BUILDING ANALYSIS IN THE SEISMIC ZONE USING THE SOFTWARE STAAD Pro V8i

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ABSTRACT

Natural disasters have been a part of human life on Earth since the dawn of time, wreaking havoc on our lives and property. Earthquake is one of the biggest causes of destruction among the many natural disasters. Sudden ground shaking has posed challenging challenges to the withstanding of structures on the Earth, as well as resulting in the collapse of structures, due of improper design considerations to structures without any seismic resistance. To achieve the desired strength to withstand seismic forces, various shapes and materials are now being considered, as well as various techniques to make the building earthquake resistant. Shear walls, bracings, and base isolation are examples of these techniques. In this paper, we use software to perform a comparative study of earthquake retaining methods on a G+6 storey building using different types of floating columns and shear walls. An un-Retaining structure, Alternate and parallel shear walls, Floating column, and a mixture of both shear wall and floating column are all compared. According to the IS 1893:2002 codal provisions, the study is performed on a G+6 building for seismic Zone IV. Staad pro V8i is the program that we used to conduct the research. Shear walls reduce deflection by raising the building's strength and stiffness, while floating columns are dangerous to remain in because the structure has more deflection than unrestrained seismic techniques.

Keywords: Floating Column, Shear Walls, and Comparative analysis, Earthquake resistant.

I. INTRODUCTION

Earthquakes have a long history of causing death and damage to humans and their buildings. As a result, a variety of approaches would be used to address this major issue. When we talk about earthquakes, we're talking about ground shaking caused by tectonic plate cracks or slippage. This slip releases steam, which causes different types of waves to be released from the epicentre of the earthquake. Epicentre is a term used to describe the epicentre of an earthquake. Earthquakes can be quantified in terms of frequency, amplitude, and position of seismic waves, as well as intensity. If we speak about India, it has experienced the world's largest earthquakes in the last century, whether in Bum (2005), Latur (1993), or Jabalpur (1997), where thousands of people were injured, many died, and thousands of buildings were destroyed. Approximately half of the total area is vulnerable to damaging earthquakes. In India, earthquakes of magnitude greater than 8 are more common in the northern part of the country, especially in the Himalayan region. This is due to the Indian plate moving at a pace of about 50mm per year towards the Eurasian plate.

One of the most significant factors in resisting the lateral loads that come through the wall during an earthquake is the shear wall. It has high strength and plane stiffness, allowing it to withstand horizontal loads while also supporting gravity loads, greatly reducing lateral sway of high-rise buildings and, as a result, the structures and their contents. The horizontal loads will be transferred to the walls, shear walls, columns, and footings due to the shear wall's weight. It also provides lateral stiffness to prevent lateral swaying of the roof and floor during an earthquake. It's rigid enough to keep the roof and floor from slipping off their supports. The overturning impact on it is high since it carries large horizontal earthquake powers. To minimize the effects of twisting in high-rise buildings, shear walls should be located in plan. By minimizing lateral displacement under earthquake loads, shear walls installed in appropriate locations in a building may form an effective lateral force resisting device. As a result, the location of the shear wall in a high-rise building is a critical factor in reducing lateral displacement during an earthquake.

Engineers tend to construct multi-story buildings to reduce the pressure on the environment, and lateral forces have a greater impact on multi-story buildings, so we built the building with all forces in mind. To - the effect of lateral forces, we built a shear wall. We produced five models in this paper: A0, A1, A2, A3, and A4.

Model A0: G+6 Building without any seismic restraints.

Model A1: G+6 Building with floating columns.
Model A2: G+6 Building with parallel shear walls.
Model A3: G+6 Building with alternate shear walls.
Model A4: G+6 Building with floating columns and Shear walls.

II. TECHNIQUES OF ANALYSIS APPLIED ON STAAD PRO

A. Maximum Axial Force

The axial force is defined as the force acting along a member's axis in general. The structure's foundation or the bottommost columns typically feel the most axial force.

B. Maximum Bending Moment

When the shear force at that section is zero or changes sign as the bending moment is zero at the point of contra flexure, the maximum bending moment in a beam occurs. The positive bending moment in a section is considered because it causes convexity downwards.

