ISSN: 0974-5823 Vol. 7 No. 5 May, 2022

International Journal of Mechanical Engineering

"Analysis of C, Plus and Rectangular Building with and Without Belt Wall"

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ABSTRACT: The outrigger and belt wall system is often used as one of the structural systems to successfully manage excessive drift due to lateral load, so that the danger of structural and non-structural degradation may be avoided during minor or medium lateral load owing either by wind or seismic load. This technology can be considered as an acceptable structure for high-rise structures, particularly in seismic active zones or wind load dominating areas. Outrigger is a type of tall building structural technology that is designed to lessen wind-related structure reactions. Outrigger systems, which are commonly employed with shear wall-framed systems in tall structures, strengthen the structural bearing system's lateral stiffness and lower the structure's lateral drift during lateral loads. Traditional outrigger systems, however, in addition to their good contributions, have significant limits and issues that impact the structure's modeling. Some of these include utilizing more internal space as an architect, as well as issues developing in the link of outrigger and central core.

Key words: Belt wall, Damper, Bare Frame, Bending moment, Shear Force, Deflection etc.

1. INTRODUCTION

Various structural systems or passive and active control equipment can be used to lessen the building's structural reaction. Belt wall and outrigger systems are tall building structural solutions that may be utilized to reduce the effects of wind on the structure. A stiff beam that links the center of a high-rise structure to the outlying columns is known as an outrigger. When the structure is exposed to lateral load, the presence of outrigger creates tensile forces in the columns on the windward surface and compressive forces in the columns on the leeward surface. In addition to the columns positioned at the extremities of the outriggers, a belt wall is attached to the structure with outriggers to mobilize the other peripheral columns in repelling the lateral load. A belt wall is a deep spandrel beam that is built from around structure at the same elevation as the outriggers and can be one or two storey tall. The effectiveness of the belt wall in further decreasing the reactions of structures with outrigger systems is unknown. The goal of this investigation is to see how successful a belt wall solution is in reducing the structure's reaction to wind loading (displacement and acceleration).

Belt Wall

Outriggers are solid horizontal structures, such as trusses or beams that link the building's core wall and exterior column to increase the structure's strength and overturning stiffness. Although outriggers have been employed in tall buildings for over half a century, new design principles have improved their performance. An outrigger system is a sort of structural system that is made up of a horizontal element with a cantilever shape that is attached to the structure's inner core and outer columns. The moment arm of the core will be enhanced as a result of the interconnection, resulting in greater lateral stiffness of the systems. Outriggers are given to lessen overturned moments in the core and to transmit moment from the core to the outer column by connecting the core and column of a building. Outrigger systems may be made from a variety of materials, including steel, concrete, and composites. Outriggers can be stretched on both sides of the central core, or the core can be positioned on one side of the structure with outriggers extending on the other. Belt walls link a structure's outside perimeter columns and provide a larger perimeter to prevent lateral displacement. When compared to outriggers without a belt wall, the behavior of outriggers with a belt wall has proved to be more successful. Outrigger arms restricted the core wall from rotating freely as a result of the outside columns. The performance of outrigger and belt wall can be influenced by a variety of variables such as the location of outrigger and belt wall, the amount of outrigger, the geometry of the structure, the kind of core (concrete or steel), and the height from floor to floor.

Dampers

Damper systems absorb seismic energy and limit structure deformations, safeguarding structural strength, reducing structural damage, and avoiding injuries to occupants. Seismic dampers enable the structure to endure high input energy while reducing structurally and occupant deflections, forces, and accelerations.

The installation of additional dampers is a standard seismic retrofitting procedure. There are various kinds of dampers available, including viscous, visco-elastic, friction, metallic yielding, visco-elastic, and others. These devices for operate as energy sinks, dissipating the incoming seismic energy and lowering the seismic response on structural elements. However, a haphazard spatial arrangement of dissipation devices in the building may not result in a significant decrease in seismic response.

The efficiency of a damper in lowering structural response is determined by the amount to which it participates in the structure's reaction to external stimulation. Considering damper expenses and efficiency in decreasing structural responses, it is vital to optimize damper position and quantity to enhance the seismic behavior of the building. Optimization of supplemental damping/controlling devices for installation in a structural system, the challenges studied were mainly open-ended, and no restriction on the allowable amount of dampers was applied however, because to cost restrictions, only a limited amount of dampers may be provided, or the seismic retrofit may be implemented in stages.

2. OBJECTIVES

- To study the uses of belt walls, dampers.
- To know the properties of belt walls, dampers.
- To study the building response with and without belt walls, dampers.
- To analyze the bending moment, shear force, deflection and base shear.

3. METHODOLOGY

In this research work, make three different shape of building with three different cases one is bare frame, second is model with belt wall and last one building with damper. After prepare models analyze bending moment, shear force and deflection. G+15 Storey; No. of Column=64; C, Plus, Rectangular Shape; Column Size= 600*600; Beam Size= 500*600; Floor Height=3m; Length of Beam =4m; Belt wall and Damper Applied on 4^{th}, 8^{th}, 12^{th}, 16^{th} Floor.

MODEL GEOMETRY

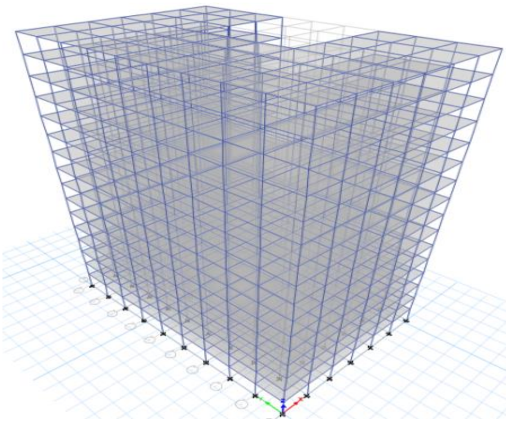

Fig. 1 3D view of C bare Frame (Case 1)

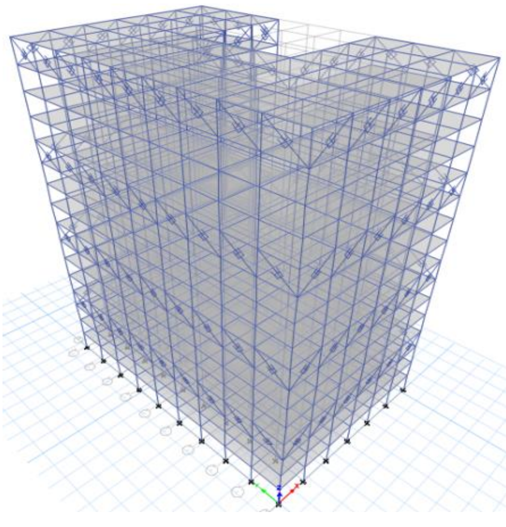

Fig. 2 3D view of c bare Frame with Damper (Case 1)

