"COMPARATIVE ANALYSIS OF RC CIRCULAR DIAGRID FRAME AND CIRCULAR BARE FRAME IN CONTEXT OF DIFFERENT EARTHQUAKE ZONES OF INDIA"

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Abstract : Diagrid system is one of the evocative designs which are recently accepted by the designers and architects for the design of skyscrapers. As we move vertically up in the design of skyscraper the main problem which concern are changes from the gravitational loads to the lateral loads. Diagrid is a form of a perimeter grid which is made up of a series of triangulated truss generated by intersecting the diagonal and horizontal members. The present research study is an attempt to understand the behaviour of the diagrid system in the circular edifice. A circular plan of the edifice is created for this research study of g+16 storeys with diagrid system at the outer periphery having an angle of 430 and the diagrid is formed for each story.

IndexTerms **- Seismic analysis, RC Circular Frame, Diagrid structure, Comparative study, Software based analysis.**

INTRODUCTION

The rapid increment in the population exerts a consequent pressure on the limited space available in the urban areas influenced the residential development in the form of a skyscraper. The acceptance of skyscraper is also influenced by the need to preserve the agricultural land by the continuous sprawl of urbanization. As the building height increases the lateral load resisting system becomes more predominant than the system resisting gravitational loads. In the design of skyscraper to make them laterally resistive, there are several systems that are used like rigid frame, shear wall, wall-frame, braced tube system, outrigger system and tubular system. In the recent century, there is a new system that is developed to make the edifice laterally resistive are diagrid which is widely used in the developed countries due to its structural efficiency and its aesthetical appearance. The number of building components is reduced by the use of the diagrid system due to its effective structural configuration. In the diagrid system, the diagonal member due to their triangulated configuration can carry the lateral loads as well as the gravity loads. As the diagrid is a form of a truss it can carry the lateral shear by the axial action of its diagonal component thus it reduces the shear deformation of the structure. Thus due to the axial action, the structure cannot require any special shear rigidity. In this research paper, the design and analysis of 16 storey concrete diagrid building circular in plan with the outer radius of 20m is considered. The diagrid edifice is also compared with the bare frame structure with the same configuration. The analysis and design of both the edifices are done with the help of the analysis and design software tool STAAD.pro. All the components of the building are designed as per the Indian standard IS 456:2000 considering all general loading as well as the combination. The earthquake load are considered as per IS 1893. The typically each of the storey height is 3m and the total height of edifice is 48m. The interior part of the edifice is designed particularly to carry the gravity load for which the vertical columns are provided while the outer periphery of the building is provided with the diagrid to carry the lateral as well as some amount of gravity loading. Both the structure is compared on the basis of analysis results in terms of displacement of storey, axial force, shear force and bending moment comparison.

OBJECTIVES

[1] The objective of this study is to understand the concept of RC diagrid frame structure system.
[2] To determine the out of the two which one is the most appropriate using STAAD. Pro software.
[3] To determine the reason for the variation in forces due to use of diagrid element in a structure under the action of seismic forces.
[4] A comparison of results in terms of Max story drift, max story displacement, base shear in seismic cases.

METHODOLOGY

STEP 1.The first step is the Selection of the geometry of edifice which is of circular shape in plan with outer diameter of 20m, intermediate diameter 15m & 10m and the inner diameter of 5m with G+16 storey of the 3-D frame. Fig-1.

STEP 2.In the next step selected geometrical model is assigned with the required property in the analysis tool STAAD.pro and translating it to G+16 edifice frames. Two same edifices with different lateral load resisting system are developed for comparison. An RC circular bare frame, RC diagrid frame created for comparison.

STEP 3.The above-created frame are analyzed with the equivalent static load of seismic analysis for Seismic zones (Zone III & V) and soft type soil condition as per IS- 1893 (part I) -2002 in the software.

STEP 4.Graphs are prepared for the comparison of different results values obtained from the analysis to show the research in a systematic manner.

