

# Structural Analysis of RCC Building Structure with Variations of Its Types by Using STAAD-PRO

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**Abstract-** The latest trend in high rise building is diagrid structures because of structural and architectural effectiveness. In the study previous literatures are studied for Flat-slab Building and detailed analysis is carried out to check the behaviour of flat-slab buildings with and without diagrid. It is very crucial that the chosen structural system is such that the structural components are used efficiently while meeting design criteria. Due to its structural effectiveness and flexible in architectural planning, recently diagrid structural system is implemented in tall buildings. In this research, comparison assessment and layout of 12-story structural system construction and simple frame construction are provided here. A regular floor plan of 18m x 18m size is considered. STAAD Pro software is used for modelling and analysis of structure. Analysis results like displacement, storey drift, storey shear is presented here. We compare two types of the RCC building structure with each other i.e. regular building structure with diagrid building structure so we optimize the deflections and maximum possible height of building in both designs..

**Keywords-** Diagrid building, conventional building, Tall Buildings, Storey Displacement, Diagrid Structures, Storey Displacement.

## I. INTRODUCTION

Tall building development involves various complex factors such as economics, appearance of aesthetics, technology, municipal regulations, and politics. Economics has been the main ruling variable among these. Its structural design is usually controlled by its lateral stiffness for a very large construction. Compared to standard orthogonal systems for high buildings such as framed pipes, diagrid systems bear lateral wind loads much more effectively due to the axial movement of their diagonal member.

A Diagrid design has also opened up fresh aesthetic possibilities for large construction architecture without vertical pillars providing excellent structural effectiveness. Diagrid has a nice appearance and is readily identified. The configuration and efficiency of a diagrid system reduces the number of structural elements required on the façade of the houses, thus reducing obstacle to the outside perspective. The operational effectiveness of the diagrid scheme also helps to avoid pillars in the middle and corner, thus enabling important flexibility with the floor plan.

The "Diagrid" system around the perimeter saves about 20 percent of the structural steel weight relative to a standard moment frame structure. Due to their triangulated setup, the diagonal elements in diagrid structural systems bear gravity stresses as well as horizontal stresses. Diagrid can

save up to 20% to 30% of the number of structural concrete in a high-rise construction.

The word "diagrid" is a mixture of the phrases "diagonal" and "lattice" and refers to a structural system that is single-thick in design and receives its structural integrity through the use of triangulation. Diagrid structures can be planar, crystalline or take on various curvatures, often using crystalline shapes or curvature to improve their stiffness.

Perimeter diagrams usually hold the lateral and gravity loads of the construction and are used to promote the corners of the ground. This article provides a comparison analysis of both diagrid and periodic structure construction systems. The primary goal of this analysis is to explore the efficiency of the grid system in an uneven construction and to figure out the structure's reaction to lateral load resistance.

## II. METHODOLOGY

In this research, the comparison of diagrid and periodic construction design scheme is contrasted in terms of displacement, with increased construction height.

Following steps are adopted in this study.

Step 1: Selection of diagrid, hexagrid and standard structural system construction geometry and modeling using Staad-Pro software for the same scheme.

Step 2: Site status selection and seismic area selection.

Step 3: Application of stresses and load mixture according to conventional instructions to the structural model.

Step 4: Analysis of designs for each construction frame.

Step 5: comparison analysis of outcomes in terms of storage displacement, storage drift, storage shear and time span.

### III. STRUCTURAL MODELLING AND ANALYSIS

A 12 storied steel framed structure with different plan dimensions upto certain storey levels are chosen. Height of each storey is 45.5 m. plan dimensions are 18 m x 18 m for 12 stories building structure with diagrid and regular building. Fig. 1 shows the elevation selected for building.

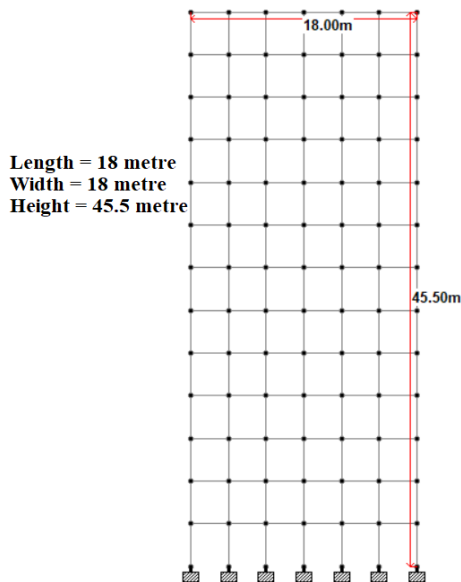


Fig 1. Regular Building Structure.

