Analysis of the Performance of RC Framed Structures under Linear Dynamic Analysis

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Abstract
The construction of multi-storey buildings is increasing constantly all over the world. The development of highly advanced structural system is mainly based on the quality of aesthetic expression, structural efficiency, and geometric versatility. The selected structural system should be such that it has to be effectively utilized for structural requirements. The unique geometrical configuration of the diagrid structural systems have driven them to be used for high rise buildings providing the structural efficiency and aesthetic potential. In this present work, four different models of I section of a 30 storey RC Frame building with plan size 18 m × 18 m located in seismic zone V have been considered for analysis. Steel diagrid structure of 2 storey and 6 storey models and Infill wall model are analyzed and compared with conventional RC Frame model and is studied using linear dynamic analysis. ETabs software is used for modeling and analysis of structural members. Comparison of analysis results in terms of storey Displacement, Drift, Bending Moment, Axial forces, Time period, Base shear is presented and the results obtained were compared with those obtained from other models.

Keywords:*Axial force, Base shear, Conventional RC Frame, Diagrid wall Frame, Infill wall Frame, Drift, ETabs, Linear dynamic analysis, Storey Displacement.*

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I. INTRODUCTION

The quick development of urban population and restriction of accessible land, multi storied structures are ideal now a days. As the structure height increases, the consideration of lateral load plays an important role[1].Some of the lateral load resisting systems used are rigid frame, shear wall, masonry infill walls, braced tube system, tubular system and outrigger system. Newly the diagonal grid system has come up. The structural configuration of the diagrids is characterized by a narrow grid of diagonal members which involve in both resistance of lateral load and gravityload.

The diagrid structural systems are the progression of braced tube structures in which the inclined members spread over the periphery which gives rise to closely spaced diagonal members and also it is allowing for the complete omission of the conventional vertical columns. Hence the diagonal members present in the diagrid structural system can act both as bracing elements and as inclined columns, andcarry lateral forces as well as gravity loads. Lateral loads are introduced directly to diagrid structureand immediately transferred in to triangular system. These loads are then handled in a similar manner to vertical loads [2]. Due to their triangulated system, the major portion of lateral load is taken by external diagonal members who release the forces in other members, thus minimizing shear racking effects. Hence the diagird structure has a better appearance and gives better results and also easily notified[3]. The load distribution in diagrid structure [4] is shown in the followingFig1.

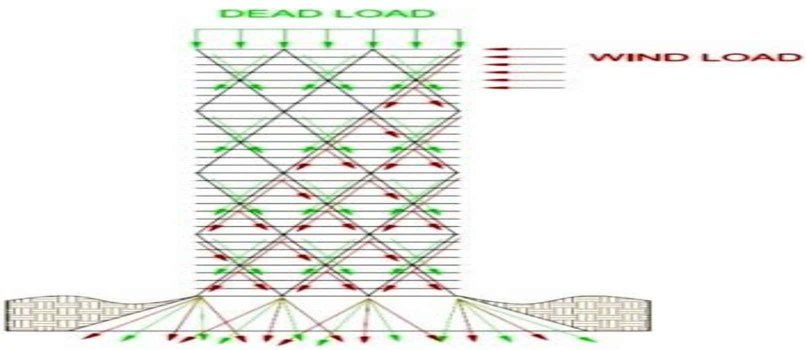


Figure 1 Load Distribution in Diagrid StructuralSystem.

II.OBJECTIVES

The main requirement of high rise buildings is safety and least possible damage level of a structure. By arrangingthestructuralmembersinaparticularpattern,theefficientstructurecanbeproduced[5].To approachtheserequirements,thestructureshouldhaveanadequatelateralstrengthandalsosufficient ductility. In this work four G+30 storey building models are chosen for analysis, one for diagrid 2 storey, one for diagrid 6 storey, one for Infill wall and other for conventional RC frame model, in which every storey is of 3m height is taken in all buildings and analysis values are compared in terms of Shear force, Bending moment, Axial force, Drift, Displacement and also the economical aspect is compared for the seismic zone V.

