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# Effect of Thickness, Numbers, and Positions of Shear Walls on Seismic Behaviour of Multistoried Structure

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**ABSTRACT:** These days, tall buildings are in demand. Lateral forces from wind or seismic activity become more significant as a structure's height increases. The structural components will resist the majority of them. Two of the main structural solutions utilised in sturdy concrete buildings to withstand seismic and wind stresses are frames that resist momentarily and shear wall frames. The quantity, thickness, and locations of shear walls are some of the variables that affect a multi-story building's seismic behaviour. Increasing the number of shear walls generally enhances the building's lateral stiffness and resistance to seismic forces. Thicker shear walls can contribute to greater strength and stiffness, but they also affect the overall building mass. The position of shear walls is crucial. Strategic placement helps distribute lateral forces effectively, reducing building sway during an earthquake. Corner locations and along building edges are common positions for shear walls to optimize their effectiveness. Ultimately, a well-designed combination of shear wall number, thickness, and placement is essential for achieving optimal seismic performance in multi-storied buildings. For my analysis, I have used the Response Spectrum approach and time history. The software package ETABS has been used to model 12 multi-story buildings, all of which are G+15 stories, for quake zone V in India. Shear walls, with their variations in thickness, number, and position, are taken into consideration in order to evaluate how well they resist lateral stresses.

**KEYWORDS:** Shear wall, deflection, Base shear, E-tabs, Response Spectrum analysis.

## I. INTRODUCTION

The primary concern The goal of seismic loading structural design is to guarantee public safety during significant earthquakes. But other important factors include serviceability and possible financial loss. In contrast to wind or gravity loading, seismic loading necessitates an understanding of the behaviour of structures under substantial inelastic deformations. For this complicated behaviour to ensure satisfactory seismic performance outside of the elastic region, a thorough investigation is required. Shear walls play a vital role in countering lateral loads. In residential construction, they're typically straight external walls forming a box that provides lateral support. Properly designed and constructed shear walls offer strength against forces. This project investigates five shear wall thickness models (100 mm, 150 mm, 200 mm, and 250 mm) to evaluate seismic performance. A particular challenge in seismic design is the "soft storey" phenomenon. A soft storey building has weak lower levels, often connected to parking garages or retail areas. This irregularity creates significant vulnerability during earthquakes. A floor is considered "soft" if it's 70% less rigid than the floor above. Soft storey failure can lead to collapse due to lateral pressures during earthquakes.

The upper stories of soft storey buildings are often stronger than foundation floors, exacerbating seismic reactions. The lack of obstructions in soft storeys may be aesthetically or commercially appealing but reduces opportunities for shear wall installation. This highlights the importance of careful design and construction to ensure structural integrity. In seismic events, soft storeys are particularly hazardous due to lateral pressures created by building wobbling. Even intermediate floors, referred to as "soft" floors, are vulnerable. The potential for collapse underscores the need for robust seismic design and shear wall placement.

The size of shear walls significantly impacts a building's structural integrity, particularly in seismic and wind-prone areas. Increasing shear wall size enhances lateral load resistance, improves stability, and reduces damage from earthquakes and wind, but also reduces floor space and increases construction costs. Conversely, decreasing shear wall size increases floor space and reduces costs, but compromises stability and increases vulnerability. The optimal size depends on factors like building height, seismic zone, wind loads, material properties, and design codes. Typically, thicker shear walls (200-250 mm) provide greater stability, while thinner walls (100-150 mm) suffice for lower-rise buildings. Key considerations include aspect ratio, shear wall placement, opening sizes, and material selection. Consulting structural engineers and following local building codes ensures optimal shear wall design and sizing.

## II. SHEAR WALL

Shear walls are specifically designed to prevent damage from earthquake and wind-induced lateral strains. Their position and shape significantly impact their structural response to lateral loads. By acting as a horizontal diaphragm, the structure transfers lateral loads to perpendicular shear walls, ensuring stability. Shear walls function as deep beams, exhibiting high rigidity and reactivity to shear and flexure. This prevents collapse under horizontal stresses. To optimize support for tension, bending, and direct shear, the central core should be positioned eccentrically relative to the building's form.

