TIJER || ISSN 2349-9249 || © February 2023, Volume 10, Issue 2 || www.tijer.org

LITERATURE REVIEW ON DIAGRID STRUCTURE

[1st] **Kushappa M K**, [2nd]**Sayed Mohammed Aqib**, [3rd]**Mohammed Abrar Aherikar**, [4th]**Shafiullah Sangapur**
[1]Assitant professor, [2]UG student, [3]UG student, [4]UG student
[1]Civil Engineering Department,
[1]Secab Institute of Engineering and Technology, Vijayapur, Karnataka, India

Abstract – The development of high-rise buildings was facilitated by advancements in building technology, materials, structural systems, and design and analysis techniques. The structural design of high-rise structures is based on the lateral forces produced by wind or earthquakes. A structure's lateral loads can be supported by both the interior and exterior structural systems. Materials placed on the edge of the structure resist lateral stresses, although braced tube structural systems resist lateral loads on framed tubes. It is essential that the structural system chosen meets design standards while allowing the structural components to be employed effectively. The diagrid structural system has lately been used in tall constructions due to its structural efficacy and adaptability in architectural planning. The diagrid architecture is formed of inclined columns on the building's façade, as opposed to the closely spaced vertical columns of a framed tube.

Index Terms - Diagrid, Bracings, Linear analysis, Wind Load Analysis.

I. INTRODUCTION

The preference for higher structures has changed over time due to the metropolitan population's fast increase and the limited amount of available land. In light of this, it is crucial to take lateral load into account as a structure's height grows. Because of this, the structural system that withstands gravity loads becomes less significant than the system that withstands lateral stresses. Rigid frames, shear walls, wall frames, he most often used lateral load resisting systems include braced tube systems, outrigger systems, and tubular systems. The diagrid - diagonal grid structural system is increasingly frequently used for tall structures due to its structural efficacy and aesthetic possibilities made available by the system's distinctive geometric design. Therefore, the diagrid has rekindled the interest of architectural and structural designers of tall structures due to its structural efficacy and attractiveness. Current diagrid buildings differ from traditional exterior-braced frame structures in that they nearly entirely do away with traditional vertical columns. Due to their triangulated configuration, the diagonal elements of diagrid structural systems are able to support both gravity loads and lateral forces, unlike the diagonals in traditional braced frame structures, which can only support lateral loads. Because diagonal structures transmit shear through the axial action of the diagonal elements rather than traditional framed tubular structures, which carry shear by the bending of the vertical columns, they are far more successful at minimizing shear deformation. Diagrid structures don't require high shear stiffness cores since the diagrid at the periphery can handle shear.

Diagrid has good appearance and it is easily recognized. A diagrid system's design and effectiveness allow for less structural parts to be used on building facades, which results in less visual hindrance from the outside. The diagrid system's structural effectiveness also aids in eliminating interior and corner columns, providing for a great deal of freedom in the floor layout. Comparing a perimeter "diagrid" construction to a typical moment-frame structure results in a weight reduction of around 20% in structural steel.

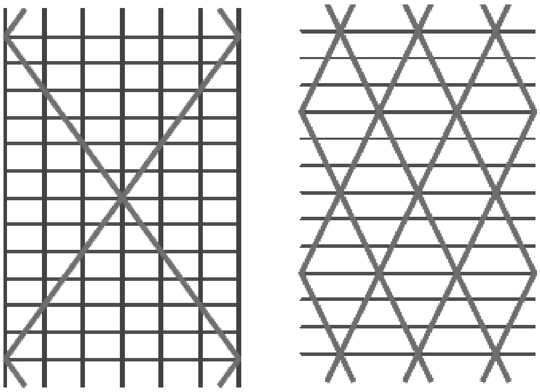


Fig-1: (i) Braced Tube (ii) Diagrid Structure

The Swiss Re in London, Hearst Tower in New York, Cyclone Tower in Asan (Korea), Capital Gate Tower in Abu Dhabi, and Jinling Tower in China are some of the well-known diagrid structures in the globe, as depicted in Fig 1. One example of using a diagrid structural system to sustain a difficult form is the new Central China Television (CCTV) headquarters in Beijing.

Fig. 2 (a) **Fig. 2 (b)** **Fig. 2 (c)** **Fig. 2 (d)**

Fig. 2 (e)

Fig. 2. Diagrid buildings (a) Swiss Re in London (b) Hearst Tower in New York (c) Cyclone Tower in Asan (Korea) (d) Jinling Tower in china. and (e) Capital Gate Tower in Abu Dhabi.

Advantages

- Allows for less steel consumption compared to projects using traditional steel frames, and can span a longer distance.
- Removes the need for internal columns and big corner columns in a structure.
- Greater load distribution effectiveness when a structure is degraded lowering the likelihood of a gradual collapse.
- If the building is well constructed, less room is needed overall.
- Allows for highly intricate and entirely organic structure designs.
- Allows you to convert a standard structure into one with a complicated yet smooth outside layer.
- Despite being light, materials have a higher level of strength.
- In addition to static stresses, diagrid structures should have lateral stiffness for dynamic loads that produce reactions in both the windward and across-wind directions.
- It enables the best possible utilization of available natural illumination.

Limitations

- The diagrid system's intricate architecture may provide difficulties throughout the computation and building phases.
- It is impossible to foresee in advance whether the requirement for member strength or for global stiffness would prevail because of design factors like the diagonal angle and the bending to shear flexibility ratio.
- The maximum height for diagrid made of steel is 100 storeys, whereas the maximum height for diagrid made of concrete is 60 stories.
- Concrete's diagrid structure is quite intricate. As a result, it necessitates a lot of form work, which ultimately drives up the cost of building.
- Due to their complexities, steel members are similarly pre-fabricated, which raises the price of construction
- Strange interior height might be the consequence of inside diagrids.
- The diagrid makes a very powerful design statement, which can occasionally be overwhelming.

II. LITERATURE SURVEY

2.1 Khushbu Jani, Paresh V. Patel (ELSEVIER)[1] studied Analysis and Design of Diagrid Structural System for High Rise Steel Buildings. They considered 36 storeys building with regular floor plan 36m×36m and storied 3.6m. They studied the seismic response of buildings with varying storey level ranging from 50, 60, 70 and 80. They carried out linear dynamic (Response spectrum) analysis along wind and across wind are considered for design of the structure. They have carried out comparison of results in terms of time period, storey displacement and inter storey drift. It is indicated from the results that, as the modes increase time period decreases. It as shown in the Figure 3a. They observed that storey shear, storey displacement, Inter-storey drift in X-direction and Y-direction due to wind load is higher compared to earthquake load as shown in Figure 3b, 3c, 3d. It has been also observed that, 97.68% of lateral load is taken care by Diagrid (exterior frame) and 2.31% of lateral load is handled by internal structure (interior frame). Similarly, 51.62% is taken care by Diagrid (Exterior frame) and 48.38% is handled by internal structure (interior frame). Thus, they conclude that most of the lateral load is taken care by diagrid columns on the periphery, while gravity load is handled by both the internal columns and peripheral diagonal columns as shown in Figure-3e.

