BUILDING HAVING DIFFERENT HEIGHT

Mr. Raskar Apurv Vinayak[1], Dr. Pujari A.B.[2] Prof. Undre A.R [3]

[1]Student M.E. Dept. of Civil Engineering, KJ college of engineering and management research, Pune

[2]PG-Co-Ordinator, Dept of Civil Engineering, KJ college of engineering and management research, Pune 48

[3]Assistant Professor, Dept of Civil Engineering, KJ college of engineering and management research, Pune 48

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Abstract - Buildings located in seismically active regions must be built with an emphasis on their lateral stability during severe earthquakes. The contemporary idea of reversing the direction of the vertical column to a diagonal column helps in the transfer of all forces to axial forces. Diagrid (Diagonal Grid of Columns) is a revolutionary new structural system intended to increase the lateral stability of a structure. The aesthetics and structural benefits of the diagrid structural system have made it a popular choice for a wide variety of buildings worldwide, including many notable high-rise projects built in recent years. This article examines the nonlinear behaviour and design of mid-to-high-rise RCC diagrid structures. The findings are compared to those obtained for comparable moment resistant frames and concentrically braced frames in terms of storey drift, time duration, base share, and diagrid displacement. Practical design recommendations are given for diagrid structures in high seismic areas utilising virtual work/energy diagrams and nonlinear seismic analysis using ETABs for G+7, G+11, and G+16 to enhance nonlinear behaviour and boost collapse load potential using time history and Pushover analysis.

Keywords: Diagrid structure, seismic forces, time history analysis, and pushover analysis

I. INTRODUCTION

The term "earthquake" refers to any kind of seismic event that generates seismic waves, whether natural or induced by people. Earthquakes are often triggered by the rupture of a seismic fault, although they may also be triggered by volcanic activity, mine explosions, landslides, and nuclear testing. Numerous constructions have main structural systems that do not meet current seismic requirements and therefore sustain significant damage during an earthquake. According to the Seismic Zoning Map of IS: 1893-2002, India is split into four seismic zones. The four zones are II, III, IV, and V. Certain businesses build full-scale models and do significant study before mass manufacturing thousands of identical systems that have been researched and designed with test results in mind. Regrettably, the building sector may lack this option, making large-scale production impossible. While many contemporary constructions in India are constructed in accordance with Indian standard code 456:2000, IS 1893-2002 should be added to make buildings more earthquake resistant.

In certain instances, gravity loads are the sole loads acting on these systems, resulting in elastomeric structural behaviour. However, during a severe earthquake, a system may be subjected to forces greater than its elastic limit. Following the most recent earthquake in the past four decades, which significantly damaged or destroyed many concrete buildings, it has been critical to evaluate the seismic appropriateness of existing or proposed structures. As a consequence, the structure's hazard susceptibility must be determined. Simplified linear elastic methods are not optimal for pursuing or attaining this objective. As a consequence, structural engineers developed a new modelling methodology and seismic protocol that combines performance-based structures and nonlinear methods.

The four kinds of analysis are linear static, linear dynamic, nonlinear static, and nonlinear dynamic. The first two are appropriate only when systemic loads are modest and stress strains are less than the elastic maximum. Following an earthquake, structural loads may surpass collapse pressure, resulting in material stresses beyond their yield points. To achieve good findings in this scenario, it is necessary to include both material and geometric nonlinearity into the research. Pushover analysis is a fundamental technique for determining the nonlinear static nature of a structure. Thus, this project will cover pushover analysis utilising output thresholds, the pushover curve, and the pushover analysis methodology.

