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Seismic Analysis of a Tall Structure Considering Diagrid & Tuned Dampers using ETABs

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ABSTRACT

Construction of multi-storey buildings is increasing nowadays throughout the world. This is because of advances in construction methodology, materials, analysis and design software. "DIAGRID" Diagonalised Grid structure has arisen as quite possibly the most imaginative and versatile way to deal with primary structure in a thousand years. Diagrid comprises a border framework consisting of a progression of located support frameworks. Diagrid is framed by crossing the corner to corner and level parts. The corner-to-corner individuals from diagrid can convey both gravity load just as sidelong burden by pivotal activity as in support. Modellers consistently pursue new complex constructions. Diagrid framework gives a wide scope of primary productivity and has tasteful potential. The located module can likewise be ornament diamond formed. Advances in development innovation, materials, primary frameworks and logical strategies for investigation and configuration worked with the development of elevated structures.

The underlying model of tall structures is represented by horizontal loads because of wind or quake. Parallel burden opposition of the construction is given by the inside primary framework or outside underlying framework. Generally, the centre, supported casing and their blend with outlines are inside frameworks, where the parallel burden is opposed by midway found components. While outlined cylinder, supported cylinder underlying frameworks oppose horizontal burdens by components gave on the outskirts of the construction. The chose underlying framework should be with the end goal that the primary components are used successfully while fulfilling plan prerequisites. As of late, the diagrid primary framework has been received in tall structures because of its underlying proficiency and adaptability in design arranging.

KEYWORDS: *Diagrid, Structural System, High rise buildings, Structural design, Structural Analysis, Tuned Dampers, displacement*

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I. INTRODUCTION

The quick development of the metropolitan populace and subsequent tension on restricted space has impressively impacted the private advancement of the city. The significant expense of land, the craving to stay away from ceaseless endless suburbia, and the need to protect significant horticultural creation have all added to private structures up. As the stature of a structure expands, the lateral load opposing frameworkturns out to be a higher priority than the underlying framework that opposes the gravitational burdens. The horizontal burden opposing frameworks that are generally utilized are the inflexible edge, shear divider, divider outline, propped tube framework, outrigger framework and rounded framework. As of late, the diagrid – Diagonal Grid – the primary framework is generally utilized for tall steel structures because of its underlying productivity and stylish potential given by the novel mathematical design of the framework. Diagrid has a decent appearance and it is handily perceived. The design and effectiveness of a diagrid framework diminish the quantity of underlying components needed on the façade of the structures, thusly less check to the external view.

Diagrid structures:
The diagrid underlying framework can be characterized as a corner to corner part shaped as a system made by the crossing point of various materials like metals, concrete or wooden pillars which are utilized in the development of structures and rooftops. Diagrid designs of the steel individuals are proficient in giving arrangements both as far as strength and solidness. Yet, these days a far-reaching use of diagrid is utilized inthe enormous range and elevated structures, especially when they are complex calculations and bent shapes.

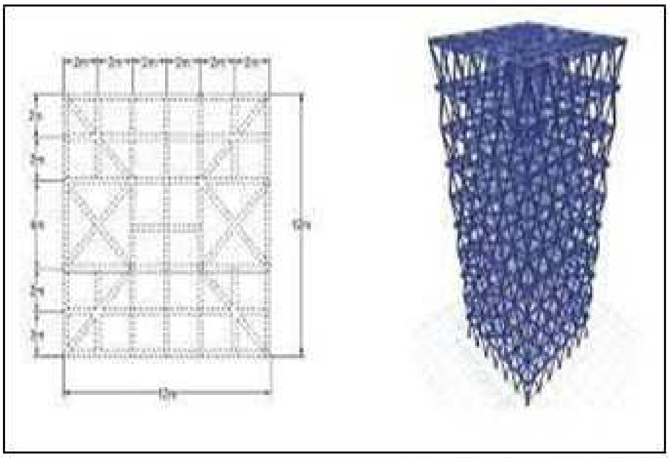

Fig 1.1 Diagrid structure of square shape building

Steel Diagrid Structural System:
The most normally and prevalently utilized material in the development of diagrids is steel. The segments generally utilized are rectangular HSS, adjusted HSS and wide spines. The weight and size of the areas are made to oppose the high bending burdens.They can be immediately raised and the expense of work for the establishment is low.

