The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1019 - 1025

Effect of Building Geometry on its Performance Under Earthquake and Wind Loading

Prof. A. V. Gorle[1], Dr. R. S. Tatwawadi[2]
[1]Assitant Professor Civil Engineering Department, Jawaharlal Darda Institute of Engineering and Technology, Yavatmal, 445001, Maharashtra, India.
[2]Principal, Jawaharlal Darda Institute of Engineering and Technology, Yavatmal, 445001, Maharashtra, India.
[1]amolgorle8@gmail.com, [2]principal@jdiet.ac.in

Abstract:

Recently new trend generated to resist lateral forces using truss system called as diagrid structure. Diagrid structural system adopted to resist lateral load due to its structural efficiency and flexibility of architectural planning. This study report contain effect of geometry of structure on its performance. To find out effect of geometry of structure on performance. Comparative analysis is done on circular and square shaped diagrid steel structure under earthquake and wind loading. To analyse models under earthquake and wind loading, response spectra method and gust factor method are adopted respectively. E tabs 2015 software used for modelling and analysis of diagrid steel structure. The loading conditions is based on their action of transmission like wind loading acting exposed surface to ground and earthquake loading acting ground to structure. Comparison of structural performance is done on the basis of storey displacement, storey shear, time period, material consumption.

Keywords: Diagrid Structure, Storey forces, Storey Displacement, Storey Drift, ETABS v 2015

1. Introduction:

The rapid growth of urban population and consequent pressure on limited space have considerable influence on the residential development of city. The high cost of land, the desire to avoid a continuous urban sprawl and the need to preserve importance agricultural production have all contributed to drive residential building upward. High rise structure need more sound lateral load resisting system. The lateral load resisting systems that are widely used are: rigid frame, shear wall, wall - frame, braced tube system, outrigger system and tubular system. Recently, the diagrid system widely used for tall steel buildings due to its structural efficiency and aesthetic potential provided by unique geometric configuration. To find out influence of geometry of structure on performance. Two diagrid steel structure taken with different plan shape (circular and square) but similar area and relative stiffness. Etabs 2015 software used for modelling and analysis of diagrid steel structure. To analyse models under earthquake loading and wind loading, response spectra method (dynamic analysis) and gust factor method (dynamic wind analysis) are adopted respectively.

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1019 - 1025

2. Modeling of Structure:

In this report performance of different shape diagrid structure observed under earthquake loading and wind loading. In the earthquake inertia forces act on the structure i.e. F = mass xacceleration that means mass and stiffness of the structure is responsible for the forces. To observe behavior of circular diagrid structure and square diagrid structure under earthquake loading. It must have same relative stiffness of internal columns and same masses. Themodelling of diagrid structure based on same relative stiffness and masses as given below

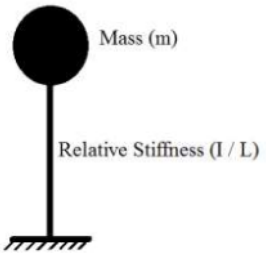

Figure.2.1 Dynamic Model of structure

Table 2.1Comparing parameter of square and circular diagrid structure

Parameter	**Square Diagrid Structure**	**Circular Diagrid Structure**
Area	35.244 x 35.244 = 1242.13	14 x 88.7210 = 1242.08
Floor weight	5902.09	5902.10
Relative Stiffness	0.1052	0.1051

Table 2.2 Models of Diagrid Structure.

MODELS OF DIAGRID STRUCTURE		
On the basis of Geometry	Circular Diagrid structure	Square Diagrid Structure

Table 2.3 Required site condition for analysis

Data for response spectra analysis		**Data for wind analysis**	
Zone factor	0.36		
Importance factor	1.0	Basic wind speed	50 m/sec
Response reduction factor	5	Category	1
Soil condition	Hard rock	Life period of structure	50 year
Live load	2 kN/m2	Topography factor	1
1. On roof	3 kN/m2		
2. On floors			

