A Review on Influence of Fluid Viscous Damper on The Behaviour of Multi-storey Building Under Different Seismic Zones

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Abstract - *Here we implemented high rise structure construction everywhere as we have urbane designing software and due to improvement in the field of engineering and technology. As we know if we rise height of building seismic and wind load response also increase. Indian standard codes propose that the displacements and forces of a structure are directly relational to its height. Continuously study is going on for reduction of response during extreme horizontal loading due to shaking and wind. Passive controller device like various type of dampers is used for controlling response of shaking and wind load.*

***Key Words*: Fluid viscous dampers, Displacement, Storey Drift and Storey shear, ETABS.**

1. INTRODUCTION

1.1 General

➢ **Which different kind of load is acting on RC building?**

There are many types of loads are acting on RC building. If we discus majorly in India we consider Dead load, Live load, Seismic load and Wind load (if height if building is more than 10m, as per IS 875 part 3). But according to IS 456 table-18 while we consider earthquake effect then in given load combination wind load is substitute by earthquake load.

→ **Dead Load:**

Dead load is mainly caused by the individual weight of the structure and the completion of the structure. Dead loads are carried out only in the vertical direction. We can only assume that no tipping occurred due to static properties.

→ **Live Load:**

Live load is acting due to human stay in building, furniture, vehicle etc. In different type of building, we consider different value of Live load as suggested in IS 875 part 2.

→ **Earthquake Load (Seismic load):**

Seismic load is the horizontal load on the building as result of the shaking of the ground during an earthquake. Earthquake loads are "dynamic load". Other types of loads usually slowly acts on structure, but seismic load act rapidly and vibrate the structure.

➢ **What is earthquake resistant building?**

Earthquake resistant building is defined as there is no damage allowed in structural member and no major damage allowed in non-structural member in weak earthquake, Structural damage allowed but not major damage allowed it should be repairable in moderate or moderately strong earthquake, and in strong earthquake major damage allowed but structure should not collapse during earthquake, this type of building known as earthquake resistant building.

➢ **What is damper?**

"Dampers are energy dissipation system".

Dampers are device used to disperse or absorb vibration resulting from earthquake in the structure to increase the damping and stiffness of the structure.

➢ **Different type of damper majorly used in building.**

1] Fluid Viscous Dampers (FVD)
2] Viscoelastic Dampers
3] Friction Dampers
4] Tuned Mass Damper (TMD)
5] Yielding Dampers
6] Magnetic Damper

1.2 Fluid viscous dampers:

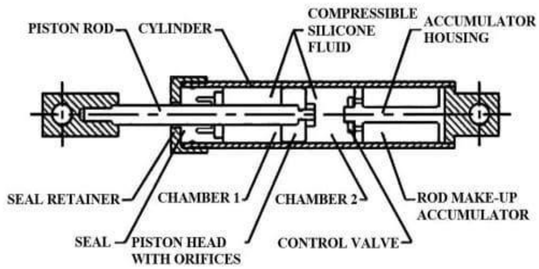

Figure 1: Schematic Detailing of Fluid Viscous Damper Components

In the fluid viscous dampers, seismic energy absorbed by silicon-based fluid passing through the piston-cylinder arrangement. Viscous dampers are used in many building in higher earthquake zone. It operates in the temperature range of 40° C to 70° C. Viscous dampers reduce vibration caused by earthquake.

➢ **Component of Fluid viscous dampers.**

1] Piston Rod
2] Cylinder
3] Silicone Fluid
4] Accumulator Housing
5] Seal and Seal Retainer
6] Chamber-1 and Chamber-2
7] Piston Head with Orifices
8] Control Valve
9] Rod Make-up Accumulator

➢ **Types of connection of Fluid viscous dampers.**

There are three ways to connect dampers,

1] In floor or foundation
2] In stern pericardial braces
3] In diagonal braces

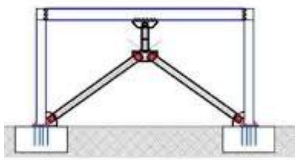

Figure 2: stern pericardial braces

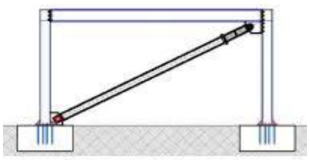

Figure 3: Diagonal Braces

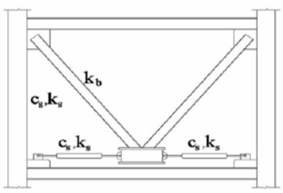

Figure 4: Floor or Foundation

1.3 Terminologies:

Displacement:

"The distance from the original position of sample point of structure to its final location of the deformed structure is known as displacement of structure."