A. Thought

The diagrid (a portmanteau of diagonal grid) is a building and roof design structure made up of diagonally crossing metal, concrete, or wood beams. It utilises less structural RCC than a conventional RCC frame. The diagrid structural system is described as a framework comprised of diagonal elements produced by the junction of various materials such as metals, concrete, or wooden beams that is used to construct structures and roofs. The diagrid constructions of the RCC members are effective in terms of strength and stiffness. However, diagrid is increasingly widely utilised in big span and high rise structures, especially those with complicated geometries and curved forms. The diagrid's diagonal member carries both shear and moment. As a result, the optimum angle at which the diagonals should be placed is depending on the building's height. In a typical building, the optimum angle of the columns for greatest bending stiffness is 90 degrees, whereas the optimal angle of the diagonals for maximum shear rigidity is 35 degrees. The optimum angle for the diagrid is considered to be between these two. Typically, a range of 60 to 70 degrees is used. As a building's height rises, the optimum angle likewise increases.

B. Advantages

The diagrid system offers a number of advantages that may favour it above other systems in the designer's opinion. Several of these advantages include the following:

• The exterior and interior are mostly column-free.

• Abundant natural light owing to the absence of internal columns and construction.

• Approximately a fifth decrease in RCC is feasible.

• Straightforward building methods (although they need to be perfected yet).

• Optimal use of structural materials.

• Similar design/construction tolerances as a normal moment frame structure (for example, in an M.F. project, a type. columnar element would be built 1/8th of an inch longer than required to account for compression in the final result). Similarly, for a Diagrid project).

• Uncomplicated and distinct floor designs are available.

• Predominantly aesthetic and emotive.

C. Goals

• To investigate the behaviour of RC plane frames and Diagrid structures when subjected to seismic stresses (Earthquake loads).

• To conduct non-linear analysis on the diagrid structure using ETABS.

• To investigate the Diagrid structure's performance in relation to various factors such as storey drift, storey displacement, and base shear.

• To conduct a pushover analysis on the demand capacity curves of diagrid and conventional structures.

II. SYSTEM ENGINEERING

Three G+7, G+11, and G+16 diagrid building models for RCC were developed and evaluated in ETABs for various shear wall locations in zone V with subsoil Type medium - II. Both structures are exposed to the same earthquake packing in order to confirm seismic activity with the same storey and storey height. These simulations are analysed using a variety of seismic analysis approaches, but in this study, both linear static and non-linear static methods are utilised. The methods are detailed below.

A. Analysis Techniques

The Equivalent Static Method is used to determine the design lateral force due to an earthquake.

• **Horizontal seismic coefficient of design:**

The following expressions may be used to determine a structure's horizontal seismic coefficient Ah: - Ah equals (Z/2) X (I/R) X (Sa/g) X (Z/2) X (Z/2) X (Z/2) X (Z/2) X (Z/2) X (Z/2) X (Z/2) X (Z/2) X (Z/2)

Assume that whatever the meaning of I/R is, the value of Ah for any structure of T0.1 s cannot be less than Z/2.

What is the address?

The zone aspect is denoted by the letter Z.

I = Importance factor, which is decided by the actual use of the structure.

R=Response reduction factor, which changes in accordance with the perceived magnitude of the seismic shock.

Efficiency of the structure is an aspect to consider.

Coefficient of average response acceleration (Sa/g)

• **Seismic Base Shear Design :**

The following equation determines the overall design lateral force or seismic base shear (Vh) along any main direction:-

Vb =.W

Where W denotes the building's seismic load.

• **Force distribution in design:**

The calculated design base shear (Vb) is spread as follows along the building's height:

Qi = Vb (wihi2/wihi2).

Where,

Qi = lateral force specified at each floor level I

Wi = Seismic load on the floor i.

hi = Floor height as measured from the base.

Response Spectrum Analysis

This technique is also known as the modal form or modal superposition method. The technique may be used to structures in which modes other than the basic one have a significant influence on the structure's response. It is particularly helpful for analysing stresses and deformations in multi-story structures produced by moderate-intensity ground shaking, which produces a fairly substantial but essentially linear response in the structure. Seismic analysis's response continuum method offers analytical benefits in terms of forecasting displacements and component forces in structural systems. The method involves computing just the maximum values of displacements and participation forces in each mode using smooth design spectra that represent the average of numerous seismic movements. The seismic coefficient system evaluated just one form of vibration (single mode method). Without performing a free vibration study, a very rough time span for this mode was estimated.