C. Maximum Deflection

The top deflection of the system is also known as the highest deflection. It is the maximum displacement of a structure in the X and Z directions when subjected to seismic loads in both perpendicular directions.

III. BUILDING MODELING

A. GENERAL

For this paper/project, we considered a G+6 storey structure with the floor plan remaining same as shown in the figure, with lengths of 9.144m and widths of 13.716m. The desired plan is created in accordance with the seismic analysis codal provision of IS 1893:2002. Height is believed to be constant in the design of building storeys, i.e. 3m. The building's plan is shown below.

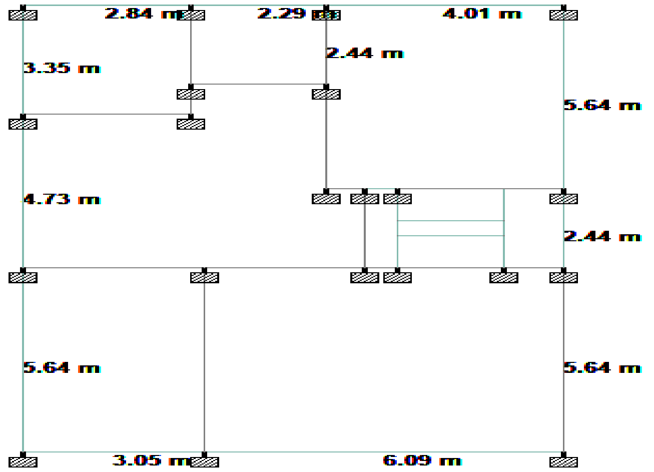

Figure-1: plan of the structure (Top view)

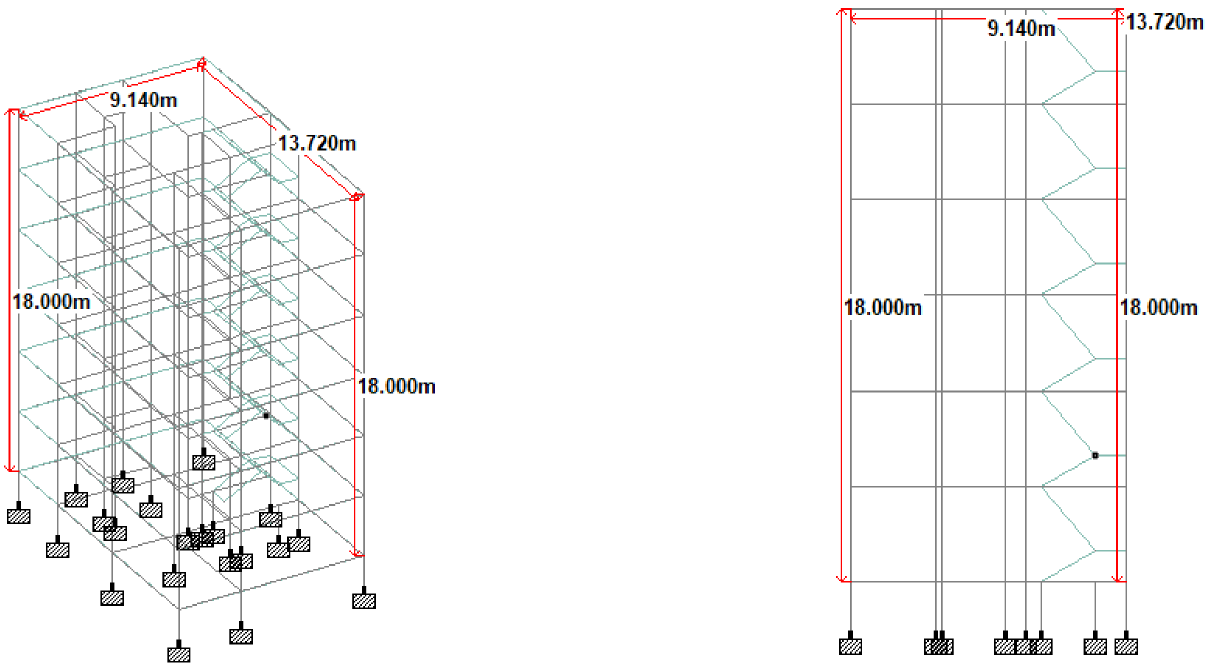

Figure-1.1: Dimensions (Isometric view, side view)

