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Evaluation of seismic performance of diagrid building with different arrangement of secondary bracing system.

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Abstract

The diagrid structure has emerged into an innovative method in the recent construction field and has led to the advancement of tall buildings and high-rise structures not only in the engineering field but also in the architectural field. It has also made the structure stiffer and lighter when compared to the normal conventional buildings. However, recent studies on diagrid system reported insufficient energy dissipation capacity and inadequate ductility in high seismic zones. The limited ductility and energy dissipation capacity become critical under solid ground motion as diagrid elements carry both gravitational and lateral load. These diagrid members lose elasticity at certain deformations and start yielding leading to global collapse. The present work reviews studies regarding seismic performance assessment of diagrid structures with different arrangement of secondary bracing system. The diagrid structures are modelled with different arrangement of secondary bracing system and are analyzed using ETABS software. IS 1893: 2016 is considered for load combination of seismic analysis. Results show that secondary bracing system increases the seismic resistance of diagrid building. The X- arrangement of secondary bracing improves the seismic performance of building the most.

Keywords- Diagrid buildings, Bracing, Response Spectrum Analysis, ETABS.

I. INTRODUCTION

The advancement in technology has made our life simpler and comfortable when compared to earlier times and has also led to the need for space for living for the growing population. According to the records, if we analyse our world population, it right now exceeds 8 billion, which mandates the need to fulfil the growing demands of the population. With the restricted land accessible, there is a need to develop tall structures.

The diagrid structure is one such method in which the vertical perimeter columns are eliminated, the frame carries the gravity load, as well as the lateral load and the usage of steel is also minimized when compared with the conventional building. Diagrid system consists of perimeter grid made up of a series of triangulated truss system. It is a structural system in which all perimeter columns are eliminated and consists of only inclined columns on the outer face of the building. Nearly 20% of structural steel is saved when compared to a conventional moment frame structure. However, recent studies on diagrid system reported insufficient energy dissipation capacity and inadequate ductility in high seismic zones. In this study we apply secondary bracing system to diagrid building in order to improve the seismic performance of diagrid building.

II. LITERATURE REVIEW

Giovanni Maria Montuori, Giuseppe Brandonisio [4] defined a framework for assessing the ‘‘local’’ structural issues in the design of diagrid tall buildings, and present a methodology for establishing the need for a specific secondary bracing system (SBS) as a function of the diagrid geometry. Further, design criteria for secondary bracing systems are worked out and applied to some 90 story building models, characterized by perimeter diagrid structures with different module height and diagonal cross sections. All analysed diagrid models exhibited problems concerning stability of interior columns (i.e. multi-storey buckling modes) and/or local flexibility (excessive inter story drift); the above local problems are completely solved after the introduction of a SBS at the central core location, and, against a modest increase of structural weight (about 3%), any flexural engagements in the diagrid member is eliminated.

Saman Sadeghi, Fayaz R. Rofooei [5]. The seismic performance of diagrids equipped with buckling restrained braces (BRBs) is investigated. In that regard, the effects of BRBs on the seismic performance characteristics of diagrids such as response modification factor, R, overstrength factor, Ω_0, ductility ratio, μ, and median collapse capacity, $S\hat{}_{CT}$, are evaluated. To this end, 6 three dimensional diagrid structures with various heights and diagonal angles are modelled using OpenSees program and are equipped with BRBs in a novel arrangement. Utilizing nonlinear static analysis, the seismic performance factors of models are evaluated. Subsequently, the median collapse capacity ($S\hat{}_{CT}$) of the models is determined by performing nonlinear dynamic analyses. The results indicate that using BRBs improve the seismic performance of the considered models due to accumulation of plastic damages in BRBs and a better distribution of plastic hinges over those models.

