ANALYSIS OF G+20 DIA GRID STRUCTURAL SYSTEM BY USING ETABS SOFTWARE

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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: *dia grid, ETABS, Seismic isolation, story drift, story shear, story bending, time period, model stiffness.*

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 seismic isolators and energy dissipating devices are seen to be effective solutions within this context, which are placed in the building appropriately to damp the seismic energy or placed between the foundation and vertical structural systems damping the seismic energy under the ground of the building, thus decreasing the effects of lateral loads on top floors. Application of earthquake protection systems in buildings whether will be constructed and were

constructed -especially the historical ones-, increases the importance of these technologies.

1.1 Dia grid 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.

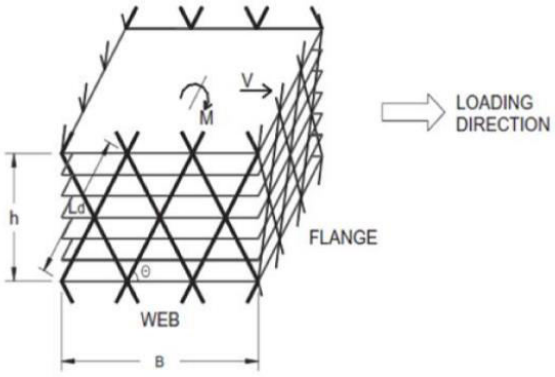


Fig 1: Dia grid structure

1.2 Objectives of the study

The following are the main objectives of the project

1. To study the seismic behavior of dia grid building with isolation systems by using IS 1893:2002
2. To analyse the 21 stories dia grid building in high seismic zone.
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 Software in Response spectrum analysis.

2. LITERATURE REVIEWS

Priyanka Panwar, and Anubhav Rai et al.,(2023)

In this work, the concrete diagrid structure is analysed and compared with the conventional concrete building according to earthquake conditions. This paper considers G+3, G+11 and G+19 storey RC buildings with plan size 15 m x15 m located in zones II and III for analysis. ETABS 17 software is used for the study of structural members. This paper compares maximum storey displacement, maximum storey drift, storey stiffness, shear force and bending moment with different results. From this work it is concluded that displacement is less in zone 2 and zone 3 in the diagrid building.

Mr. Anirudha Date, Dr. R A Dubal et al.,(2021)

The results are compared to corresponding moment resisting frames and concentrically braced frames in terms of tale drift, time length, base share, and displacement in diagrids. Practical design guidelines are suggested using virtual work/energy diagrams and nonlinear seismic analysis using ETABs for G+7, G+11, and G+16 to improve nonlinear behaviour and increase collapse load potential of diagrid structures in high seismic regions with time history and Pushover analysis. From the result we concludes that the diagrid structure is more economical than normal structures up to the 11th floor, but G+16 less economical than the G+7 and G+11 structures.

KOKKONDA SOUMYA, et al.,(2022)

In the present study a10 stories building is analyzed by using ETABS software by using dia grids in different seismic zones. The results like story drift, story shear, story bending and time period, are compared with bare frame building model. From this study it is observed that most of the lateral load is resisted by dia grid columns onthe periphery, while

gravity load is resisted by both the internal columns and peripheral diagonal columns.

3. METHODOLOGY USED

3.1 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).

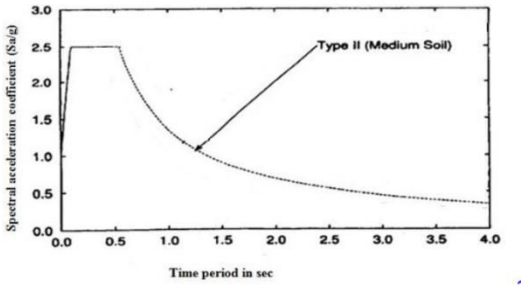


Fig 2: Response spectrum for medium soil type for 5% damping

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.

