



COMPARATIVE STUDY OF DIAGRID STRUCTURE SYSTEM IN HIGH RISE BUILDINGS WITH BRACED FRAME STRUCTURE

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ABSTRACT

Diagrid and braced frame structural system are very popular in high rise buildings and is opening new dimensions in buildings design, twisted, tilted and free form have become possible with greater stability with the use of this system. Diagrid system is more efficient than frame structure of columns and beams due to its flexibility in designing the high rise building. Although it's not just geometry of the diagrid structure with give it so much importance in high rise building but also aesthetic appearance of structures. Diagrid and braced frame structure have increased stiffness of high rise building to a great extent and here a comparative study is made to review it in a better way that which system is more efficient. These two kind of structures are compared for displacement, storey drift and base shear and conclusion is made for the better suitability of different approach. By providing diagrid triangulation in the periphery more space is brought into efficient use.

Keywords: Diagrid, geometry, twisted, stability, periphery, module, braced.

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1. INTRODUCTION

As in the modern world we are seeing giant structures which will mesmerize anybody, high rise buildings are also one of them. Around the world we can see a rapid growth of multi-story buildings construction in its full swing. In diagrid structure system diagonal member are used to connect the beam and diaphragm and lateral loads and gravity loads are transferred by

these members. Diagrid system have become very popular in the complex structures such as curved shape. With the use of diagrid conventional vertical column are not in use and diagonal elements use is rapidly increasing. However different parameters involved in diagrid system needs to figure out to give the structure better optimization, such as optimal angle of diagonal member. A diagrid system in any high rise building can be analysed for many things such as for different angle of diagonal elements or a comparative study between conventional frame structure building by moment resisting frame building, shear wall position in building at different places to study the structure.

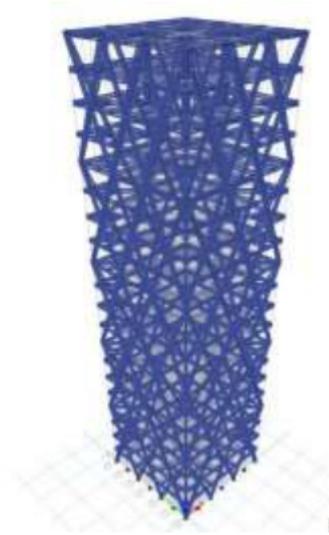


Figure. 1 Isometric View of Diagrid building

In addition, by eliminating the most of the columns except the core columns, a huge amount of structural material is saved and it provide economy to the project. Indeed, the efficiency of the diagonal members makes the total number of interior columns less, and which allow more free space for the architect to design the things. This approach is much preferred by architects and designers as compare to braced frame system.

2. MODEL DESIGN APPROACH

Total six model are made in three sets, Set A, Set B, Set C. Each set is having two model of diagrid structure type and braced tube type. Set A models of both diagrid and braced tube is of G+48 storey having 12 modules of height 15.64m each. Each module consists of 4 storeys and each storey having height equals to 3.91m. The restriction in height is applied, so that the angle of diagonal member can be maintained. Other two set of models are of G+32 and G+20 storey height having storey height 3.91m. Diagonal member angle is kept constant for all the sets of model but change in density has been made in the Set B and Set C.

2.1. Model Description

1. Set A

Storey Height = 3.91

Number of storeys = G+48

Angle of diagonal member = 69°

Number of module = 12

2. Set B

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Storey Height = 3.91

Number of storeys = G+32

Angle of diagonal member = 69°

Number of module = 8

3. Set C

Storey Height = 3.91

Number of storeys = G+20

Angle of diagonal member = 69°

Number of module = 5

The beam and column used in both type of building is ISWB 550, ISWB 500, ISWB400 except built up column is used in the diagrid structure.

