Comparative Study Between Conventional System & Diagrid Structural System With Module Variation

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Abstract- *The present study is aimed to understand the different structural aspects related to this system. Linear static analysis & linear dynamic analysis of different structures has been performed in ETABS. Analysis results in terms of top storey displacement, inter-storey drift, base shear, overturning moment, storey stiffness, lateral force and time period have been compared to understand the variations.*

Firstly, a comparison between diagrid and a conventional system has been studied to depict the advantages of a diagrid system.

The effectiveness of a diagrid structure mainly depends upon its module size. It's a crucial element as the entire load is distributed through it. It also plays an important role in conferring shear and bending rigidity to the structure. Hence, it becomes necessary to study the effect of module variation on different analytical parameters. Therefore diagrid structures of height varying from 24 storeys, 30 storeys & 36 storeys with variation in module size have been studied.

Comparison of Diagrid structure with a conventional frame structure depicted the importance of Diagrid System in the reduction of various lateral load parameters such as top storey displacement, inter- storey drift ratio, modal periods. Value of top storey displacement in case of conventional frame was found to be 19% higher for Earth quake loading and 34% higher for Wind loading, when compared to diagrid system.

Effect of module variation showed that module size significantly influences the structural parameters of Diagrid. In case of 24-storey, optimal size came to be 6- storey module, for 30 and 36- storey, it was 8- storey module. Thus the optimal angle came out to be in the range of 69 degrees to 75 degrees.

Keywords- Diagrid System, Storey Module, Lateral Load Parameters, Top Storey Displacement, Inter Storey Drift Ratio, Modal Periods

I. INTRODUCTION

The rapid increase in the population and scarcity of land has increased the demand of taller buildings. Expanding the building vertically seems to be an efficient option considering all the factors. As the building height increases role of lateral load (Wind and Seismic) resisting systems becomes more prominent as compared to gravity load resisting system. Basically, there are three main types of buildings: steel buildings, reinforced concrete buildings, and composite buildings. Most of the tallest buildings in the world have steel structural system, due to its high strength-to-weight ratio, ease of assembly and field installation, economy in transport to the site, availability of various strength levels, and wider selection of sections. Innovative framing systems and modern design methods, improved fire protection, corrosion resistance, fabrication, and erection techniques combined with the advanced analytical techniques made possible by computers, have also permitted the use of steel in just any rational structural system for tall buildings.

Besides this, when compared to steel, reinforced concrete tall buildings have better damping ratios contributing to minimize motion perception and heavier concrete structures offer improved stability against wind loads. All tall buildings can be considered as composite buildings since it is impossible to construct a functional building by using only steel or concrete. That is, in a critical sense, using mild steel reinforcement can make a concrete building a composite structure, and in the same way, reinforced concrete slabs can make a steel building a composite building.

1.1 Structural systems for the tall buildings are classified as follows (M. HalisGunel et.al 2006)

- Rigid frame systems
- Braced and Shear Walled Frame Systems
- Outrigger Systems
- Framed-Tube, Braced-Tube & Bundled-Tube Systems

1.2 Diagrid Structural System

Diagrids are basically an arrangement of inclined columns, as opposed to conventional vertical columns, at the perimeter of a structure making diamond shape modules along multiple floors. The diagrid system is not the same as the braced columns since in the former system; there are no vertical columns at the perimeter.

Diagrids have evolved from braced tube structures, as the perimeter configuration provides the bending resistance and rigidity while the diagonal members are spread over the facade giving rise to closely spaced diagonal elements.

Here the diagonal members act both as inclined columns as well as bracing elements and carry gravity loads as well as lateral forces. Due to their triangulated configuration mainly the axial forces arise in the members.

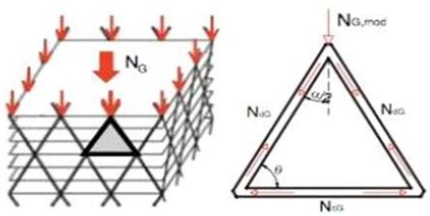


Figure 1.1: Effect of Gravity loading
(Elena Mele et.al 2014)

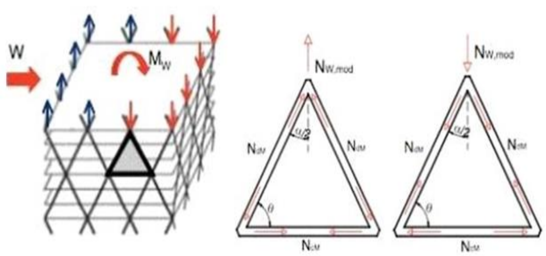


Figure1.2:Effect of Lateral loading
(Elena Mele et.al 2014)

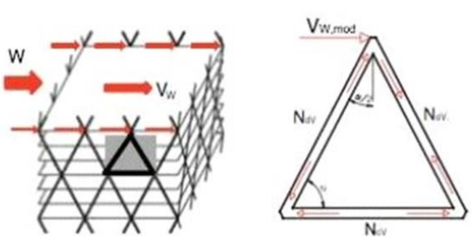


Figure1.3:Effect of Shear loading
(Elena Mele et.al 2014)

In Fig.1.1, the distribution of gravity loading is shown. The vertical load is converted to axial load along the diagonal.

In Fig.1.2, the distribution due to the moment generated by the lateral load is shown. Due to the moment one side is in tension and the other side in compression thereby acting as vertical tension force on one side and compression force on the other.

In Figure 1.3, the distribution due to shearing caused by the lateral load is shown.

1.3 Methodology

The present study was carried out to study different structural aspects related to diagrid structural system.

1. Study of previous work related to diagrid system.
2. Modelling of various structures and different forms of diagrid structures.
3. Response spectrum analysis of these structures using ETABS V-16.
4. Study of analysis results in terms of top Storey displacement, inter-Storey drift, base shear, time period, Storey stiffness and overturning moment to understand the response of different systems.

