A COMPARATIVE STUDY ON THE PERFORMANCE OF TALL STRUCTURES WITH DIAGRID SYSTEMS AND EXTERIOR BRACED FRAME SYSTEMS SUBJECTED TO SEISMIC LOADING

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***Abstract*: Tall building has developed with respect to the necessities rising from the continuous growth in world's population. In recent days, the want for such buildings is increased largely, specially driven by environmental thought process. A braced frame is a structural component that is widely used in buildings subjected to horizontal loads. It is a specific form of space truss. It comprises of perimeter grid made up of the series8of8triangulated8truss8system. Diagrid is made by coinciding the diagonal component and horizontal components. The primary objective of my study is to understand the structural performance of the structure with diagrids and comparing the same buildings with exterior braced frame systems in place of the diagrids. The structural performances like lateral displacement, lateral drift, and stiffness of the structure, base shear and modal time period of the structure are investigated.**

Key Words: Diagrids, Exterior braced frame sytems, seismic loading.

I. INTRODUCTION

The instant growth of urban population and subsequent pressure on limited space has considerably influenced the residential growth in the city. The huge cost of land, the urge to avoid continuous urban sprawl, and the necessity to preserve important agricultural production and all contributed to drive residential structures upwards. A braced frame is a structural component that is widely used in buildings subjected to horizontal loads. The inclusion of a braced frame raises structure's resistance against lateral loads like loads due to wind and seismic force. The components in a braced frame are usually made of structural steel, that can work efficiently both in compression and tension. This system has been used in steel construction; it is both effective and economical way for raising the horizontal stiffness and resistance of rigid frame system. The bracing eliminates the bending of columns as well as beams by being resistant to lateral loads basically through axial stress, hence letting for slender elements. It is a specific form of space truss. It comprises of perimeter grid made up of the series of triangulated truss system. Diagrid is made by coinciding the diagonal component and horizontal components. The structural effectiveness of diagrid system even helps in abstaining interior and corner columns, and thus letting noticeable flexibility in floor plan. Perimeter "diagrid" system saves around 20% of the structural weight of the steel when compared to regular moment frame buildings. In diagrid structural system, both gravity loads and lateral forces are resisted by the diagonal components because of their triangulated configuration. These structures take up lateral shear by axial action of diagonal members. Thus diagrids are more efficient in reducing shear deformation.

II. OBJECTIVES OF THE PRESENT STUDY

The primary objective of my study is to understand the structural performance of the structure with diagrids and comparing the same buildings with exterior braced frame systems in place of the diagrids. The structural performances like lateral displacement, lateral drift, and stiffness of the structure, base shear and modal time period of the structure are investigated:Modelling of buildings with 2 different plans for the same storey.

1. To assess the structural performance of the buildings by excluding columns with the diagonal diagrid element for the models.
2. To study and compare the lateral displacements of the all the diagrid models for dynamic seismic loading.
3. To compare the base shear values, stiffness and time period of the models with diagrid members.
4. To compare the above parameters of both diagrid structures and structures with exterior braced frame system with dynamic seismic loading.

III. METHODOLOGY

The essential objective of the project was to study the behavior of the tall structures with the diagrid systems and the exterior braced frame system of the structure.Hence two distinct shapes of the plans were considered they are Square and rectangulaAll the six models in the plan are symmetric in plan.For each shape with same storey heights structures are modeled that is 24 stories.From the past researches it was found the optimum angle for diagrid is around 70 degrees.Hence provided with 70 degree.For comparative purpose we have used exterior braced frame system as an external lateral load resisting system. For the

same plans and storey heights we have used exterior braced frame system in place of diagrid.Thus we will have six models with square plan and rectangular plan that is 2 models with square diagrids,2 models with circular diagrids and 2 models with exterior braced frame systems.

