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Optimization of Circular RC Frame Structure by Using Shear Wall at a Different Location in the Structure: A Review

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Abstract - *In this review article, we look at the many forms of RCC buildings, such as H, L, T, rectangular, and other shapes, as well as the varied positions of shear walls, such as shear walls on the building's outside, inner, and center walls. The majority of RCC structures are assessed using the Etabs and SAP2000 software, but certain RCC structures are studied using the Staad-Pro program. We know that advanced RCC constructions such as slanted buildings, box-shaped buildings, and circular form buildings are built presently. The primary goal of putting the shear wall in a different location in the strictures is to see which position of the shear wall in the structure is more stable than another. The IS code 1893 part-1:2002 is used to examine the majority of the papers in the literature review.*

Key Words: Dynamic Analysis, Shear Wall, Circular Building, Seismic Analysis, and Optimization.

1. INTRODUCTION

The primary notion behind adopting a circle shape building is that, as we all know, the aerodynamic impact of a circular shape building is smaller than that of other shapes. We give the circular shape at the top of the building to lessen the influence of the wind when we create a high-rise structure since the effect of the wind is large at the top of the building. The circular has several advantages, including lower embodied energy, increased energy efficiency, earthquake and wind resistance, and lower cost. The circular building's figure-1 is as follows:

Fig -1: Circular Shape Building.

There are two types of a circular building which is given below:

Circular Building with Courtyards: There is open space inside the circular building in this sort of structure, which can be utilized for parking or other purposes. The Apple Company's headquarters are in California, hence this style of the structure was built there. The Circular building with a courtyard is depicted in Figure-2, which is a plan of the circular shape of the structure.

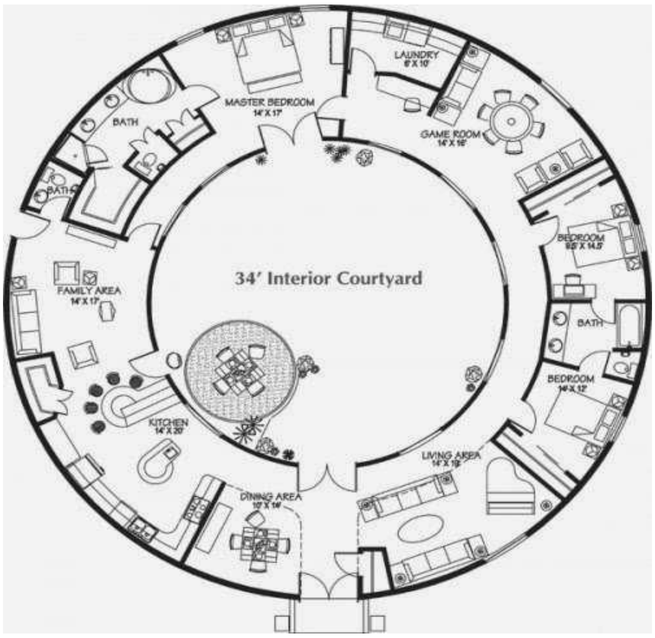

Fig -2: Circular Shape Building with Courtyard

There is an inner courtyard, which is an open space, as seen in the diagram above.

Circular Building without Courtyards

There is no courtyard in this style of circular structure (no open space inside the circular). The biggest disadvantage of this style of circular structure is that there is no open area within it that can be used for parking. The following is a diagram of the Circular Building without Courtyards:

Fig -3: Circular Shape Building without Courtyard

In the above figure you can see there is no open space inside the circular building.

1.1 Shear Wall

A shear wall is a structural element that resists lateral pressures, or forces that are parallel to the wall's plane. The Shear wall resists loads owing to Cantilever Action on narrow walls where bending deformation is greater. Shear walls, in other terms, are vertical components of a horizontal force-resisting structure. The shear wall runs the length of the structure, from the ground to the top, with no gaps in between. The shear wall is seen in Figure 4 below:

