Comparative Study on The Effect of Composite Shear Wall on the Performance of RC Buildings with Non-Parallel Lateral Force System

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ABSTRACT
Generally, in multi-story building the use of conventional RC wall is limited because of high concentration of reinforcement at boundary element. use composite shear wall with different vertical Indian standard section as a longitudinal reinforcement bar at boundary element alternative. here Comparative study of composite shear wall against conventional RC shear wall is taken with non-parallel force system in building. G+19 storey building model is considered for analysis using ETAB or SAP2000. After that check for different parameter like base shear, story drift, story displacement. After check different parameter, compare that parameter for composite shear wall against conventional RC shear wall. composite shear walls are modelled as equivalent frame element and analyzed using a modelling software.

Key Words*: RC Shear wall, Composite Shear wall, Response Spectrum Analysis, Storey Displacement, Storey Shear, ETABS.*

I. INTRODUCTION

Steel-concrete composite beams and columns have been widely used in many structures as their construction is economical and faster. Shear walls are also an integral part of modern high-rise buildings to resist lateral loads. A shear wall is a structural panel that can resist lateral forces acting on it. Lateral forces are those that are parallel to the plane of the wall, and are typically wind and seismic loads. In simple terms, lateral forces could push over parallel structural panels of a building were it not for perpendicular shear walls keeping them upright. When a structural member experiences failure by shear, two parts of it are pushed in different directions, for example, when a piece of paper is cut by scissors. Shear walls are particularly important in large, or high-rise building, or buildings in areas of high wind and seismic activity. Shear walls are typically constructed from materials such as concrete or masonry. Shear forces can also be resisted by steel braced frame which can be very effective at resolving lateral forces but may be more expensive.

Shear walls are used in buildings to resist the lateral load induced during earthquakes. Conventional Shear walls generally have rectangular cross section with the high concentration of vertical reinforcement at the boundary elements. The use of conventional reinforced concrete shear wall in multistoried buildings is sometimes limited because of the high concentration of reinforcement provided at the boundary element. Later, steel plate shear walls proposed as a promising alternative of concrete walls. thin plate walls contribute to weight reduction of the structures with greater stiffness, higher ductility and enable rapid construction.

Shear walls can be positioned at the perimeter of buildings or they may form a shear core – a structure of shear walls in the Centre of a building, typically encasing a lift shaft or stairwell.

II. DESCRIPTION OF COMPOSITE SHEAR WALL

Composite steel concrete elements made by steel and concrete are used in worldwide almost as soon as the two materials became available for structural engineers, taking into account the two main advantages of these materials, good compression strength of concrete and higher tension strength of steel. A composite element which can be used together with perimeter frames in obtaining dual systems is the composite wall obtained from encasing steel shapes in the reinforced concrete wall. Composite walls are reinforced concrete walls with additional steel shapes or plates, being subjected to combined vertical and horizontal loads. Walls with additional shapes referred as composite steel-concrete shear walls, contain one or more encased steel shapes, usually located at the ends of the wall.

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Composite steel-concrete shear wall with encased vertical steel sections provide good alternative. The composite shear walls are consisting a steel plate shear wall with reinforced concrete walls attached to one side or both sides of the steel plate using mechanical connectors such as shear studs or bolts. In the AISC Seismic Provisions (AISC, 1997) these systems are denoted as "Composite Steel Plate Shear Walls, (C-SPW). The composite shear walls have been used in buildings in recent years although not as frequently as the other lateral load resisting systems. Composite shear walls offer the advantages like flexural stiffening, strengthening of compression elements, improved deformability, increased floor area, fire protection, easy repairs and economy. A lot of studies have been reported on the seismic behavior of the RC shear walls. However, limited studies are available for the seismic behavior of such composite shear walls and their performance.

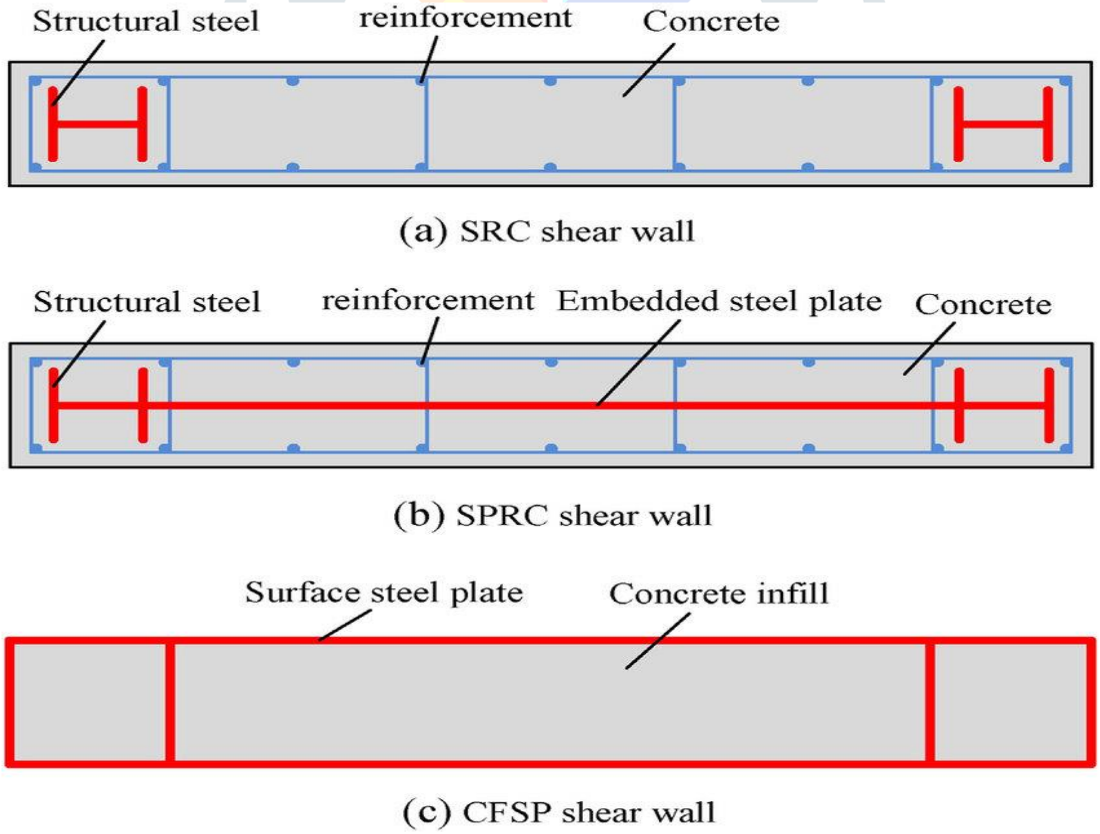

Fig. 1 Type of Composite Shear walls

1.1 Types of Shear walls used in Structure:

There are mainly three types of coupling beams used in structure:

1. Conventional reinforced concrete shear wall
2. Steel plate shear wall
3. Composite steel plate reinforced concrete shear wall

1.1.1 Conventional Reinforced Concrete shear wall:

- Conventional Shear walls generally have rectangular cross section with the high concentration of vertical reinforcement at the boundary elements.
- The use of conventional reinforced concrete shear wall in multistoried buildings is sometimes limited because of the high concentration of reinforcement provided at the boundary element.
- Due to high concentration of reinforcements at boundary the self-weight Of building is increased.