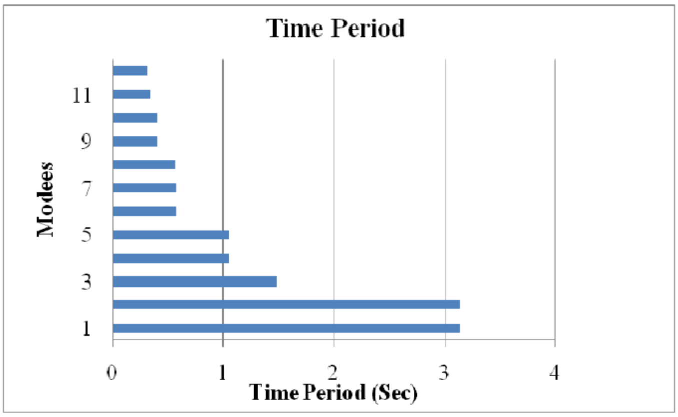


Fig 3 (a) Time Period

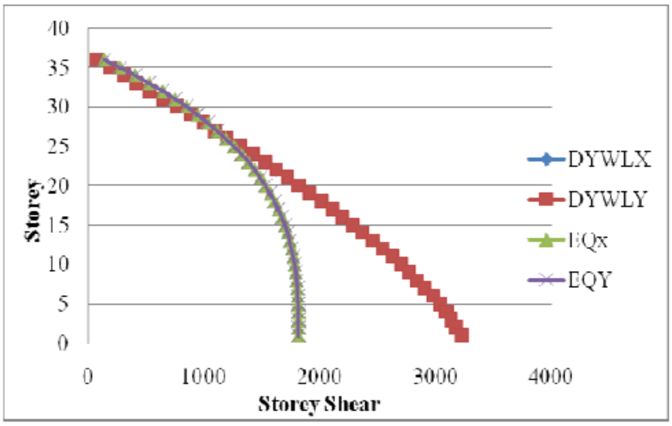


Fig 3 (b) Storey shear

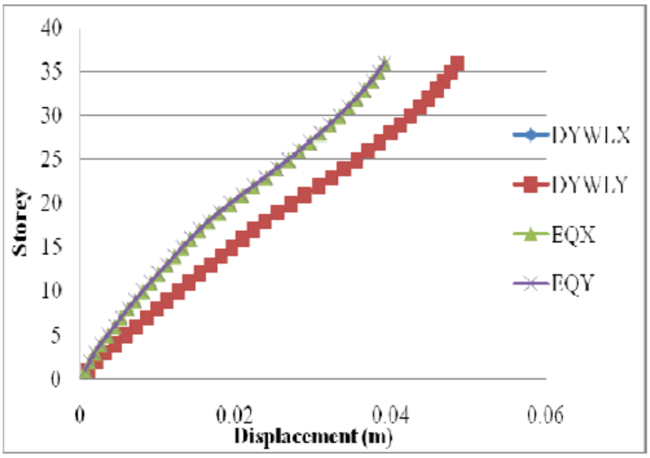


Fig 3 (c) Storey Displacement

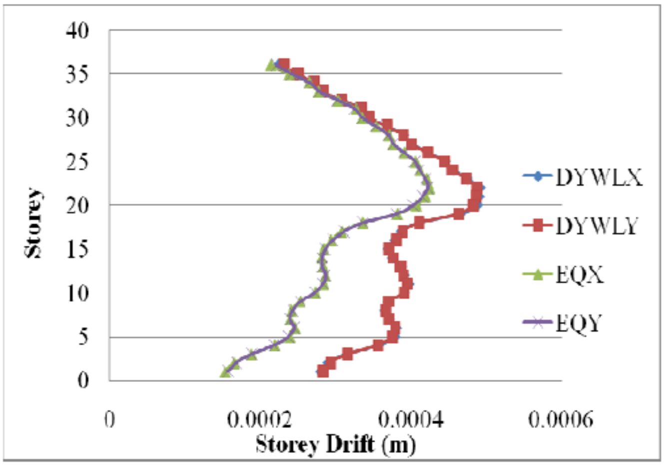


Fig 3 (d) Storey Drift

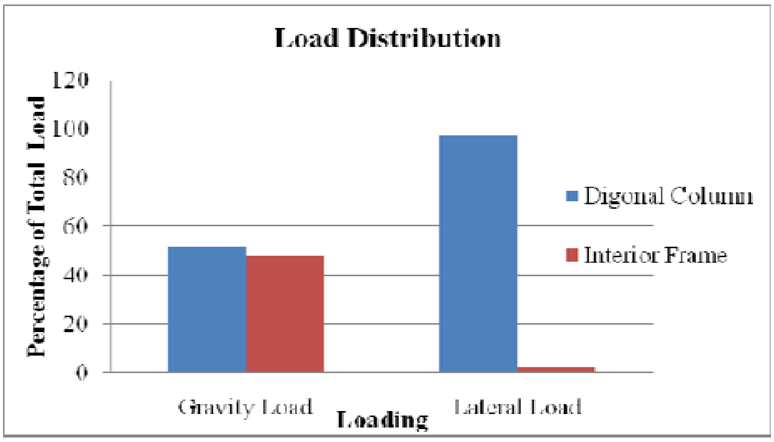


Fig 3 (e) Load Distribution

2.2 Sameeran R. Takle, et.al [2] studied the dynamic analysis of a diagrid structural system in a high-rise RCC building with a range of geometrical configurations. They took into consideration a G+41 storey, multi-story R.C.C. building model that was created utilising the ETABS-2018 programme. Buildings located in zone III are considered while doing a response spectrum study. The ETABS-2018 programme analyses building models to investigate the impact of base shear, time period, base moments, maximum storey displacement, maximum storey drift, etc. They used the ETABS-2018 programme to study a 41-story diagrid structure with 3.6 m floor to floor height using the finite element method (III). The chosen plan has a rectangular form. Both linear static and linear dynamic tests of wind and seismic force were conducted. They have taken into account a number of crucial factors, including time, base shear, storey shear, storey drift, and storey displacement. According to fig. 4b, the G+41 Storey of Rectangular geometry analysis takes 8.89% less time than square geometry analysis. In comparison to and square geometry analysis frames, the earthquake load scenario of Storey shear of plinth level for G+41 Storey of rectangle geometry analysis is 20.87% lower According to fig. 4c, rectangular geometry analysis frames have a base shear earthquake load scenario that is 14.16% higher than square geometry analysis frames for G+41 Storey in the X-direction. As demonstrated in fig. 4d, the maximum storey drift for the G+41 Storey of rectangular geometry analysis is 10%–30% smaller than that for square geometry analysis frames. Rectangular geometry analysis frames for the G+41 Storey earthquake load example have a 15%–25% lower maximum displacement in mm than square geometry analysis frames, as illustrated in fig. 4e.

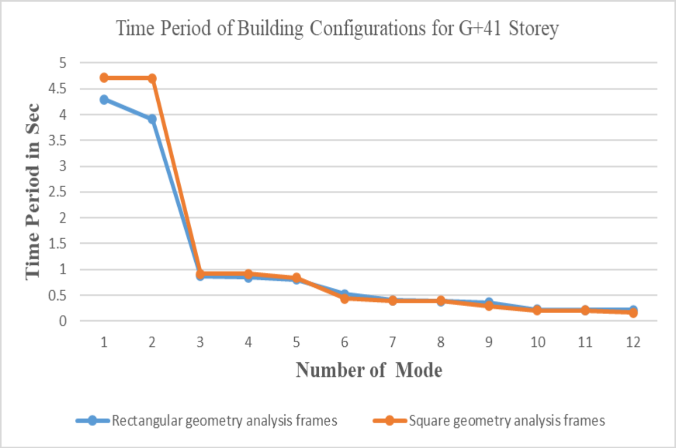


Fig 4 (a) Time period

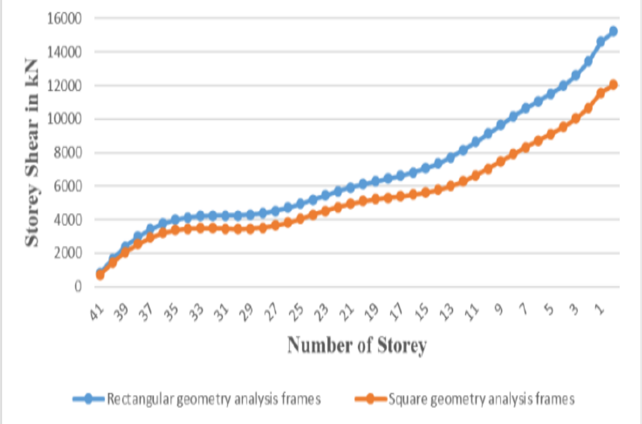


Fig 4 (b) Storey shear

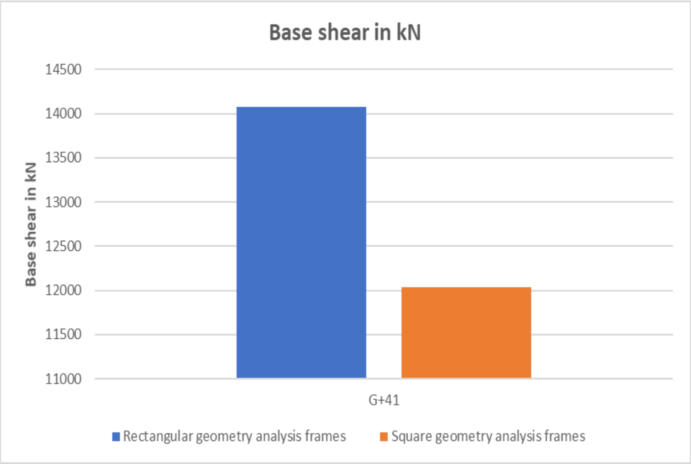


Fig 4 (c) Base Shear

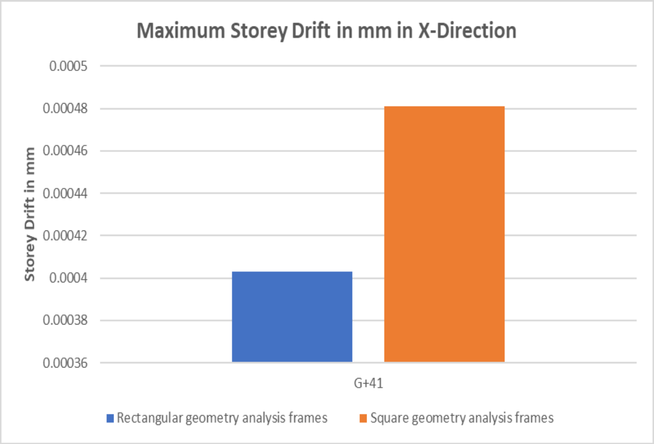


Fig 4 (d) Maximum Storey Drift

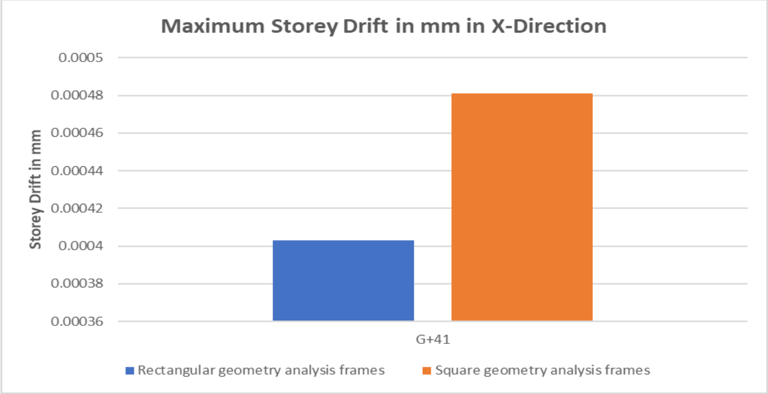
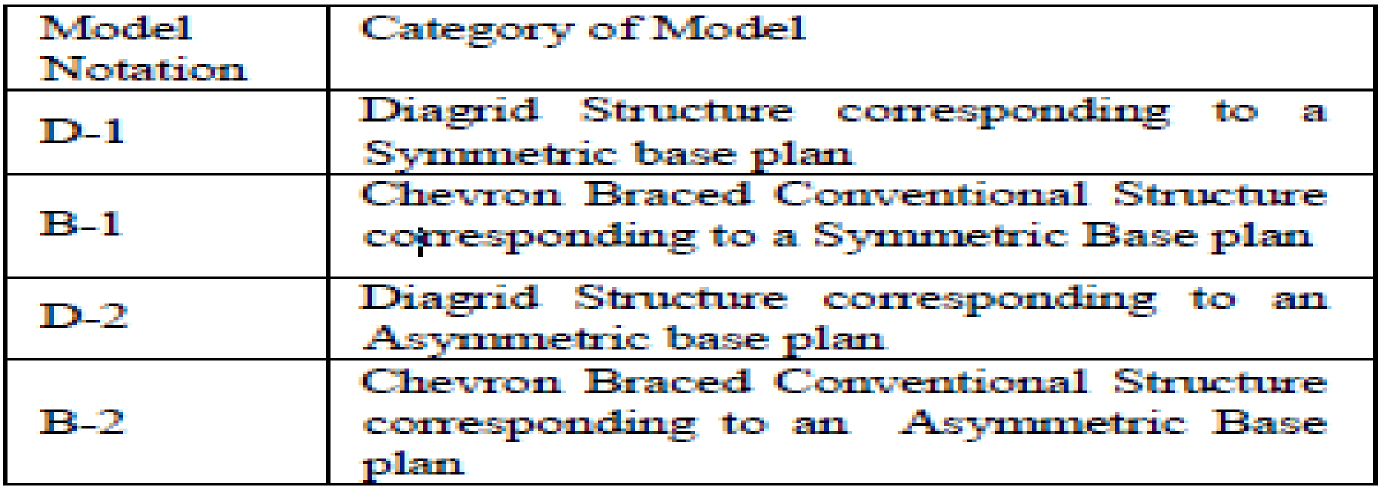