While symmetrical buildings with shear wall layouts can still experience torsion, careful design can minimize this risk. For instance, wind blowing through the building's center of mass or striking facades with direct surface textures can cause torsion, as noted by Schueller (1977). Shear walls are a cost-effective solution for buildings up to 35 floors due to their superior stability compared to horizontal rigid frames. The combination of shear walls & frames in low- & medium-rise buildings allows the former to support lateral stress while the latter may support gravity loads. Although a shear wall's thickness affects its resistance, its width has a much bigger effect. Understanding these factors is crucial for designing and constructing effective shear walls that mitigate earthquake and wind damage.

Shear walls are essential in building design, providing seismic and wind resistance, structural support, and stability. They distribute lateral loads to foundations, minimize deflection, and enhance overall building integrity. Shear walls are cost-effective, architecturally flexible, and ensure safety by maintaining structural stability during emergencies. Compliance with building codes requires shear walls in high-rise buildings, seismic-prone areas, high-wind zones, and complex designs.

## III. OBJECTIVE

1. to construct the earth quack-resistant structure and use IS 1893:2002 to investigate the seismic behaviour of the multistory complex G+15 of T Shape.
2. to compare multi-story buildings using and without shear walls at various places, as well as the thickness and quantity of rip walls on multi-story buildings.
3. To compare the Base Shear Values, Story Drift, Frequency, and Time period of structures without shear walls at various places on multistory buildings
4. To examine the structures using Response Spectrum Analysis in ETABS software

## IV. LITERATURE REVIEW

**Anas M Fares (2019).** Shear wall configuration significantly impacts a building's seismic design. Positioning affects floor stiffness, diaphragm displacement, and drift. To optimize seismic resistance, engineers align the center of mass and rigidity. This study compares perimeter, intermediate, and core walls using ETABS. Core walls prove the most effective configuration for resisting earthquake loads.

**Anil Baral, SK Yajdani (2015).** Shear walls resist lateral forces and support gravity loads in buildings. Their positioning significantly impacts building behavior. This study analyzes optimal RC shear wall placement using ETABS 2013. Five RCC building models with varying shear wall positions were evaluated. The study examines seismic performance, bending moments, shear forces, and axial forces.

**K LovaRaju, Dr KVG D Balaji (2015).** This study conducts nonlinear analysis of frames with varying shear wall positions. Four models are analyzed: bare frame and three dual-system structures with shear walls. An 8-story building in zones II-V (IS 1893-2002) is subjected to earthquake loads. ETABS software is used to analyze and compare pushover curves. Optimal shear wall placement significantly reduces displacement and increases base shear.

**V Shreelakshmi, S Kavitha (2020).** This study optimises the thickness and location of shear walls in a G+20-story structure located in Area IV (medium soil). Linear static analysis is performed via the ETABS 2016 program. Three locations—corner, mid-span, and central core—and four razor-thin wall thicknesses (150–225 mm) are assessed. Among the parameters examined are base shear, modal time period, overturning moment, storey displacement, and storey drift.

**Hema Mukundan, S Manivel (2015).** Rising urbanization has led to increased demand for multi-storey and high-rise buildings, necessitating advanced structural dynamics research. Earthquake engineering studies focus on mitigating damage from seismic activity, which causes significant global losses. This paper investigates the seismic resilience of a 10-storey building in Zone IV using reinforced concrete shear wall-framed structures. Response spectrum analysis using ETABS 9.7.4 software assesses maximum storey displacements, Mode shapes, base shear reactions, and storey drifts. Different thicknesses and shear wall holes are used to study irregularity effects.

**Rajat Bongilwar, VR Harne, Aditya Chopade (2018).** Because they provide strength and stiffness during earthquakes, shear walls are essential in multi-story buildings. This study looks into how they affect structural vulnerability. An eight-story G+ building with and without wall shear was examined, assessing: The base shear Bending moment, shear force, lateral displacement, and storey drift ratio. The Equivalent Static Method was employed to develop and analyse two models using ETABS 2016 software. A shear wall with apertures, or a bare frame without one.