Fig 1 Steel diagrid structure

II. LITRATURE REVIEW:
In this chapter we are reviewing the literatures and research publications of authors related to analysis of tall structure with lateral loadings and different lateral load resisting elements.

Ramadhan and Barbosa (2014) In this work, a model structure with 72 stories is utilized to act as an illustration for which the plan and investigation of the diagrid framework were performed. Grinding mass dampers are given at the highest point of the structure to moderate the conceivable enormous relocation and base shear requests that these constructions may go through under seismic occasions.

Gurudath et al. (2019) the project introduced a solidness based plan approach for deciding primer part sizes of R.C.C. diagrid structures for a G+14 story building utilizing ETABS 2015. The strategy was applied to the diagrid to decide the ideal framework arrangement of the diagrid structure and further its correlation was with ordinary R.C.C structure. Examination of a G+14 story working with an edge diagrid of 630,660,690 was done by the Equivalent Static Method.

Akhand and Vyas (2019) in this paper, they planned a 16 story diagrid structure with an arrangement of 18 m × 18 m size is thought of. Staad proficient programming framework is utilized for demonstrating and examination of primary individuals. All primary individuals were planned according to IS 456:2000 thinking about all heap blends. and Wind load as IS 875-section 3 considered for examination and plan of the construction. Burden dispersion in the diagrid framework was likewise read for 16 storystructures.

Takle et al. (2020) the paper contemplated a G+41 story multistoried R.C.C building model that was displayed utilizing Etabs 2018 programming. Reaction range examination was made by considering structures arranged in zone III. Building models are examined by Etabs 2018 programming to consider the impact story shear, base shear, time span, base minutes, most extreme story relocation and greatest story float and so forth This investigation was intended to examine and plan the diagrid structures for elevated structures with shifting calculation. To examine the conduct of parallel powers on tall structures with differing math. To apply diagrid underlying frameworks on the constructions and discover the ideal exhibition of this framework with reasonable calculation in the separate seismic zone. To analyze the designs dependent on firmness boundaries, relative dislodging, flexibility and obstruction contrasted and one another. To propose a reasonable, monetary and ideal situation of diagrid underlying framework appropriate as per the separate sidelong burden. To contemplate the reaction of structures as far as story shear, base shear, time span, baseminutes, greatest story relocation.

Sadeghi and Rofooei,(2020) the paper explored that respect, the impacts of BRBs on the seismic execution qualities of diagrids, for example, reaction alteration factor, R, over strength factor, Ω0, pliability proportion, μ, and middlebreakdown limit, ^ SCT, are assessed. To this end, 6 three dimensional diagrid structures with different statures and inclining points are displayed utilizing the OpenSees program and are furnished.

III. EXPERIMENTAL PROGRAM:

To fulfill the requirements of 90% mass participation ratios, 24 modes are used for thebasic diagrid model while 48 modes are used for the diagrid model with TD units. Thelatter has more modes due to additional modes generated by TD. Figure 3.5 shows the four modes of interest that characterize the building behavior under earthquake events. Those modes are holding the biggest percentage of mass participation factors on each major direction except UZ (vertical direction). Table 3.1 shows the first seven vibration periods of the building with their respective modal participation factors that represent the four main mode shapes of the building. The total mass participation ratios for each directions of the prototype building model accounting for the 24 modes are.