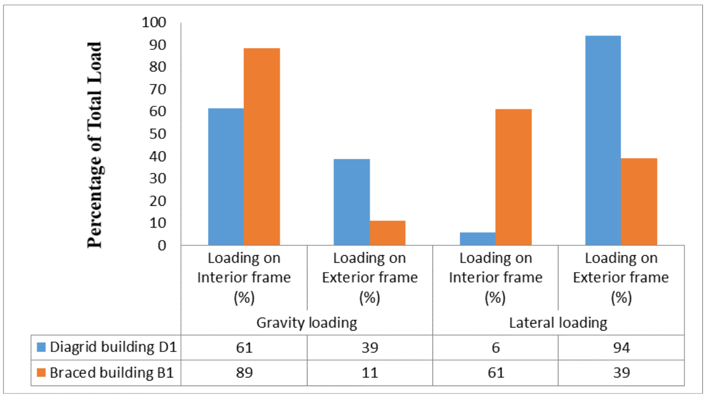
Fig 4 (e) Maximum Displacement in mm

2.3 Mohammed Abdul Rafey, M.A. Azeem [3] Studied Comparative Analysis of a Diagrid Structure and a Conventional Structure with Chevron Bracing. The authors have looked at models of both traditional braced frame structures and diagrid structures with various symmetric and asymmetric plan geometries. Two symmetrical and two asymmetrical structures were modelled for study. They used the linear static approach for their analysis. They have taken up a plan dimension of 24m×24m with 16 storey plan with each storey height of 3.6m. Two structural models were taken into account for their study which are diagrid model (symmetric and asymmetric) and conventional model with chevron bracing (symmetric and asymmetric). Results in terms of load distribution, storey shear, base shear, storey displacement, and storey drift have been carried out. The model D1 bears 94% of the lateral load on the external frame with no exterior columns, compared to 39% for the model B1 with all exterior vertical columns present, and 6% and 61%, respectively, for the inner frames of the two models. According to the figure, model D1's exterior and internal frames take on 39% and 61% of the gravity loads, respectively, whereas model B1's are 11% and 89%. According to figs. 5a and 5b, the storey shear in the models D-1 and D-2 is significantly lower than that in the models B-1 and B-2. Figures 5e and 5f demonstrate that the top storey displacements in the models D-1 and D-2 are lower than those in the models B-1 and B-2. According to figures 5g and 5h, the top storey drift values for models D-1 and D-2 are higher than those for B-1 and B-2. According to figs. 5c and 5d, the base shear in the models D-1 and D-2 is significantly lower than that in the models B-1 and B-2.

Table1: Categorization of the models used in the study

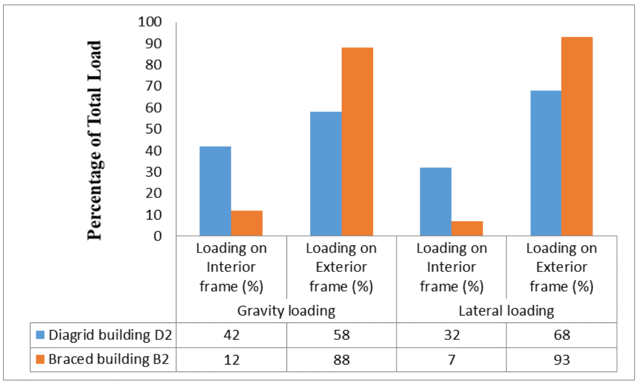


Model Notation	Category of Model
D-1	Diagrid Structure corresponding to a Symmetric base plan
B-1	Chevron Braced Conventional Structure corresponding to a Symmetric Base plan
D-2	Diagrid Structure corresponding to an Asymmetric base plan
B-2	Chevron Braced Conventional Structure corresponding to an Asymmetric Base plan



	Loading on Interior frame (%)	Loading on Exterior frame (%)	Loading on Interior frame (%)	Loading on Exterior frame (%)
	Gravity loading		Lateral loading	
■ Diagrid building D1	61	39	6	94
■ Braced building B1	89	11	61	39

Fig 5 (a): percentage of the models D2 and B2's external frames that support weight



	Loading on Interior frame (%)	Loading on Exterior frame (%)	Loading on Interior frame (%)	Loading on Exterior frame (%)
	Gravity loading		Lateral loading	
■ Diagrid building D2	42	58	32	68
■ Braced building B2	12	88	7	93

Fig 5 (b): percentage of the models D1 and B1's exterior and frames that carried the weight

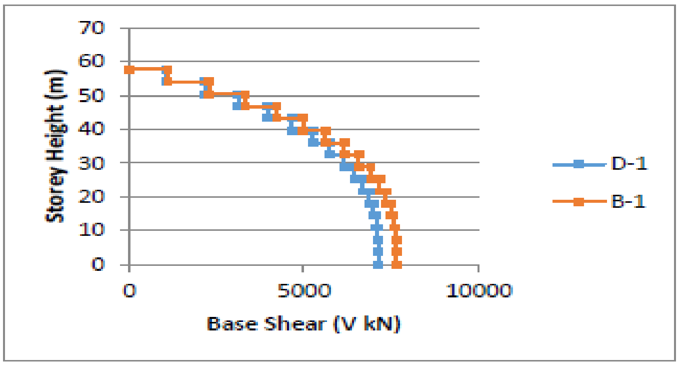


Fig 5 (c): D1 and B1 model base shear

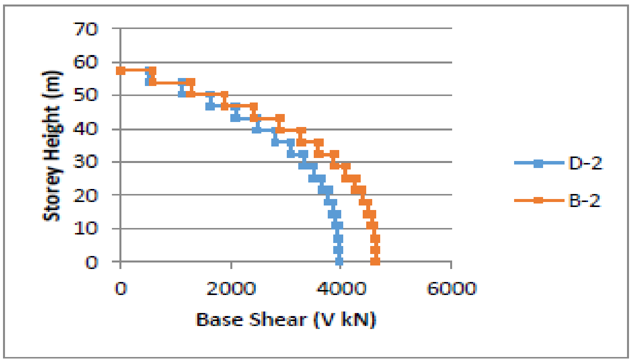


Fig 5 (d): Base shear of model D2 and B2

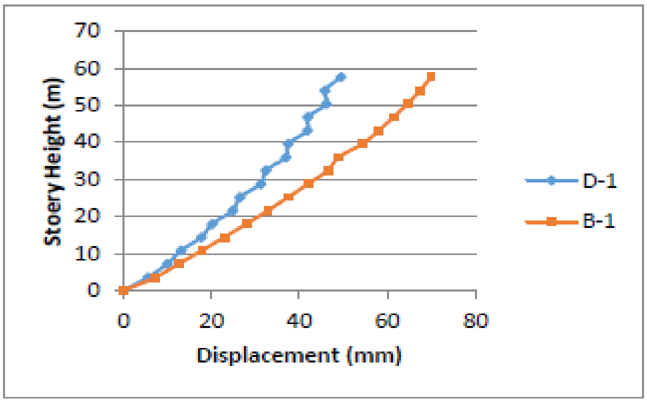


Fig 5 (e): Displacement of model D1 and B1

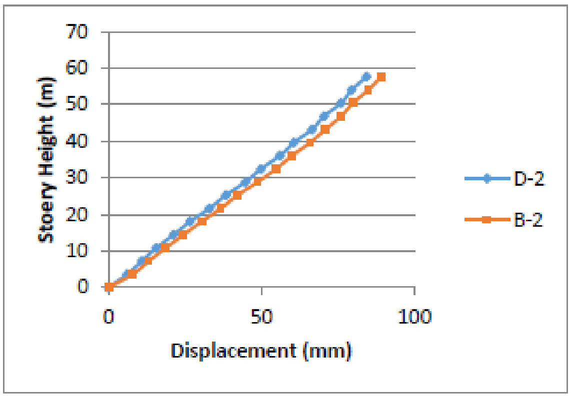


Fig 5 (f): Displacement of model D2 and B2

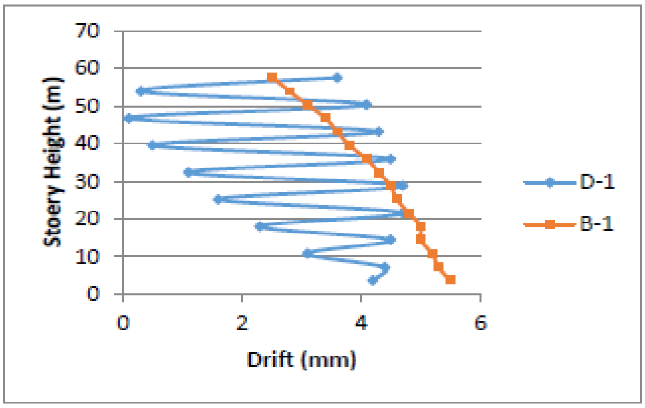


Fig 5 (g): Storey Drift of model D-1 and B-1

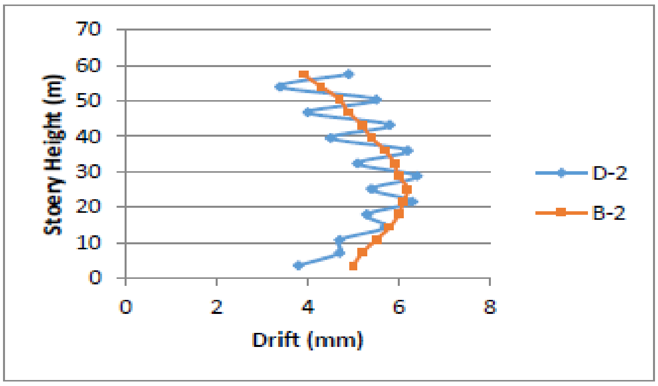
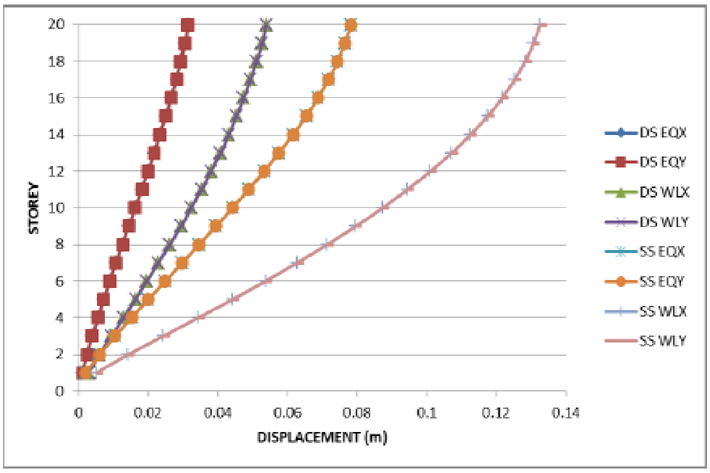


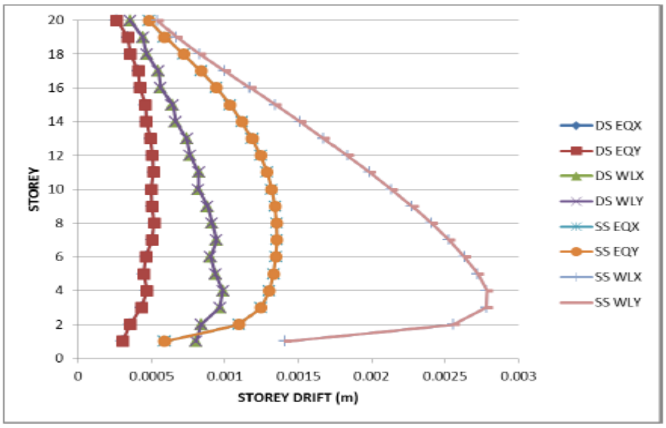
Fig 5 (h): Storey Drift of model D-2 and B-2

