

Comparision of Seismic Analysis of a Residential Structure between Normal Rcc, Shear Wall Columns

T.G.N.C.Vamsi Krishna, S.V.Surendhar, Mirza Mahaboob Baig, Atif Zakaria

Abstract: In high raised structures, mostly columns are preferred with either Normal RCC Columns or Steel Columns. In India, most probably RCC columns only used because it depends on the availability of materials, workmanship and RCC Columns occupies more space in high raised structures due to the large dimensions but it controls the large deflections of the structure due to an earthquake. Steel Columns occupied less space and it can also give more strength than RCC Columns but the availability of material is less because steel consumption in India very low compared with other foreign countries and due to the earthquake large deformations occurred in steel columns. For controlling or eliminating these problems shear wall columns are better in High Raised Structures. Shear wall columns stronger than the RCC Columns, it can increase usable floor area in the structure and also it can decrease the deflections than the RCC Columns. Considered a geometrical irregularity of residential structure (G+18 Storey) in the seismic zone-III, Medium type of soil condition. Analyse the structure with Linear and Non-linear Dynamic analysis in various types of columns they are Normal RCC, Shear wall Columns by ETAB Software. Due to an analysis of these structures compare the Storey displacements, Storey drifts, Base shears, Response Spectrum curve, Time History curve, Self-weight, Time period of the structure. From these above parameters conclude that shear wall type of columns most suitable in all possible conditions.

KEYWORDS: RCC Columns, Shear Wall Columns, Deflections, Self-weight, Time period of the structure.

I. INTRODUCTION

In general, especially in India high raised structures constructed with either reinforced concrete columns or steel columns. In India, the production of steel is very low compared with other countries. Due to the RCC columns in high raised structures, the column sizes are increased more, a large amount of steel quantity required and also it occupies the more feasibility space in the rooms.

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The seismic behaviour on RCC columns in High raised structures; it controls the displacement, drift and shear of the structure within permissible limits of the structure. Due to the heavy earthquakes, RCC Columns are not protected to the structure, at particular time columns are twisted through that buckling failure effected to structure Shear walls are stronger than RCC Columns. Shear walls are provided from foundation to top of the structure with single connectivity it can act as a single unit. Shear walls can protect the structure from earthquakes acting on the structure. Shear wall presence in the structure can give more stiffness, efficient solution to the structural system and to increase the rigidity of lateral load resistance than the RCC Columns of structure. Shear walls not only helped to a lateral load resistance, but it can also decrease the gravity load of the structure due to this base shear and the time period the structure will vary in a positive manner. In high raised structures, mostly shear walls are provided at the lift portions because it can resist more lateral loads and vibrations. For controlling the severe earthquakes sometimes shear walls are provided at the external walls of the structure to resist the lateral loads directly affecting to the structure. If shear walls are provided at the outer and inner walls of the entire structure, stiffness and load resisting capacity of structure increases and good protection from earthquake forces but due to this arrangement sometimes opening shear walls are required to provide for doors and windows in the structure here their resistance, stiffness capacity decrease and earthquake forces will act more. Finally, shear walls are required for high raised structures at the same time full length of shear walls also not sufficient to the structure due to the some shear wall opening problems so, shear walls can be provided at column positions it can also give better performance, good earthquake lateral load resistance and stiffness than the RCC Columns of the structure. Swetha K S, Akhil P A., Conducted a study on performance and effects of the high raised building with shear wall openings by ETAB software using Time history method. They concluded that at where doors and windows are available; their stiffness, rigidity and load resistance capacity decreases than the shear wall area but remaining shear wall position in the structure stiffness, lateral load resistance are increased. Ashok Kankuntla, Prakarsh Sangave, Reshma Chavan., Conducted a study on seismic performance of 15-storey high raised structure with openings in the shear wall at earthquake Zone-V. The response spectrum analysis was done by SAP 2000 software.

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They conclude that opening type of shear walls is more economical but resistance behaviour from an earthquake is low. HimaleeRahangdale, S.R.Satone., Studied G+5 storey building at Seismic zone IV using STAAD Pro software. In this they changing various positions of shear wall in structure and analysed. Finally, they concluded that shear walls at corner sides of the structure behaving the full load resisting from an earthquake and some other positions of shear walls also behaving similar but the columns axial forces and bending moments are raised very high but the shear wall can be supported that forces and moments also.

