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Analysis Dynamic Behaviour of Diagrid Structural System

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Abstract: *Multi-story building construction is quickly rising over the world. Because of the structural efficiency and aesthetic possibilities given by the system's distinctive geometric layout, the diagrid structural system has been frequently adopted for modern tall structures. Diagrid is a structural method for skyscrapers that consists of triangulated beams, either straight or curved, and horizontal rings. In general, digrid structures employ less structural material than traditional structural systems made up of orthogonal components. The diagrid system's structural efficiency reduces the amount of interior columns, allowing for greater freedom in plan design. The idea of the diagrid structural system is investigated in this journal through a literature study, and the best configuration for buildings and diagrid placement is determined by comparing conventional and diagrid structures with the same plan area using STAAD Pro software.*

Keywords: Diagrids, Storey Displacement, Storey Drift, Design Base Shear

I. INTRODUCTION

Because of the growth in population, economic success, and land scarcity, towering buildings or high rise structures are becoming increasingly popular in this century. The demand for tall buildings has increased due to increased demand for business and residential space, advances in construction, high strength structural elements, materials, and various software such as ETABS, Staadpro, and other analysis and design softwares that have enabled the development of high rise structures. Tall buildings were built in the United States in the nineteenth century, but now, due to people's needs, tall buildings are being built all over the world, leading to sustainable development of society, which is defined as "development that meets the expectations and needs of current generations without jeopardising future generations' ability to meet their requirements." According to research and papers published in 1980, the majority of tall buildings were located in America; however, contemporary studies suggest that the number of tall structures and construction processes are increasing in Asian nations, with roughly 32% and 24% in North America and Europe, respectively. Tall structures are commonly erected and utilised for commercial office buildings, housing, and other purposes.

1.1 Merits of Diagrid Structural System

- The diagrid structures have mostly column free exterior and interior, hence free and clear, unique floor plans are possible.
- The glass facades and dearth of interior columns allow generous amounts of day lighting into the structure.
- The use of diagrids results in roughly 1/5th reduction in steel as compared to braced frame structures.
- The construction techniques involved are simple, yet they need to be perfect.
- The diagrids makes maximum exploitation of the structural material.
- The diagrid structures are aesthetically dominant and expressive.

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Figure 1: Diagrid buildings: (a) Jinling Tower in china, (b) Swiss Re in London and (c) Capital Gate Tower in Abu Dhabi

1.2 Objectives

- The purpose here is to determine how the Diagrid arrangements helps to over come Seismic effects.
- How efficient the diagrid structures are in providing solution in terms of strength and stiffness.
- In present study the behavior of Structures with Diagrid system with different plan with Dynamic Analysis is studied.
- To determine the variation in forces due to provision of Diagrid on structure under seismic forces
- Comparison of results concluded from the analysis in terms of Maximum Base reaction, Story Displacement, Bending Moment and Shear Force in Seismic case and Quantity of steel and Concrete.

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III. Model Geometry

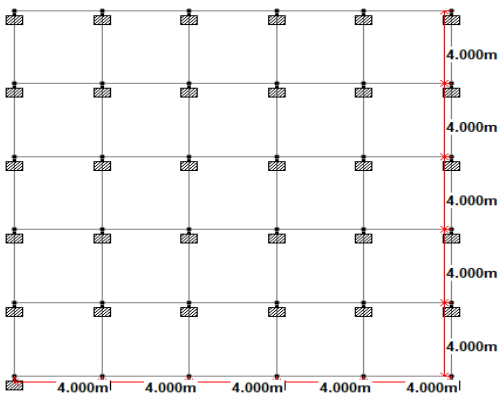

Fig 2: Plan of Building

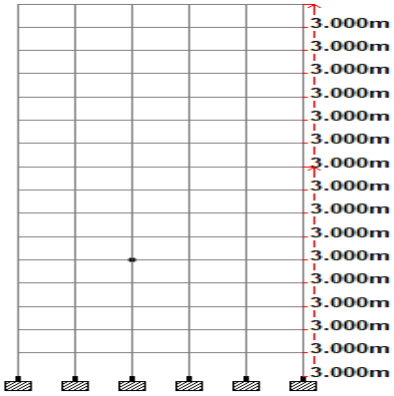

Fig 3: Elevation of Building

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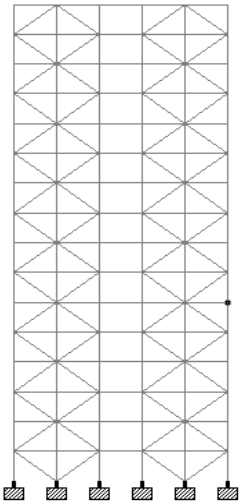