III. Proposed Work

One diagrid building is modelled and four diagrid buildings with different arrangement of secondary bracing are modelled and analyzed in ETABS. The load combination were assigned the same for all the buildings. The structural dimensions of the 30 storey diagrid buildings are 30m X 30m plan area. The floor-to-floor height is 3m. The buildings are considered to be earthquake zone V which has zone factor of 0.36 and the wind speed is taken as 50m/s. Total height of structure is 90m.Therefore Response Spectrum Analysis method is used. The fig 1.1 shows diagrid building. The fig 1.2 show diagrid building with X-arrangement of secondary bracing system. Fig 1.3 show diagrid building with V-arrangement of secondary bracing. Fig 1.4 shows diagrid building with inverted V-arrangement. Fig 1.5 shows diagrid building diagonal arrangement of secondary bracing.

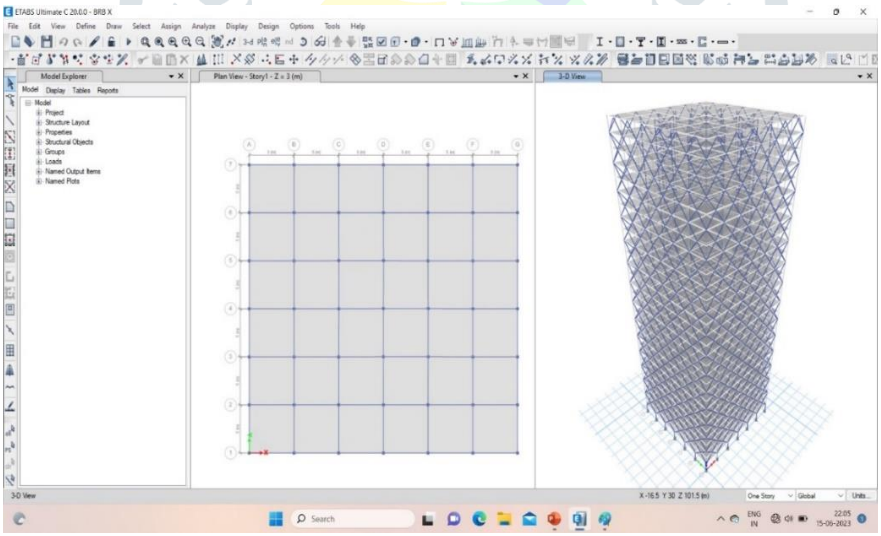

Fig 1.1 Diagrid building.

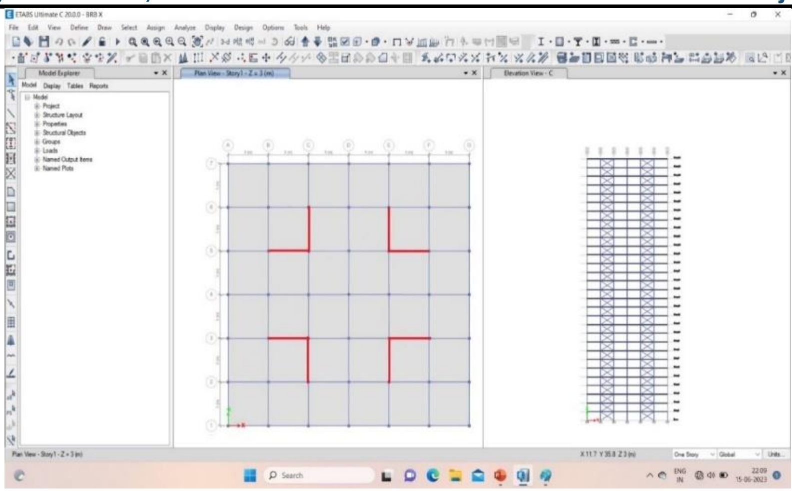

Fig 1.2 Diagrid building with X-arrangement of secondary bracing.