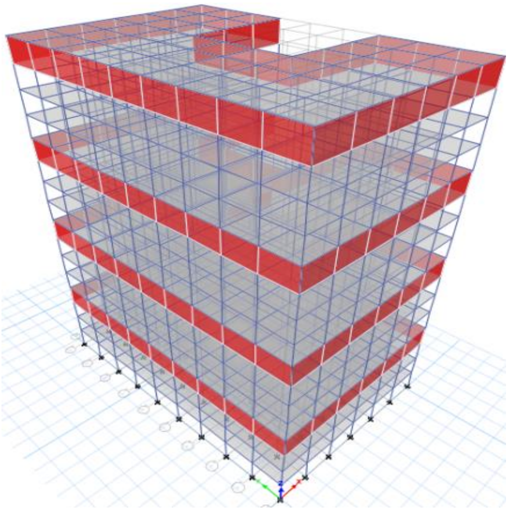

Fig. 3 3D view of C bare Frame with Shear wall (Case 1)

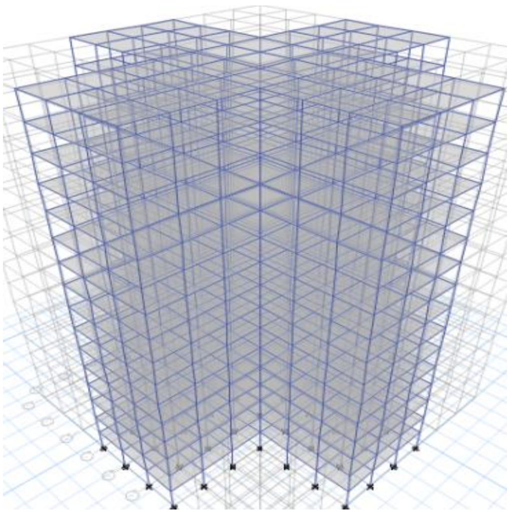

Fig. 4 3D view of Plus Bare Frame (Case 2)

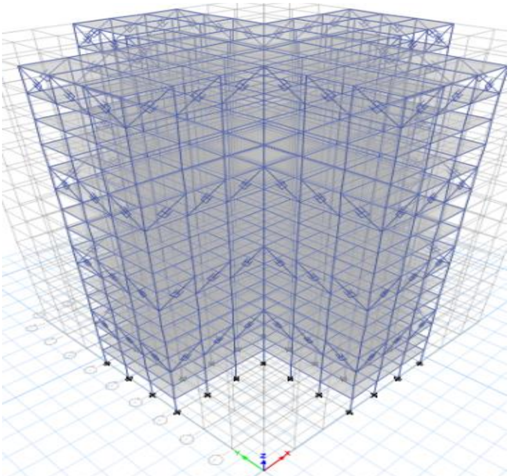

Fig. 5 3D View of plus Bare Frame with Damper(Case 2)

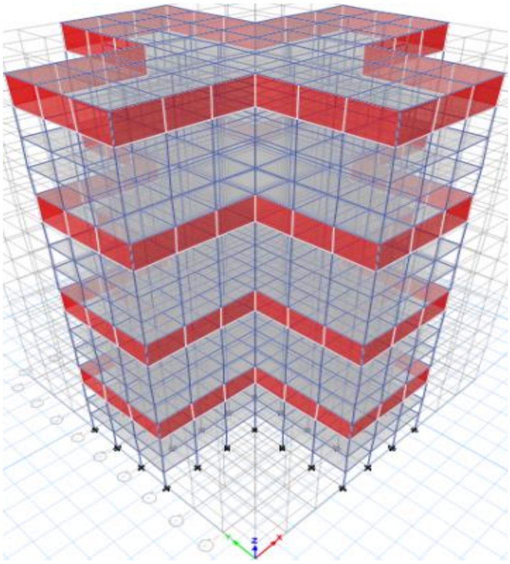

Fig. 6 3D View of plus Bare Frame with Shear Wall(Case 2)

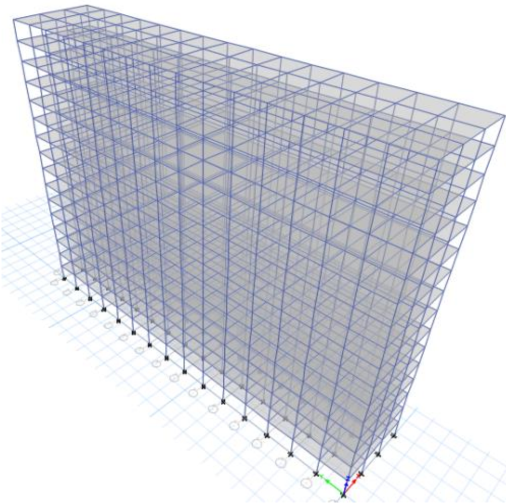

Fig. 7 3D View of Rectangle bare frames (Case 3)

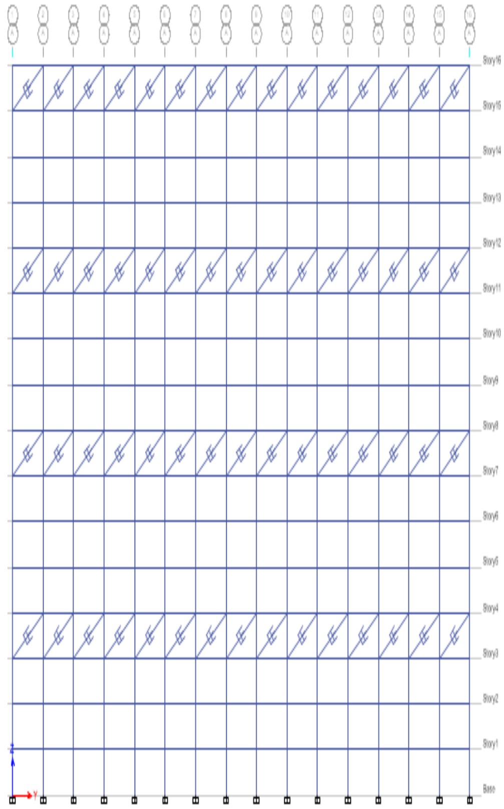

Fig. 8 Elevation View of Rectangle bare frame With Damper(Case 3)

