MULTISTOREY BUILDING COMPARATIVE ANALYSIS OF OUTRIGGER BRACED SYSTEM WITH DIFFERENT LATERAL LOAD RESISTING SYSTEM

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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*

The primary goal of the research is to determine the best location for the outrigger system. And determine the most cost-effective lateral load resisting system. According to the results of various analyses, the optimum location of the outrigger bracing system for high rise buildings is at the top and mid height of the building, where the top displacement and drift is the least. Outrigger structures are more rigid than conventional, diagrid, and shear wall structures. The top and 0.5H outrigger models demonstrated the greatest reduction in storey displacement, base shear, and slab stresses.

***Key Words*:** Outrigger braced system, Diagrid Structure, Response Spectrum Method, Storey Shear, Node Displacement. Stresses in Slab and beam.

1. INTRODUCTION

Because of the increase in population and decrease in available land, the demand for high-rise buildings has increased rapidly in recent years. Engineering techniques and technological advancements have enabled the development of super high-rise structures with precision and safety. There is a trend toward taller and more slender structures due to aesthetic demands and, more importantly, the limited land area available as a result of rising land prices and rapid urbanisation.

Tall buildings are more vulnerable to lateral loads caused by wind and seismic forces, and thus must be designed to withstand any lateral loadings. The requirements for strength and stiffness must be adequately met in the design of high-rise buildings, and the lateral displacements and drift caused by seismic and wind loads must be properly controlled to avoid structural and non-structural damage. Various types of structural systems emerged over time for this purpose, which are briefly described.

Various studies have revealed that the shear wall, when used alone, provides effective resistance only up to a certain height, after which it becomes uneconomical in comparison to the benefit it provides. As a result, there is a need for a more efficient structural system that provides more stiffness and strength to high-rise structures while also considering economic criteria. The outrigger bracing system stiffens tall buildings against lateral displacement and drifts without incurring additional steel costs, and it proves to be a very cost-effective solution for drift control.

Diagrid buildings are becoming more popular as structurally and architecturally important tall-building assemblies. Because of the structural efficiency and aesthetic potential provided by the system's distinctive geometric configuration, the diagrid structural system has recently been widely used for tall buildings. Steel is commonly used for tall building diagrid structures. The current work analyses and compares a concrete diagrid structure with vertical geometric irregularity to a conventional concrete building. The diagrid structural system can be defined as a diagonal member shaped as a framework formed by the intersection of various materials used in the construction of buildings and roofs, such as metals, concrete, or wood beams. Diagrid structures of steel members are effective in providing a solution in terms of both time and cost.

2. OBJECTIVES OF STUDY

- To compare the concept of an outrigger structural system with other lateral load resisting systems such as the Diagrid system and the Shear wall system, and to investigate the response of the same using dynamic analysis. & Vary the location of outrigger bracings with belt trusses along the height of the structure and determine the best outrigger system location in terms of performance, least lateral displacement, and economic consideration.
- To compare the results of the outrigger system with the conventional framed structural system, Diagrid structural system, and Shear wall system in terms of storey drift, storey shear, and top storey displacement.& compare the moment in the outrigger system models' peripheral columns to that of the conventional models, Diagrid Model, and shear wall model.

3 METHODOLOGIES

- The use of Staad Pro software is used to model conventional frames with central cores, conventional frames with central cores and outrigger systems, diagrids, and shear walls. Preliminary member sections are assumed.
- The models have a height of 20 stories. Zone IV seismicity.
- Where "H" is the height of the structural model, one outrigger's position is kept fixed at the top and the other is varied along the height as 0.5H and 0.75H.
- The results are compared with linear dynamic analysis, also known as Response Spectrum Analysis, to determine parameters such as displacement, inter-storey drift, moment, base shear, time period, and axial force in the peripheral column.

The data used in this study is summarized below:

Number of storey	20 storey
Plan area	20 m x 30m
Storey height	3 m
Spacing of columns	5 m
Grade of concrete	M25
Grade of steel	Fe415
Size of columns	500 mm x 500 mm
Size of Cantilever beams	2000 mm x 500 mm
Slab thickness	200 mm
Shear Wall Thickness	150 mm