Figure 4: Elevation of Diagrid Building

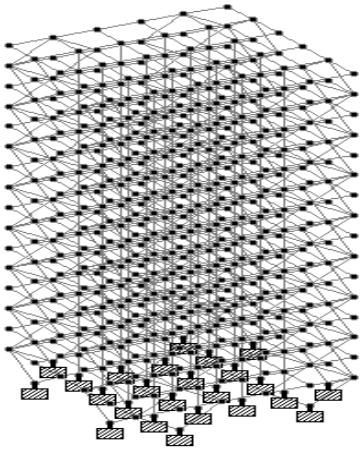

Figure 5: 3D of Diagrid Building

IV. Structural Parameters Of Building

Table 1: Structural Parameters

Concrete Properties		Steel Bar Properties	
Unit weight (γc)	25 kN/m3	Unit weight (γs)	76.33kN/m3
Modulus of elasticity	21718.8MPa	Modulus of elasticity	2x105MPa
Poisson ratio (νc)	0.17	Poisson ratio (νs)	0.3
Thermal coefficient (αc)	1x10-5	Thermal coefficient(αs)	1.2x10-5
Shear modulus (ςc)	9316.95MPa	Shear modulus (ςs)	76.8195MPa
Damping ratio (ς c)	5%	Yield strength	500MPa
Compressive strength (Fc)	30MPa	Compressive strength (Fs)	545MPa

Table 2: Structural Element for without Diagrid

Structural Element for Without Diagrid	Sizes
Beam's size	230 x 450mm
Column's size (Periphery)	500 x 500 mm
Column's size (Middle & Centre)	700 x 700 mm

Table 3: Structural Element for Diagrid

Structural Element for Diagrid	Sizes
Beam's size	230 x 450mm
Diagrid Columns	300 x 300 mm
Column's size (Middle & Centre)	1000 x 1000 mm

V. Structural Parameters Of Building

- Structure = G + 15
- Floor height = 3.0m
- Grade of concrete (for all structural elements) = M30

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- Unit weight of concrete = 25kN/m3
- Unit weight of cement mortar = 24kN/m3
- Unit weight of water = 10kN/m3
- Unit weight of Brick = 20kN/m3
- A slab load of 3.75 KN/m2 is considered for analysis.
- The wall load is taken as 11.73 KN/m.
- Parapet wall load taken as 3 KN/m.
- A floor finish load of 0.75 kN/m2 is applied on all beams of the RC building as per IS 875:2015 (part1)
- A live load of 3 KN/m 2 is provided as per IS 875:2015 (part2)

Seismic Parameters AS PER IS 1893:2016

1. Seismic Zone = Zone II (0.1)
2. Response Reduction Factor = 5 (SMRF)
3. Soil Typ3. Importance Factor = 1.5
4. e (Sa/g) = 2 (Medium Soil)
5. Type of Structure = 1 (RCC Frame)

Load Combination As Per IS 1893:2016

- Combination designing Beam and Column
- LOAD COMB 1.5(DL+LL)
- LOAD COMB 1.5(EQX+DL)
- LOAD COMB 1.5(-EQX+DL)
- LOAD COMB 1.5(EQZ+DL)
- LOAD COMB 1.5(-EQZ+DL)
- LOAD COMB 1.2EQX+1.2DL+.3LL
- LOAD COMB -1.2EQX+1.2DL+.3LL
- LOAD COMB 1.2EQZ+1.2DL+.3LL
- LOAD COMB -1.2EQZ+1.2DL+.3LL
- LOAD COMB .9DL-1.5EQX
- LOAD COMB .9DL+1.5EQZ
- LOAD COMB .9DL-1.5EQZ
- Combination for Seismic load
- LOAD COMB DL+0.5LL
- Combination for Support Reactions.
- LOAD COMB (DL+LL)
- LOAD COMB (EQX+DL)
- LOAD COMB (-EQX+DL)
- LOAD COMB (EQZ+DL)
- LOAD COMB (-EQZ+DL)

