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Comparative Study of RC Shear Resisting Structure by Non Linear Time History Analysis

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Abstract –*Structures need to have suitable earthquake resistant features to safely resist large lateral forces that are imposed on them during frequent earthquakes. Ordinary structures for houses are usually built to safely carry their own weights. Lateral forces can produce the critical stresses in a structure, set up undesirable vibrations and, in addition, cause lateral sway of structure, which could reach a stage of discomfort to the occupants. Shear wal, Steel bracings, infill wall, stiffer size columnsare one of the most commonly used lateral load resisting element in high rise building. In this study, the non-linear El-centro time history analysis is carried out for special moment resisting frame under earthquake loading using computer software E-TAB 2016.*

Keywords- Shear wall, steel bracing, infill wall, stiffer column, Non-linear time history, E-TAB 2016.

INTRODUCTION

Tall building developments have been rapidly increasing worldwide. The growth of multistory building in the last several decades is seen as the part of necessity for vertical expansion for business as well as residence in major cities. It is observed that there is a need to study the structural systems for R.C. framed structure, which resists the lateral loads due to seismic effect. Safety and minimum damage level of a structure could be the prime requirement of tall buildings. To meet these requirements, the structure should have adequate lateral strength, lateral stiffness and sufficient ductility. Among the various structural systems, shear wall frame or braced concrete frame and stiffer column could be a point of choice for designer. Therefore, it attracts to review and observe the behavior of these structural systems under seismic effect. Hence, it is proposed to study the dynamic behavior of reinforced concrete frame with and without shear wall or bracings, RC frame with infill wall effect and RC frame with stiffer column size. The purpose of this study is to compare the seismic response of above structural systems. Axial forces and moments in members and floor displacements will be compared.

The most effective and practical method of enhancing the seismic resistance is to increase the energy absorption capacity of structures by combining bracing elements in the frame. The braced frame can absorb a greater degree of energy exerted by earthquakes.

The present study is an effort towards analysis of the structure during the earthquake. G+15 stories residential building is considered. Nonlinear time history method is carried out. For all the models mentioned above the base shear result are compared.

METHODOLOGY

In order to examine the exact nonlinear behavior of structures, nonlinear time history analysis has to be carried out. In this method, the structure is subjected to real ground motion records. This makes this analysis method quite different from all of the other approximate analysis methods as the inertial forces are directly determined from these ground motions and the responses of the building either in deformations or in forces are calculated as a function of time, considering the dynamic properties of the structure.

In Etabs 2016, the nonlinear time-history analysis can be carried out as follows:

1. The models representing the buildings are created and vertical loads (dead load and live load), member properties and member nonlinear behaviours are defined and assigned to the model.

2. The ground motion record is defined as a function of acceleration versus time.

Here after, the analysis and the time history parameters are defined in order to perform a nonlinear time history analysis. The total time of the analysis is the number of output time steps multiplied by the output time-step size. To match time history to target response spectra, there are two options in ETABS 2016.

PROBLEM STATEMENT

The building is analyzed is G+15 R.C framed building of symmetrical rectangular plan configuration. Complete analysis is carried out for dead load, live load & seismic load using ETAB 2015. Non linear time history analysis is used. All combinations are considered as per IS 1893:2016.

Site Properties:
Details of building:: G+15
Plan Dimension:: 30m x 20m , 5m span in each direction.
Outer wall thickness:: 230mm
Inner wall thickness:: 230mm
Floor height ::3 m
Parking floor height :: 3m
Seismic Properties
Seismic zone:: IV
Zone factor:: 0.24
Importance factor:: 1.2
Response Reduction factor R:: 5
Soil Type:: medium
Material Properties
Material grades of M35 & Fe500 is used for the design.
Loading on structure
Dead load :: self-weight of structure
Live load :: Floor :: 2.5 kN/m²
Roof:: 1.5 kN/m²
Seismic load:: Seismic Zone IV
Preliminary Sizes of members
Column::850mm x 350mm
Beam:: 300mm x 600mm
Slab thickness:: 125mm
Shear wall thickness:: 250mm
Steel bracing section::ISMB 350