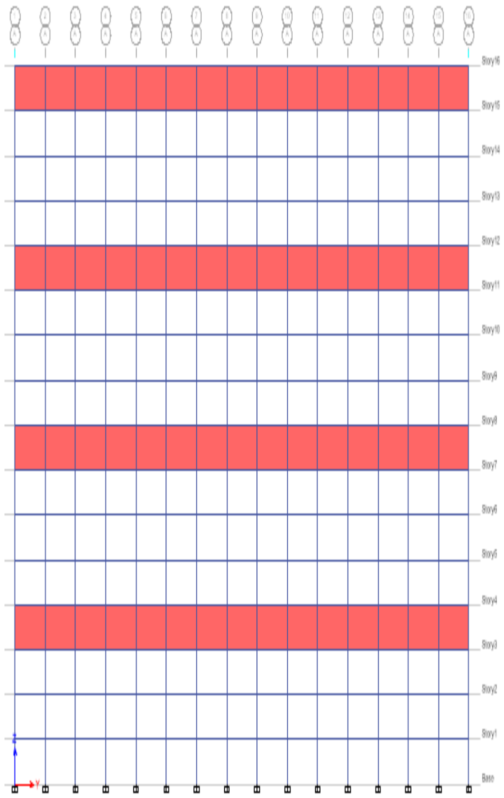

Fig. 9 Elevation View of Rectangle bare frame With Shear Wall (Case 3)

4. RESULT AND DISCUSSION

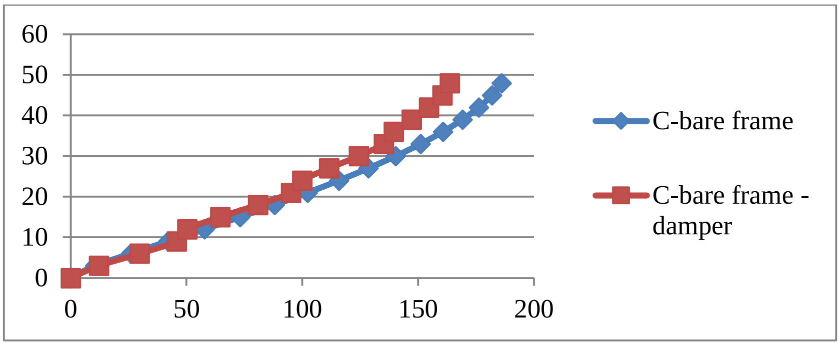

Fig. 10 Joint Displacement between C bare Frames with and without Damper (Case 1)

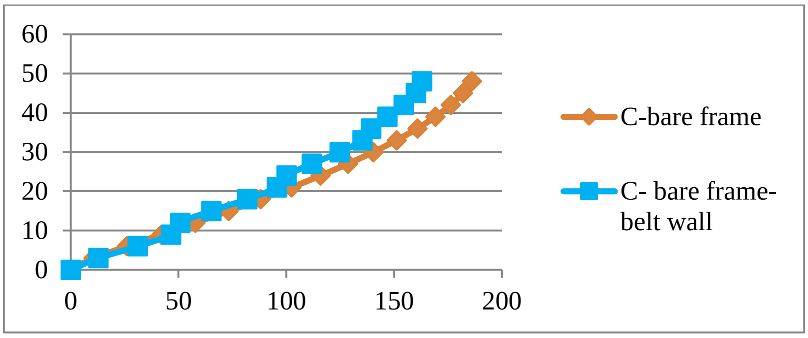

Fig. 11 Joint Displacement between C bare Frame with and without Belt wall (Case 1)

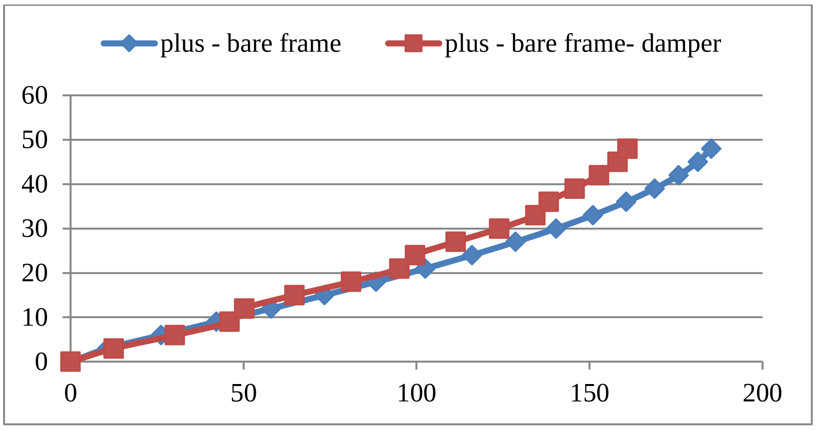

Fig. 12 Joint Displacement between plus bare Frame with and without Damper (Case 2)

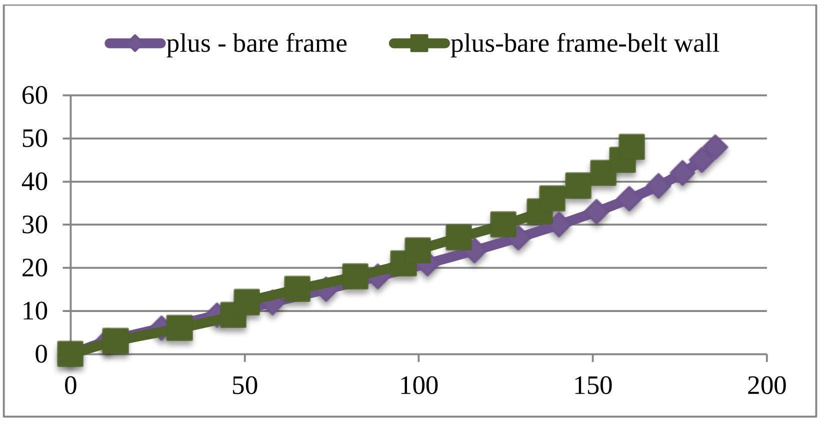

Fig. 13 Joint Displacement between plus bare Frame with and without Belt wall (Case 2)

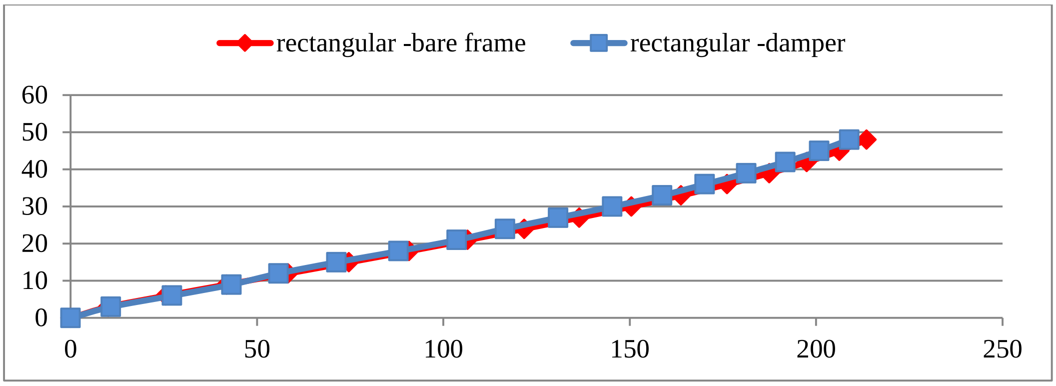

Fig. 14 Joint Displacement between Rectangular bare Frame with and without Damper (Case3)

