Journal of Science Engineering Technology and Management Science *ISSN: 3049-0952*
Volume 03, Issue 04, April 2026 *www.jsetms.com*

SEISMIC LOAD ANALYSIS AND WIND LOAD ANALYSIS OF 25 STOREY BUILDING COMPARATIVE ANALYSIS OF G+20 DIA GRID BUILDING IN DIFFERENT SESIMIC ZONES BY USING ETABS

P SUBHASRI[1], KONDEPOGU ABHINESH[2], SHAIK ARSHAD[3], POLUDASU DEEPAK KUMAR[4]

[1]Assistant Professor Department of Civil Engineering, Dr.K.V.Subba Reddy Institute of Technology, Opp: Dupadu Railway Station, NH-44, Laksmipuram – Post, Kurnool, Andhra Pradesh 518218

[2, 3, 4]UG Scholar, Department of civil engineering, Dr.K.V.Subba Reddy Institute of Technology, Opp: Dupadu Railway Station, NH-44, Laksmipuram – Post, Kurnool, Andhra Pradesh 518218

Submitted: 18-02-2026 Accepted: 23-03-2026 Published: 01-04-2026

Abstract In modern era, construction of high-rise buildings is rapidly increasing throughout the world. Due to decrease of available free land and due to wide spread urban area, the architects and the engineers have started developing cities vertically. Recently, the dia grid structural system has been widely used for tall buildings due to structural efficiency and aesthetic potential provided by triangulation of the system. Compared to the conventional frame buildings having exterior vertical column, dia grid structure resists the lateral loads more efficiently due to presence of inclined columns. In dia grid system the lateral loads are resisted by the axial action of the inclined columns that are placed at the exterior periphery of the buildings. Seismic isolation and energy dissipating systems present an effective way to common seismic design for improving the seismic performance of structures. These techniques reduce the seismic forces by changing the stiffness and damping in the structures, whereas conventional seismic design is required for an additional strength and ductility to resist seismic forces.

In the present study a 21 storied dia grid building is analyzed with in different seismic zones by using ETABS software . The results like story drift, story shear, story bending, time period, model stiffness are compared for different seismic zones as response spectrum analysis.

Key words: diagrid, ETABS, Seismic isolation, story drift, story shear, story bending, time period, model stiffness.

This is an open access article under the creative commons license
https://creativecommons.org/licenses/by-nc-nd/4.0/
CC BY-NC-ND 4.0

1. INTRODUCTION

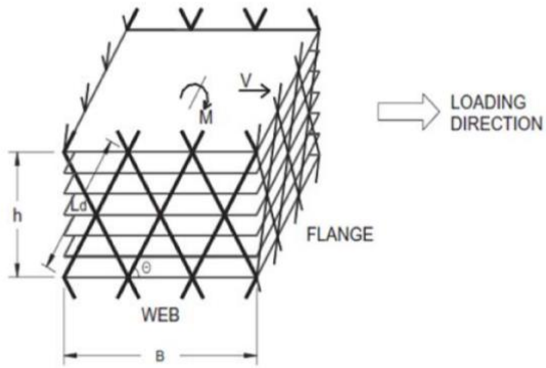
The contemporary architectural design trend has produced various complex shaped tall buildings such as twisted, tilted, tapered and freeform towers. As the height of building increase, the lateral load resisting system becomes more important than the structural system that resists the gravitational loads. The lateral load resisting systems that are widely used are: rigid frame, shear wall, wall-frame, braced tube system, outrigger system and tubular system. Recently, the diagrid structural system is widely used for tall steel buildings due to its structural efficiency and aesthetic potential provided by the unique geometric configuration of the system.

Diagrid is a particular form of space truss. It consists of perimeter grid made up of a series of triangulated truss system. Diagrid is formed by intersecting the diagonal and horizontal components. The famous examples of diagrid structure all around the world are 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. The new headquarter for Central China Television (CCTV) in Beijing is one of the examples of utilization of diagrid structural system to support the challenging shape. Diagrid has good appearance and it is easily recognized.