II. OBJECTIVE

Considering the G+18 storey of a geometrical irregularity of residential high raised structure with variation of both longitudinal and transverse direction using 2 models (RCC Columns and Shear wall Columns) by ETAB software under Seismic Zone-III at Medium soil condition. The linear static, dynamic analysis and Nonlinear Dynamic analysis of the structure. Comparing these two models with the help of following parameters such as Storey displacements, Storey drifts, and Storey shear, Stiffness of column, Self-weight, Time period of the structure, Response spectrum and Time history curve.

III. REINFORCED CONCRETE SHEAR WALL

Mostly in residential buildings, Reinforced Concrete shear wall are used. In this, reinforcement should be provided in both longitudinal and transverse directions and also bars are anchored and closely spaced at the end of each wall. RC Shear wall of thickness varied from 120mm to 500mm depending upon many factors like Number of storeys in the structure, Age of the Structure, Thermal Insulation required in a structure.

It is connected from foundation to the top of the structure but sometimes due to the doors, windows shear wall openings are required and also at parking places especially in tall structures. Shear wall efficiency totally depends on Stiffness, Rigidity of the structure. Shear walls are provided with either solid Shear wall, Opening type shear wall. The opening type of shear walls are varied with various cross sections it's depending on their situation as shown in Fig 1. The shape, position of shear wall is impact on behaviour of shear wall. Mostly shape of shear wall either plane or flanged or channel section as shown in Fig 2.

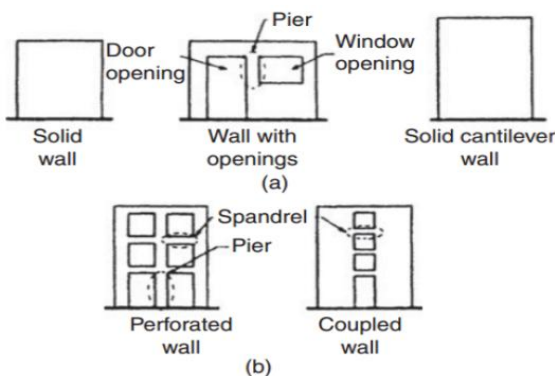


Fig. 1 Various opening ways of shear walls

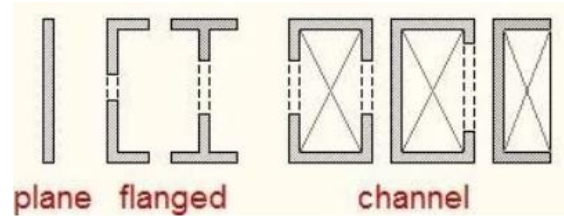


Fig. 2 Various Shapes of Shear walls

IV. MODELLING & ANALYSIS

A. Description of the model

In this study, residential building is considered. The structure has geometric irregularities such as varying spacing between columns in X & Y directions. The AutoCAD plan of the structure is shown in Fig. 3. The same building plan is used to model and design an RCC Column structure and a Shear wall Column structure. The floor to floor height, dead loads, live loads and seismic analysis data remains same for both the structures. The structure consists of G+18 storeys. The Equivalent static analysis, Response spectrum analysis and Non-linear time history analysis are performed using ETAB software.

B. Details of the structure

G+18 storey building is considered, the grade of concrete for RCC Columns and Shear wall Columns are M30 and M50 respectively. Similarly the grade of steel is Fe500 for both the structures. The overall length, width, depth of the building is 53m X 33m X 62m respectively. The height of plinth and each floor is 2m, 3m respectively. The thicknesses of slab, shear wall are 0.125m and 0.23m respectively for both the structures additionally the thickness of shear wall is 0.3m, 0.35m provided only to particular columns in shear wall column structure. Sizes of RCC beams are 0.23m X 0.50m, 0.30m X 0.50m, 0.40m X 0.50m, 0.50m X 0.50m. Sizes of RCC columns are 0.23m X 0.90m, 0.23m X 0.75m X 0.75m (L-Column), 0.30m X 1.0m, 0.30m X 1.20m, 0.40m X 1.20m. The dead loads, live loads, wind loads are taken from IS code (IS: 875:2015) part I, II, III respectively. The location of the structure is Guntur, zone type III is considered. The seismic zone is taken from IS: 1893:2016. Equivalent Static analysis, Response spectrum analysis, Non-linear time history analysis are carried out on the structure. These two structures are analysed and designed with according to IS: 456:2000 and IS: 1893:2000. The modelled RCC Column structure and Shear wall Column structures are shown in Fig. 4 and Fig. 5 respectively.