B. Input Data

Table-1: Assumed data

PARAMETERS	ASSUMED DATA
Length of building	9.144m
Width of building	13.716m
Height of building	21m
Exterior/Floating column size	450mm x 450mm
Interior column size	400mm x 400mm
Beam size	350mm x 450mm
Floor slab size	125mm
Roof slab size	150mm
Plate/Surface thickness	150mm
Depth of foundation	1.5m
Material properties	Concrete (M40)
Support	Fixed
Floor height	3m
Wall thickness	230mm
Inner plastering	12mm
Outer plastering	15mm
Unit weight of plain cement	20kN/m^3
Unit weight of RCC	25kN/m^3
Beam depth deduction	450mm

C. Loading Details.

Dead Load

We have wall without opening and wall with opening like door and windows.

9" wall without opening =**13.1kN/m**

6" wall without opening =**9.13kN/m**

9" wall with opening =**11.1kN/m**

6" wall with opening = **7.76kN/m**

Floor slab load

S_f = **4.85kN/m^2**

Roof slab load

S_r = **6.36kN/m^2**

Live Load

Floor live load = **3kN/m^2**

Roof live load = **1kN/m^2**

D. Load Combinations

The discussion is carried out for dead load (D.L) , live load (L.L) and earthquake load (EL) in all the possible direction i.e. sway to left (-EQ) and sway to right (+EQ) by using the software called staad pro. The load combination has been made accordingly:

Load Cases	Details of Load Cases
i.	1.5 (D.L+L.L)
ii.	1.2 (D.L+L.L+EQX)
iii.	1.2 (D.L+L.L+EQZ)
iv.	1.2 (D.L+L.L-EQX)
v.	1.2 (D.L+L.L-EQZ)

E. Earthquake Loads

Earthquake loads are calculated as per IS189:2002 (Part1) seismic parameters are considered for analysis are:

Earthquake Zone	IV (Jalandhar)
Earthquake Intensity	Severe
Zone Factor	0.24
Response Reduction Factor (RF)	3 (Ordinary Moment Resistance Frame)
Importance Factor (IF)	1.5
Rock and Soil Sites Factor (SS)	2 (Medium Soil)
Type of Structures	1 (RCC Frame Structure)

Damping Ratio (DM)	**5% for Concrete**
Period in X- direction	**0.535 seconds**
Period in Y- direction	**0.437 seconds**
Depth of Foundation	**1.5 m**

IV. ANALYSIS

The building analysis was done with the aid of the program STAAD PRO. The sample models was created in software by the applications of various types of RC shear walls, such as Parallel and Alternate shear walls, as well as floating columns located in the software. Research was also carried out using the modelling framework.

A. Base Structure (With no any seismic restraints)

There are no any additional seismic restraints offered in this structure, which is made up of columns and beams. All models are compared to this plan or base structure. This is a G+6 storey structure with no any seismic restrictions that was based on staad pro.

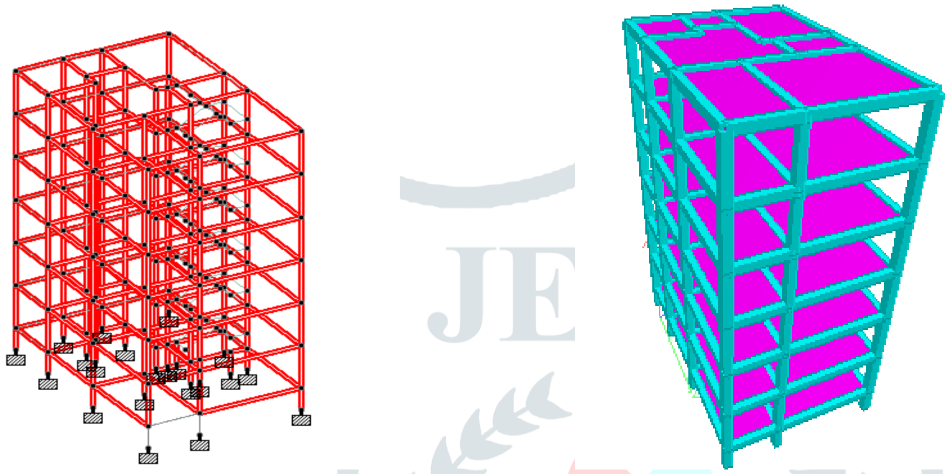

Figure-2: Bottom structure (without any restraint)