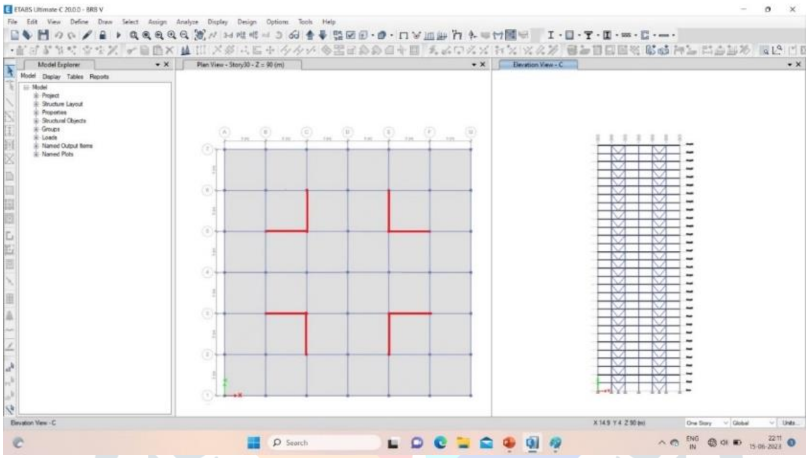

Fig 1.3 Diagrid building with V-arrangement of secondary bracing.

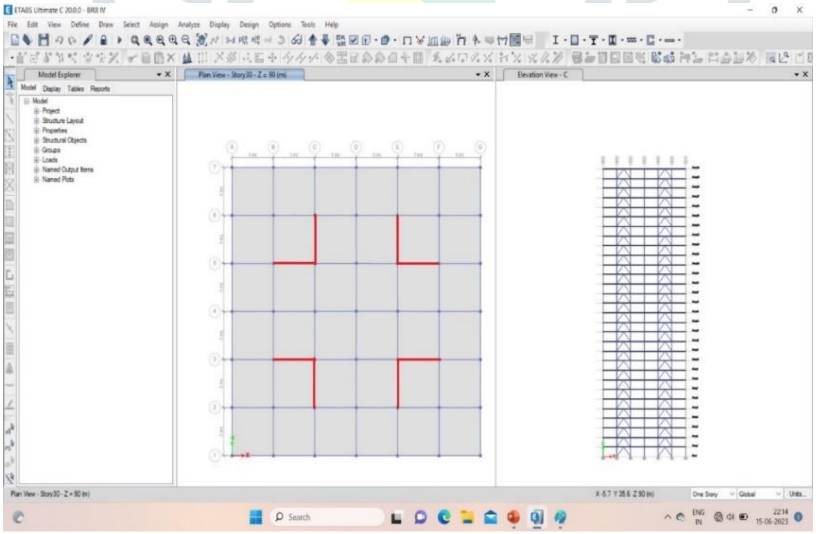

Fig1.4 Diagrid building with inverted V-arrangement of secondary bracing.

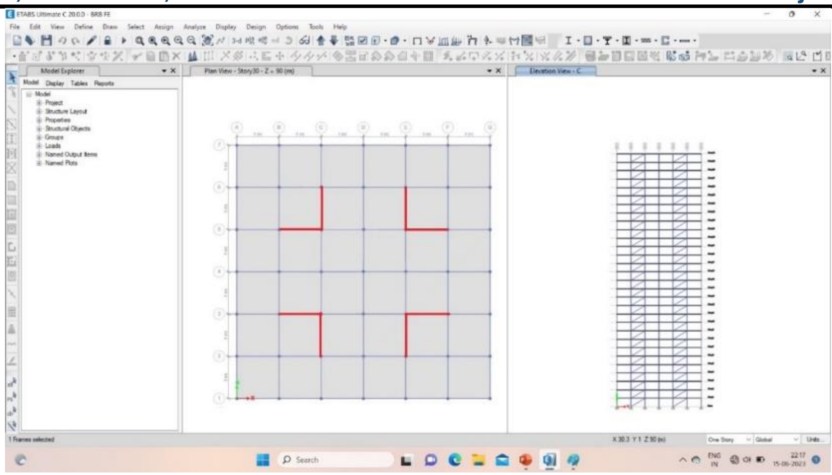

Fig 1.5 Diagrid building with diagonal arrangement of secondary bracing.

