# Outrigger Braced System Comparison with Various Lateral Load Resisting System in Multi-storey Building.

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*Abstract*— In this study, we look at three types of lateral load resisting systems: outrigger braced systems, diagrid systems, and shear wall systems. Outrigger bracing is a solution for controlling excessive drift and displacement in high-rise buildings. It is made up of outrigger bracings or outrigger trusses that connect the central core of the building to the peripheral columns, and the peripheral columns are connected to one another via belt trusses. For the 20 storey building heights, the conventional structural model with a reinforced concrete central core and models with outriggers at the top, top and 0.75H, top and 0.5H, and top where H is the total height of the building are modelled. Finding the perfect location for the outrigger system is the study's major goal. discover the most effective lateral load resisting system at the lowest cost. According to the findings of many evaluations, the top and middle heights of a high-rise building, where top displacement and drift are at their lowest, are the best places to install an outrigger bracing system. In comparison to traditional, diagrid, and shear wall constructions, outrigger structures are more rigid. The largest reduction in storey displacement, base shear, and minimal loads on slabs were demonstrated by the top and 0.5H type of outriggers.

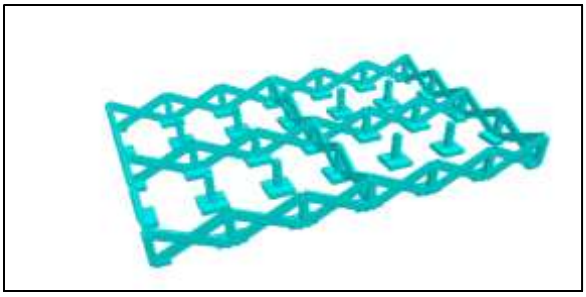
***Keywords:*** Outrigger Braced System, Diagrid Structure, Response Spectrum Method, Storey Shear, Node Displacement. Stresses in Slab and Beam

## I. INTRODUCTION

Due to the recent growth in population and loss in available land, there has been a sharp surge in the demand for high-rise structures. The development of extremely high-rise structures with perfection and safety is now possible thanks to technology and engineering developments. Due to aesthetic requirements and, more importantly, the limited amount of land that is currently accessible as a result of the increase in land prices and fast urbanization, there is a trend toward building taller, more slender structures. Tall buildings must be designed to withstand any lateral loadings since they are more vulnerable to lateral stresses caused by wind and seismic forces.

The requirements for strength and stiffness must be sufficiently met in the design of high-rise buildings, and the lateral displacements and drift caused by seismic and wind loads must be effectively controlled to prevent structural as well as non-structural damages. Different kinds of structural systems that are briefly detailed over the ages have developed for this aim.

Numerous studies have revealed that the shear wall, when employed alone, only effectively resists forces up to a particular height before becoming uneconomical relative to the advantages it offers. There is a need for another, more effective structural system that can provide high-rise structures with increased stiffness and strength against wind and seismic loadings while also taking economic considerations into account. The outrigger bracing system proved to be a very cost-effective way to reduce drift by giving tall buildings more stiffness against lateral displacement and drifts without increasing the cost of the steel.



Diagrid structures are becoming more and more popular as structurally efficient and significant design components for tall buildings. Due to the structural effectiveness and aesthetic possibilities offered by the unique geometric structure of the system, the diagrid structural system is now widely employed for tall buildings. Steel is typically used for tall buildings with diagrid structures. The vertical geometric irregularity of a concrete diagrid structure is examined in the current work and contrasted with a typical concrete structure.

The diagrid structural system can be described as a diagonal member formed as a framework made by the junction of several materials, such as metal, concrete, or wood beams that are utilised in the construction of buildings and roofs. In terms of strength and stiffness, steel diagrid constructions are effective in offering a solution. However, high-rise buildings and structures with broad spans now use diagrid extensively.

## II. OBJECTIVE OF STUDY

– Compare the idea of an outrigger structural system to other lateral load resisting systems, such as the Diagrid system and the Shear wall system, and analyse how each system responds under dynamic conditions.
– Determine the ideal site for the outrigger system in terms of performance, least lateral displacement, and economic consideration by varying the placement of the outrigger bracings with belt trusses along the height of the structure.
– To compare the outcomes of the outrigger system with the conventionally framed structural system, the Diagrid structural system, and the Shear wall structural system in terms of storey drift, storey shear, and top storey displacement.
– Diagrid Model and Shear Wall Model were used to compare the moment in the peripheral columns of the

outrigger system models with that of the conventional models.