B. Parallel Shear Wall

This modal is constructed with a parallel type shear wall on the all sides i.e. four sides. To counteract lateral loads which is parallel to the wall, we have an application of shear wall. Because of the cantilever motion, it opposes the loads. Elements which is vertical of a horizontal or lateral resisting force structure are the shear walls.

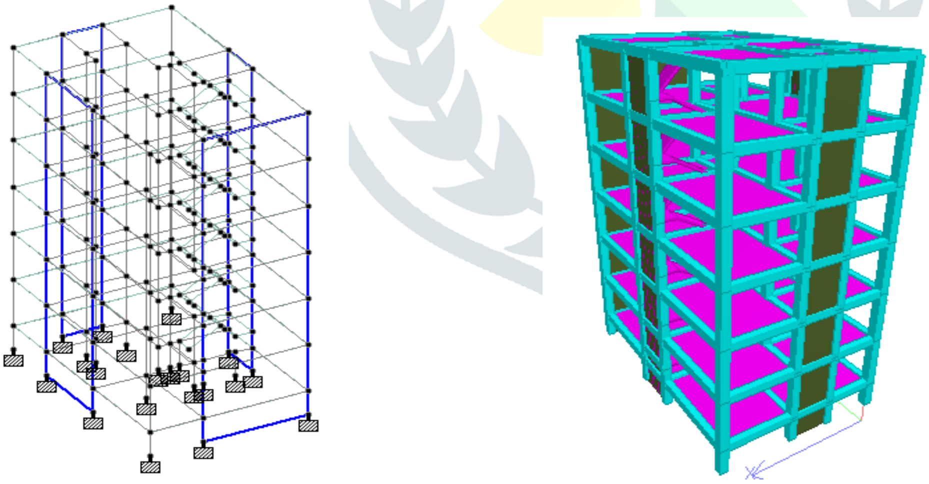

Figure-2.1: Parallel shear walls

C. Alternate shear wall

We prepared this modal to provide shear wall in alternate section of the wall of all sides. After providing the alternate shear wall we further compare it with all our other modals by checking the maximum deflection, loads and bending moment.