II. MODELLING AND ANALYSIS

The aim of the current chapter is to understand the load transfer mechanism and analysis of diagrid structures using ETBAS software. ETABS is chosen because of superiority of the software in modelling the building structures among different available softwares. ETABS stands for Extended Three Dimensional Analysis of Building Structures. ETABS is integrated building design software for the structural analysis of buildings

2.1Analysis Method

The Diagrid Structures are mostly suitable for tall structures, the design or the analysis of the structure should be such that it considers the effect of seismic and the wind loading. To keep in mind the effect of lateral loading in the tall buildings, designing based on gravity loads are obsolete in today’s world and has been replaced by seismic designing. Some of the seismic designing methods are as follows:

- Static Analysis method
- Dynamic Analysis method
    - Response Spectrum Analysis
    - Time History Analysis
    - Pushover Analysis

Response spectrum method is applicable for those structures where modes other than the fundamental one affect significantly the response of the structure. In this method the response of multi-degree-of-freedom (MDOF) system is expressed as the superposition of modal response, each modal response being determined from the spectral analysis of single degree of freedom (SDOF) system, which is then combined to compute the total response. This is a linear approximate method based on modal analysis and on a response spectrum definition. Modal analysis leads to the response history of the structure to a specified ground motion.

Thus, linear static analysis & response spectrum analysis has been carried out for the earthquake load while linear static analysis has been done for wind loading.

2.2 Comparative study between Conventional and a Diagrid structural system

Diagrid as the lateral load resisting system comprises of a highly efficient perimeter structural steel diagonal columns usually combined with a central, ductile, reinforced concrete core wall system. The lateral loads are resisted by a perimeter network of diagonals and horizontals in which the angles of the columns are optimized to limit lateral loads and overall shear forces. The diagonals resist both lateral and gravity loads, thus carrying them to the base of structure. Therefore, owing to this triangulated network, diagrids are more effective in resisting lateral loads as compared to other structural system.

In this section dynamic analysis of both conventional as well as diagrid structural system has been carried out to understand the behaviour of these structures under dynamic loading. Plan of both structures has been kept same. Both the structures consist of 30 stories with each Storey height of 3 meters. The structures are assumed to be located in Seismic zone 4 with medium soil. Both the Structures have a shear wall core of RCC at the centre of plan. Structural configuration is symmetrical. Angle of Diagrid has been taken as 69 degrees that is module extending to 6 stories.

2.3 Study of Effect of Module Variation in a Diagrid Structural System

Module angle is one of the important parameter that affects various structural parameters of a diagrid. As per (Moon K.S, 2007), a module angle equal to 35 degrees ensures maximum shear rigidity to diagrid system while for bending stiffness module angle of 90 degree (i.e., vertical column) ensures maximum rigidity. Thus, in diagrid systems where vertical columns are completely eliminated; both shear as well as bending stiffness has to be provided by diagonals. Therefore a balance between these two requirements has to be met to define the optimum angle of diagrid. Also the rate of increment of shear forces and bending moments toward the base of a tall building are different. Shear forces increase almost linearly whereas bending moment increase non-linearly towards the base of building. It can be said that upper portion of diagrid should be designed for shear and lower portion for bending.

Also as per (Moon K.S, 2011) as the diagrid angle becomes steeper toward the building corner, the system’s lateral stiffness increases and consequently its lateral displacement decreases. Therefore variation can be horizontally as well. Thus in order to get a range of optimal angles and to study the behaviour of Diagrid System with variation in module size, structures with number of stories as 24, 30 & 36 with variation of module sizes ranging from 4 Storey module to 8 Storey module has been taken for the study. Storey Height has been kept3 meters for all the structures. All the structures are symmetrical.

2.4 Material Properties

Following material properties have been used in the diagrid and conventional frame structures.

- Fe345 steel for all steel sections.
- M40 concrete in slabs and shear walls.
- HYSD 415 as reinforcing steel in concrete

Elastic properties of the materials are taken as per IS 456:2000 and IS 800:2007.

2.5 Building Configurations

- Plan Dimension 21*21 m
- Storey Height 3 m
- Shear Wall core Dimensions 7*7 m
- External to Core Distance 7 m

2.6 Load Definitions

- Dead load: Self-weight of the structure.
- Superimposed load due to finishing etc: 2 KN/m2
- Live Load : 3 KN/m2
- Earthquake in X-direction: As per IS 1893:2016
- Earthquake in Y-direction: As per IS 1893:2016

2.7 Lateral Load parameters (EQ)

The following Earthquake Load parameters were taken as per IS 1893:2016:

- Response reduction factor, R=5
- Seismic zone III
- Seismic zone factor, Z=0.16
- Soil Type Medium
- Importance factor I=1
- Time period Program calculated

2.8 Frame Section properties conventional system

- **Beams:**ISMB600 (internal) &ISWB550 (outer)
- **Exterior columns:**ISWB600-2
- **Shear wall:**350mm thick RCC
- **Slab:**200 mm thick RCC

2.8 Frame Section properties 24, 30 & 36 storey Diagrid system with module variation of 4, 6 & 8 storey

- **Beams:** ISMB600 (internal) & ISWB550 (outer)
- **Diagrid member:** ISNB350H
- **Shear wall:** 350mm thick RCC
- **Slab:** 200 mm thick RCC

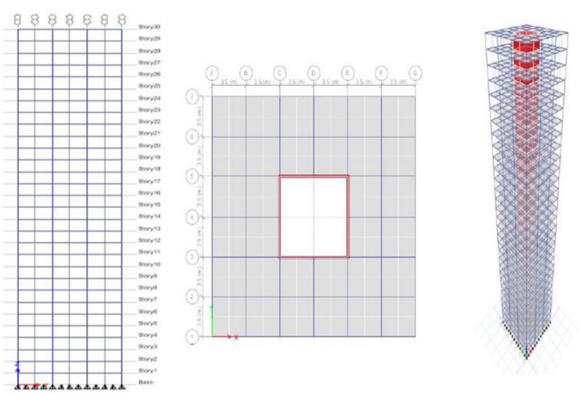


Figure1: Elevation, Plan and 3-D View of 30-Storey Conventional Moment Resisting Frame