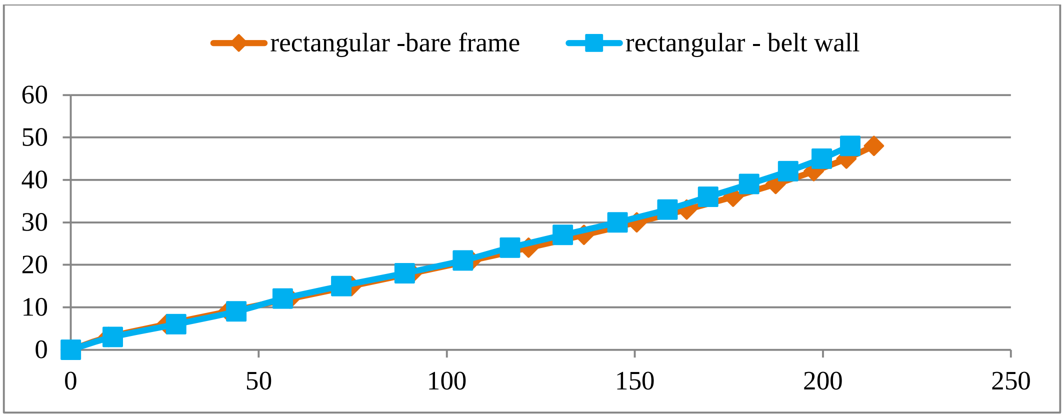

Fig. 15 Joint Displacement between Rectangular bare Frame with and without Belt wall (Case 3)

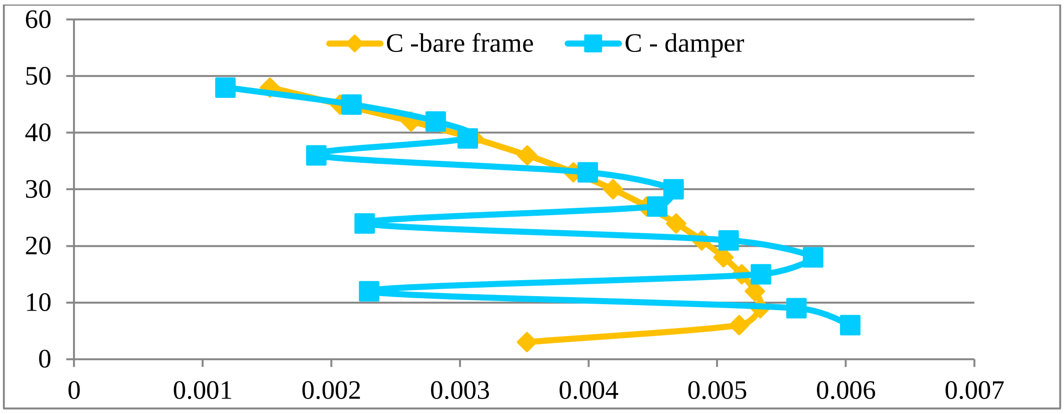

Fig. 16 Storey Drift between C bare frame with and without damper (Case 1)

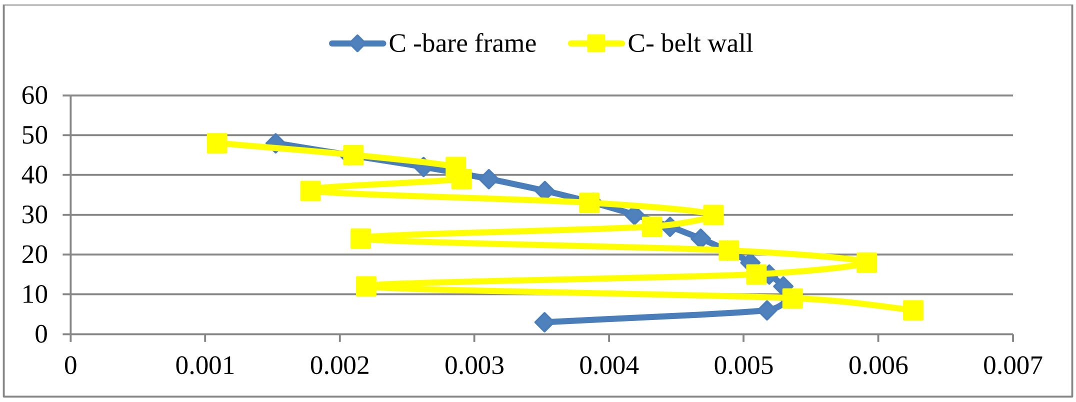

Fig. 17 Storey Drift between C bare frame with and without Belt wall (Case 1)

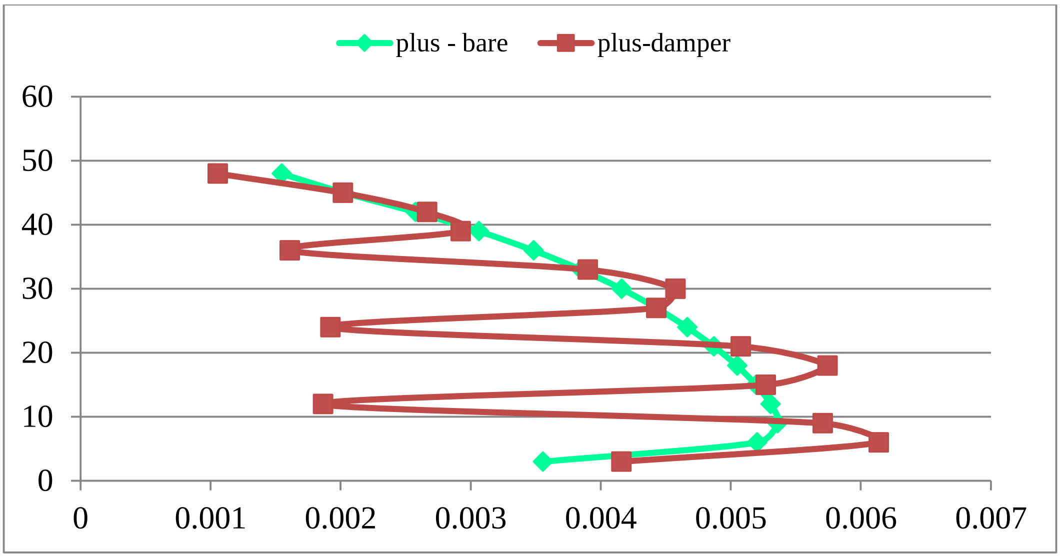

Fig. 18 Storey Drift between Plus bare frame with and without damper (Case 2)