The configuration and efficiency of a diagrid system reduce the number of structural element required on the facade of the buildings, therefore less obstruction to the outside view. The structural efficiency of diagrid system also helps in avoiding interior and corner columns, therefore allowing significant flexibility with the floor plan. Perimeter diagrid system saves approximately 20 percent of the structural steel weight when compared to a conventional moment-frame structure.

Diagrid Structure

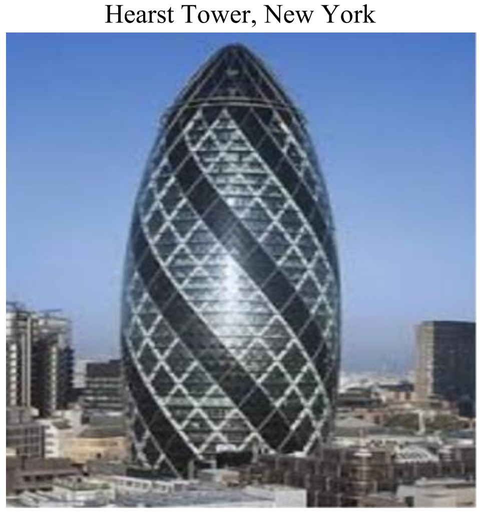
Diagrid (diagonal grids) structure is a system of triangulated beams, straight or curved and horizontal ring that together make up a structural system for a skyscrapers (Tall Building).In short, it is made up of intersecting diagonal and horizontal components. It requires less structural steel than a conventional steel frame. Diagrid has good appearance and it is easily recognized. The configuration and efficiency of a diagrid system reduce the number of structural element required on the façade of the buildings, therefore less obstruction to the outside view. The structural efficiency of diagrid system also helps in avoiding interior and corner columns, therefore allowing significant flexibility with the floor plan. Perimeter "diagrid" system saves approximately 20% structural steel weight when compared to a conventional moment-frame structure.



Diagrid structure

There are so many diagrid structures constructed all over the world as shown in the images below

Hearst Tower, New York



SwissRe, London, UK

Objectives of the study

The following are the main objectives of the project

1. To study the seismic behavior of building by using IS 1893:2002
2. To analyse the 25 stories dia grid building in different seismic zones.
3. To compare the results of story drift, shear force, bending moment, building torsion of buildings.
4. To study the multi story buildings in ETABS in Response spectrum analysis.

2. LITERATURE REVIEWS

Khushbu Jani, et. al. studied comparison of analysis results in terms of time period, top storey displacement and inter-storey drift. ETABS software is used for modeling and analysis of structural members. All structural members are designed as per IS 800:2007 considering all load combinations. Dynamic along wind and across wind are considered for analysis and design of the structure. Load distribution in dia grid system is also studied for 36 storied building. Similarly, analysis and design of 50, 60, 70 and 80 storied dia grid structures is carried out.

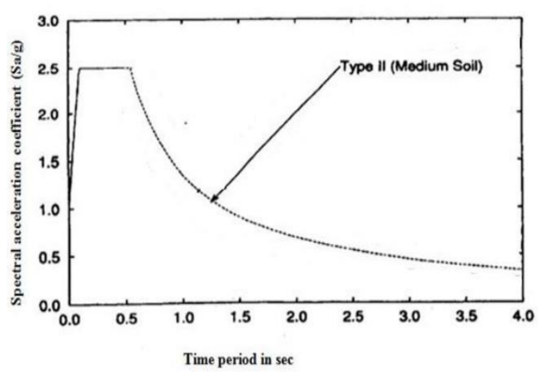
Femy Maria Thomas, et. al. studied the concept of steel diagrid structural system by conducting literature review, then optimum configuration for building and optimum angle for diagrid is found out comparing square, rectangular and circular building with same plan area using ETABS software. Square and circular Diagrid buildings perform almost equally better than rectangular diagrid buildings and circular Diagrid buildings perform better than square diagrid buildings.

