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ANALYSIS OF G+2 MONO-COLUMN BUILDING FOR DIFFERENT PLAN CONFIGURATIONS WITH THE SAME PLAN AREA USING STAADPRO

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Abstract - *During the monsoon season, due to the floods, water reaches the ground story of the building and causes a problem for the occupants of the building. So, to avoid these problems, we use mono-column structures. In this geometry such as rectangular, pentagonal, and circular are analyzed. The building plans are drawn in Auto-cad 2023 software. The plan area of each mono-column building was taken as 1000 sq. ft. Then modeling and analysis were carried out using the Staad-pro software as per Indian standards. The analysis for buildings was carried-out under seismic zone III. The cross-section for each mono-column was taken as a square of side 1m. The parameters such as displacement, bending moment, and shear force for each building's structural components are studied and later compared.*

***Key Words*: Auto-Cad, Design of building, Equivalent static analysis, Mono-column structure, Seismic analysis, Staad-pro.**

1. INTRODUCTION

In India some parts of the country like Andhra Pradesh, Tamil Nadu, and West Bengal experience cyclones, which are often accompanied by heavy rainfall leading to flooding in the monsoon season. During such cases, the water level reaches approximately the first floor of the building. One of the best solutions for this problem is to rise the living area higher from the ground level. So, the mono-column buildings are very effective to control floods.

And also, with the increase in population, the availability of land decreases, and the cost of land increases. The total cost of the construction includes the cost of building and land cost also. So, to reduce the cost of the building by reducing the foundation cost and excavation cost, mono-column structures are constructed. As they are resting on a single column, the area required for the foundation is less so the foundation cost as well as the excavation cost is also reduced. They require less ground space as require less area for providing the foundation. And the remaining spacing is useful to provide for parking.

1.1 Monocolumn Structure

A building that is supported on a single column is called a mono-column structure. They require less ground space as required less area for providing the foundation so that more space is available for parking. A structure supported on a single column provides a better architectural view compared to a structure supported on many columns. They are also unique.

1.2 Objectives of the Present Project

1. To develop plans for the different shapes of the same plan area.
2. To analyze a model of the Mono column structure for different plan configurations with the same plan area such as rectangle, circular, and the pentagon in Staad-Pro software.
3. To analyze the structure as per Indian standards.
4. To compare three different mono-column buildings based on analysis in the STAAD-pro software.

2. LITERATURE REVIEW

Madireddy Satyanarayana [2016]: They take this project to analyze the design of mono-column by using different code provisions available. They draw a layout plan of the proposed building drawn by using AUTO CADD 2010. The structure consists of six floors including the ground floor, with each floor having one house. The staircase must be provided separately. The planning in their study is done as per Indian standard code provisions. Frames are analyzed by using various textbooks as references Using this so many standard books analyses of bending moment, shear force, deflection, end moments, and foundation reactions are calculated are given in this paper.

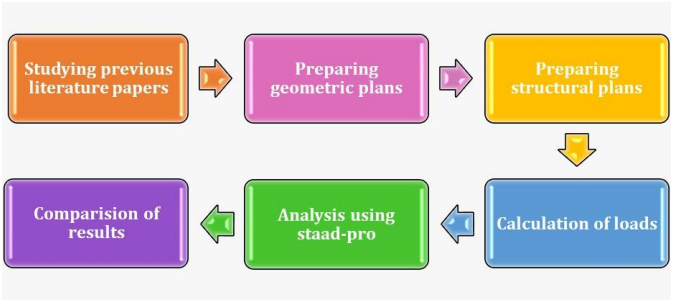
T. Subramani (2019): The purpose of this study is to lay out a whole building relaxation on a single-column design. This paper finds that the express boost in population and scarcity of land tends to the progress of construction technology and high-rise structures. This building is composed. A single-column structure is out of the ordinary mono-column structure.

