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Review on Analysis and Comparison between Diagrid and Conventional structures using Etabs

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ABSTRACT:
In recent times, Tall buildings structures are becoming very common in construction of various types of Structural marvels. Tall buildings usually refers to skyscrapers, the Skyscrapers are noticeable and land saving and in many systems, Diagrid system are one of the popular system in tall building systems among different systems. A diagrid structure is a type of structural system that uses diagonal members to provide support and stability to a building. The diagonal members are typically made of steel or other high-strength materials, and they are placed at angles that provide maximum strength and stability while minimizing the amount of material needed. The result is a highly efficient and visually striking structural system that is often used in tall buildings, bridges, and other large structures. The diagrid structure is known for its ability to withstand lateral forces such as wind and earthquakes, as well as its ability to create open and flexible interior spaces. Diagrid also gives a very aesthetic appearance to the structure. In this research paper we had done a comparison and analysis between the Conventional and Diagrid structures on the basis of Lateral loads Seismic activity and Wind Forces on G+60 Storey Building. This paper also shows different parameters like Storey displacement, Storey shear, and Storey stiffness under the Earthquake Zone 3,viz. high intensity zone.

KEYWORDS: Diagrid, Conventional, G+60 Storey, Wind loads, Seismic load, Lateral load, flexible interior spaces.

I. INTRODUCTION

Conventional structures are the more traditional method of construction, relying on vertical columns and horizontal beams to support the weight of the building. This system is straightforward and easy to construct, making it a popular choice for many construction projects. However, conventional structures can have limitations in terms of strength and efficiency, especially in taller buildings and structures. On the other hand, diagrid structures offer a more innovative approach to building design, utilizing a network of diagonal members to support the weight of the building. This system is known for its strength and efficiency, allowing for the use of less material while still maintaining structural integrity. The word "diagrid" is a combination of "diagonal" and "grid" which refers to the crisscross pattern created by the diagonal members. The crisscross pattern of the diagonal members also creates a visually striking facade, making diagrid structures a popular choice for architects and designers. Nowadays as the population is increasing rapidly, the demand of land is also increasing simultaneously, to meet this demand tall building structures are constructed. The Lateral loads plays a very crucial role in the height increment of High-rise building structures, as the height increases the Earthquake load and wind load increases. To overcome this issue, different types of structural design systems are used. High-rise buildings which has a unique Geometric designs are widely used under Diagrid structural system. Diagrid structure has a mesh type structure system of inclined columns at facade. Unlike the conventional system which has an entire vertical columns. Diagrid consist of diagonal and horizontal component were diagonal member acts as inclined member which carry both lateral loads and gravity loads. Even diagrid structure saves 20% of steel weight in comparison of conventional frame moment. Similar work analysis of these system is reviewed below.

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II. LITERATURE REVIEW

AbhraTandon & Praveen Singhai (2021) has studied the tall structures and had done analysis onlateral load resisting members. Comparing and studying different structures and their effectiveness but none of the structure could resist the lateral loading, even though Diagrid structure is less effective against lateral load. Based on the author research,the conclusion is that current structures do not have a sufficient ability to resist lateral loads, and further research is needed to improve their effectiveness.

Dr. B. H. Shinde& Neha Thakare (2021) had usedETABS software for examination of various structures models. Two Models had a lateral displacement of 65mm in X-Direction. One Model had a Maximum Lateral displacement of 68mm in X-Direction with respect to proportionally increasing number of storeys. Storey Drift and Storey forces in X-direction increases upto level 30 and storey 1-40 respectively.This implies that as the number of storeys increases, the lateral displacement of the structure also increases, and the storey drift and forces in the X-Direction become larger. Therefore, from above research we can conclude that the ETABS software is a useful tool for examining the behavior of different structural models and analyzing their response to lateral loads. The findings suggest that engineers and designers must consider the number of storeys when designing structures to ensure that they can resist lateral loads effectively.

