

Performance based analysis of diagrid structure over braced tube structure by response spectrum analysis

v.mounika, p.sathish, m.priyanka, k. sravya

P.G student, Department of civil engineering, Vignan University, vadlamudi, india, vallabanimounika1@gmail.com

Assistant Professor, Department of civil engineering, Vignan University, vadlamudi, India, sathish40polu@gmail.com

P.hd student, Department of civil engineering, Vignan University, vadlamudi, India, mukkala.priyanka@gmail.com

P.G student, Department of civil engineering, Vignan University, vadlamudi, India, kakanisravya@gmail.com

Abstract— As population goes on increasing, the structural engineer has to provide shelter for all the people. To reduce this problem tall buildings are established. Lateral forces are major challenge for tall buildings. To resist the lateral forces in tall buildings structural systems has been adopted. These structural systems are useful in a structural view and also the architectural view. There are different types of structural systems to adopt.

This paper presents comparison between two different types of structural systems in structural and architectural view. And then comparison between the shapes of the structure has been done. Main aim of this paper is to adopt best structural system with best shape. Analysis has been carried by E-Tabs 2015. And the results are compared in terms of maximum story displacement, maximum story drift and the time period

Keywords— braced tube , Diagrid, story displacement, Story drift, Structural system, Time period

I. INTRODUCTION

Main role of a structure is ability to resist the loading conditions not only the gravitational and also the lateral loads. As the height goes on effect of lateral load will increase. To reduce that effect structural systems were developed.

1. Interior structural system
2. Exterior structural system

are the two structural systems.

Diagrids comes under the type of exterior structural system which is having a triangulated structure connecting diagonals with any type of material. Diagrids are connected to the beams of each storey they avoid the columns in the perimeter of the structure. The diagrid will take care of both tension and compression of the structure.

Tubular structures are later improved as braced tube structures by providing cross bracings with more stories. These cross bracings are connected to the exterior columns to reduce the shear lag effect. The result is reduce the bending of the members.

II. OBJECTIVE OF THE WORK

1. Analysis of Diagrid and braced tube for structures in three earthquake zones.
2. Analysis of Diagrid and braced tube in two different shapes.(rectangle, octagonal).
3. To study the earthquake effects on Diagrid and braced tube structure.
4. Comparative study of Diagrid and braced tube structures of different shapes and obtain the response in terms of displacement, story drift, time period.

III. BUILDING CONFIGURATION

1. Model

As a preliminary work one model is considered consisting of six cases That are 3 zonal cases for two different structures(Diagrid ,braced tube). Plan and the details are adopted from performance comparative study of Diagrid structure over braced tube structures

After examination of all the cases the main work is fixed to zone 5 Under the medium soil condition. In this work two different shapes of models are considered – rectangle and octagonal having same plan area, height. Plan area of 280m² was taken. Plan view of different models are shown in fig. 1, 2.



Fig.1:Plan Of Square Building

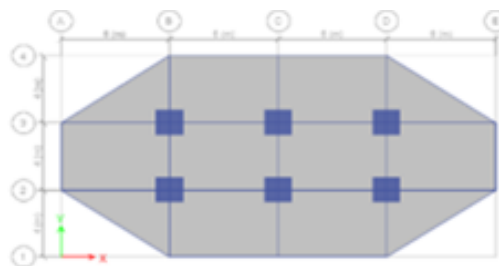


Fig.2:Plan of octagonal building

2. Geometry

Geometry of all the models are given by

Grade of concrete for slabs	M25
Grade of the steel	HYSD 500
Story height	3.5M
Slab thickness	200MM
Zone type	III,IV,V (from IS 1893:2002 PartII)
Importance Factor	1 (from IS 1893: 2002 Part-II)
Response Reduction Factor	5 (from IS 1893:2002 Part-II)
Wind Speed	50 (from IS 875 Part II)
Floor Finish	1.5 kN/m ²
Live Load	2.5 kN/m ²
Wall Load for the inner side	0.74 kN/m (from IS 16231: 2014 part 4)

Angle of Diagrids and braced tube is 74.5 degrees it is based on storey module. In this work 5-storey module is taken for modelling. Both the structures are pinned at both ends and The Diagrids are connected to the horizontal beams of each floor which are connected to interior columns and braced tubes are connected to the exterior columns of the building.

Modelling, analysis and design are carried by using ETABS 2015. concrete frame design is used for analyse the members.