Basavaraju S N (2020): This paper describes that from static and dynamic analysis, the Storey displacement, Storey drift, Storey shear, and overturning moment of all shapes increase as we go to a higher seismic zone. 5. Storey displacement & Storey drift are less in circular shape structure and more in rectangular shape mono column structure in all seismic zones of India. According to this paper story shear, overturning moment, and story stiffness are minimum in square shape structures and maximum in triangular shape mono column structures in all seismic zones of India. The Time-period is more for rectangular shapes and less for circular shapes and mono-column structures given by conducting analysis.

Gomasa Ramesh (2021): In this study multi-story building with a single-column construction has been successfully engineered to withstand all loads, including earthquake loads. In this study, they state that under static loading conditions, RCC columns have adequate results. STAAD-Pro advanced software provides us with a platform for analyzing and designing structures that is fast, reliable, simple to use, and accurate. The ultimate strength and serviceability of the building must be met by the structural design.

3. METHODOLOGY

The methodology of our project is shown in the below flow chart.



3.1Loads And Load Combinations

The loads acting on the structure are calculated based on the IS 875-1987(part 1 and part 2). The IS 875-1987 is a code of practice for design loads (other than earthquake loads) that deals with the magnitude of such loads that are being used for designs in India. And the earthquake loads in our study are calculated as per IS 1893-2002. Load combinations are taken as per Table no. 18 from IS 456-2000.

3.2Structural Analysis

The models of G+2 story for mono-column buildings such as rectangular, pentagonal, and circular are created, investigated, and configured using Staad-pro V8i software. Auto-cad 2023 was used for the planning of building drawings. The building is arranged in zone III. The seismic zone coefficient is taken as 0.16 according to IS code.

4. ANALYSIS OF MONO-COLUMN STRUCTURE

Specifications of the mono-column buildings are shown in the table below.

Table -1: Primary data

Description	Specification
Number of stories	G+2
Story height	3.0m
Height of building	9.0m
Beam size	0.45m*0.6m
Column size	0.45m*0.6m
Monocolumn size	1.0m*1.0m
Slab thickness	150mm
Zone	III

4.1Structural plans of building

The structural plans are further required to analyze in the Staad pro software.