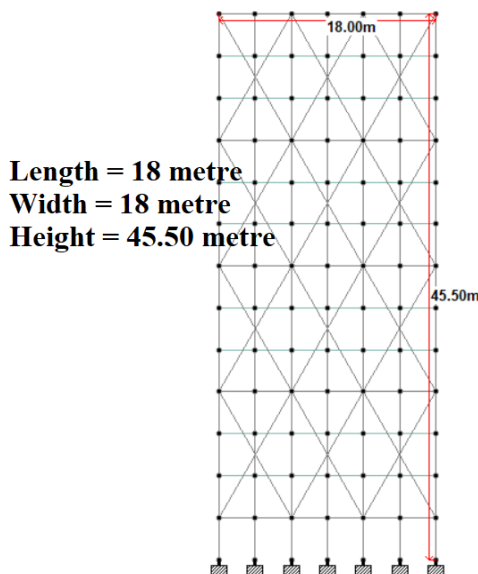


Fig 2. Diagrid Building Structure.

### IV. STRUCTURAL MODELS

A stored G+12 model is created, analyzed and designed using STAAD-Pro software. For both structures, a normal floor plan of 18 m x 18 m is regarded. The height of the storey is 45, 50 m. The angle of the inclined section (45 °) remains continuous across the length. The dead load and grid load of the layout are 4.5 KN / m<sup>2</sup> and 4 KN / m<sup>2</sup> respectively. Both structures take minimal external wall load. Both building frames are analyzed for dead load, beam load and floor load.

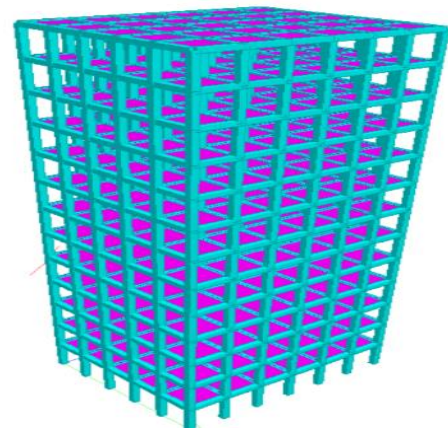


Fig 3. 3D model of conventional building.

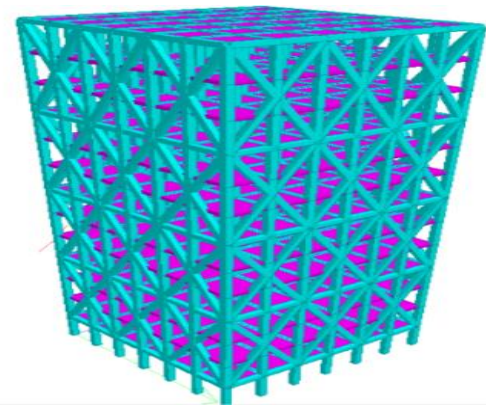


Fig 4. 3D model of diagrid building.

#### 1. Self-weight:

The structures self-weight can be constructed by STAAD-Pro with the self-weight order in the load case row. These values are provided as an input to the STAAD-Pro software for drawing, analysis and designing purposes.

#### 2. Supports:

The base supports of the structure are assigned as fixed.

#### 3. Dead Load from Slab:

STAAD-Pro can also produce dead load from the sheet by denoting the density of the ground and the space per square on the ground. m. Load calculation per sq. The meter was completed taking into account the weight of the

beam, the weight of the column, the weight of the RCC slab, the weight of the terrace, the external walls, the internal walls and the parapet over the roof.