## III. Methodologies

Staad Pro software is used to simulate conventional frames with central cores, conventional frames with central cores and outrigger systems, diagrids, and shear walls. Preliminary member sections are assumed. The models are 20-story structures. Zone IV seismicity. One outrigger's location is set at the top while the other is moved up and down by 0.5H and 0.75H, where "H" stands for the height of the structural model. The linear dynamic analysis is carried out to determine variables in the peripheral column such as displacement, inter-storey drift, moment, base shear, time period, and axial force. Response Spectrum Analysis is used to compare the outcomes with linear dynamic analysis.

Based on the aforementioned factors and the ideal outrigger site where displacement and drift are at their lowest, the effectiveness of the outrigger system, diagrid, and shear wall system is determined. Ultimately, the number of outriggers bracing systems is also raised one at a time, and a comparison analysis of the resulting decrease in lateral displacement is conducted.

Types of models consider for the study

- Conventional Building
- Conventional building with outriggers.
- Location of outriggers One fixed at the top
- Location of second one is varied at 0.5H and 0.75H

| | |
|---|---|
| Number of storeys | 20 storeys |
| Plan area | 20 m x 30m |
| Storey height | 3 m |
| Spacing of columns | 5 m |
| Grade of concrete | M30 |
| Grade of steel | Fe415 |
| Size of columns | 500 mm x 500 mm |
| Slab thickness | 200 mm |
| Shear Wall Thickness | 150 mm |

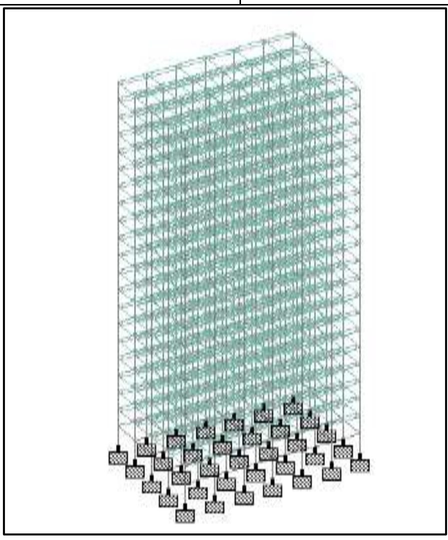


Fig. 1: Conventional Building

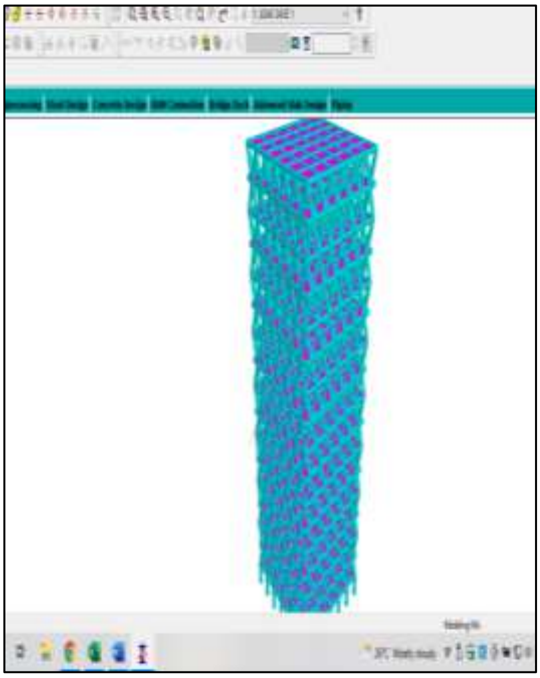
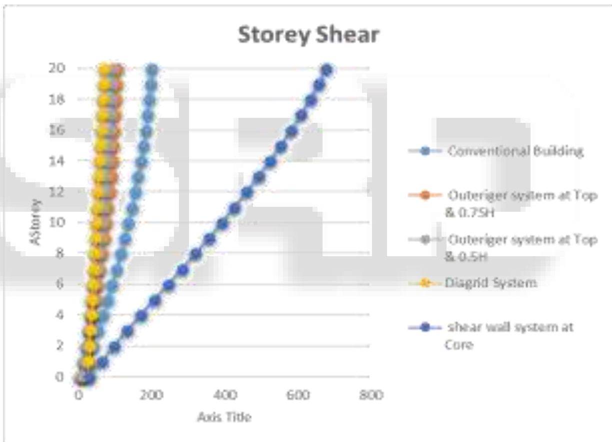
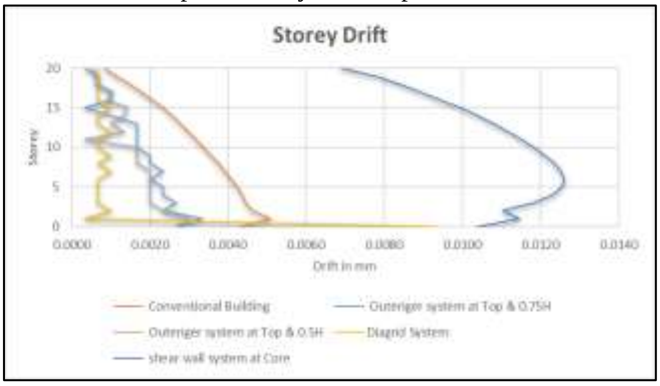