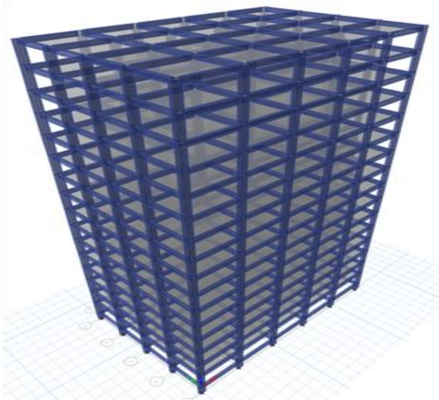

Fig.1- 3D view of G+15 RC frame building

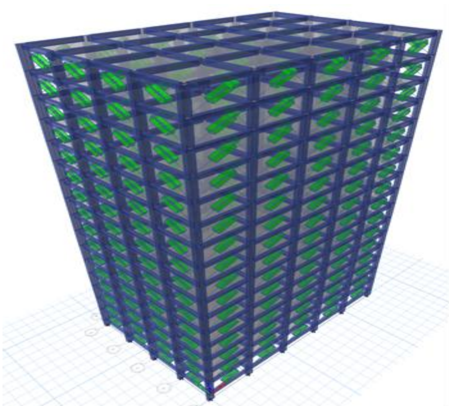

Fig.2- 3D view of G+15 RC frame building with infill wall

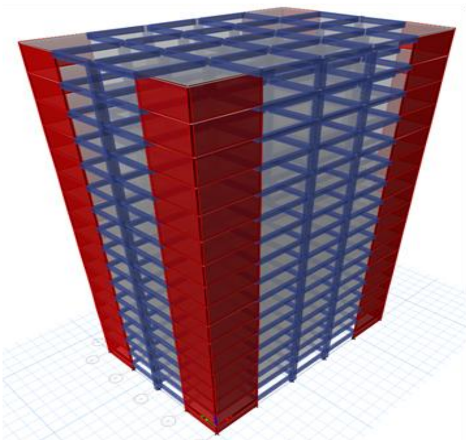

Fig.3- 3D view of G+15 RC frame building with outer shear wall

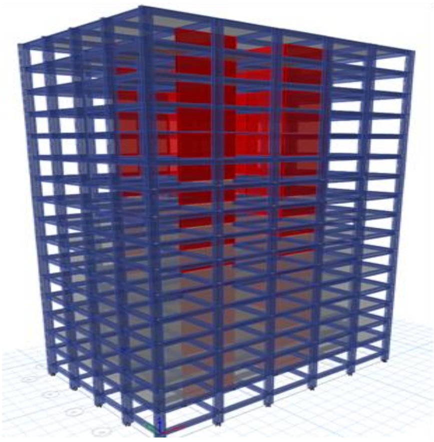

Fig.4- 3D view of G+15 RC frame building with inner shear wall

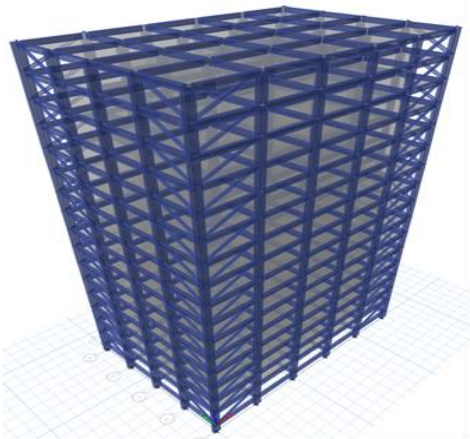

Fig.5- 3D view of G+15 RC frame building with outer diagonal steel bracing

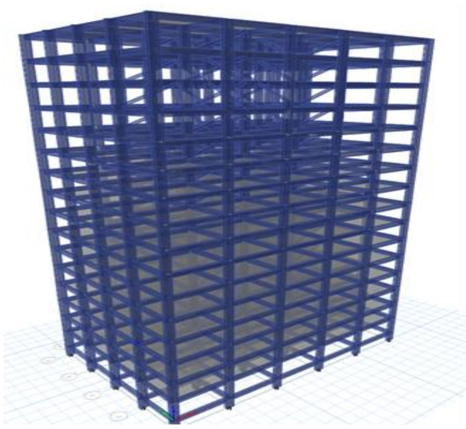

Fig.6- 3D view of G+15 RC frame building with inner diagonal steel bracing

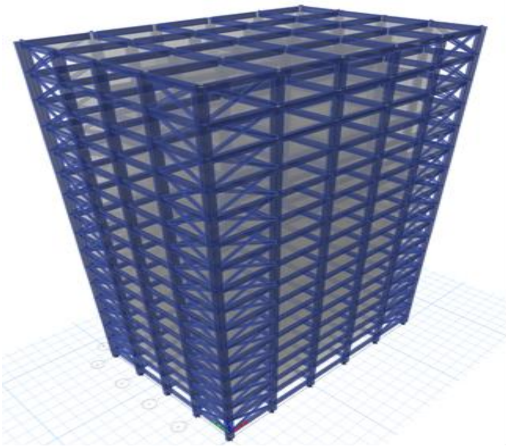

Fig.7- 3D view of G+15 RC frame building with outer X type steel bracing

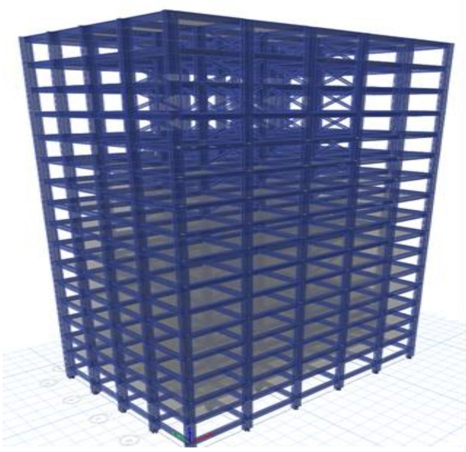

Fig.8- 3D view of G+15 RC frame building with inner X type steel bracing

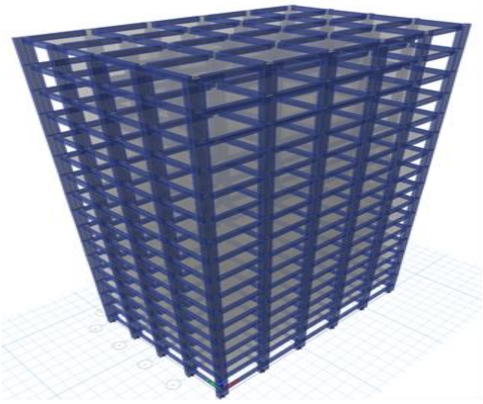

Fig.9- 3D view of G+15 RC frame building with stiffer column

RESULTS

Table 1- Base shear (kN) in X-direction

Type of Model	Base shear (kN)
Bare Frame	2625.722
Infill wall	3755.236
Outer shear wall	2729.949
Inner shear wall	4588.213
outer Diagonal Brace	1981.139
Inner Diagonal Brace	2012.569