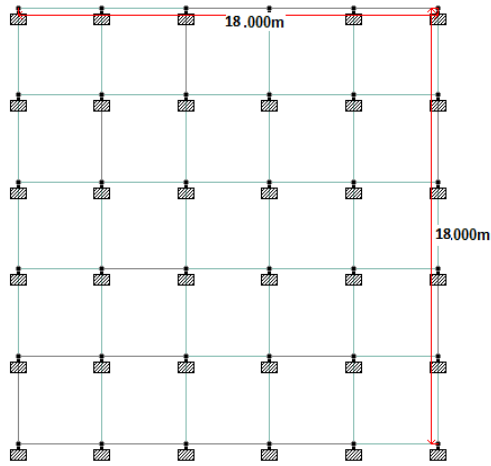


Fig 5. RCC building frame with fixed ground support.

#### Loading:

The loadings were optimized partially manually and remaining was analysed using STAAD-Pro load generator. The loading cases were considered as: -

- Dead load
- Beam load
- Floor Load

## V. RESULTS & DISCUSSIONS

A symmetrical structure is chosen for the parametric comparison. StaadPro models, analyzes and designs seven steel buildings for distinct heights for two structural systems; diagrid and standard frame. Dead load, beam load and floor load are analyzed and designed.

For standard and diagrid construction, both static and response spectrum assessment are performed. In order to consider severe lateral load circumstances, the structures are deemed to be situated in Zone V. The parameters chosen for contrast are basic time periods, highest top-story lateral displacement with combination load and peak storage displacement.

Table 1. Total Deformations of buildings due to Dead load, Beam load and Floor Load.

Building Types	Total Def. Dead Load	Total Def. Dead Load + Beam Load	Total Def. Dead Load + Beam Load + Floor Load
Diagrid Building	4.398	5.994	7.068
Regular Building	8.775	10.301	11.328

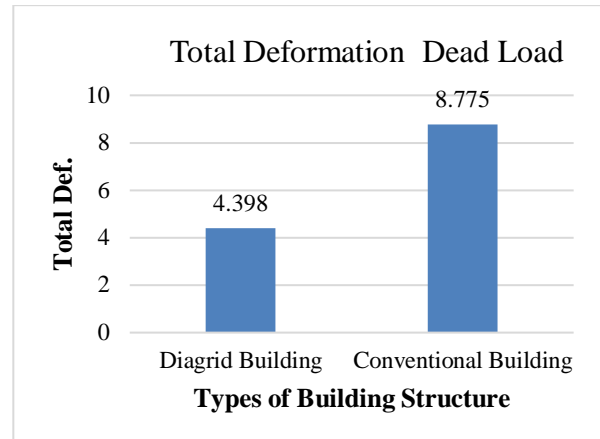


Fig 6. Total deformation b/w conventional and diagrid buildings due to dead load.

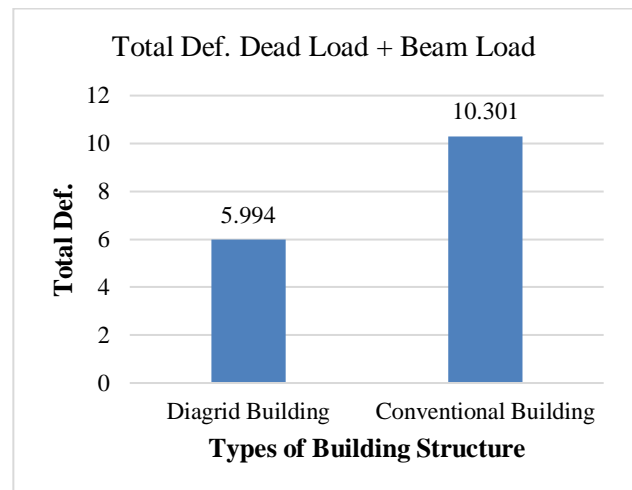


Fig 7. Total deformation b/w conventional and diagrid buildings due to dead load and Beam Load

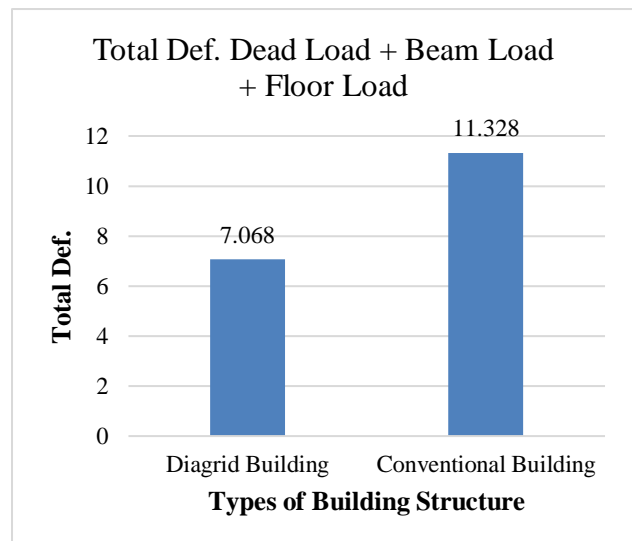


Fig 8. Total deformation of buildings due to dead load and Beam Load with Floor Load.