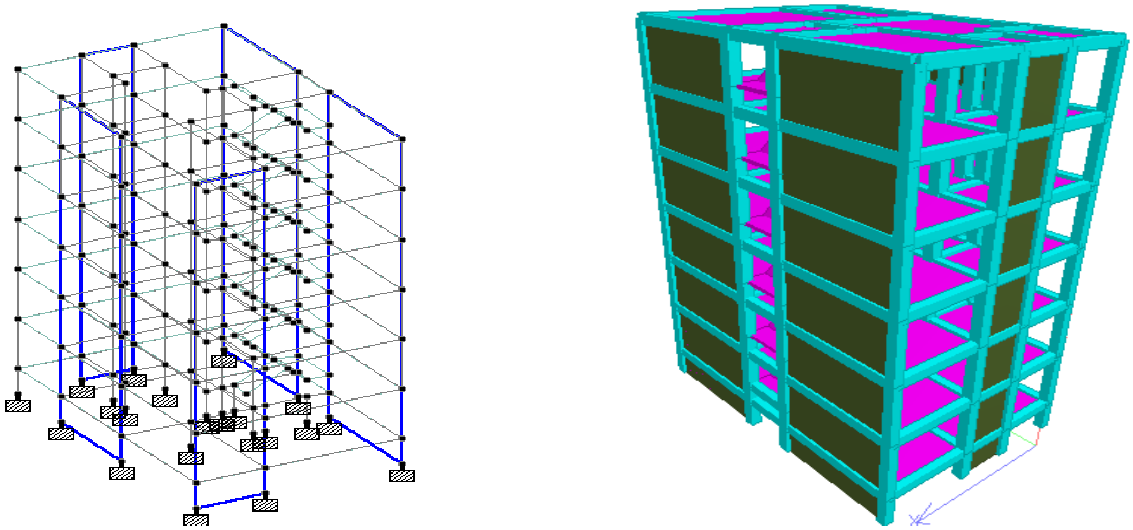

Figure-2.2: Alternate shear walls

C. Floating columns

The floating column is called as a vertical member that rests on a beam but does not directly pass load to the base. It serves as a point load on the beam, and here the load is transferred to the columns below it by the beam. While resting on a beam, the column may begin on the first, second, or any other intermediate floor. To pass load from slabs and beams, columns usually rest on the foundation. The floating column, on the other hand, is supported by the beam.

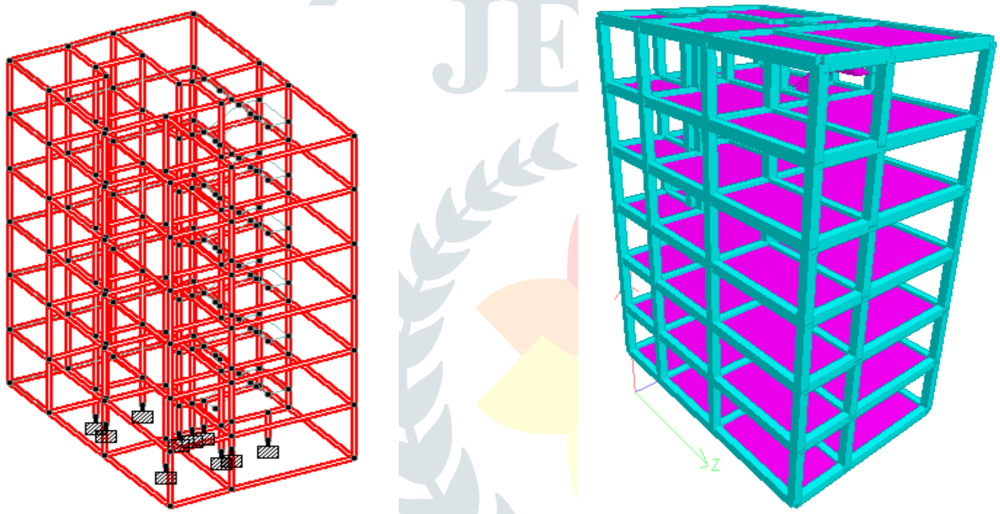

Figure-2.3: Floating columns

E. Shear wall with floating column

This last modal is prepared by using floating column with parallel shear wall because when we compare the parallel shear wall with alternate shear wall we found that we got the less deflection in parallel shear wall. So we combine the both floating column with parallel shear wall and done the further analysis by using staad pro. We have taken (500*450)mm as beam size as it require higher strength alongside we increases our concrete strength to M90 and done the analysis.