Rohit Kumar Singh, et. al. studied comparison of analysis results in terms of storey drift, node to node displacement, bending moment, shear forces, area of reinforcement, and also the economical aspect is presented. Drift in Diagrid building is approximately half to that obtained in conventional building. In these steel reinforcement used in Diagrid structure is found to be 33% less compared to conventional building. It is observed that due to diagonal columns in periphery of the structures, the Diagrid structure is more effective in lateral load resistance. They concluded that the diagrid buildings show structural performance, material saving property, better resistance to lateral loads, aesthetic look.

3. METHODOLOGY USED IN THE STUDY

RESPONSE SPECTRUM METHOD

The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2002 (part1). Here type of soil, seismic zone factor should be entered from IS 1893-2002 (part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABS 2013 software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g).



Response spectrum for medium soil type for 5% damping

This approach permits the multiple modes of response of a building to be taken in to account (in the frequency domain). This is required in many building codes for all except very simple or very complex structures. The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the “harmonic” computer analysis can be used to determine these modes for a structure. For each mode, a response is read from the design spectrum, based on the modal frequency and the modal mass, and they are then combined to provide an estimate of the total response of the structure. In this we have to calculate the magnitude of forces in all directions i.e. X, Y & Z and then see the effects on the building. Combination methods include the following:

- absolute - peak values are added together
- square root of the sum of the squares (SRSS)
- complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes

The result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum.

In cases where structures are either too irregular, too tall or of significance to a community in disaster response, the response spectrum approach is no longer appropriate, and more complex analysis is often required, such as non-linear static analysis or dynamic analysis.

Wind load analysis as per IS 875:1987 Part 3:

Buildings are subject to horizontal loads due to wind pressure acting on the buildings. Wind load is calculated as per IS 875(Part III)-1987. The horizontal wind pressures act on vertical external walls and exposed area of the buildings. Some of the pressure acting on exposed surfaces of structural walls and columns is directly resisted by bending of these members. The infill walls act as vertical plate supported at top and bottom by floor beams, thus transferring the loads at slab level. The parapet wall is at terrace transfers the wind loads to the surface slab by cantilever action. For simplicity, the wind loads acting on exposed surfaces of a given storey are idealized to be supported by upper and lower floors.

Wind load analysis as per IS 875 (Part 3)-1987:

Wind forces acting on a given surface is equal to the wind pressures multiplied by the effected area.

Design wind speed (Vz):

Design wind speed is given by the equation

Vz= Vb K1 K2 K3

where Vz =Design wind velocity (m/sec)

Vb= Basic wind speed in m/sec (Based on Appendix -A of various cities in IS 875 –Part 3)

Basic wind speed Vb, depends on the location of the building. For this purpose, the country is divided in to six zones with specified wind speeds ranging from 33m/s to 55 m/s. Basic wind speed is based on gust velocity averaged over a short time interval of 3 seconds at 10m height from mean ground level in an open terrain and for 50 years return period.

4. PROBLEM STATEMENT AND BUILDING MODELS

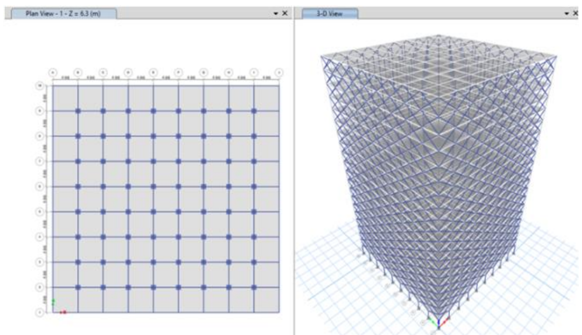
Problem statement

In the present study, analysis of G+20 multi-story dia grid building is carried Basic parameters considered for the analysis are