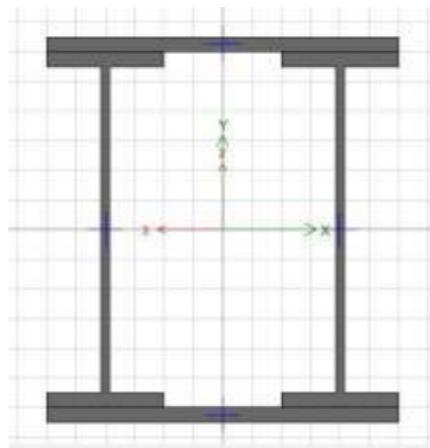


Figure. 2 Built up section

Since it requires a lot of strength to hold the structure within the permissible limits for diagrid structure so built up sections are the best option which we can use to adhere the structure within limits.

3. METHODOLOGY

The diagrid structure are designed by opting different ways such as changing angle and different sizing of the diagonal member may be used to analyse the structure. The combinations of different elements such as shear wall with diagrid may be used for better results. These different models are analysed on the Etabs or STAADPro software for lateral displacement, storey drifts, shear force calculations and bending moments can be found out as per requirements of the researcher. In this paper we have analysed diagrid and braced frame structure for the lateral forces i.e. seismic and wind forces by the Etabs software for dynamic analysis. The structure are assumed in zone 4 at Chandigarh and site condition is assumed to be medium. The loading conditions are applied as per the codal provisions of IS 875(3):1987 for wind loading conditions and for seismic loading IS 1893:2002 is used.

The imposed load and dead load on the building has been taken as per the IS 875:2000(1) and IS: 875:2000(2) of average value of 3.0KN/m^2 and the average dead load value is taken as 4.0KN/m^2 for the all structure models.

To find the responses of structure models seismic coefficient method is used. For this design base shear is determined by below formula

$$V_B = A_h \times W$$

where,

V_B - Design base shear of building,

A_h - Coefficient of horizontal acceleration spectrum,

W - Weight of building utilised in seismic analysis

The Response spectrum analysis is used to do the dynamic analysis for the structures. One of the important term that is used in the RSA system is scale factor which is find by

$$\text{Scale factor} = I g/2R \times 0.8 \times \text{Static base shear/Response spectrum base shear}$$

This scale factor is only require if base shear in dynamic analysis become more than 80% of the static base shear. In that case it is applied and dynamic base shear is brought within the limits.

4. RESULTS

The results for the different models are obtained for maximum displacement, storey drift and these results are shown in the graphs