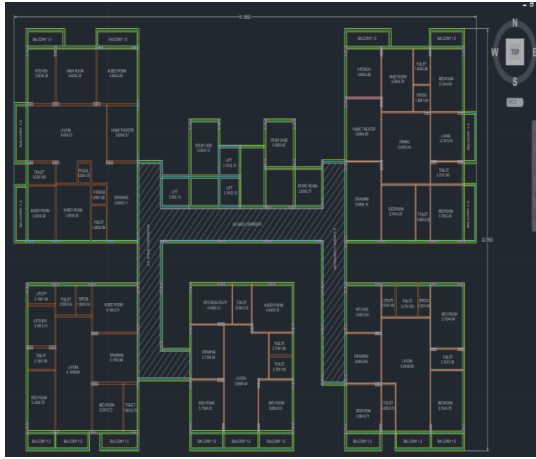


Fig. 3 AutoCAD Plan of the Structure.

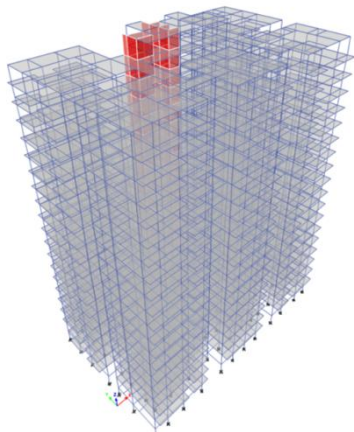


Fig. 4 RCC Column of the Structure

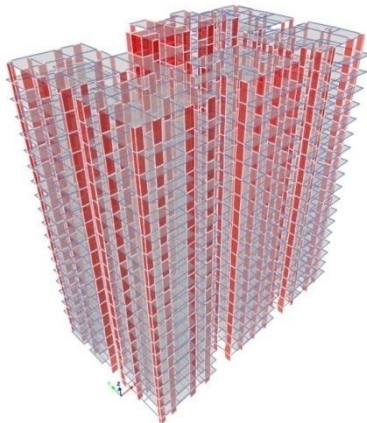


Fig. 5 Shear wall Column of the Structure.

V. RESULTS & DISCUSSIONS:

1. RCC Column structure has more storey displacement than the Shear wall Column structure in both the directions as shown in Fig. 6 & 7.
2. Shear wall Column structure has less storey drift than the RCC Column Structure in both the directions as shown in Fig. 8 & 9.
3. In both X, Y Directions, storey shears in RCC Columns has more shear than the Shear wall Columns up to 4th storey, from 5th storey to 16th storey Shear wall Columns has more storey shears than the RCC Columns and the remaining storeys; Shear wall Columns has less shear than the RCC Columns as shown in Fig. 10 & Fig. 11.