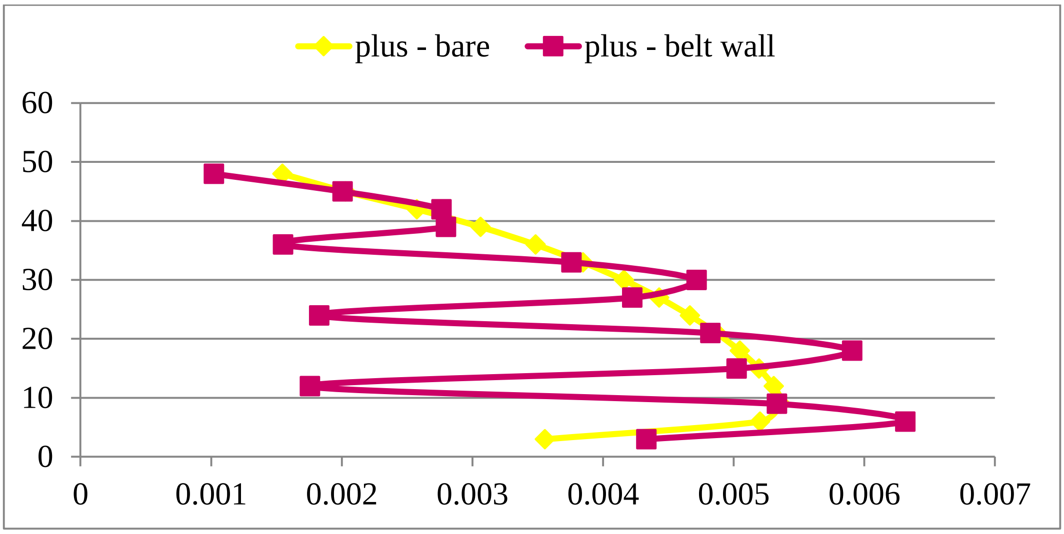

Fig. 19 Storey Drift between plus bare frame with and without Belt wall (Case 2)

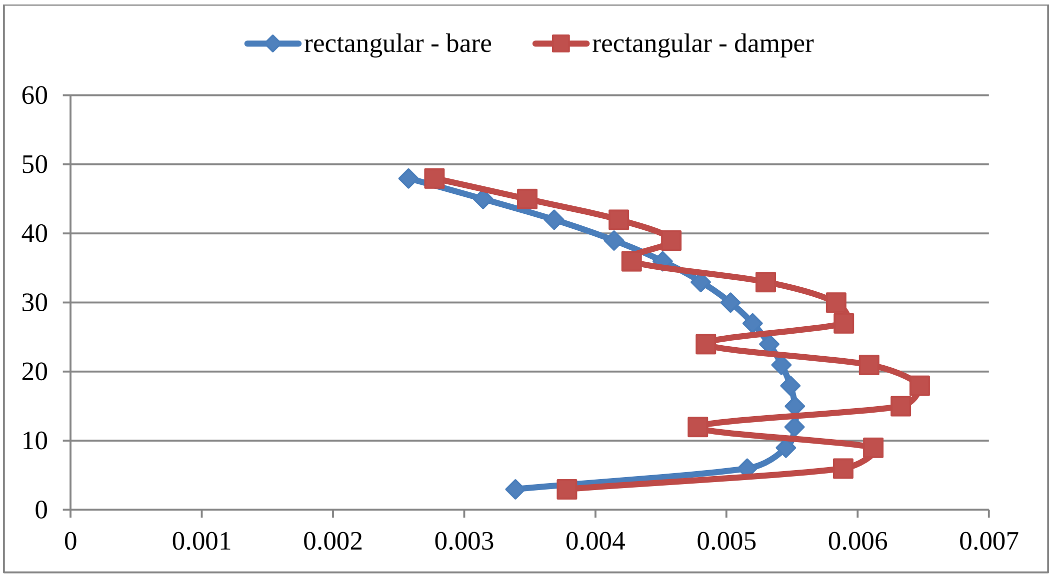

Fig. 20 Storey Drift between Rectangular bare frame with and without damper (Case 3)

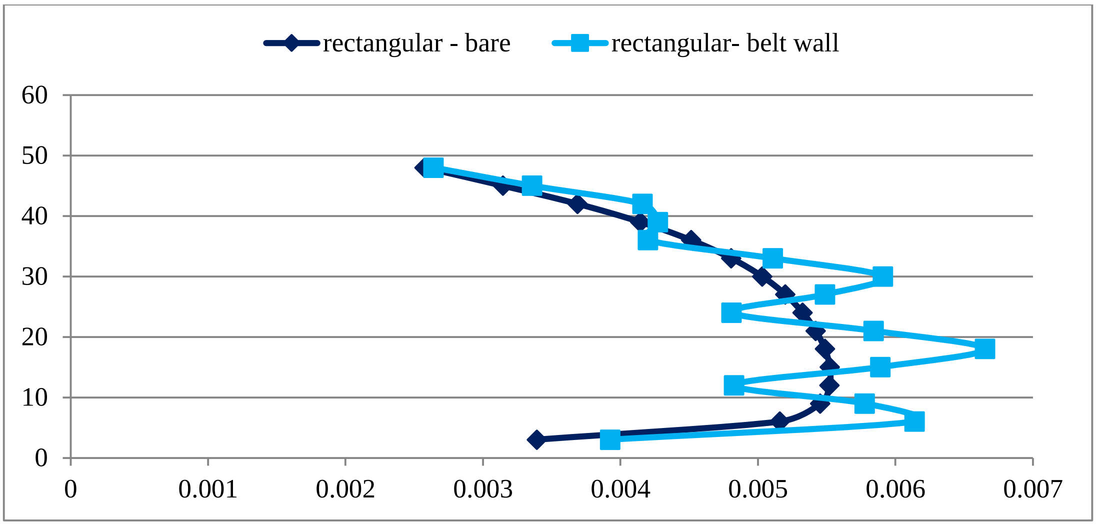

Fig. 21 Storey Drift between Rectangular bare frame with and without Belt wall (Case 3)

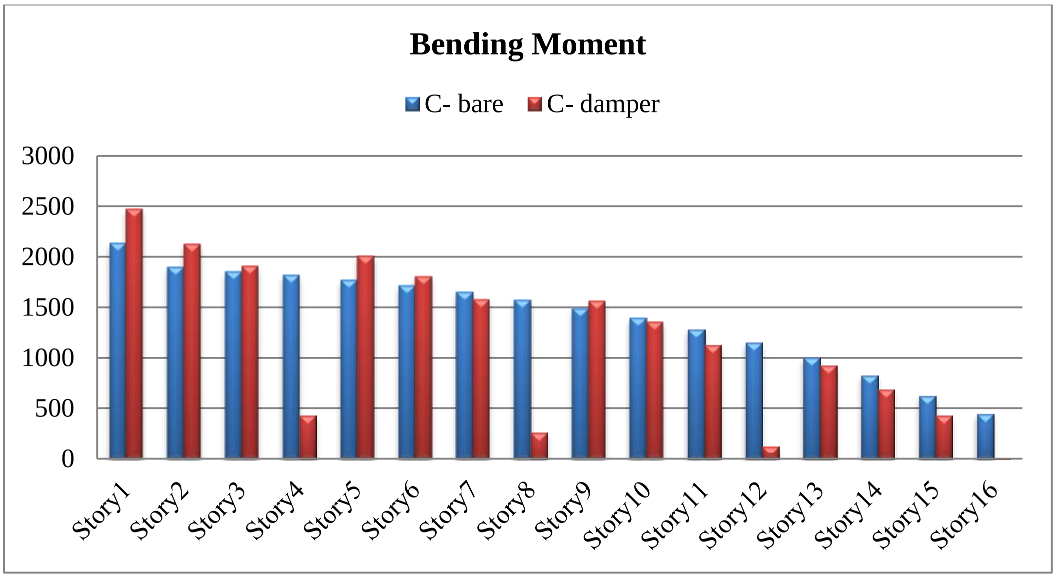

Fig. 22 Bending Moment between C bare frame with and without damper (case1)