Fig -1: Conventional Building

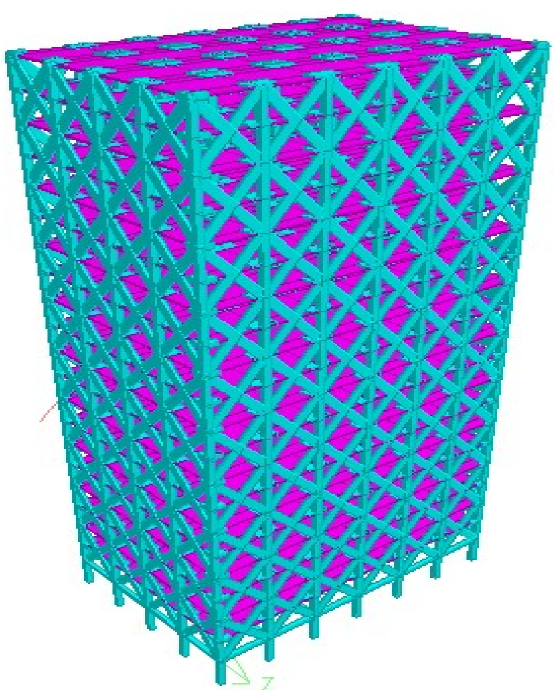


Fig -2: diagrid Building

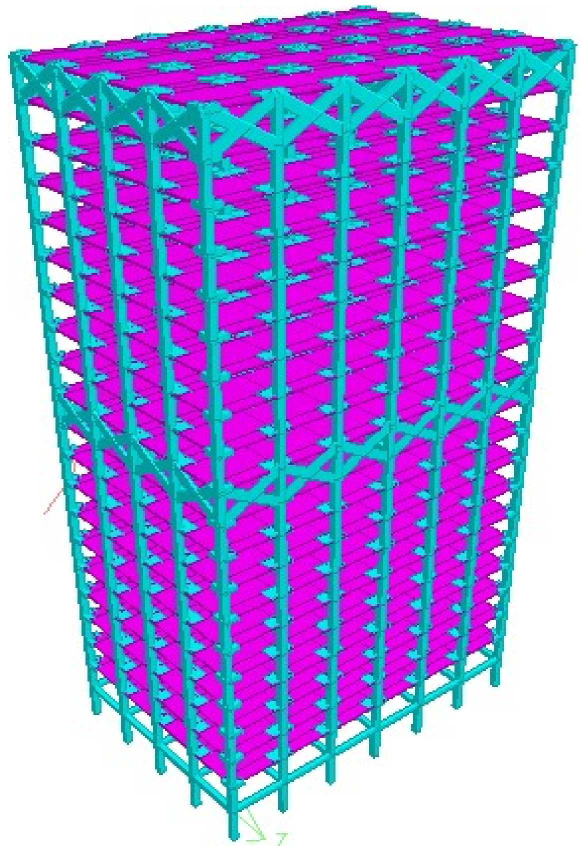
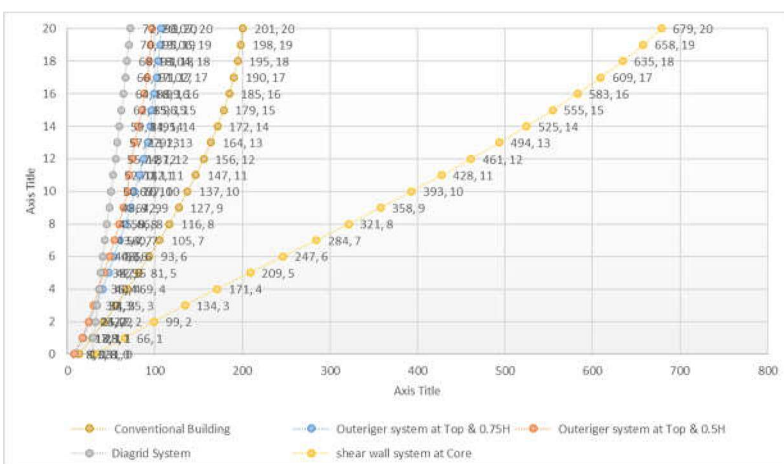
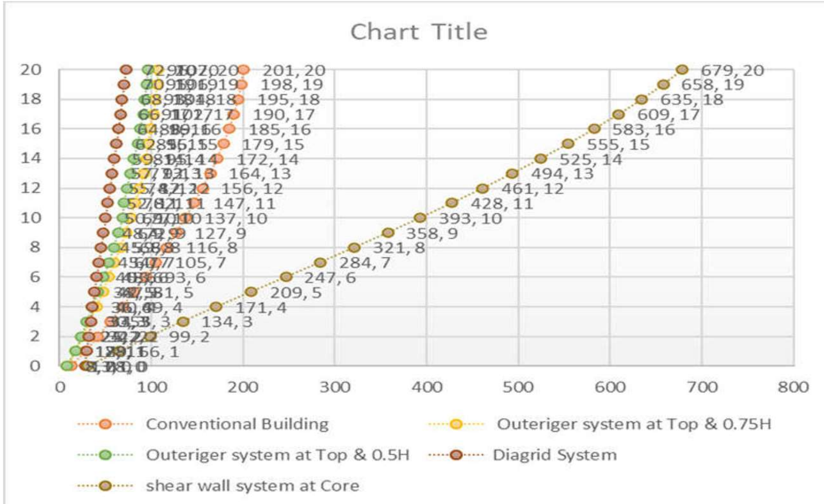


