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Comparative Study of Seismic Performance of Multistorey Diagrid Structures with Conventional Structures

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Abstract:- The difference between conventional outer brake frame structures and current diagrid structures is that for diagrid structures, almost all conventional vertical columns are removed. Elimination of vertical columns is possible because diagonal elements in diagrid structural systems can carry gravitational loads as well as lateral forces, while diagonals in conventional elastic frame structures carry only lateral loads. The most normal and popular material in the process of building diagrids is steel. The incisions commonly used are rectangular, rounded and wide flanges. The weight and size of the sections are made to withstand high bending loads.

Keywords:- *Diagrid, Multistorey Building, Lateral Displacement And Storey Drift.*

I. INTRODUCTION

The diagrid structural system can be defined as a diagonal element formed as a frame created by crossing different materials, such as metals, concrete or wood beams, which are used in the construction of buildings and roofs. Diagrid structures of steel elements are effective in providing a solution both in strength and rigidity. But nowadays, diagrid is widely used in giant spans and high-rises, much after they equip a unit of complex geometries and arched figures. The diagrid structure consists of inclined columns on the outer surface of the building. Due to the inclined columns, the lateral loads are opposed by the axial action of the diagonal compared to the bending of the vertical columns in the framed structure of the pipes. Diagrid structures, as a rule, do not require a core due to lateral displacement, can be transferred diagonally on the outer border of the building.

Houses of the Diagrid building :

30 St. Maria Axe

30 St. Mary's Axe was developed by Foster and Partners of Arup, which performs structural engineering for the project. The building is 180 meters high and has a Diagrid, which monitors the twisting profile of the building and rises at the top. The use of Diagrid allows you to use office space for columns, and beams covering from the core to the Diagrid, around the perimeter of the building.

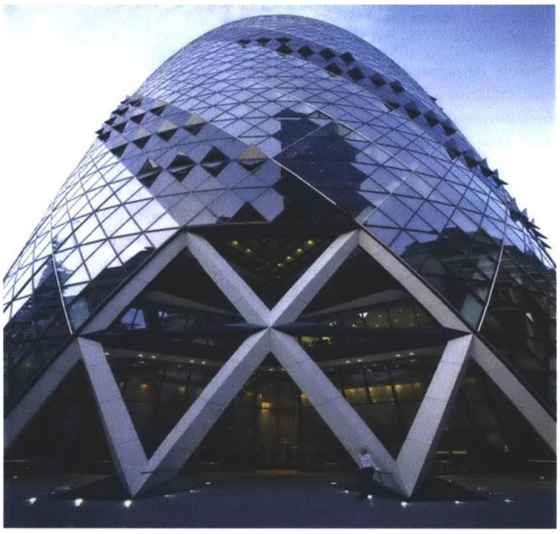

Figure *1*: 30 St. Mary Axe (Commons.Wikimedia.Org)

Hearst Tower

The Hearst Tower was also designed by Foster and Partners of WSP, which performs structural engineering for the project. The building is 182 meters high and has a Diagrid without corner columns. It also has a wide lobby space without internal columns, which can be attributed to the existing structure below.

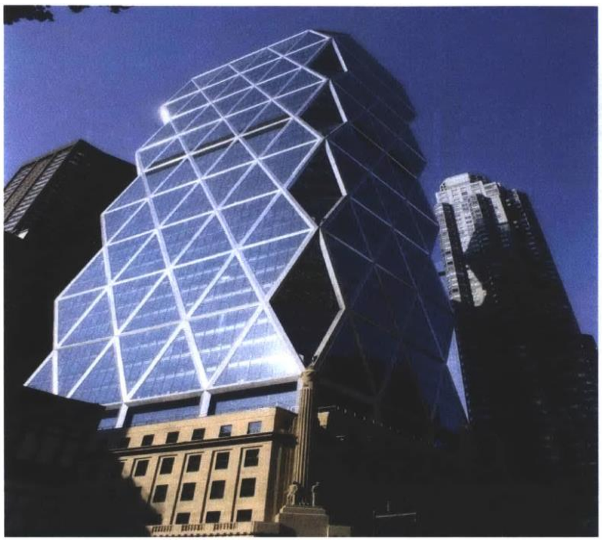

Figure 2: The Hearst Tower (Commons.Wikimedia.Org)

II. REVIEW OF LITERATURE

K. Jani and P. IN. Patel [2] conducted a seismic survey of multi-storey buildings with a fill separator, a shift separator and a support. Examination is performed in order to read the various systems of counteraction to the horizontal forces following the structure, and to find the most intelligent technique along with the plan of the structure G + 25, which uses a fill separator, shift separator and support. The study of the structure is completed using scientific techniques in the same way as ETAB programming.