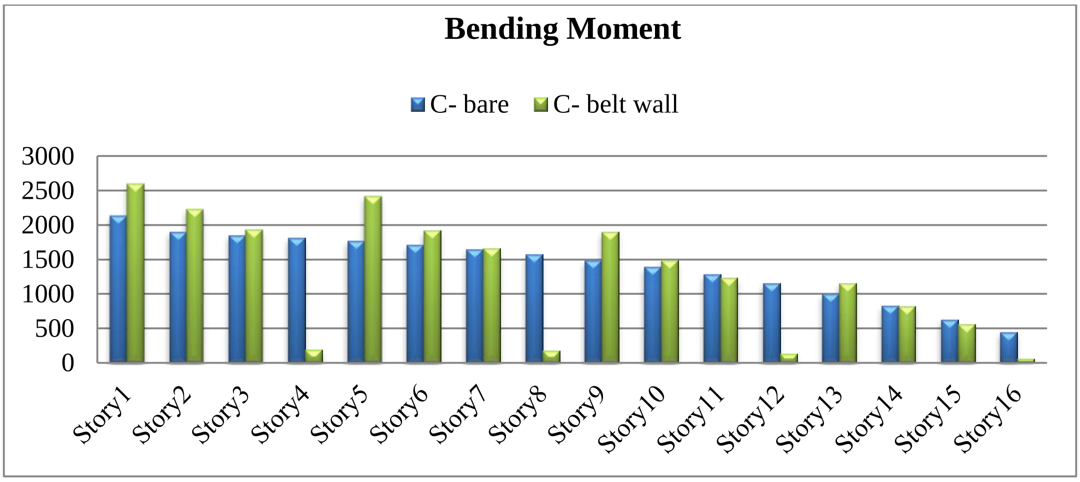

Fig. 23 Bending Moment between C bare frame with and without Belt Wall (case1)

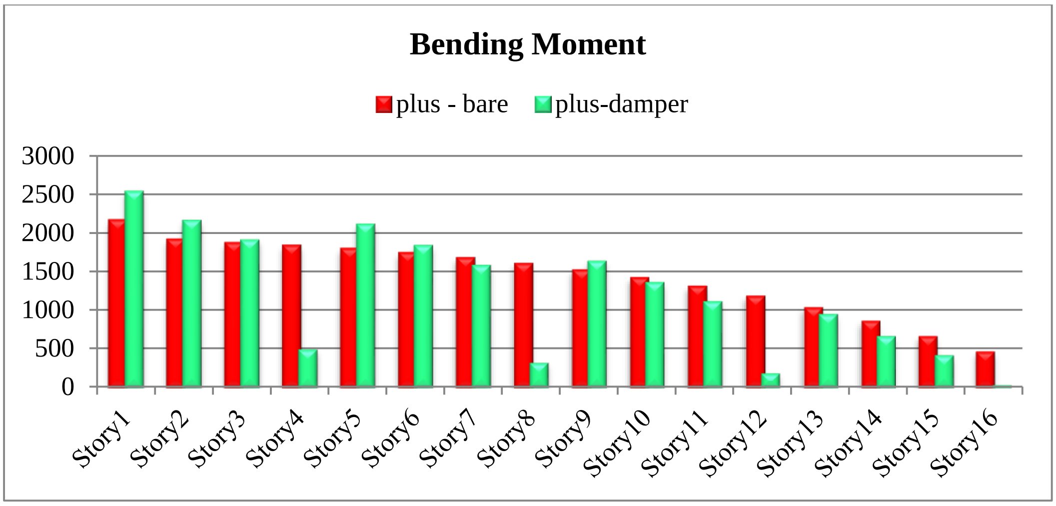

Fig. 24 Bending Moment between Plus bare frame with and without damper (case 2)

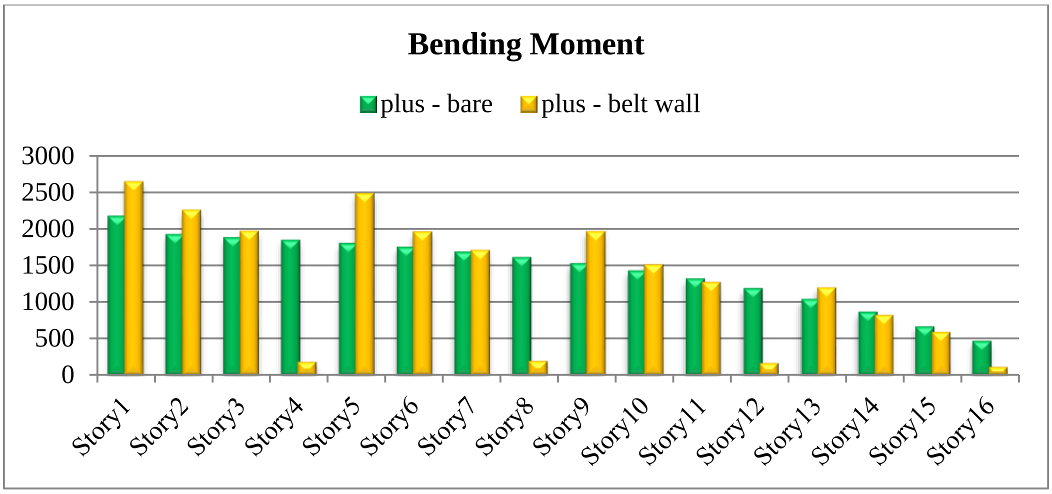

Fig. 25 Bending Moment between plus bare frame with and without Belt Wall (case 2)