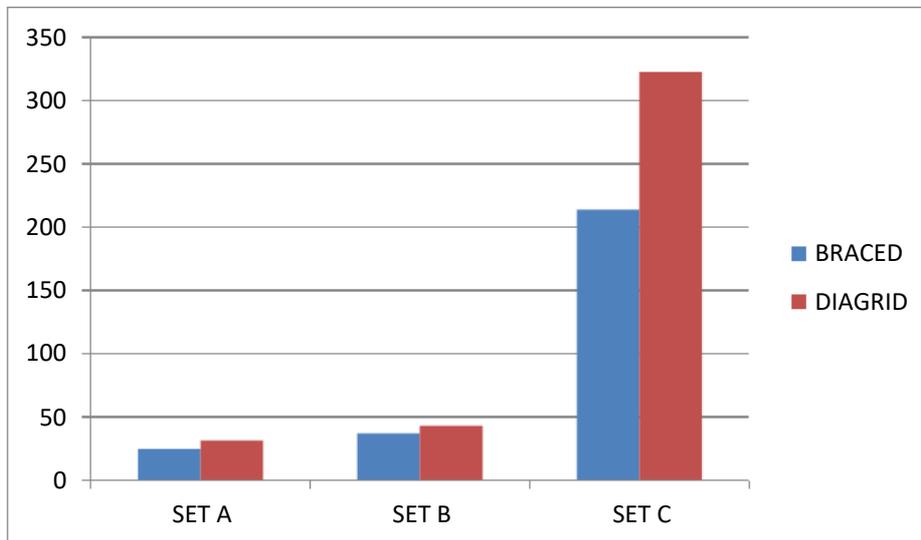


Figure. 3 Maximum displacement

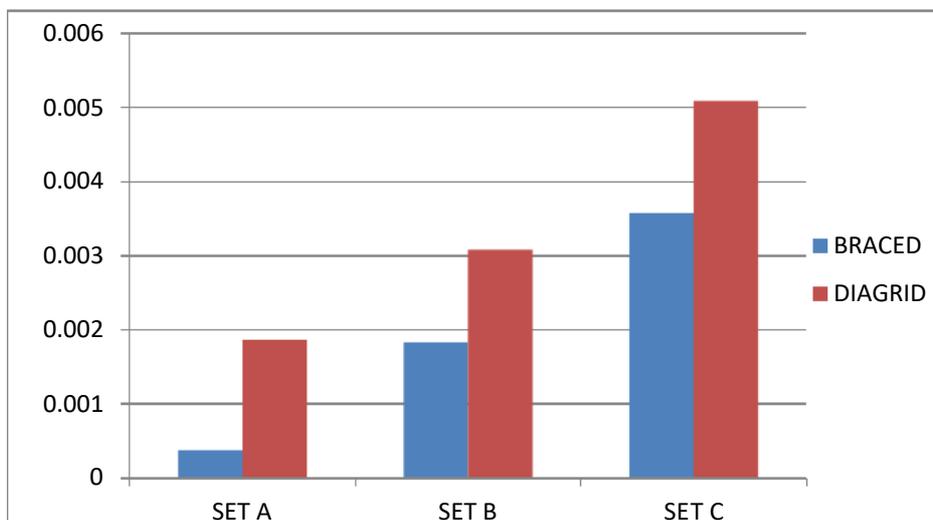


Figure. 4 Maximum Storey Drift

For the displacement and drift due to seismic load are given as follow:-

Maximum lateral displacement should not be more than $H/250$, where H is the total height of building and the maximum storey drift for the building should not exceed $0.004h_i$, where h_i is the storey height of the building. Since storey height of all the models are same so maximum storey drift limit is 0.01553 for all the models and maximum lateral displacement for set A is 750mm, 500mm for set B and 312mm for set c models. Since all the results are within permissible limits a better comparison can be made.

5. CONCLUSION

Since the use of diagrid structure system is very much in use in high rise buildings and this is making it convenient to design and built the complex structures in modern days. Also the braced tube structures have shown excellent resistant to the lateral displacements and storey drifts. Although both structures values are under the maximum permissible limits but braced frame structure results are much better for a luxury building because it will increase the comfort conditions in the building but it involve a lot of structure materials as it has both columns and cross bracing too whereas in diagrid structure, columns are only in the core of the building and bracing are in the periphery of the building which leads to the costing of building and building doesn't remain economic any more. So as far as costing or economy will remain issue diagrid structure can fulfill all requirement of the permissible limits of storey drift and lateral movement and will also provide lot of space to work in the building since there will be no column excepts the core columns, whereas braced frame structure are the convention frame structure which will restrain the lateral movements and storey drift and brought them under permissible limits but simultaneously increase the cost of building.