Table 1.1 shows dimensional data of the models

Table 1.1. Dimensional data:

Sr No	Parameter	Value
1	Grade of concrete	M30
2	Grade of steel	Fe250
3	Live Load	3 KN/m^2
4	Wind speed	44 m/s
5	Beam	300x300mm
6	Column	300x300mm
7	Thickness of slab	150mm
8	Floor Height	3 m
9	Seismic Zone	V
10	Zone Factor	0.36
11	Soil type	Medium
12	Wall Load	24.3 KN/m^2

IV. RESPONSE SPECTRUM ANALYSIS.

This is a very useful method for analysing the performance of structures during earthquakes. It makes use of the peak period obtained from a dynamic analysis of a single degree-of-freedom-system. Peak ground accelerations are recorded for different periods of the structure and then these accelerations are plotted against their equivalent periods to come up with a graph called dynamic response spectrum.

The response spectrum analysis method is used to calculate and estimate the response of the structures under dynamic loadings. Dynamic analysis of diagrid building with secondary bracing system is done using response spectrum analysis. The buildings are considered to be in earthquake zone V as per Indian standard code.

A 30-storey diagrid building is modelled and four diagrid buildings with different arrangement of secondary bracing are modelled. The different arrangements being X-arrangement, V-arrangement, Inverted V-arrangement and Diagonal arrangement. Storey displacement, storey drift and base shear are considered as the most useful responses used for earthquake resistant design strategy are obtained along the floors of the building models and presented in a comparative way for all models.

V. RESPONSE SPECTRUM ANALYSIS RESULTS

After analysis the values of storey displacement, storey drift and base shear are recorded and compared.

1. **Storey displacement**

The storey displacement value is the value of displacement of a storey with respect to the base storey or ground level of the structure. The fig 1.6 shows the comparison of storey displacement of all models.

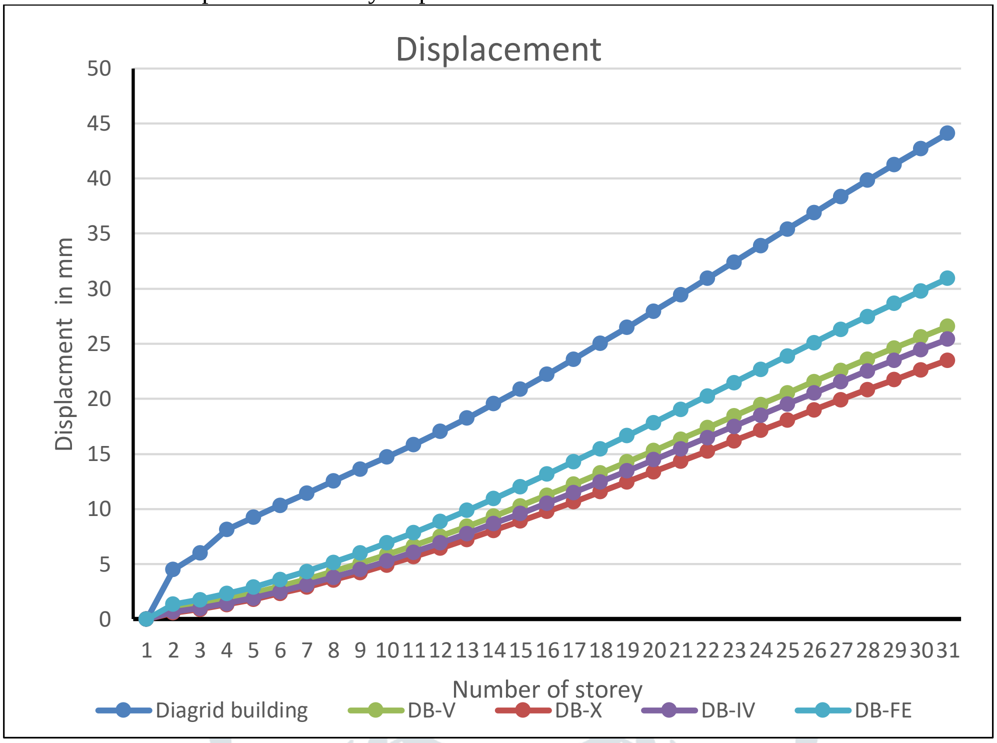

Fig 1.6 Comparison of storey displacement of all models.

2. **Storey drift**

The storey drift is the displacement between two consecutive storeys. The fig 1.7 shows the comparison of storey drift of all models.