III. METHODOLOGY

1) Determination of Lateral displacements, Drifts, Base shear, Time period, Bending moment, Overturning moment, Axial force for Conventional frame using Response Spectrum method in ZoneV.

2) Determination of Lateral displacements, Drifts, Base shear, Time period, Bending moment, Overturning moment, Axial force for frame with Infill wall using Response Spectrum method in ZoneV.

3) Determination of Lateral displacements, Drifts, Base shear, Time period, Bending moment, Overturning moment, Axial force for frame with Diagrid 2 storey wall and also Diagrid 6 storey wall using Response Spectrum method in ZoneV.

IV.STRUCTURAL MODELLING

The ETABS software is used in the present study to develop RC frame Models and to carry out the analysis. Linear dynamic analysis of the building models is performed on ETABS. The buildingsconsidered are RC frame model, infill and diagrid models of 30 storied structures. The storey height is kept uniform of 3m for all building models which are shown in the below table. The lateral loads generated by ETABS with respect to the seismic zone V and the 5% damped response spectrum are given in code IS: 1893-2002.

The physical properties and the data of the building models considered for the present study is as follows

	Type of structure	RC Frame model	Infill wall model	Diagrid two storey model	Diagrid six storey model
S. No.	Description	Information	Information	Information	Information
1	Plan (I Shape)	18mx18m	18mx18m	18mx18m	18mx18m
2	Building heights	90m	90m	90m	90m
3	Slab thickness	150 mm	150 mm	150 mm	150 mm
4	Grade of Concrete	M35	M35	M35	M35
5	Grade of steel	Fe 500	Fe 500	Fe 500	Fe 500
6	Live loads Floor load floor finishes	4 KN/m2 1.25KN/m2	4 KN/m2 1.25KN/m2	4 KN/m2 1.25KN/m2	4 KN/m2 1.25KN/m2
7	Importance factor	1.0	1.0	1.0	1.0
8	Software used	Etabs 2015	Etabs 2015	Etabs 2015	Etabs 2015
9	Type of diagrid and its dimensions	--------	--------	Fe250 500 x 500mm	Fe250 500 x 500mm
10	Thickness of Infillwall	--------	150mm	--------	---------

The models that we had taken for the analysis are asfollows

Model 1 –RC Frame building I shaped - 30 storied

Model 2 –RC Frame building with Infill wall I shaped -30 storied.

Model 3 –RC Frame building with diagrid two storeymodule I shaped -30 storied. Model 4 – RC Frame building with diagrid six storeymodule I shaped - 30 storied.

All the Plans of 4 models are shown in the below Fig2, Fig3, Fig4,Fig5.

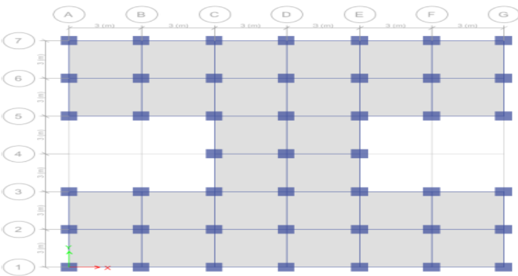


Figure 2 Plan of RCFramemodel

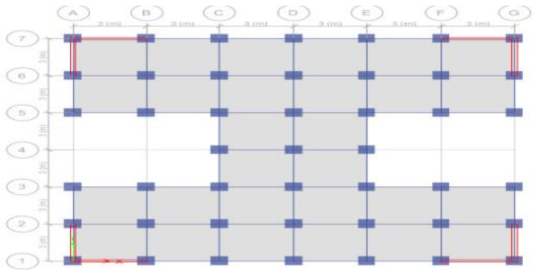
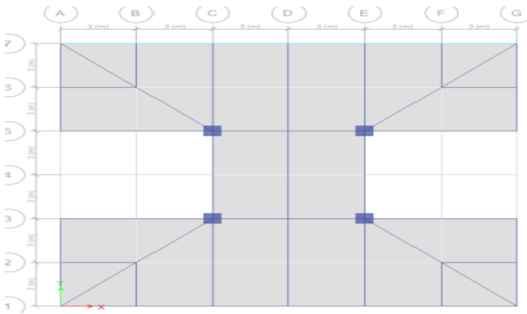
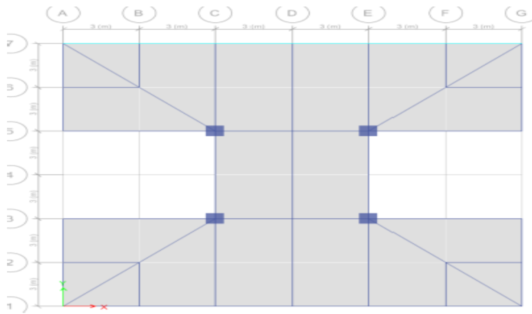