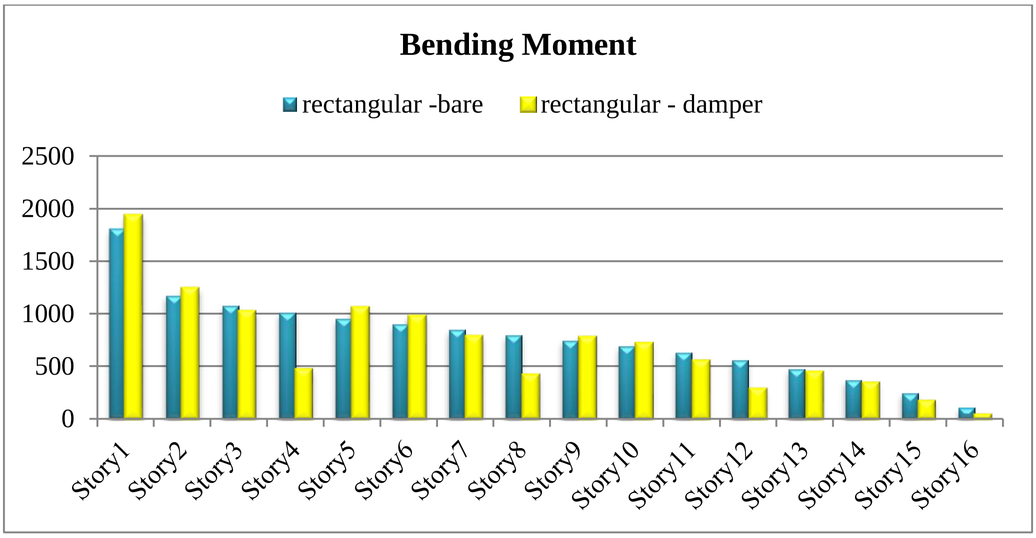

Fig. 26 Bending Moment between Rectangular bare frame with and without damper (case 3)

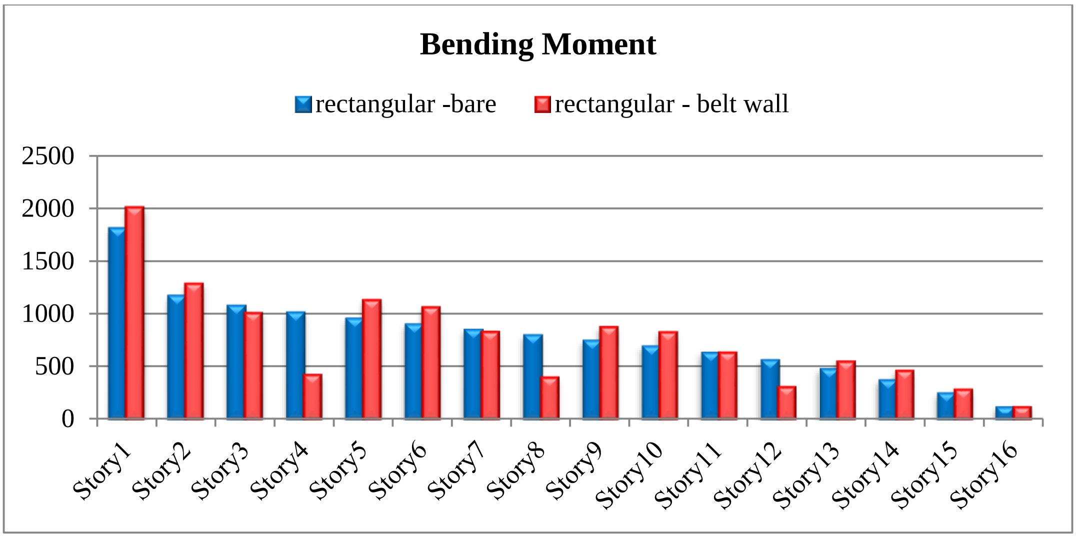

Fig. 27 Bending Moment between Rectangular bare frame with and without Belt wall (case 3)

