International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishing

Evaluation Study of Multi-Storied Frames with "O Grid Bracing System"

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***Abstract*: Researches in various types of bracing systems that can be used in order to reduce he seismic effect, vibrations etc. On the structures are being carried out now-a-days. Various types of bracing systems that are available are X bracings, H bracing etc. Here in my project I am put forwarding a new shape of bracing as "O grid". Several studies are already in O grids, which already show they provide more desired values comparing to the conventional ones. As a continuation in my project I am finding out which cross section provided for o grid give more desired value and in which all patterns O grid can be arranged in order to give the best value. The analysis for the different cases studies to choose the cross section and performance under different arrangements in multi storied frames is done using ANSYS Workbench 16.1 software. Total deformation is found by both model analysis as well as time historic analysis. Hence this work will offer a good clarity on comparison of deformation, story shear, and frequency.**

***Keywords*: Experimental Behavior, Lateral bracing system, Modal analysis, O grid bracing system, Response spectrum analysis, Time historic analysis.**

1. Introduction

The development of lateral bracing systems and proper details of braces that began in 1960 and research's been continuing on them so far, has made it possible to achieve a system with suitable stiffness and ductility. The experiments conducted on centric bracing frames (CBF) showed that CBF system has a very higher stiffness compared to moment resisting frame (MRF) system and thus is incapable of providing sufficient ductility. Using X-bracing is one of the most common approaches for bracing and strengthening against lateral forces particularly earthquake forces.

An important standpoint in structures design is changing the form of buildings to provide more rigidity and stability, therefore in this project the idea of using circular shape for braces are studied. As the load increase, the geometry changes, hence the characteristics of such a circular system are geometrically nonlinear and leads to this new bracing system with circular shape has more ductility. So, the bracing systems, called the O Grid, which has both appropriate stiffness and good ductility is going to studied by this project.

2. O Grid Bracing System

The O Grid bracing system is braced frame with circular brace connected to moment resisting frame (MRF) with joint connections. The lateral stiffness of this system is provided by circular brace, and the circular brace yield in axial force and bending to dissipate energy during severe seismic excitation.

3. Analytical Study

Analytical study of o grid bracing is done with the help of ANSYS Workbench 16.1 Software. It is conducted in order to find the best cross section which suits the O grid bracing and to find how to arrange the o grids in multi storied frames for the best results.

A. To find the best cross section

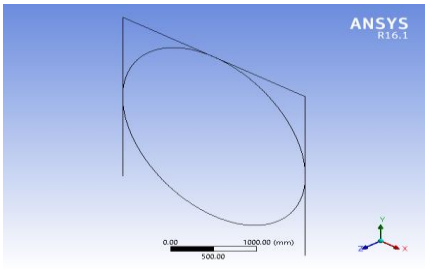

Fig. 1. Modal diagram of O grid bracing obtained from ANSYS

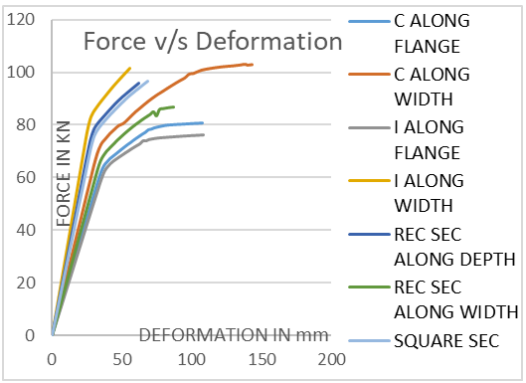

Fig. 2. Comparison Graph of Force vs. Deformation of various cross sections

Cross section of the O frame is changed one after other and obtained the values of Total deformation, equivalent stress, strain, force reaction etc. The comparison showing the graph of different cross section is as below.

From the fig. 2 it is clear that cross section with I section placed along width has less deformation compared to all other sections.

B. To find the suitable Arrangement in Multi storied frames

The most viable cross section "I section placed along the width" is placed under different multi storied frame condition. The various conditions are

- O Grid placed diagonally
- O Grid placed to all frames on all stories
- O Grid placed at Ends
- O Grid placed at Middle
- O Grid placed alternatively condition 1
- O Grid placed alternatively condition 2

These various conditions are analysed by both Modal Analysis method and also Time Historic Method. The value provided in Time historic method is the vibration value from ELENTRO earthquake. The pattern of earth quake is as follows.