outer X Brace	2391.413
Inner X Brace	2892.142
Stiffer Column	2751.883

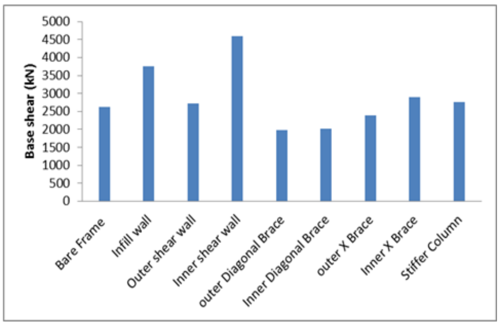

Fig. 10 - Base shear (kN) in X-direction

Table 2 - Base shear (kN) in Y-direction

Type of Model	Base shear (kN)
Bare Frame	1817.95
Infill wall	2533.7
Outer shear wall	2104.625
Inner shear wall	2077.236
outer Diagonal Brace	2784.128
Inner Diagonal Brace	2485.21
outer X Brace	2886.541
Inner X Brace	1958.452
Stiffer Column	2872.971

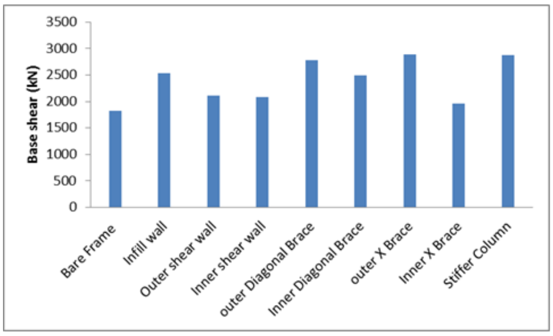

Fig. 11-Base shear (kN) in Y-direction

Table 3 - Maximum Lateral Displacement (mm) in X-direction

Type of Model	Ux (mm)
Bare Frame	35.457
Infill wall	16.095
Outer shear wall	15.747
Inner shear wall	22.749
outer Diagonal Brace	20.657
Inner Diagonal Brace	19.044
outer X Brace	21.555
Inner X Brace	22.633
Stiffer Column	28.224

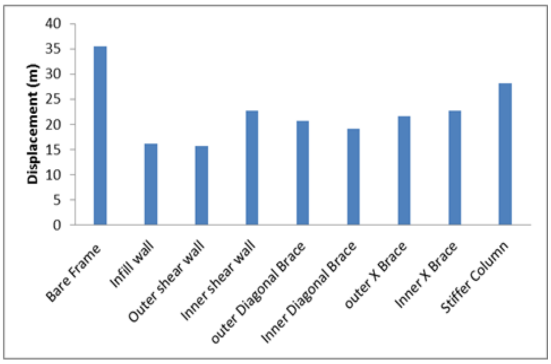

Fig. 12 - Maximum Lateral Displacement (mm) in X-direction

Table 4 - Maximum Lateral Displacement (mm) in y-direction

Type of Model	Uy (mm)
Bare Frame	45.803
Infill wall	18.473
Outer shear wall	18.106
Inner shear wall	6.106
outer Diagonal Brace	43.074
Inner Diagonal Brace	30.409
outer X Brace	37.405
Inner X Brace	19.404
Stiffer Column	37.595