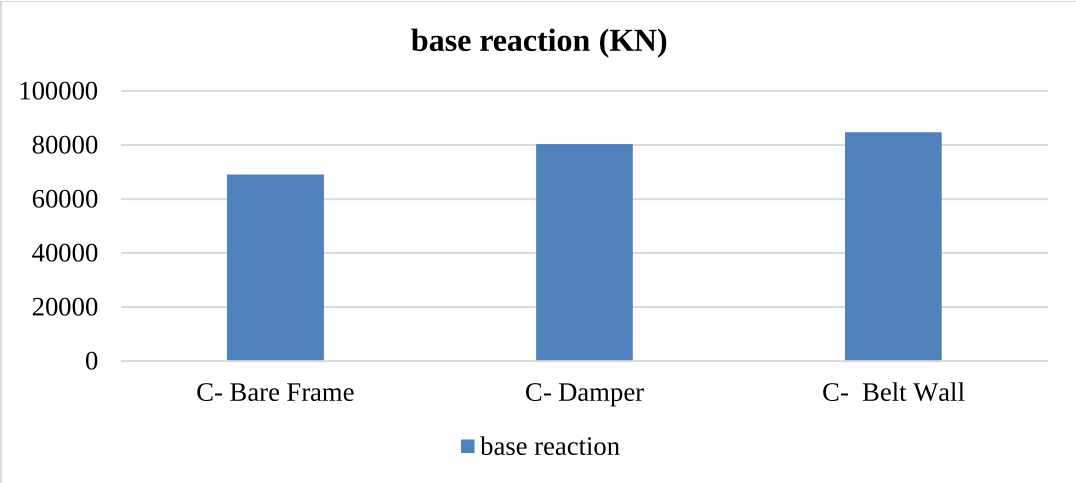

Fig. 28 Base reactions in C Shape Building

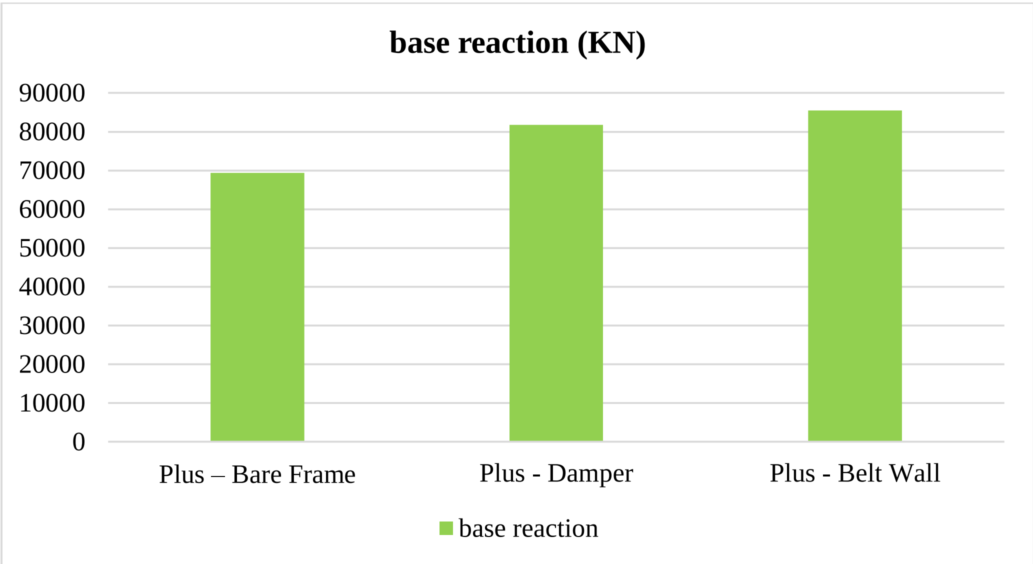

Fig. 29 Base reactions in plus Shape Building

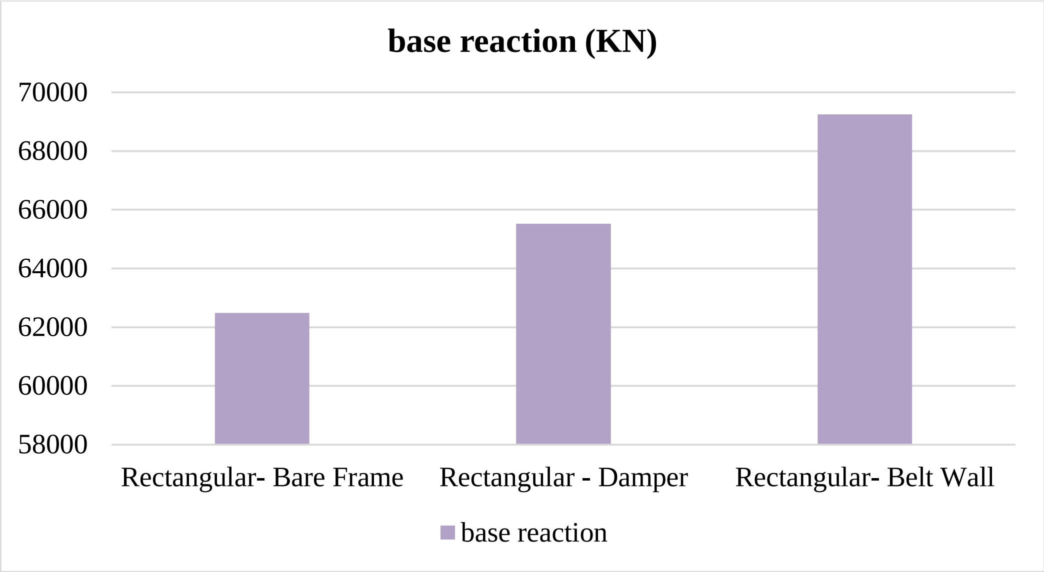

Fig. 30 Base reactions in Rectangular Shape Building

5. CONCLUSION

In section of study conclude data from software and study their graph of bending moment, joint displacement, base shear, and storey drift.

Joint Displacement

- Maximum Joint Displacement occurs at 16th storey that reduced from 186.066mm to 163.714mm when apply dampers in C shape building.
- Maximum Joint Displacement occurs at 16th storey that reduced from 186.066mm to 162.931mm when apply belt wall in C shape building.
- Maximum Joint Displacement occurs at 16th storey that reduced from 185.213mm to 160.997mm when apply dampers in plus shape building.
- Maximum Joint Displacement occurs at 16th storey that reduced from 185.213mm to 161.265mm when apply belt wall in plus shape building.
- Maximum Joint Displacement occurs at 16th storey that reduced from 213.596mm to 208.897mmwhen apply dampers in rectangular shape building.
- Maximum Joint Displacement occurs at 16th storey that reduced from 213.596mm to 207.307mmwhen apply belt wall in rectangular shape building.

Storey Drift

- Maximum Storey Drift occurs at 1th storey that increases from 0.003521mm to 0.004129mm when apply dampers in C shape building.
- Maximum Storey Drift occurs at 1th storey that increases from 0.003521mm to 0.004306mm when apply belt wall in C shape building.
- Maximum Storey Drift occurs at 1th storey that from 0.003555mm to 0.004159mm when apply dampers in plus shape building.
- Maximum Storey Drift occurs at 1th storey that from 0.003555mm to 0.004331mm when apply belt wall in plus shape building.
- Maximum Storey Drift occurs at 1th storey that from 0.003391mm to 0.003783mm when apply dampers in rectangular shape building.
- Maximum Storey Drift occurs at 1th storey that reduced from 0.003391mm to 0.003925mm when apply belt wall in rectangular shape building.

Bending Moment

- Maximum Bending Moment occurs in bare frame is 2134.708 KN-m that increases up to 2473.9968 KN-m and when apply dampers in C shape bare frame bending moment reduce due to damper application in building.
- Maximum Bending Moment occurs in bare frame is 2134.708 KN-m that increases up to 2593.5554 KN-m and when apply dampers in C shape bare frame bending moment reduce due to belt wall application in building.
- Maximum Bending Moment occurs in bare frame is 2155.6455 KN-m that increases up to 2526.1002 KN-m and when apply dampers in plus shape bare frame bending moment reduce due to damper application in building.

- Maximum Bending Moment occurs in bare frame is 2155.6455 KN-m that increases up to 2629.5914 KN-m and when apply dampers in plus shape bare frame bending moment reduce due to belt wall application in building.
- Maximum Bending Moment occurs in bare frame is 1806.7668 KN-m that increases up to 1933.606 KN-m and when apply dampers in rectangular shape bare frame bending moment reduce due to damper application in building.
- Maximum Bending Moment occurs in bare frame is 1806.7668 KN-m that increases up to 2006.2866 KN-m and when apply dampers in rectangular shape bare frame bending moment reduce due to belt wall application in building.

Base Reaction

- Minimum Base reaction occurs in bare frame is 69113.4466KN that increases up to 80395.2392KN when apply dampers in C shape bare frame in building.
- Minimum Base reaction occurs in bare frame is 69113.4466KN that increases up to 84767.3682KN when apply dampers in C shape bare frame in building.
- Minimum Base reaction occurs in bare frame is 69436.0175KN that increases up to 81756.3606KN when apply dampers in plus shape bare frame in building.
- Minimum Base reaction occurs in bare frame is 69436.0175KN that increases up to 85468.4855KN when apply dampers in plus shape bare frame in building.
- Minimum Base reaction occurs in bare frame is 62486.7327KN that increases up to 65523.56KN when apply dampers in rectangular shape bare frame in building.
- Minimum Base reaction occurs in bare frame is 62486.7327KN that increases up to 69255.2936KN when apply dampers in rectangular shape bare frame in building.

Future Scope of the Work

- In this survey, we propose a concrete belt wall on the outer circumference. However, further research is needed on belt walls that have an opening effect.
- Simple beam-column-wall-string element because the complete FEM model must be included.
- The effect of curvature should be reversed by optimizing the walls of the stabilizing rope to investigate the effect on the column moment.
- For further study of belt wall are also done with only steel structures and dampers.

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