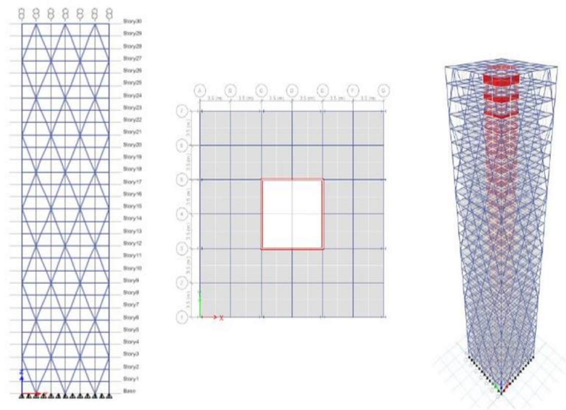


Figure 2: Elevation, Plan and 3-D View of 30- Storey Diagrid Structural System

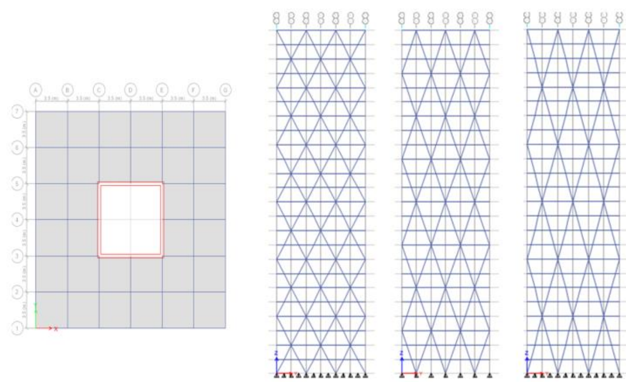


Figure 3: Plan & Elevation of 24 Storey Diagrid Structural System with 4Storey, 6Storey & 8Storey Module variation

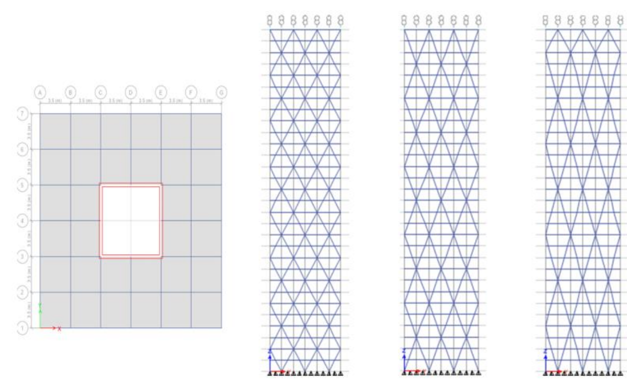


Figure 4: Plan & Elevation of 30 Storey Diagrid Structural System with 4Storey, 6Storey & 8Storey Module variation

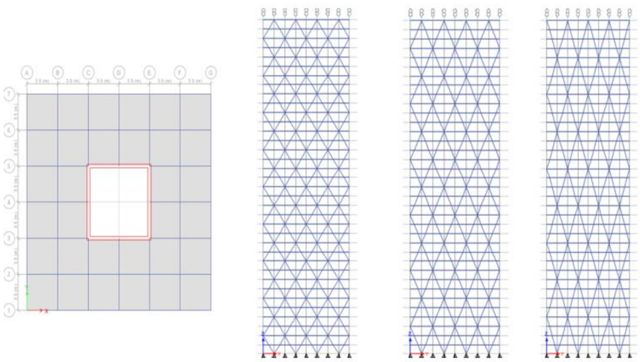


Figure 5: Plan & Elevation of 30 Storey Diagrid Structural System with 4Storey, 6Storey & 8Storey Module variation

2.10 ETABS modelling steps

ETABS is a 3Dmodelling software for any kind of structural analysis and design. Using this program we can analyse and design both steel structure and RC Structure. Here are some important steps of ETABS software for 3D modeling

- Prepare Beam-Column plan with centerline
- Enter grid spacing in ETABS i.e, centerline spacing of beams
- Enter Concrete, Rebar & Steel properties & Beam-Column sizes
- Model the structure using ETABS quick drawing tools
- Apply DL, LL, EQ & WL using IS Codes as per site conditions
- Assign support conditions
- Analyse the Structure
- Results in the form of Storey Response plots & Table

III. COMPARATIVE STUDIES BETWEEN CONVENTIONAL SYSTEM & DIAGRID STRUCTURAL SYSTEM

3.1 General

Response Spectrum Analysis for seismic loading has been carried out for all the structures using ETABS 2016 and the results are represented in the following form:

- Storey displacement
- Storey drift
- Storey shear
- Overturning moment
- Storey stiffness
- Lateral Force
- Time period

Since, in high rise structures the loads which govern the design of the structures are the lateral loads, hence the analysis results for the maximum values of these parameters due to lateral loads only are shown which are earthquake and wind loads

3.2 Study of different parameters:

The analysis results are presented in the parameters discussed above and are due to lateral loads as tall structures are critical under lateral loading. The following tables & graphs show the comparison of different parameters

3.2.1 Maximum Displacements.

Table 3.2.1: Maximum Displacements for Diagrid and Conventional System

Type of Structure	Maximum displacement (mm)	Position
Conventional Frame	31.196	Storey30
Diagrid structure	24.928	Storey30

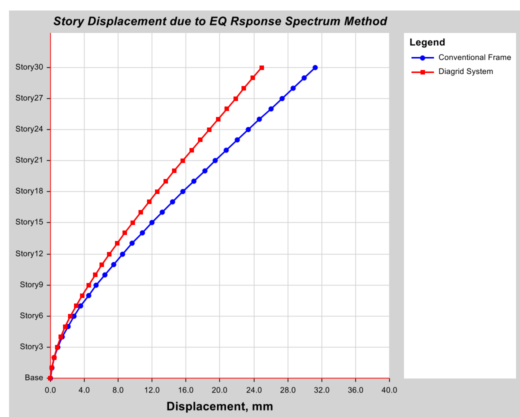


Figure 3.2.1: Maximum Displacements for Diagrid and Conventional System

3.2.2 Maximum Inter-Storey Drift Ratio

Table 3.2.2: Maximum Inter-Storey Drift Ratio for Diagrid and Conventional System