K. S. Moon [3] conducted a 24-storey round structure study to find the ideal diagrid point for limiting the horizontal float and brood in a high structure. The round arrangement of 30.7 m wide is considered with five different types of diagrid edges, which are 36.8 °, 56.3 °, 66 °, 77.5 ° and 83.6 °.

K. S. Moon et al [4] studied the lateral performance of multi-storey buildings in different load conditions, strongly influenced by different parameters, such as rigidity of the structure and the ratio of the base and height of the building. Optimization and improvement of such indicators have become the basis, as well as a constraint for design engineers in their design practice.

Hushbu Yani, Paresh V. Patel [5] This document focuses on improving the obstacles and strength of the high structure against the various loads and forces it suppresses throughout its life. Investigation parameters are time frames, base shifts and joint movements, and these parameters are responsible for the overall stability of any structure. He argued that the shift separator was the best option to improve resilience, counter power, and a sequence of increased structure.

Kiran Kamath et al. [6] This paper discusses the evolution of structural systems of tall buildings and the technological driving force of high construction development. For primary structural systems, a new classification is presented - internal structures and external structures. Although most representative structural systems for tall buildings are being discussed, this paper focuses on current trends such as autrigger systems and diagrid structures. Auxiliary damping systems that control the movement of the building are also discussed.

III. MODELING

The modeling is carried out in the ETABS software as follows:

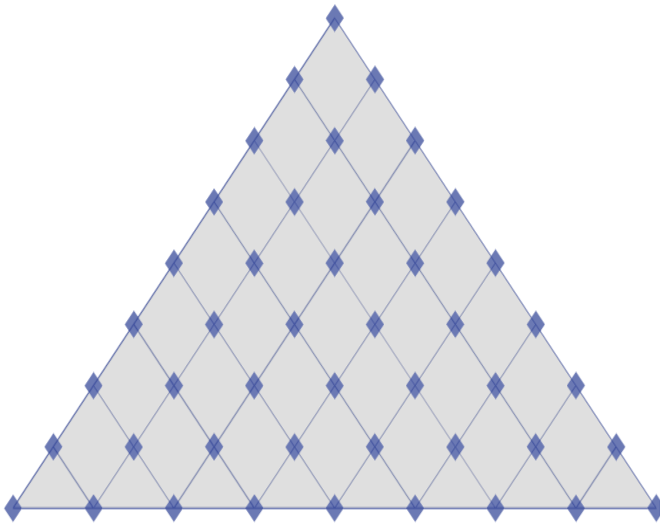

Figure 3: Typical floor plan of the model

The above plan is generated after the model is prepared in the ETABS software and this gives typical floor plan of the model.

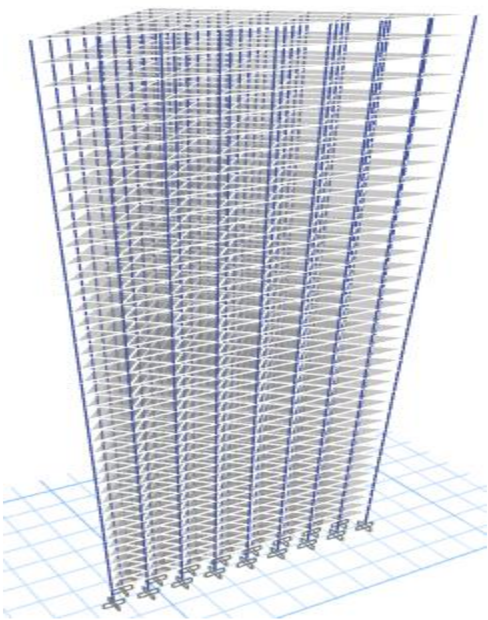

Figure 4: Elevation of G+40 Building with Conventional system without diagrid

The above figure is about the elevation of G+40 Building with Conventional system without diagrid obtained in the ETABS software.