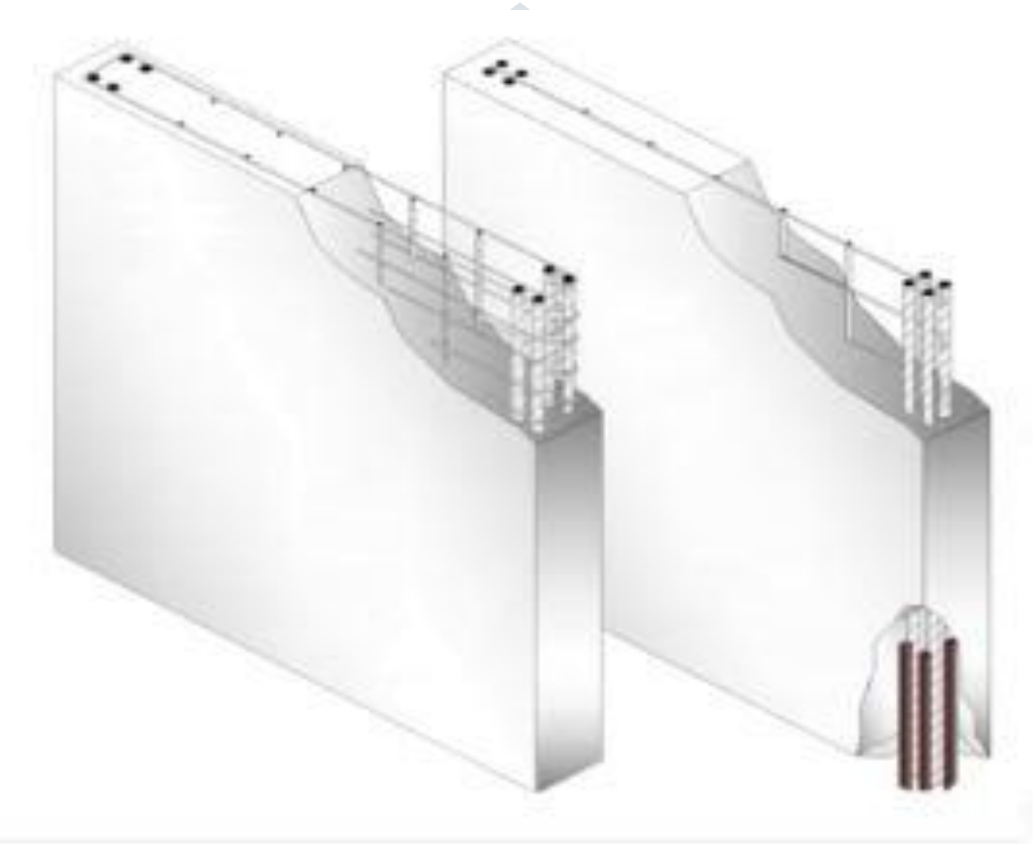

Fig. 2 Conventional reinforced concrete shear wall

1.1.2 Steel plate shear wall:

- Steel plate shear walls proposed as a promising alternative of concrete walls. Thin plate walls contribute to weight reduction of the structures with greater stiffness and higher ductility.

Fig. 3 Steel plate shear wall

1.1.3 Composite steel reinforced concrete shear wall

- The composite shear wall is consisting a steel plate shear wall with reinforced concrete wall attached to the one side or both sides of the steel plate using mechanical connecters such as shear studs or bolts.

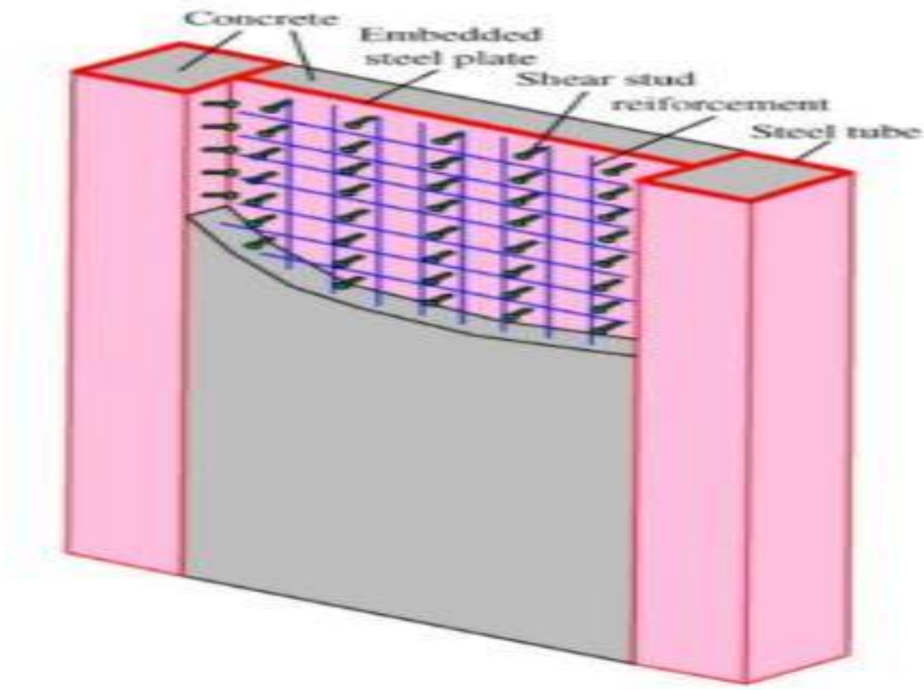

Fig. 4 Composite steel plate reinforced concrete shear wall

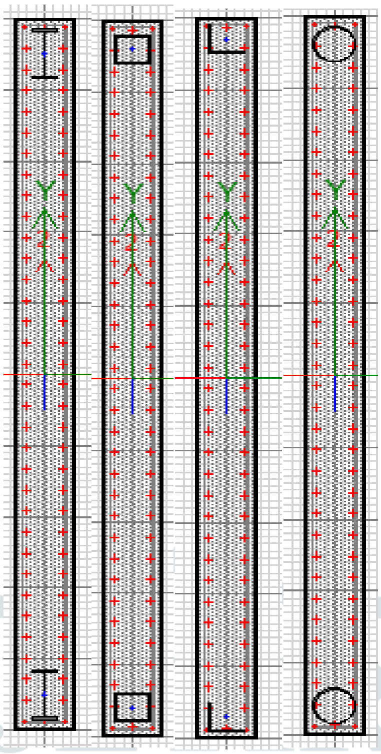

Fig. 5 Cross section of composite shear wall with different steel sections

- Two type of composite shear walls is used in the structures
  1.3.3.1 Traditional Composite Shear walls
  1.3.3.2 Innovative Composite Shear walls
- **Traditional Composite Shear wall:**
  If gap is not provided between steel plate and Concrete wall is called Traditional composite Shear wall.
- **Innovative Composite Shear wall:**
  If gap is provided between steel plate and Concrete wall is called Innovative composite Shear wall.

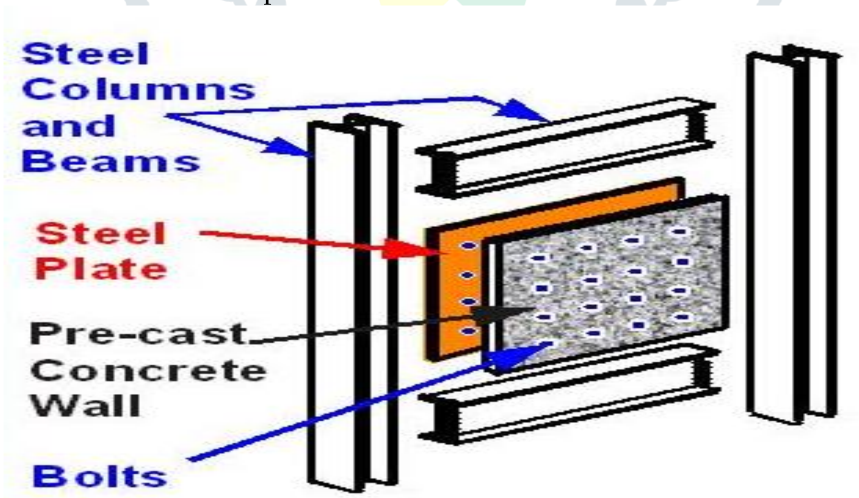

Fig. 6 Component of composite shear wall

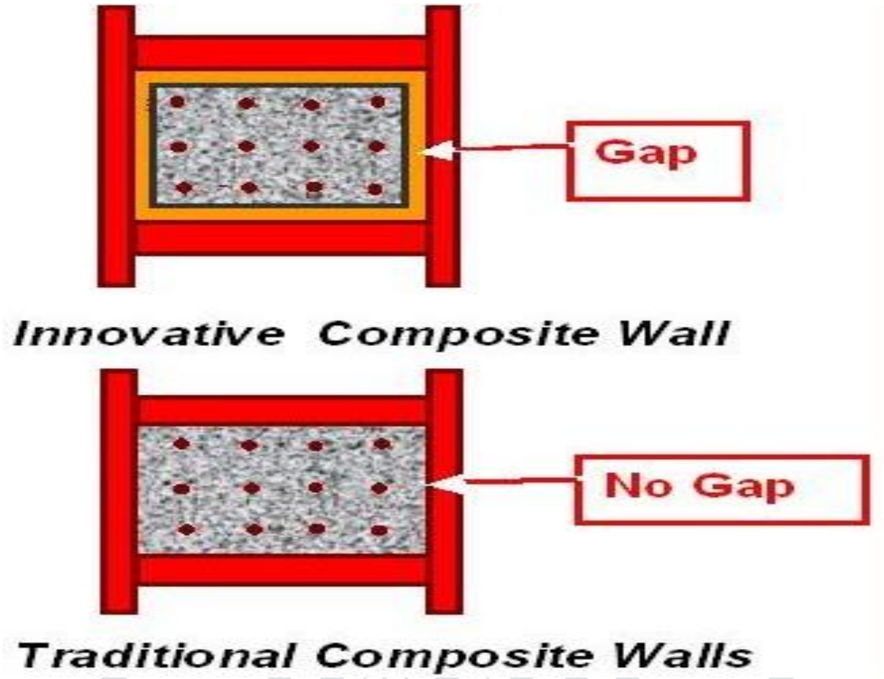

Fig. 7 Type of composite shear wall

Table 1 Storey Building description

Description	**Dimension**
Storey	G+25
Storey Height	3.2 m
Column Size	800 x 800 mm
Beam Size	450 x 500 mm
Slab Thickness	150 mm
Shear Wall thickness	150 mm
Composite Wall Thickness	350mm
Material Property	
Concrete grade	M25 and M30
Steel Grade	Fe415
Seismic Parameters	
Seismic Zone	3,4 and 5
Soil type	Medium
Importance factor	1
Response reduction factor	5
Load Data	
Live Load On Floor	3.5 KN/m^2
Live Load On Roof	1.5 KN/m^2
Dead Load on roof and floor	1 KN/m^2
Dead Load on frame	12 KN/m
Type of support	Fix