3.1 Modeling And Analysis

The ETABS is an integrated building analysis and design software which has been developed by computers and structures Inc. (CSI), Berkeley, California.The static and dynamic analysis can be done using this software. ETABS 9.7.2 2013 can perform a nonlinear static (pushover) analysis. The software graphically displays the results and the results can be exported to the excel and used further

3.1.1 Models used in tha analysis

Models Used In the Analysis:
MODEL-SQ-D(S): 2 Square plan models with square diagrid structures
MODEL-RC-D(C): 2 Rectangular plan model with circular diagrid structures
MODEL-SQ-B : square plan model with exterior braced frame structure
MODEL-RC-B: rectangular plan model with exterior braced frame structure

Table 1: Material properties

CONCRETE	M 30
STEEL	Fe 345
REINFORCEMENT	HYSD 500

Table 2: Sectional properties

MEMBERS	SECTIONS
COLUMNS	1500x1500 mm
BEAMS 1	500x1000 mm
BEAMS 2	300x700 mm
DIAGRIDS	1.500 mmdia hollow pipe with 30 mm thickness 2.450 mmx450 mm
SHEAR WALLS	500 mm and 300 mm thick
SLABS	125 mm thick
BRACED FRAME	180 mm depth with width of single angle 180 m

Table 3:Seismic loadings

FACTORS	VALUES
ZONE FACTOR (ZONE 3)	0.16
SOIL TYPE	II
IMPORTANCE FACTOR	1
RESPONSE REDUCTION FACTOR(R)	5
TIME PERIOD	Program calculated

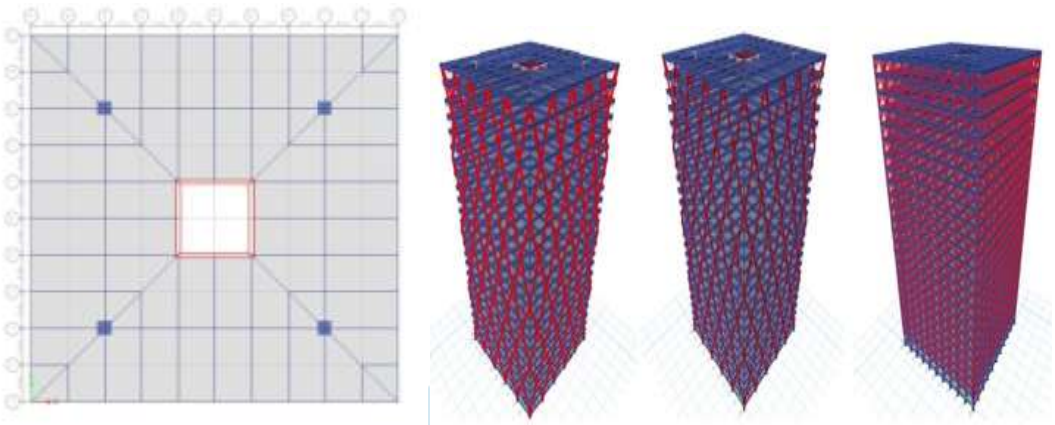

Figure 1: Plan of square plan square diagrid and 3D view of square square diagrid model and braced frame model

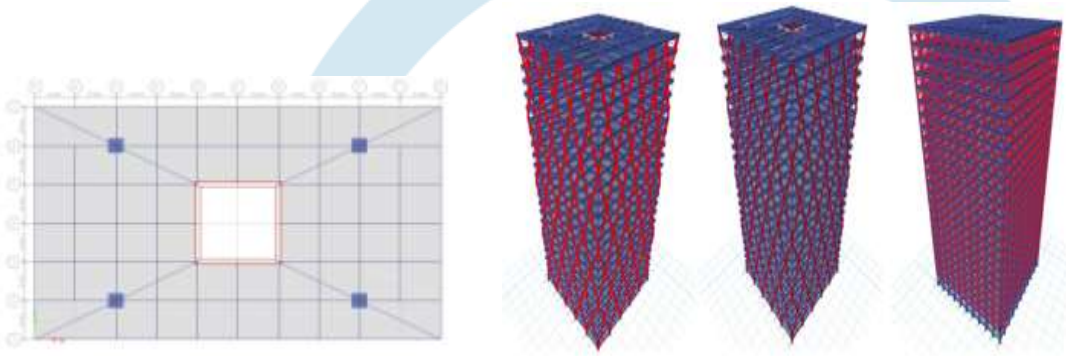

Figure 2:Plan of Rectangular plan square diagrid model and 3D view of rectangular plan square diagrid model and braced frame model