Dr. J. Premalatha & Mr. P. Gokulakannan (2020) has studied the behavior of diagrid structures in tall buildings. The author found that almost all of the lateral load in these structures is resisted by diagrid columns on the perimeter, while the interior columns and fringe standing diagonal columns resist gravity loads. Therefore, the internal columns can be designed for vertical loads, providing greater flexibility in designing the interior space and facade of the building. The author also notes that diagrid structures are particularly useful for complex-shaped tall buildings such as twisted, inclined, and freeform towers. This suggests that diagrid structures can provide innovative solutions for architects and engineers looking to create unique and complex building designs while still maintaining structural integrity and stability. Therefore, from above researchour conclusion is that diagrid structures have several advantages, including their ability to resist lateral loads through perimeter columns and their flexibility in interior design. These features make them a suitable choice for complex-shaped tall buildings,liketwisted,inclined,andfreeformtowers.

Rahul Birla et. al (2020) has concluded that Diagrid is better in resisting thelateral loads and due to this, inner columns get relaxedand carry only gravity loads. Diagridstructure saves about 34% steel without affecting the efficiency of the structure. On the other hand, conventional buildinginnerandoutercolumns botharedesignedforgravityandlateralloads.Theuseof diagridssignificantlydecreasesthemaximumshearforceandmaximumbending momentininternaland perimeter beams.Therefore, fromabove we conclude that the use of Diagrid structures can provide several advantages, including improved resistance to lateral loads, reduced steel usage, and lower costs, without compromising the overall efficiency and stability of the structure.

Rajesh Kumar & Prince Sharma(2019)had utilized ETABS software to model and analyze a structure and determined that the Diagrid structural system is extensively employed in tall buildings, making it easier to design and construct complex structures in contemporary times. The Braced Frame structure, a traditional frame structure that limits lateral movements and story drift but also raises the building's cost, was also evaluated. While both structures met the maximum allowable limits, the Braced Frame had superior results for a luxurious building.From the above research we conclude that both the Diagrid and Braced Frame systems can be effective in meeting structural requirements for tall buildings, but the choice between the two may depend on various factors, such as the building's intended use, cost constraints, and desired level of stability and safety. ETABS software can be a useful tool for analyzing and comparing different structural systems and can help designers and engineers make informed decisions regarding the best structural system for a particular building project.

Sawan Rathore & Prof.Sumit Pahwa (2019) using ETABS 2016 software for modelling and analysis of structure they work on comparative analysis of G+12 & G+18 storeys diagrid structural system building. Diagrid at 2-4 storey alonged with angles of 38° to 58° respectively.The result of the analysis like Displacement the top, Storey shear and Storey Drift are presented. Designing of both the structure are noted, to satisfy the safest designcriteria optimummember inclination is been decided. Therefore, from above we conclude that

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ETABS 2016 software can be used to model and analyze different structural systems, such as diagrids, and compare their effectiveness for different building heights. The results of the analysis can inform the design process and ensure the safest and most efficient structural system is chosen. Additionally, considering the optimum member inclination can further enhance the stability and safety of the structure.

Narsireddy & Vinayak Vijapur (2018)performed, modelled and analyse the wind and seismic load condition from Etabs 2016 software by the Diagrid structure. In this structure, diagrid connecting two floors provides better results in seismic and wind analysis as compared to other models. The main factor that are determined are, axial force conditions, storey drift, bending moment, storey displacement and natural time period.Overall,from above we conclude that the use of the Diagrid structure with diagrids connecting two floors is recommended for buildings in areas with high wind and seismic activity, as it provides better performance and safety during such events.

Divya M. S & B. Saraswathy (2017)had studied Diagrid Structure and Hexagrid Structure and examined both the structure andhadtakenfivemodelsofdiagridstructures with various angles from 30° to 74° at interval of 10° respectively for every model. Similarly, for hexagrid structures, angle between the diagonal member and horizontal member are from 139° to 105° respectively. For both the grid system the storey drift and model time period is significantly lower.The utilization of diagrid is advisable for constructing a cost-effective structure, as the material design is contingent on the quantity of edges. We can conclude that the implementation of both the diagrid and hexagrid systems using ETABS 2016 software can result in highly efficient structures. The use of these structural systems can significantly reduce construction costs while ensuring that the structure can withstand expected loads without significant deformation or failure.