PLAN AND 3-D VIEW OF BUILDING

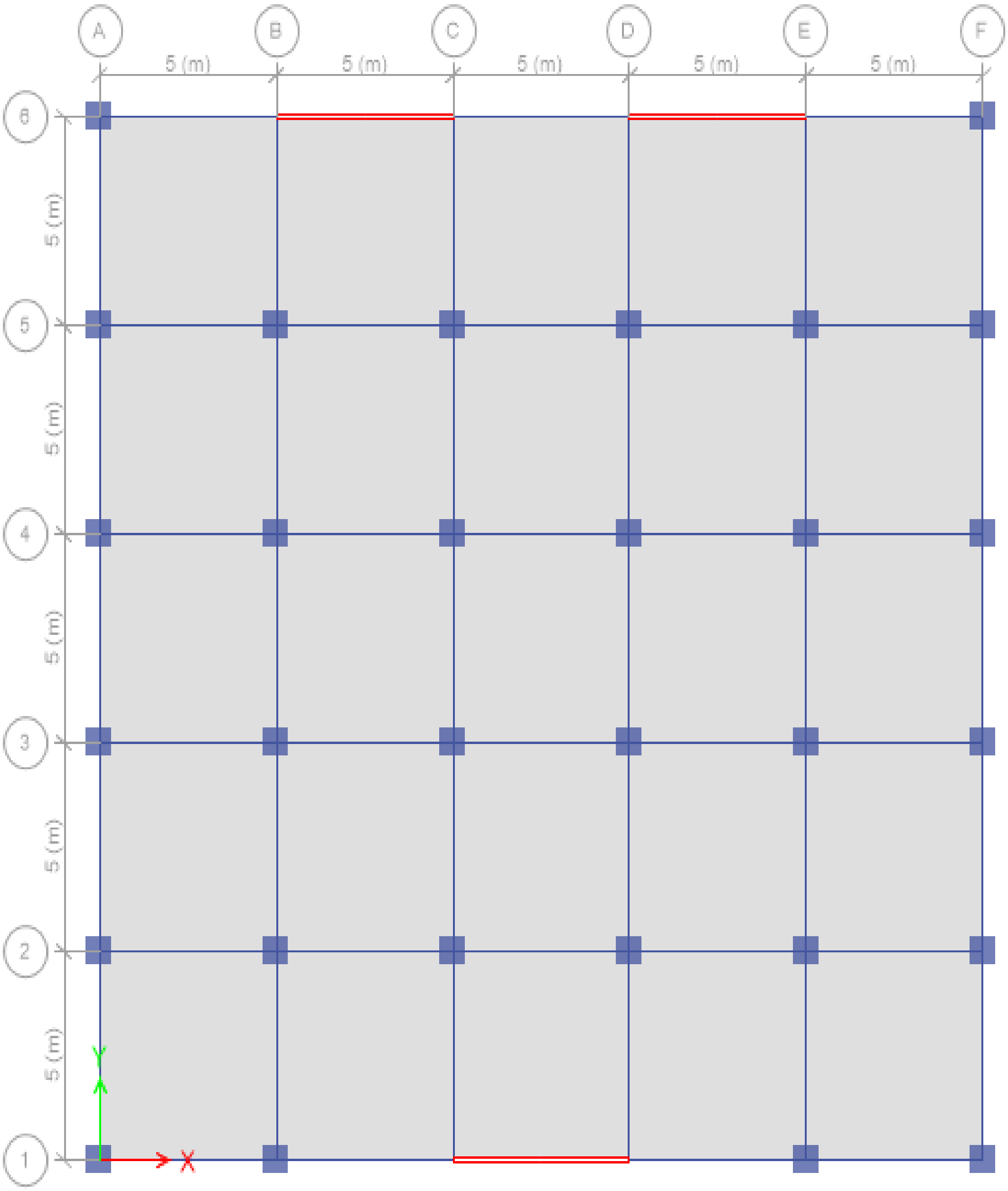

Fig 8 Plan of Building with Non-parallel Force System

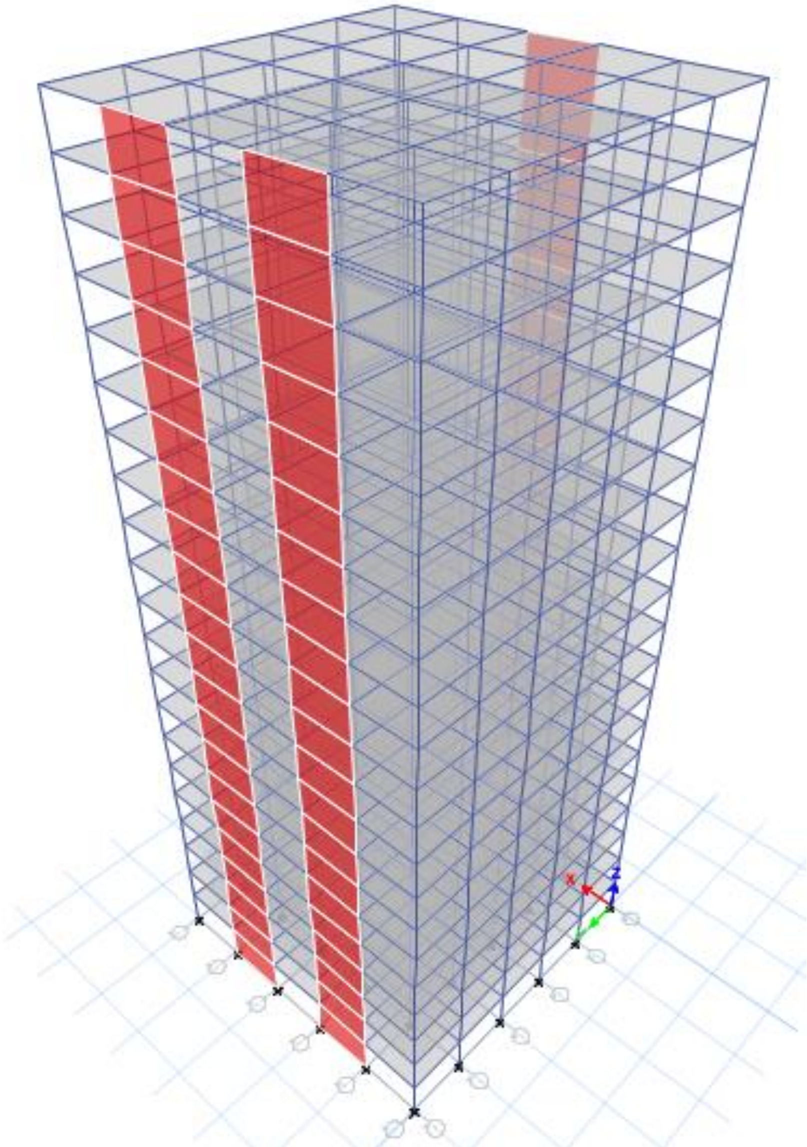

Fig 9 3D Model of building with Non-Parallel Force System

V. Load Combinations:

Following primary load cases are considered for design of building.

1. Dead Load (DL)
2. Live Load (LL)
3. Floor Finish
4. Wall load (Wall)

 Earthquake Load along X direction (EQX)

6. Earthquake Load along Y direction (EQY)

Along with the above cases, following load combination are considered for design of structural elements as per IS 1893:2002.

1. 1.5 (DL+LL)
2. 1.2 (DL+LL±EQX)
3. 1.2 (DL+LL±EQY)
4. 1.5 (DL±EQX)
5. 1.5 (DL±EQY)
6. 0.9 DL ± 1.5 EQX
7. 0.9 DL ± 1.5 EQY

Building design

Building analysis and Response spectrum method is carried out using computer program ETABS.

