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Abstract - Recently there has been a considerable increase in the number of unsymmetrical buildings in plan, both residential and commercial. The slab may be supported on directly walls, on reinforced concrete beams usually cast monolithically with the slab, on structural steel beams, on directly columns, or on the ground surface. Slabs may be classified in different types used in different structures. Flat slab, grid slab and conventional slab are one of them. The object of the present work is to do Response Spectrum analysis and Time history analysis of multi-storey buildings having Flat slabs, Grid Slab and Conventional slab system for G+9, G+14 and G+19 with various plan irregularities, with Fluid viscous damper and shear wall in different zones i.e., IV & V with medium soil type conditions. Software E-TABS is used for this purpose. The parameters considered are Time Period, Base shear, Displacements & Story Drift.

Key Words*: *FLUID VISCOUS DAMPER, SHEAR WALL, FLAT SLAB, CONVENTIONAL SLAB, GRID SLAB, RESPONSE SPECTURUM, TIME HISTORY, E-TABS.

1. INTRODUCTION

The development of vertical growth consisting of low-rise, medium-rise and high-rise buildings is significantly affected by the rapid growth of the urban population and the lack of land. Reinforced concrete structures are often subject to gravity and lateral loads, such as seismic load and wind load, which are live load, dead load, superimposed load, and lateral loads. Previously buildings were designed for only gravity loads that may not have resistance to lateral loads.

In structural engineering, there are many methods of seismic reaction regulation of structural structures, such as energy absorption at plastic hinges, base isolation, and energy dissipation. In the last 2 decades, energy dissipation devices such as viscous dampers have been extremely developed. The technology used by US military cannons & navy ships is basically very old (1860s) Fluid Viscous dampers. Taylor Devices got permissions to sell this FVD technology to the whole public society from 1990s. It is therefore a recent one and has yet to be explored, particularly in building structures, as it is beneficial to be used as a huge energy dissipater for shock devices and Vibration and protection against seismic hazards. Many types of dampers, such as steel dampers, viscoelastic dampers, friction dampers and tuned mass dampers, etc., are available on the market, but FVD has a wide range of in application variety and versatility that preferred it to be mostly suitable in buildings.

Usually, a structural part that may be column, beam and slab is adjusted in reinforced concrete buildings to resist lateral load, but there is more concern about slabs in this project. There are usually so many types of slab, but three different types of slabs, Flat slab, Traditional Slab & Grid slab, will be discussed here. Since shear wall is a highly efficient method of resisting horizontal forces in a reinforced concrete structure, shear wall is widely used to ensure greater strength in reinforced concrete structures.

1.1 Dampers

Dampers are the devices which are used to absorb or dissipate the vibration caused by the earthquake to the structure and to increase the damping and stiffness of the structure.

Types of dampers:

- Hydraulic dampers
- Fluid Viscous dampers
- Viscoelastic dampers
- Friction dampers
- Tuned mass dampers

Fluid viscous damper:

In viscous dampers, seismic energy is absorbed by silicone-based fluid passing between piston-cylinder arrangement. viscous dampers are used in high-rise buildings in seismic areas. It can operate over an ambient temperature ranging from 40° to 70°c. viscous damper reduces the vibrations induced by both strong wind and earthquake.

Table 1.1 Parameter of FVD

Force (KN)	Taylor Device model number	weight (Kg)
500	17120	44

Working procedure of viscous damper

- The viscous damper operates by allowing fluid to pass through an orifice in the chamber.
- The silicone-based fluid is used in the chamber. The piston which is made up of stainless steel which travels in the chamber which is filled by the silicone oil.
- Silicone oil has the characteristics of being inert, non-flammable, non-toxic, and highly stable over a long period of time.
- This difference in pressure between two chambers will force the oil to flow through orifice in piston head. The internal energy is converted to heat, which is released into the atmosphere.

1.2 floor systems

Slabs are used as flat surfaces, floors, roofs, bridges, slabs and many other forms of structures typically horizontal. The slab can be supported directly on walls, on reinforced concrete beams that are normally cast monolithically on the slab, on structural steel beams, directly on columns, or on the surface of the ground. Slabs can be categorized into various categories that are used in different frameworks. One of them is a flat slab, a grid and conventional slab.

1.3 Objectives

- To find Response of different Slab system under seismic load.
- To analysis the different slab system with different plan irregularity. (Rectangle, C and T Shape)
- To find Response of Slab system with shear wall
- To find Response of Slab system with Fluid Viscous dampers
- Comparison of slab system with fluid viscous dampers and Shear wall system

2. BACKGROUND LITERATURE

According to previous study of: Kapil P. Gunjal, Prof. Sanket S. Sanghai, the study examines the Dampers at base, middle level and at all story have reduced 40 to 50% displacement compare to bare frame.