III. METHODS

A. Statement of the Problem

The plan area of the proposed work is 18 × 18 m, with panels measuring 3x3 m for conventional structures with square diagrids, and comparable areas evaluated for different levels. G+7, G+11, and G+16 G+7, G+11, and G+16

The study's design parameters were as follows:

• III Seismic Zones • G+7, G+11, G+16 models

• 3.6-meter-high floor

• Both setups use the same grid size: a 3 × 3 square grid.

• 67.4° diagrid angle

• The plan is 18X18 metres in size.

• Dimensions of the column: 500mm x 500mm

• Dimensions of the beam: 300mm x 500mm

• Thickness of the slab: 125 mm

• Dimensions of the diagonals: 300X500 mm

• The concrete grade is M30.

• Fe 500 RCC grade

The project study was divided into two stages. The main data was gathered via a study of the literature, which includes internet searches and examinations of eBooks, manuals, passwords, and journal papers. Following the assessment, a problem statement is developed and a model is created for in-depth study and analysis. This study will be conducted in the following manner:

Procedure For Analyzing And Designing Software

1. Define Grids for Plans and Story Data

2. Specify Material Characteristics

3. Specify the frame sections

4. Specify the Slab Sections

5. Specify the Load Cases

6. Create Objects using Beams (Frame Members)

7. Create Objects for Columns (Frame Members)

8. Assign Sections to Slabs

9. Distribute Restraints

10. Assign Loads to Slabs

11. Tabular Display of Input Data

12. Conduct an Analysis

13. Visualize Analysis Results

14. Construct a Concrete Framing Element

IV. MODELING IN ETABS

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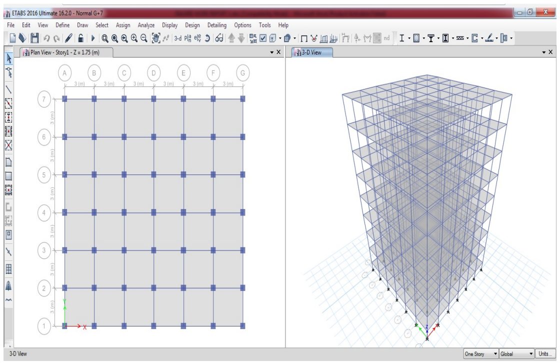
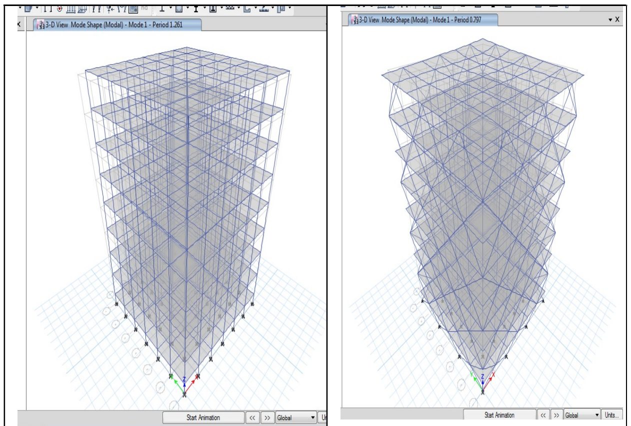
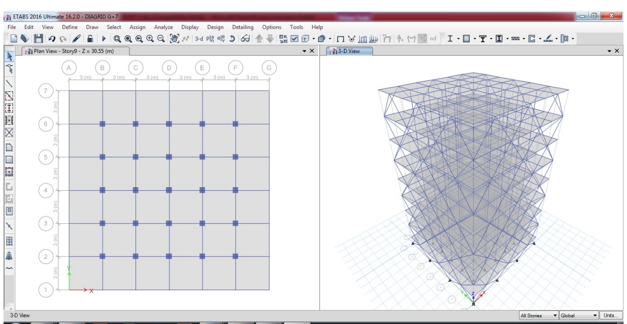