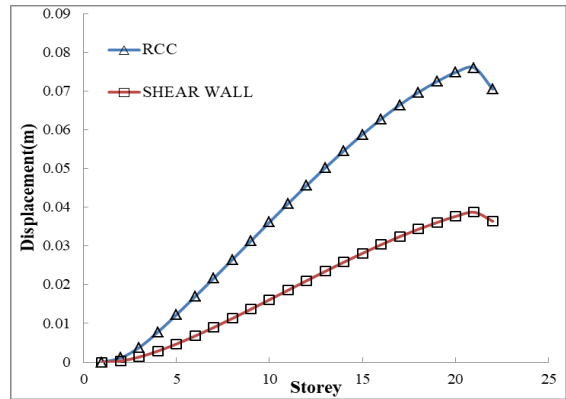


Fig. 6 Storey Displacement in X-Direction

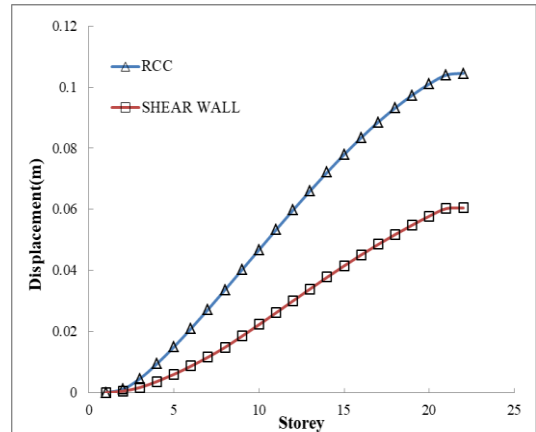


Fig. 7 Storey Displacement in Y-Direction

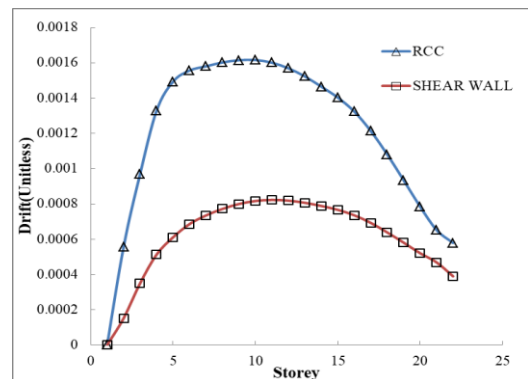


Fig. 8 Storey Drift in X-Direction

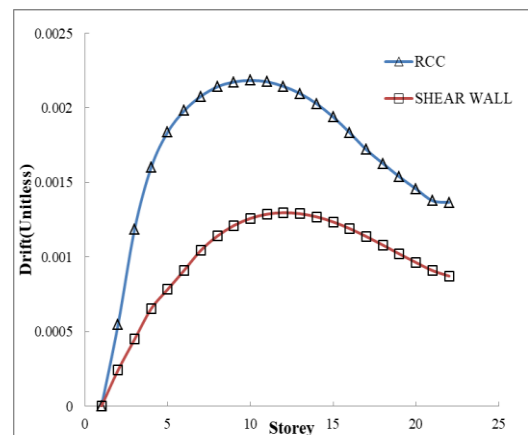


Fig. 9 Storey Drift in Y-Direction

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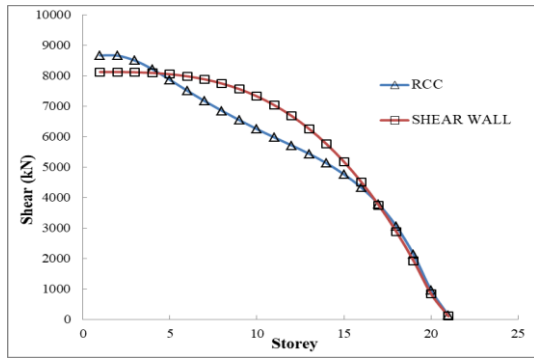