Fig -3: steel outrigger system Building

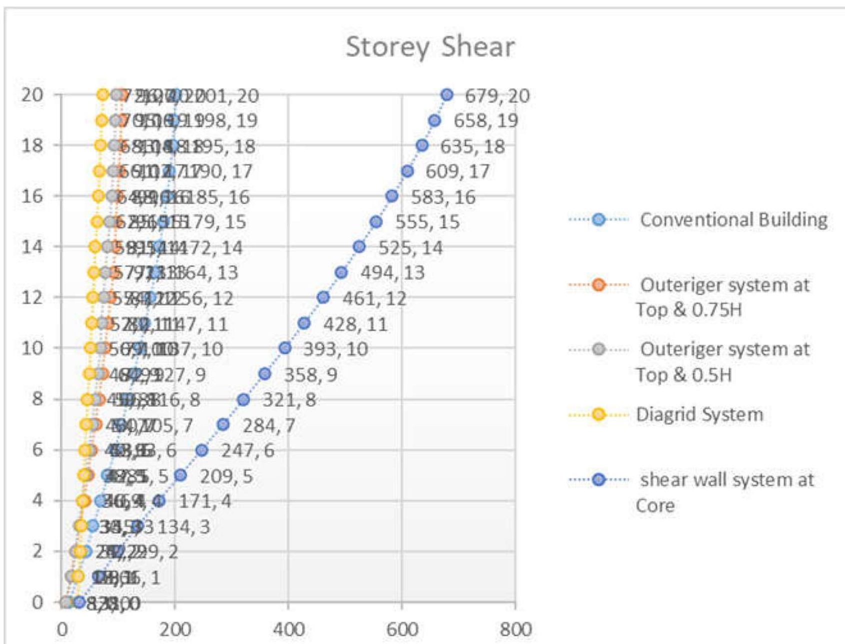
3. RESULTS



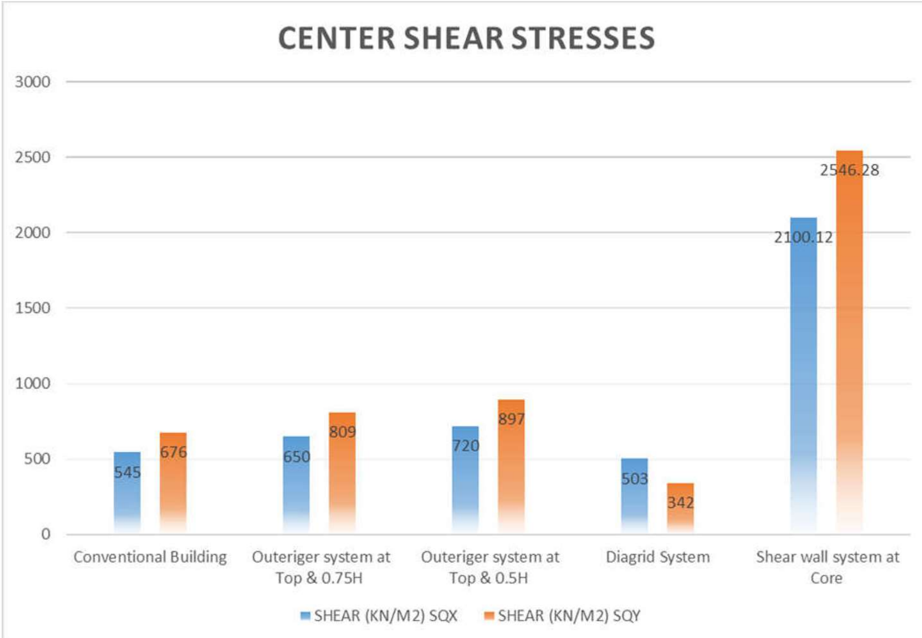
Graph 1 Storeys Vs Displacement



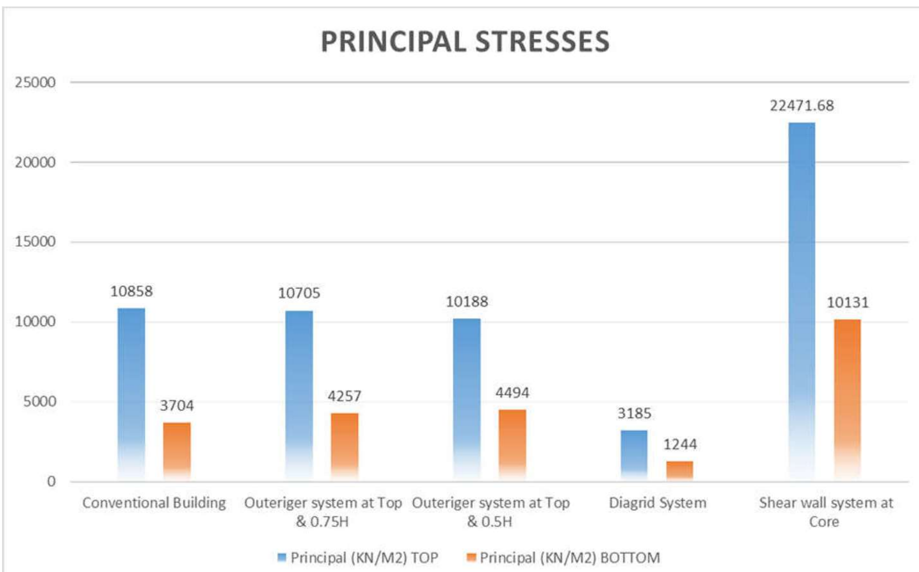
Graph 2 Storey Shear in different load resisting system



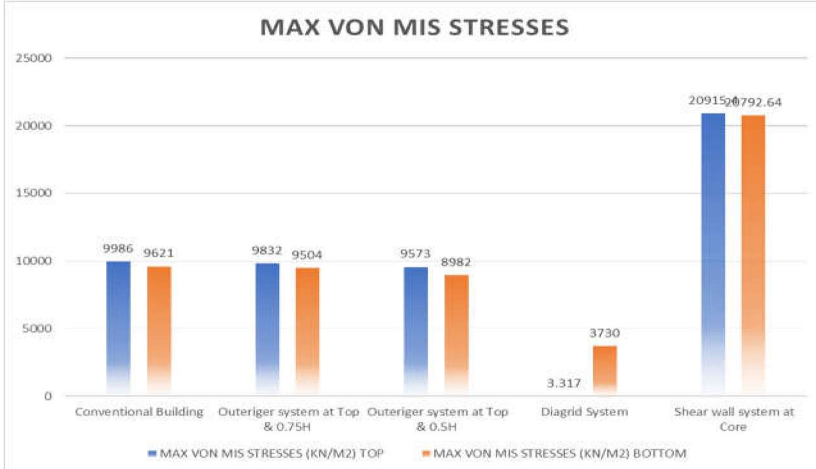
Graph 3 Storey Drift in different load resisting system



Graph 4 Center Shear Stresses Vs Different types of Building



Graph 5 principal stresses Vs Different types of building for Seismic Analysis



Graph 6 Max Von Mis stresses in Slab

4. CONCLUSION

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

- The optimum location of outrigger system is found to be at top and 0.5 times the height of the structure. Significant reduction in lateral displacement and drift is seen in providing outriggers at this location.
- The lateral displacement for 20 storey structural models with outrigger at top and 0.75H is reduced by 47%, & for 0.5H is reduced by 52% and for diagrid structure is reduced by 64% and for shear wall system is increased 238% respectively by Response Spectrum Method.
- 3.The best results in reducing lateral displacement are shown by structural models with outriggers at the top and a 0.5H & Diagrid Structural System.
- Similarly, compared to the conventional model, the maximum storey drift for 20 storey structural models with outriggers at the top and 0.5H & Diagrid system is decreased by 42% & 20%, respectively.
- 5.When compared to the conventional 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%.
- 6. The introduction of the outrigger bracing system reduces the moment in the central core, and the peripheral columns resist the moment to an impressive degree. The lateral loads are more effectively resisted by the peripheral columns, which help form a tension-compression couple.
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