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TORSIONAL INSTABILITY & SEISMIC PERFORMANCE OF DIAGRID STRUCTURES UNDER VARIOUS IRREGULARITY CONDITION

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Abstract – In the last decades for the construction of tall buildings diagrid structure has emerged into an innovative method in both engineering and architectural field. It is because of their high structural efficiency and flexibility. It has also made the structure stiffer and lighter when compared to normal conventional building. Diagrid structure consists of inclined columns on the exterior surface of building which resist the lateral loads. Application of diagrid structure system has recently increased and substantial analytical studies have been conducted. This paper studies the structural performance of diagrid system of different angles and different densities. Analysis and modeling of 36 story diagrid steel building using ETABS software is presented in this paper. The best diagrid angle is identified.

Key Words: Tall Building- Diagram System- Static Analysis- Diagrid Angle-Story Displacement-Base shear- Story Drift- ETAB

1. INTRODUCTION

Advances in construction technology, materials, structural systems and analytical methods for analysis and design facilitated the growth of high rise building. Due to the limited space and the need for environmental conservation, it has important for a civil engineer to focus on stiffer, lighter and new technology savvy methods for the construction. The diagrid structure is one such method in which the vertical columns are eliminated, the frame carries the gravity load as well as the lateral loads and the usage of soil is also minimized compared to conventional building. Recently diagrid structural system is adopted in tall buildings due to its structural efficiency and flexibility in architectural planning. Using this new solution to create elegant tall building with unusual shapes is undoubtedly due to the advantage of triangulation pattern of diagrid. Also it improves the aesthetic appearance of building along with structural efficiency. Compared to closely spaced vertical columns in framed tubes, diagrid structure consists of inclined columns on the exterior surface of building. Diagrid structure generally do not require core because lateral shear can be carried by the diagonals on the periphery. Diagrid has good appearance and it is easily recognized. The configuration and the efficiency of a diagrid system reduces the number of structural element required on façade of building, therefore there is only less obstruction to the outside view. Most of the constructed diagrids are standing in the low seismic regions without experiencing intense ground motion. This might be a primary reason for the less interest of the researchers in studying the seismic behavior of diagrids.

This paper investigates the seismic performance and torsional instability of diagrid structures under various irregularity conditions.

1.1 OBJECTIVE

The objective of this study to investigate the diagrid structures with different degree of diagrid angles, different densities and stiffness irregularity. The lateral displacement, base shear and storey drift for different models are find out. The results are analysed to get the best model.

2. MODELING AND ANALYSIS

2.1 Building configuration

A 36 storey building is having 36 m x 36 m plan dimension. The story height is 3.6 m. The pair of braces is located in the periphery of tall building with diagrid structures. The inlcined columns are provided at 6 m spacing along the perimeter. The angle of inclination is different for different models. The design dead load and live load on floor slab are 3.75 and 2.5 kilo Newton per meter square respectively. The design earthquake load is computed based on the zone factor of 0.16, medium soil, importance factor of 1 and response factor of 5. Modeling, analysis and design of diagrid structure are carried out using ETABS software. The support conditions are assumed as hinged. All structural members are designed using IS 800:2007. Secondary effect like temperature variation is not considered in the design, assuming only small variation in the outside and inside temperature.