VI. Results and Discussion

The result of Conventional and Composite Shear Wall Building for Zone 3, Zone 4 and Zone 5 is discussed in the following section.

Result- Comparison of Storey shear

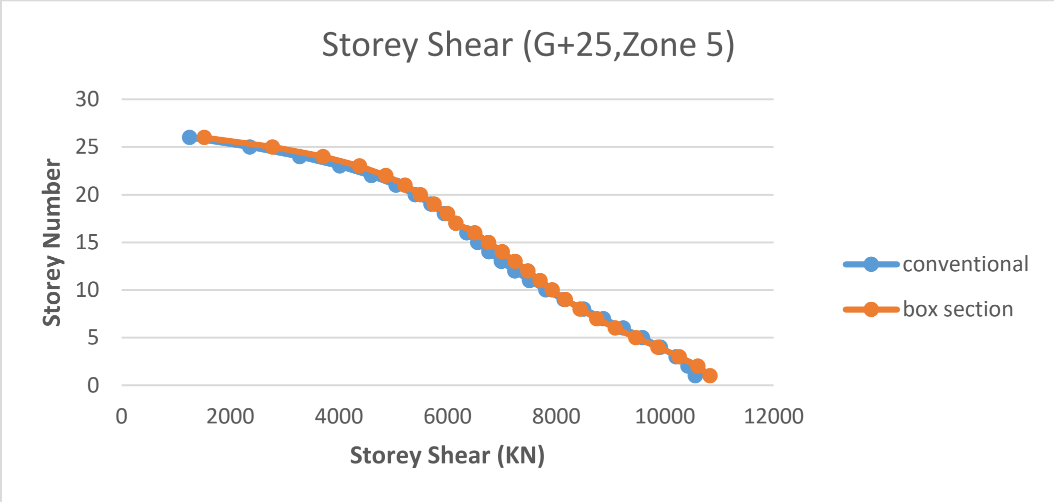

Fig. 10 Storey Shear comparison in Zone 5 for G+25 building (Conventional Vs. Box Section Wall)

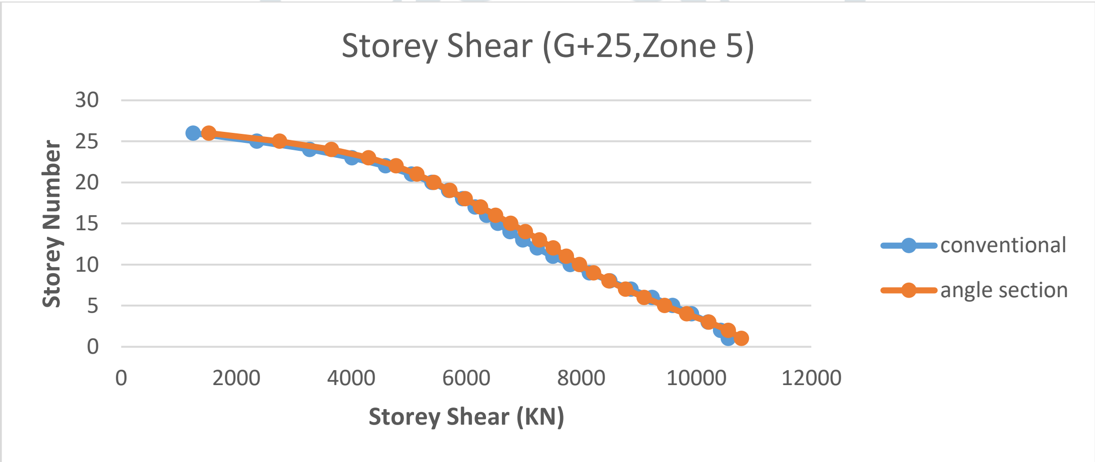

Fig. 11 Storey Shear comparison in Zone 5 for G+25 building (Conventional Vs. Angle Section Wall)

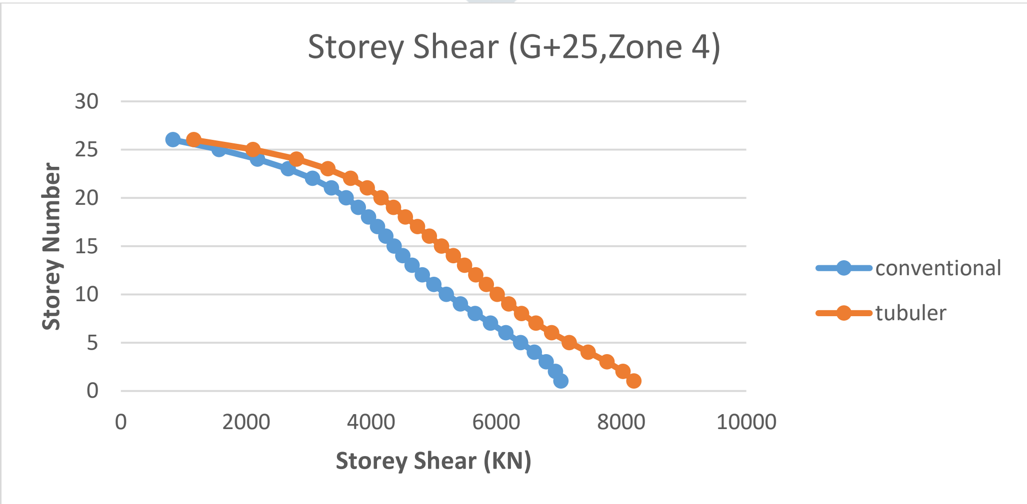

Fig. 12 Storey Shear comparison in Zone 4 for G+25 building (Conventional Vs. Tubular Section Wall)

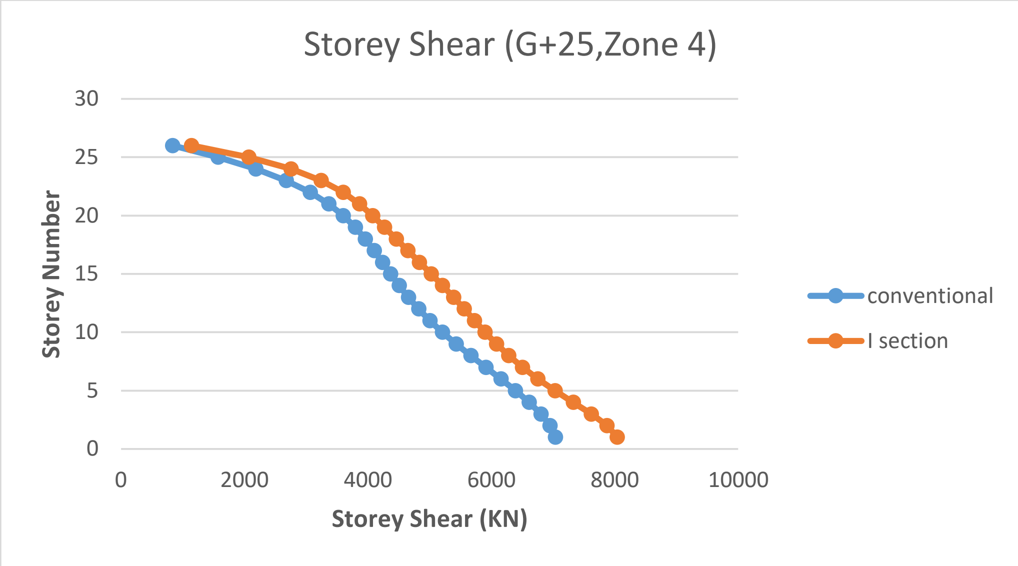

Fig. 13 Storey Shear comparison in Zone 4 for G+25 building (Conventional Vs. I Section Wall)

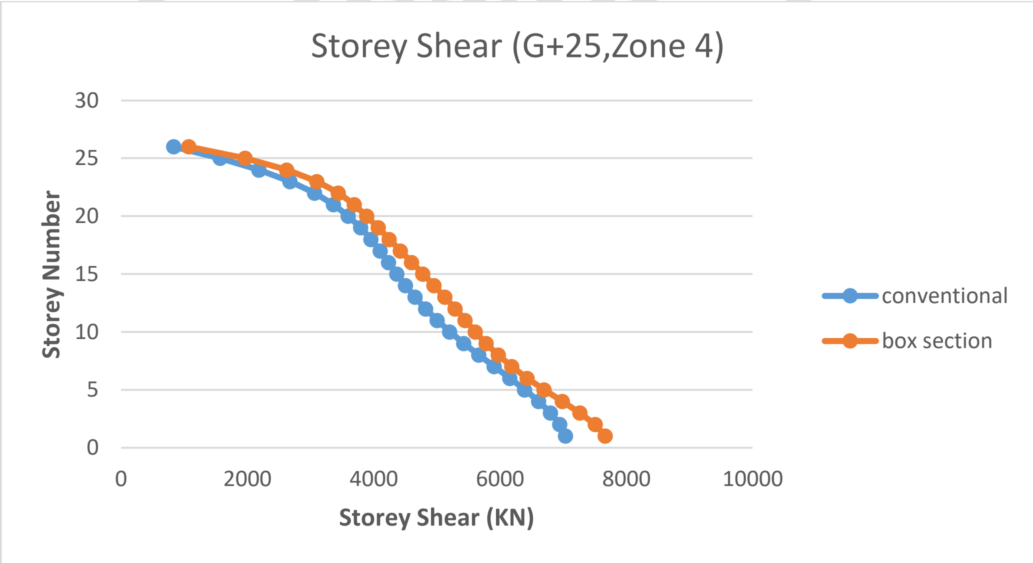

Fig. 14 Storey Shear comparison in Zone 4 for G+25 building (Conventional Vs. Box Section Wall)