Type of Structure	Drift	Position
Conventional Frame	0.000460359	Storey25
Diagrid structure	0.000372334	Storey24

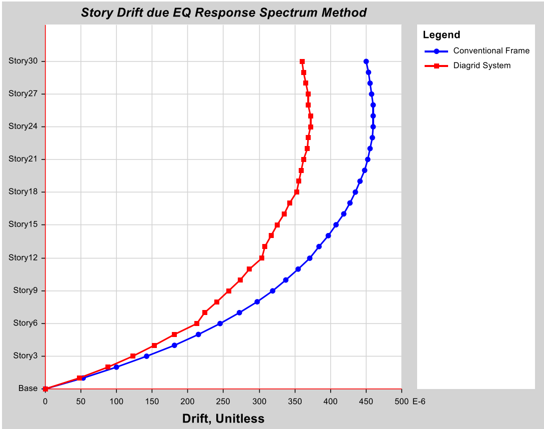


Figure 3.2.2: Maximum Inter-Storey Drift Ratio for Diagrid and Conventional System

3.2.3 Maximum Storey Shear

Table 3.2.3: Maximum Storey Shear for Diagrid and Conventional System

Type of Structure	Storey Shear kN	Position
Conventional Frame	1753.421809	Storey1
Diagrid structure	1831.543211	Storey3

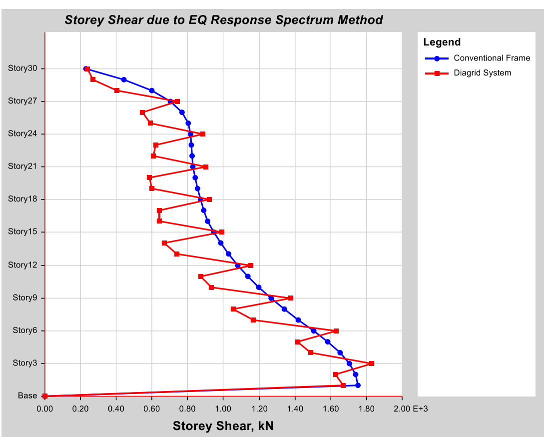


Figure 3.2.3: Maximum Storey Shear for Diagrid and Conventional System

3.2.4 Maximum Overturning Moment

Table 3.2.4: Maximum Overturning Moment for Diagrid and Conventional System

Type of Structure	Overturning Moment kN-m	Position
Conventional Frame	6.74 x 104	Base
Diagrid structure	5.96 x 104	Storey3

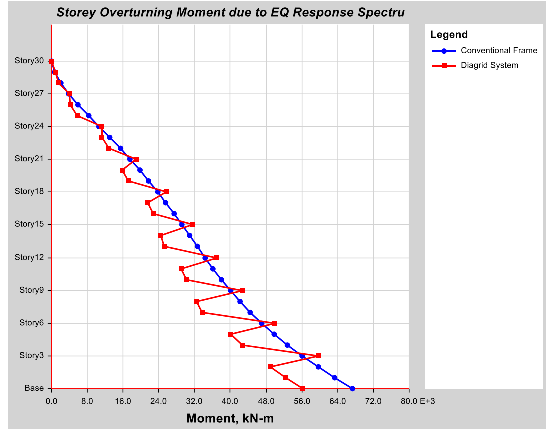


Figure 3.2.4: Maximum Overturning Moment for Diagrid and Conventional System

3.2.5 Maximum Storey Stiffness

Table 3.2.5: Maximum Storey Stiffness for Diagrid and Conventional System

Type of Structure	Storey Stiffness kN/m	Position
Conventional Frame	1.17 x 107	Storey1
Diagrid structure	1.24 x 107	Storey1

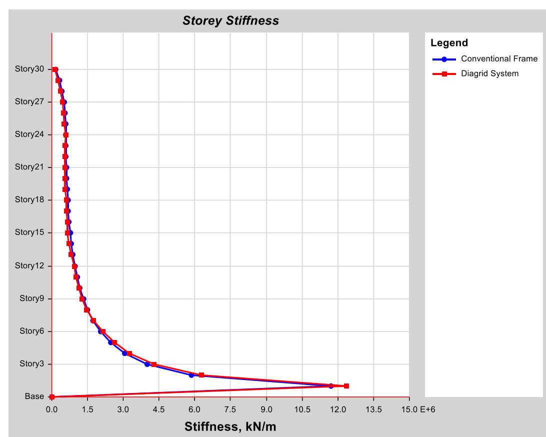


Figure 3.2.5: Maximum Storey Stiffness for Diagrid and Conventional System

3.2.6 Maximum Lateral Force

Table 3.2.6: Maximum Lateral Force for Diagrid and Conventional System

Type of Structure	Lateral Force kN	Position
Conventional Frame	165.779	Storey29
Diagrid structure	165.985	Storey29

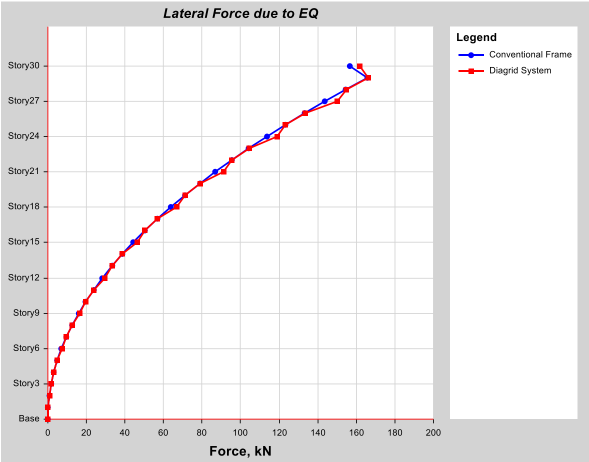


Figure 3.2.6: Maximum Lateral Force for Diagrid and Conventional System

3.2.7Maximum Time Period

Table 3.2.5: Maximum Maximum Time Period for Diagrid and Conventional System

Type of Structure	TIME PERIOD (Sec)
Conventional Frame	4.258
Diagrid structure	3.683