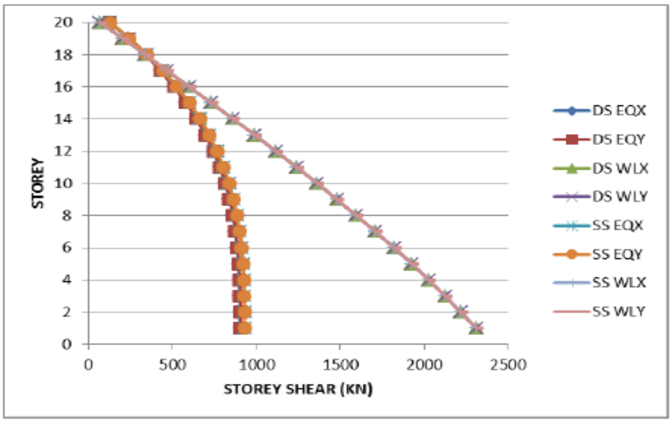
2.4 Nishith B. Panchal1, Vinubhai R. Patel [4] In this paper, the comparison study of 20-storey simple frame building and diagrid structural system building with a simple floor plan of 18m x 18m size is considered. The study is provided using the ETABS 9.7.4 programmed for a 20-story structure with a floor height of 3.6 meters. Here, they compare the analysis of their results on top storey displacement, storey drift, and steel and concrete usage. From the results and discussions authors had been observed that displacement in simple frame is higher compared to the diagrid frame building as shown in Fig-6a. The inter storey drift of diagrid structure and simple frame structure building is It is observed that inter storey drift in simple frame building is higher compared to the diagrid frame building, as shown in Fig-6b. The distribution of storey shear along diagrid buildings with 20 stories and basic frame buildings with the same height It has been found that basic frame buildings exhibit higher story shear than diagrid frame buildings as shown in Fig-6c. From this author had been concluded that, because diagonal columns resist lateral stresses, diagrid structures have significantly lower top story displacement than basic frame structures. Additionally, it has been found that diagrid structural systems have extremely little storey drift and shear. Diagrid increases building resistance, enhancing system performance. The authors came to the additional conclusion that, when compared to a basic frame construction, the diagrid structure system is more economical in terms of the use of steel and concrete. Diagrid structural technology offers additional freedom in developing the building's inner area and façade.

Table-2 Displacement Results

	CASE	DIAGRID STRUCTURE	SIMPLE FRAME BUILDING	PERMISSIBLE VALUES
TOP STOREY DISPLACEMENT	EQX/EQY	31.5 mm	78.3mm	144mm
	WLX/WLY	53.9mm	132.3mm	144mm
STOREY DRIFT	EQX/EQY	0.264mm	0.483mm	14.4mm
	WLX/WLY	0.353mm	0.542mm	14.4mm







2.5 Saket Yadav, Dr. Vivek [5] In this study, the structural response of conventional and diagrid building is investigated to evaluate the structural benefits of diagrid system. STAAD Pro is used to assess and design a typical G+15 story steel building with a plan dimension of 18 m x 18 m that is situated in seismic zone V. The exterior diagonal elements of a diagrid structure absorb the majority of the lateral load, which releases stresses from other structural parts. The maximum shear force and bending moment in internal and perimeter beams are greatly reduced by using diagrids. In diagrid buildings, the interior column's bending moment also lowers. As a result, the diagrid building's sectional demand for beams and columns is reduced. Compared to traditional architecture, diagrid building achieves an overall economy of around 12%. The main distinction between a braced tube building and a diagrid building is the presence of vertical columns in the perimeter of the braced tube structure as opposed to the absence of vertical columns in the diagrid building. The diagonal members of diagrid constructions carry gravity loads as well as lateral forces and operate as both inclined columns and bracing components. Because of their triangulated configuration, the members' major internal axial forces are reduced, which reduces the impacts of shear racking. The axial force of every column has risen due to the introduction of diagrid. The maximum and minimum axial forces in conventional buildings were determined to be 7374.05 kN and 69.09 kN, respectively, while they were determined to be 9617.89 kN and 113.48 kN, respectively, in diagrid buildings The maximum bending moment in columns in conventional buildings was 765.89 kN-m, but it was lowered to 408.22 kN-m in diagrid structures, as illustrated in fig. 7a. As a result, fewer sections of columns were needed. Diagrid has successfully decreased the beam's shear force. According to research, the conventional building's beam's maximum shear force was 212.59 kN, but the diagrid building's beam's maximum shear force was 177.07 kN, as illustrated in fig. 7b. In terms of construction weight, diagrid buildings weigh 17% less per beam and roughly 6% less per column when compared to conventional buildings. In general, the diagrid has a weight advantage of about 12%.

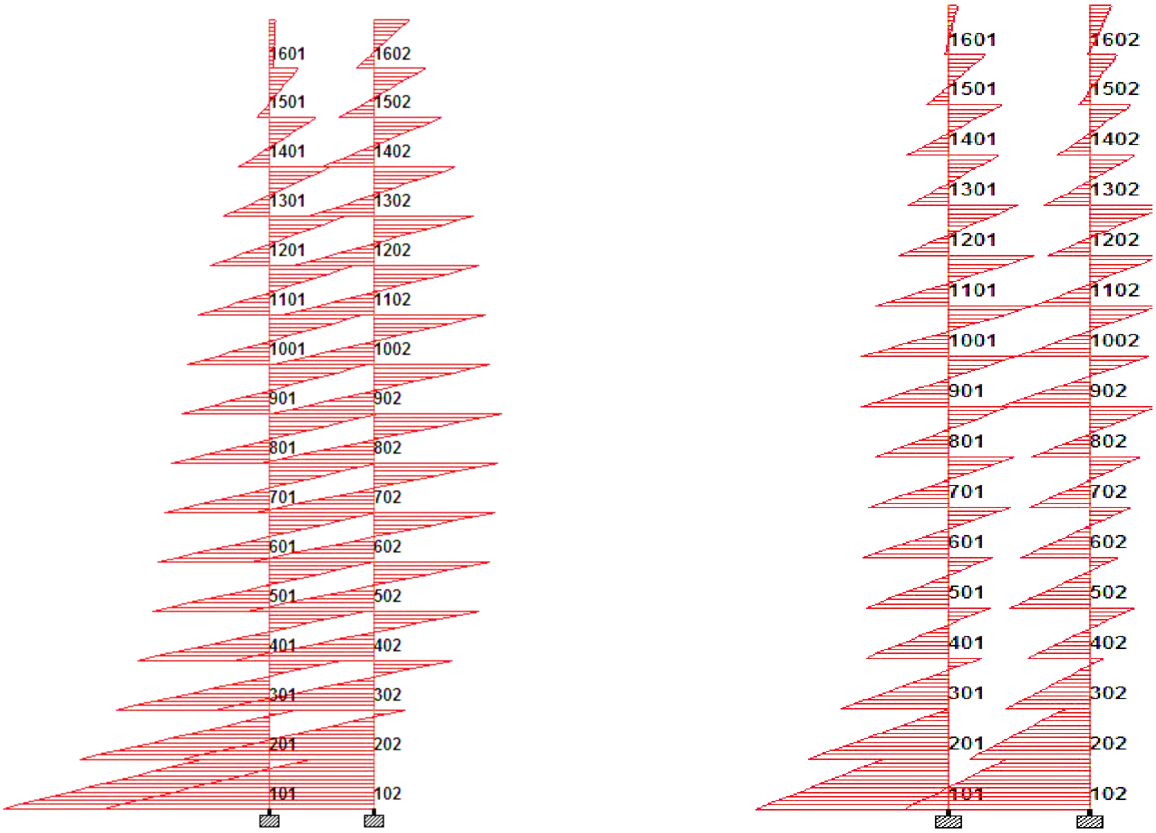


Fig 7(a): Bending moment diagram of interior column for conventional and Diagrid buildings

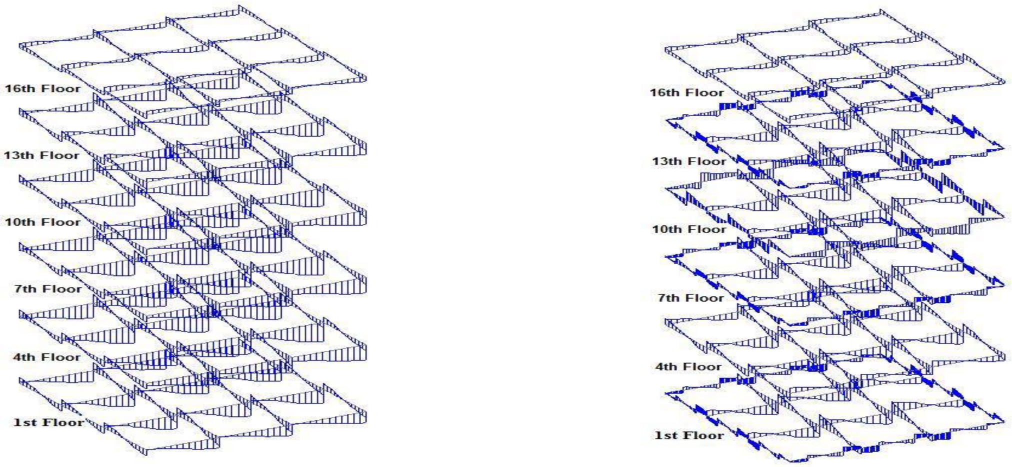


Fig 7(b): Shear force diagram of beams for conventional and diagrid building.

2.6 Chittaranjan Nayak, Snehal walke, and Suraj Kokare (VPKBIET) [6] This study comprises the necessary information, a model, an earthquake and wind analysis, and diagrid structures with circular, square, and rectangular plans. Then, with the same plan area and structural data for circular, square, and rectangular plans, earthquake and wind analysis results of both braced tube and diagrid structures are performed, and conclusions about the current investigation are drawn by comparing the braced tube structures results and diagrid structures results As per IS 800:2007, IS-1893:2002 (Part I), IS 875:1987 (Part I), IS 875:1987 (Part II), and IS 875:1987 (Part III), results were derived based on the examination of both Braced Tube and Diagrid Structures with Circular, Square, and Rectangular Plans. This approach compares the results of Braced Tube and Diagrid Structure earthquake and wind analyses. According to this study's findings, diagrid structures have baser shear than braced tube structures and less storey displacement and storey drift than braced tube structures in earthquake analysis (Fig. 8a, 8b, and 8cAccording to the results of the wind study, the diagrid construction has less storey displacement and storey drift than the braced tube structure (Fig. 8d,8e). We may infer that square plan performs better than circular and rectangular plan in diagrid construction from the findings of earthquake and wind study of storey drift, storey displacement, and base shear. In comparison to a braced tube construction, the diagrid structure has the least storey displacement and storey drift values and the greatest base shear values, hence we can claim that it performs better.