According to Daksh S. Davda, Pravin L. Hirani, Narendra R. Pokar. Base Shear for Response spectrum analysis is more in flat slab. Base Shear for Response spectrum analysis is more in rectangular shape than C-shape building. Base Shear for Response spectrum analysis is more in shear wall compared to without shear wall.

According to Chandra Kumar, Ramendra Kumar Singh, the maximum storey displacement of the model-01(H) is low as compared to another two models (T and L). The value of the storey stiffness of the model-03(L) is low as compared to the two models. The value of the storey stiffness of model of L shape is 32.82% less than model of H shape and 7.18% less than as compared to model of T shape.

According to Y. Sarath Kumar Reddy, M.S. Anantha Venkatesh, Maximum reduction in displacement is 50% when dampers are provided at each floor for soil-1, 50% of displacement is reduced from zone-3 to zone -5. Fort soil-2, 60% of displacement is reduced from zone-3 to zone -5. For soil-3, 65% of displacement is reduced from zone-3 to zone -5.

According to Chetna Sahu, Bhavesh Kumar Jha, in multi storey building, provision of coupled shear wall with damper is found to be effective in increasing the overall seismic response and characteristics of the structure. The presence of coupled shear wall with damper can significantly affects the seismic behavior of the structure; it increases the stiffness and strength of structure. Damper is an energy dissipation device so it is more effective with coupled shear wall to dissipate the vibration energy. If we decrease seismic zone than no need to provide damper because the seismic response will be decrease. To consider the coupled shear wall with damper in the seismic analysis of structure, it decreases the probability of damage of the structure. Storey drift is minimum in the coupled shear wall with damper as compare to other model it means the structure is more stable. Storey stiffness is more in case of coupled shear wall with damper in every storey. The structure has been rigid using damper. Base shear of the structure is depending upon the weight of the structure.

According to MAHEK H DHOLU, PINTU R SENGHANI, NARENDRA R POKAR. Displacement for Response spectrum analysis varies up-to 17.33%, 20.22% and 25.21% for 20, 25 and 30 storeys respectively for Flat slab without Bracing compared to Conventional slab. Displacement for Response spectrum analysis varies up-to 16.20%, 19.07% and 25.73% for 20, 25 and 30 storeys respectively for Flat slab with Bracing compared to Conventional slab. Displacement for Response spectrum analysis varies up-to 28.41%, 31.32% and 34.71% for 20, 25 and 30 storeys respectively for Grid slab without Bracing compared to Conventional slab.

3. METHODOLOGY

In the present work the analysis of following structures with different type of slabs with fluid viscous damper and shear wall are been carried out:

- Flat Slab System
- Conventional Slab System
- Grid Slab System

For the study, the plan areas of all three structures are different; the beam and column dimensions are also kept constant. In all buildings, materials such as the Poisson ratio, RCC density, Masonry density, Young's modulus, steel and concrete compressive strength, etc., are kept constant.

Step -1 DYNAMIC ANALYSIS OF BUILDING

Regular Building Rectangular in Plan with Shear wall

- 10 Storey Building
- 15 Storey Building
- 20 Storey Building

Irregular Building C-Shaped in Plan with Shear wall

- 10 Storey Building
- 15 Storey Building
- 20 Storey Building

Irregular Building L-shaped in Plan with Shear wall

- 10 Storey Building
- 15 Storey Building
- 20 Storey Building

Regular Building Rectangular in Plan with fluid viscous damper

- 10 Storey Building
- 15 Storey Building
- 20 storey Building

Irregular Building C-Shaped in Plan with fluid viscous damper

- 10 Storey Building
- 15 Storey Building
- 20 Storey Building

Irregular Building L-shaped in Plan with fluid viscous damper

- 10 Storey Building
- 15 Storey Building
- 20 Storey Building

Step-2 Comparison of the parameters considered in the study of regular as well as the irregular type structures.

- It is important to carry out static analysis and dynamic analysis of the normal as well as irregular structure with shear wall, fluid viscous damper and various slab forms.
- It is important to analyze both structures according to the different seismic zones.
- The result parameter includes the base shear, displacement, moments etc., which are to be compared

Structure details

Plan dimension (Rectangular shape)	36m x 25m
Plan dimension (C-shaped shape)	36m x25m
Plan dimension (L-shaped shape)	36mx25m
Number of arms in x-axis	6
Number of arms in y-axis	5
Arm length in x-axis	6m
Arm length in y-axis	5m
Height of the floor	3m
Shear wall thickness	230mm

4. Result and Discussion

The basic model of different types of slab with regular & irregular in plan are prepared in ETABS 2018. Different models of the structure are analyzed under Response Spectrum and time history method using software ETABS 2018. In soil II and Zone IV & V, this study is performed for 10, 15, and 20 storey structures. The fluid viscous damper and shear wall are used in this study for conventional, flat and gird slab system. Storey displacement, storey drift, storey shear, and time period are all seismic parameters which is consider.