Fig. 2: diagrid Building

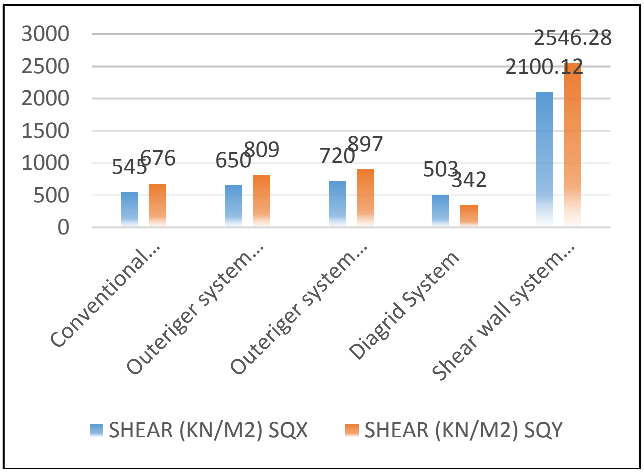
## IV. Results



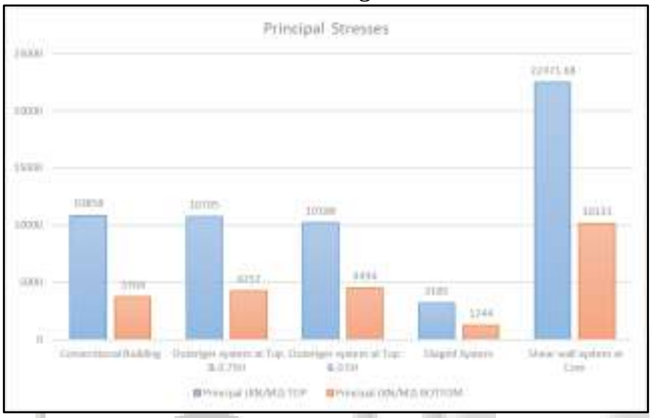

Graph 1: Storeys Vs Displacement




Graph 2: Storey drift in different load resisting system



Graph 3: Centre Shear Stresses Vs Different types of Building



Graph 4: Max Von Mis stresses in Slab

## V. CONCLUSION

The various conclusions drawn within the scope of present work are as follows:

- The top of the structure and 0.5 times its height is determined to be the best locations for outrigger systems. By installing outriggers at this point, lateral displacement and drift are significantly reduced. By using the Response Spectrum Method, the lateral displacement for 20 storey structural models with outriggers at the top and 0.75H is decreased by 47 percent, for 0.5H by 52 percent, for diagrid structures by 64 percent, and for shear wall systems by 238 percent, respectively.
- The best results in reducing lateral displacement are displayed by structural models with outriggers at the top and a 0.5H & Diagrid Structural System. When compared to the traditional model, the maximum storey drift for 20 storey structural models with outriggers at the top and 0.5H & Diagrid system is decreased by 42 percent & 20%, respectively.
- When compared to the traditional model, the base shear for the 20, 40, and 60 storey structural models with an outrigger at the top and 0.5H is increased by 35%. A remarkable amount of moment is resisted by the outer columns, and the installation of the outrigger bracing system minimizes the moment in the central core. The lateral loads are more efficiently resisted by the periphery columns, which assist form a tension-compression couple. After study, it was discovered that when compared to a traditional structural model with various load resisting systems, there was no appreciable modification in the slab stresses, including the centre shear stresses, principal stresses, and Max Von Mis stresses.

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