VI. RESULT

6.1 Base Reaction

- The Total Load of the Structure is transferred to base by column in both Diagrid and without diagrid.
- The number of columns in diagrid structure is less as compared to the non-diagrid structure so the maximum base reaction is diagrid structure is more

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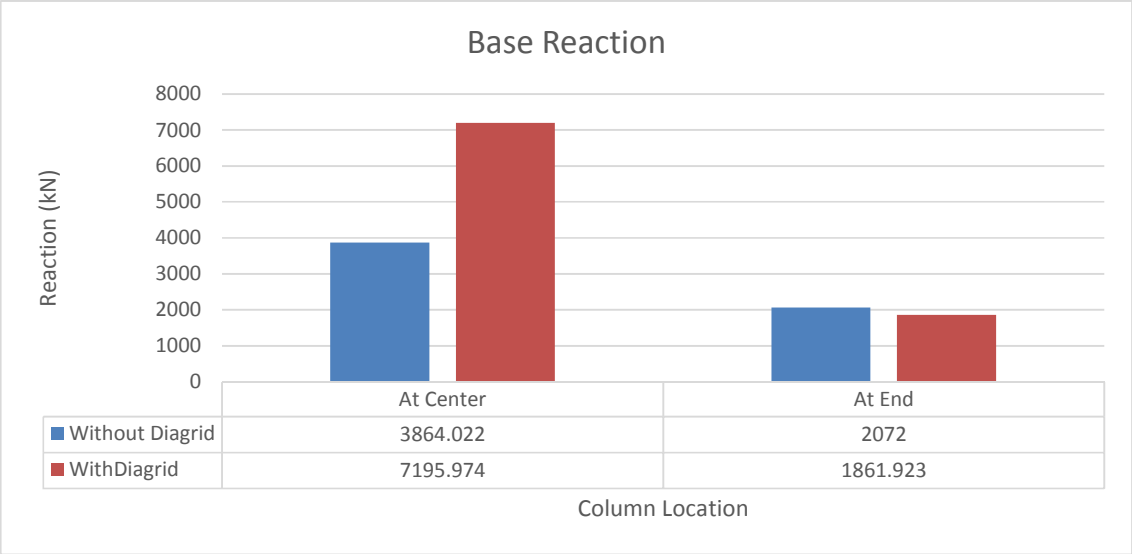

