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Seismic Performance Evaluation of Fluid-viscous Damper

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ABSTRACT:

In this study, the seismic performance of a G+15 story RC framed structure was examined in relation to the use of passive control devices. At the four various locations of the building, the RC framework is outfitted with linear fluid viscous dampers for this purpose. Using the software Etabs, a response spectrum method of study was carried out to look at the seismic behavior of each system. For four alternative locations of damper arrangement, the seismic response of the frame was examined and compared in terms of the maximum storey displacement, maximum storey drift, and maximum storey shear. In comparison to the original structure, the results show that the structure with dampers had excellent seismic performance.The fluid viscous damper offered at the corner dampers provides noticeably higher seismic performance when compared to the other configurations among the four sites that were taken into consideration.Also, linear fluid viscous damper that enhance the seismic overall performance of the body and nook dampers had the maximum useful impact for the structural studied.

Keywords: ETABS 2019, Fluid-viscous damper (FVD), Response Spectrum Method.

I. INTRODUCTION

An earthquake is one the scary herbal phenomena which rising from the derivation of electricity withinside the earth's core. The earthquake waves inspire maximum of lateral hundreds reviews a massive deflection or entire crumble relying on form of building, value of the earthquake, Zone component and different parameter. The crumble of the shape can cause lack of existence and belongings damage, ensuing in more economic losses and the social disaster. Therefore, systems are designed to face up to earthquake.

The performance of structure throughout the earthquake depends on the severity of the earthquake and also the structural characteristic admires material property, sectional property, and structural capability of the structure. However, several codes have specific style specification for seismically protected building however there's still would like of some changed rules for energy dissipation protection system.

In the present study, an attempt was made to introduce a fluid-viscous damper into the planar arrangement at various points.

II. FLUID VISCOUS DAMPER

As one of the energy dissipation devices, FVD has been widely used to reduce the vibration of various structures. And in the military and aerospace industries, shock absorbers are becoming widely used and recently adopted in the civil engineering field due to their unique ability to reduce both deflection and stresses within the structure.

FVD has a stainless-steel piston rod and a self-contained piston displacement accumulator unit with a bronze shield head. The shock absorber cylinder is filled with a compressible viscous liquid (silicone oil), which is generally non-toxic, non-flammable, thermally stable and environmentally friendly. The longitudinal section of the fluid viscous damper is shown in Figure 1

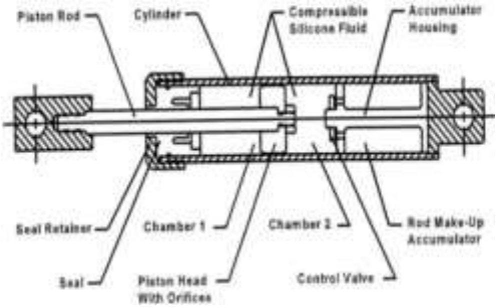

Fig 1:Longitudinal section of Fluid viscous damper

III.METHODOLOGY

One of the basic requirements in structural design is to reliably predict the desired structure under given loading conditions. When designing structures with multiple dampers added, the most important design parameter is the property of the damper. First, the structural analysis is carried out without a damper. The structural analysis is then performed with four different damper positions. The design typically contains subsequent steps that can be continuously updated to determine the structural properties once in each design cycle.

IV.DETAILS OFREINFORCED CONCRETE BUILDING

In this studio, the model of a rectangular RC building with 5 spans in X-direction and 5 spans in Y-direction for 15-story frames is made of grade M25 (beam and plate) and M30 (column) concrete and Fe500 grade steel constructed. A system with a field width of 5 m is considered. The floor height is assumed to be 3.6 m. Therefore, the overall width of the frame is 25 x 25 m. The support conditions are assumed to be fixed and the reduction factor is assumed to be 5 (SMRF) for soil type 2 (medium) and seismic zone V.