Figure 3 Plan of Infillwallmodel

Figure 4 Plan of diagrid 2storeymodel

Figure 5 Plan of diagrid





6storeymodel

All the Elevations of 4 models are shown in the below Fig6, Fig7, Fig8, fig9

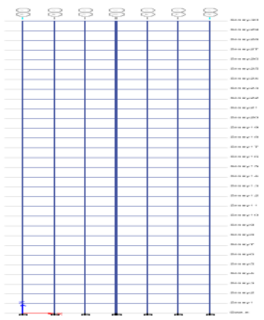


Figure 6 Elevation of RCFramemodel.

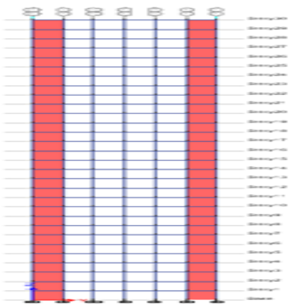
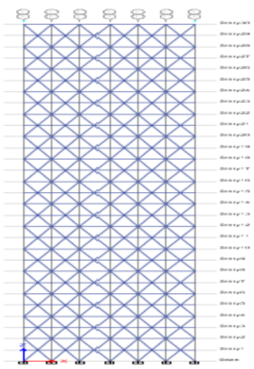


Figure 7 Elevation of Infillwallmodel



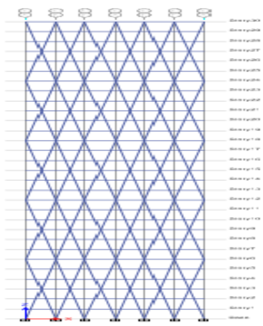
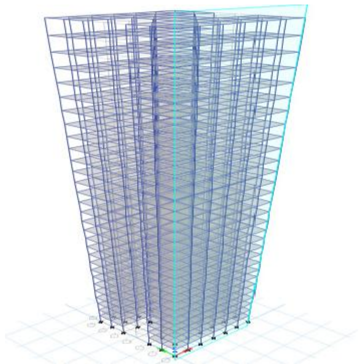


Figure 8 Elevation of diagrid 2storey model **Figure 9** Elevation of diagrid 6storey model

All the Isometric views of 4 models are shown in the Fig10, Fig11, Fig12, andFig13



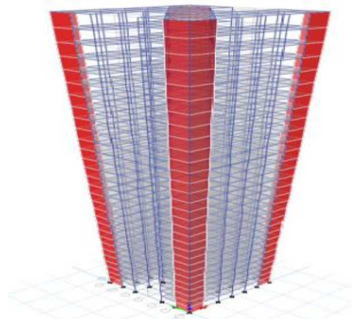
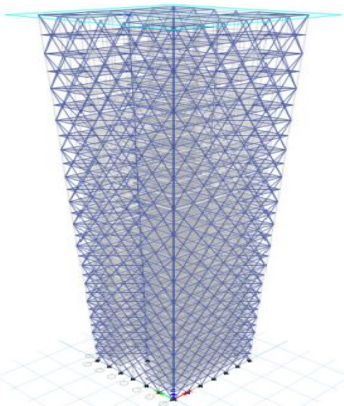


Figure 10 Isometric View ofRCFrame **Figure 11** Isometric View of Infill
wallFrame