IV. RESULTS AND DISCUSSIONS

4.1 Storey Displacements

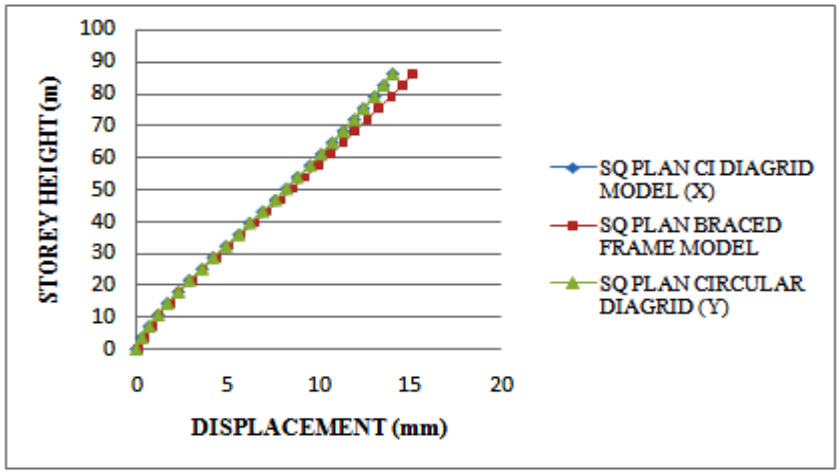

Figure 3 Plot showing lateral displacement of Square Plan Circular Diagrid Model and Square Plan Braced Frame Model

Graph show that the displacement of circular diagrid models in both the directions are less compared to braced frame models.This shows that diagrid models displace less and thus more efficient against lateral forces compared to braced frame models.

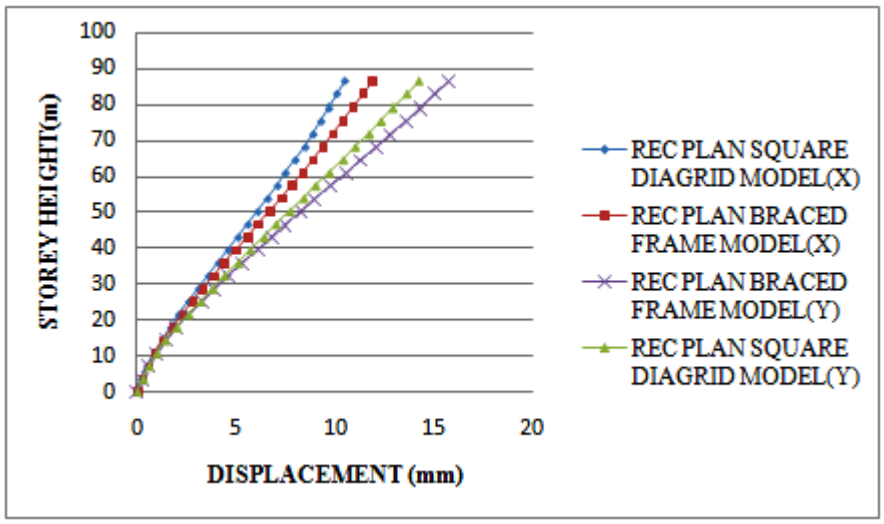

Figure 4: Plot showing lateral displacement of Rectangular plan square diagrid model and rectangular plan braced frame

Graph show that the displacement of square diagrid models of rectangular plan in both the directions are less compared to braced frame models.This shows that diagrid models displace less and thus more efficient against lateral forces compared to braced frame models.