Table -1 geometry & load consideration

Description	Values
Number of storey	16
Number of bays in	18
Height of each storey	3.0 m
Diameter of outer circle	20 m
Diameter of intermediate circle	15m and 10m
Diameter of outer circle	5m
Size of beam in zone III	500 x 500 mm
Size of column in zone III	800 x 800 mm
Size of beam in zone V	650 x 600 mm
Size of column in zone V	1000 x 1000 mm
Thickness of R.C.C. slab	150 mm
Size of diagrid	1000 x 1000 mm

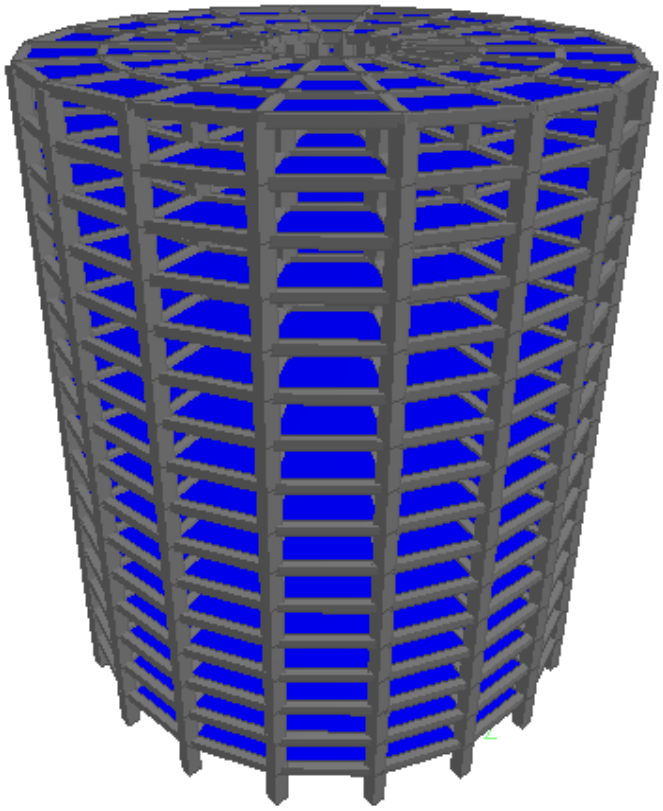


fig 1: bare frame (model 1)

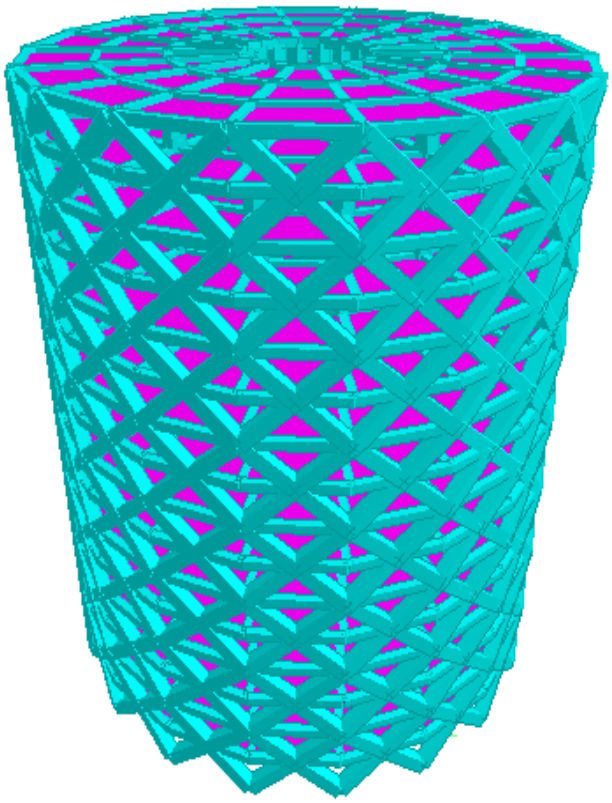
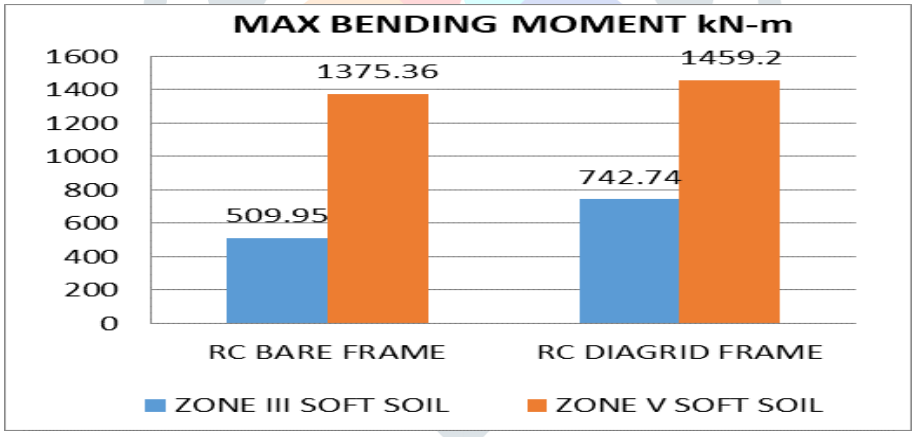


fig 2: diagrid frame (model 2)