Fig. 10 Storey Shear in X-Direction

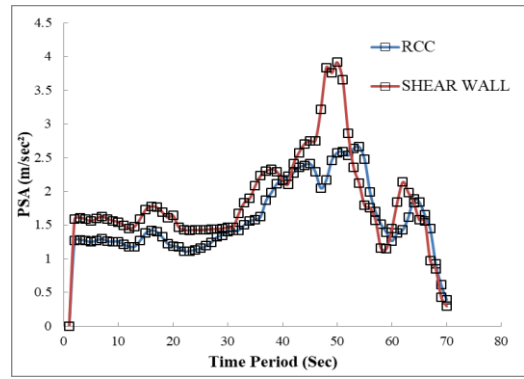


Fig. 14 Damping Ratio 10% in X-Direction

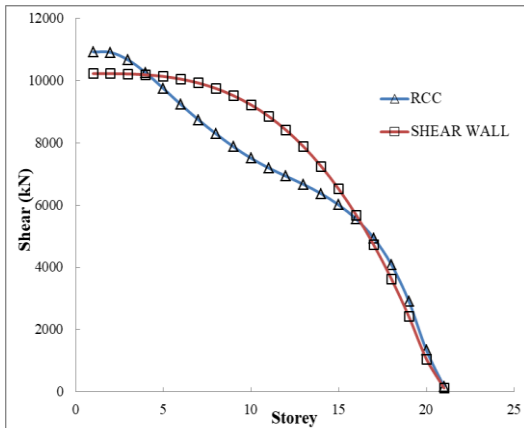


Fig. 11 Storey Shear in Y-Direction

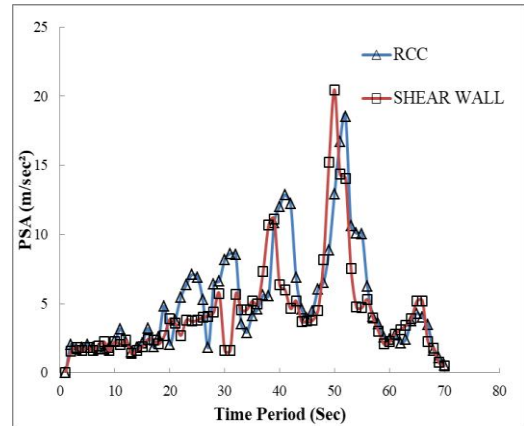


Fig. 15 Damping Ratio 0% in Y-Direction

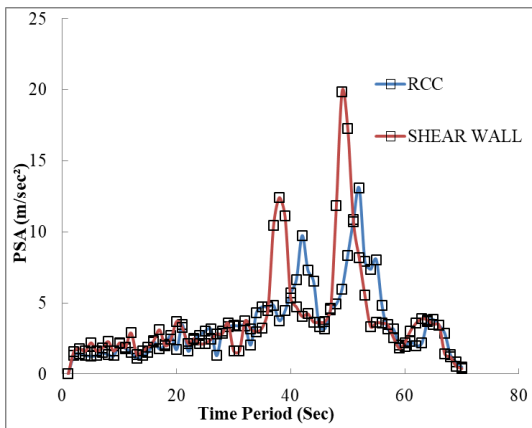


Fig. 12 Damping Ratio 0% in X-Direction

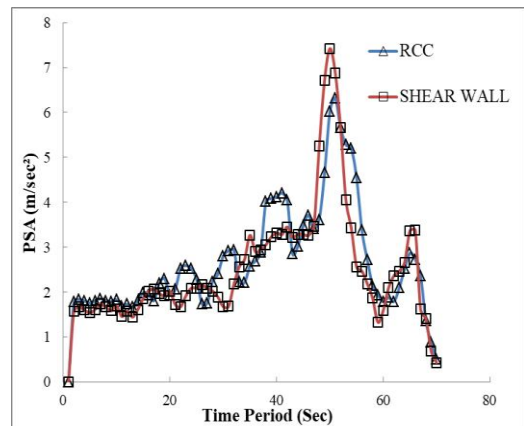


Fig. 16 Damping Ratio 5% in Y-Direction

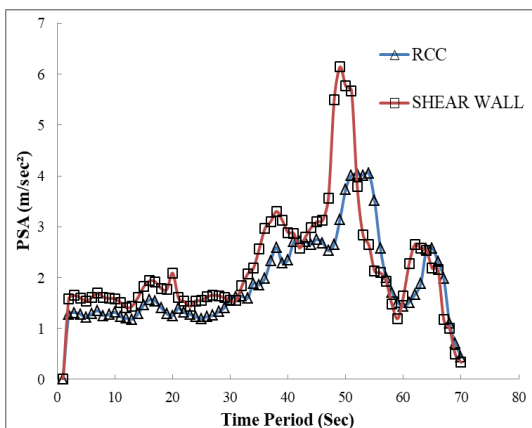


Fig. 13 Damping Ratio 5% in X-Direction

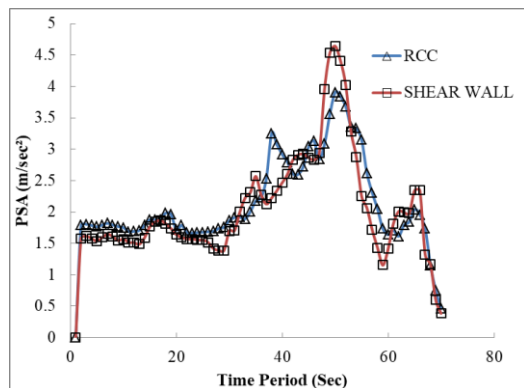


Fig. 17 Damping Ratio 10% in Y-Direction

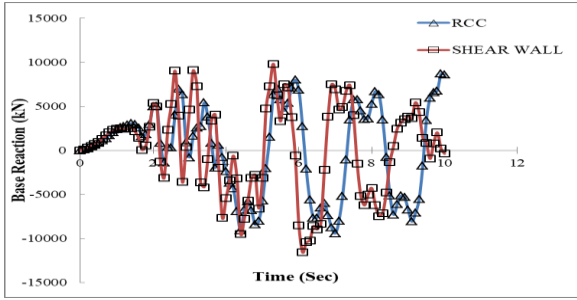


Fig. 18 Time History Curve in X-Direction

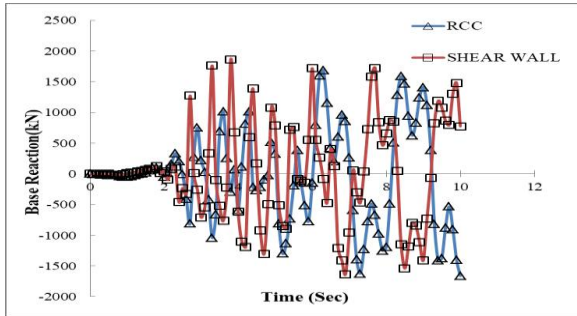


Fig. 19 Time History Curve in Y-Direction

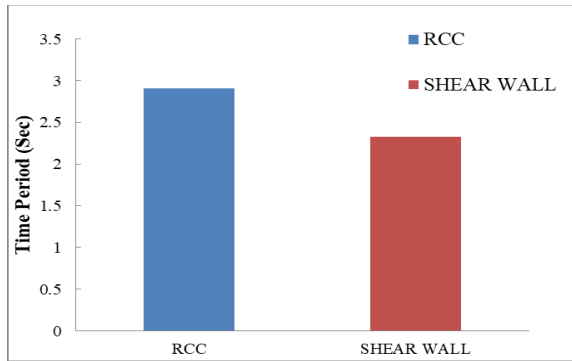


Fig. 20 Time Period of the Structure

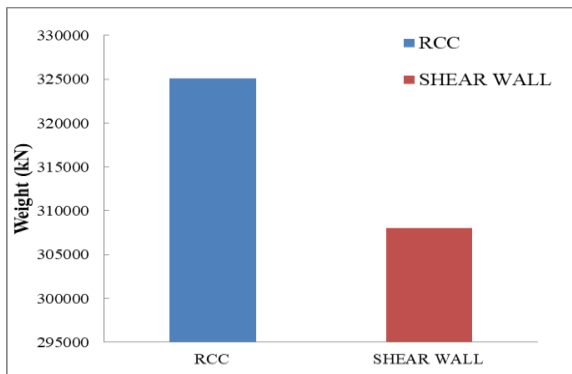


Fig. 21 Self-weight of the Structure

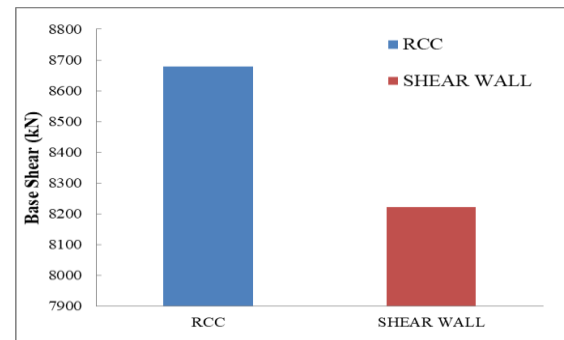


Fig. 22 Base Shear in X-Direction

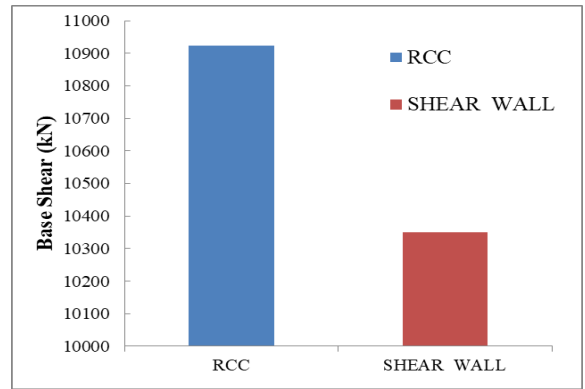


Fig. 23 Base Shear in Y-Direction

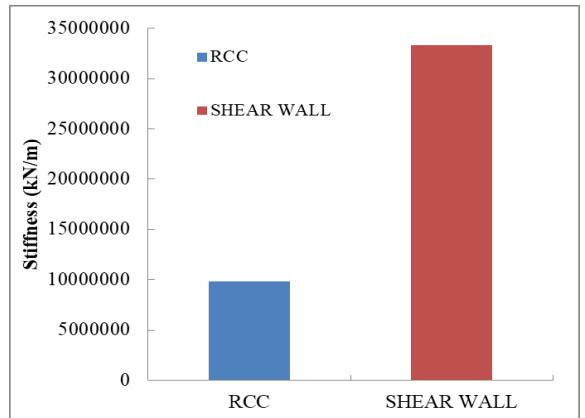


Fig. 24 Maximum Storey Stiffness in X-Direction

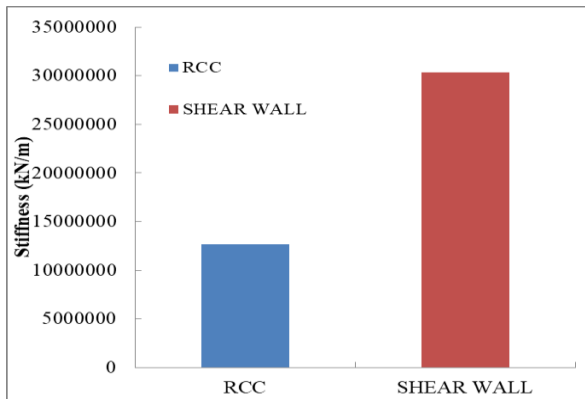


Fig. 25 Maximum Storey Stiffness in Y-Direction

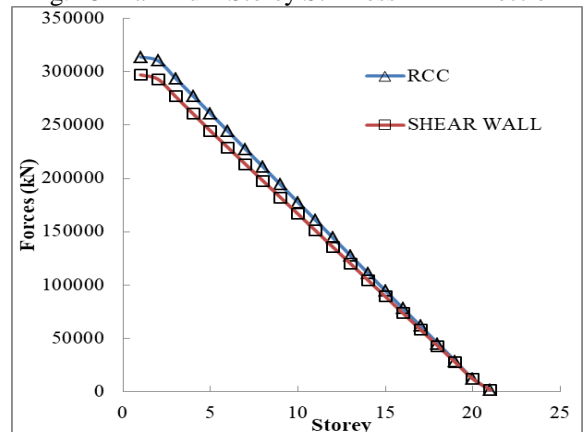


Fig. 26 Story Forces