Table 2. Comparison deflections of Diagrid building due to increase of storey level.

Diagrid Building Design results			
Deflections in mm			
Storey Numbers	Dead Load Diagrid	Dead Load +Beam Load Diagrid	Dead Load +Beam Load + Floor Load Diagrid
Ground Floor	0.902	1.096	1.19
1	1.264	1.535	1.665
2	1.614	1.963	2.13
3	1.946	2.371	2.574
4	2.25	2.744	2.98
5	2.532	3.093	3.361
6	2.79	3.414	3.712
7	2.988	3.659	3.978
8	3.162	3.876	4.214
9	3.308	4.061	4.418
10	3.395	4.168	4.533
11	3.455	4.244	4.615
12	3.487	4.287	4.663

Table 3. Comparison deflections of conventional building due to increase of storey level.

Conventional Building Design results			
Deflections			
Storey Numbers	Dead Load Regular	Dead Load +Beam Load Regular	Dead Load +Beam Load + Floor Load Regular
Ground Floor	1.017	1.193	1.3
1	1.968	2.31	2.518
2	2.855	3.35	3.653
3	3.67	4.307	4.697
4	4.41	5.174	5.645
5	5.071	5.949	6.491
6	5.65	6.629	7.232
7	6.146	7.211	7.868
8	6.558	7.695	8.395
9	6.885	8.079	8.813
10	7.126	8.363	9.121
11	7.281	8.546	9.318
12	7.348	8.626	9.403

Diagrid Building vs Conventional Building

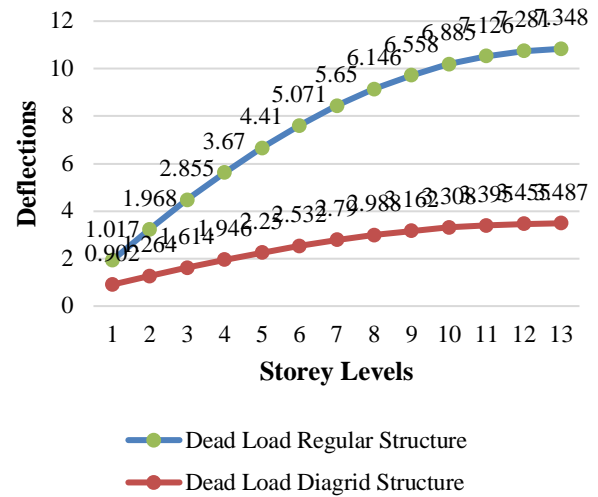


Fig 9. Comparison of structure deflections due to Dead load.

Diagrid Building vs Conventional Building

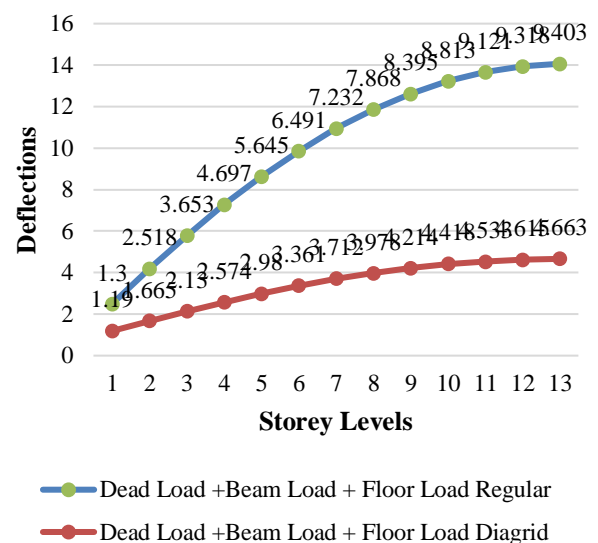


Fig 10. comparison of structure deflections due to Dead load, beam Load with floor load.