3.3 Observations:

- Diagrid system maximum top Storey displacement is 24% less for Earthquake loading as compared to the conventional frame system.
- The top Storey displacement in case of Diagrid System is which is well below the permissible range which is H/500 (180 mm), where H is the height of the structure as per Indian Standards
- Maximum value of Inter Storey Drift ratio for the conventional system is higher than Diagrid System for EQ
- Inter Storey Drift ratio is also well within the permissible range which is .004 as per Indian Standards
- Time period for the first mode is 15% less for the diagrid system (3.683 Sec) as compared to conventional system (4.258 Sec)
- Thus, the diagrid system resist the lateral loads more effectively as compared to the conventional system as the diagrid system has an external lateral load resisting system in the form of diagrids.

IV. EFFECT OF MODULE VARIATION IN A DIAGRID SYSTEM

4.1 General

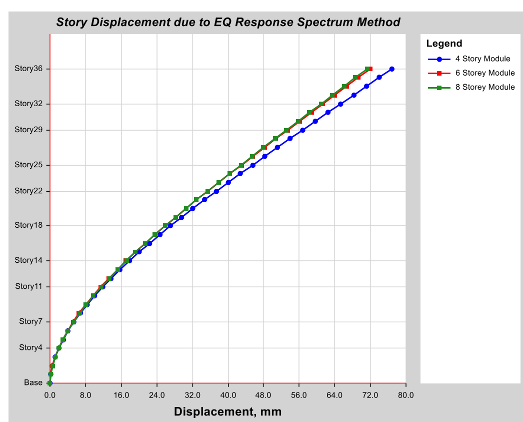
Diagrid Structures of different heights ranging from 24 Storey, 30 Storey & 36 Storey with module variation of 4 Storey, 6 Storey & 8 Storey were modelled and analysed and the results are presented in the form of tables & graphs

4.2 Study of different parameters:

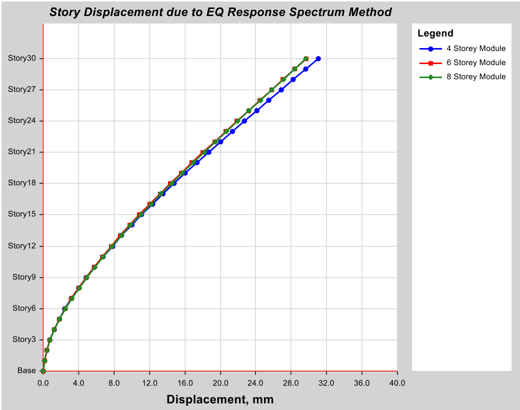
4.2.1 Maximum Displacements

Table 4.2.1: Maximum Displacements for Response Spectrum Method

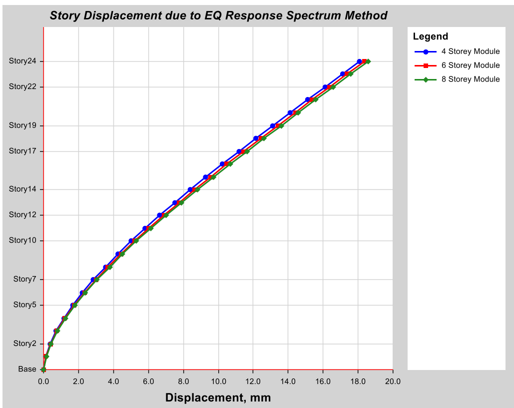
No of storeys of diagrid structure	Module Variation	Maximum displacement (mm)	Position
36 Storey	4 Storey	76.854	Storey36
	6 Storey	71.907	Storey36
	8 Storey	71.272	Storey36
30 Storey	4 Storey	31.03	Storey30
	6 Storey	29.699	Storey30
	8 Storey	29.636	Storey30
24 Storey	4 Storey	18.1	Storey24
	6 Storey	18.372	Storey24
	8 Storey	18.586	Storey24