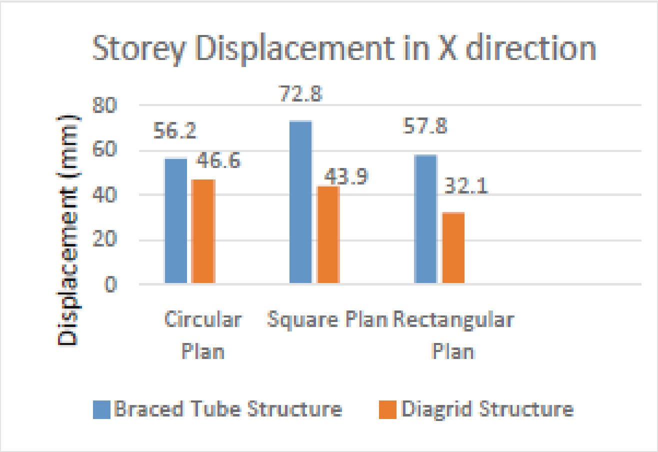


Fig 8 (a): Storey displacement

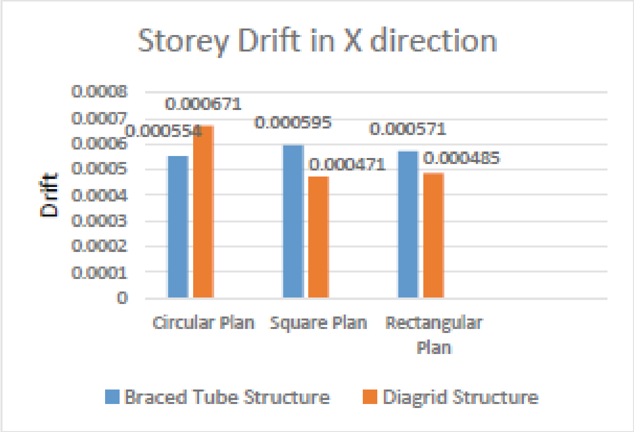


Fig 8 (b): Storey drift

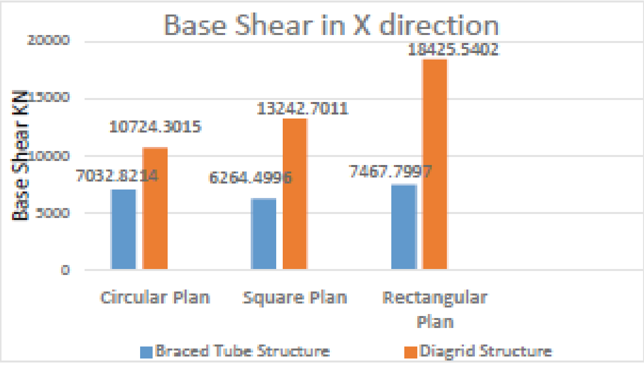


Fig 8 (c): Base Shear

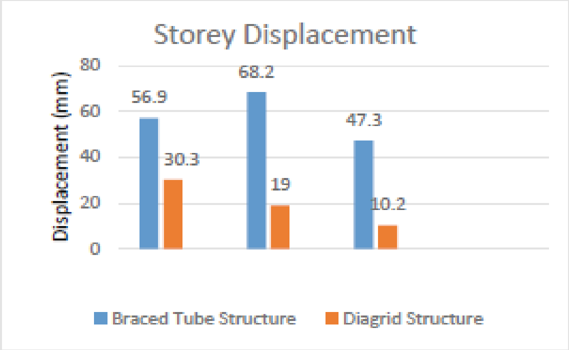


Fig 8 (d): Storey displacement

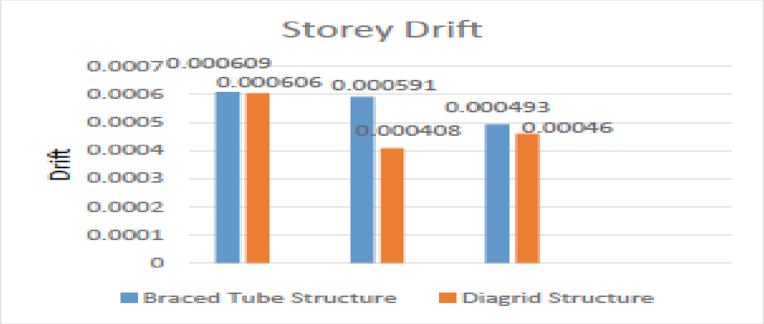


Fig 8 (e): Storey drifts

2.7 K. Moon [7] In order to determine the preliminary member sizes of steel diagrid structures for tall buildings, this research proposes a stiffness-based design process. To establish the ideal grid configuration of the diagrid structure within a specific height range, the approach is applied to diagrids of different heights and grid geometries. Due to the structural effectiveness and aesthetic possibilities offered by the system's distinctive geometric arrangement, the diagrid structural system has been utilized extensively for modern tall structures but diagrid nodes are more complex than those of traditional orthogonal structures, constructability is a significant problem for diagrid structures. Additionally, this study offers several methods for enhancing the constructability of diagrids by prefabricating the nodes fig 9a. Since it is assumed that the diagonal members are pin-ended, they are able to withstand the transverse shear and moment by axial action. The design issue is hence reduced, using this idealization, to finding out the usual cross-sectional areas of web and flange members for each module. Equations (1) and (2) may be used to calculate the member sizes for the modules in accordance with the design approach proposed by Moon et al. (2007) and adapted for each design instance. In this design studies A pair of diagrid buildings, 60 and 80 storeys high, with height-to-width aspect ratios ranging from 4.3 to 8.7, are designed using the stiffness-based approach. In order to find the ideal grid geometry of the structure within a specific height range, the diagonal structure of each story height is created using diagonals of various uniform angles as well as diagonals of gradually increasing angles across the building height as shown in Table 3. Compared to typical orthogonal buildings, which are often covered in rectangular-shaped curtain wall units, diagrid structures are covered in curtain wall units that are triangular, diamond-shaped, or parallelogram-shaped fig 9b. Additionally, it is crucial to remember that wind loads are first applied on building facades before being transferred to the structures. For improved constructability, performance, and aesthetic expression, non-orthogonal curtain wall units for diagrid buildings need careful design and construction procedures.

Fig 9 (a): Prefabricated Nodes

Fig 9 (b): Facade construction of the 30 St. Mary Axe

$$A_{d,w} = \frac{VL_d}{2N_{d,w}E_d h\gamma \cos^2\theta}$$

$$A_{d,f} = \frac{2ML_d}{(N_{d,f}+\delta)B^2 E_d \chi h \sin^2\theta}$$

$A_{d,w}$: Area of Each Diagonal on the Web
$A_{d,f}$: Area of Each Diagonal on the Flange
V: Shear Force
M: Moment
L_d: Length of Diagonal
E_d: Modulus of Elasticity of Steel
θ: Angle of Diagonal Member
γ : Transverse Shear Strain
χ : Curvature
$N_{d,w}$: Number of Diagonals on Each Web Plane
$N_{d,f}$: Number of Diagonals on Each Flange Plane
δ: Contribution of Web Diagonals for Bending Rigidity
B: Building Width in the Direction of Applied Force

Equations (1) and (2) may be used to calculate the member sizes for the modules in accordance with the design approach proposed by Moon et al. (2007)

Table 3: Structural efficiency comparison between the uniform and varying angle diagrids of various heights

Diagrid Height	Height/Width	Angles Configuration	Steel Mass (Ton)
60 Stories	6.5	Uniform Angle (69 degrees)	3820
		Varying Angles (73, 69 & 63 degrees)	4104
80 Stories	8.7	Uniform Angle (69 degrees)	15611
		Varying Angles (73, 69 & 63 degrees)	11574

2.8 KYOUNG SUN MOONa (ELSEVIER)[8] The structural performance of diagrid systems used for complex-shaped tall structures, such as twisted, slanted, and freeform towers, is examined in this research**.** Probabilistic structural models are utilized in this work to examine the effects of changing significant geometric configurations of complex-shaped tall structures, such as the rate of twisting and angle of tilting. Design issues for the effective usage of diagrid structures for complex-shaped tall buildings are examined in light of the study's findings. For twisted diagrid, Figure 10a illustrates four different cases studied. The building's lateral stiffness diminishes as the rate of twisting rises, which causes an increase in deflection. These phenomena, which is closely connected to the change in the diagrid angle brought on by twisting the tower, is illustrated in Figure 10b with a summary of the highest deflection at the top of each tower. The first straight tower design has the ideal diagrid angle set at roughly 70 degrees. Hence twisted tower generally performs better than a straight one. The tilted diagrid is significantly deformed laterally by dead and live loads due to their eccentricity as shown in figure 10c. Despite the size of the dead and live load caused deformations, they may be altered throughout the building process with proper planning. Therefore, diagrid structures may be a viable alternative for slanted towers if other non-structural design criteria can be satisfactorily addressed by them. In freeform structure due to its intricate geometry, precisely defining and building any freeform structure is a highly difficult operation. A freeform skyscraper is extremely susceptible to distortion if its geometry is specified by polygons other than triangles. Any freeform skyscraper may be specified more precisely and without distortion using the triangular structural geometric units that are naturally defined by diagrid structural systems as shown in the figure 10d.

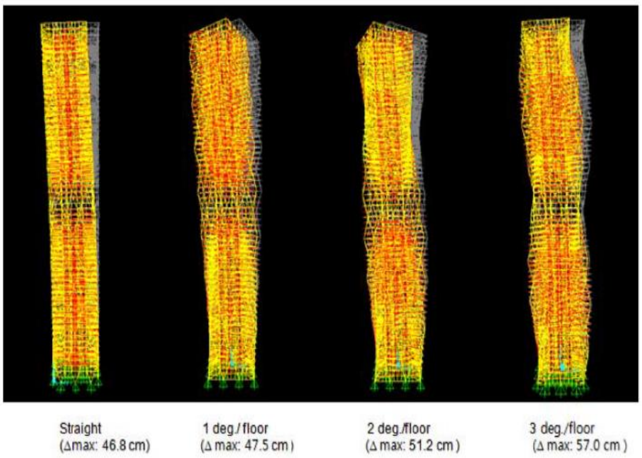


Fig 10(a) : diagrid structures of various twisted rates.