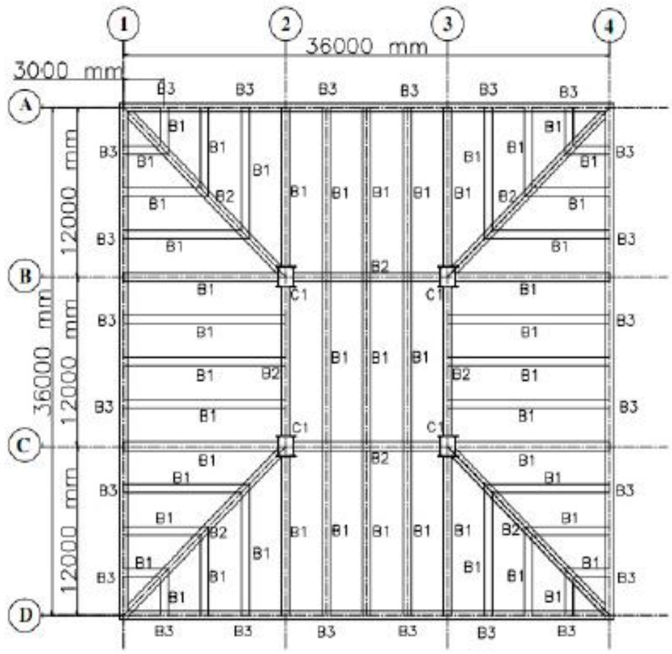

Fig-1: Plan layout of building

The beam B1 and B3 are of IS MB 550 and the beam B2 is of IS WB 600. All the interior columns have a size of 1500 x 1500 mm. The diagonal columns are provided such that from first to eighteenth storey 450 mm pipe section with 25 mm thickness and from the nineteenth to thirty-sixth storey 375 mm pie section with 12 mm thickness.

2.2 DIAGRID MODELS

Table -1: Details of models

Details of models			
SL. NO:	Model Type	No: of storey	Angle in degree
1	Diagrid structure – 60.56	36	60.56
2	Diagrid structure-74.28	36	74.28
3	Diagrid structure- 78.13	36	78.13
4	Diagrid structure – All combined	1-12	78.13
		13-24	74.28
		25-36	60.56
5	Diagrid structure – 60.56 (A)	36	60.56
6	Diagrid structure – 60.56 (B)	36	60.56