Normal Building G+7

V. RESULTS FOR THE MODEL

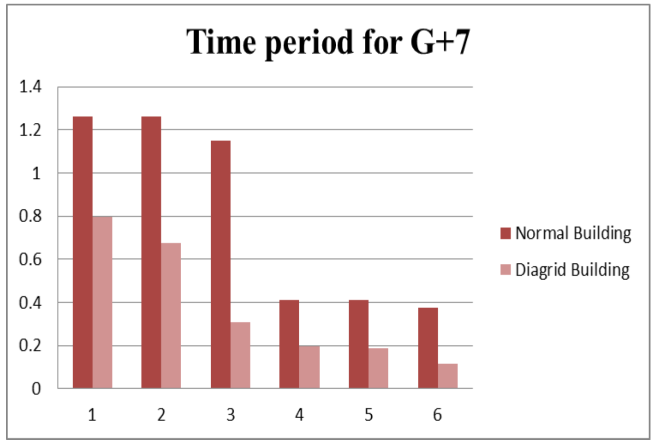


Mode Shape 1 For Normal G+7	Mode Shape 1 For Normal G+7

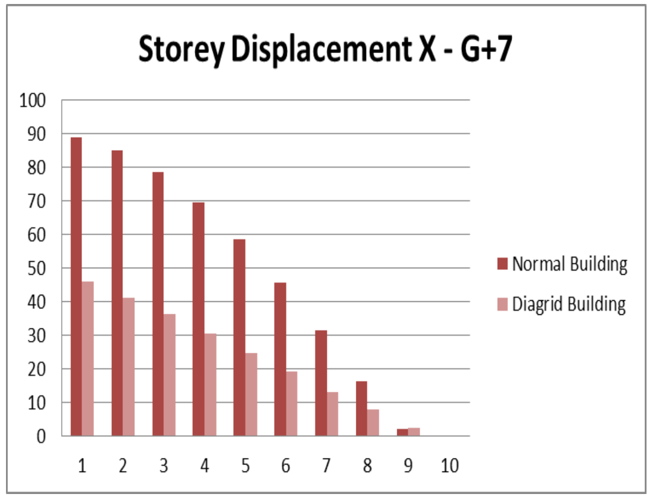


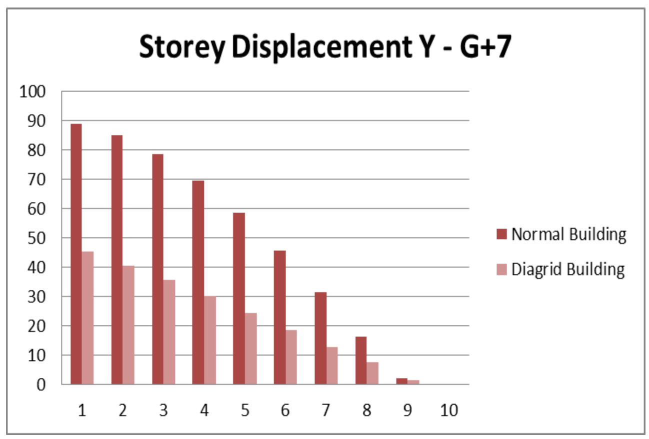
Mode	Normal Building	Diagrid Building
1	1.261	0.797
2	1.261	0.677
3	1.149	0.306
4	0.41	0.196
5	0.41	0.189
6	0.376	0.116