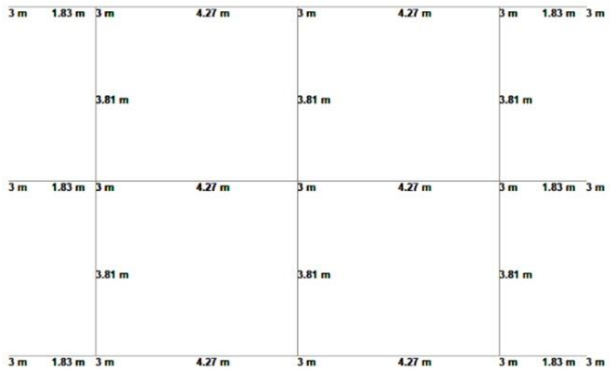


Fig -1: Rectangular structural plan

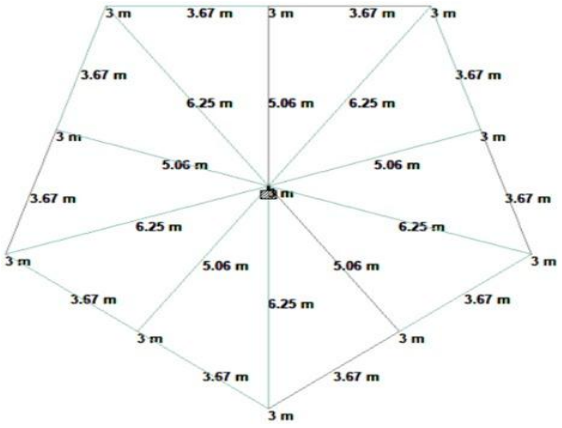


Fig -2: Pentagonal structural plan

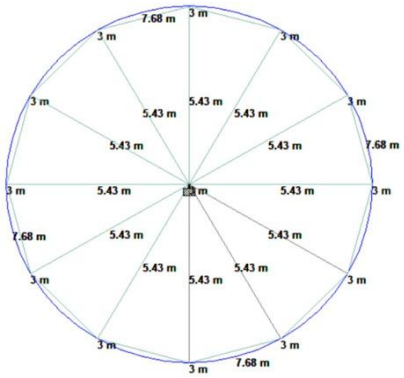


Fig -3: Circular structural plan

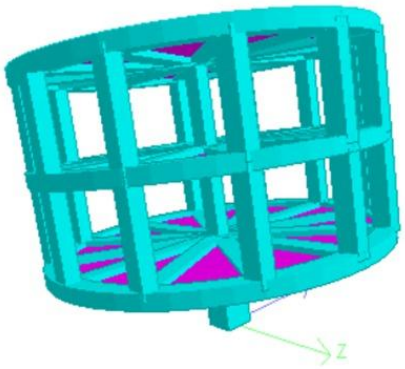


Fig -6: Circular frame

4.2 3D view of buildings

The following is the 3D view of mono-column buildings.

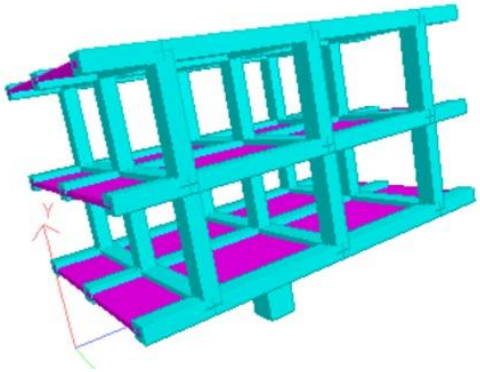


Fig -4: Rectangular frame

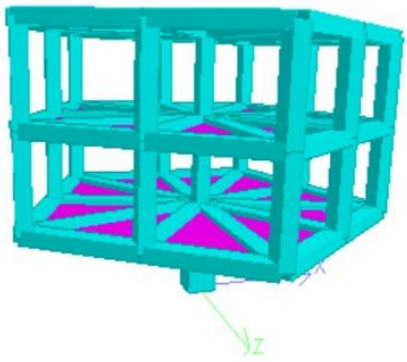


Fig -5: Pentagonal frame

4.3 Analysis result

The results obtained from the analysis are displacement, bending moment, and shear force.

4.3.1Displacement

The displacement produced by the rectangular, pentagonal, and circular mono-column buildings occurs as shown below.