Figure 6: Graph for Maximum Base Reaction

6.2 Storey Displacement

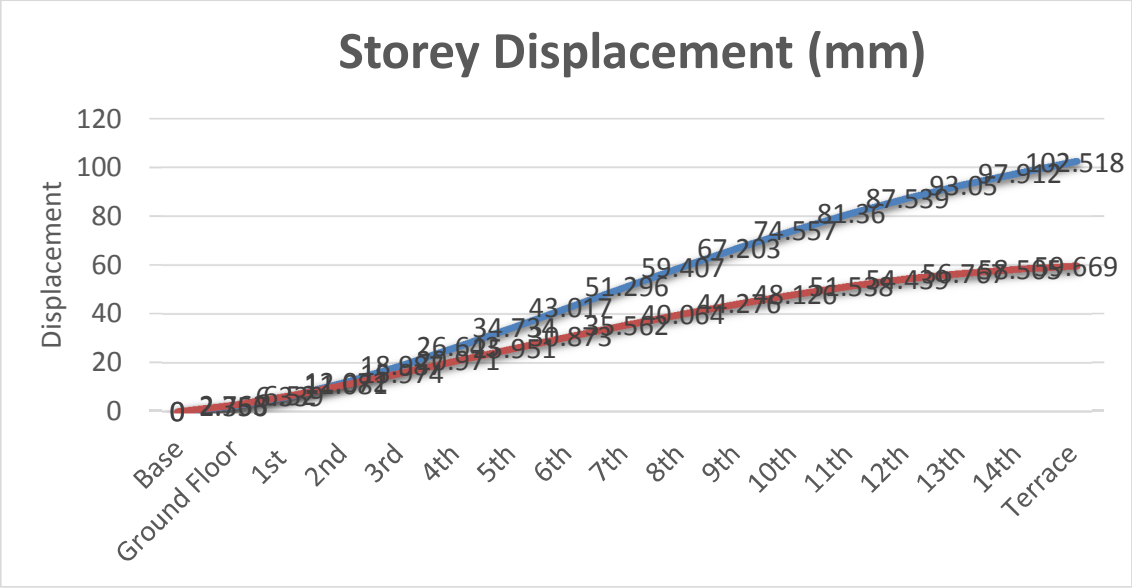

Figure 7: Graph for Maximum Storey Displacement

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6.3 Bending Moment

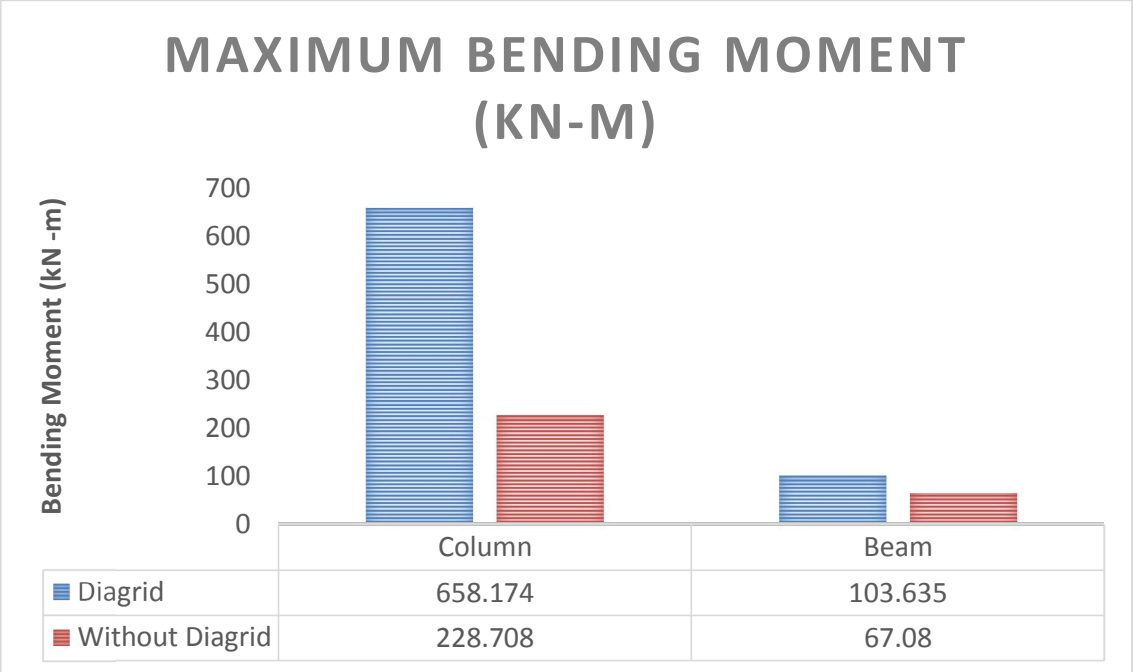

Figure 8: Graph for Maximum Bending Moment

6.4 Shear Force

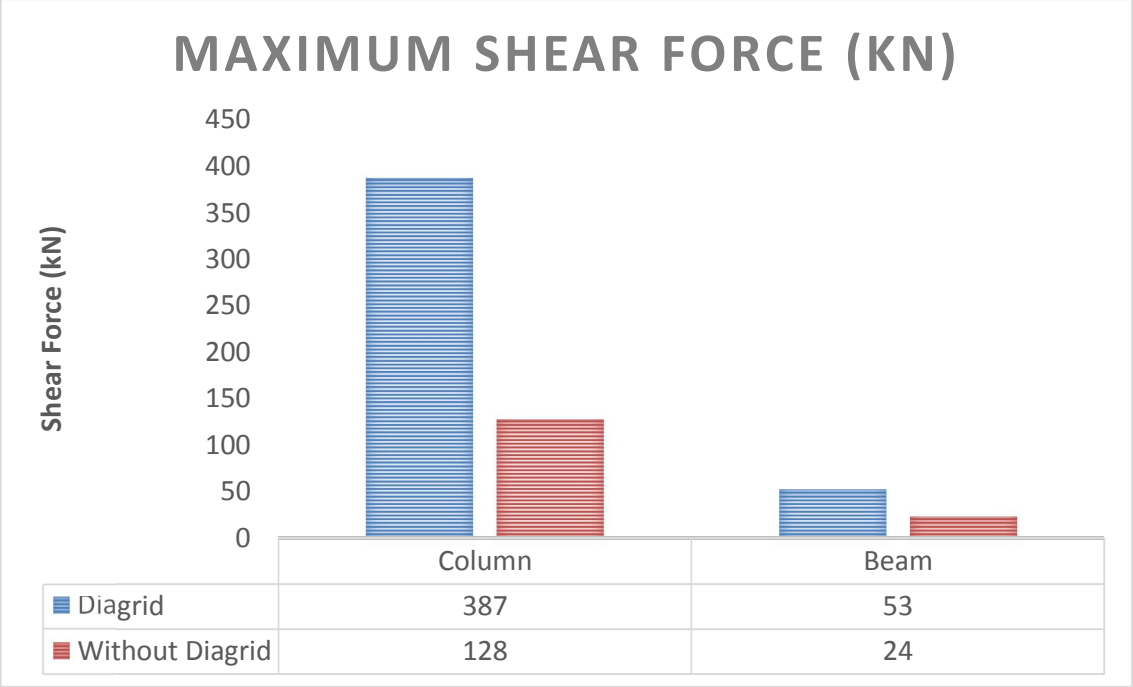

Figure 9: Graph for Maximum Shear Force

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6.5 Quantity of Concrete

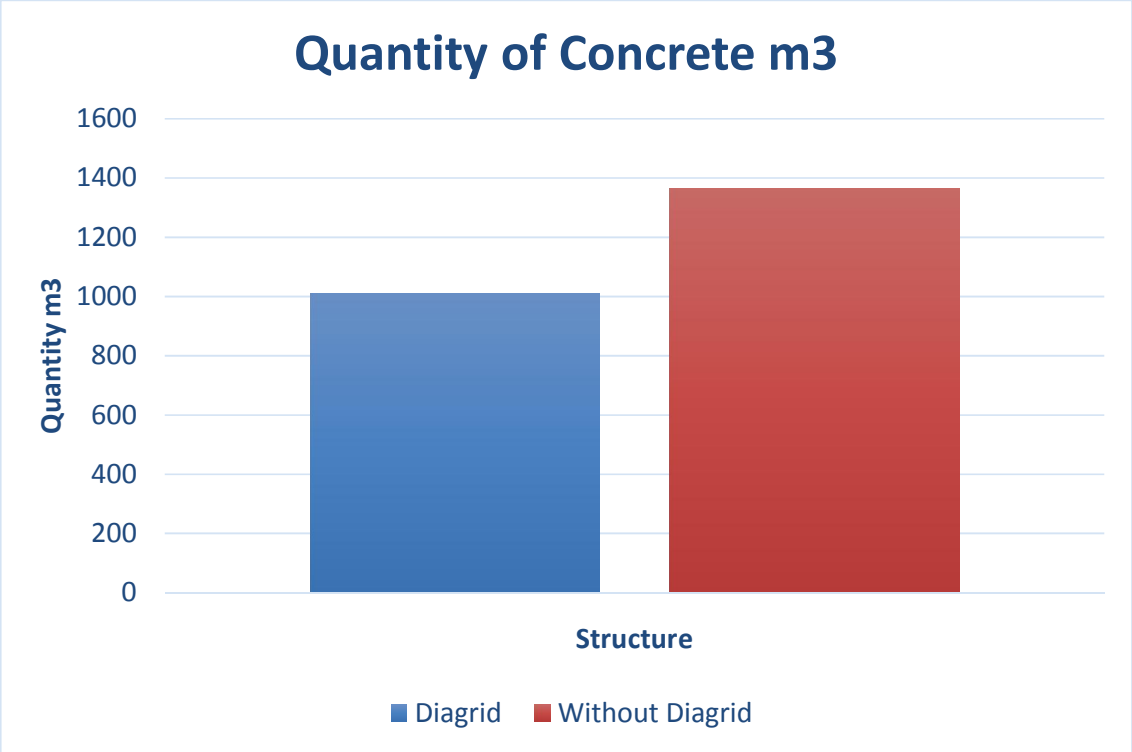

Figure 10: Graph for Quantity of Concrete

6.6 Quantity of Steel

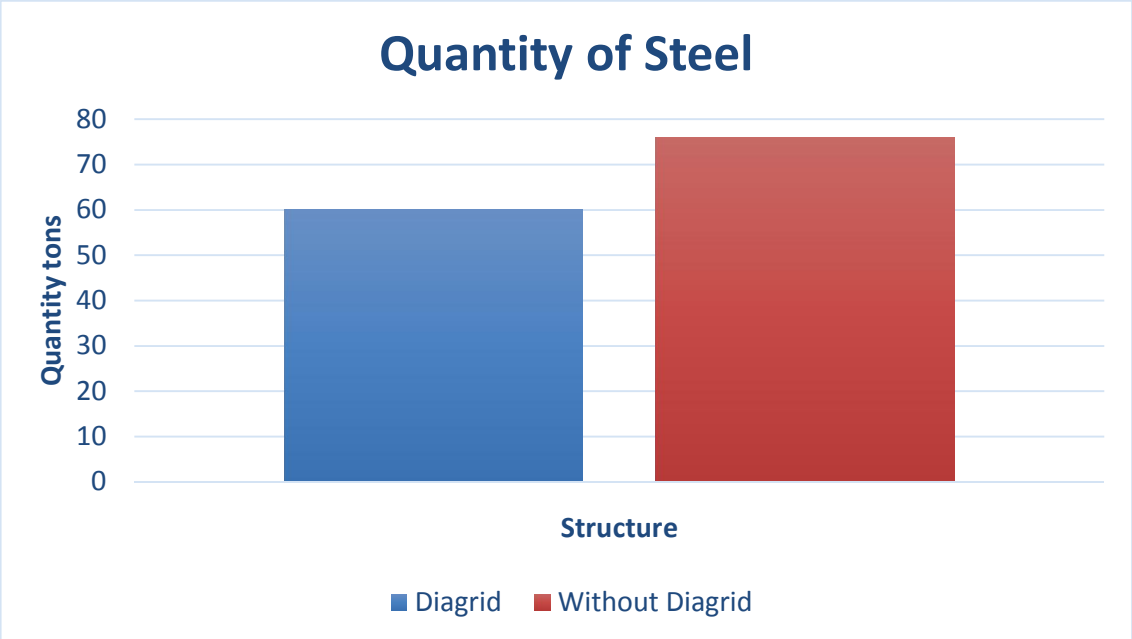

Figure 11: Graph for Quantity of Steel

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VII. CONCLUSION

- The analysis results specifies a clear view for both the Diagrid and non diagrid structure.
- Diagrid structure has more Base reaction which is because of less number of columns present as the periphery of the structure.
- The diagrid structure also has more deflection, shear force and bending moment as compared to non diagrid