Member	Property
Beam-1	700*700
Beam-2	600*600
Beam-3	500*500
Beam-4	470*470
Column-1	750*750
Column-2	700*700
Column-3	650*650
Column-4	500*500
Column-5	470*470
Column-6	450*450
Diagrid interior columns	
Column-A	1500*1500
Column-B	1000*1000
Column-C	750*750
Braced Tube	500mm dia,200mm thick
Diagrid	500mm

IV. ANALYSIS

The analyze have been done by response spectrum method by considering the scale factor using formula [4]

$$(I/R)*(Z/2)$$

Where I=importance factor taken it as 1

Z= zone factor taken it as 0.36

R= reduction factor taken it as 5

Response spectrum becomes more popular to study and face difficulties while considering ground motions and the dynamic properties of structures. By this method we get only maximum displacement and member forces using response spectra curve which is taken from several earthquake motions.

V. RESULTS AND DISCUSSION

In the present study comparison of the performance of rectangle and octagonal buildings considering diagrid and braced tube structural system is carried out and the results are represented in the form of graphs.

1. Preliminary work result

Displacement of the structure in different zone conditions are shown in fig.3

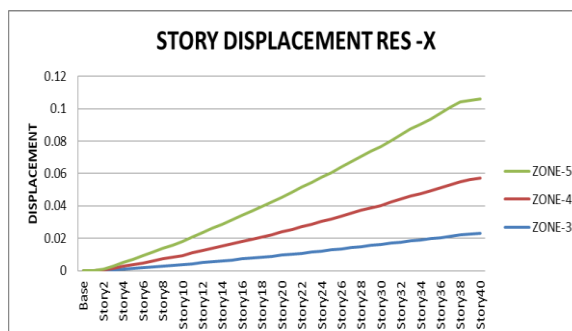


Fig.3 storey vs displacement in different zone conditions

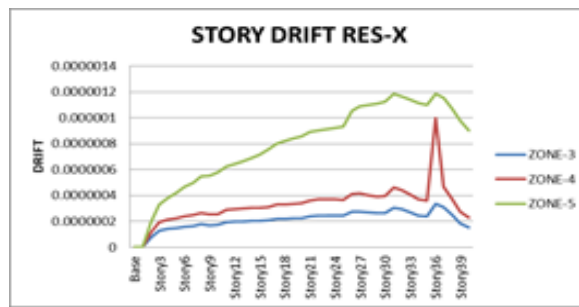


Fig.4: storey vs drift in different zone conditions

Generally zone 5 is most severe and it gives more values than the other zones but by observing the primary work of this paper not only the zone soil condition also will change the performance of the building. Here sever zone in hard soil gives less displacement than the moderate zone in soft soil.

2. MAIN WORK RESULTS

a. Maximum Storey Displacement

Structure	Displacement(Mm)
diagrid	987.3
Braced tube	205.8

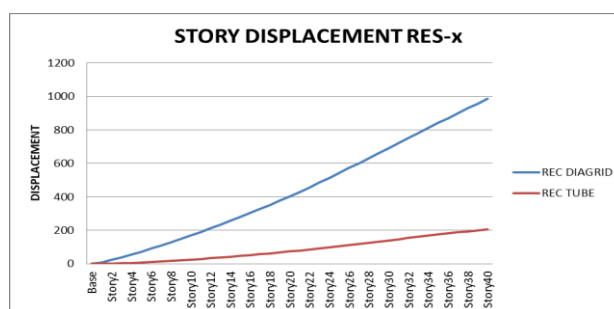


Fig.5: storey vs displacement with respect to structure

shape	Displacement(mm)
rectangle	987.3
octagonal	474.5

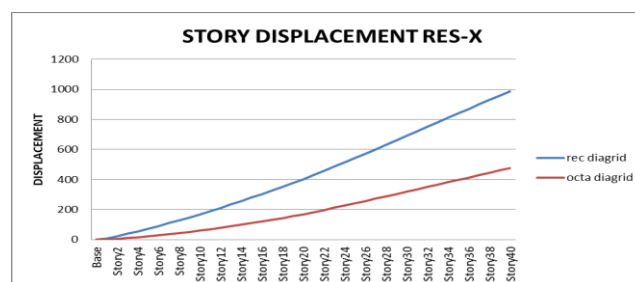


Fig .6.storey vs displacement with respect to shape

The displacements of three structures are increasing linearly from base to storey 40. Pattern of the graphs are uniform because of symmetry of geometry. Comparing both Diagrid and braced tube structures braced tube structures gives least maximum displacement than Diagrid structure. While comparing the shape rectangular structures is gives least maximum displacement.