Fig-2: 3D view of model 1

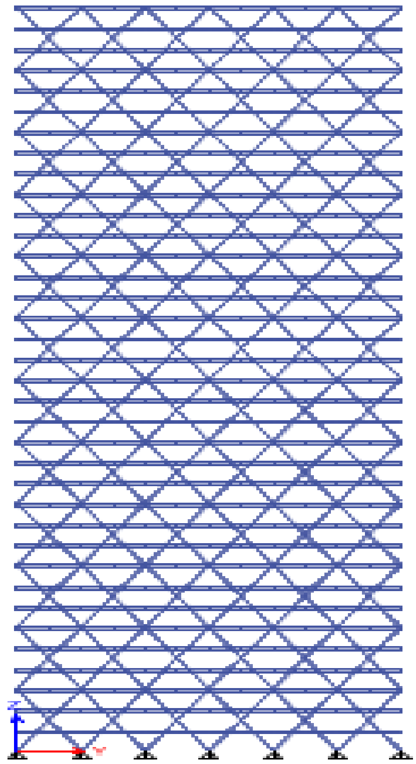

Fig-3: Elevation of model 1

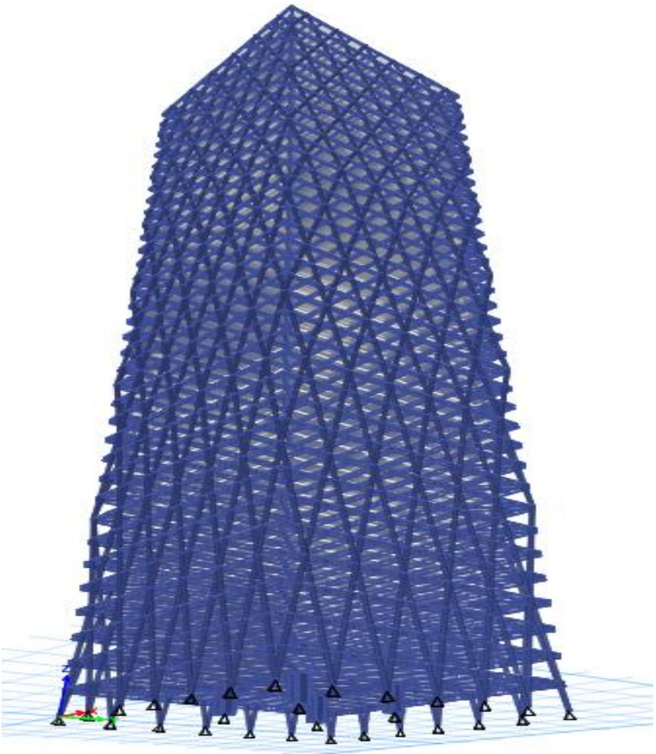

Fig-4: 3D view of model 4

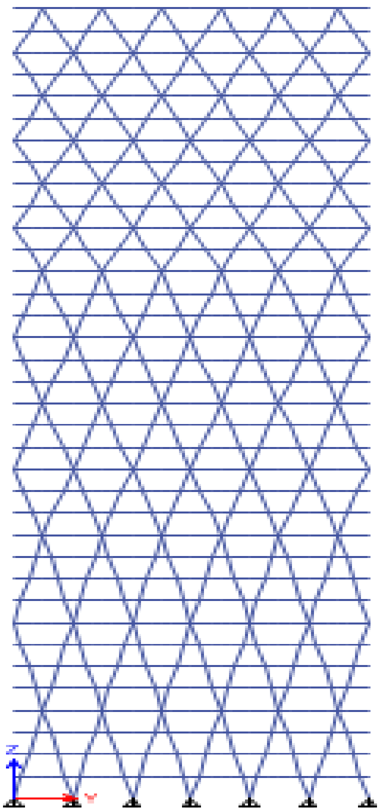

Fig-5: Elevation of model 4

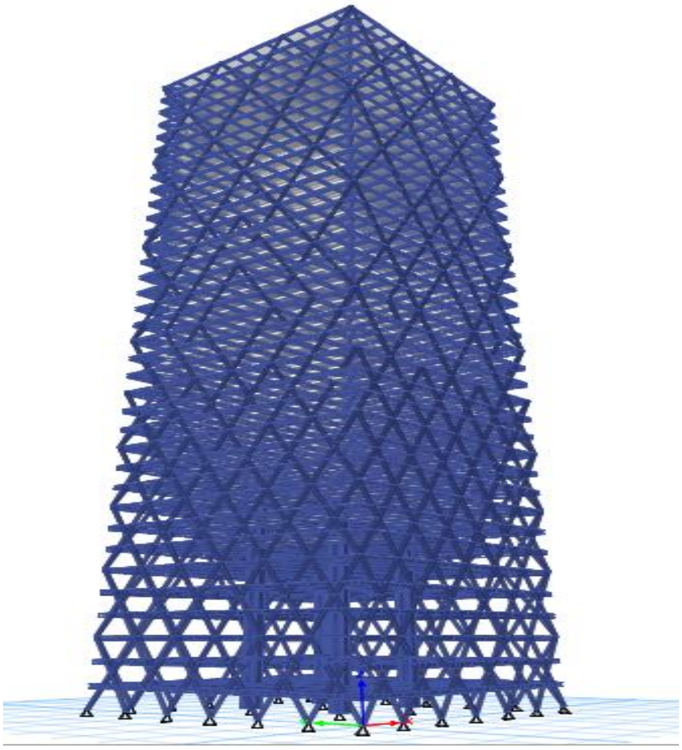

Fig-6: 3D view of model 5

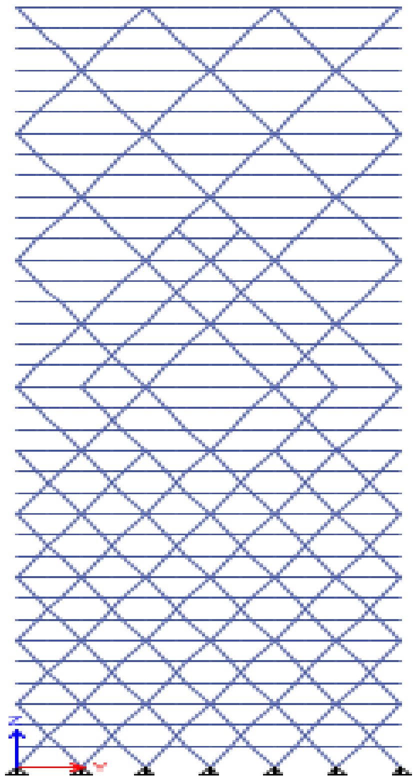

Fig-7: Elevation of model 5