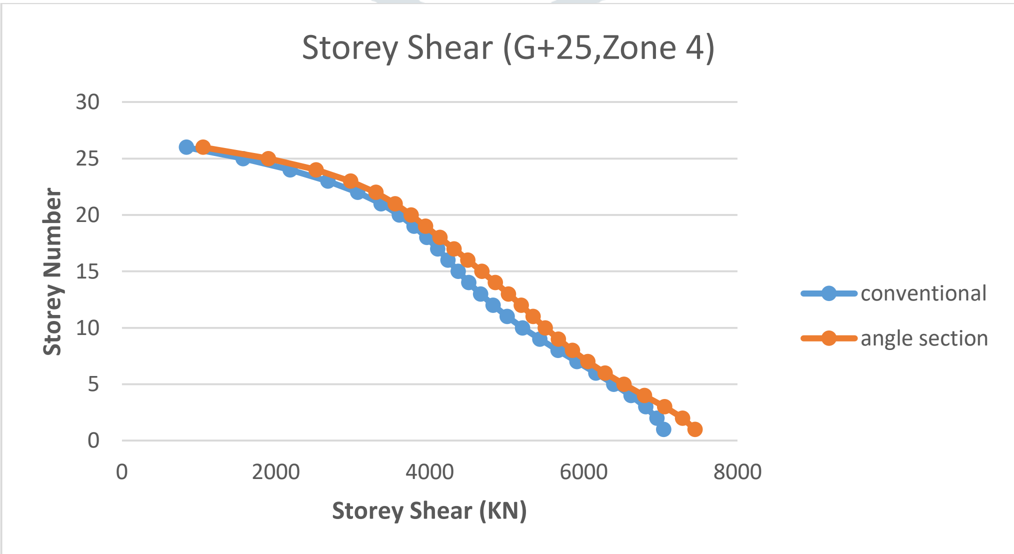

Fig. 15 Storey Shear comparison in Zone 4 for G+25 building (Conventional Vs. Angle Section Wall)

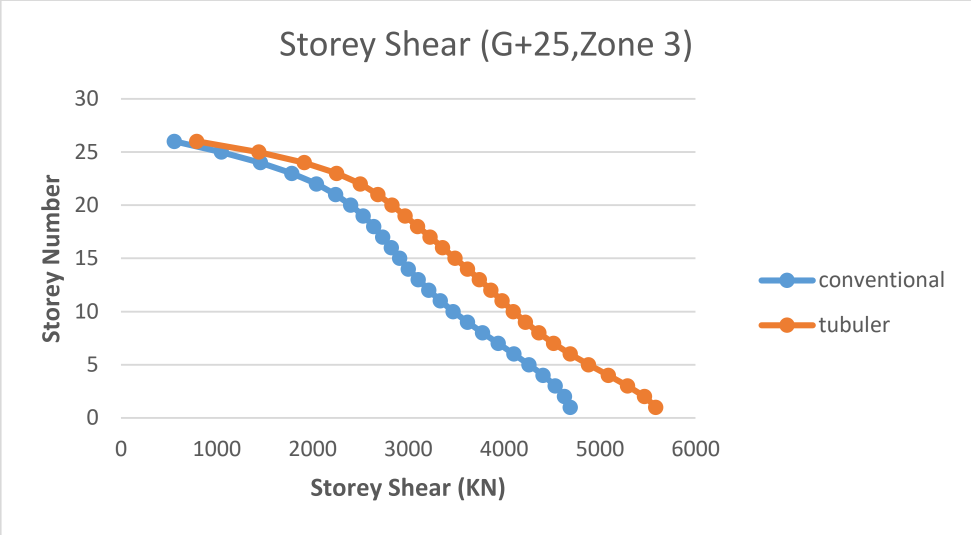

Fig. 16 Storey Shear comparison in Zone 3 for G+25 building (Conventional Vs. Tubular Section Wall)

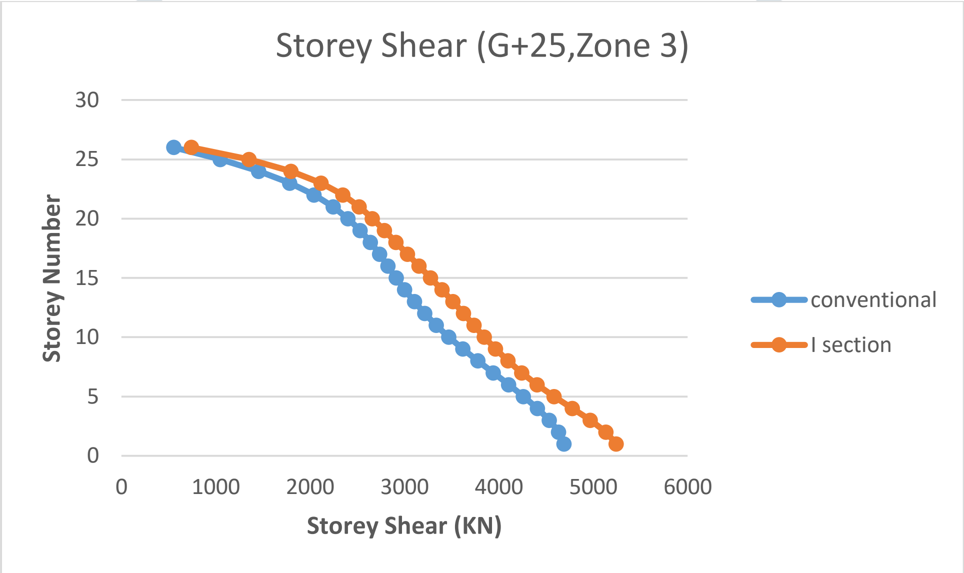

Fig. 17 Storey Shear comparison in Zone 3 for G+25 building (Conventional Vs. I Section Wall)

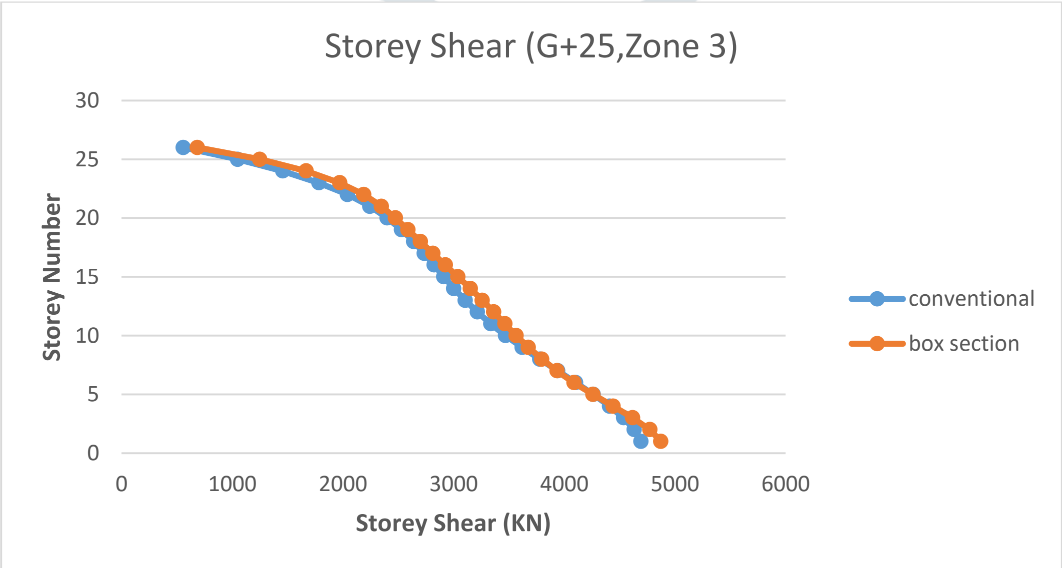

Fig. 18 Storey Shear comparison in Zone 3 for G+25 building (Conventional Vs. Box Section Wall)