1. Utility of building : Residential building
2. Number of stories : G+20
3. Shape of building :Square
4. Type of walls : Brick wall
5. Geometric details
   a. Ground floor : 3.3m
   b. floor to floor height : 3m
6. Material details
   a. Concrete Grade : M40 (COLUMNS AND BEAMS)
   b. All Steel Grades : HYSD reinforcement of Grade Fe550
   c. Bearing Capacity of Soil : 200 KN/m^2
7. Type Of Construction : R.C.C FRAMED structure

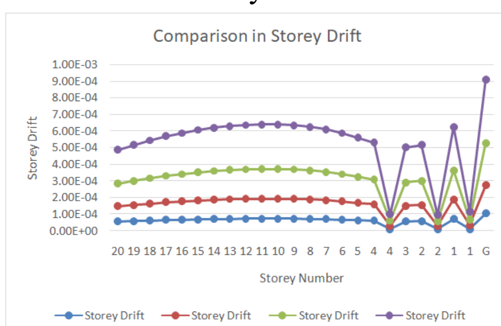
8. Column : 0.8m X 0.8m
9. Beams : 0.80m X 0.69m
10. Slab : 0.150m
11. Live load :3.5kN/m2
12. Dead load :2Kn/m2
13. Seismic zone :II,III,IV,V
14. Soil type :medium
15. RCC code :IS 456-2000
16. Steel code :IS 800-2007
17. Seismic code :IS 1893:2016
18. Wind code :IS 875:2015