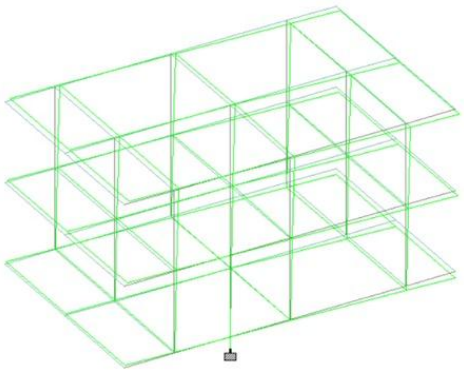


Fig -7: Displacement of the rectangular structure

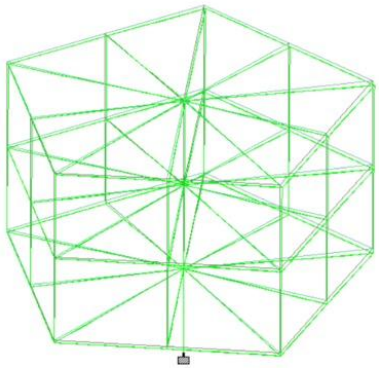


Fig -8: Displacement of pentagonal structure

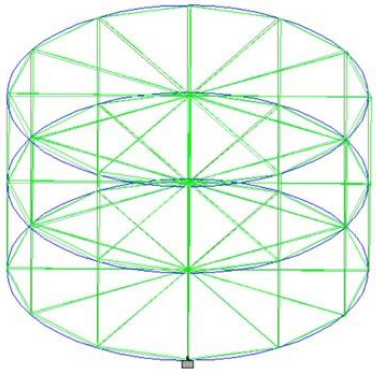


Fig -9: Displacement of the circular structure

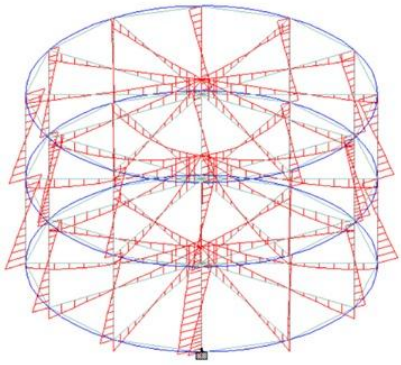


Fig -12: Bending moment of the circular structure

4.3.2Bending Moment

The bending moment produced by the rectangular, pentagonal, and circular mono-column buildings occurs as shown below.

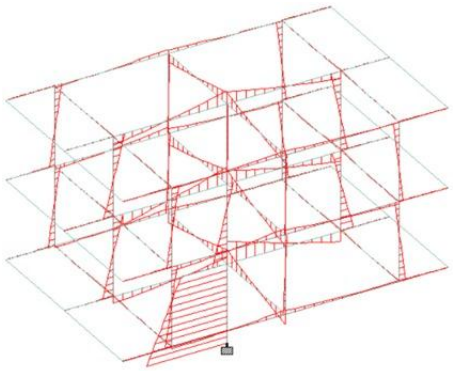


Fig -10: Bending moment of the rectangular structure

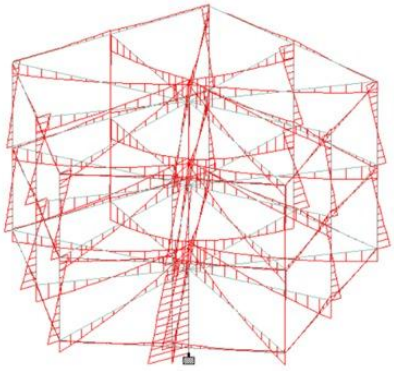


Fig -11: Bending moment of pentagonal structure

4.3.3Shear Force

The shear force produced by the rectangular, pentagonal, and circular mono-column buildings occurs as shown below.

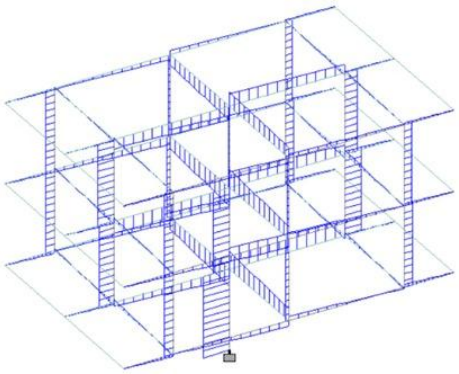


Fig -13: Shear force of rectangular structure

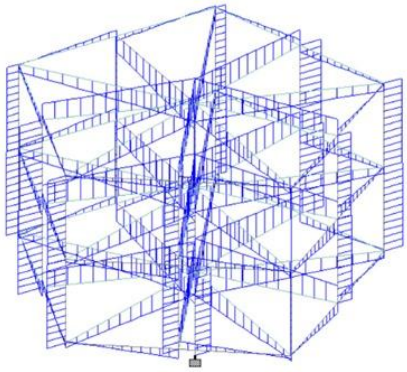


Fig -14: Shear force of pentagonal structure

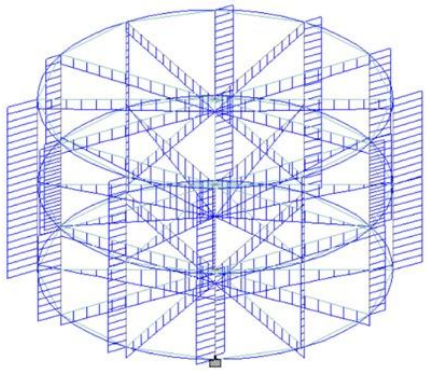


Fig -15: Shear force of circular structure

5. RESULTS AND DISCUSSIONS

In this chapter, the results which are obtained from the analysis are discussed.