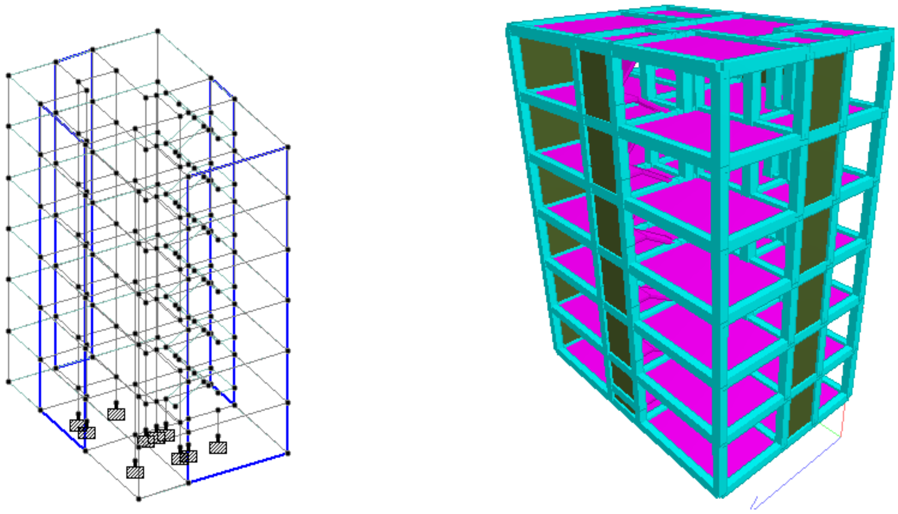

Figure-2.4: Shear wall with floating columns

V. RESULT AND DISCUSSION

In this research paper various cases are analysed according to IS CODE 1893:2002 for seismic zone IV against all the cases given the above table. Seismic analysis had been performed for all the different cases against various load combinations with or without shear wall, Floating columns too. Maximum deflection, axial force (maximum), shear force (maximum), bending moment (maximum) with and without shear wall, floating column, and both shear and floating columns were used in the comparative study.

A. Maximum Deflection

Table-2: Max. values of deflection

BUILDING	Index	MAX .DEFLECTION(mm)
Building without any restraints	A0	5
Building with floating columns	A1	202
Building with parallel shear wall	A2	4.22
Building with alternate shear wall	A3	5
Building with floating column and shear wall	A4	169.19

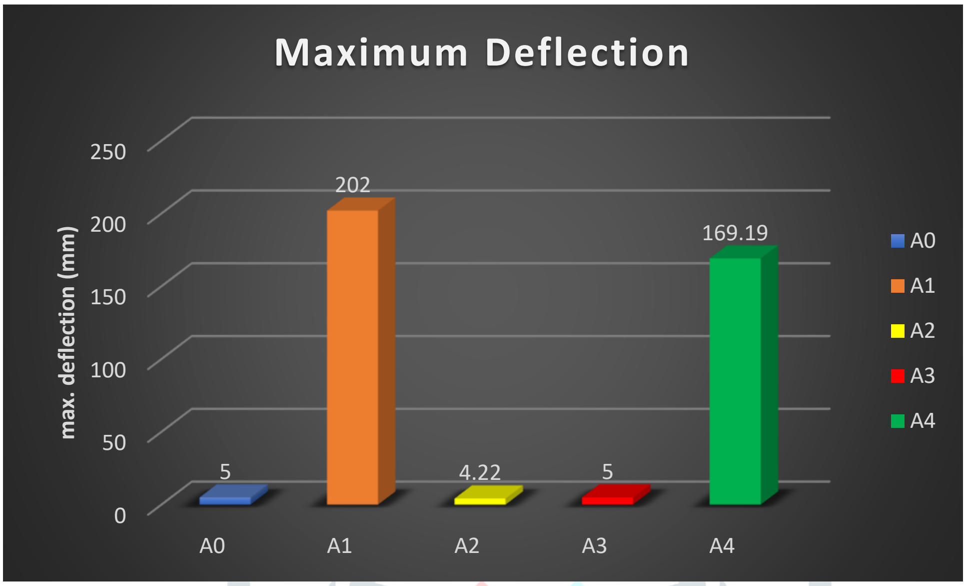

Figure-3: Max. deflection

Discussion:

Here overall displacement of a nodes of the specific models in the seismic loads is indicated by the max.deflection. Since the top structure experiences the greatest displacement when loads are applied, it is also known as the top deflection. The overall deflection in a building with floating columns is 202mm. 1.5(DL+LL) is the critical load combination for achieving maximum displacement. The models with parallel shear walls display a substantial reduction in maximum deflection, indicating an improvement in the structure's strength and stiffness. It is also an earthquake-resistant structure and a safe place to live.