RESULTS AND DISCUSSION

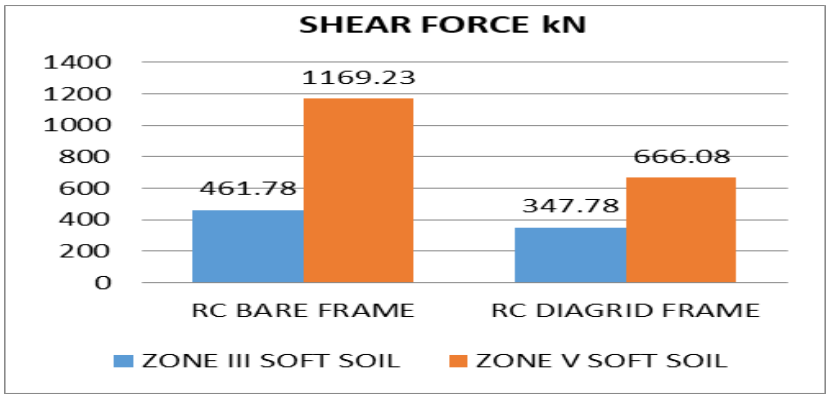
1. Max bending moment



Graph 1: bending moment comparison

Above graph depicts that the maximum bending moment comparison in which the RC bare frame showing the lower value while the bending moment increase in the frame with diagrid. Therefore RC bare frame structure frame is comparatively more stable and minimizes reinforcement requirement.

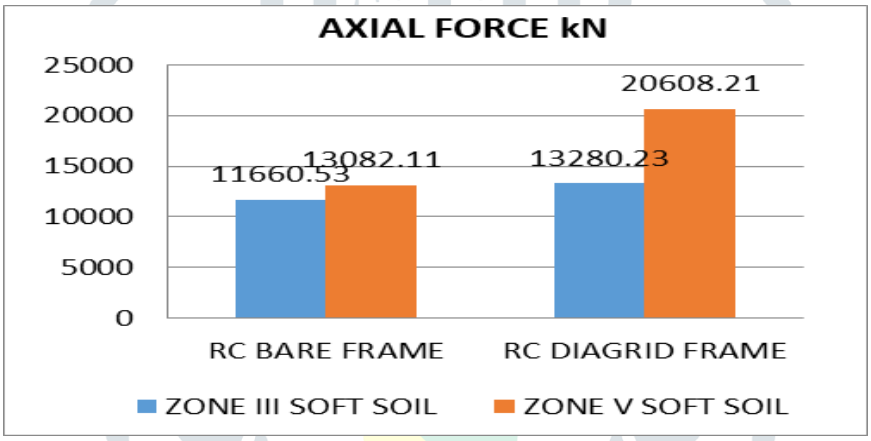
2. Maximum shear force



Graph 2.shear force comparison

As we can see the above graph that the shear forces for RC bare frame having a higher value compared to the RC frame with diagrid structure. There is a huge reduction in the shear force in the RC frame with diagrid with the condition of zone V and soft soil case. Therefore it is clearly depicted that RC braced frame structure frame is comparatively more stable and minimizes shear reinforcement requirement.