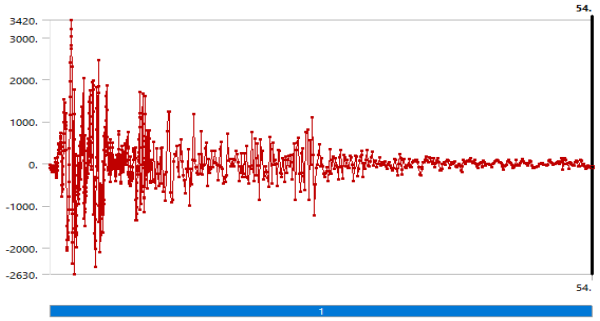

Fig. 3. Pattern of ELCENTRO earth quake

For conducting analysis choose 10 storey heights with 5 bays. The modal diagrams of various conditions are as follows.

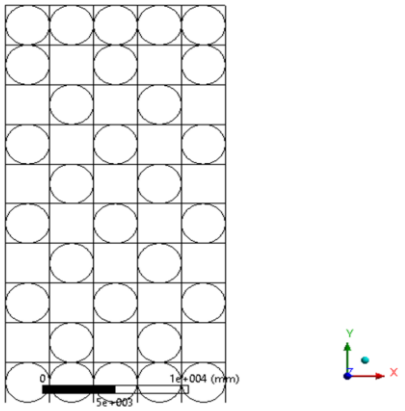

Fig. 4. Model diagram of O grid placed diagonally

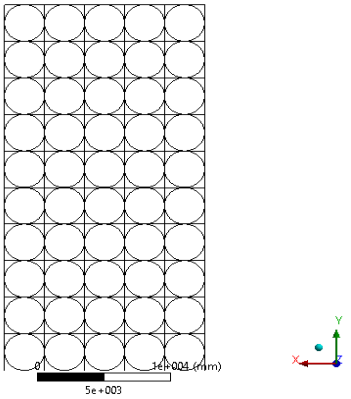

Fig. 5. Model diagram of O grid placed to all frames on all stories

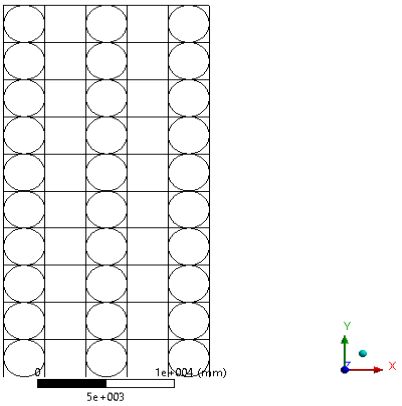

Fig. 6. Model diagram of O grid placed at ends

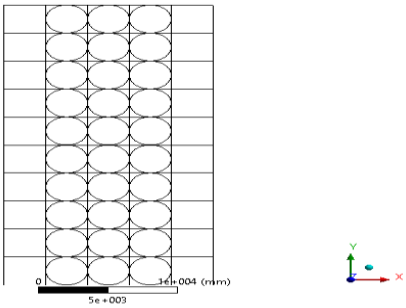

Fig. 7. Model diagram of O grid placed at middle

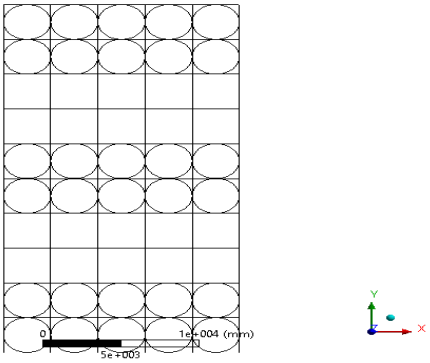

Fig. 8. Model diagram of O grid placed alternatively condition 1

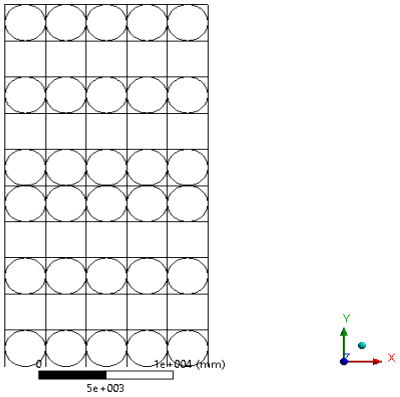

Fig. 9. Model diagram of O grid placed alternatively condition 2

After conducting the experiment in various patterns using software obtained the total deformations by both modal and time historic analysis. The comparison study of various patterns can be expressed by the table and figures below.