B. Maximum Axial Force

Table-2.1: Max. values of axial force

BUILDING	Index	MAX. AXIAL FORCE(kN)
Building without any restraints	A0	1510
Building with floating columns	A1	112
Building with parallel shear wall	A2	1423
Building with alternate shear wall	A3	1321
Building with floating column and shear wall	A4	98

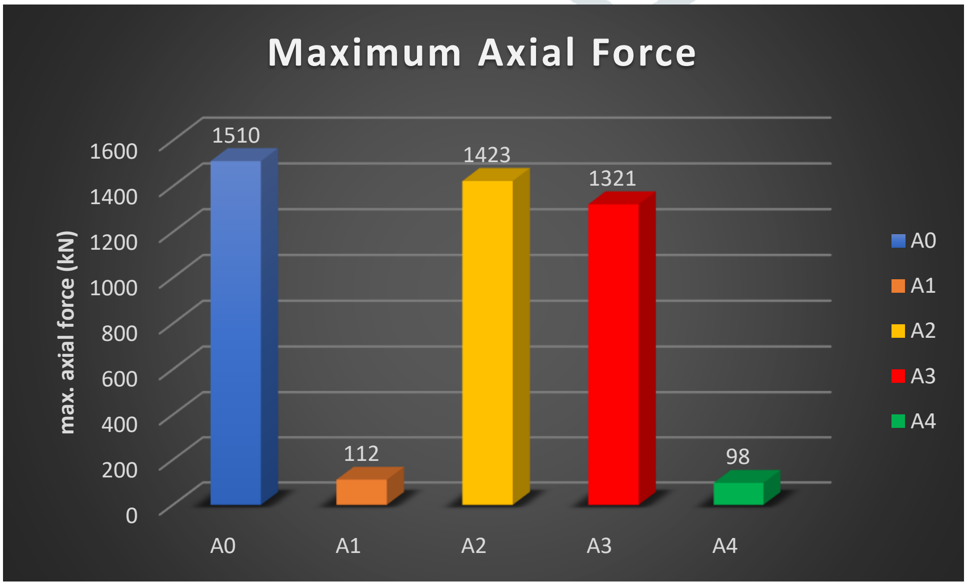

Figure-3.1: Max. axial force

Discussion:

The axial force through columns at the structure's base is represented by the maximum axial force. As the weight of the framework on the columns increases, the maximum axial force increases. The structure with no seismic restraints has the highest maximum axial force, while the structure with both floating columns and parallel shear walls has the lowest maximum axial force. As a result of its light weight and high seismic resistance, this structure is the strongest seismic restraint member for the building/structures.

C. Maximum Bending Moment

Table-2.2: Max. values of bending moment

BUILDING	Index	MAX. Bending Moment(kN.m)
Building without any restraints	A0	12.18
Building with floating columns	A1	93
Building with parallel shear wall	A2	18.3
Building with alternate shear wall	A3	20.4
Building with floating column and shear wall	A4	97.13

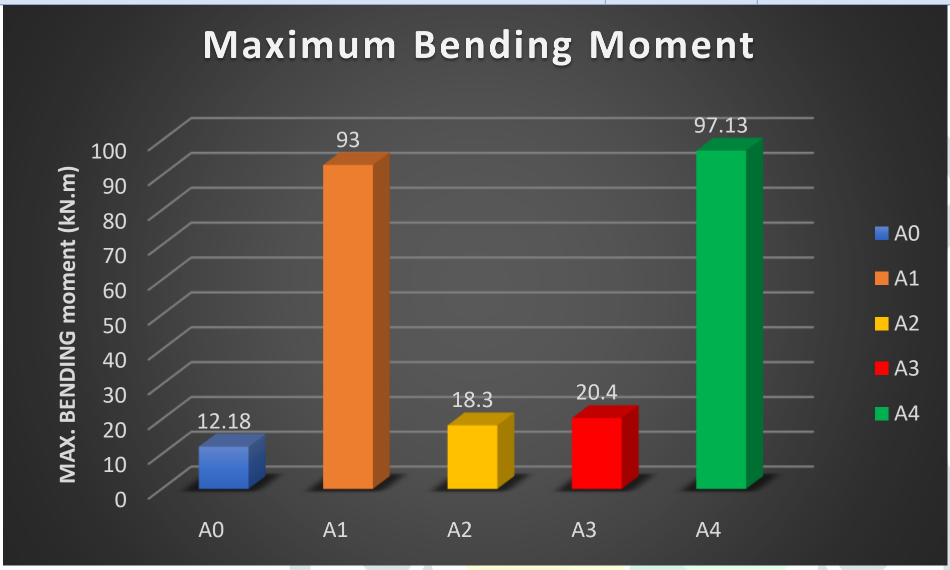

Figure-3.2: Max. bending moment

Discussion:

Here, from the above graph it can be seen that the structure with the combination of both floating column and parallel shear wall in seismic reason observed to have more bending moment as result structure becomes unstable whereas the structure without any seismic restraint has least bending moment hence this type of is more resistance to earthquake/seismic forces.