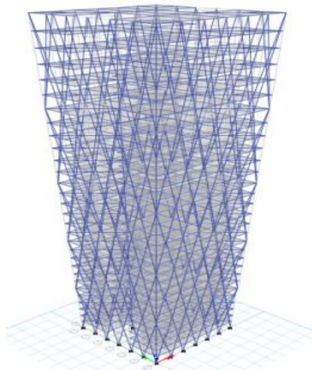


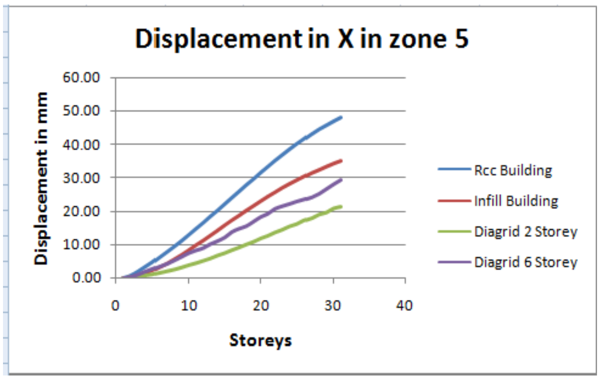
Figure 12 Isometric View of diagrid 2storeymodel **Figure 13** Isometric View of diagrid 6
storeymodel

V. ANALYSIS OFRESULTS

The Comparative analysis results of RC Frame model, Infill wall model and Diagrid structure models in terms of Time period, Storey Displacement, Inter-storey Drifts, Bending moments, Base Shear and Axial forces are presented in this section.

Lateral displacement and DriftResults

The lateral displacement of any building increases with increase in height of the building [8] because of its lateral load effect. Fig14 and Fig15 shows the lateral displacement of all models corresponding to each storey.



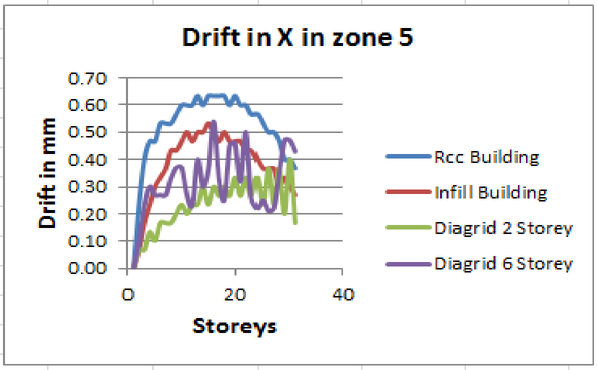


Figure 14 DisplacementsinX-direction **Figure 15** Drifts inX-direction

From the above results on the graph we observed that Diagrid 2 Storey model frame has lesser Displacement [6]

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and Drift among all the 4 models which are shown in Figure.

Response Spectrum Displacement and DriftResults

As per code IS: 456-2000, the maximum top storey displacement due to wind load should not exceed 0.004 times of H, where H is the total height of the building. The Response Spectrum displacement values for all the models are within the permissible limit.

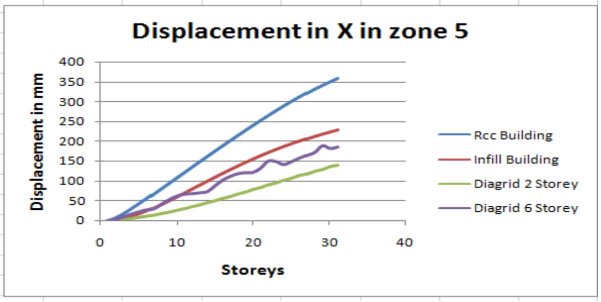

Figure 16 RS DisplacementsinX-direction

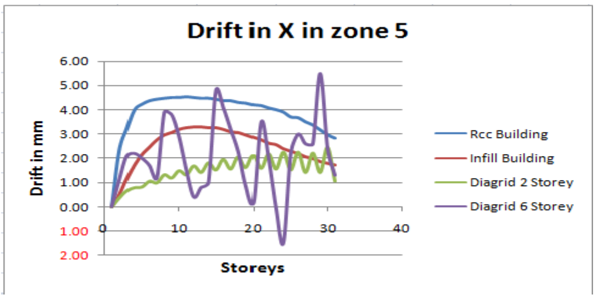

Figure 17 RS Drifts inX-direction

It can be seen that as number of stories is increasing, the top storey displacement is also increased but for the case of all 4 models, displacement value is smaller for diagrid 2 storey by comparing others. And also the drift value is small for diagrid 2 storey among all which shown in Fig16 and Fig17.