## VI. CONCLUSION

STAAD PRO is multipurpose analysis tool used to analysed structure and has the potential to compute the reinforcement required for any concrete element, to estimate lateral deflection caused by dead load, Beam load and floor load. Several structural behaviours are considered on building elements such as axial, flexure, torsion etcas per to their behaviour.

After analysing and designing all the structures, the governing loads for each building for both diagrid and conventional frame systems are studied. It is observed that in diagrid system having lower deflection with dead load and beam load. Regular building shows higher deflection as compared to the diagrid structure.

Also we found that with increasing height of structure deflection increases at 12 floor of building but after 12 floor deflection values decreases it means at 12 floor it show sustain conditions against deflection. It can be concluded that diagrid system resists load and forces up to higher heights than conventional frame system. Further it is important to note that the section for conventional frame is not possible from feasibility and practicability point of view. So diagrid structure is better than regular structure as per design purpose of RCC building structure.

The dead load, Beam load and floor loads are analysed for G+12 RCC framed structure. Conclusions based on the optimized results are described below:

- The dead load and beam load increases with height of structure.
- Floor loads are more critical for tall structures but it is higher in conventional building structure than diagrid structure.
- Buildings should be designed for loads optimized in both directions separately for deflection and stresses in buildings.

## VII. SCOPE OF FUTURE WORK

Design hexa-grid building structure and compare that with diagrid building structure. Deformation and seismic analysis using different building structure in the study.

## REFERENCES

- [1] Jateen M. Kachchhi, Snehal V. Mevada, Vishal B. Patel, "Comparative Study of Diagrid Structure with Other Structural Systems for Tall Structures", Global Journal of Engineering Science and Researches, vol. 4, 2019.
- [2] Jayesh Akhand, J.N Vyas, "Comparative Study of Different shapes of Diagrid Structure System with Conventional System using Response Spectrum Analysis", International Research Journal of Engineering and Technology (IRJET), Volume: 06, Issue: 04, Apr 2019.
- [3] Safiya Daliya Ahammed, Shahla C. P, "Seismic Behaviour of Hexagrid Type Structural System", International Journal of Engineering Research & Technology, Vol. 8 Issue 02, February-2019.
- [4] Yash Bhardwaj, "A Review on Structural Behaviour of Hexagrid&Diagrid Structural Systems in Multi Storey Buildings", International Journal for Scientific Research & Development, Vol. 6, Issue 11, 2019.
- [5] Akshat, Gurpreet Singh, "Dynamic Analysis of Diagrid Structural System in High Rise Steel Buildings", International Journal of Civil Engineering and Technology, Volume 9, Issue 8, August 2018, pp. 71–79.
- [6] Deepthi M, Umashankar Patil G H, "Parametric Evaluation of Outrigger Structural System for High Rise Buildings", International Journal of Research in Advent Technology, Special Issue, August 2018.
- [7] Pattan Venkatesh, Sujay Deshpande, Shweta Patil, "A Comparative Study on the Structural Analysis of Diagrid Structural Systems with Conventional Structural Systems for different Plan Configurations", International Journal for Research in Applied Science & Engineering Technology, Volume 6 Issue VI, June 2018.
- [8] Sayyed Kamran Altaf, "Parametric Study of Diagrid, Pentagrid and Hexagrid Structural System", International Journal of Technical Innovation in Modern Engineering & Science, Volume 4, Issue 8, August-2018.
- [9] Yogeesh H.S, V. Devaraj, "A Seismic Study on Diagrid Structure", International Journal for Research in Applied Science & Engineering Technology, Volume 6 Issue VI, June 2018.
- [10] Avnish Kumar Rai, Rashmi Sakalle, "Comparative analysis of a high-rise building frame with and without diagrid effects under seismic zones III & V", International journal of engineering sciences & research Technology, 2017.
- [11] Divya, B. Saraswathy, "Comparative Analysis of High-Rise Steel Building with Hexagrid, Diagrid and Conventional Structural System", International Research Journal of Engineering and Technology, Volume: 04, Issue: 04, Apr -2017.
- [12] Gopisiddappa, M. Divyashree, Sindhuja, "Performance Study of High-Rise Building with Diagrid System Under Dynamic Loading", International Research Journal of Engineering and Technology, Volume: 04 Issue: 06, June -2017.