The size of the beam and the column is assumed to be (300 x 450) mm and (450 x 450) mm, respectively. The thickness of the slab is assumed to be 150mm resting on all the floor joists and the live load is 3kN/m2 and the floor surface is 1.5kN/m2, the wall load is in the floor along the length of the joist. According to IS 1893:2016 (Part 1), in seismic analysis and wind loads according to IS 875:2015 Code.

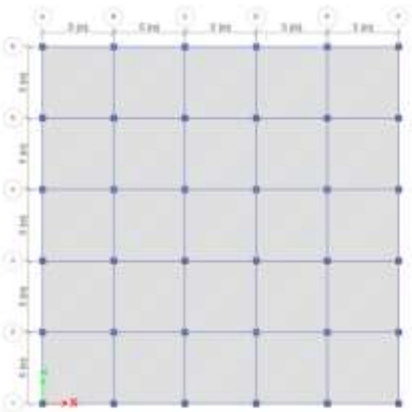

Fig 2:Plan of the model

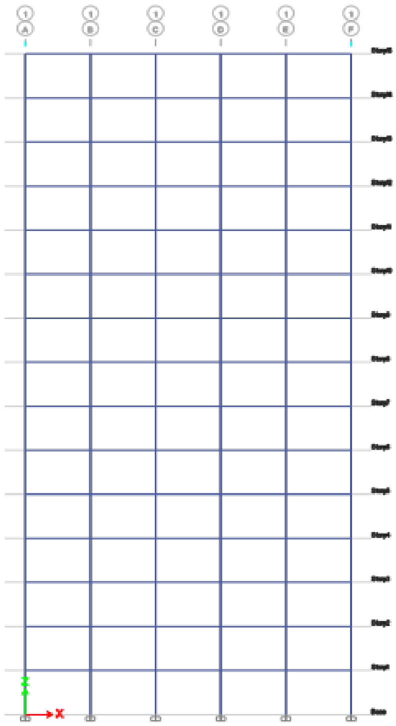

Fig 3: Elevation of the model

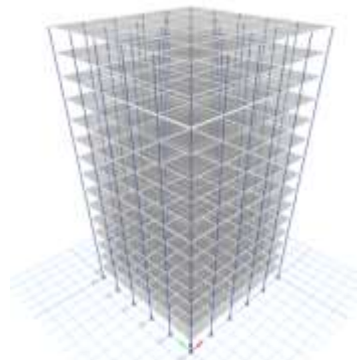

Fig 4:3D (isometric) view of the model

Dampers are provided at various locations in the building. Liquid viscous dampers manufactured by Taylor Devices Inc.; The United States is included in this study.

Property of Linear Fluid Viscous Dampers [3]:
Model #17120 (from Taylor Devices)
Force: 250 kN
Weight: 44 kg
Viscous fluid dampers will be installed in the building to counteract the acceleration forces due to the earthquake. A trial-and-error method was used to find the optimal position of the dampers in the building.

The Models are:

- Model without damper
- Model with dampers at ground floor only (base damping)
- Model with dampers at Middle of all storey's (middle damping)
- Model with dampers at corners of all storey's (corner damping)
- Model with dampers at alternate floor of all storey's (alternative damping)

V.RESULTS AND ANALYSIS

The results of the model analysis are presented here in terms of bullet displacement, bullet drift and bullet shear.

Story Displacement Results

Here the results are shown in a Fig 5 and 6.

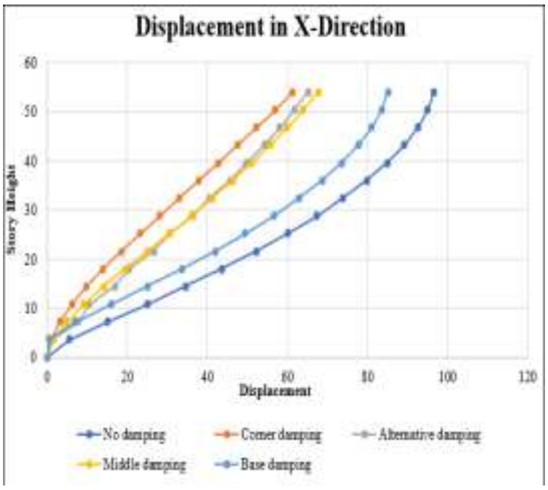

Fig 5: Variation of Story Displacement in X-direction.