4.2 Storey Stiffness

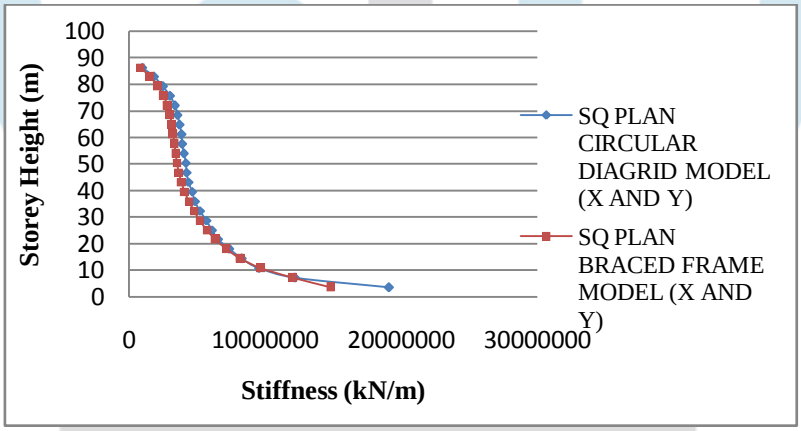

Figure 5: Plot showing Stiffness (kN/m) v/s storey height for Square plan circular diagrid model and square plan braced frame model

We can see gradual decrease of stiffness from bottom storey to top storey. And stiffness of circular diagrid model is more in both the directions compared to braced frame models. And thus diagrid models are stronger comparatively.

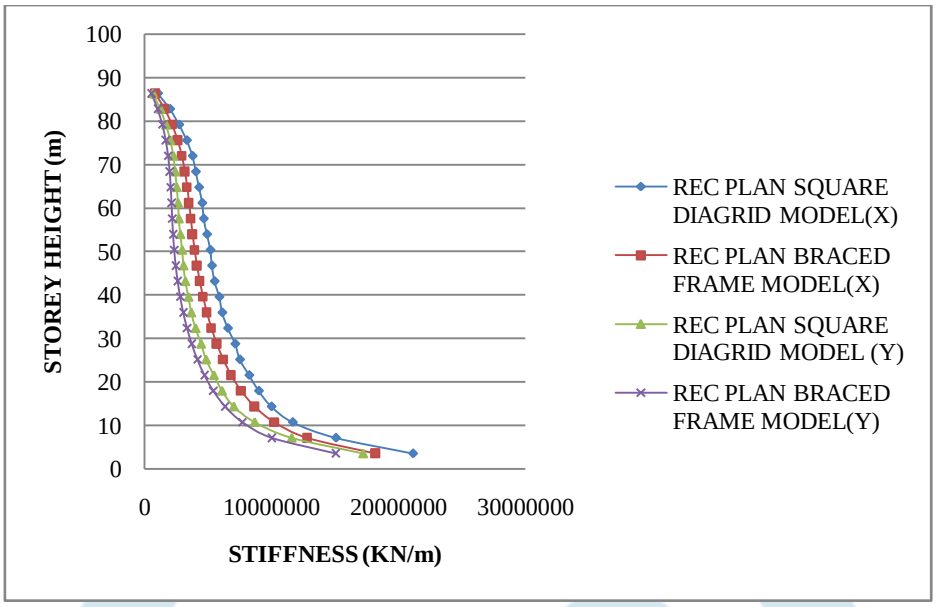

Figure 6: Plot showing Stiffness (kN/m) v/s storey height for Rectangular plan square diagrid model and rectangular plan braced frame model

We can see gradual decrease of stiffness from bottom storey to top storeys. And stiffness of square diagrid model of rectangular plan is more in both the directions compared to braced frame models. And thus diagrid models are more strong comparatively.