**Kalesha Shaik, B Ajitha (2022).** With an emphasis on the operating room floor, a case study was carried out to examine how well seismic floor isolation can lower a hospital building's seismic reaction. Using SAP2000 software, a three-floor hospital building model was created, and floor isolation was implemented on the operation theatre floor. Time-history analysis was then performed for both isolated and non-isolated building models. The results showed a significant reduction in seismic response on the isolated operation theatre floor, characterized by decreased floor acceleration, displacement, and base shear. This reduction in seismic response enhances the safety of critical equipment and services on the isolated floor. The study concludes that floor isolation is an effective strategy for mitigating seismic risk and ensuring operation theatre safety during earthquakes. Based on these findings, recommendations include implementing floor isolation in sensitive hospital areas, conducting site-specific seismic hazard assessments, and optimizing isolation system design through detailed analysis. This research demonstrates the potential benefits of seismic floor isolation in protecting critical infrastructure and promoting resilience in healthcare facilities. By adopting this strategy, hospital designers and engineers can create safer and more reliable environments for patients and medical staff.

## V. METHODOLOGY

Two phases were detailed in the project study. Web searches and reviews of e-books, manuals, codes, and journal articles were used to gather the core data for the literature survey. Following evaluation, an issue statement is clarified, and the chosen frame models are used for in-depth investigation and analysis.

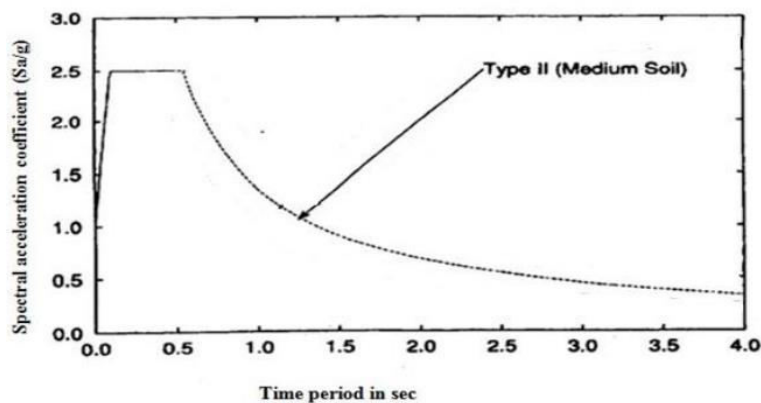
In the methodology of seismic analysis of Shear walls building we are considering following some main guidelines:-

1. Here seismic analysis done by Responsespectrum and time history method.
2. The effect of position of shear wall in the building plan.
3. Modeling and analysis of particular analysis techniques.
4. For analysis purpose use standard software ETAB
5. Responsespectrum results are compared

### Response Spectrum Method

In seismic engineering, the term spectrum refers to the idea that a single graph may summarise the reaction of buildings with a wide range of periods. A typical response spectrum plots earthquake-related reactions, including acceleration, velocity, and deflection, for a whole range, or range, of building periods, given a specific seismic motion and a

percentage of essential damping. The fluctuating response of a sequence of cantilever pendulums gaining natural periods and progressively longer lengths that respond to a constant lateral tremor of the base can thus be represented graphically as a response spectrum. The idealised single-degree-of-freedom system's maximum response to ground vibrations during earthquakes, with a specific period and damping. In accordance with IS 1893-2002 (part 1), this analysis is conducted. Here, the seismic zone factor and soil type would be specified into IS 1893-2002 (part 1). In order to analyse the building, the ETABS 2018 software applies the usual response spectra for the kind of soil taken into consideration.. The typical reaction spectrum for medium soil type is displayed in the following diagram, which may be expressed as time length versus the wavelength acceleration coefficient (Sa/g).



