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COMPARATIVE ANALYSIS OF A HIGH RISE BUILDING FRAME WITH AND WITHOUT DIAGRID EFFECTS UNDER SEISMIC ZONES III & V

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ABSTRACT

The diagrid system nowadays widely used for high rise buildings due to its structural efficiency. In present research work, steel diagrid structure at an outer portion of the building at 60 degrees having an inner core of R.C.C columns with R.C.C beam and the slab is analyzed and compared with a conventional concrete building. The diagonal member of diagrid structure transferred the lateral loads by axial action compared to bending of vertical columns in the conventional building system. A regular eleven storey RCC building with plan size 16 m × 16 m located in seismic zone V & III is considered for analysis. STAAD.Pro software is used for modeling and analysis of structural. Seismic zone is considered as per IS 1893(Part 1): 2002. The Comparison between the diagrid and conventional building analysis results presented in terms of a node to node displacement, bending moment,storey drift, shear forces, an area of reinforcement, and additionally the economical aspect.

I. INTRODUCTION

Skyscraper development involves various complex factors such as economics, aesthetics look, technology, municipal regulations, and politics. Among these, economics has been the primary governing factor. For high rise building, the structural design is generally governed by its lateral stiffness. Diagrid structures carry lateral seismic loads much more efficiently by their diagonal member's axial action in comparing with conventional orthogonal structures for tall buildings such as framed tubes, A diagrid structure provides

great structural efficiency without vertical columns have also opened the new aesthetic potential for tall building architecture. Diagrid has a good appearance and it is facilely apperceived. The configuration and efficiency of a diagrid system reduce the number of the structural element required on the façade of the buildings, therefore less obstruction to the outside view. The diagrid system structural efficiency also helps in avoiding interior and corner columns and therefore allowing significant flexibility with the floor plan.

A diagrid structure is a type of structural system consisting of diagonal grids connected through horizontal rings which create an elegant and redundant structure that is especially efficient for high-rise buildings. A diagrid structure is different from braced frame systems since diagonals as main structural elements participate in carrying gravity load in addition to carrying lateral load due to their triangulated configuration, which eliminates the need for vertical columns. The column free structure of a diagrid system offers several advantages such as high architectural flexibility and elegance, and cyclopean day lighting due to its immensely colossal free facade surface.

Ravi K Revankar et.al. (2014)analyzed a G+12 storey structure which consists of diagrid members, the geometry of structure consider in his study was 27 X 27 m in lateral dimensions and 48 m in height consist of 12 storey considering 4m each storey height. Modelled and analysed the structure using analysis tool SAP2000, considering dead, live and seismic loads as per Indian Standards and conducted non linear analysis (pushover analysis), designed the structure as per specifications, and concluded that structure with diagrid is more stable and resistible during collapse and found more durable to counteract forces in terms of displacement.

Kiran Kamath et. al. (2015)performed a comparative study on a circular plan with different angels of diagrid are considered as 64.00°, 72.00°, 76.30° and 90.00°. the geometry of circular plan is G+36 storey tall structure with 3.6 m each floor height and 36 m diameter of lateral dimensions are provided, considering wind load as per

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875 part3 and seismic zone III as per 1893 part-1. Compared the structure in terms of base shear, top storey displacement, concluded that As the angle of diagrid increases, axial rigidity of the diagonal columns decreases, time period is minimum for 72o whereas top storey displacement is minimum for angle of 64.0°.

Moon et al., (2007) studied the behaviour of diagrid structure square in plan. Size of the plan is 36m x 36m. Braced core is also provided. Shear lag effect is compared between diagrid and tubular structure. They concluded that for a diagrid structure square in plan, the optimal angle lies between 65° to 75°. They also suggested member sizing methodology for preliminary design of diagrid structure so that structural and architectural decisions can be made at an early stage.

Kyoung (2011) studied the behaviour of diagrid structure with floor twisting at different rates. He found that twisted tower perform better than straight tower under across wind loading. Optimal angle of twist is though not established.