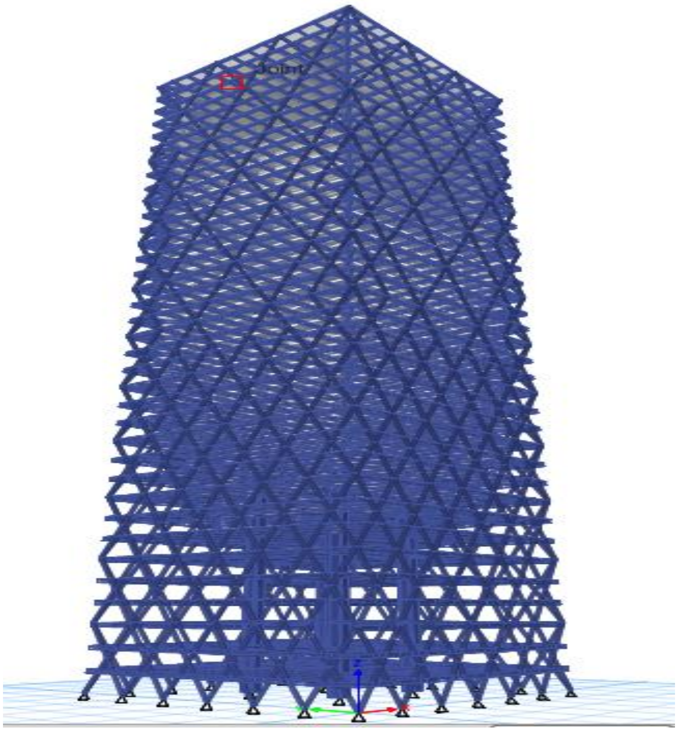

Fig-8 3D view of model 6

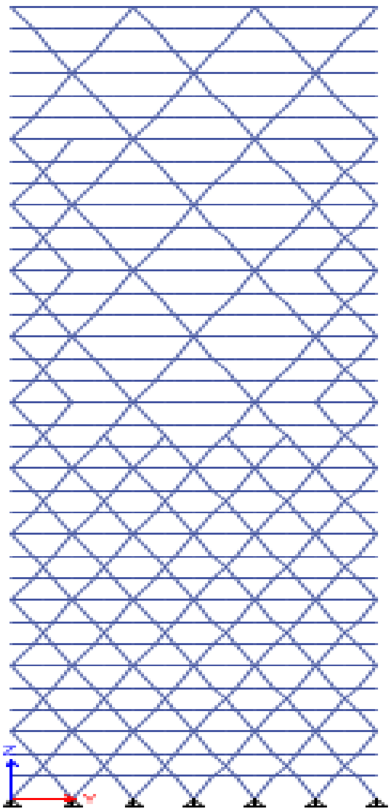

Fig-9: Elevation of model 6

4. RESULT AND DISCUSSION

The storey displacement, base shear and storey drift of all the six models are compared and analyzed. By analyzing different models in ETABS from static earthquake and wind analysis following results were achieved.