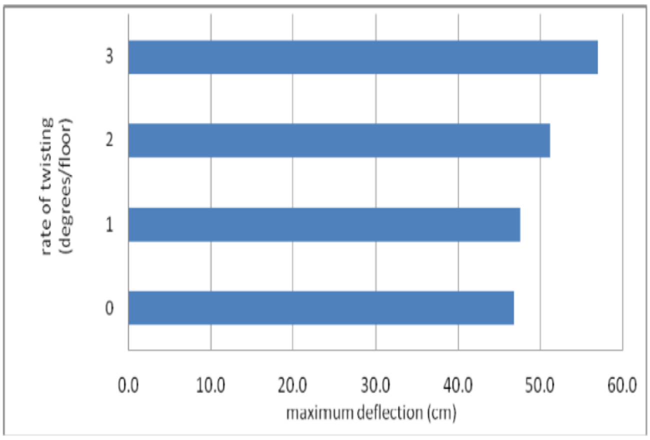


Fig 10(b): Maximum deflection comparison between the towers

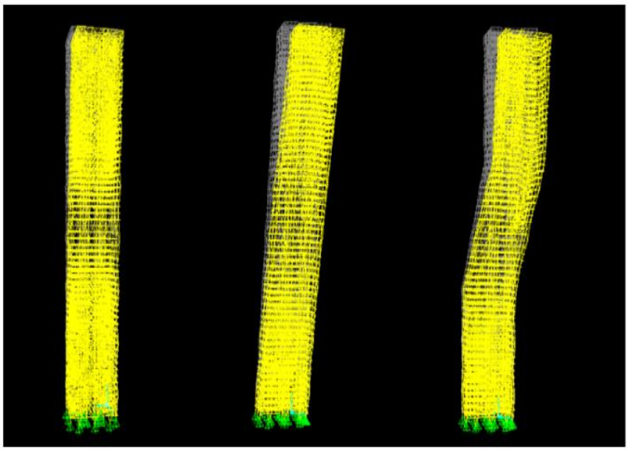


Fig 10(c): tilted diagrid structures of different configurations

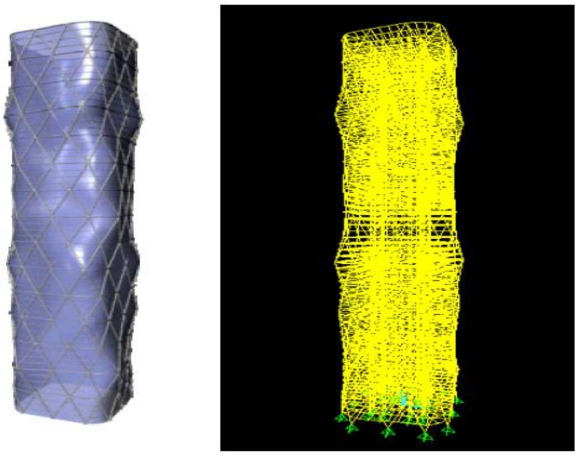


Fig 10(d): 3D rendering (left) and structural analysis model (right)

2.9 Shylaja N, Ashwini R M and Babu E R [9] The current study examines diagrid structures on sloping terrain, compares them to the traditional approach, and determines the ideal diagrid angle on various terrain slopes**.** When comparing diagrid with conventional structures on sloping land, a 12-story building is employed, and the best angle for diagrid on sloping land is found using ETABS software using a 48-story skyscraper. is used for analysis and modelling. The best diagrid angle is between 60° and 75°, and the research using the response spectrum technique shows that diagrid structures are more successful than traditional construction on sloping terrain. As the mass and stiffness change along the height and width of the building, designing a structure on level ground and sloping ground requires entirely distinct approaches. Consequently, any high-rise building on an inclined surface or even one that is flat requires a unique structural system. For study, a 12-story building with a plan dimension of 24 m×24 m and a conventional frame building on a sloping ground are both taken into consideration. Fig. 10 displays the elevation and plan. (a) to (d). The construction has a 3.5m storey height. Design dead and live loads for the floor slab are 3 kN/m2 and 1.5 kN/m2, respectively. The design of all structural components follows IS 800:2007. Using ETABS software, diagrid structure modelling, design, and analysis are performed. The two models' seismic performance is contrasted in terms of displacement of the storey, drift, stiffness, time period, and overall building weight. models were analyzed by varying diagrid angles. When built on sloped terrain, a diagrid structure demonstrated less lateral displacement and storey drift than a conventional structure. When compared to typical buildings, diagrid has higher base shear and storey stiffness. Compared to typical buildings, diagrid structures have substantially lower seismic weights. Despite being lightweight, the materials used to make diagrid have a high level of strength. The results are, for models with a diagrid angle of 60.94°, the storey displacement and storey drift are reduced on terrain with a 15° slope. Additionally, for models with a diagrid angle of 69.67°, the storey displacement and storey drift are fewer for ground slopes of 25°. For models with diagrid angles of 60.94°, storey stiffness and base shear are considerable in terrain with a 15° slope. Additionally, for 60.94° (angle of diagrid) models, the storey stiffness and base shear are high in ground with a 25° slope. We can deduce that the ideal diagrid angle for a slope of 15 degrees is 60.94 degrees, and for a slope of 25 degrees, the ideal diagrid angle is 69.67 degrees fig