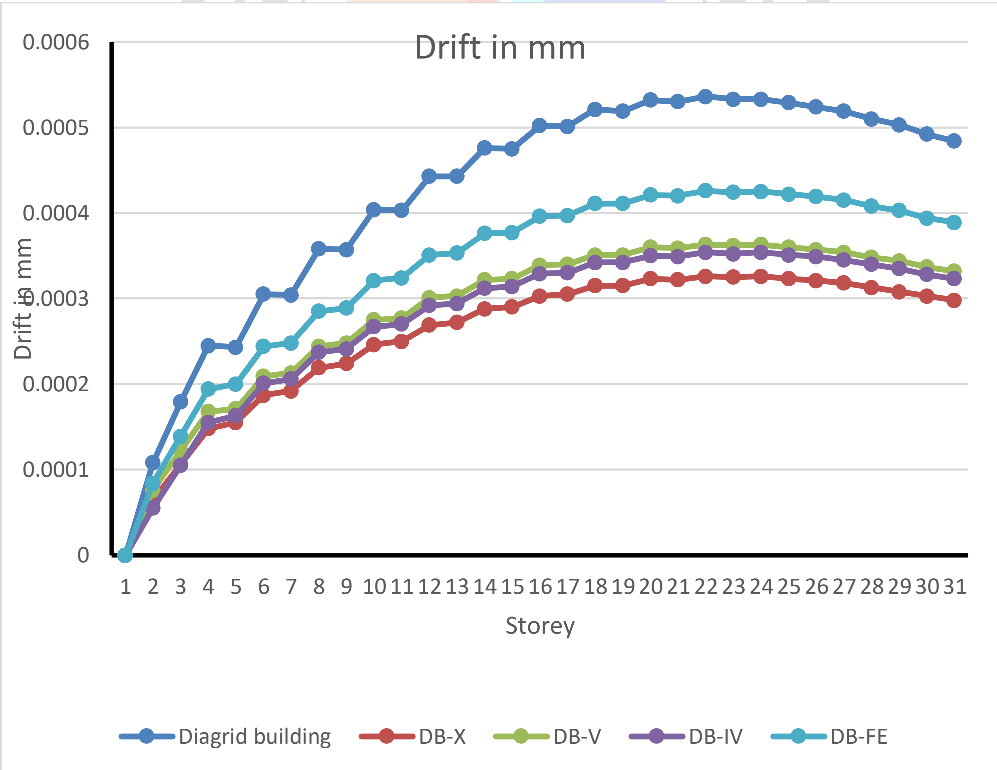

Fig 1.7 Comparison of storey drift of all models.

3. **Base Shear:**

Base shear is the maximum expected lateral force that will occur due to seismic ground acceleration at the base of the structure.

The fig 1.8 show the comparison of base shear of all models.