4. DESIGN CONSIDERATIONS AND MODELING OF BUILDING

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 : Rectangular
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 Fe500
   c. Bearing Capacity of Soil : 200 KN/m^2
7. Type Of Construction : R.C.C FRAMED structure
8. Column : 0.69m X 0.69m
9. Beams : 0.69m X 0.3m
10. Slab : 0.150m
11. Live load :3.5kN/m2

12. Dead load :2Kn/m2
13. Seismic zone :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

4.1 BUILDING MODEL IN ETABS SOFTWARE

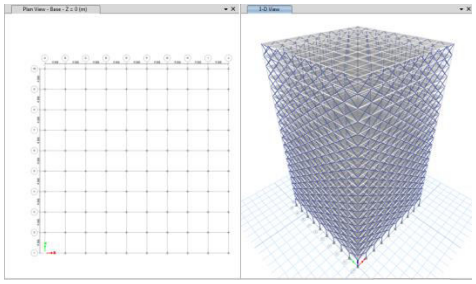
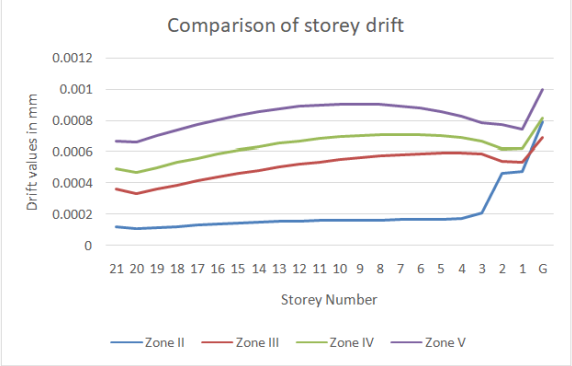
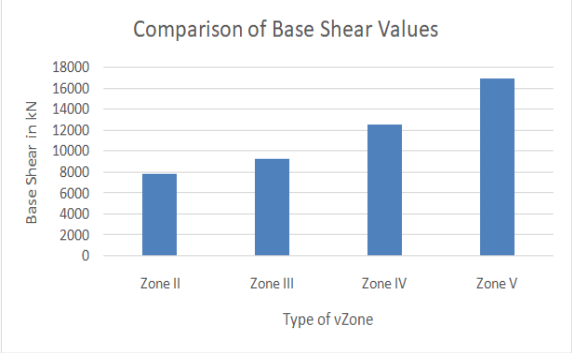


Fig 3: Building 3D Model in ETABS

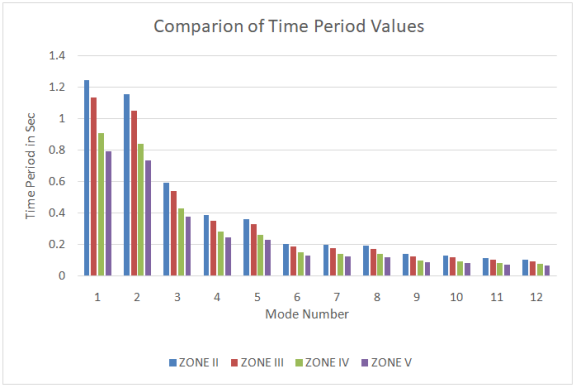
5. RESULTS AND ANALYSIS



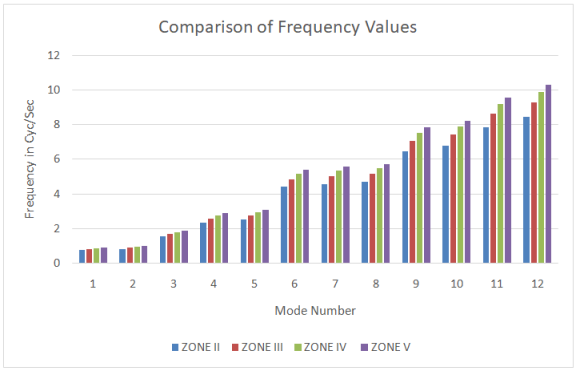
Graph 1: Comparison of storey drift in mm