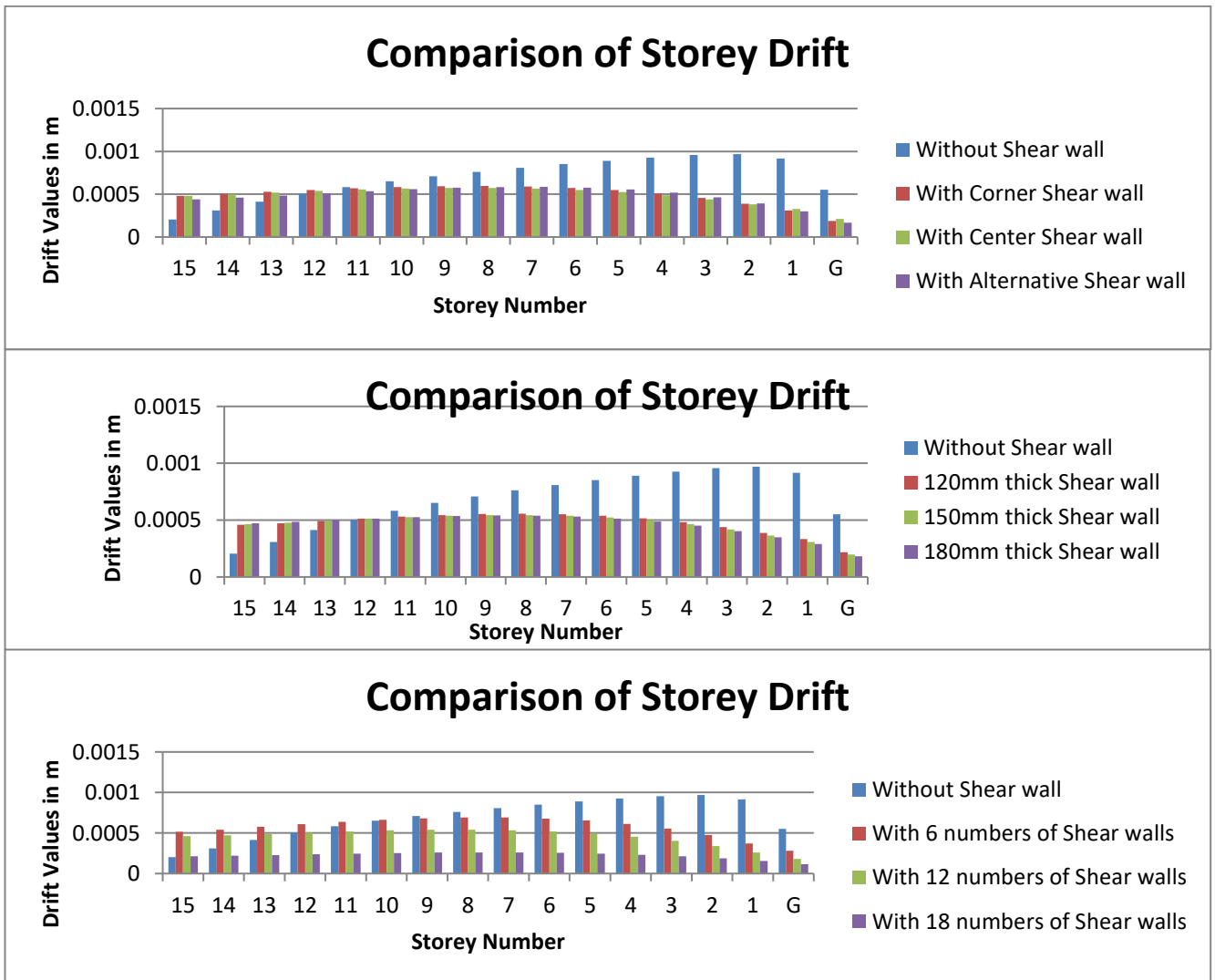
## GEOMETRY

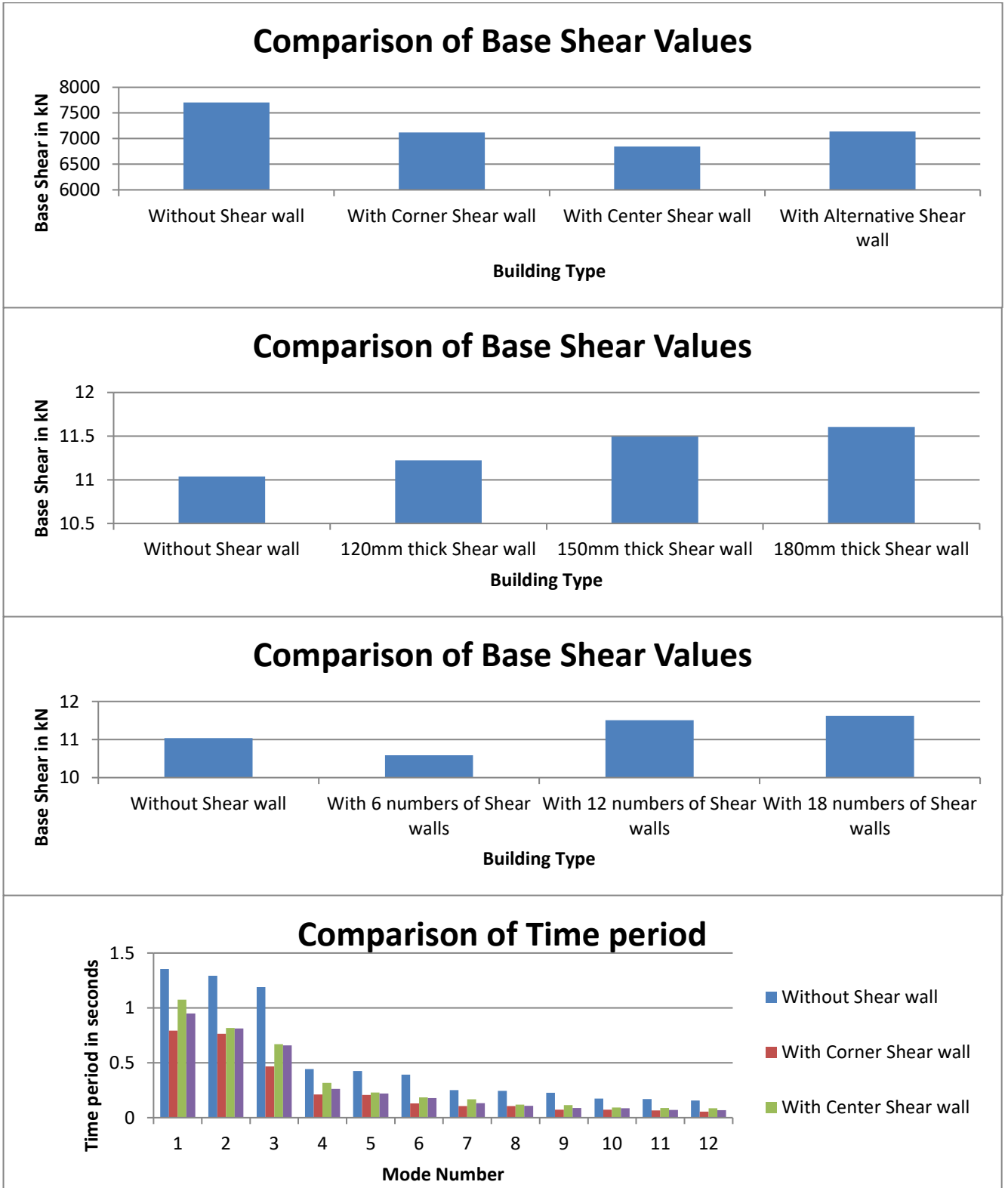
### Geometry of frame

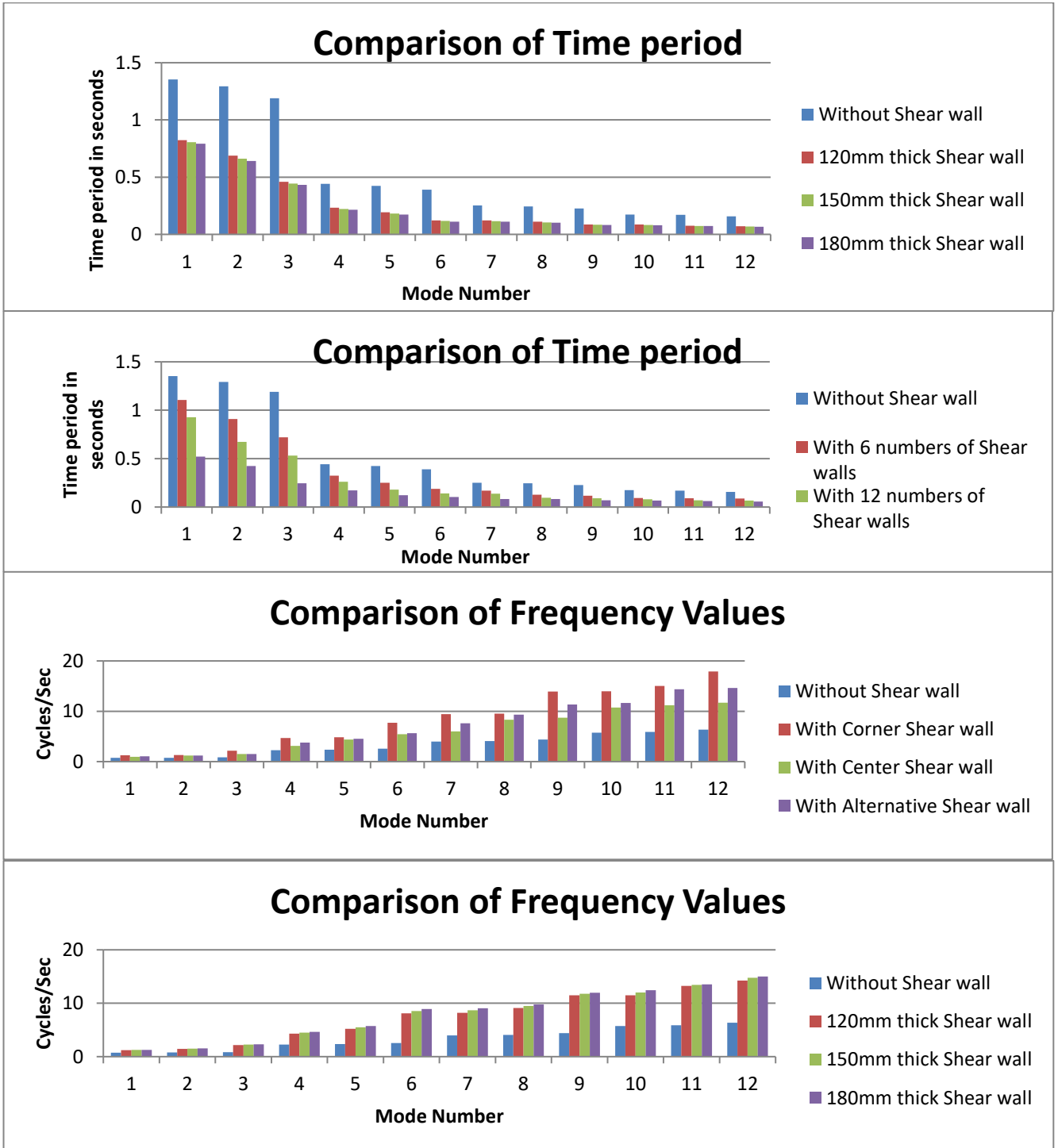
- |                               |   |
|-------------------------------|---|
| 1. Grade of concrete          | : M30   |
| 2. Grade of Reinforcing steel | : HYSD Fe500                                    |
| 3. Dimensions of beam         | : 460mmX690mm                                   |
| 4. Dimensions of column       | : 690mmX690mm                                   |
| 5. Thickness of slab          | : 150mm   |
| 6. Height of bottom story     | : 3m  |
| 7. Height of Remaining story  | : 3m  |
| 8. Shear wall thickness       | : 120mm, 150mm, 180mm                           |
| 9. Shear wall location        | : At corner, at center, at alternative position |
| 10. Live load                 | : 3.5 KN/m <sup>2</sup>                         |
| 11. Floor load                | : 1.5 KN/m <sup>2</sup>                         |
| 12. Density of concrete       | : 25 KN/m <sup>3</sup>                          |
| 13. Seismic Zone              | : Zone 5  |
| 14. Site type                 | : II  |
| 15. Importance factor         | : 1.5   |
| 16. Response reduction factor | : 5   |
| 17. Damping Ratio             | : 5%  |
| 18. Structure class           | : B   |