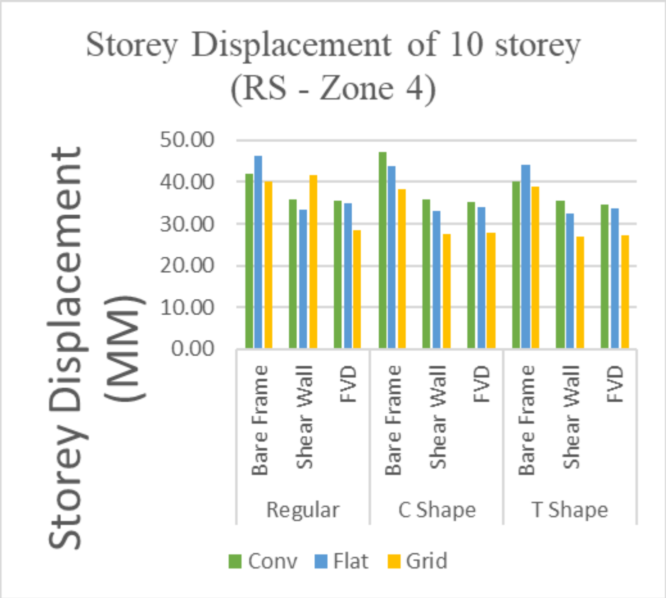

FIG4.1 Maxi. 10 Storey Displacement for RS-zone 4

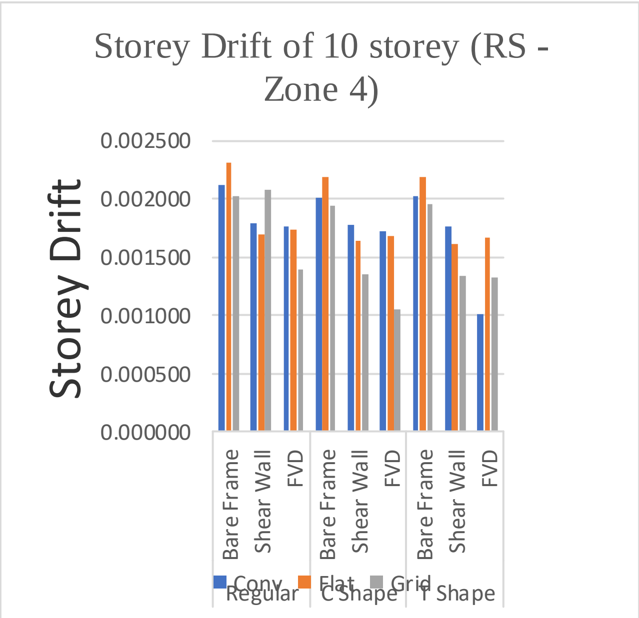

FIG4.2 Maxi. 10 Storey Drift for RS-zone 4

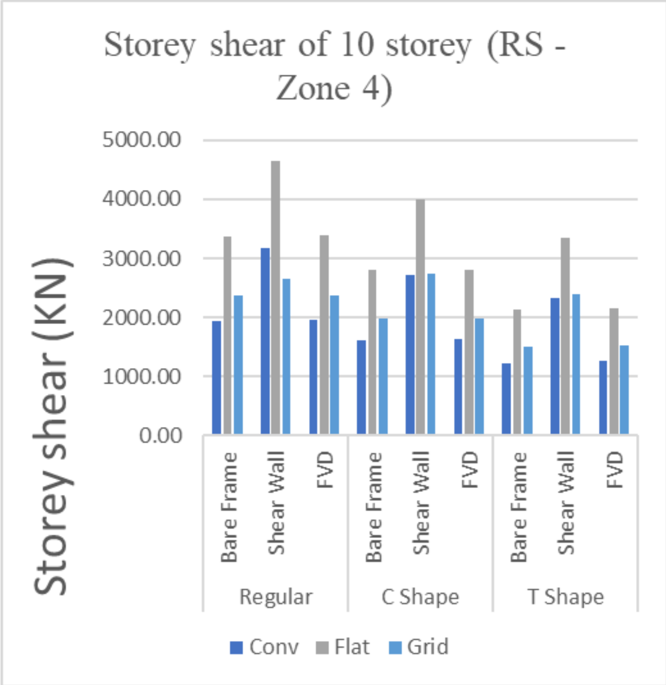

FIG4.3 Maxi. 10 Storey shear for RS-zone 4

CONCLUSIONS

- The values of Maximum Displacement for Response spectrum analysis are least in Conventional slab, & values of Maximum Displacement are less in Flat slab compared to Grid slab for Rectangular in plan.
- The values of Maximum Displacement for Response spectrum analysis are least in Conventional slab, & values of Maximum Displacement are less in Grid slab compared to Flat slab for C-shaped & L-shaped in plan.
- The values of Maximum Displacement for Time History analysis are least in Grid slab, & values of Maximum Displacement are less in Conventional slab compared to Flat slab for Rectangular, C-shaped & L-shaped in plan.
- The values of Base Shear are least in Grid slab & values of Base Shear are less in Conventional slab compared to Flat slab for both Rectangular and C-shaped & L-shaped in plan.
- The values of Maximum Displacement for Response spectrum analysis are least with FVD.
- FVD has better response in C type structure compared to T type structure.

REFERENCES

1. Kapil P. Gunjal, Prof. Sanket S. Sanghai "Seismic Analysis of Building Using Dampers in Shear Walls" International Journal of Innovations in Engineering and Science International Journal of Innovations in Engineering and Science Vol. 4, No.6, 2019 e-ISSN: 2456-3463
2. Daksh S. Davda, Pravin L. Hirani, Narendra R. Pokar "Study the behavior of Flat, Conventional and Grid Slab of R.C.C. Structures for Regular & Irregular in Plan with & without Shear wall" Journal of Emerging Technologies and Innovative Research March 2019, Volume 6, Issue 3, ISSN-2349-5162
3. Chandra Kumar, Ramendra Kumar Singh "Seismic Analysis of Different Shape of RC Building by Using the Viscous Damper" International Research Journal of Engineering and Technology (IRJET)Volume: 07 Issue: 04 | Apr 2020
4. Y. Sarath Kumar Reddy, M.S. Anantha Venkatesh, "Vibration control Of High-Rise Building with Viscous Dampers Using ETABS" International Journal of Science, Engineering and Technology Research (IJSETR) Volume 7, Issue 6, June 2018, ISSN: 2278 -7798