BUILDING MODEL IN ETABS SOFTWARE



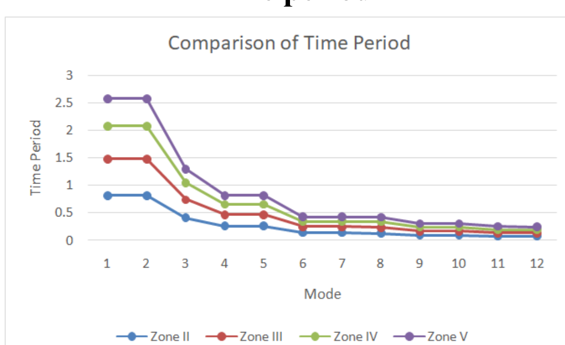
5. RESULTS AND ANALYSIS

Storey drift

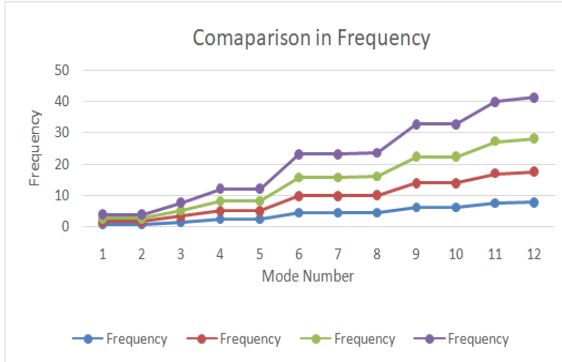


Comparison in Storey Drift

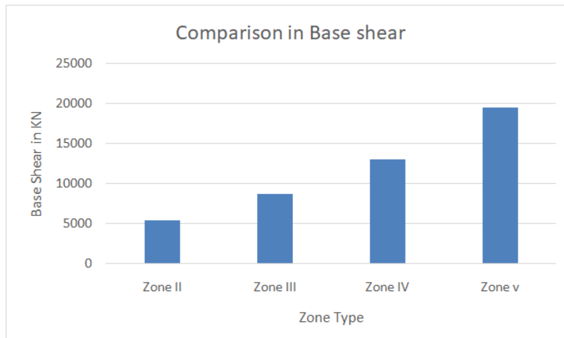
Time period



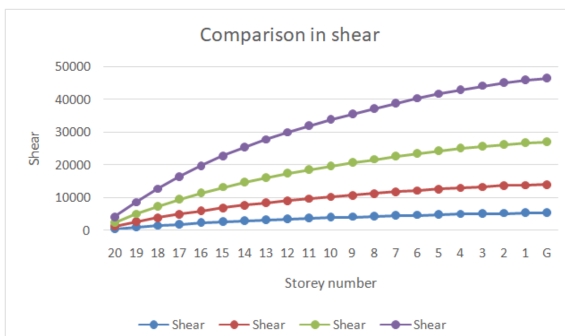
Comparison of time period



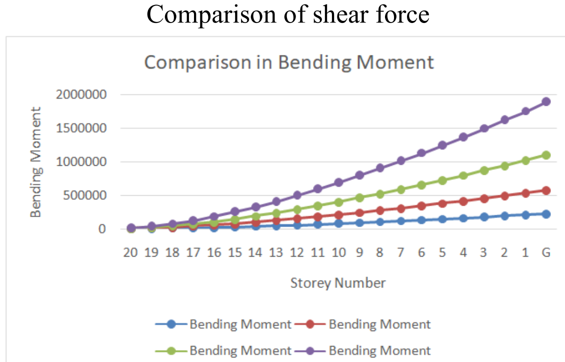
Comparison of frequency



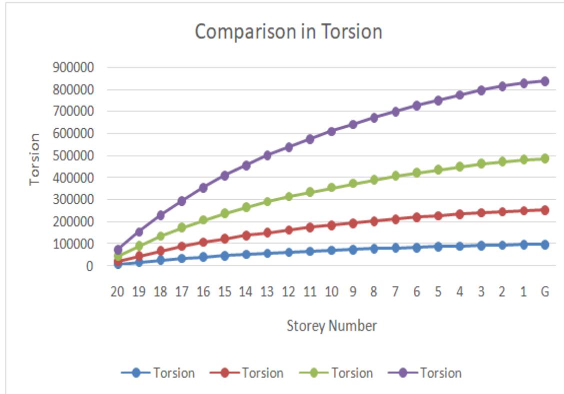
Comparison of base shear



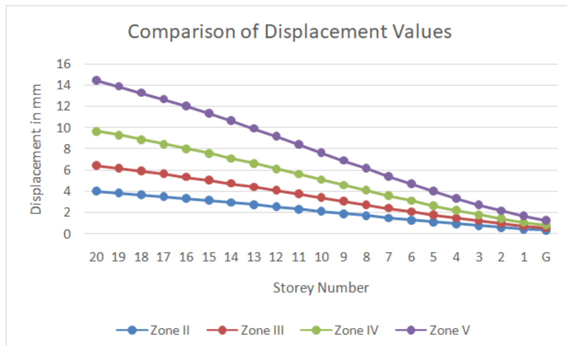
Comparison of shear force



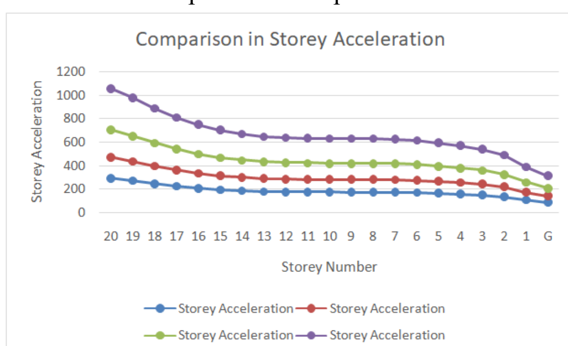
Comparison in bending moment



Comparison in torsion



Comparison of displacement



Comparison in Storey Acceleration

6. CONCLUSIONS

From the above analysis results of the structural models the following conclusions were made

1. From the study it is observed that most of the lateral load is resisted by diagrid columns on the periphery, while gravity load is resisted by both the internal columns and peripheral diagonal columns.
2. So, internal columns need to be designed for vertical load only. Due to increase in lever arm of peripheral diagonal columns, diagrid structural system is more effective in lateral load resistance.
3. Lateral and gravity load are resisted by axial force in diagonal members on periphery of structure, which make system more effective. Diagrid structural system provides more flexibility in planning interior space and façade of the building.
4. The values of storey drift are obtained high for the Zone V seismic condition when we observed with other seismic zones.
5. By increase in the seismic zone from Zone II to Zone V the values of base shear increases
6. From the above analysis results it also observed that in Zone V seismic condition the shear force, bending moment and torsion values are high when we compared with other seismic zones.