5.1Displacement

Displacement of mono-column buildings such as rectangular shape buildings, pentagonal shape buildings, and circular shape buildings are obtained by analyzing as shown below.

- Maximum displacement occurs in the rectangular shape mono-column building due to the action of loads is 83.78mm.
- Maximum displacement occurs in the pentagonal shape mono-column building due to the action of loads is 42.52mm.
- Maximum displacement occurs in the circular shape mono-column building due to the action of loads is 41.07mm.

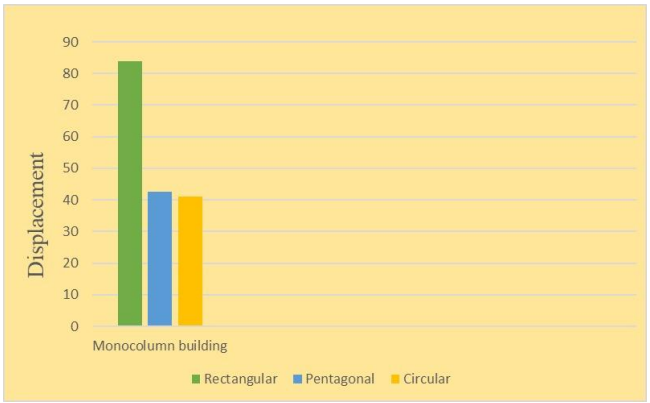


Chart -1: Displacement of building

5.2 Bending Moment

Bending moment developed in beams of mono-column buildings such as rectangular shape, pentagonal shape, and circular shape occur as follow.