5. Chetna Sahu, Bhavesh Kumar Jha, "Analysis the Behavior of Coupled Shear Wall in High Rise Building with and without Damper" International Research Journal of Engineering and Technology (IRJET) Volume: 07 Issue: 01 | Jan 2020
6. Navjot Kaur Bhatia, Tushar Golait, "Studying the Response of Flat Slabs & Grid Slabs Systems in Conventional RCC Buildings" International Journal of Trend in Research and Development (IJTRD) Volume 3(3), June 2016.
7. Mohammed Fatir, M.H. Kolhar, AnjumAlgur "Relative Study of Seismic Analysis Between Flat Slab and Grid Slab of Rcc Structures with Different Masonry Infills in Two Different Zones" International Journal of Research in Engineering and Technology, Volume: 05 Issue: 07 | Jul-2016
8. Romy M and Prabha C (2011), Dynamic Analysis of RCC Buildings with Shear Wall, International Journal of Earth Sciences and Engineering, ISSN 0974- 5904, Vol. 04, 659662.
9. Patwari K G, Kalurkar L G (2016), "Comparative study of RC flat slab and shear wall with conventional framed structure in high rise building", Volume No. 05, International Journal of Engineering Research.
10. Makode R. K., Akhtar S., Batham G. (2014), Dynamic analysis of multi-storey RCC building frame with flat slab and grid slab, al Int. Journal of Engineering Research and Applications, Vol. 4, Issue 2(Version 1), February 2014, pp.416-420.
11. Visnesh P. Thakkar, Anuj K. Chandiwala, Unnati D. Bhagat. "Comparative Study of Seismic Behavior of Flat slab and Conventional RC Framed Structure". International Journal of Research in Engineering and Technology, Volume: 06 Issue:04 April 2017, ISSN: 2278-0181.
12. Mr. Devaraju T.S, Prof. Shridhara Y, "The Dynamic Analysis of L and H shape of G+15 Storey Building". International Research Journal of Engineering and Technology, Volume: 05 Issue: 06 June-2018.

IS CODE

1. IS: 1893(Part-I)-2016, "Criteria for Earthquake Resistant Design of Structures". Bureau of Indian Standard, New Delhi.
2. IS 875-2015 Part III (Wind Load), Indian Standard code of practice for Design loads (Other than Earthquake Load) For Building and Structure, Bureau of Indian Standards, New Delhi, India.