7. The values of storey displacement has high values in Zone V than remaining zones namely Zone II, Zone III and Zone IV.

8. The values of base shear high values in Zone V due to the effect of high seismic coefficient factor as per IS 1893-2016 code.

9. The intensity of time period are less in Zone V when we compared with other seismic Zones.

10. The intensity of frequency are less in Zone V when we compared with other seismic Zones.

REFERENCES

1) **Anirudha , Dr. R A Duba,et al.,(2021),** Patel, K., Patel, P. V., &Mevada, S. (2020). Design and Analysis of Core and Outrigger Structural System. June, 3026–3033.

2) **Shital S Wani, Pranav G Kokate,et al.,(2022),** Comparison of Diagrid and Conventional Structural System, International Research Journal of Engineering and Technology (IRJET). 2015;2(3).Gupta A, Saini P. Analysis and design of concrete diagrid building and its comparison with conventional frame building, International Research Journal of Engineering and Technology (IJSR).

3) **Adarsh M. Kadekar, Dr.V.S.Thorat,et al.,(2023),**DengjiaFang,"MechanicalCharacteristicsandDeformationcalculationofdiagridstructures inhigh risebuildings"Journalof buildingengineering ,Volume-42,October-2021.

4) **Yugandhara Rahul Sonawane, R. S. Patil,et al.,(2025),** Ali, M., & Moon, K. (2007). Structural developments in tall buildings: Current trends and future prospects. Architectural Science Review.

5) **Abhishek Admane,Sharif H. Shaikh,et al.,(2021),** Kiran Kamath et al. On November 30, 2016, the research gate for An Analytical Study on the Performance of a Diagrid Structure Using Nonlinear Static Pushover Analysis will open.

6) **Harshitha R P,Manjunath N Hegde,Mary Bhagya Jyothi J,et al.,(2023),** Arbaz Ahmad Lone, Gurpreet Singh and Jagdish Chand, "Comparative Study on Dynamic Analysis of Diagrid Bracings and Shear Wall in Different Locations in Terms of Sustainability using ETABS," IOP Conference Series: Earth and Environmental Science, Volume: 1110, Issue: 01, PP: 1-13, February 2023.

7) **Priyanka Panwar1, and Anubhav Rai,et al.,(2023),**Kudumula, A., Ghorpade, D. V. G., & Rao, D. H. S. (2017). Seismic Performance of RC Framed Buildings Under Linear Dynamic Analysis. International Journal of Civil Engineering and Technology.

8) **Surchandrajeet Kamble, P.S.Lande,et al.,(2023),** Giovanni Maria Montuori ⇑, Elena Mele, Giuseppe Brandonisio, Antonello De Luca Secondary bracing systems for diagrid structures in tall buildings

9) **Manish S. Ramteke, Kirti R. Padmawar,et al.,(2025),** Priyanka Panwar and Anubhav Rai "Comparative Analysis of Conventional RCC Structure and Diagrid Structure of U-Shape Plan" 2023. Mr. Dheekshith K, Ms. Durga, Mr. Bhavani Shankar "Comparative study of regular and irregular plan geometric diagrid structure on varying soil stratum under lateral loading" 2020.Performance of Tubular Frame, Diagrid, Pentagrid, and Hexagrid Structural Systems using ETABS" 2022.

10) **Arvish Panchal1, Aakash Suthar,et al.,(2022),** Rahimian A. and Eilon Y., "Hearst Headquarters: Innovation and Heritage in Harmony", CTBUH 8th World Congress, Dubai, March 2008.