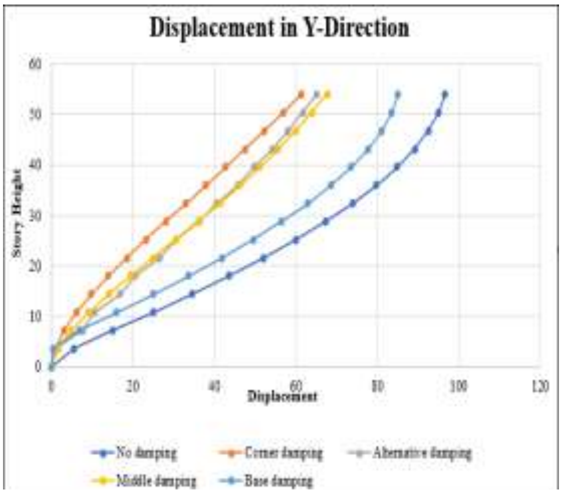

Fig 6: Variation of Story Displacement in Y-direction.

From Figures 5 and 6 it can be seen that the fluid viscose damper reduced soil displacement by 36% for the model with dampers placed at all outside corners (corner damping) and by 32.2% for the model with alternate soil corners placed Dampers reduced (alternative damping), also by 29% and 11% respectively for models with FVD placed in the middle of all floors and only on the ground floor versus the model without dampers in X and Y directions.

Story Drift Results

Here the results are shown in a Fig 7 and 8.

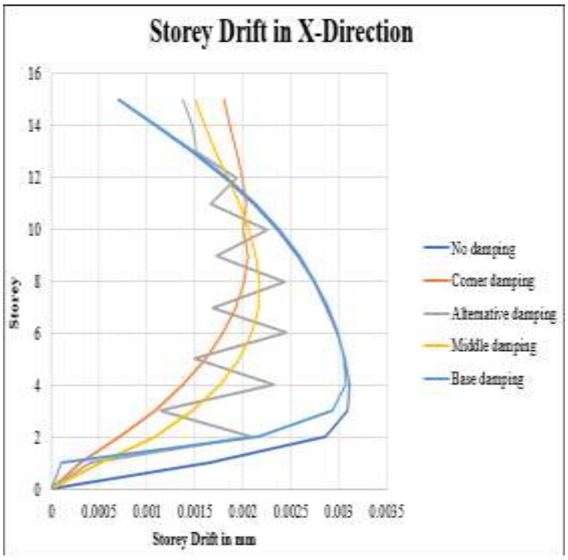

Fig 7: Variation of Story Drift in X-direction.

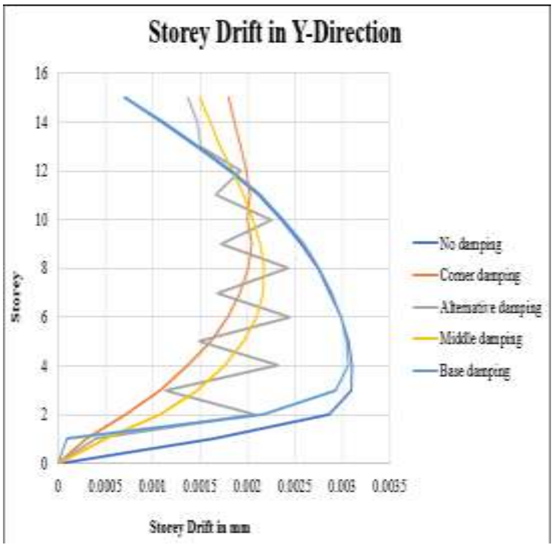

Fig 8: Variation of Story Drift in Y-direction.