4.3 Base Shear

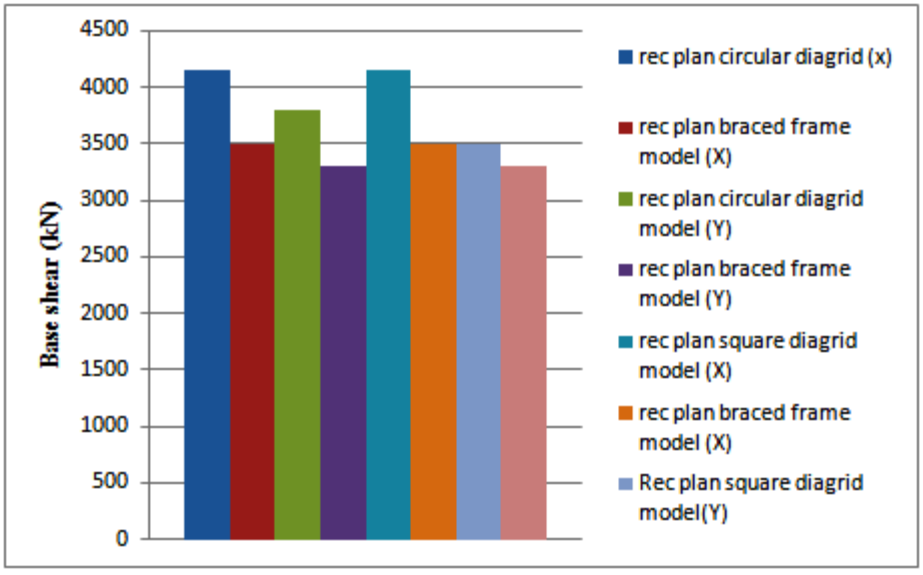

Figure 6: Plot showing Base shear of rectangular plan

Graph show that base shear value is more in diagrid models which means diagrid models have more capacity to take the seismic force compared to braced frame models. Hence in this case also diagrid found to be effective.

4.4 Time period

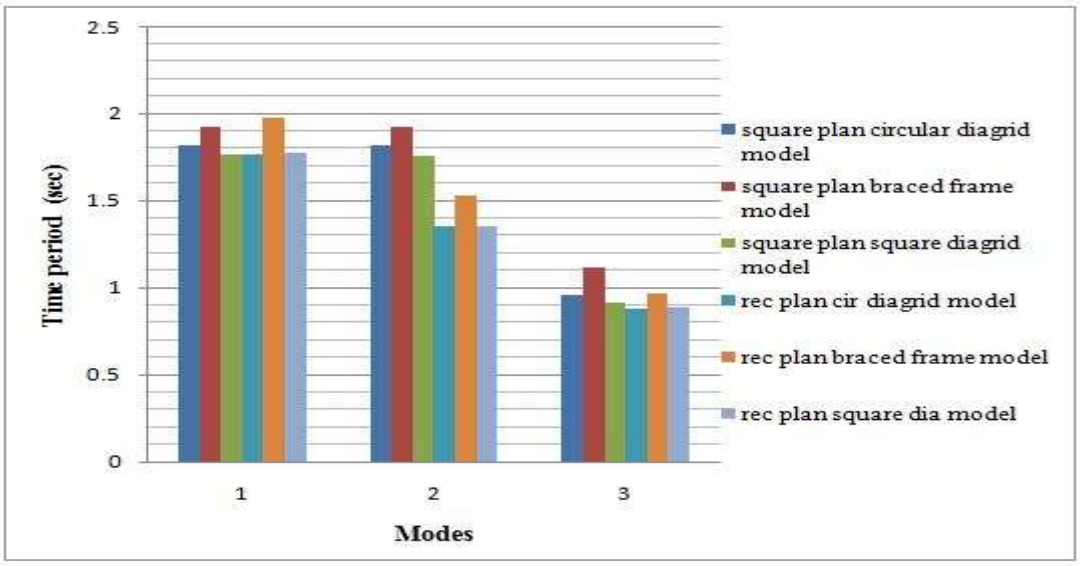

Figure 7: Comparison of Time Period for different plans and models

More the time period more is the vibration of the structure due to lateral loads.Time period of all the models of 3 modes are shown in the table and the graph.the value of the time period is small in diagrid models than the braced frame models.hence the diagrid models are more stiff than braced frame models.

V. CONCLUSION

The present study was carried out mainly to study the performance of the diagrid systems on the tall structures.. In order to advance this study from past works on diagrid system the performance of the diagrid systems with different shapes for plan is studied in this work. From the study the conclusions are as follows,

1. From the comparison of diagrid system with braced frame system it is found that the lateral displacements in diagrid models is much lesser than the braced frame models.
2. The lesser lateral displacements in diagrid shows the enhanced resistance of the buildings against lateral seismic force.
3. The stiffness values of the diagrid models are also comparatively higher than the braced frame models. The diagrid models are stiff against vibrations due to seismic forces than the braced frame models.
4. The base shear values in diagrid models are higher than other models with shows higher seismic forces are acting on the diagrid models.
5. The time periods are less in diagrid system models. lesser values of the time period than braced frame models shows that diagrid models are less flexible against seismic vibrations.

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