- The size of column use in diagrid is also more than the non diagrid structure.
- But on the other hand there is a good advantage for the diagrid structure as there is less number of column so the total quantity of concrete and steel is also less.
- Which ultimately results to low construction cost.
- Glass can be used as a wall material in diagrid structure for more space and clear view as less column present in exterior side of building.
- Overall the diagrid is better when it comes to cost and aesthetic looks and non diagrid structure is better for structure where more columns or partition wall is required.

REFERENCES

[1]. H. U. Lee, Y. C. Kim, "Preliminary design of tall building structures with a hexagrid system", Procedia Engineering, 171 (2017) 1085–1091.

[2]. IS 1893 (Part 1):2016, "Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions and Buildings (Fifth Revision)", Bureau of Indian Standard, New Delhi.

[3]. IS 456:2000, "Plain and Reinforced Concrete – Code of practice (Fourth Revision)", Bureau of Indian Standard, New Delhi.

[4]. IS 875(Part 1):2015, "Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures Part 1 Dead Loads – Unit weights of building materials and stored materials (Second Revision)", Bureau of Indian Standard, New Delhi.

[5]. IS 875(Part 2):2015, "Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures Part 2 Imposed Loads (Second Revision)", Bureau of Indian Standard, New Delhi.

[6]. IS 875(Part 3):2015, "Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures Part 3 Wind Loads (Second Revision)", Bureau of Indian Standard, New Delhi. Vol. 2, Issue 3, PP 2295–2300.

[7]. K. Jani, P. V. Patel, "Analysis and Design of Diagrid Structural System for High Rise Steel Buildings", Procedia Engineering, 51 (2013) 92–100.

[8]. K. S. Moon, "Diagrid Structures for Complex-Shaped Tall Buildings", Procedia Engineering, 14 (2011) 1343–1350.

[9]. R. D. Deshpande, S. M. Patil, S. Ratan, "Analysis and comparison of diagrid and conventional structural system", International Research Journal of Engineering and Technology (IRJET), June 2015,