Story Drift:

"The lateral displacement of consecutive floor is known as storey drift." And "The ratio of floor drift to the floor height is known as storey drift ratio."

Story Shear force:

"The lateral force act on the storey duo to force such as wind load or seismic load is known as storey shear force."

Building having less stiffness attracts less storey shear and buildings having more stiffness attract more storey shear.

1.4 Objective

The main objective of this study is to check the kind of performance a building can give when designed as per Indian Standards.

The Analysis of the building frame is carried out by using structural analysis and design software ETABS (version 21).

- To analyse Storey displacement of building.
- To analyse Storey drift of building.
- To analyse Storey shear of building.

We are use ETABS (version 21) for analyse model of RCC building. Take random parameters of column, beam and other structural component. Different seismic zone and different type of soil is considered for analysis.

2. LITERATURE REVIEW

[1] Milton Fernandes 1, Swane Rodrigues 2, Suraj Sharma3, Smit Raut 4, Mr. Shreeshail Heggond 5, "Comparative Study of Seismic Behavior of High-Rise Building with and Without Use of Fluid Viscous Damper Using E-Tabs", International Journal of Innovations in Engineering and Science.

G+25 RCC commercial office building located in Mumbai with higher height to plan dimension ratio is examined using fluid viscous dampers at exterior corner of building. Model is run in ETABS 2019 and examined model with two methods, **(1) Equivalent static method and (2) Response spectrum method.**

For a G+ 25-storey RCC building with and without ice damper, floor displacements, floor drifts, floor shear forces and models along x and y directions, static equation method and response spectrum method time and frequency value were used.

The study concluded that the floor deflection of a conventional reinforced concrete building without a tipper will have the highest deflection compared to a building with a tipper. By adding dampers to the structure, we will reduce the displacement factor and increase the stability of the structure. Since the displacement value increases as the height of the building increases, dampers are used to reduce ground displacement. By adding dampers to the structure, the inter-storey drift value can be reduced, and the maximum inter-storey drift value of the building does not exceed the limit specified in Indian standards.

[2] Daniel C, Arunraj E, Vincent Sam Jebadurai S, Joel Shelton J, Hemalatha G, "Dynamic Analysis of Structure using Fluid Viscous Damper for Various Seismic Intensities", International Journal of Innovative Technology and Exploring Engineering (IJITEE)

Dynamic analysis done for 5 story RCC structure with fluid viscous damper with different earthquake intensity, the model is done using SAP 2000 in this research paper. Using SAP 2000, run the model and examine the model with the dynamic analysis method. Roof displacement and base shear of RCC building with liquid viscous dampers and without liquid viscous dampers were investigated.

Based on this research, it is concluded that the base shear obtained was reduced by 50% for the X-axis using FVD. The base shear obtained was reduced by 61.3% for the Y-axis using FVD. The roof drift was reduced by 50.65% for the X-axis using FVD. The roof drift was reduced by 51.35% for the Y-axis with FVD.

[3] Vibha More, Dr. Vikram Patil, Somanagouda Takkalaki, "Dynamic Analysis of RCC Frame Structures with and Without Viscous Damper Having Different Aspect Ratio", IJISET - International Journal of Innovative Science, Engineering & Technology.

Detailed analytical study of liquid viscous damper using ETABS version 15. The study is limited to the analysis of 20 storey and 40 storeys R.C.C. building. A total of four different structures are modelled for two different heights and two different aspect ratios.

This work includes a study of the structure with and without a fluid viscous damper. The different heights to be considered for this study are 20 storeys and 40 storeys. Different aspect ratio should also be considered, for example 1, 1.5. The aim of the study is to find out the differences in various parameters of the structure using ETABS software by performing response spectrum analysis.

Liquid viscous dampers will be installed in the building to combat the acceleration force due to the earthquake. A trial-and-error method was used to find the optimal location of the dampers in the building.

Research indicates that up to 44% reduction in floor drift has been observed when FVD is provided to the 10th floor in a zigzag pattern, while the reduction is up to 54% when FVD is provided at all exterior corners in a zigzag pattern. Floor drift reduced by up to 78% when FVD is secured to the 10th floor in a zigzag pattern. It is also reduced by up to 65% when FVD is provided at all outer corners in a zigzag pattern. Approximately 40% reduction in time-period was observed when using FVD. It was observed that the B model with aspect ratio of 1 with dampers provided with a zigzag pattern at all outer corners gives a satisfactory result compared to other models.