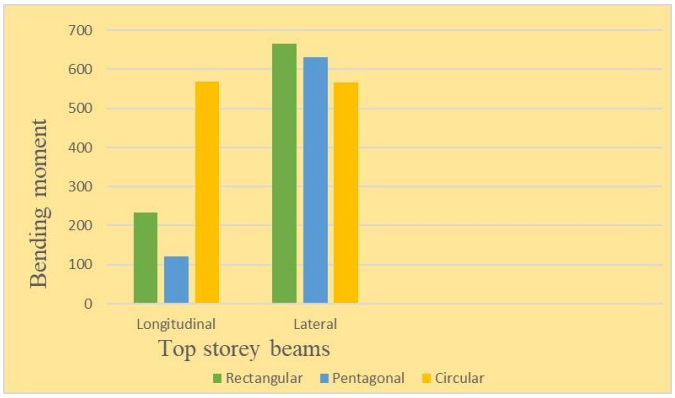


Chart -2: Bending moment in top-story beams

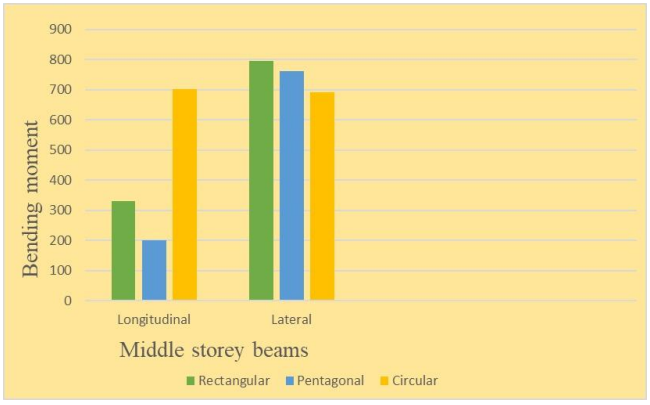


Chart -3: Bending moment in middle-story beams

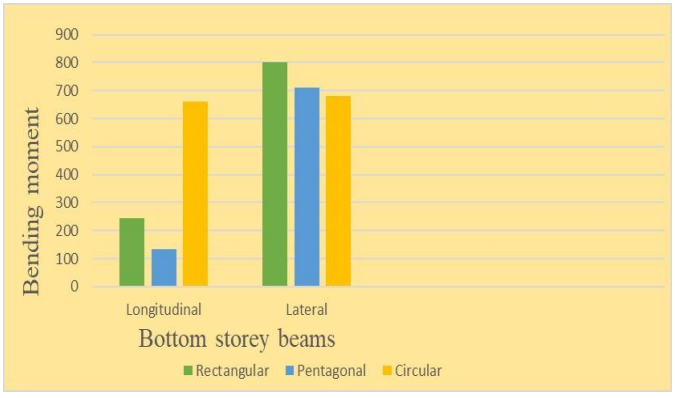


Chart -4: Bending moment in bottom-story beams

Bending moment developed in columns of mono-column buildings such as rectangular shape, pentagonal shape, and circular shape occur as follow.

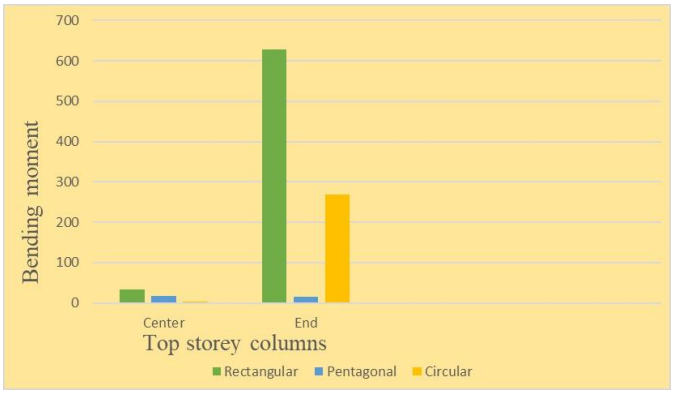


Chart -5: Bending moment in top story columns

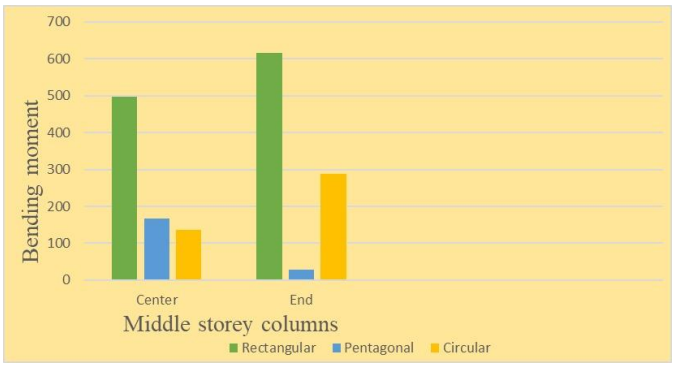


Chart -6: Bending moment in middle story columns

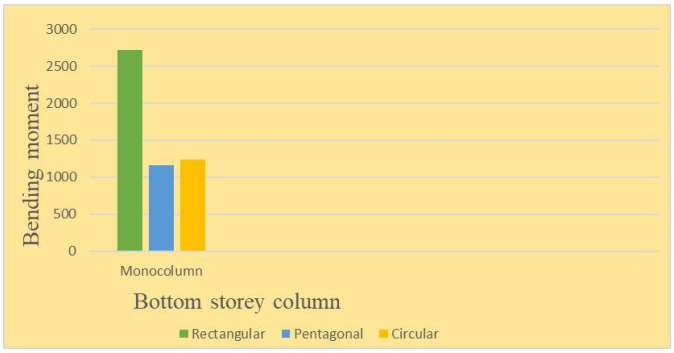


Chart -7: Bending moment in bottom-story columns

5.3Shear Force

Shear force in beams of mono-column buildings such as rectangular shape, pentagonal shape, and circular shapes occur as follows.