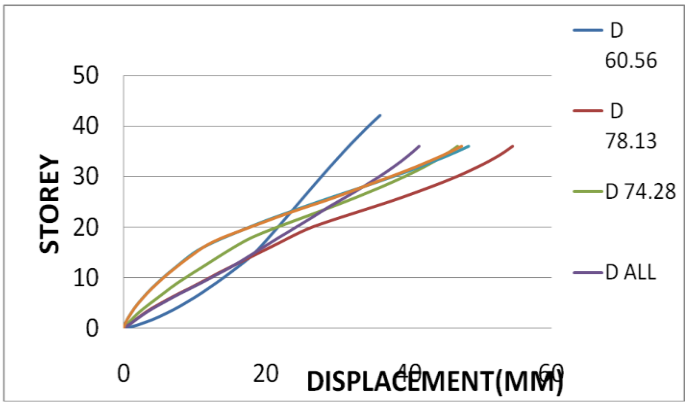

Fig-15: Comparison of storey displacement - EQX

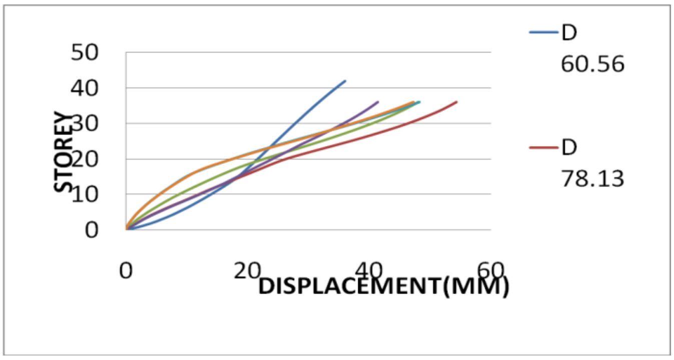

Fig-10: Comparison of storey displacement- EQY

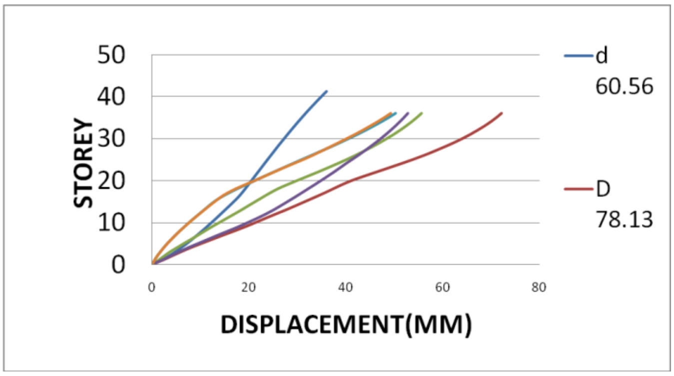

Fig-11: Comparison of storey displacement- WLX

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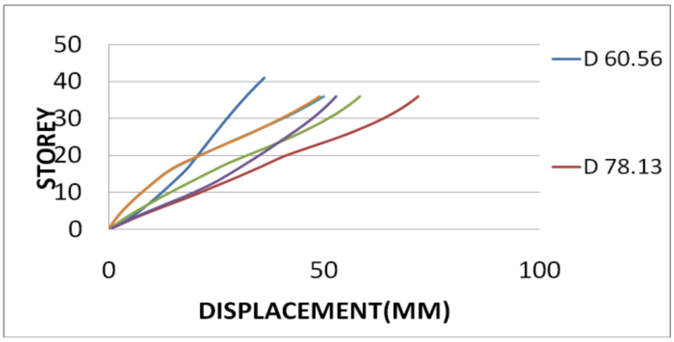