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4. From Fig. 12 to 17 observed that response spectrum curve at damping ratios of 0%, 5%, 10% in both directions are slight variations in both RCC Column and Shear Wall Column Structure.
5. Time History Curve indicates that Shear wall Column structure is slightly more than the RCC Column Structure as shown in Fig. 18 & 19.
6. The time period is more in RCC Column structure than the Shear wall Column structure as shown in Fig. 20.
7. The self-weight of the structure in the RCC Column structure is more than the Shear wall Column Structure as shown in Fig. 21.
8. The base shears of the structure in both X & Y Directions are less in shear wall Column structure than the RCC Column structure as shown in Fig. 22 & 23.
9. Stiffness of the structure in Shear wall columns is more than the RCC Column Structure in both the directions as shown in Fig. 24 & 25.
10. From Fig. 26, the storey forces in RCC Structure are slightly higher than the Shear wall Column Structure.

VI. CONCLUSIONS

1. The Storey displacement in Shear wall column structure is less than the RCC Column structure because the presence of a shear wall in the structure can help to control the displacements in the structure. Due to this, structure performance increases more.
2. The Storey drift in RCC Column structure is more than the Shear wall Column structure because the storey drifts always depending on the storey displacement of the structure. So, the shear wall column structure is most preferable than the RCC Column structure.
3. The storey shears in both structures at both directions slightly varied at particular storeys. It cannot affect the structure.
4. Response spectrum curve indicates that shear wall structure has high acceleration than the RCC structure. Here, acceleration more in structure indicates the resistance capacity of the structure from the earthquakes so; shear wall structure is stronger than RCC structure.
5. The time history curve says that both structures can be performed similarly in both directions.
6. The Time period of shear wall structure indicates the stability condition of the structure.
7. The Self-weight of the shear wall structure is less than the RCC Column structure. Due to less self-weight of the structure base shear also decreases in both directions. So, the shear wall structure is stronger than the RCC structure.
8. The stiffness of the structure more means it can stand to control or resist the earthquake forces in the structure. Here, the shear wall structure has more stiffness than the RCC structure.
9. Finally, the shear wall type of column structures can give more space, high strength and cost of construction also will decrease when compared to the Normal Columns in RCC structure.

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