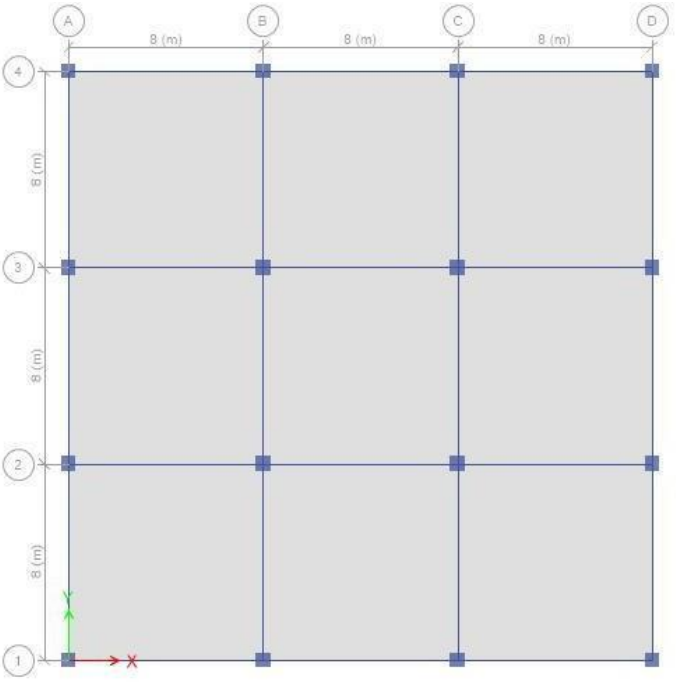


Fig 11 (a): Conventional Building floor

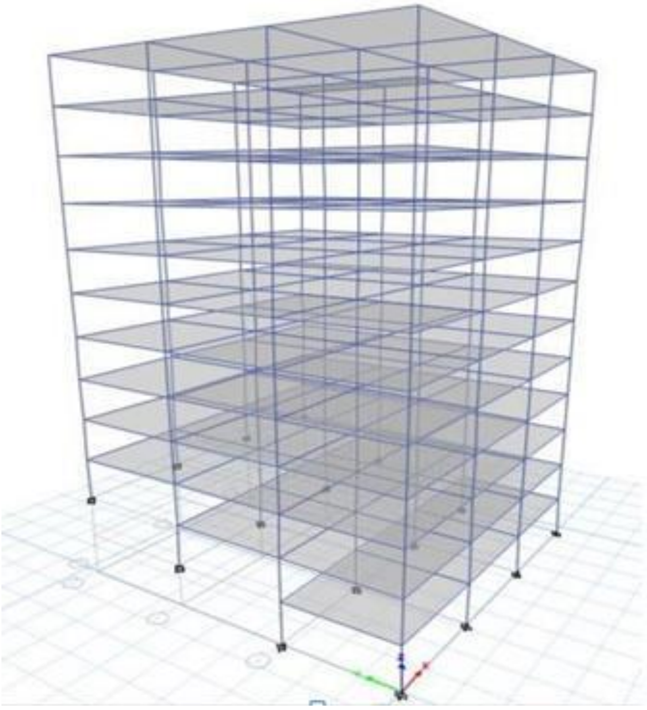


Fig 11 (b): 3D View of conventional building

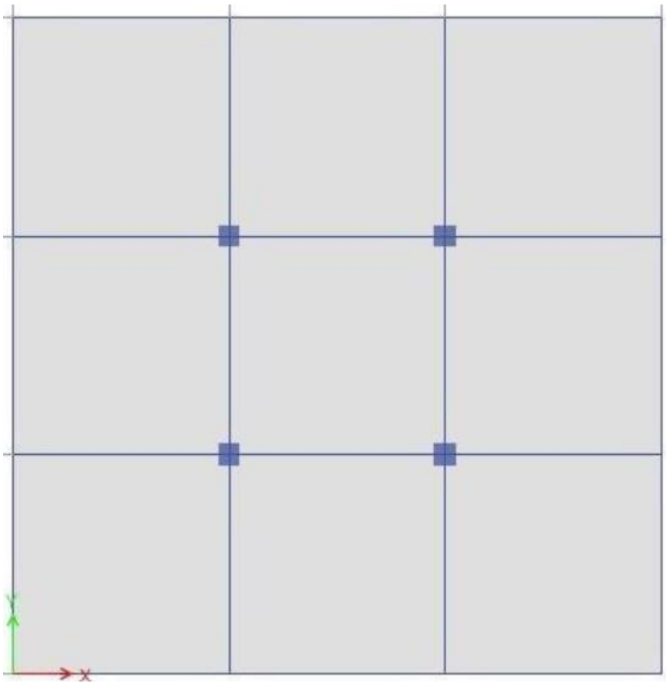


Fig 11 (c): Diagrid Building floor

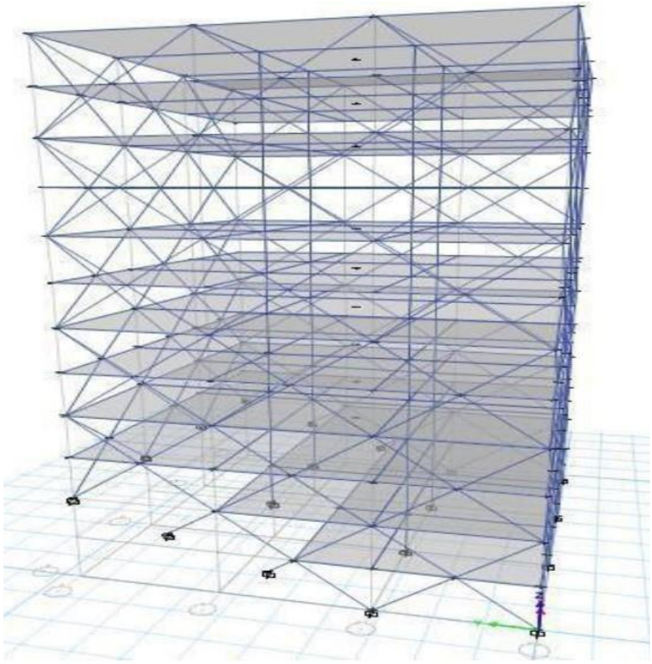


Fig 11 (d): 3D View of Diagrid building at slope

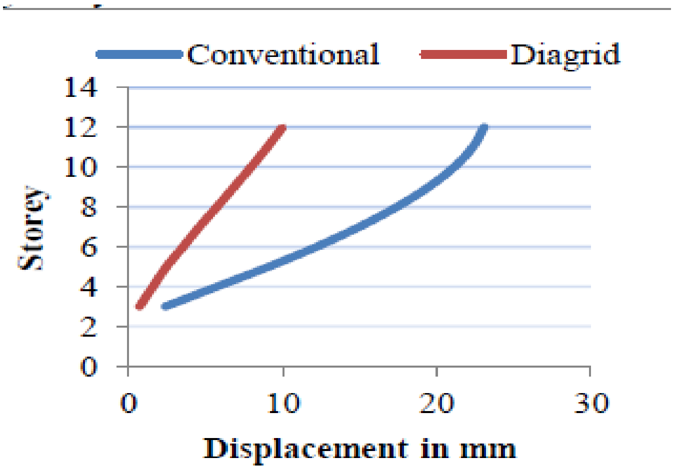


Fig 11 (e) Storey Displacement of Conventional and Diagrid Building on slope.

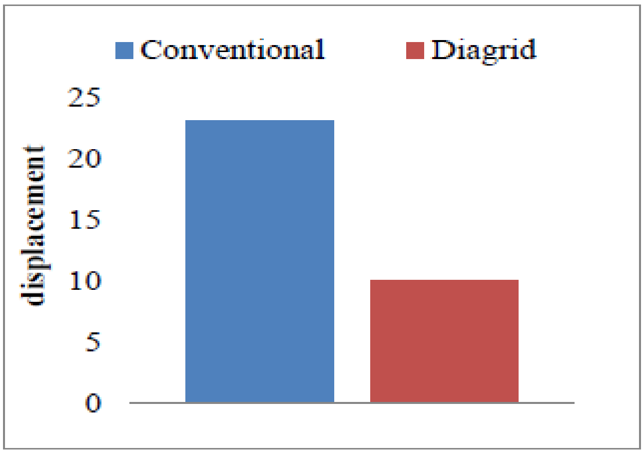
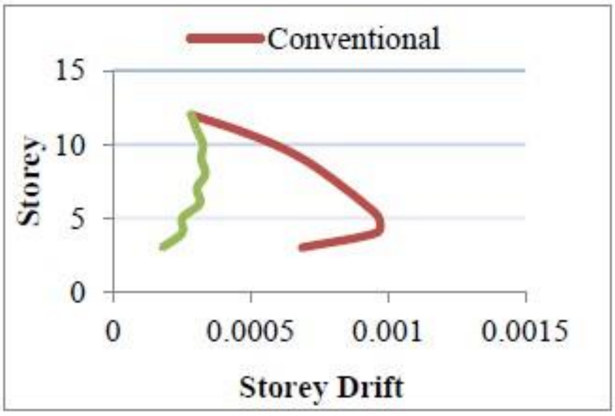


Fig 11 (f) Max Storey Displacement of Conventional and Diagrid Building on slope.



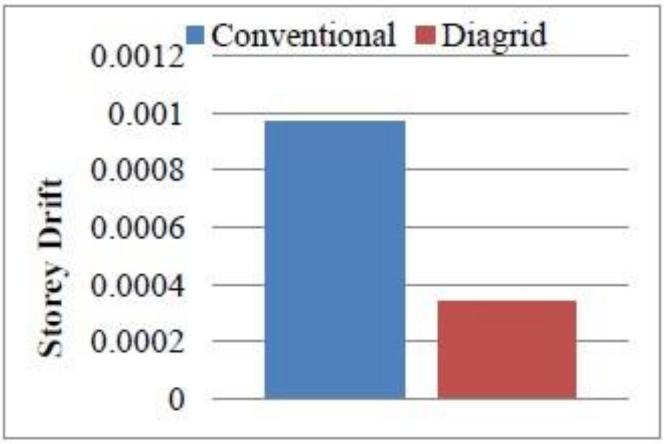


Fig 11 (g) Storey Drift for Conventional Building and Diagrid Building on slope

Fig 11 (h) Max Storey Drift for Conventional Building and Diagrid Building on slope

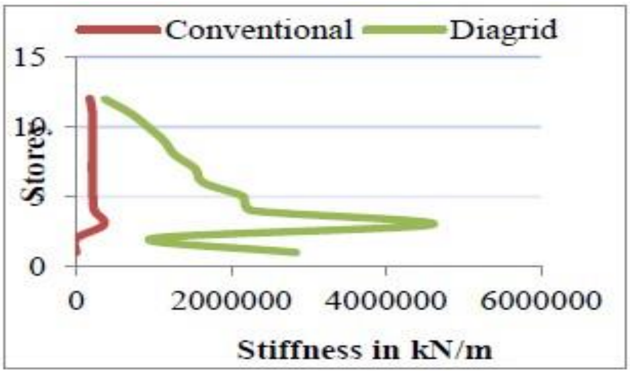


Fig 11 (i) Storey Stiffness for Conventional Building and Diagrid Building on slope

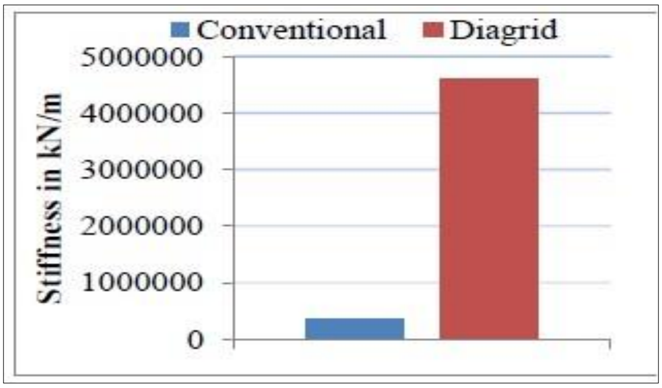


Fig 11 (j) Max Storey Stiffness for Conventional Building and Diagrid Building on slope

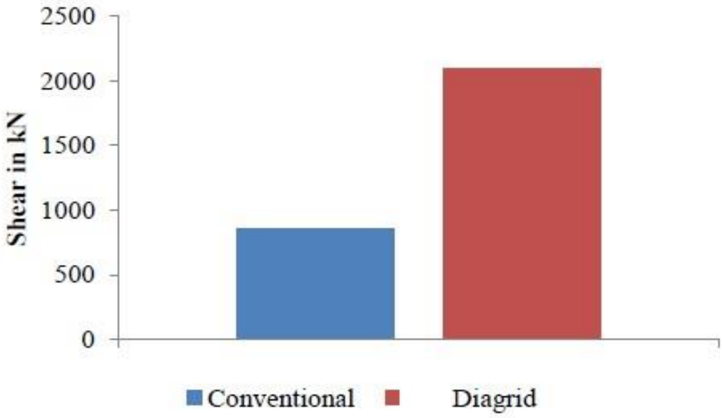


Fig 11 (k) Variation of Shear force

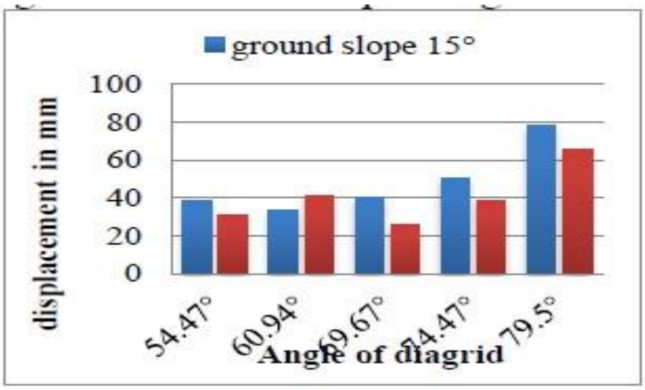


Fig 11 (L) Storey Displacement for Diagrid building on 15° and 25° slopes respectively in X-direction

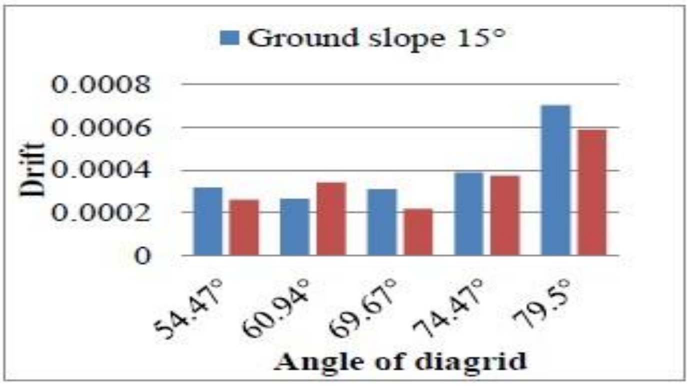


Fig 11 (m) Storey drift for Diagrid building on 15° and 25° slopes respectively in X-direction

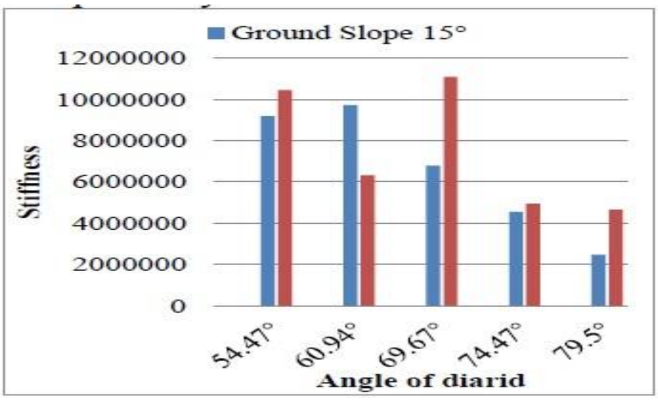


Fig 11 (n) Storey Stiffness for Diagrid building on 15° and 25° slopes respectively in X-direction