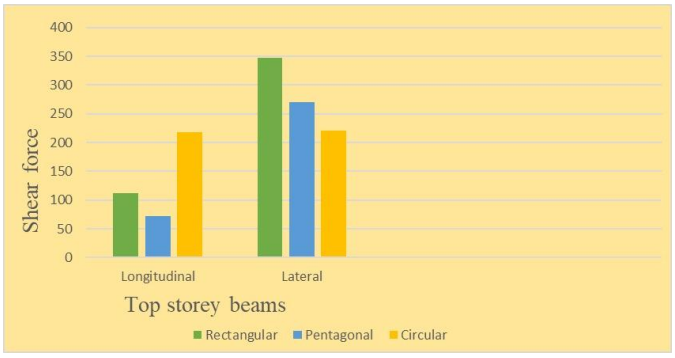


Chart -8: Shear force in top-story beams

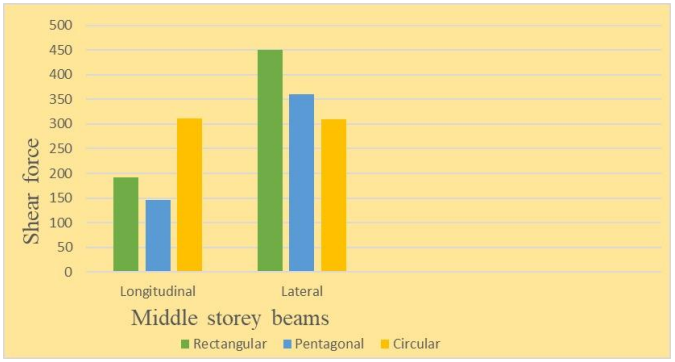


Chart -9: Shear force in middle-story beams

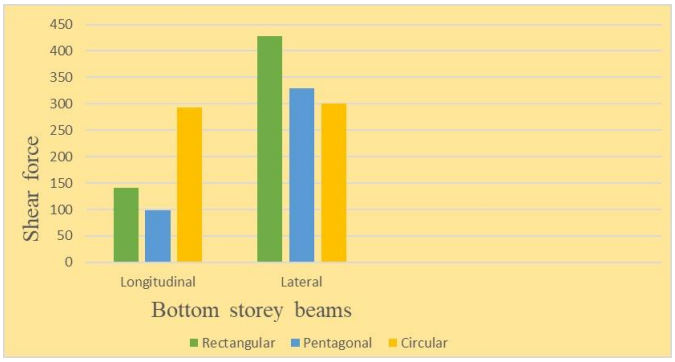


Chart -10: Shear force in bottom-story beams

Shear force developed in columns of mono-column buildings such as rectangular shape, pentagonal shape, and circular shapes occurs as follows.