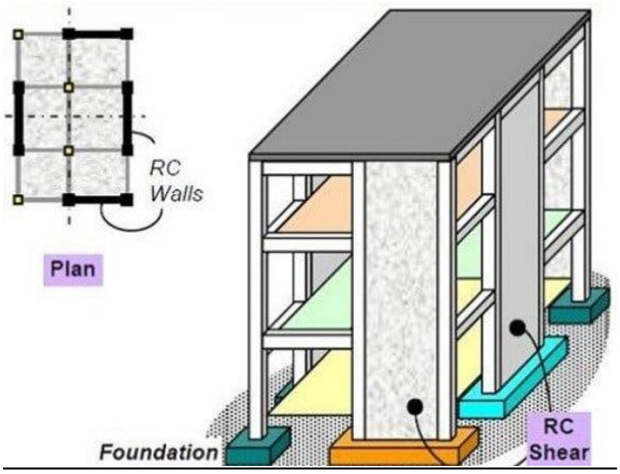

Fig -4: Shear Wall

1.2 Location of Shear Walls in a Building

The shear wall's form and planned location have a significant impact on the structure's behavior. The shear walls should be placed in the middle of each half of the structure from a structural standpoint. However, because it controls the use of space, this is rarely practicable, thus they are placed at the ends. In the short direction, the design and position of the walls provide adequate flexural stiffness, but in the long direction, the rigidity of the frame is required.

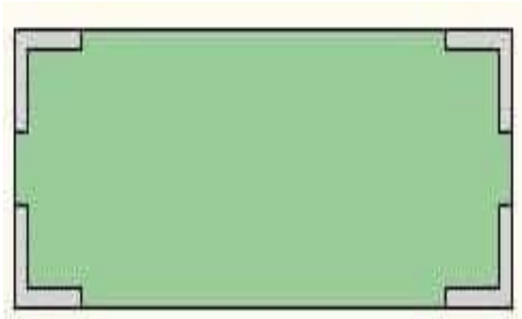

Fig -5: Location of Shear Wall

2. LITERATURE REVIEW

After studying the paper related to the shear wall in the different shapes of RC frame structure there is the following conclusion given below:

[1]Shaikh et al [2013] These authors study "Seismic Analysis of Vertically Irregular Buildings," and the model of the building in this paper is a setback building, with the conclusion that "Three-dimensional analysis of a building using general-purpose analysis computer programs can take care of the displacement but without displaying its magnitude." However, because there is no direct technique to compute the centre of rigidity or shear centre for each floor/storey of a structure, there is no general-purpose computer programme that can account for design deflection and base shear. Deflection is also a crucial component contributing to substantial damage or entire collapse of structures, according to several studies of structural damages during historical wind storms and earthquakes. As a result, irregular structures must be thoroughly examined for deflection. Soft storey-The greatest choice for all-new RC frame structures is to prevent such abrupt and substantial decreases in stiffness and/or strength in any storey; it would be excellent to instal walls (either masonry or RC walls) in the ground storey as well. Designers can prevent the harmful impacts of the flexible and weak ground storey by not discontinuing too many walls in the ground storey, i.e., the decline in stiffness and strength in the ground storey level is not abrupt owing to the lack of infill walls. Existing open ground-level structures must be adequately fortified to avoid falling during severe earthquake shaking.

[2]Bajarang [2015] The title of this author's article is "Study of Different Shear Wall Locations on Seismic Performance of RCC Framed Buildings," and the research concludes that, among all load combinations, 1.5DL+1.5EQ is shown to be the most crucial combination in both the X and Y directions for all models. For constructions in earthquake-prone locations, the zigzag shear wall layout is the most effective. Structures in earthquake-prone locations have also been proven to benefit from a diagonal shear wall layout. Because zigzag shear walls reduce lateral displacement and storey drift more than other forms of shear walls, they improve the structure's strength and stiffness.

[3]Mohaiminul, Sourabh [2016] This author's paper is titled "Seismic Performance Analysis of RCC Multi-Story Buildings with Plan Irregularity," and the conclusion is that, based on the analysis of various-shaped multi-story buildings, all structures meet displacement criteria for equivalent static analysis, even though Model-1 just touches the allowable limit curve. Model-1 deflection was found to be more than 80% higher than Model-4. Storey drift indexes rise with floor height until the third storey when they hit their maximum and begin to fall for all four types. For all of the Models, the displacements derived from the time history analysis are substantially greater than the permitted limit. Because the weights of the structures are comparable, the differences in displacement values across the models are minimal. The greatest displacement for all of the structures exceeds the allowed limit, according to the response spectrum study. These results, however, are significantly lower than those found from time history analysis. In lower levels, the difference in displacement values between the four forms is negligible, but it grows in higher stories and peaks at the top floors. The displacement of irregular-shaped structures (Model-1 and Model-2) is larger than that of regular-shaped buildings (Model-3 and Model-4). As a result of the total research, it can be stated that buildings with irregular plan shapes are more vulnerable to earthquake load than regular-shaped ones.