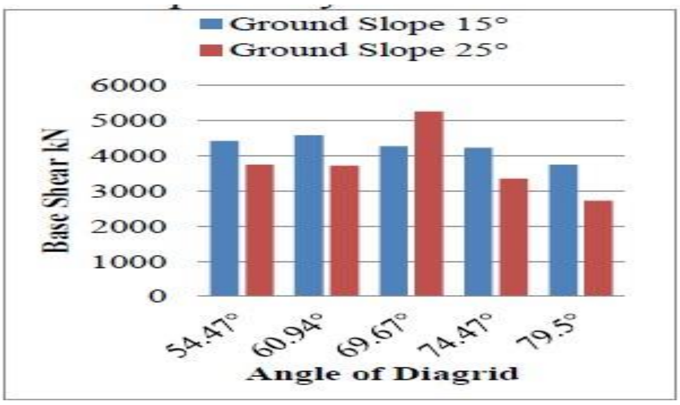


Fig 11 (o) Storey Base Shear for Diagrid building on 15° and 25° slopes respectively in X-direction

2.10 Raghunath.D. Deshpande (IRJET)[10] A 60-story diagrid steel building's analysis and design are given. A standard floor layout measuring 24 m 24 m is taken into account. The modelling and analysis of structural members are done using ETABS software. According to IS 800:2007, all structural components are created taking into account all load combinations. dynamic across and along the wind. For the structure's study and design, wind is taken into account. Later, the two types of structural systems—conventional and diagrid—are compared. The methodology studied in this paper are dead load and Live load are both a part of gravity. Across all of the structural systems taken into consideration, the live load on the floor will stay constant. To determine the lateral load, dynamic analysis for wind force estimates shall be done in accordance with IS 875 (Part 3). Geometrical requirements the most cost-effective part of the members is obtained based on the analysis and design from ETABS software. Parameters which are considered here are load combinations. In the calculations of design wind forces are Wind Data, Design Factors, Design Wind speed, Design Wind Pressure are considered. All performance evaluation criteria, including efficiency, expressiveness, and sustainability, are better met by Diagrid. Comparatively speaking, structure has less deflection. Greater reduction in structural weight is achieved. The structure is more resistant to lateral stresses as a result. Eco-friendly and economical. Diagrid requires 11247 tonnes of steel, which is 28% less than the 15255 tonnes used by a regular orthogonal construction.

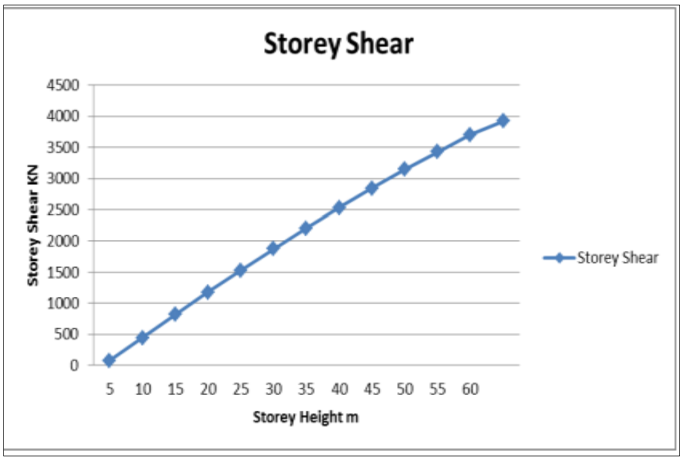


Fig.12 (a): Storey Shear conventional building

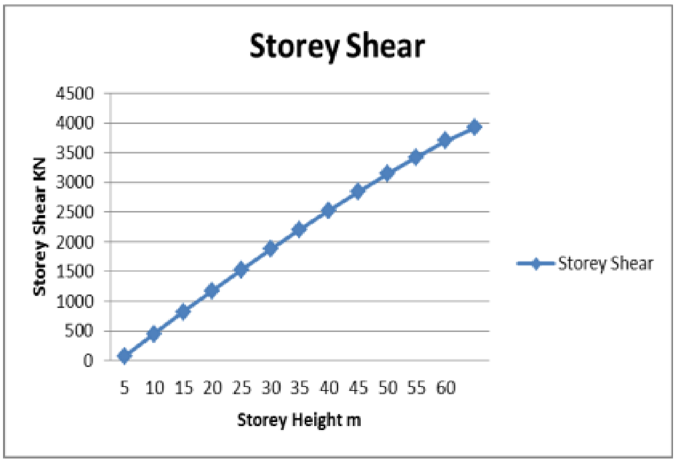


Fig.12 (b): Storey Shear diagrid building

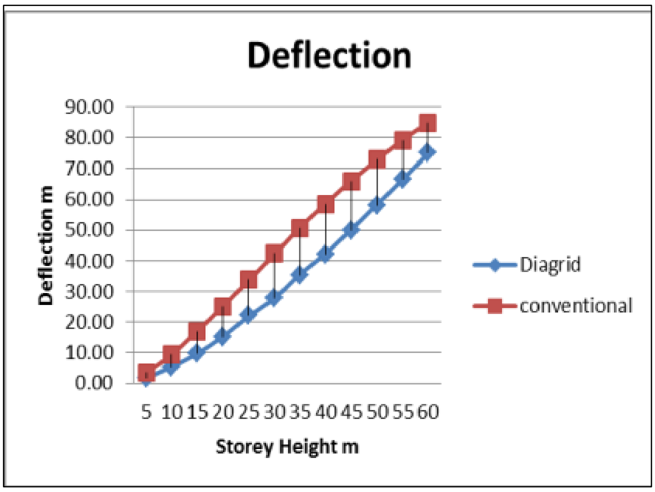


Fig.12(c): comparing deflection of both structural systems

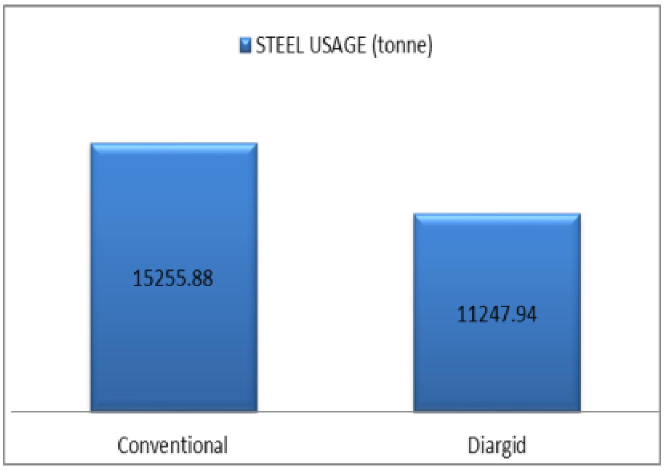


Fig.12(d): Comparison of steel usage of both structural frames

III. CONCLUSIONS

From the literature study the following conclusions are drawn

1. The most of the lateral load is resisted by diagrid columns on the periphery, while gravity load is resisted by both the internal columns and peripherical diagonal columns.[1]
2. The top story displacement is significantly less in a diagrid construction compared to a conventional frame building because the diagonal columns resist the lateral stresses.[2]
3. Diagrid increases building resistance, enhancing system performance.[2]
4. The diagrids are giving more member stiffness than the conventional braced structures.[3]
5. Also, diagrid structures give more aesthetic look and gives more interior space due to less columns and facade of the building can also be planned more efficiently.[3]
6. Diagrid performs better across all the criterions of performance evaluation, such as, efficiency, expressiveness and sustainability.[4]

7. A significant decrease of maximum shear force and maximum bending moment in beams and columns respectively., And also approximate 12% of weight reduction in diagrid building.[5]
8. The square design performs better than the circular and rectangular plan in a diagrid construction based on the storey drift, storey displacement, and base shear. [6]
9. It is possible to maximize the structural effectiveness of diagrids for tall buildings by setting them up with the best grid designs. A diagrid structure is difficult to build because of its intricate nodes, but using the right prefabrication techniques can make it easier to build.[7]
10. Any existing urban context, which is typically made up of structures with orthogonal components, can benefit greatly from the structural efficiency and aesthetic possibilities offered by diagrids due to their distinctive compositional properties.[8]
11. Diagrid performs better across all the criterions of performance evaluation, such as, efficiency, expressiveness and sustainability. Due to this structure has more resistance to lateral forces[09]

III. COMMENTS

1. All performance assessment criteria, including efficiency, expressiveness, and sustainability, are better met by Diagrid.
2. Diagrid structures can carry maximum lateral load when subjected to earthquake and wind loads.
3. Diagrid is Cost effective and Eco-friendly
4. The diagrid structures are suitable for buildings with storey less than 100 storey.
5. Diagrid structures can show better performance against earthquake compared to buildings with bracings.
6. Due to diagonal members on its periphery, Diagrid building shows good resistance to lateral loads.
7. Diagrid buildings show a good aesthetic appearance as compared to conventional building.
8. Greater reduction in structural weight.
9. Comparatively less deflection occurs in the structure

V. REFERENCES

[1] Khushbu Jani, Paresh V. Patel, (2013), “Analysis and Design of Diagrid Structural System for High Rise Steel Buildings”, International Conference on Engineering.

[2] Panchal, Nishith B., and Vinubhai R. Patel. "Diagrid structural system: Strategies to reduce lateral forces on high-rise buildings." International Journal of Research in Engineering and Technology 3, no. 03 (2014): 374-378.

[3] Rafey, Mohammed Abdul, and M. A. Azeem. "Comparative analysis of a diagrid structure and a conventional structure with chevron bracing." International Journal of Applied Engineering Research 13, no. 15 (2018): 12311-12317.

[4] Takle, Sameeran R., Aparna S. Patil, and Bharati V. Mahajan. "Dynamic Analysis of Diagrid Structural System in High Rise RCC Buildings with Varying Geometry." Int. J. Eng. Res. Technol 9, no. 12 (2020).

[5] Yadav, Saket, and Vivek Garg. "Advantage of steel diagrid building over conventional building." *International Journal of Civil and Structural Engineering Research (ISSN)* 3, no. 01 (2015): 394-406.

[6] Nayak, Chittaranjan, Snehal Walke, and Suraj Kokare. "Optimal structural design of diagrid structure for tall structure." In *ICRRM 2019–System Reliability, Quality Control, Safety, Maintenance and Management: Applications to Civil, Mechanical and Chemical Engineering*, pp. 263-271. Springer Singapore, 2020.

[7] Moon, K. "Design and construction of steel diagrid structures." *School of Architecture. Yale University. New Haven. USA* (2009): 398-405.

[8] Moon, Kyoung Sun. "Diagrid structures for complex-shaped tall buildings." *Procedia Engineering* 14 (2011): 1343-1350.

[9] Shylaja, N., R. M. Ashwini, and E. R. Babu. "Seismic Analysis of Diagrid Structure on Sloping Ground." In *IOP Conference Series: Materials Science and Engineering*, vol. 1255, no. 1, p. 012008. IOP Publishing, 2022.

[10] Deshpande, Raghunath D., Sadanand M. Patil, and Subramanya Ratan. "Analysis and comparison of diagrid and conventional structural system." *International Research Journal of Engineering and Technology* 2, no. 3 (2015): 2295-2300.