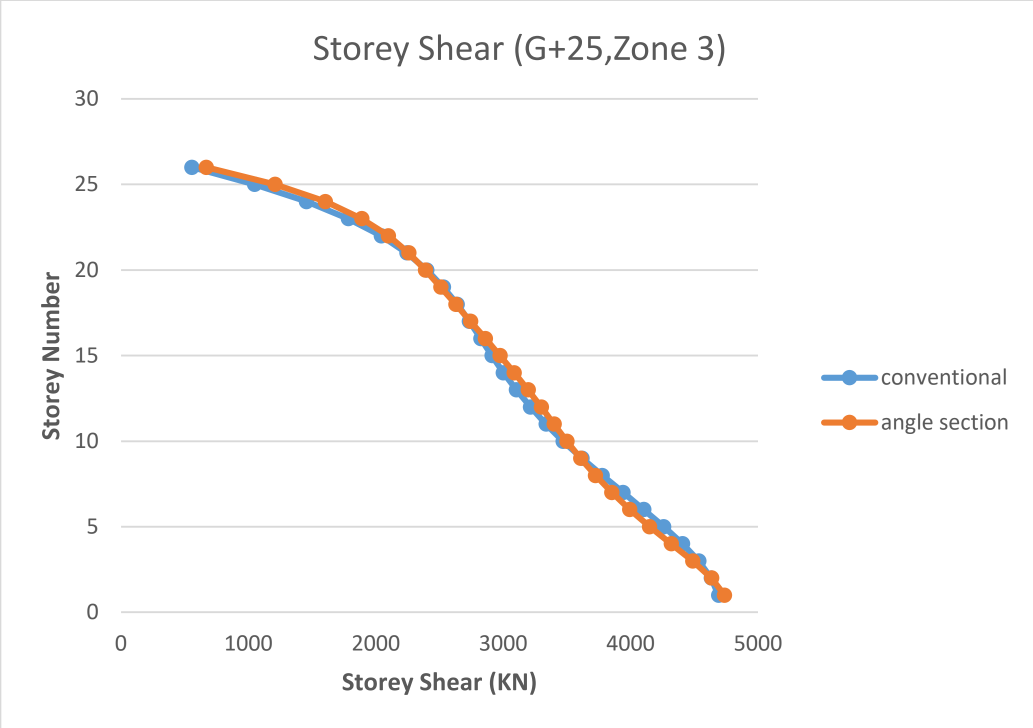

Fig. 19 Storey Shear comparison in Zone 3 for G+25 building (Conventional Vs. Angle Section Wall)

Discussion:

With different type of Indian standard section using as a boundary element in shear wall storey shear increasing hardly 6% to 8%. increasing of Storey Sher is Depend on Type of Section Which is used in the Shear wall. In Tubular and Angle Section Increasing of Storey Shear is 8% and 2% respectively. This increment of Storey Shear is Depend on per meter Weight and Type of Indian Standard section.

Result- Comparison of Displacement

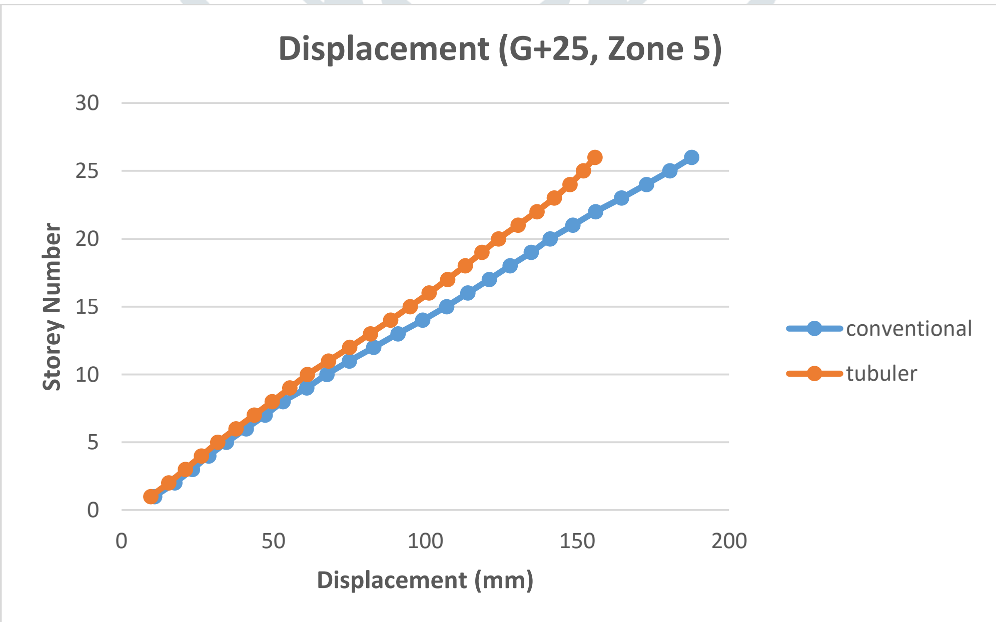

Fig. 20 Storey Displacement comparison in Zone5 for G+25 building (Conventional Vs. Tubular Section Wall)

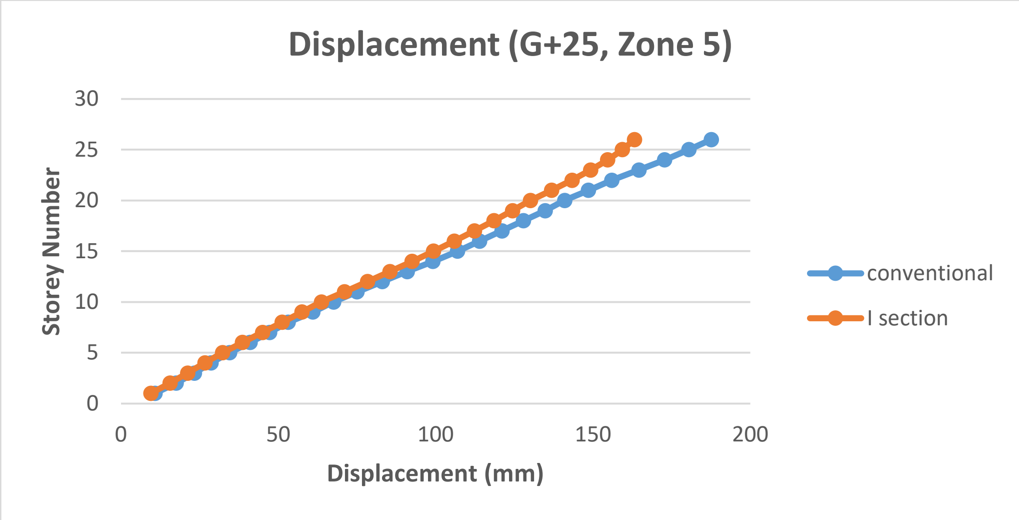

Fig. 21 Storey Displacement comparison in Zone5 for G+25 building (Conventional Vs. I Section Wall)

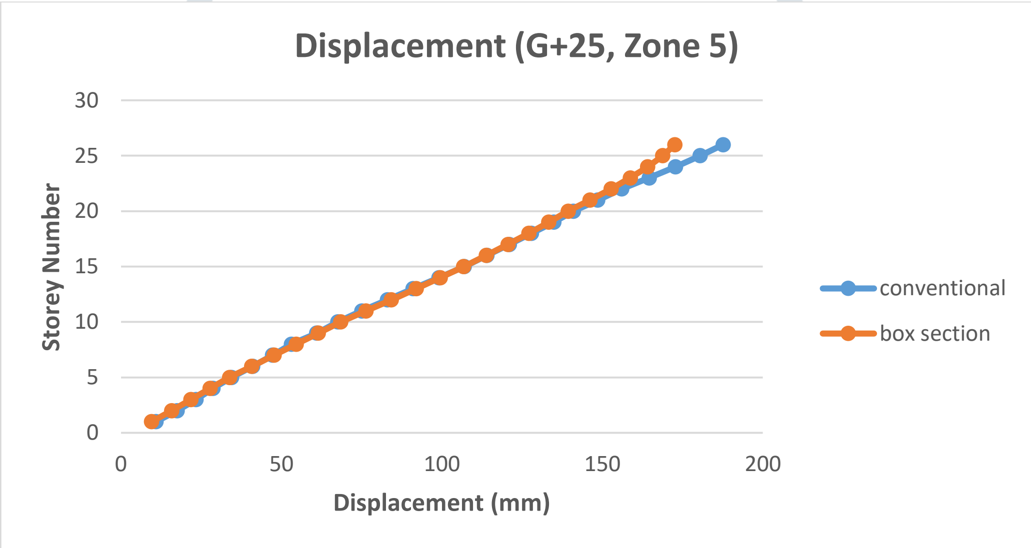

Fig. 22 Storey Displacement comparison in Zone5 for G+25 building (Conventional Vs. Box Section Wall)