REFERENCES

- [1] Valentina Tomei, Maura Imbimbo, Elena Mele. Optimization of structural patterns for tall buildings: The case of diagrid. *Engineering Structures* 171 (2018) 280–297
- [2] Tae-heon kim, Han-Ul Lee, Young-Chan Kim. Development of building structural system using an iso truss grid. *Procedia Engineering* 171 (2017) 1077 – 1084
- [3] Eunike Kristi Julistiono. Structural pattern's granularity variation to optimize a vertical structure. *Procedia Engineering* 180 (2017) 725 – 734
- [4] Viraj Baile Comparative Study of Diagrid, Simple Frame and Shear Wall System. *Int. Journal of Engineering Research and Application* ISSN : 2248-9622, Vol. 7, Issue 7, (Part -2) July 2017, pp.10-15
- [5] Jayesh Venkolath, Rahul Krishnan K. Optimal Diagrid Angle of High-Rise Buildings Subjected to Lateral Loads. *International Research Journal of Engineering and Technology (IRJET)* Vol: 03 Issue: 09 | Sep -2016
- [6] Rinju Jose. Analysis And Comparison Of Diagrid And Conventional Structure System. *International Research Journal of Engineering and Technology (IRJET)* Vol: 03 Issue: 09 | Sep-2016
- [7] Kiran Kamath, Sachin Hirannaiah, Jose Camilo Karl Barbosa Noronha. An analytical study on performance of a diagrid structure using nonlinear static pushover analysis. *Recent trends in Engineering and Material Sciences* (2016) 8, 90—92
- [8] Kamath, K., Sachin, H., Noronha, J.C.K.B., An Analytical Study on Performance of a Diagrid Structure Using Nonlinear static Pushover Analysis, *Perspectives in Science* (2016)

- [9] Xinzheng Lu, Linlin Xie, Cheng Yu, Xiao Lu. Development and application of a simplified model for the design of a super-tall mega-braced frame-core tube building. *Engineering Structures* 110 (2016) 116–126
- [10] Saket Yadav, Dr. Vivek Garg (2015). Advantage of Steel Diagrid Building Over Conventional Building. *International Journal of Civil and Structural Engineering Research Vol. 3, (394-406)*
- [11] Giovanni Maria Montuori, Elena Mele, Giuseppe Brandonisio, Antonello De Luca Geometrical patterns for diagrid buildings: Exploring alternative design strategies from the structural point of view. *Engineering Structures* 71 (2014) 112–127
- [12] Giovanni Maria Montuori, Elena Mele, Giuseppe Brandonisio, Antonello De Luca. Secondary bracing systems for diagrid structures in tall buildings. *Engineering Structures* 75 (2014) 477–488
- [13] Giulia Milana, Konstantinos Gkoumas and Franco Bontempi Sustainability. Concepts in the Design of High-Rise buildings: the case of Diagrid Systems. *Third International Workshop on Design in Civil and Environmental Engineering, August 21-23, 2014, DTU*
- [14] Giovanni Maria Montuori , Elena Mele, Giuseppe Brandonisio, Antonello De Luca Geometrical patterns for diagrid buildings: Exploring alternative design strategies from the structural point of view *Engineering Structures* 71 (2014) 112–127
- [15] Kyoung Sun Moon. Diagrid Structures for Complex-Shaped Tall Buildings. *Procedia Engineering* 14 (2011) 1343–1350
- [16] Kyoung Sun Moon. Stiffness-based design methodology for steel braced tube structures: A sustainable approach. *Engineering Structures* 32 (2010) 3163_3170
- [17] Besjak C, Kim B, Biswas P. 555m Tall Lotte Super Tower, Seoul, Korea. In: Proceedings of the 2009 structures congress, April 30–May 2, 2009. Austin, Texas: *American Society of Civil Engineers; 2009.*
- [18] Gensler, M. A. (2009). Completing a Supertall Trio, *Council on Tall Buildings and Urban Habitat 2009 Chicago Conference: New Challenges in a World of Global Warming and Recession*, October 22-23, Chicago
- [19] ALI, M.M. and MOON, K.S. (2007), Structural Developments in Tall Buildings: Current Trends and Future Prospects, *Architectural Science Review*, Vol. 50 No. 3, pp. 205-223
- [20] Moon, K., Connor, J., & Fernandez, J. (2007). Diagrid Structural systems for tall buildings: Characteristics and methodology for preliminary design. *The Structural design of tall and Special buildings*, 16, 205-230