Table 2.4 Sizes of member of diagrid structure

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1019 - 1025

Parameter	Square diagrid structure	Circular diagrid structure
Grade of concrete Grade of steel Thickness of slab	M 30 Fe 250 130 mm	M 30 Fe 250 130 mm
Beam	Symmetric I section Flange = 180 x 40 mm Web = 510 x 40 mm	ISMB 500 ISMB 550
Column	Flange = 1300 x 50 mm Web = 1410.10 x 50 mm A = 217 mm	Flange = 1300 x 50 mm Web = 1100 x 50 mm A = 525 mm
Diagrid member	Pipe 450 x 25 mm	Pipe 450 x25 mm

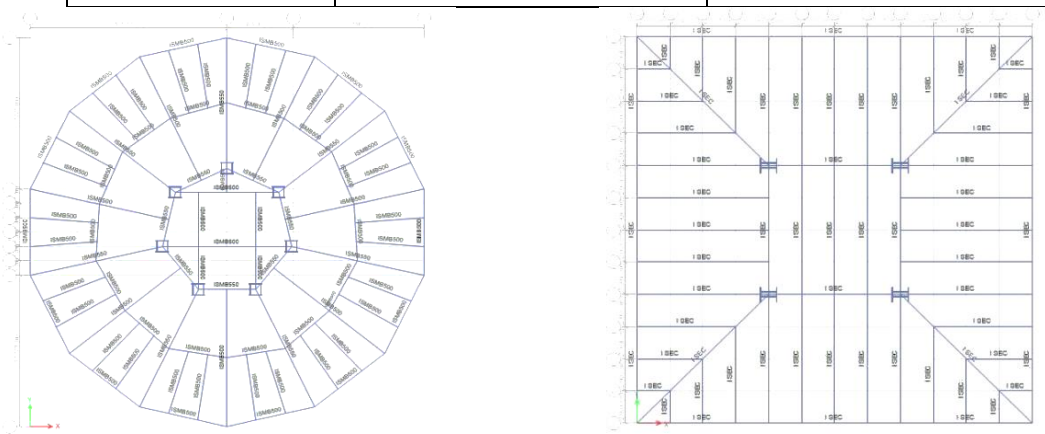

Figure 2.2 Plan of Diagrid Structure

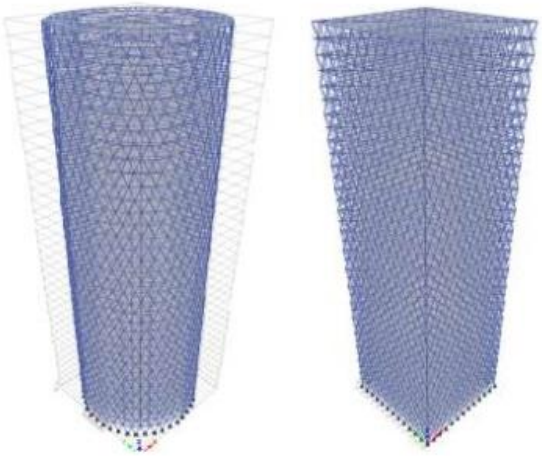

Figure 2.3 3D Model of circular and Square diagrid Structure

3. Analysis Results

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1019 - 1025

3.1 Results of Response spectra analysis

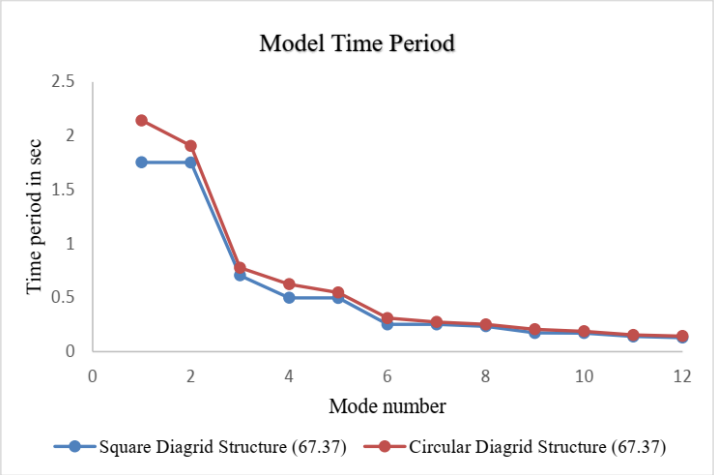

Figure 3.1.1 Comparison of model time period of circular and square diagrid structure

If the stiffness of structure is increases then modal time period is decreases. In the figure 3.1.1 comparison of modal time period of circular and square diagridstructure at an angle $67.30^0$is done. In which found out stiffness of square diagrid structure ismore than the circular diagrid structure.