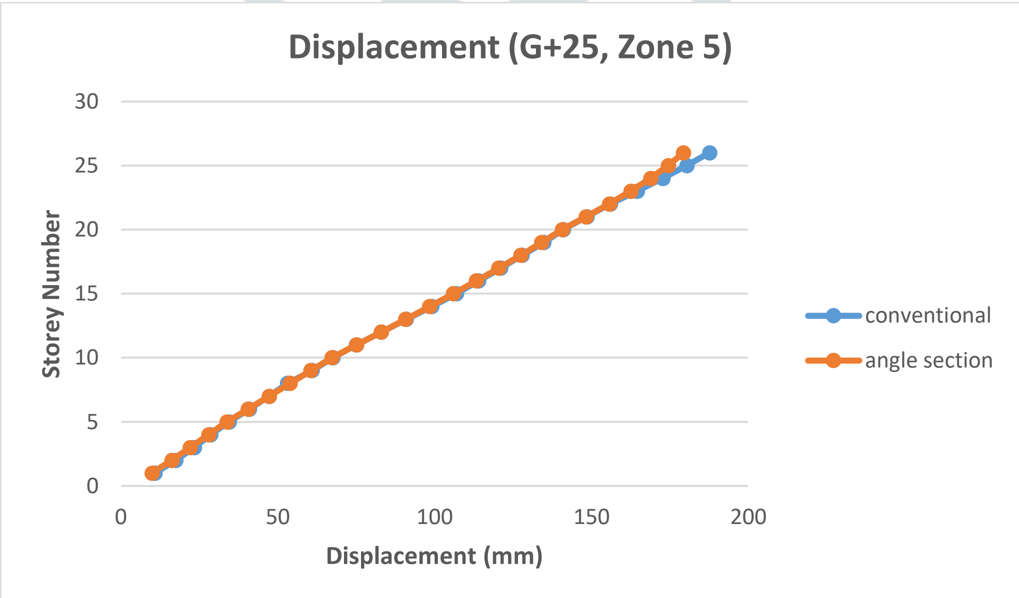

Fig. 23 Storey Displacement comparison in Zone5 for G+25 building (Conventional Vs. Angle Section Wall)

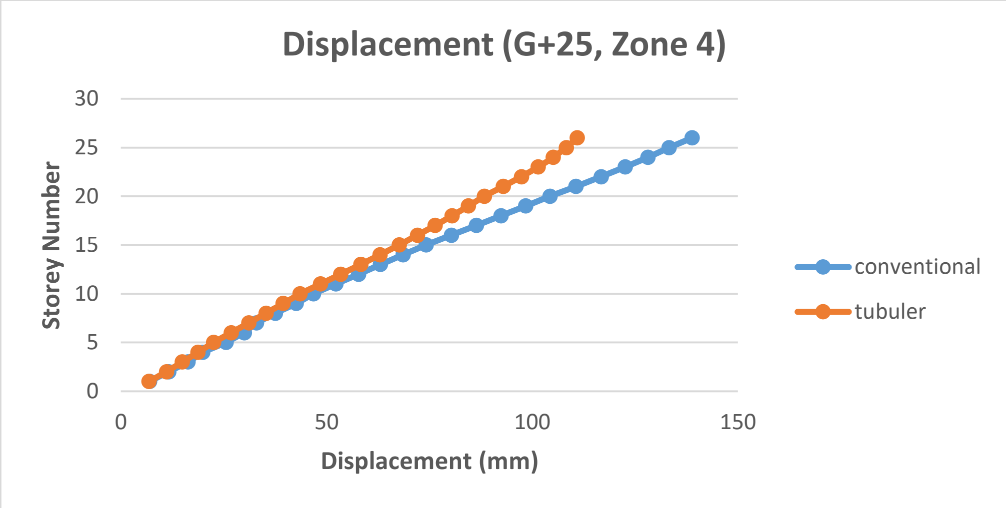

Fig. 24 Storey Displacement comparison in Zone4 for G+25 building (Conventional Vs. Tubular Section Wall)

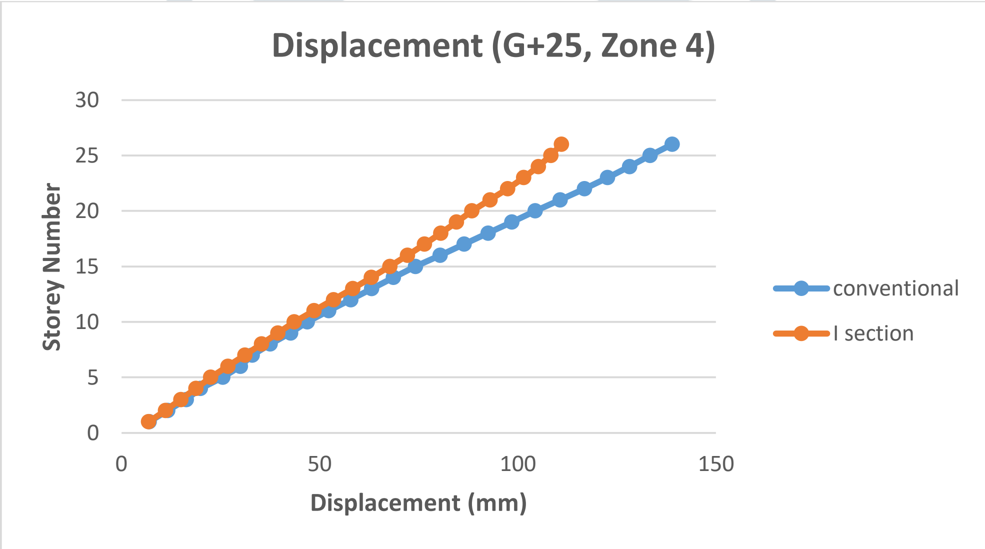

Fig. 25 Storey Displacement comparison in Zone4 for G+25 building (Conventional Vs. I Section Wall)

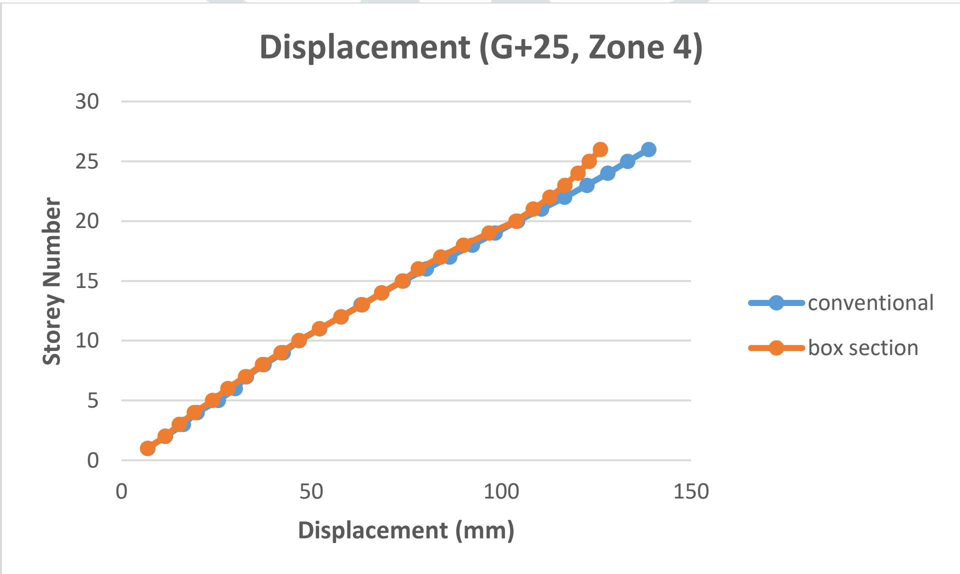

Fig. 26 Storey Displacement comparison in Zone4 for G+25 building (Conventional Vs. Box Section Wall)