[4]Anju [2017] the paper written by this author is “seismic analysis of irregular RC frame buildings with special columns” and the conclusion is given below:

For models considering plan irregularity only

When compared to models with Tee and Cross-shaped columns, the lateral displacement and story drift for the H shape model with L shape columns were lower. When compared to models with L and Cross-shaped columns, the lateral displacement and story drift for both L and Tee models with Tee-shaped columns were lower.

For models considering both plan and stiffness irregularity

When compared to models with Tee and L-shaped columns, the lateral displacement and story drift for H shape models with a Cross-shaped column were lower. When compared to models with Cross and L-shaped columns, the lateral displacement and story drifts for both L and Tee models with Tee-shaped columns were lower.

[5]Sanisha et al [2017] The title of this author's research are "Seismic Analysis of Multi-Story Building with Shear Walls of Different Shapes." The dynamic analysis of the building was the first component of the study. The base shear and storey drift (the relative displacement between the two floors) were determined. A comparison table of these data for all shear wall forms has also been provided. The study's findings are reported in the next section. Based on the base shear value and storey drift In both zones V and III, the G+14 building with W and U-shaped shear walls performs better (X-direction). In zones, V and III, a G+14 structure with an H-shaped shear wall performs well in terms of storey drift (Y-direction). In zones II and III, the bG+14 structure with a T-shaped shear wall performs well in terms of base shear (Y-direction). Based on the base shear value and storey drift In both zones V and III, the G+29 building with W and H-shaped shear walls performs better (in both X and Y directions). In zones, V and III, a G+29 structure with a T-shaped shear wall performs well in terms of story drift and base shear value (both X and Y directions). In both zones, the improved form of the shear Wall is unchanged.

[6]Yaseen et al [2018] The authors' study "Seismic Behavior of Circular Buildings with Mass Irregularity" concludes that when the heavy mass transfers upwards, the values of storey displacement and storey drift rise. The position of heavy mass in the building has little impact on the base shear. In buildings with vertical mass irregularity, the base shear values are significantly higher. Because more mass equals stronger inertia forces, lighter structures may withstand earthquake shaking better.

[7] Wang et al [2022] The major components that resisted the lateral force were the web plate and concrete. Between 55 per cent and 85 percent of the overall shearing resistance of the wall is attributed to the web plate. The vertical force was mostly resisted by the corner of the wall, whereas the shear force was mostly resisted by the rest of the wall. The stiffened plates divide the concrete into multiple columns, each of which is independent and resists vertical strain. Increases in wall thickness, steel ratio, axial compression ratio, and channel length-to-width ratio improve elastic stiffness and ultimate strength capacity. With a rising shear span ratio, elastic stiffness and ultimate strength capacity are diminished. Steel ratio, shear span ratio, axial compression ratio, and the length-to-width ratio of the channel are all factors that influence CWSC ductility. The steel ratio and shear span ratio have a favorable impact on ductility, but the axial compression ratio and the length-to-width ratio of the channel have a negative effect. The ultimate strength capacity, yielding bearing capacity, elastic stiffness, and secant stiffness of the composite shear wall's yield point are all evaluated using formulas. The formulae in this study were more accurate than the formulas in specifications in predicting ultimate strength capacity. Meanwhile, the models performed well in other tests from the literature in predicting ultimate strength capability. The formulae can be used to create engineering designs.

3. CONCLUSION

After reading numerous research articles on my issue, I've arrived at the following findings on the varying placements of the shear wall in various building shapes: If we are creating a circular structure in a limited space, it will be extremely difficult to create because we will be unable to offer the circular beam (curved beam), but if the area is wide, we will be able to simply construct the curved beam. When the width of the curved beam is increased, the deflection values for the rectangular cross-section rise at the same time. If the width remains constant but the breadth grows, the deflection values change in decimal units but are equivalent. When the dead load of the beam is considered, the deflection in the circular cross-section of the rounded beam is smaller than the deflection in the rectangular cross-section of the curved beam. When a circular building is used instead of a rectangular or regular form building, the cost of the structure is reduced by 15% to 18%.

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