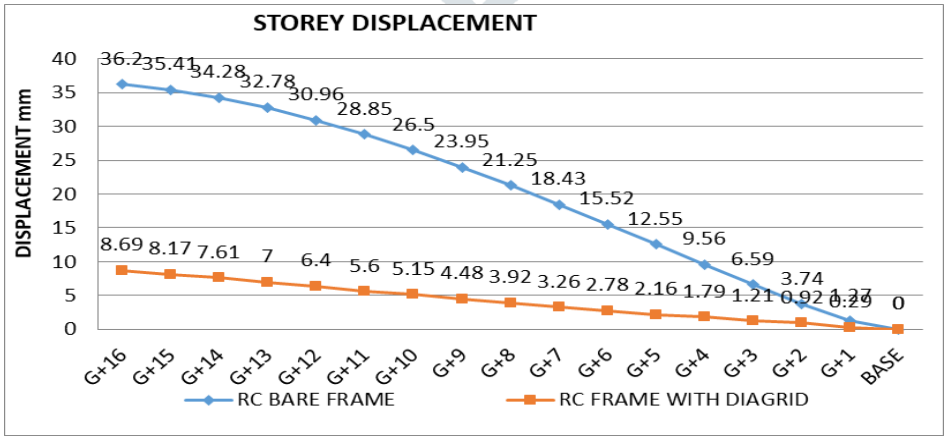
3. Maximum Axial force



Graph 3: axial force comparison

Above graph depicts that the axial force for RC bare frame is less in comparison with the frame with diagrid in seismic zones under soft soil condition because the frame with diagrid resists the lateral as well as some part of the gravity loading by the axial action thus it is a fact that the axial force in the diagrid structure is increased.

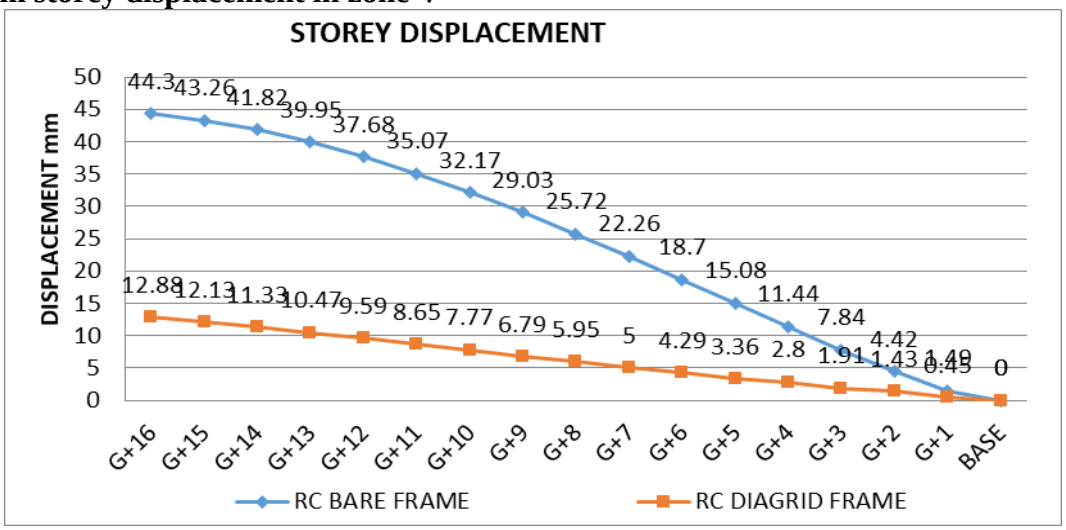
4. Maximum storey displacement in zone III



Graph 4: storey displacement comparison in z III soft soil

Here results show that maximum displacement is in bare frame top storey is 36.2mm while RC frame with diagrid top storey displacement is 8.69mm in zone III with soft soil which is about 4 times less than the bare frame structure, thus frame with diagrid is resisting lateral displacement more effectively.

5. Maximum storey displacement in zone V



Graph 5: storey displacement comparison in z V soft soil

Here results show that maximum displacement is in bare frame top storey is 44.3mm while RC frame with diagrid top storey displacement is 12.88mm in zone V with soft soil which is about 3.5 times less than the bare frame structure, thus frame with diagrid is resisting lateral displacement more effectively.

CONCLUSION

The research work bare frame and frame with diagrid both in circular plan geometry are considered for the relative seismic analysis by equivalent static load method of seismic analysis. The carried comparative analysis it is being concluded that the lateral forces over edifice can affect them in a large manner. As the storey displacement is reduced tremendously by adding the arrangement of diagrid element in both cases in which one is the worst case possible. Apart from the storey displacement, the shear force is also reduced over the diagrid structure while the axial force and bending moment is increases. In this research, we consider a circular bare frame as the base structure for comparison and compare it with a diagrid frame. The maximum BM in zone III soft soil diagrid frame is changes 1.47 times and BM in zone V soft soil diagrid frame is changed 1.06 times. Shear force is reducing in diagrid frame model 1.33times in zone III and 1.76time in zone V. In the end Research concluded that the forces are efficiently managed in the diagrid frame model and make stable during the time occurring of earth termer.

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