Table 3.4 Fundamental period of the building and mass participation ratios

Sr. No	Period (Sec)	Modal Participating Mass Ratios						Notes
		UX	UY	UZ	RX	RY	RZ	
1	6.546	0.00%	59.91%	0.00%	96.80%	0.00%	0.00%	Mode 1
2	6.487	60.04%	0.00%	0.00%	0.00%	96.86%	0.00%	
3	1.549	0.00%	20.69%	0.00%	2.77%	0.00%	0.00%	Mode 2
4	1.546	20.79%	0.00%	0.00%	0.00%	2.73%	0.00%	
5	1.531	0.00%	0.00%	0.00%	0.00%	0.00%	73.36%	Torsion
6	0.74	6.91%	0.00%	0.00%	0.00%	0.29%	0.00%	Mode 3
7	0.732	0.00%	7.04%	0.00%	0.30%	0.00%	0.00%	

Base shears that are attained from the seismic loads provided by ASCE 7-10 design response spectrum are Vx = 142,437 kN and Vy = 143,175 kN. The results from each horizontal direction are not identical due to the difference in shear wall opening at related directions as well as slight differences in the floor openings in either direction. The diagrid absorbs base shear Vx of 116229 kN and Vy of 28408.88 kN which are approximately 80% of the total. Story shear in X and Y directions.

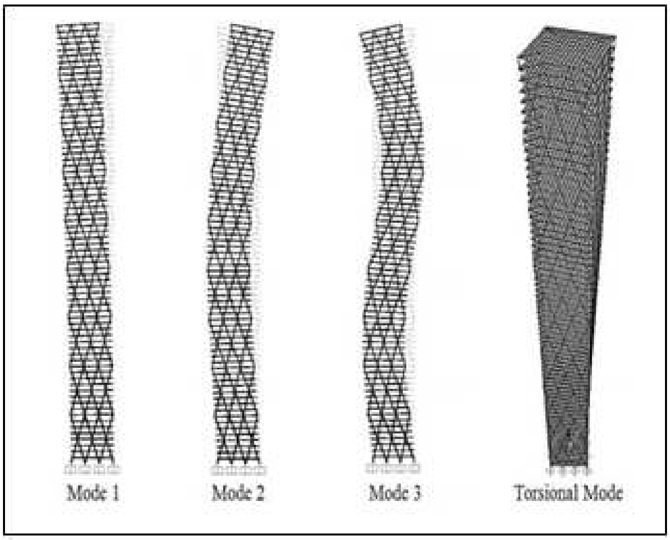

Fig 3.6 Main mode shapes (BEHAVIOUR) of the building structure

IV. METHODOLOGY:

Step 1: ETABS provide an eco-system to model structure using different grids as perplan.

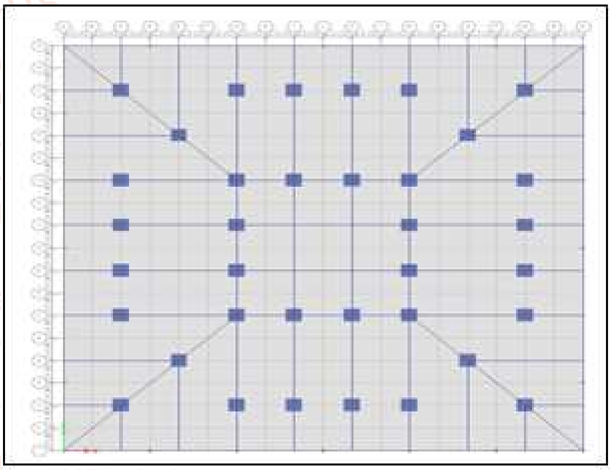

Fig 4.1 Grid Designing of the different cases

Step 2: This step includes defining material and section properties of beams and columnas per the geometry of the structure which was previously described in chapter above.