Khushbujaniet. al. (2013) Observed tall structure of G+36, G+50, G+60 and G+70 storey tall structure of lateral geometry 36 x 36 m. structures are modelled and analysed in csietab software. Considering diagrid structures and designed as per I.S. 800:2007. And concluded that most of the lateral load is resisted by diagrid columns on the periphery, while gravity load is resisted by both the internal columns and peripherial diagonal columns. So, internal columns need to be designed for vertical load only. Due to increase in lever arm of peripherial diagonal columns, diagrid structural system is more effective in lateral load resistance. Lateral and gravity load are resisted by axial force in diagonal members on periphery of structure, which make system more effective. Diagrid structural system provides more flexibility in planning interior space and façade of the building.

II. OBJECTIVES

1. To study the concept of diagrid structural system on a high rise structure.
2. To determine the optimum configuration for buildings using STAAD.pro software.
3. To determine the variation in forces due to diagrid structure under seismic forces.
4. Comparison of results in terms of Max story drift, max story displacement, base shear in seismic case, time period.

Table 1 geometry & load consideration

Type of structure	**Residential building (G+11)**
Plan dimension	**16 m X 16 m**
Total height of building	**33 m**
Hight of each storey	**3.0 m**
Diagrid section	**Steel section**
Seismic zone	**III & V**
Dead load	**875-part-1**
Live load	**875-part-2**

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III. METHODOLOGY

Step-1: firstly modelling of structure with and without diagrid system is modelled in staad with same plan area.
Step-2: secondly seismic forces as per indian standard 1893-part-1 in applied.
Step-3: comparative study is done on these structures to determine the use of implementation of diagrid.
Step-4: results are plotted in graph using m.s. Excel