Fig-12: Comparison of storey displacement- WLY

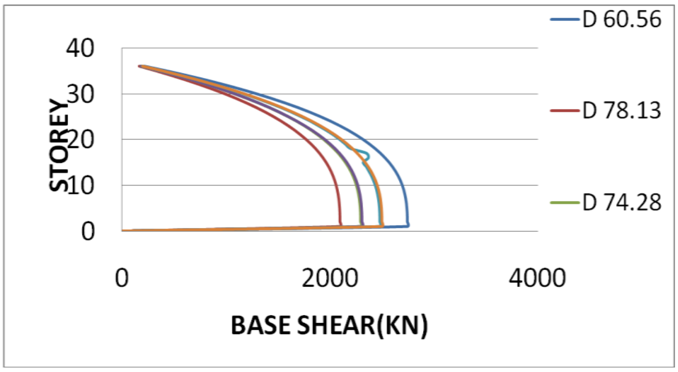

Fig-13: Comparison of base shear –EQX

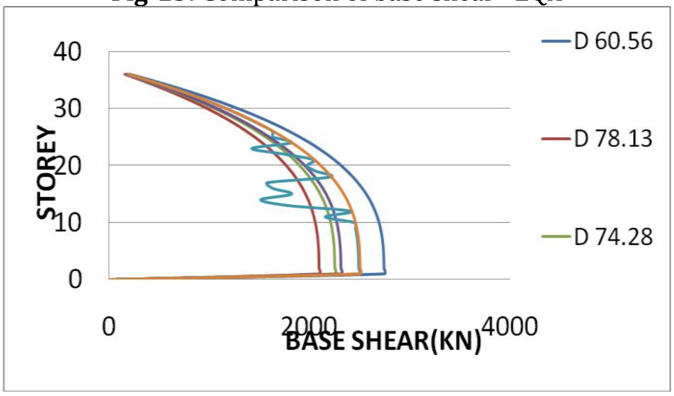

Fig-14: Comparison of base shear –EQY

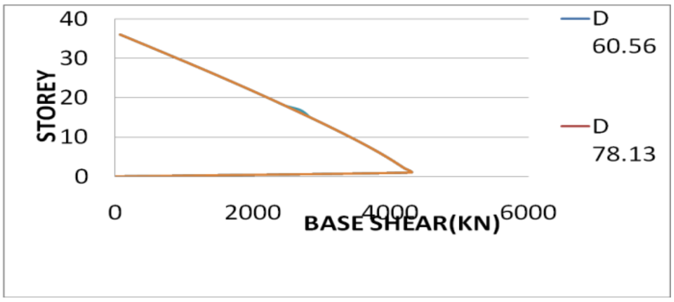

Fig-15: Comparison of base shear –WLX

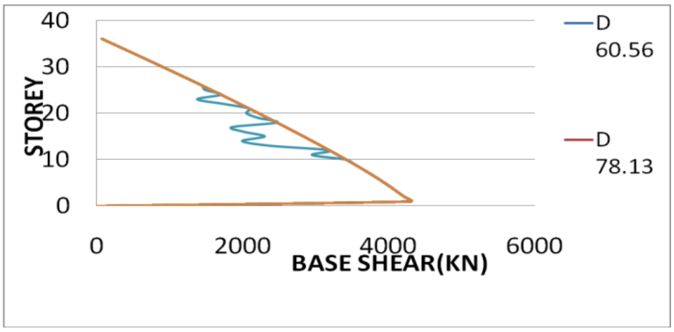

Fig-16: Comparison of base shear –WLY

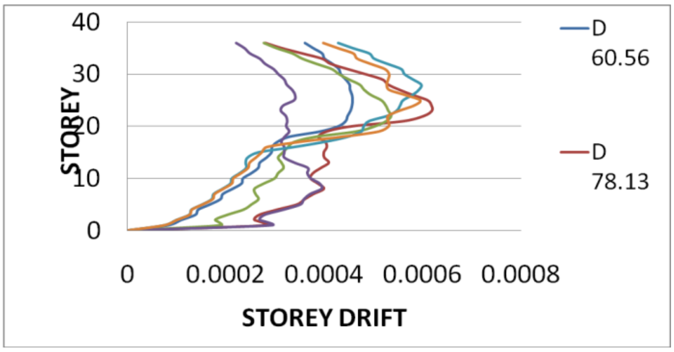

Fig-17: Comparison of storey drift- EQX

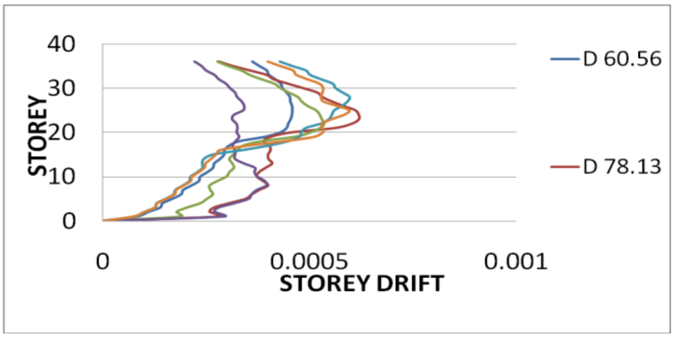

Fig-18: Comparison of storey drift- EQY

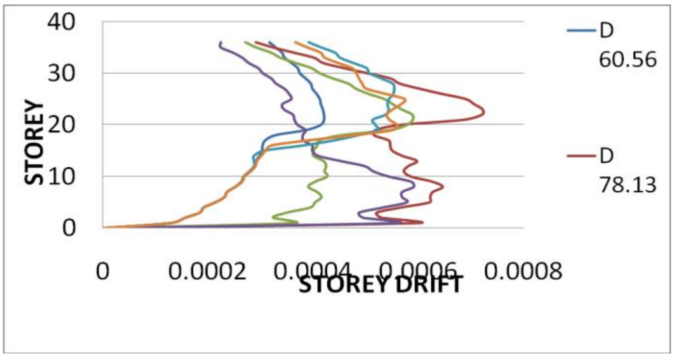

Fig-19: Comparison of storey drift- WLX

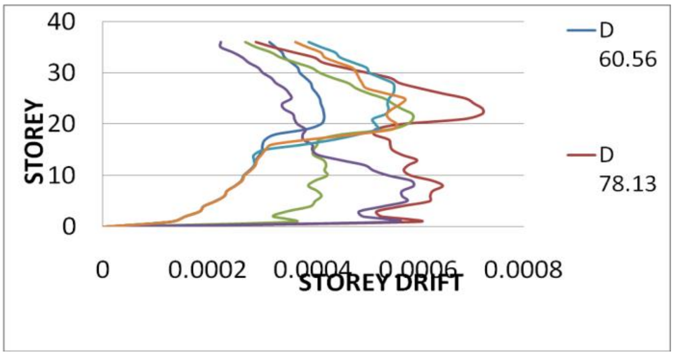

Fig-20: Comparison of storey drift–WLY

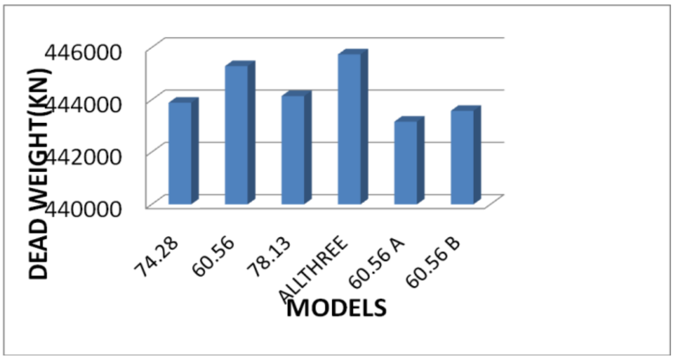

Fig-21: Dead weight comparison

5. CONCLUSIONS

The following conclusions are made from the study:

1. The top storey displacement in model 4 with the combination of all the three degrees 78.13, 74.28, 60.56 has the lowest of 41.44 mm when compared to other models.

2. From the study it is found that the base shear in model 1 with the degree 60.56 has the maximum value 2311.15 KN compared to the other ones.

3. The fourth model with the combination of all the three degrees 78.13, 74.28, 60.56 has the minimum storey drift value as 0.00395 between storey 7 and 11.

4. The whole weight of the building in model 5 with the degree 60.56 has the lowest weight value of 443050 KN when compared to other models.

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