Time period result



time period for G + 7

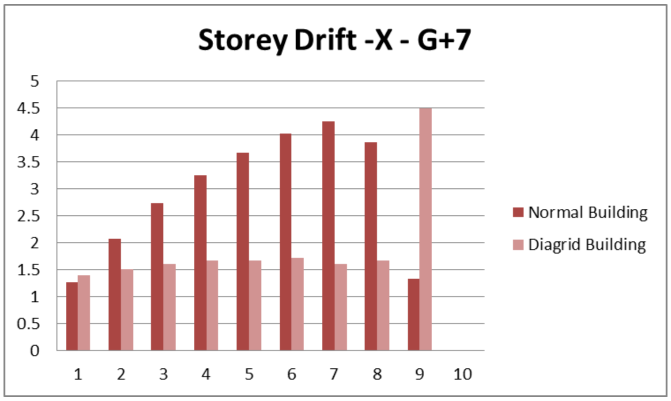




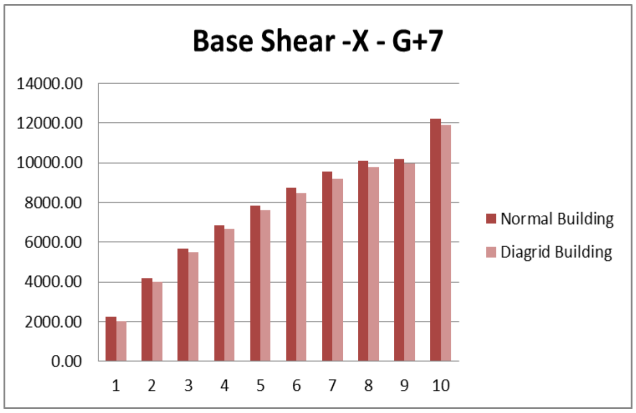
- **Storey Drift**

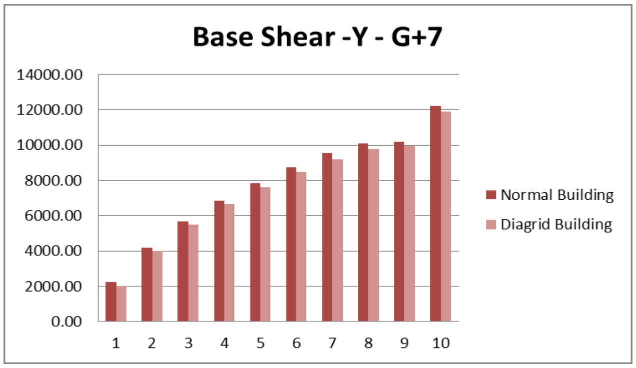
Story	Normal Building	Diagrid Building
9	1.276	1.405
8	2.078	1.507
7	2.74	1.617
6	3.256	1.678
5	3.674	1.667
4	4.024	1.722
3	4.251	1.611