Table 1
Frequency, Time period, displacement, Base shear of different conditions

Models	Frequency (Hz)	Time periods (second)	Displacement (mm)	Base shear (N)
OG @ALL STORIES	2.151	0.464	21.6	32349
OG @ DIAGONAL	1.633	0.612	45.186	41699
OG @ ENDS	1.853	0.539	24.966	30890
OG @ MIDDLE	1.971	0.507	23.558	28947
OG @ ALTERNATIVE 1	1.725	0.579	33.584	38189
OG @ ALTERNATIVE 2	1.701	0.587	36.071	42148

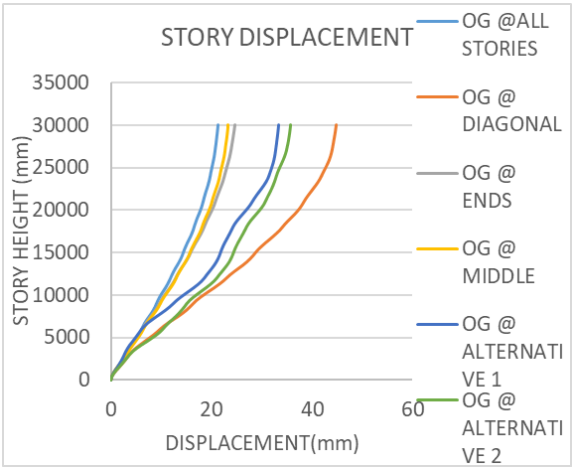

Fig. 10. Comparison graph of Storey Height/S Displacement of various cases

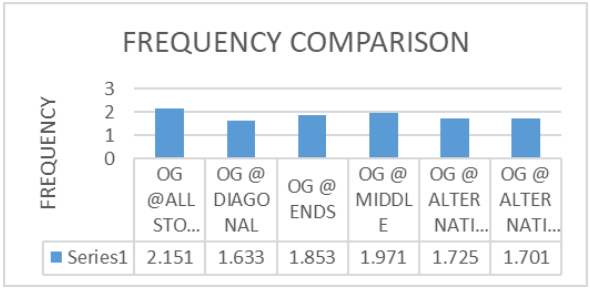

Fig. 11. Comparison graph of frequency of various cases

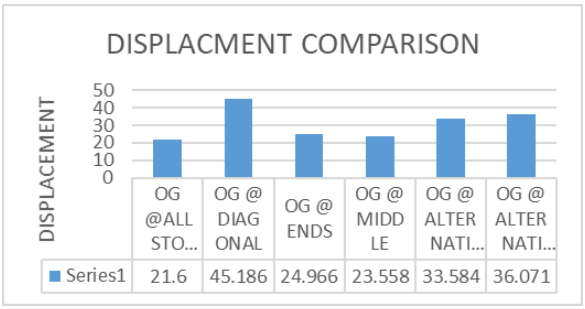

Fig. 12. Comparison graph of displacement of various cases

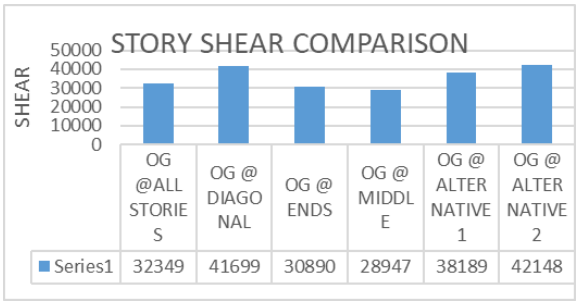

Fig. 13. Comparison graph of shear of various cases

From fig. 10, O grid placed on all stories is having less deformation compared to other conditions. But providing O grid in all frames in all stories is not economical. So the next one having less deformation is O grid placed at the middle.

From fig. 11, Frequency is high in O grid placed on all frames in all stories and the next one is O Grid placed along middle. In fig. 12, Displacement is very less in O grid placed on all frames in all stories and the next one is O grid placed at the middle. In fig. 13, storey shear is very less in O grid placed at the middle. So the best suitable pattern to arrange is O grid placed at the middle of multi storied frames.

4. Conclusion

From the research conducted above it is clear that the most apt cross section can be used in O grid is I section placed along width. In the case of multi storied frame it is better to place the O grids in all stories and all section. But while considering economic scenario it is better to place O grid at middle for the best value.

5. Future Scope

Further researches can be conducted in order to find other various shapes can be used as bracing system with many performances comparing to the conventional bracing systems.

Acknowledgement

The kind permission to publish this work is highly acknowledged. I thank all the authors of reviewed papers for their indirect support of knowledge. The support providing during the project work by Ms. Geethika G Pillai, Assistant Professor, Indira Gandhi Institute of Engineering and Technology, Kothamangalam is gratefully acknowledged. I also thank my father and my family members for their patience and cooperation without which this paper may not have come out at an expected way.

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