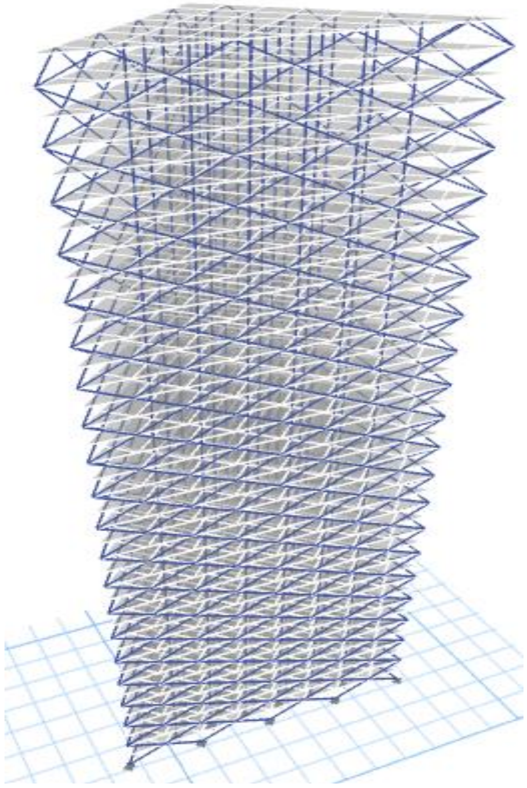

Figure 5: Elevation of G+40 Building with 2 storey module Diagrid system

The above figure is about the Elevation of G+40 Building with 2 storey module Diagrid system obtained in the ETABS software.

IV. RESULTS

From the modeling carried out in the ETABS software, the results are mentioned as follows.

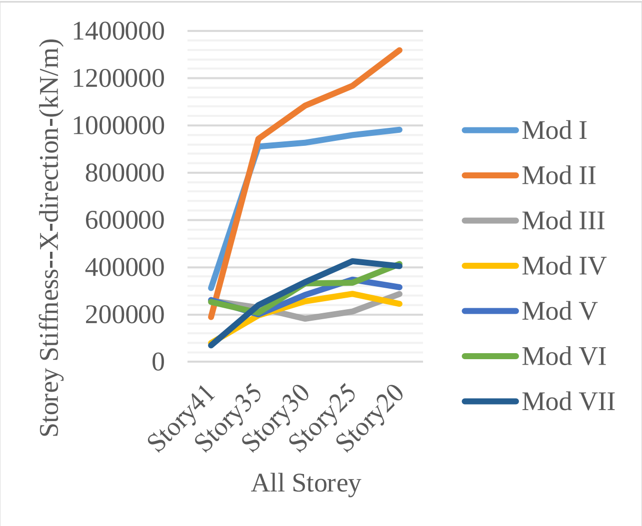

Figure 6: Storey Stiffness--X-direction-(kN/m) for all models

From the above figure it is observed that Storey Stiffness--X-direction-(kN/m) found to be minimum in the Model IV: G+40 Building with 6 storey module Diagrid systemand maximum in Model II: G+40 Building with 2 storey module Diagrid systemwith value of 1300000 kN/m. As the storey height goes on increasing the Storey Stiffness--X-direction-(kN/m) found to be decreasing. The storey no. 41 gives the minimum results for all the models with maximum in the storey-1. Storey no. 25 has more Storey Stiffness--X-direction-(kN/m) than the storey no.41 but lesser Storey Stiffness--X-direction-(kN/m) as compared to the storey-1. This is observed in all the models with diagrid structure.

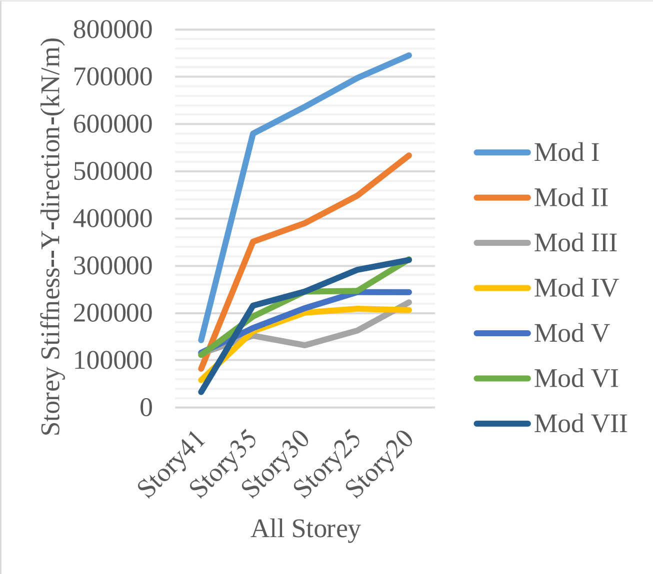

Figure 7: Storey Stiffness-Y-direction-(kN/m) for all models

From the above figure it is observed that Storey Stiffness--Y-direction-(kN/m) found to be minimum in the model-IV and maximum in the model-I with value of 700000 kN/m. As the storey height goes on increasing the Storey Stiffness--Y-direction-(kN/m) found to be decreasing. The storey no. 41 gives the minimum results for all the models with maximum in the storey-1. Storey no. 25 has more Storey Stiffness--Y-direction-(kN/m) than the storey no.41 but lesser Storey Stiffness--Y-direction-(kN/m) as compared to the storey-1. This is observed in all the models with diagrid structure.