2	3.871	1.677
1	1.33	4.493
Base	0	0

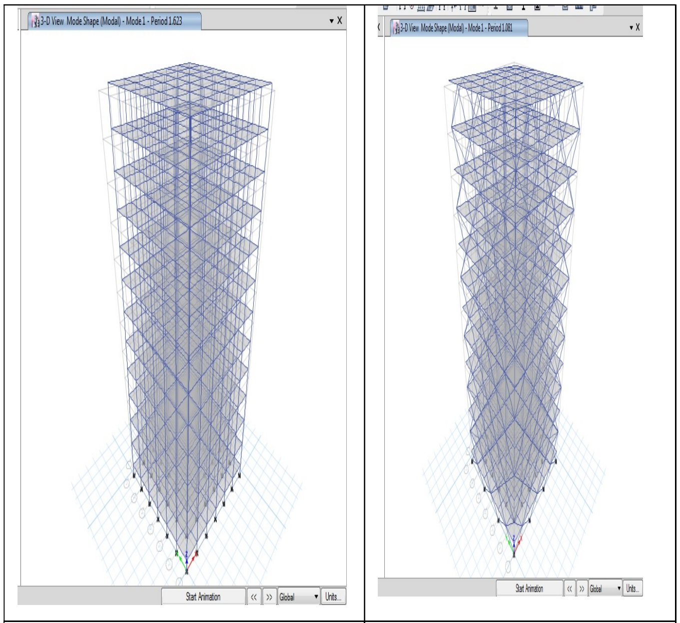


storey drift X for G + 7



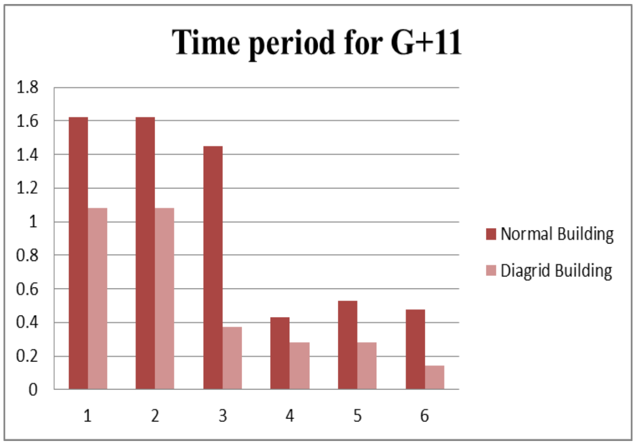


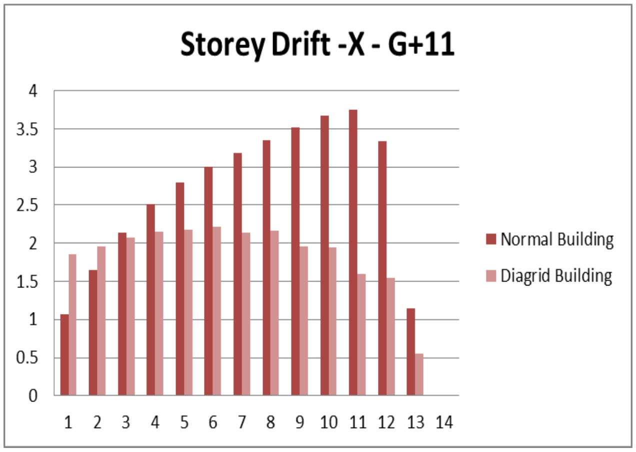
RESULTS FOR THE MODEL 2 – G+11

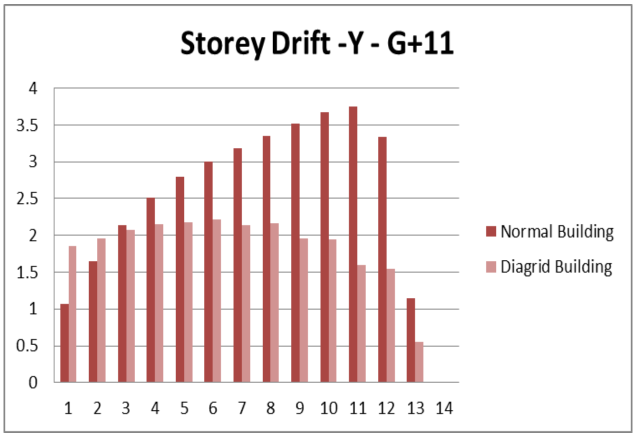


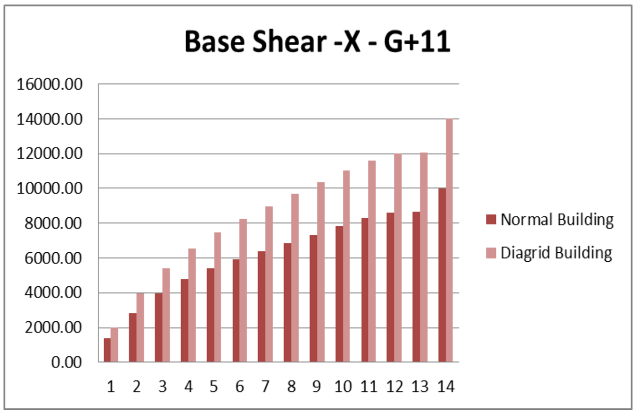
Mode Shape 1 For Normal G+11	Mode Shape 1 For Normal G+11