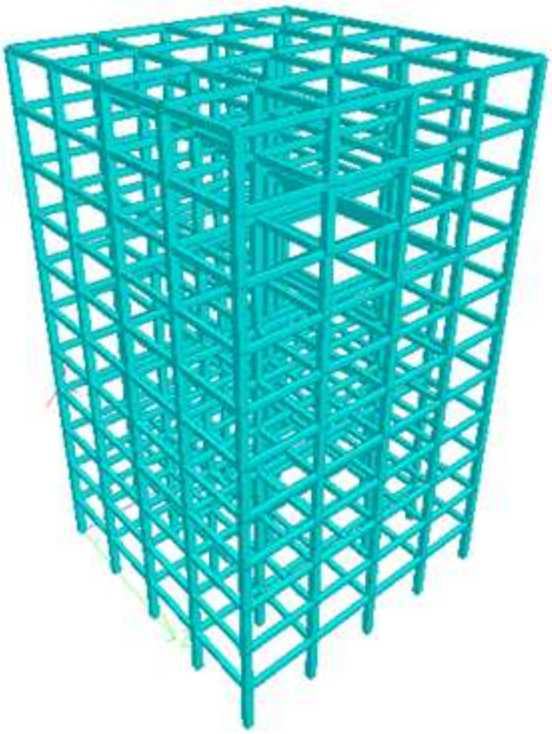

Fig 1: Bare Frame

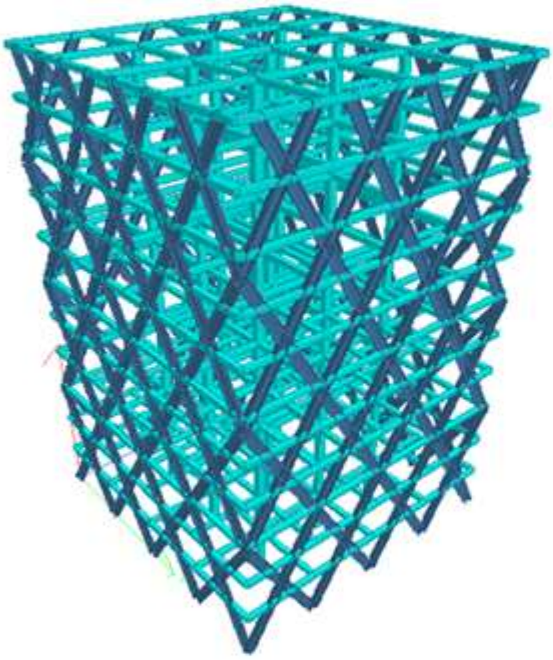

Fig 2. Diagrid frame

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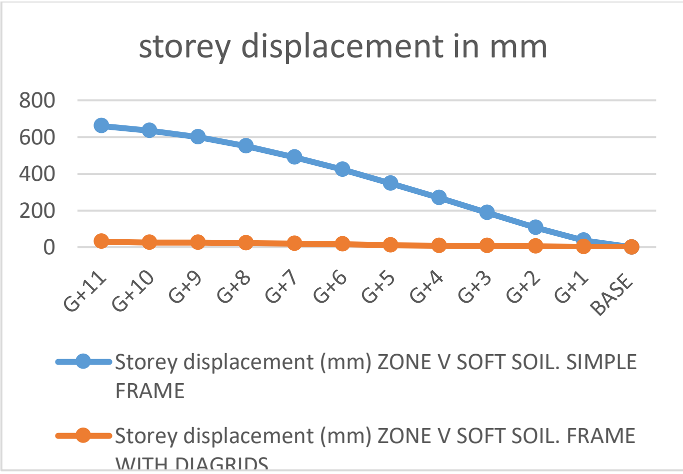
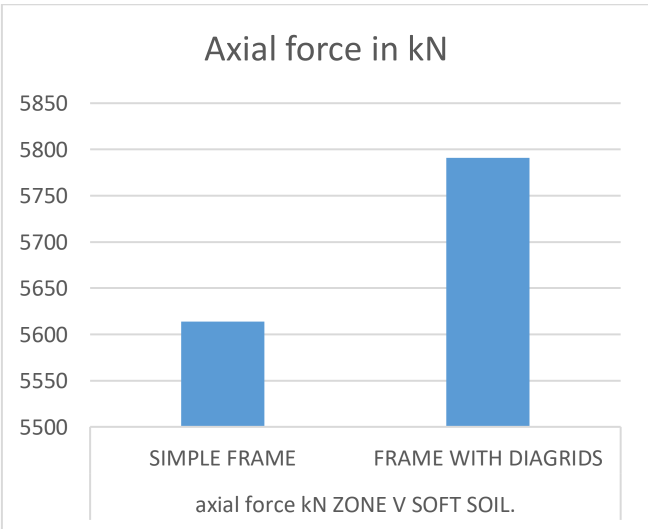
IV. RESULTS & ANALYSIS

Storey displacement in seismic zone III & V



Here results shows that displacement is gradually decreases with the use of diagrid.
Axial Force



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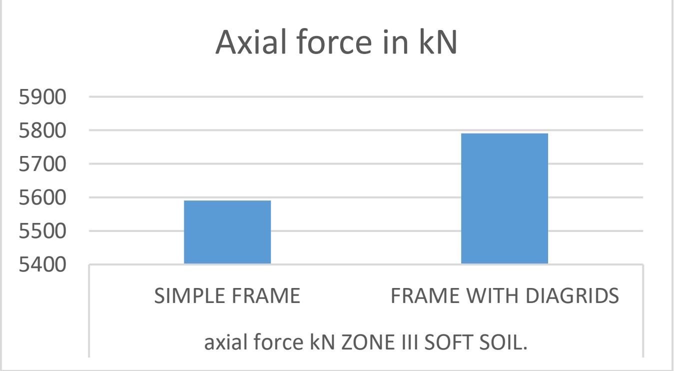
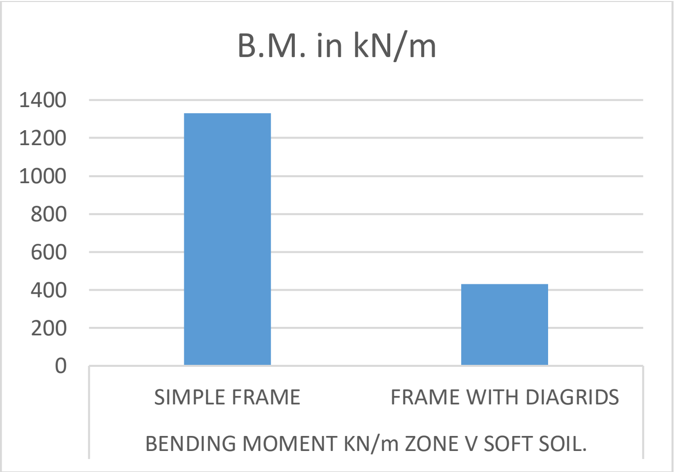
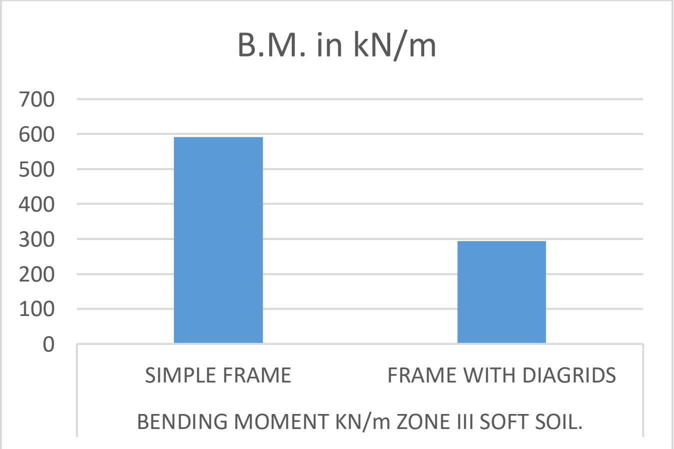