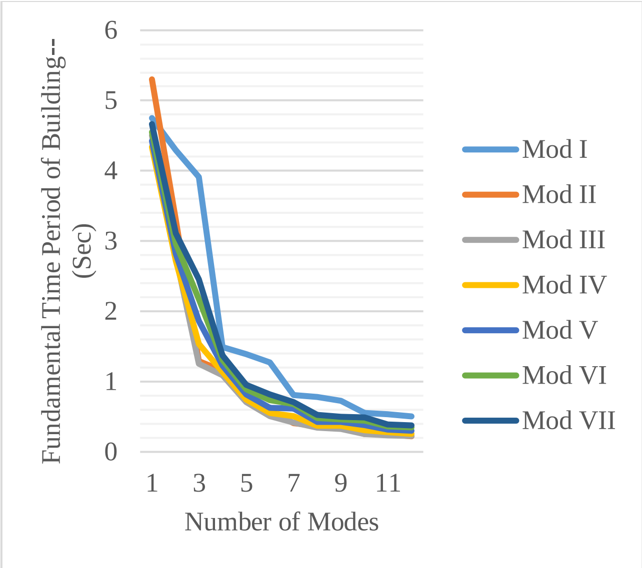

Figure 8: Fundamental Time Period of Building--(Sec) for all models

The time taken (in seconds) for each complete cycle of oscillation (i.e., one complete back-and-forth motion) is the same, Fundamental Natural Period T of the building. From the above figure it is observed that Fundamental Time Period of Building found to be minimum in the Model IV: G+40 Building with 6 storey module Diagrid system and maximum in the Model II: G+40 Building with 2 storey module Diagrid system with value of 5.4 sec. As the number of modes goes on from one to 12 the Fundamental Time Period of Building--(Sec) for all models goes on decreasing.

Figure 9: Storey Drift(mm)-X-direction for model-VII

From the above figure it is observed that Storey Drift(mm)-X-direction for Model VII: G+40 Building with 12 storey module Diagrid system found to be increasing upto storey-30 with maximum value of 2.1 mm. The storey drift is maximum in the storey-30 and then it goes on decreasing towards store-41. Also it goes on decreasing from store-5 to the storey-1. The permissible storey drift is 0.004h i.e. 12 mm as per the IS code. The storey drift is under the permissible limit for all the storey.

Figure 10: Storey Forces(kN)-X-direction for model-I

From the above figure it is observed that Storey Forces-X-direction for Model I: G+40 Building with Conventional system without diagrid found to be decreasing from storey-1 to storey-41 with maximum value of 3600 kN. The storey forces in X-direction is more in the storey no.20 but lesser as compared to the storey no.1. The storey no.1 being the base storey have the maximum storey forces as compared to earlier storey.

V. CONCLUSION

The conclusions from the above study are as follows:

a. From the above results it is observed that Lateral Displacement (mm)-X-direction for model-III found to be increasing as the number of storey increases with maximum value of 65 mm. Also it is observed that Lateral Displacement (mm)-X-direction for model-V found to be increasing as the number of storey increases with maximum value of 68 mm.
b. From the above results it is observed that Lateral Displacement (mm)-X-direction for model-VII found to be increasing as the number of storey increases with maximum value of 70 mm. Also it is observed that Storey Drift(mm)-X-direction for model-I found to be increasing upto storey-5 with maximum value of 3 mm.
c. From the above results it is observed that Storey Drift(mm)-X-direction for model-III found to be increasing upto storey-30 with maximum value of 2.1 mm. Also it is observed that Storey Forces-X-direction for model-I found to be decreasing from storey-1 to storey-41 with maximum value of 3600 kN.
d. From the above results it is observed that Storey Forces-X-direction for model-VII found to be maximum for the storey-1 with value of 1380 kN. Also it is observed that Storey Stiffness -X-direction for model-I found to be maximum for the storey-1 with value of 1650000 kN/m.
e. From the above results it is observed that Storey Stiffness -X-direction for model-III found to be maximum for the storey-1 with value of 2000000 kN/m. Also it is observed that Lateral Displacement (mm)-Y-direction for model-I

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found to be increasing as the number of storey increases with maximum value of 130 mm.

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