Fig 4.2 Defining Material Properties

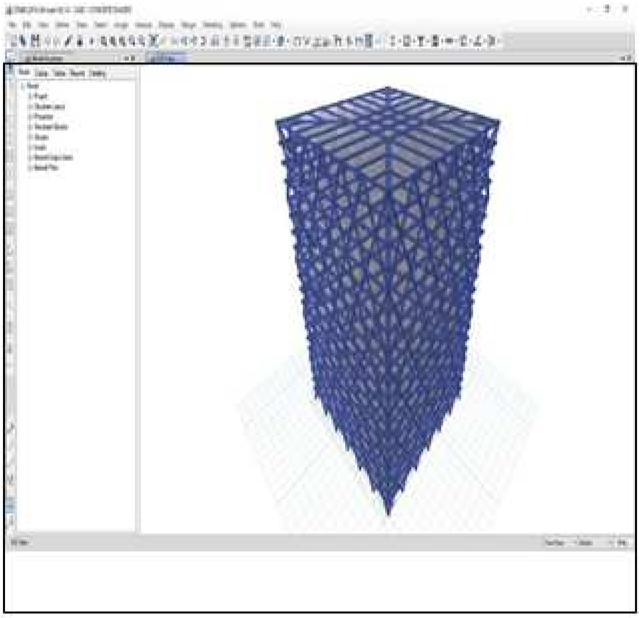

Fig 4.3 Defining Section Properties

Step 3: Fixed support are provided at the bottom of the structure

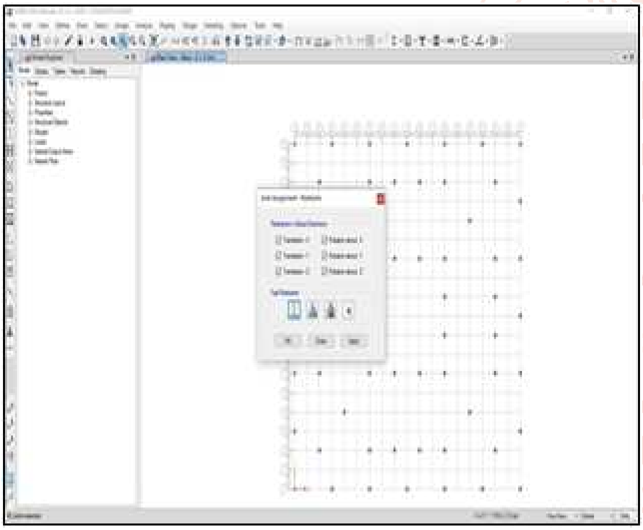

Fig 4.4 Assigning Fixed Support in X, Y and Z direction

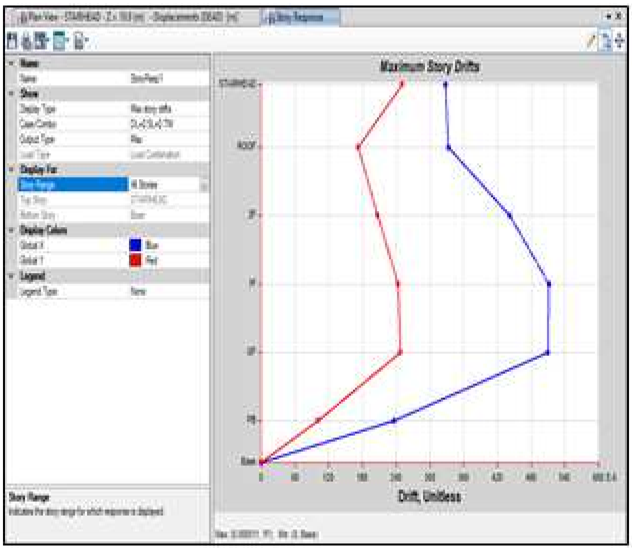

Fig 4.5 Storey Displacement

V. RESULT AND DISCUSSION:

Time Period

The natural period (Tn) of a building is the time it takes to go through a complete vibration cycle. This is the inherent nature of the building controlled by its mass "m" and stiffness "k". These three astrological signs are interconnected.

$Tn = 2\pi\sqrt{m/k}$

Its unit is second. Buildings that are heavy and flexible have more natural period than light and stiff buildings

Table 5.1 Natural Time Period in second

Mode Shape	Natural Time Period Conventional Structure	CS with Damper	Diagrid Structure	DS with Damper
1	3.04	5.56	5.98	6.01
2	2.32	4.98	5.11	5.21
3	1.45	3.56	3.67	3.79
4	1.39	2.01	2.03	2.03
5	1.09	1.11	1.17	1.21
6	0.98	1.01	1.05	1.06
7	0.87	0.94	0.96	0.96
8	0.66	0.68	0.69	0.69
9	0.46	0.49	0.49	0.49
10	0.32	0.32	0.32	0.33
11	0.28	0.29	0.29	0.29
12	0.01	0.13	0.13	0.13