Here axial force is somehow increasing with diagrid structure.

Bending Moment





Here results shows that bending moment is decreasing in diagrid structure which means less reinforcement is required.

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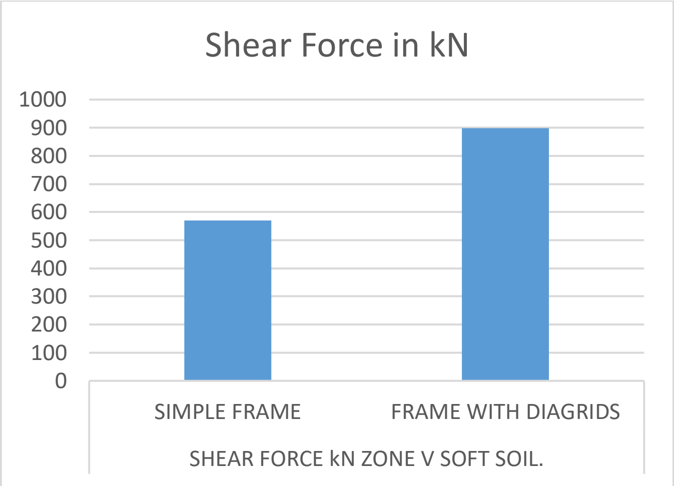
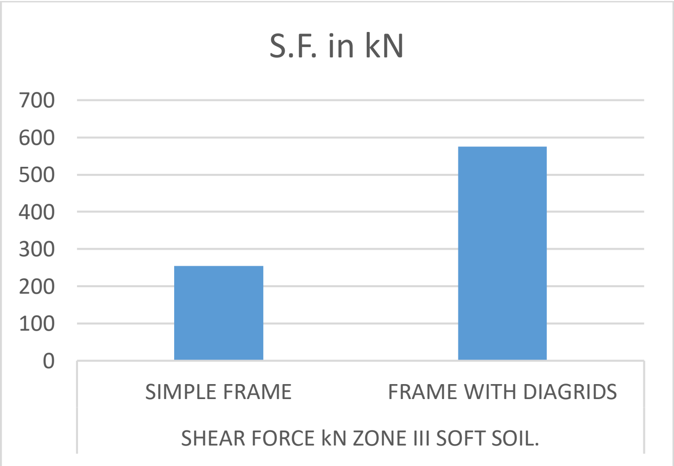
Shear Force





Here shear force increases as introduction of inclined members in diagrid.

V. CONCLUSION

In this study, it is perceived that due to diagonal columns at the outer periphery of the structures, the diagrid structure is more effectivelyresist the lateral load.

Due to this property of diagrid structure, the interior column is used of smaller size for gravity load resistance and only small quantity of lateral load is considered for it. While in conventional frame building, both gravity and the lateral load is restricted by both exterior and interior columns. The following points are concluded from above study about diagrid structure

- Study shows that diagrid structure decreases bending moment which in results decreases reinforcement requirement.
- It shows that lateral displacement in tall structures can be minimized by using diagrids

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