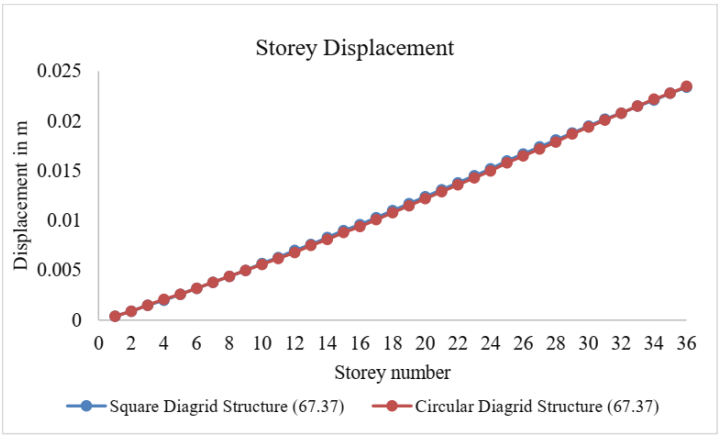

Figure 3.1.2 Comparison of storey Displacement of circular and square diagrid structure

In figure 3.1.2 comparison of storey displacement of circular and square diagrid structure under earthquake loading is done. In which found out storey displacement of circular and square diagrid structure nearly same

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1019 - 1025

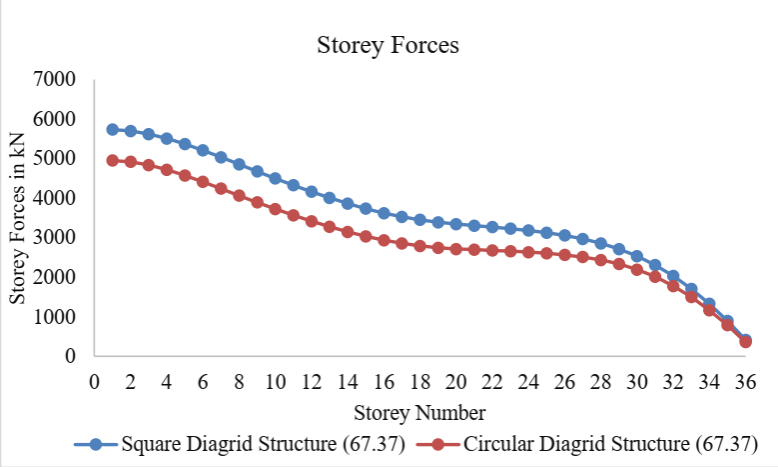

Figure 3.1.3 Comparison of storey Forces of circular and square diagrid structure

In figure 3.1.3 comparison of storey forces on circular and square diagrid steel structure at an angle 67.30^0 is done. In which found out storey forces on circular diagrid structure is reduces than square diagrid structure. This results obtain due to reduction of perimeter grid (dead load) of circular diagrid structure than square diagrid structure.

3.2 Results of Wind Analysis (Gust Factor Method)

In figure 3.2.1 comparison of storey displacement of circular and square diagrid structure under wind loading is done. In which found out storey displacement of circular diagrid structure is more than square diagrid structure. This result is obtain due to nature of loading independent on weight of building and depend on frontal area of elevation of building. Storey displacement is depend on force acting on floor and stiffness of columns. In circular diagrid structure forces and stiffness of structure reduces simultaneously as compared to square diagrid structure.