From Figures 7 and 8 we can see that fluid viscous dampers reduce ground drift by 47% for the model with dampers placed at the corners of all floors and by 41% for the model with dampers placed in the center floors, also 32 % and 19% in the model with FVD are placed on alternative floors and only on the ground floor compared to the model without applying shock absorbers in X-direction and Y-direction.

Story Shear Results

Here the results are shown in a Fig 9 and 10.

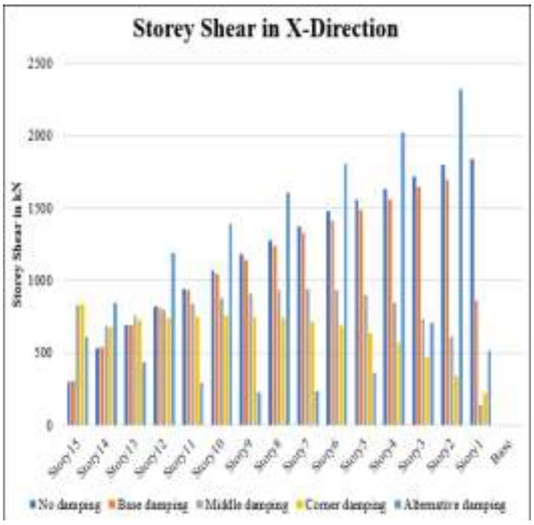

Fig 9: Variation of Story Shear in X-direction

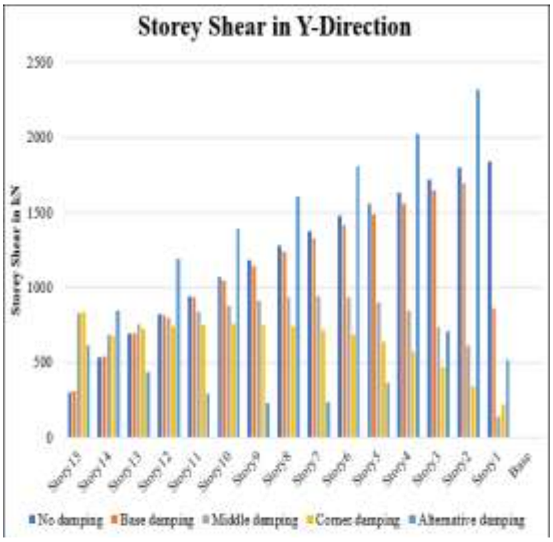

Fig 10: Variation of Story Shear in Y-direction

From Figures 9 and 10 we can see that fluid viscose dampers reduce floor shear by 47% for the model with dampers at the corners of all floors and by 35% for the model with dampers at the center of all floors, also by 20% % and 8% for models with shock absorbers placed on alternate floors and only at floor level compared to the model without applying FVD in X and Y directions.

VI.CONCLUSION

Based on the results and discussion, the following conclusions are drawn.

1. The floor offset is high at the top floor and lower at the base, with increasing height the offset increases. The displacement of the floors of the structure without the application of shock absorbers is maximum compared to the structure with shock absorbers, and by applying FVD in the corners of all floors, the maximum displacement is reduced compared to the other places in the structure.
2. The history drift follows a parabolic path along the height of the floor, with a maximum value somewhere near the fourth floor. After the fourth floor, floor drift decreases as the height of the structure increases. Bullet drift is maximum for a structure without dampers and decreases by 47% when FVDs are provided at the corners of all floors and by 41% when FVDs are provided at the center of all floors.
3. Story shear is maximum at the base and decreases with increasing height of the structure. Bottom shear with corner damping reduces peak shear compared to structures without dampers and other damper positions.
4. It is observed that the model has a square frame, it is symmetrical in both directions, the response magnitudes are also equal in both directions.
5. Looking at the results above, the RC frame with the dampers in the corners is optimal placement and offers the greatest reduction in structural response.

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