(b) 36 Storey Structure



(b) 30 Storey Structure



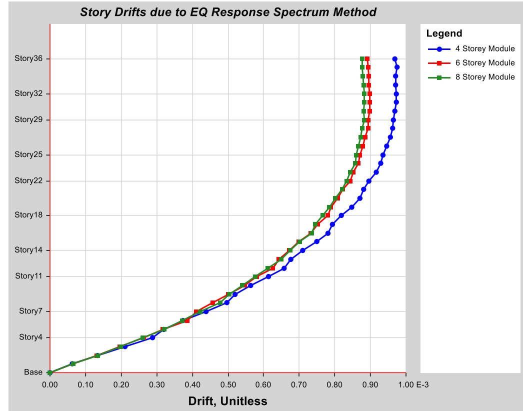
(b) 24 Storey Structure

Figure 4.2.1: Maximum Displacements for Response Spectrum Method

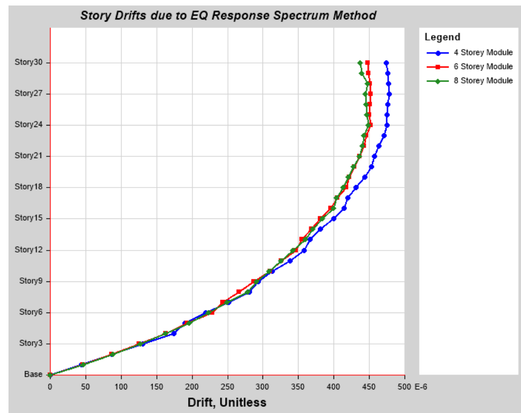
4.2.2 Maximum Inter-Storey Drift Ratio

Table 4.2.2: Maximum Inter-Storey Drift Ratio for Response Spectrum Method

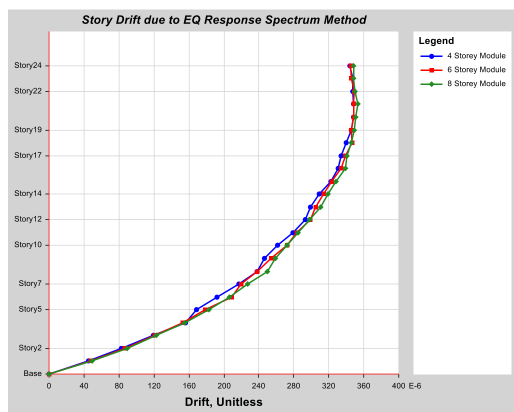
No. of Storeys of Diagrid structure	Module Variation	Drift	Position
36 Storey	4 Storey	0.000974	Storey35
	6 Storey	0.000898	Storey30
	8 Storey	0.000884	Storey32
30 Storey	4 Storey	0.000478	Storey27
	6 Storey	0.000451	Storey28
	8 Storey	0.000448	Storey28
24 Storey	4 Storey	0.000348	Storey20
	6 Storey	0.000349	Storey22
	8 Storey	0.000353	Storey21



(b) 36 Storey Structure



(b) 30 Storey Structure



(b) 24 Storey Structure

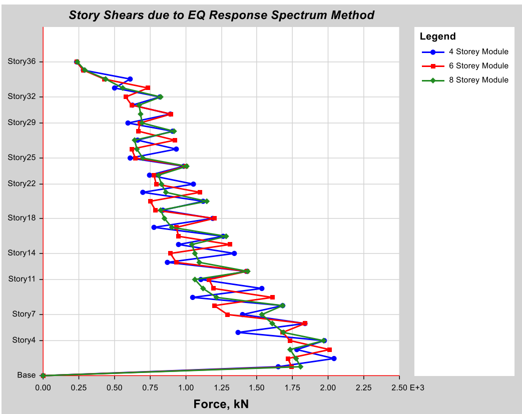
Figure 4.2.2: Maximum Inter-Storey Drift Ratio for Response Spectrum Method

4.2.3 Maximum Storey Shear

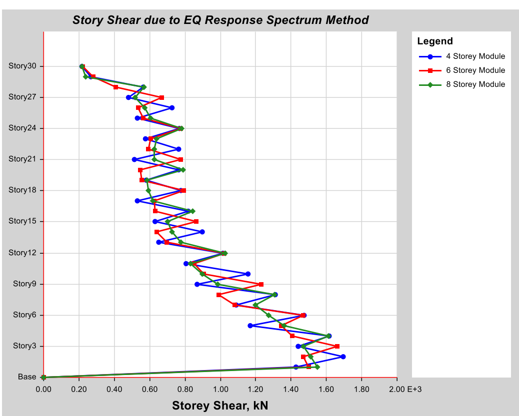
Table 4.2.3: Maximum Storey Shear for Response Spectrum Method

No. of Storeys of Diagrid structure	Module Variation	Storey Shear kN	Position

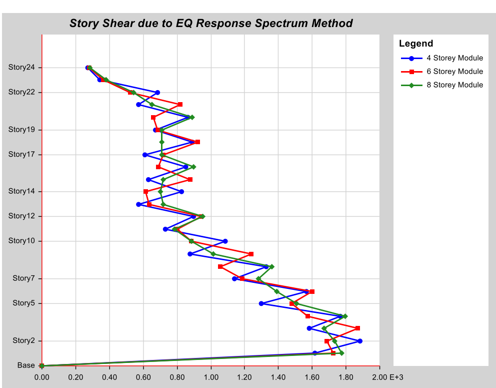
36 Storey	4 Storey	2040.2437	Storey2
	6 Storey	2011.7628	Storey3
	8 Storey	1967.6333	Storey4
30 Storey	4 Storey	1695.1841	Storey2
	6 Storey	1662.105	Storey3
	8 Storey	1611.0173	Storey4
24 Storey	4 Storey	1882.0709	Storey2
	6 Storey	1870.2892	Storey3
	8 Storey	1794.7911	Storey4