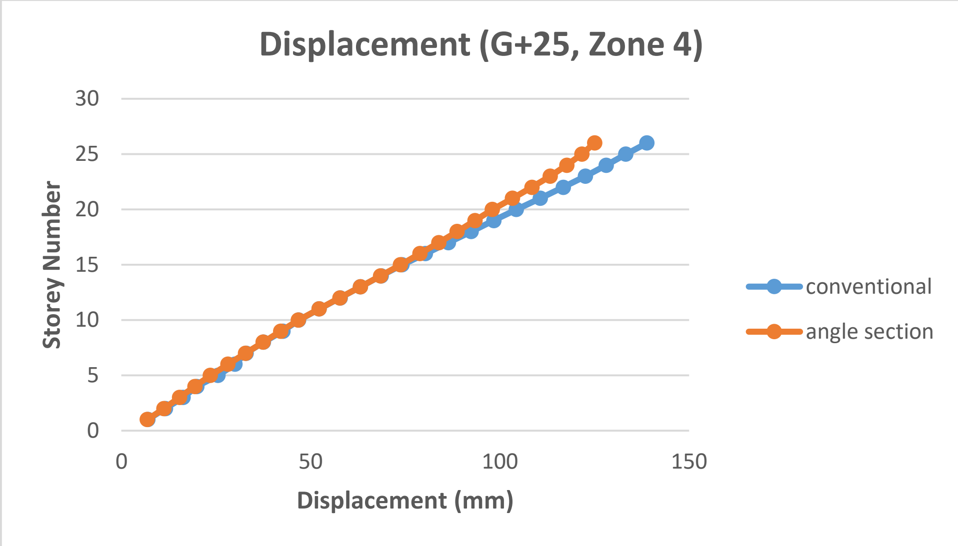

Fig. 27 Storey Displacement comparison in Zone4 for G+25 building (Conventional Vs. Angle Section Wall)

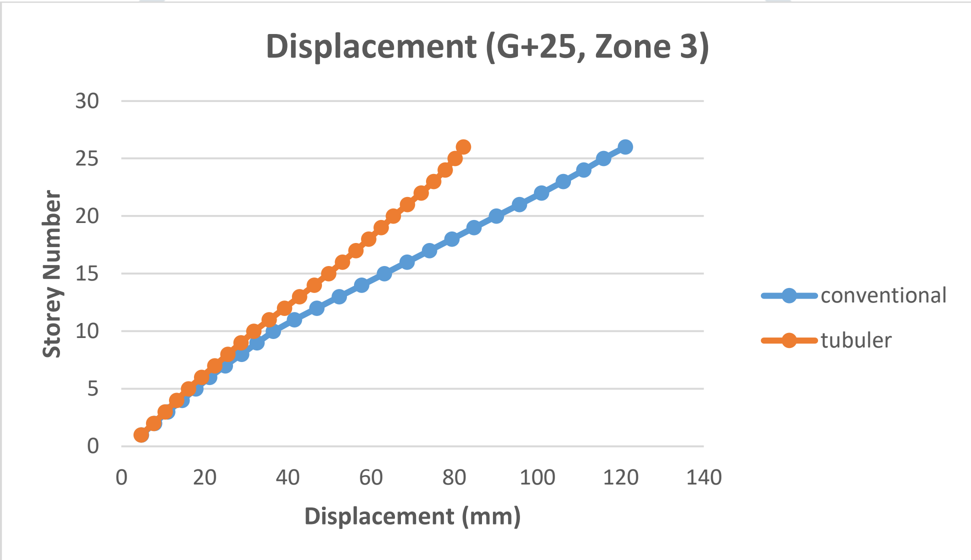

Fig. 28 Storey Displacement comparison in Zone3 for G+25 building (Conventional Vs. Tubular Section Wall)

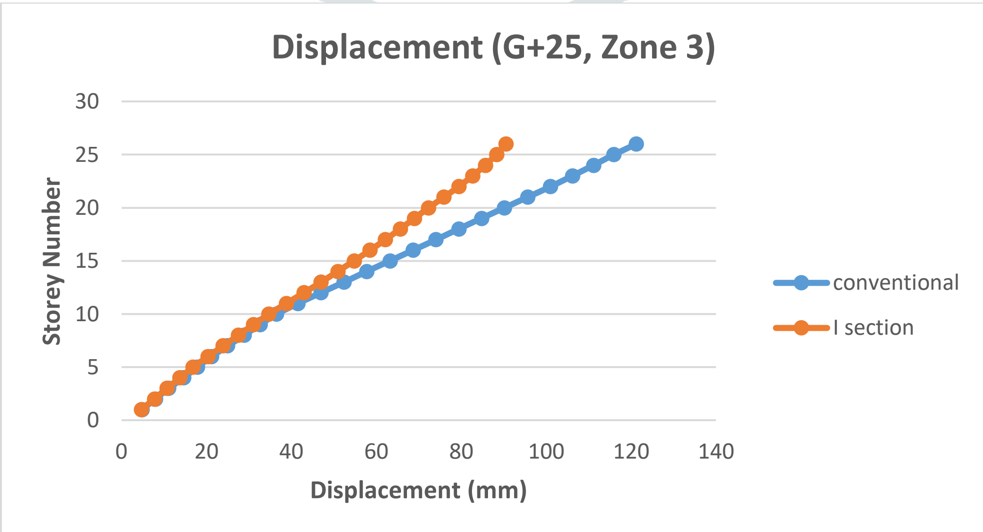

Fig. 29 Storey Displacement comparison in Zone3 for G+25 building (Conventional Vs. I Section Wall)

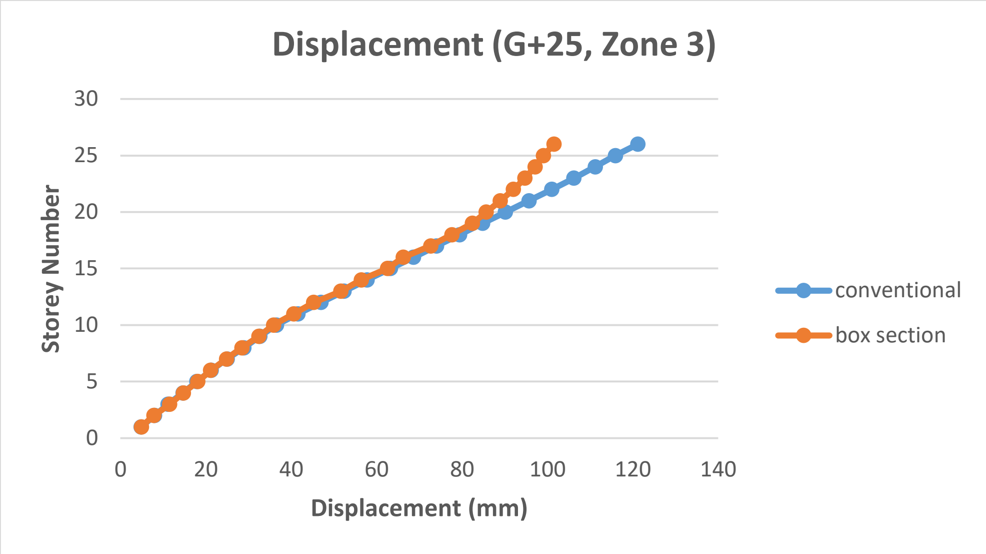

Fig. 30 Storey Displacement comparison in Zone3 for G+25 building (Conventional Vs. Box Section Wall)

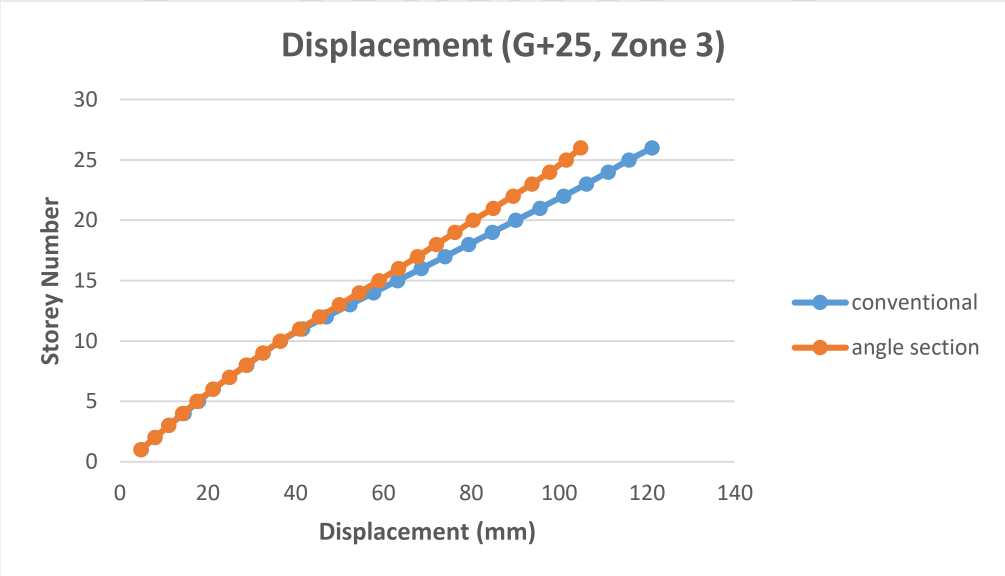

Fig. 31 Storey Displacement comparison in Zone3 for G+25 building (Conventional Vs. Angle Section Wall)

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