D. Maximum Shear Force

Table-2.3: Max. values of shear force

BUILDING	Index	MAX. Shear Force(kN)
Building without any restraints	**A0**	**12.23**
Building with floating columns	**A1**	**69**
Building with parallel shear wall	**A2**	**14**
Building with alternate shear wall	**A3**	**15**
Building with floating column and shear wall	**A4**	**71.33**

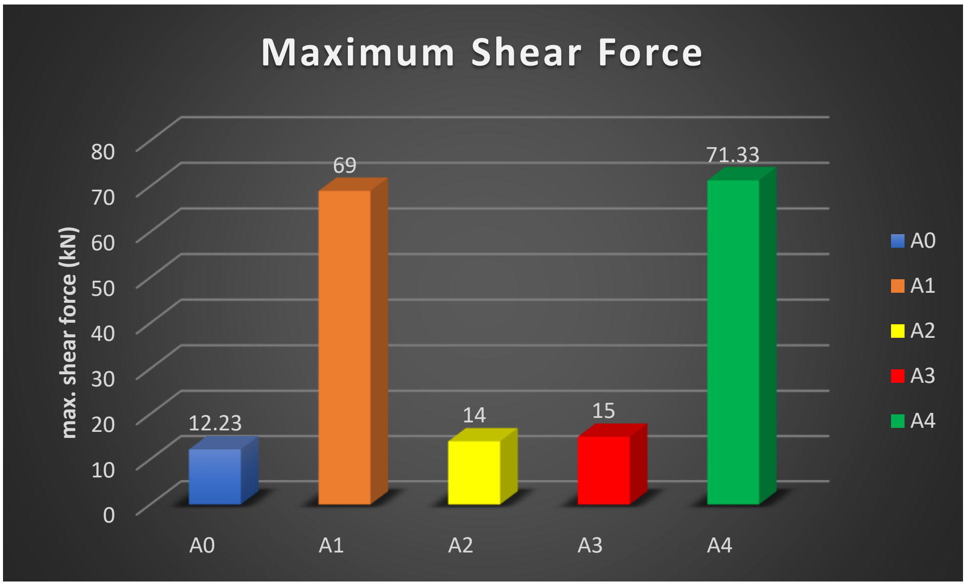

Figure-3.3: Max. shear force

Discussion:
The shear force comparatively rises in the structure provided with floating columns in seismic reasons, as well as in the structure where both a floating column and a parallel shear wall are provided, as compared to the structure without any seismic restrictions, while the structure with parallel and alternate shear walls in seismic reasons has fewer shear force. Shear force depicts the lateral force acting on a storey as a result of external forces such as earthquakes and wind.

VI. CONCLUSION

Here five RC framed structure was observed and followed by the analysis too in various seismic resisting technique members just like alternate and parallel shear walls, floating columns. From the observation of the analysis we came to knowledge that the displacement/deflection is comparatively less in the structure which is provided with the parallel shear walls than the other technique that is structure without any restraints, structure with floating columns and also the structure with the combination of both floating columns and parallel shear walls. It is also observed that the maximum deflection significantly decreases in the structure when the structure is provided with the parallel shear walls. Providing floating columns in the structure that too in the seismic condition or the reason where earthquake is prone becomes unsafe as deflection increase abruptly.so ignore providing floating column in earthquake prone reason. The best location to provide the shear wall in the structure is provide the parallel shear wall in the structure that too in the seismic reason. The lateral deflection of the structure significantly decreases in parallel shear wall condition. By the application of shear wall to the high rise building in the seismic behaviour condition stiffness and strength of the structure is increases to the greater extent. Finally, it is concluded that the optimization of the using of parallel shear wall is the best process in present to provide the more stiffness and strength to the structure in the making of earthquake resisting building/structures.

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