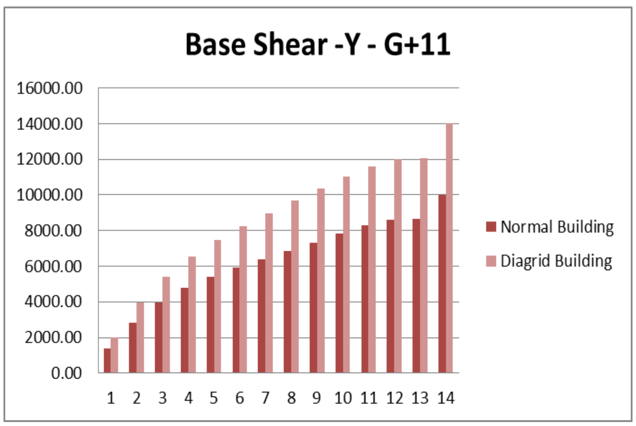
Mode	Normal Building	Diagrid Building
1	1.623	1.081
2	1.623	1.081
3	1.449	0.372
4	0.43	0.28
5	0.53	0.28
6	0.478	0.14











VI. CONCLUSIONS

- The diagrid and normal construction structures are contrasted for nonlinear analysis of response spectra for G+7, G+11, and G+16 based on the empirical review performed in this test study. The study finds that the diagrid structure is more cost effective than conventional structures up to the 11th storey, but that the G+16 structure is less cost effective than the G+7 and G+11 structures. To maintain consistency throughout this research, we do a pushover analysis on G+16 to ascertain the structure's capacity. The study indicates that the diagrid construction is capable of withstanding a higher amount of force than the conventional structure.
- • Time Period for G+7 for normal and diagrid structures for response spectrum analysis; the time period for diagrid structures is 30-40% less than for normal structures.
- • For the responcs spectrum analysis, the findings for storey displacement X for G+7 for normal and diagrid structures indicate that the diagrid structure's storey displacement is 40-50 percent less than that of the normal structure.
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- • For the responcs spectrum analysis, the findings for storey displacement Y for G+7 for normal and diagrid structures indicate that the diagrid structure has a lower storey displacement than the normal structure by 20-30 percent.
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- • For the responcs spectrum analysis, the findings for storey drift X for G+7 for normal and diagrid structures indicate that the diagrid structure has a lower storey drift than the normal structure by 30-40 percent.
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- • Base Shear X findings for G+7 normal and diagrid structures for the response spectrum analysis show that the base shear lowers the diagrid structure by 30-40% compared to the normal structure.
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- • Base Shear Y for G+7 results for normal and diagrid structure for response spectrum analysis, base shear lowers diagrid structure by 20-40% compared to normal structure
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- • Time Period for G+11 for normal and diagrid structure for response spectrum analysis; the time period for diagrid structure is 30-40% less than for normal structure.
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- • For the responcs spectrum study of Storey Displacement X for G+11 normal and diagrid structures, the storey displacement of diagrid structures is reduced by 20%-30% compared to normal structures.

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- • For the response spectrum study of the Storey Displacement Y for G+11 normal and diagrid structures, the Storey Displacement lowers the diagrid structure by 10% to 30%.
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- • Storey Drift X findings for G+11 normal and diagrid structure responcs spectrum analysis show that the Storey Drift lowers the diagrid structure by 20-30% compared to the normal structure.

- results for Storey Drift Y for G+11 for normal and diagrid structure for the responcs spectrum analysis , the Storey Drift reduces of diagrid structure than normal structure by 30-40%

- results for Base Shear X for G+11 for normal and diagrid structure for the responcs spectrum analysis , the base shear reduces of diagrid structure than normal structure by 30-40%

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COMPARATIVE Analysis OF DIAGRID STRUCTURE WITH OTHER STRUCTURAL SYSTEMS FOR TALL STRUCTURES research gate 30 june 2020 12) Vishalkumar Bhaskarbhai Patel at el.
13) On September 2, 2020, Snehal V. Mevada will present at the el. Design and Analysis of Core and Outrigger Structural System study doors.

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