b. Results on storey Drift

structure	drif
diagrid	0.0000214
Braced tube	0.00000693

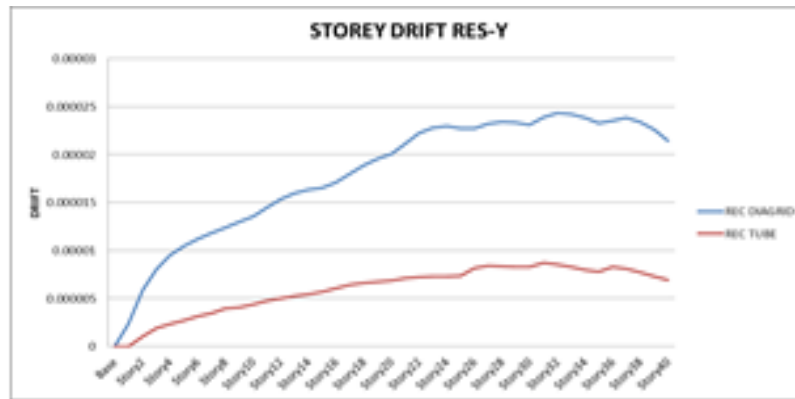


Fig.7: storey vs drift with respect to structure

shape	drift
Rectangle	0.0000331
octagonal	0.0000214

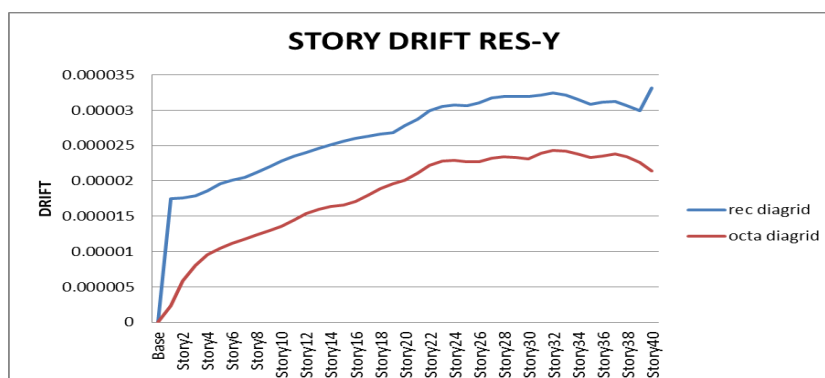


Fig8. storey vs drift with respect to shape

The story drift curves are observed as uniform but the octagonal structure gives more uniform graph than the other structures. Maximum story drifts are observed at stories from 27-40 Drift at each story of the structure in response spectrum case is shown in fig7.. Comparing the two different shapes of structures octagonal structure found to be least maximum drift.

c. Time Period

From the dynamic analysis time period is gets by considering 12 mode shapes for all the three structure, is represented in the form of graph in fig.10

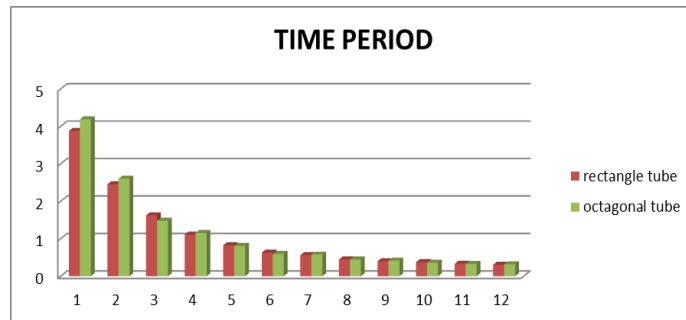


Fig.10 mode vs Time period

It is observed from the fig.10 time period for triangular structure is more than the square and octagonal and square has least time period than the others.

We have building natural time period is $T = 2\pi \sqrt{m/k}$

Where m= mass and k= stiffness of the structure

From the above equation time period is inter related to the mass and stiffness as time period is more modal mass is more. here the octagonal structure have mass greater than the other structures

VI. CONCLUSIONS

1. Zone gives less maximum displacement Of(0.04809) and drift values compared to zone IV and III
2. Braced tube structure giving least max displacement Of(205.8) compared to Diagrid structure.(987.3)
3. Octagonal shape structure (474.5) is effective than rectangular shape (987.3) structures in structural view
4. Octagonal shape structures is effective than Rectangular shape structure in architectural view
5. From the time period mass of the structure is more for octagonal shape structure (4.19) than the rectangular shape (3.87) structure.

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