(b) 36 Storey Structure



(b) 30 Storey Structure



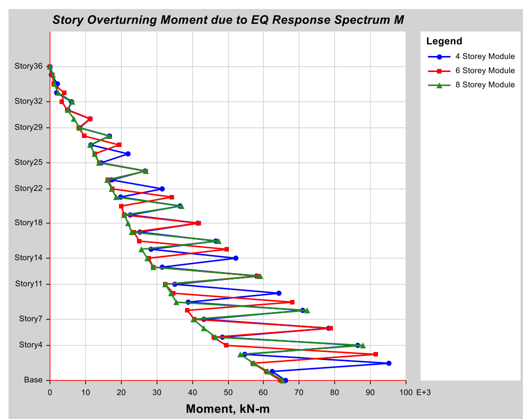
(b) 24 Storey Structure

Figure 4.2.3: Maximum Storey Shear for Response Spectrum Method

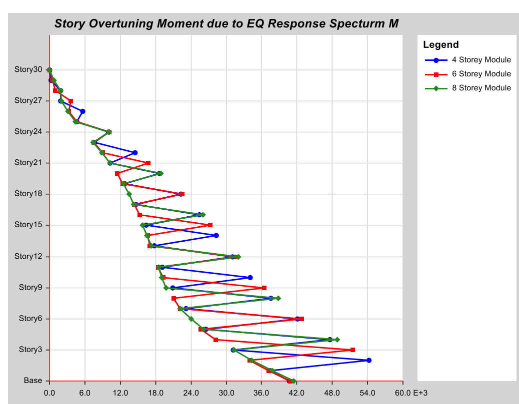
4.2.4 Maximum Overturning Moment

Table 4.2.4: Maximum Overturning Moment for Response Spectrum Method

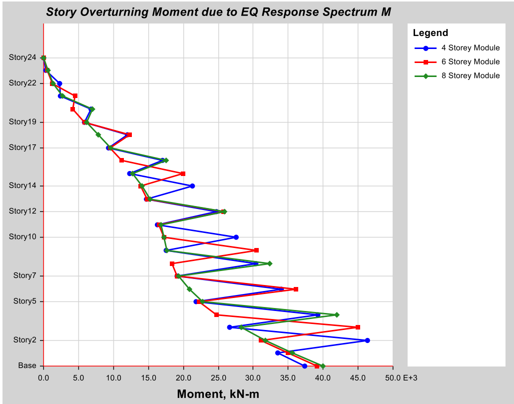
No. of Storeys of Diagrid structure	Module Variation	Overturning Moment kN-m	Position
36 Storey	4 Storey	9.52×10^4	Storey2
	6 Storey	9.14×10^4	Storey3
	8 Storey	8.79×10^4	Storey4
30 Storey	4 Storey	5.42×10^4	Storey2
	6 Storey	5.15×10^4	Storey3
	8 Storey	4.88×10^4	Storey4
24 Storey	4 Storey	4.63×10^4	Storey2
	6 Storey	4.50×10^4	Storey3
	8 Storey	4.20×10^4	Storey4



(b) 36 Storey Structure



(b) 30 Storey Structure



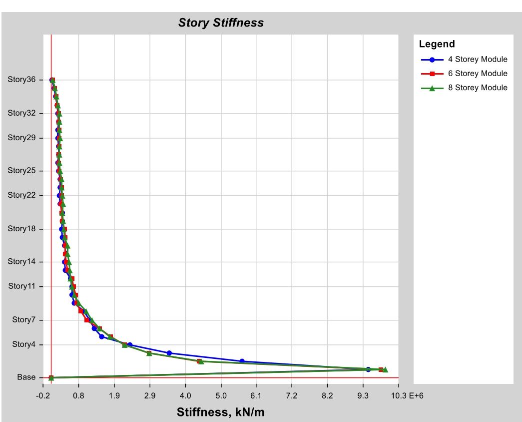
(b) 24 Storey Structure

Figure 4.2.4: Maximum Overturning Moment for Response Spectrum Method

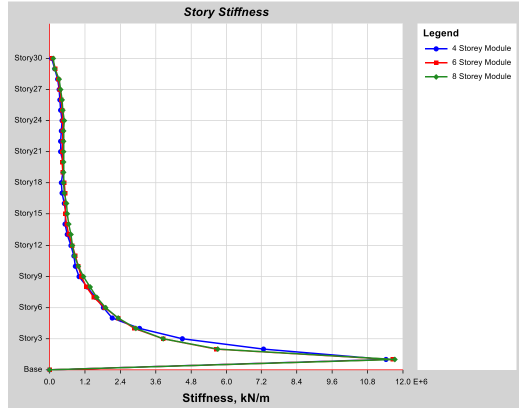
4.2.5 Maximum Storey Stiffness

Table 4.2.5: Maximum Storey Stiffness for Response Spectrum Method

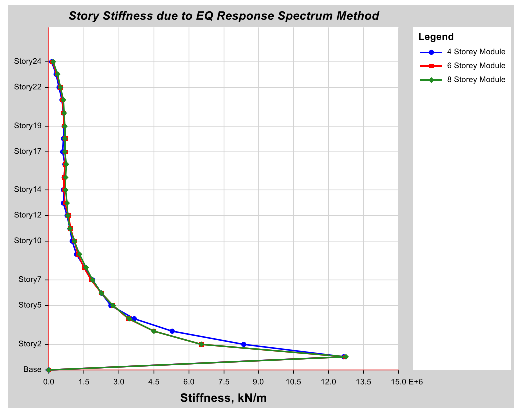
No. of Storeys of Diagrid structure	Module Variation	Storey Stiffness kN/m	Position
36 Storey	4 Storey	9.43×10^6	Storey1
	6 Storey	9.80×10^6	Storey1
	8 Storey	9.93×10^6	Storey1
30 Storey	4 Storey	1.14×10^7	Storey1
	6 Storey	1.17×10^7	Storey1
	8 Storey	1.17×10^7	Storey1
24 Storey	4 Storey	1.27×10^7	Storey1
	6 Storey	1.27×10^7	Storey1
	8 Storey	1.27×10^7	Storey1