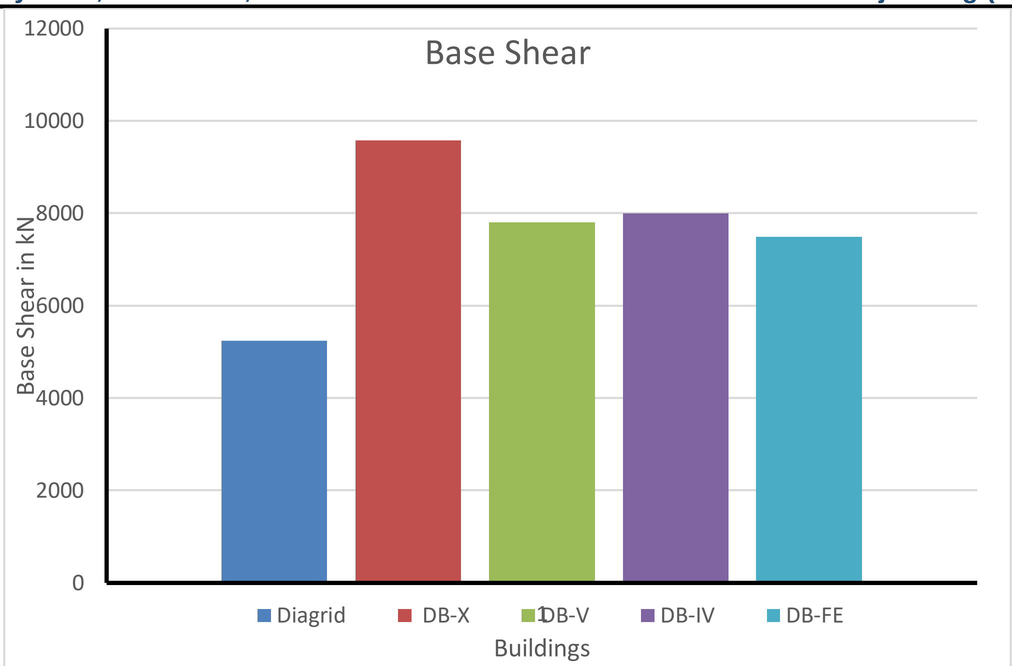

Fig 1.8 Comparison of base shear of all models.

VI. RESULTS AND DISCUSSION

1. The X-arrangement of secondary bracings reduced the storey displacement by 46% and storey drift by 38% and base shear is increased by 75%.
2. The V-arrangement of secondary bracing has reduced the storey displacement by 39% and storey drift by 31% and storey shear is increased by 49%.
3. The inverted V-arrangement of secondary bracing has reduced the storey displacement by 42% and storey drift by 33% and base shear is increased by 52%.
4. The diagonal arrangement of secondary bracing has reduced the storey displacement by 29% and storey drift by 19 % and base shear is increased by 42%
5. From the reading it can be seen that secondary bracings improve the seismic performance of building.
6. The X-arrangement significantly improved the seismic performance of diagrid building. Followed by X-arrangement is inverted V and V arrangement with shows similar results. Inverted V arrangement shows slightly better performance than V arrangement. Diagonal or Forward Eccentric (FE) bracing shows the least improvement.
7. The reduction in storey displacement, storey drift and increase in base shear indicates that stiffness of building has increased.

References

[1] Mohammed Abdul Rafey and M. A. Azeem Comparative Analysis of a Diagrid Structure and a Conventional Structure with Chevron Bracing.

[2] Manthan I. Shah, Snehal V. Mevada, Vishal B. Patel Comparative Study of Diagrid Structures with Conventional Frame Structures.

[3] Aarthi Senthilkumar, R. Umamaheswari Comparative Analysis of a Conventional Structure and a Diagrid Structure Subjected to Seismic Loading.

[4] Giovanni Maria Montuori ⇑, Elena Mele, Giuseppe Brandonisio, Antonello De Luca Secondary bracing systems for diagrid structures in tall buildings

[5] S. Sadeghi and F. R. Rofooei, “Improving the seismic performance of diagrid structures using buckling restrained braces,” J. Constr. Steel Res., vol. 166, Mar. 2020, doi: 10.1016/j.jcsr.2019.105905.

[6] Khushbu Jani , Paresh V. Patel Analysis and Design of Diagrid Structural System for High Rise Steel Buildings.

[7] Ravish Khan , S.B Shinde , 2019 , “Comparative study of diagrid structure with exterior braced frame structure”

[8] Ashwini D, Abdul Quddus Suhaib, 2020, “Comparative study of seismic performance of diagrid building with bare frame structure.”

[9] Amruta K. Potdar, G.R. Patil. Optimum design of concrete diagrid building and its comparison with conventional frame building.

[10] Krishnaraj R. Chavan, H.S.Jadhav Seismic Response of R C Building With Different Arrangement of Steel Bracing System

[11] K N Jeevan Kumar, Sabyath P Shetty, 2020 , "Analysis of RC structures with different types of bracing system."

[12] IS 456-2000, Plain and Reinforced Concrete Code of Practice, Bureau of Indian Standard, New Delhi.

[13] IS 1893-2016, Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standard, New Delhi.

[14] IS 875-2015, Code of Practice for Design Loads for Building and Structures, Bureau of Indian Standard, New Delhi.