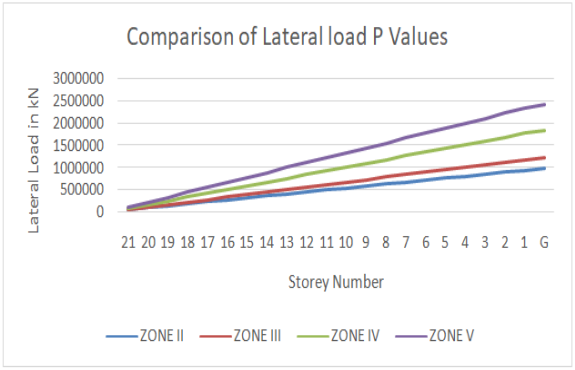
Graph 2: Comparison of Base Shear Value in KN



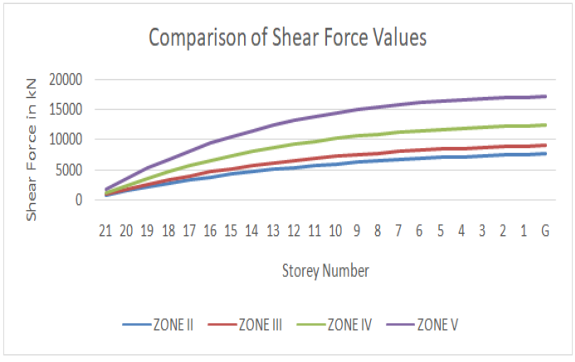
Graph 3: Comparison of Time Period Values



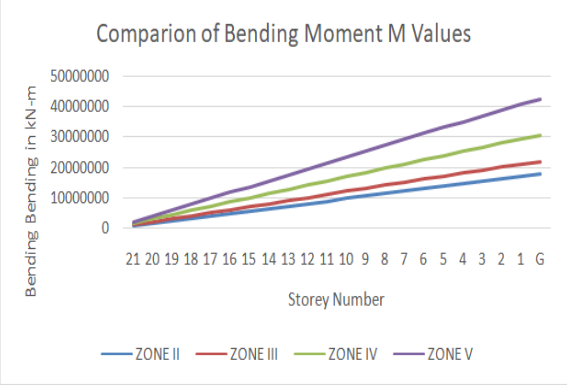
Graph 4: Comparison of Frequency Values



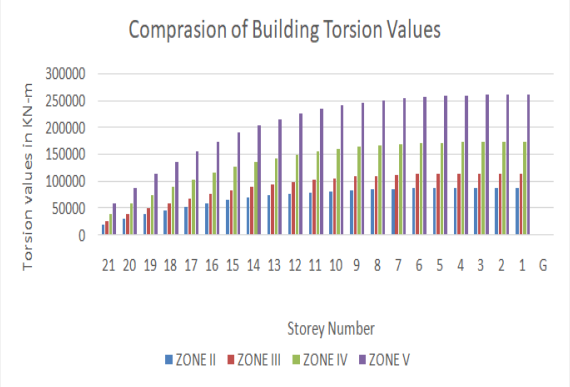
Graph 5: Comparison of Lateral load P Values



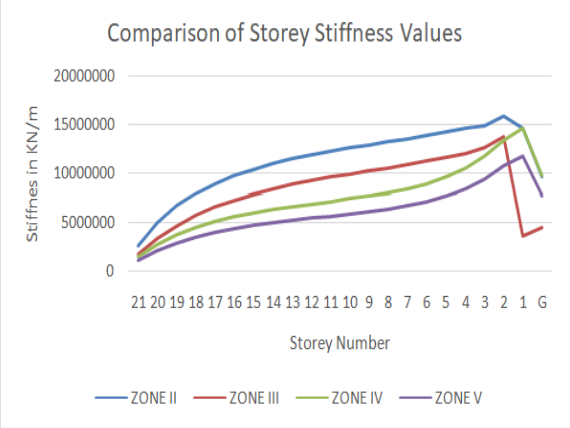
Graph 6: Comparison of Shear Force



Graph 7: Comparison of Bending Moment M



Graph 8: Compression of Building Torsion Values



Graph 9: Comparison of Storey Stiffness Values

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

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