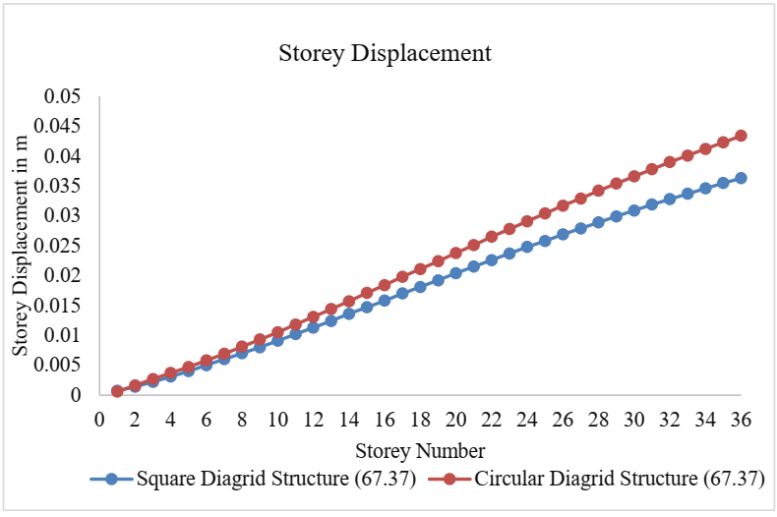

Figure 3.2.1 Comparison of storey displacement of circular and square diagrid structure

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1019 - 1025

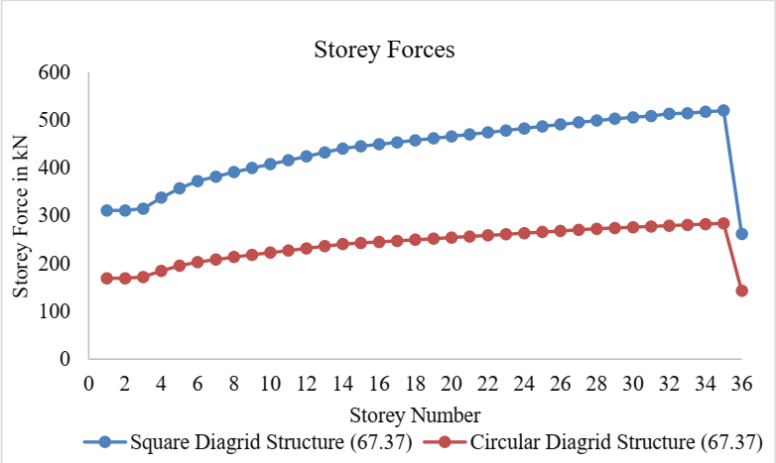

Figure 3.2.2 Comparison of storey Forces of circular and square diagrid structure

In figure 3.2.2 comparison of storey forces on circular and square diagrid steel structure at an angle 67.30^0 is done. In which found out storey forces on circular diagrid structure is reduces than square diagrid structure. This results obtain due curved shape of circular diagrid structure.

4. Conclusion:

1. Comparing storey forces of circular and square diagrid structure at an angle of 67.300 under earthquake loading. It found that storey forces of circular diagrid structure reduces. It shows that under earthquake loading circular diagrid structure gives better results.

2.Comparing storey displacement of circular and square diagrid structure at an angle 67.300 under wind loading. It found that storey displacement is minimum for square diagrid structure. This shows that performance of square diagrid structure is better than circular diagrid structure under wind loading.

4. References:

1. Kyoung-sun Moon, Jerome J. Conner, John E. Fernandez, “Diagrid structural system for tall buildings: characteristics and methodology for preliminary design”. The Structural Designof Tall and Special Building, 2007, Page no. 205-230.
2. Elena Mele, Maurizio Toreno, “Diagrid structure for tall buildings: case studies and designconsiderations”. The Structural Design of Tall and Special Buildings, 2014, Page no. 124-145.
3. Raghunath D. Deshpande, Sadanand M. Patil, “Analysis and comparison of diagrid and conventional structural system”. International Research Journal of Engineering andTechnology, June – 2015.
4. Nilesh M. Gautami, Sumant B. Patel, “Comparison of various structural systems for tall steel buildings in Indian scenario”. Journal of Information, Knowledge and Research in Civil
Engineering, 2012, Page no. 78 - 82.

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1019 - 1025

5. Harish Varsani, Dipesh Gandhi, “Comparative Analysis of diagrid structural system and conventional structural system for high rise steel building”. International Journal of Advance Research in Engineering, Science & Technology, January- 2015.