- 19. Basic wind speed : 39m/s
- 20. Risk coefficient (K1) : 1.08
- 21. Terrain size coefficient (K2) : 1.14
- 22. Topography factor (K3) : 1.36
- 23. Wind design code : IS 875: 1987 (Part 3)
- 24. RCC design code : IS 456:2000
- 25. Steel design code : IS 800: 2007
- 26. Earth quake design code : IS 1893 : 2002 (Part 1)

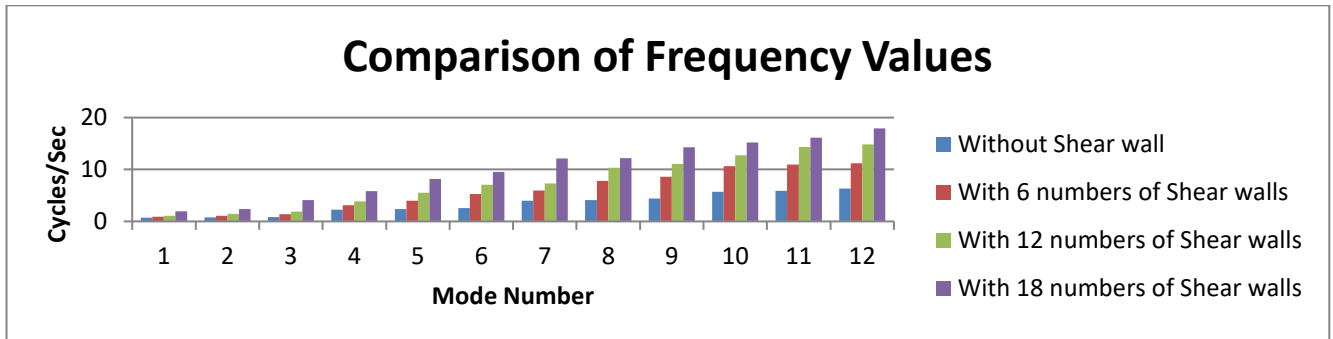
RESULTES: Response spectrum Results











## VI. CONCLUSION

1. For building with different locations the has better results for alternative case than remaining models, for the buildings with different thickness is having better results for 120mm thick shear wall and finally for number of shear walls it was observed less deflection for 18 numbers of shear wall than remaining cases..
2. The values of Shear found lower value for center shear wall, 120mm thick shear walls and 6 number of shear wall case buildings than remaining models.
3. The values of Bending found lower value for center shear wall, 120mm thick shear walls and 6 number of shear wall case buildings than remaining models.
4. The values of Torsion found lower value for center shear wall, 120mm thick shear walls and 6 number of shear wall case buildings than remaining models.
5. As per the base shear values it has better output for center shear walls, 120mm shear walls and 6 numbers of shear wall case.
6. When shear walls are opened, the bending moment & shear strain in the columns attached to the shear wall grow significantly. When the opening is at the top of the percentage increase, the opening percent decreases.
7. For a specific wall opening, it was noticed once the opening position was changed one one position to another.
8. This study found that a higher percentage of shear walls reduces drift and raises shear force, breaking moment, and building torsion.

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