[4] Madhuri S L, Lakshmi P S, "Seismic Performance Evaluation of Fluid viscous Damper", International Journal of Advances in Engineering and Management (IJAEM).

In this research, a 5-bay X-direction and 5-bay Y-direction rectangular reinforced concrete structure model for 15-story frames made of M25-grade concrete for the beam and slab and M30 for the column and Fe500-grade steel is built. A scheme with a field width of 5 m is measured. The expected floor height is 3.6 m. The total width of the frame is therefore 25 x 25 m. The support conditions are to be fixed and the reduction factor is to be 5 for soil type 2 (medium) and seismic zone V.

We concluded that the offset of the floor is high on the upper floor and lower on the base, with increasing height the offset increases. The displacement of the floors of the structure without the application of FVD is the maximum compared to the structure with FVD, and with the application of FVD in the corners of all floors, the maximum displacement is reduced compared to other places of the structure. The floor displacement follows a parabolic path along the floor height with a maximum value somewhere near the fourth floor. After the fourth floor, the floor displacement decreases as the height of the structure increases. The storey displacement is maximum for the structure without dampers and is reduced by 47% when FVDs are placed at the corners of all storey and by 41% when FVDs are placed at the center of all storey.

[5] N. Priyanka, Dr. J. Thivya, J. Vijayaraghavan, "SEISMIC STUDY OF MULTI-STOREY STRUCTURE WITH FLUID VISCOUS DAMPERS USING ETABS", International Research Journal of Engineering and Technology (IRJET).

A seismic study of a multi-story structure resting on normal terrain with different seismic intensities with and without the use of liquid viscous dampers is performed. An RC multi-storey building in seismic zones II, III, IV and V is to be designed and the most vulnerable building among them is to be identified. Fluid viscous dampers with different strengths can also be used in different types of buildings because the modelled structure has a low height; smaller devices were used to start the analysis. The FVD is added to the structure after it is defined in the joint properties by adding a new damper exponential in the joint property data.

From the results, we conclude that responses such as acceleration, base shear, displacement are reduced when FVD is included in the design. The seismic performance of buildings can only be improved by using energy dissipation devices (dampers) that dissipate the input energy during an earthquake. Damper placement plays a primary role in controlling structural vibration. Efficiency is greater when the dampers are placed in the corners instead of in the middle. The most vulnerable type of building is in zone V. Therefore, from this analysis, the location of the damper is very effective and recommended.

3. CONCLUSION

Fluid viscous dampers are devices to absorb energy produced by earthquake or wind load or any other lateral load acting on RCC building.

- Analysis of storey displacement with fluid viscous damper and without fluid viscous dampers clearly show that maximum displacement of building is reduced by some percentage after adding fluid viscous dampers.
- Storey drift of building after adding fluid viscous dampers decrease and base shear also reduce.
- Time period of building is increase so frequency of building is decrease and less frequency attract less seismic load.
- Location of fluid viscous dampers also affect on displacement, storey drift and other seismic parameters.
- Corner damping is most effective as compared to other placement of dampers. middle damping is little bit less effective as compared to corner damping.
- Building in higher seismic zone getting more displacement and storey drift as compared to lower seismic zone.
- If we want to decrease displacement and storey drift, we need to introduce some shock absorber for reduce movement of RCC building during lateral load acting during earthquake or high wind speed.
- Fluid viscous dampers are the more effective absorbers for RCC building.

4. REFERENCE

1] Milton Fernandes 1, Swane Rodrigues 2, Suraj Sharma3, Smit Raut 4, Mr. Shreeshail Heggond 5, “Comparative Study of Seismic Behavior of High-Rise Building with and Without Use of Fluid Viscous Damper Using E-Tabs”, International Journal of Innovations in Engineering and Science, www.ijies.net, e-ISSN: 2456-3463 Vol. 6, No. 5, 2021, PP. 22 -30

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4] N. Priyanka, Dr. J. Thivya, J. Vijayaraghavan, “SEISMIC STUDY OF MULTI-STOREY STRUCTURE WITH FLUID VISCOUS DAMPERS USING ETABS”, International Research Journal of Engineering and Technology (IRJET), Volume: 06 Issue: 04 | Apr 2019.

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6] IS 1893 Part 1 (2016)

7] IS 875 Part 1 (1987)

8] IS 875 Part 2 (1987)