Snehal S. Mali, Roshni John & D. M. Joshi (2017)have found that the use of a diagrid structure can significantly reduce lateral displacement in both X and Y directions compared to a conventional structure, by 45% and 41%, respectively, when utilizing Equivalent static analysis. The adoption of a diagrid structure can effectively control the overall displacement of the structure. Additionally, the author conducted a Wind Analysis which confirmed that the lateral displacement in X and Y directions for the diagrid structure is significantly less by 45% and 41% compared to the conventional structure. Overall, the diagrid structural system has emerged as a superior solution for a lateral load resisting system in terms of reducing lateral displacement.Based on the author research, we can conclude that the use of diagrid structure is highly effective in reducing lateral displacement in both X and Y directions compared to conventional structures. The results of the wind analysis also confirm the superiority of the diagrid structure in reducing lateral displacement. Thus, diagrid structural system could be considered as a better solution for lateral load resisting system.

Dr.Gopisiddappa et. al (2017)had conducted an analysis of a 30-story linear building and various diagrid systems with diagonal angles ranging from 45° to 81°. Using the ETABS software, they modeled and analyzed the structure and compared the results, including storey displacement and inter-storey drift, between the linear and diagrid buildings. The results showed that the framing building without any load-resisting system had the highest drift and displacement values compared to the diagrid system. Additionally, the diagrid system with a diagonal angle of 63° had the least top storey displacement. Within the diagonal angle range of 63° to 75°, the diagrid system exhibited better stiffness, as the storey drift and storey displacement were less in this region.From the results we can suggest that a diagrid system with an appropriate diagonal angle can provide better stiffness and reduce displacement in tall buildings compared to a conventional linear building without a load-resisting system.

Amruta K.Potdar et. al (2017) had presents a comparative analysis and design of a 20-storey diagrid structural system building and a simple frame building with a regular floor plan of 15m x 15m size. The author has created different models with varying diagrid angles using ETABS 15 software to model and analyze the structure, and has presented results such as displacement, storey drift, shear force, and axial force. The findings suggest that the diagrid building has less lateral displacement and drift, as well as reduced axial load on internal columns and interior beam shear force compared to the conventional building. The optimal range of diagrid angle for a 20-storey structure is between 60º to 70º. Diagrid structures are more aesthetically pleasing and provide more flexibility in planning the interior space and facade of the building. However, the torsional rigidity in

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diagrid structure is less compared to conventional, and this factor should be carefully studied. Finally, diagrid structures are also more economical than conventional ones due to requiring fewer members at the interior and exterior of the structure. From above study we can conclude that diagrid structures are more aesthetically pleasing and provide more flexibility in planning the interior space and facade of the building. However, the torsional rigidity in diagrid structure is less compared to conventional, and this factor should be carefully studied. Finally, diagrid structures are also more economical than conventional ones due to requiring fewer members at the interior and exterior of the structure.

Raghunath .D. Deshpandeet.al(2015) had concluded that the diagrid structural system performs better than conventional orthogonal buildings across various performance criteria such as efficiency, expressiveness, and sustainability. The use of diagrid structure results in comparatively less deflection and reduces the overall structural weight, resulting in more resistance to lateral forces. The diagrid system is also cost-effective and eco-friendly. According to the study, the diagrid system uses 28% less steel compared to the conventional orthogonal building, which results in significant cost savings. The article emphasizes the advantages of using diagrid structures in reducing the environmental impact of construction activities. From the above research we concludes that the diagrid structural system is a superior alternative to conventional orthogonal structures in terms of performance, cost, and sustainability. The use of this system can lead to reduced material usage and environmental impact, making it an attractive option for building designers and owners.

III. SUMMARY AND CONCLUSION

The above literature review shows comparison betweendiagrid structure models and conventional frame model. There are variouschanges in diagrid angles, different storeys, shapes etc. Are performed by usingthe ETABS software. From the above studied it is concluded that

- Diagrid System has more stiffness than the conventional system and the top displacement is less in diagrid system.
- Diagrid structures offer a unique combination of strength, efficiency, and aesthetic appeal.
- Diagrid structures are also known for their ability to resist lateral forces, making them suitable for areas prone to earthquakes and high winds Diagrid system is more stable and Diagrid angle changes with respect to height of the model.
- Diagrid provide more resistance in building, making the system more effective.
- The crisscross pattern of the diagonal members creates an interesting and visually striking facade. Overall, the diagrid structure is an innovative and effective solution for modern construction projects.

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