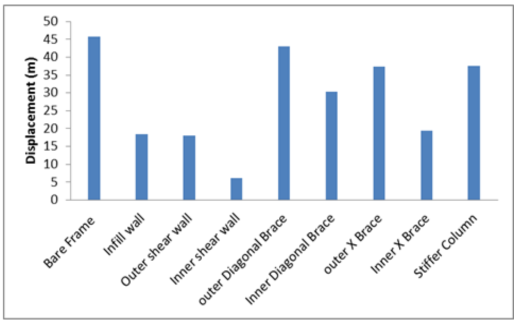

Fig.13-Maximum Lateral Displacement (mm) in Y-direction

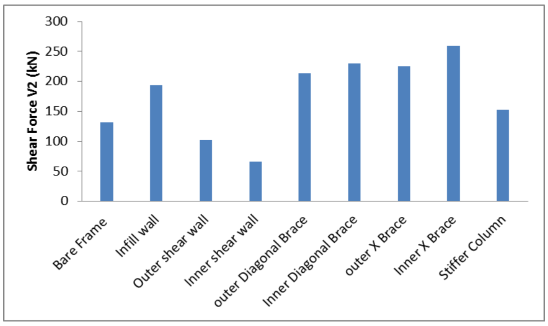

Fig. 15 - Shear Force V in Columns (kN)

Table 5- Axial Force in columns (kN)

Type of Model	Axial Force (kN)
Bare Frame	3974.255
Infill wall	3715.238
Outer shear wall	3924.92
Inner shear wall	2737.464
outer Diagonal Brace	3970.048
Inner Diagonal Brace	4090.676
outer X Brace	3968.875
Inner X Brace	3986.89
Stiffer Column	3952.34

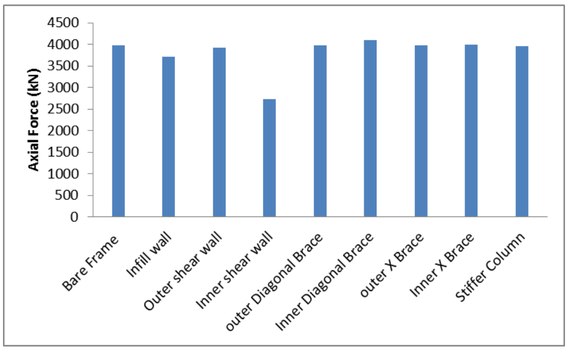

Fig.14 - Axial Force in Columns (kN)

Table 6.- Shear Force in columns (kN)

Type of Model	Shear Force V2(kN)
Bare Frame	131.2473
Infill wall	194.1598
Outer shear wall	102.2299
Inner shear wall	66.587
outer Diagonal Brace	213.5637
Inner Diagonal Brace	230.3087
outer X Brace	224.7055
Inner X Brace	259.6161
Stiffer Column	152.34

Table 6 - Moment in columns (kNm)

Type of Model	Moment M3 (kNm)
Bare Frame	276.0882
Infill wall	292.0555
Outer shear wall	129.4382
Inner shear wall	102.116
outer Diagonal Brace	348.2895
Inner Diagonal Brace	340.554
outer X Brace	326.5206
Inner X Brace	347.4251
Stiffer Column	295.61

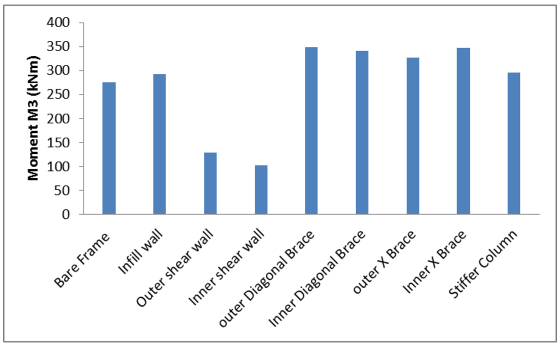

Fig. 16 - Moment in Columns (kNm)

CONCLUSIONS

1. **Base Shear** - Buildings with inner shear wall increased base shear upto 50% as that of bare frame in X direction. Also base shear is increased upto 40% in outer brace frame as compared to bare frame in Y direction and base shear is increased to 50% in vertical direction by adding inner shear wall.
2. **Lateral Displacement –** Maximum lateral displacement is reduced to 60% by adding infill

wall in X direction and upto 85% by adding inner shear wall.

3. **Column Forces -** The critical axial force in columns is reduced to 30% by adding inner shear wall as compared to bare frame. Also shear force and moments in columns is reduced to 80% by adding inner shear wall as compared to bare frame

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