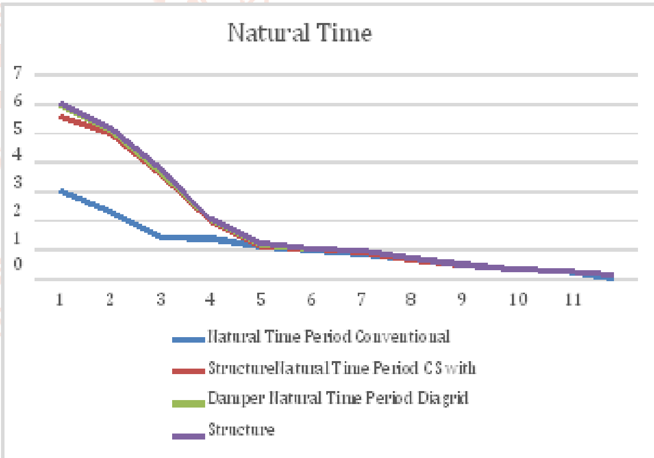

Fig 5.1 Fundamental Time Period

VI. CONCLUSION:

Based on results following conclusions are drawn from the study

Total base shear increases in the circular form of diagrid constructing and decreases in square and triangular form of diagrid constructing while comparing with traditional constructing for seismic analysis.

The node displacement decreases in all shapes of diagrid buildings whilst examined with conational kind of building.

Maximum Centre shear stresses in slab SQX and SQY are increased in diagridbuildings with flat slab as compared to conventional building and diagrid building without flat slab.

Maximum bending moment at the middle of the slab i.e. MX, MY & MXY more growth in diagrid construction as examined to standard construction.

Similarly, Principal, Max Von Mis and Tresca stresses at top and bottom of theslab more increase in diagrid building as compared to conventional building butslightly increases in flat slab diagrid building.

SCOPE FOR FURTHER STUDY

In this study following future scopes can be consider as

1. In this study we are considering tall structure whereas stability in low height of mid-rise structures can be justify in future with same conditions
2. In this study we consider viscous dampers in future frictional dampers can alsobe used.
3. In this study seismic loading is considered whereas in future wind load orthermal load can be utilize.
4. In this study ETABS software is used whereas in future SAP2000 or tekla structure can be proffered.

REFERENCES:

[1] Avnish Kumar Rai & RashmiSakalle, [Comparative Analysis Of A High Rise Building Frame With And Without Diagrid Effects Under Seismic Zones Iii & V], International Journal Of Engineering Sciences & Research Technology, 2017

[2] Bhavani Shankar And Priyanka M V, [Comparative Study Of Concrete Diagrid Building And Conventional Frame Building Subjected To Seismic Force], International Research Journal Of Engineering And Technology (Irjet) June -2018.

[3] GarlanRamadhan And André R. Barbosa, [Improving The Seismic Performance Of Diagrid Steel Structures Using Friction Mass Damper], National Conference In Earthquake Engineering, Earthquake Engineering Research Institute, Anchorage, Ak, 2014,

[4] Gurudath, Ganesh BahadurKhadka and Hafiz Faiz Karim, [Analysis of Multi- Storey Building with and without Diagrid System Using Etabs], "InternationalJournal of scientific research", May 2019.

[5] IS: 875 (Part 1)-1987, "Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures Part 1 Dead Loads (Second revision)", Bureau of indian Standard, New Delhi.

[6] IS: 875 (Part 2)-1987, "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.

[7] JayeshAkhand And J. N Vyas, [Comparative Study Of Different Shapes Of Diagrid Structure System With Conventional System Using Response Spectrum Analysis], International Research Journal Of Engineering And Technology (Irjet), Apr 2019

[8] MemanSuraiyabanu Mohamed Salim, [Comparative Study of Diagrid System, Hexagrid System and Shear Wall System in Tall Tube-Type Building], Multidisciplinary International Research Journal of Gujarat Technological University July 2020.

[9] SamanSadeghi And Fayaz R. Rofooei, [Improving The Seismic Performance Of Diagrid Structures Using Buckling Restrained Braces], Journal Of Constructional Steel Research (2020).