(b) 36 Storey Structure



(b) 30 Storey Structure



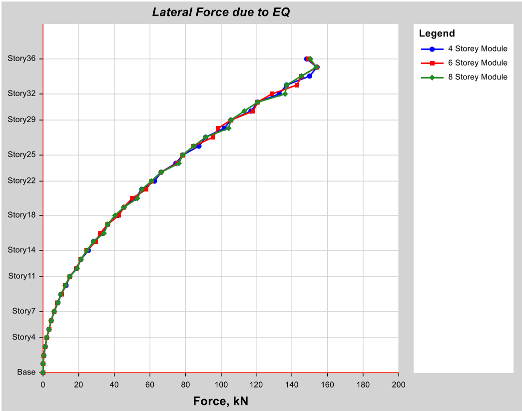
(b) 24 Storey Structure

Figure 4.2.5: Maximum Storey Stiffness for Response Spectrum Method

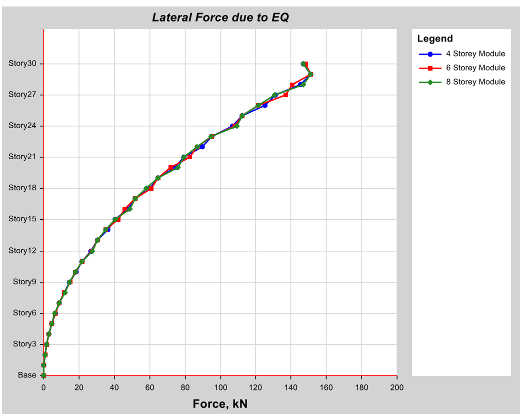
4.2.6 Maximum Lateral Force

Table 4.2.6: Maximum Lateral Force

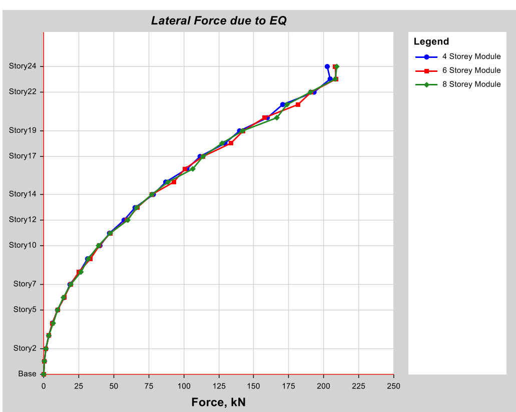
No. of Storeys of Diagrid structure	Module Variation	Lateral Force kN	Position
36 Storey	4 Storey	153.937	Storey35
	6 Storey	153.882	Storey35
	8 Storey	153.846	Storey35
30 Storey	4 Storey	151.101	Storey29
	6 Storey	151.048	Storey29
	8 Storey	150.977	Storey29
24 Storey	4 Storey	204.674	Storey23
	6 Storey	208.589	Storey23
	8 Storey	209.129	Storey24



(b) 36 Storey Structure



(b) 30 Storey Structure



(b) 24 Storey Structure

Figure 4.2.6: Maximum Lateral Force

4.2.7 Maximum Time Period

Table 4.2.7: Maximum Lateral Force

No. of Storeys of Diagrid structure	Module Variation	Time Period (Sec)
36 Storey	4 Storey	6.424
	6 Storey	6.181
	8 Storey	6.128
30 Storey	4 Storey	4.437
	6 Storey	4.306
	8 Storey	4.284
24 Storey	4 Storey	2.872
	6 Storey	2.817
	8 Storey	2.821

4.3 Observations:

- Maximum top Storey displacement is minimum for 8-Storey module. Whereas, value is maximum for the 4-Storey module in 36 & 30 Storey Diagrid Structures
- Maximum top Storey displacement is minimum for 6-Storey module. Whereas, value is maximum for the 4- Storey module in 24 Storey Diagrid Structure
- The top Storey displacement in case of Diagrid System is which is well below the permissible range which is H/500 (216, 180 & 144 mm for 36, 30 & 24 Storey Diagrid Structure), where H is the height of the structure as per Indian Standards
- Inter-Storey Drift Ratio is minimum for 8-Storey module. Whereas, value is maximum for the 4-Storey module in 36&30 Storey Diagrid Structures
- Inter-Storey Drift Ratio is minimum for 6-Storey module. Whereas, value is maximum for the 4-Storey module in 24 Storey Diagrid Structure
- Inter Storey Drift ratio is also well within the permissible range which is .004 as per Indian Standards
- Base shear is found to be minimum for 8- Storey module as compared to others as dead load will be reduced due to less number of diagrids in 36 & 30 Storey Diagrid Structures
- Base shear is found to be minimum for 6- Storey module in 24 Storey Diagrid Structure
- modal period for the first mode is found to be maximum for 4- Storey module as compared to other module sizes. Modal Period is least for the case of 8-Storey module in 36 & 30 Storey Diagrid Structures
- modal period for the first mode is found to be minimum for 6- Storey module in 24 Storey Diagrid Structure
- Lateral Force due to Wind & EQ is found to be minimum for 8- Storey module in 36 & 30 Storey Diagrid Structure & for 6- Storey module in 24 Storey Diagrid Structure
- Overturning Moment is found to be minimum for 8-Storey module as compared to others as dead load

will be reduced due to less number of diagrids in 36 & 30 Storey Diagrid Structures and Overturning Moment to be minimum for 6- Storey module in 24 Storey Diagrid Structure

- Storey Stiffness is found to be more for 8- Storey module as compared to others as dead load will be reduced due to less number of diagrids in 36 & 30 Storey Diagrid Structures and Storey Stiffness to be more for 6- Storey module in 24 Storey Diagrid Structure
- Thus, 8-Storey module (diagrid angle of 74 degrees) found to be optimum for 36 & 30 Storey Diagrid Structures & 6-Storey module (diagrid angle of 69 degrees) found to be optimum for 24 Storey Diagrid Structures considering the above parameters.

V. CONCLUSION

5.1 Summary

- In this work, a comparison has been drawn between a diagrid and a conventional system to depict the effectiveness of diagrid system in tall steel buildings.
- Effect of module variation on the structural behaviour of diagrid system and calculation of optimum angles for different building heights is done

5.2 Conclusion

From the analysis of various types of diagrid structures it is concluded:

Comparison of Diagrid structure with a conventional frame structure depicted the importance of Diagrid System in the reduction of various lateral load parameters such as top Storey displacement, inter- storey drift ratio, modal periods.

- Value of top Storey displacement in case of conventional frame was found to be 19% higher for Earthquake loading when compared to diagrid system.
- For maximum inter storey drift, value for conventional system found to be 19% higher for Earthquake loading when compared to diagrid system.
- Value of modal period for the first mode was 13.5% higher in case of conventional frame building.
- This is all due to the fact that diagrid system has an external lateral load resisting system which can serve the purpose of resisting gravity loads as well.
- Whereas in case of Conventional System there isn't any lateral load resisting system and the loads are resisted through flexural action.
- Thus for the tall structures where lateral loads govern the design, diagrid is a better option.

Results of effect of module variation showed that module size significantly influences the structural parameters of Diagrid. Optimal size of module is thus critical for the design of diagrid. In case of 24 Storey, optimal size came to be 6 Storey module (diagrid angle of 69 degrees), for 30 and 36 Storey, it was 8 Storey module (diagrid angle of 74 degrees).

- Thus the optimal angle came out to be in the range of 69 degrees to 74 degrees.
- Thus it can be concluded that as the height of building is increasing optimal size also increases. It is also to be noted that smaller size of module would result in more number of nodes which is not desirable as nodes are complex to design as well as fabricate. But on the other hand they provide smaller unsupported length which is desirable from design point of view.

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