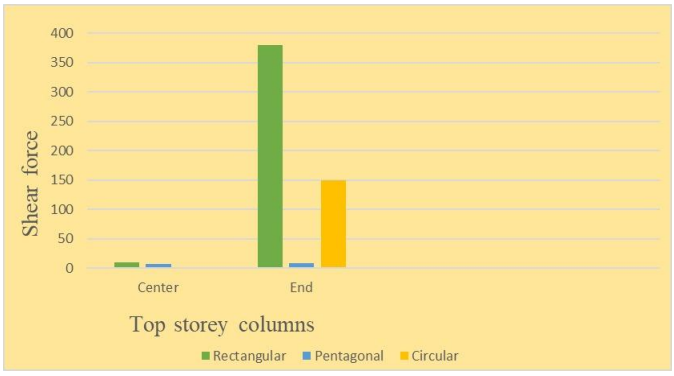


Chart -11: Shear force in top story columns

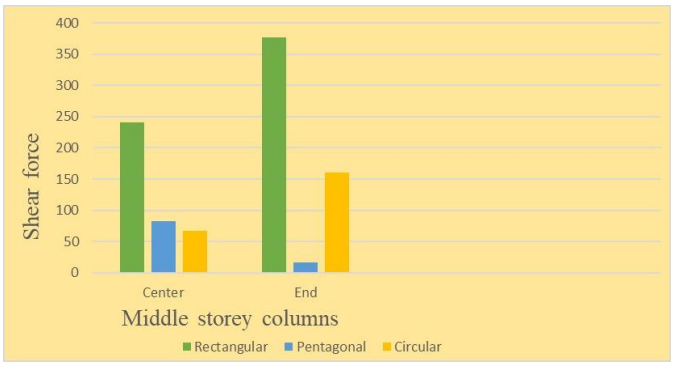


Chart -12: Shear force in middle-story columns

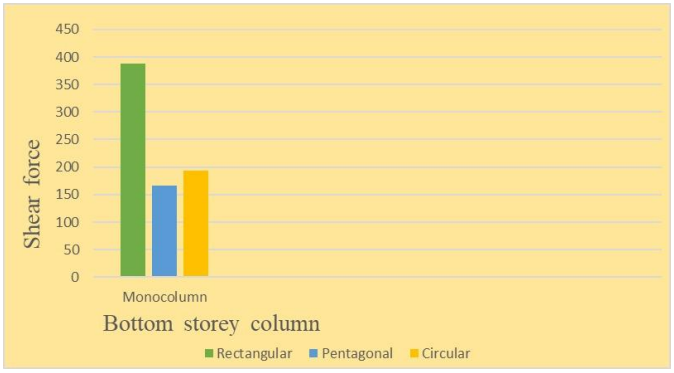


Chart -13: Shear force in bottom-story columns

6. CONCLUSIONS

We prepared the building plans using Auto-cad software and then analyzed G+2 mono-column buildings using the Staad-pro software.

The following conclusion can be drawn out from the analysis:

Displacement:

Displacement of the building occurs maximum in case of rectangle shape and minimum in case of circular shape building.

- Maximum displacement occurs in the rectangular shape building is 83.785 mm. Displacement in this building is 102% greater than the displacement in the circular shape mono-column building.
- The maximum displacement that occurs in the pentagonal shape building is 42.52 mm. Displacement in this building is 2% greater than the displacement in the circular shape mono-column building.
- Maximum displacement occurs in the circular shape building is 41.079 mm

Bending moment and shear force in beams:

- Bending moment and shear force in longitudinal beams occur maximum in the case of circular shape buildings and minimum in the case of pentagonal shape buildings.
- Bending moment and shear force in lateral beams occur maximum in the case of rectangular shape buildings and minimum in the case of circular shape buildings.

Bending moment and shear force in columns:

- The bending moment and shear force of center columns occur maximum in the case of rectangular shapes and less in the case of circular shapes in the top and middle stories of the building.
- The bending moment and shear force of end columns occur maximum in the case of rectangular shapes and less in the case of pentagonal shapes in the top and middle stories of the building.
- The bending moment and shear force of mono-column occur maximum in the case of rectangular shapes and less in the case of pentagonal shapes in the bottom story of the building:
- The bending moment is 2717kN-m and the shear force is 387kN in a mono-column of rectangular shape building. The bending moment and shear force in the mono-column of a rectangular shape building are134% & 133% greater than the bending moment and shear force in the mono-column of a pentagonal shape building respectively.
- The bending moment is 1161kN-m and the shear force is 166kN in the mono-column of the pentagonal shape building.
- The bending moment is 1239kN-m and the shear force is 193kN in a mono-column of circular shape

building. The bending moment and shear force in the mono-column of circular shape building are 6% and 16% greater than the bending moment and shear force in the pentagonal shape building respectively.

So finally, the relative maximum displacement of the building, bending moment, and shear force in the mono-column occur less in the case of a pentagonal shape building compared to other shapes of the building.

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