Axial Forces and BendingMoment

Fig18 shows the comparison of Axial forces in between RC Frame, Infill, Diagrid 2 Storey and Diagrid 6 Storey Models

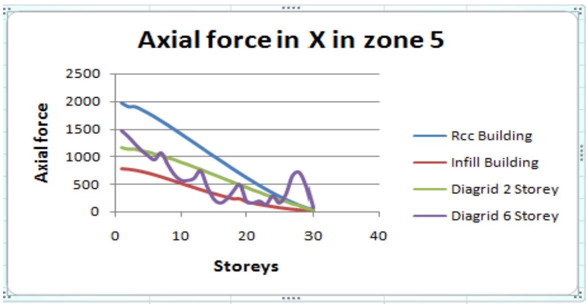

Figure 18.Axial ForcesinX-direction

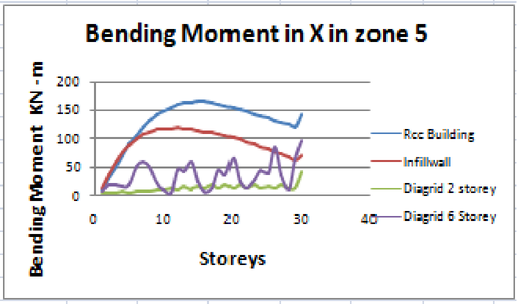

Figure 19 Bending Moment inX-direction.

From the Fig19 it is notified that diagrid 2 storeymodel is completely relaxed in bending moment compared with all other models.

Time Period and BaseShear

From the Fig20 it can be noticed that the time period is minimum for the diagrid 2 storey model, so the stiffness of that model is more as compare to others and as the structure is stiff, it will have the less displacement and the Base Shear will be more [7] which was observed in Diagrid 2 storey model shown in Fig 21.

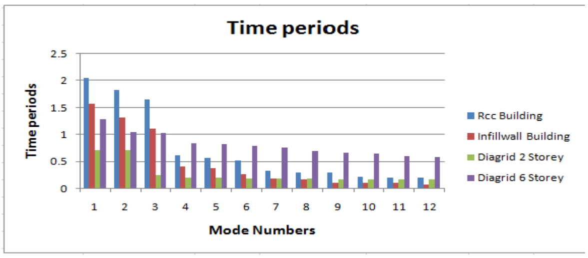

Figure 20.Time PeriodinX-direction

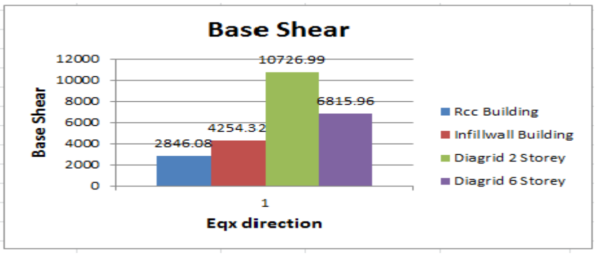

Figure 21 Base Shear inX-direction.

VI.CONCLUSION

- As the lateral loads are resisted by diagonal columns, the top storey displacement is very much less in diagrid structure as compared to the simple RC Framebuilding.
- As the lateral loads are resisted by diagonal columns, the top storey displacement is less in also Infill wall structure as compared to the simple RC Framebuilding.
- When number of storey increases means height of building increases, diagrid 2 storeys is optimum for 30 storied structure and gives better results in terms of top storey displacement, storey drift, storey shear, time period and materialconsumptions.
- As time period is less, lesser is mass of structure and more is the stiffness. The time period is observed less in diagrid structure which reflects more stiffness of the structure and lesser mass ofstructure.
- Diagrid provide more resistance in the building which makes the structural system moreeffective.
- The overall results suggested that diagrid is excellent seismic control for high-rise symmetric Buildings and diagrid 2 storey is optimum which gives betterresult.

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