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Cost Evaluation & Stability in RC-Frame; RC-Frame with Bracing & Shear Wall

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Abstract— In short type of building structure to prevent the deflection by increase property of element. But in tall structures apply many different type of methodology to prevent deflection. A shear wall and a Bracing framework in a RCC confined structure is a wall or framework which is intended to resist shear, the lateral force due to earthquake or wind and to control the deflection and to increases the ductility demand. Shear wall is an auxiliary part used to lateral force i.e. parallel to the plane of the wall. Wall Bracing is a development procedure used to improve the auxiliary execution of a building. Using of staad.pro v8i programming take 5 storey, 10 storey and 20 storey structure outline and every story have two zone (zone3 and zone5).Now contrast with each of the three kinds and in development which is efficient and satisfy the criteria of value that will utilize. In this paper a correlation cost and redirection of common structure with shear wall and supporting in RCC framed structure with various location is contemplated and results are presented utilizing Staad pro v8i Software.

Keywords— Lateral loads, RC-frame, Shear wall, Bracing, Deflection, Stiffness, STAAD pro.

I. INTRODUCTION

Reinforced concrete building is most common type of construction in India. When high rise buildings are constructed these building have problems to bear lateral deflection due to lateral load and moment at base. Bracings and shear walls are provided as a structural member to resist lateral loads due to earthquake and wind by increasing the stiffness of high rise building in place of infill walls. A shear wall is a structural system composed of braced panels to counter the effects of lateral load acting on a structure. Wind and seismic loads are the most common loads that shear walls are designed to carry. Cross bracing is a system used to reinforce building structures in which the support of the diagonals breaks down. Due to cross-bracing, one can increase the capacity of a building to face seismic activity. The shear wall accepts a shear of proportional to lateral playback for its rigidity.
Behaviours of RC frames with bracings or with shear wall have been studied by number of researchers experimentally and analytically. Conclusion is made by them that shear wall and bracing members influence the seismic response significantly. Use of shear wall or bracing members improves the performance of RC frame structure. A shear wall decreases lateral deflections, storeys drift and bending moments in the frame and thus reduces the probability of collapse.
In different earthquake zones, behaviour of members is different. Earthquake zones according to IS CODE: 1893.1.2002 is considered.
During the earthquake, it is the destruction of buildings and structures that primarily cause life-loss. The huge amount of damage related to earthquake and the consequent loss of life reflects poor manufacturing practice in India.

(A) Types of Bracing:

There are two type of bracing systems
1) Concentric Bracing System- It contains diagonal braces placed in the plane of building frame and both ends of bracing join at the end points of other frame member to form a truss like structure hence making a stiff frame.
2) Eccentric Bracing System- It contains diagonal braces placed in the plane of building frame where one or both ends of the bracing do not join at the end points of other frame members.

Fig. 1.1 Concentric Bracing

Fig. 1.2 Eccentric Bracing

(B) ***Shear wall***

Shear wall, in building construction, a rigid vertical diaphragm capable of transferring lateral loads from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples - reinforced-concrete wall or vertical truss. Shear walls have high stiffness and strength, so shear walls can resist lateral loads as well as support gravity loads and this make these walls very useful in reinforced concrete structures. Lateral sway of high rise buildings can be controlled up to a great extent by using shear walls in construction. Shear walls can be located as exterior wall and also can be interior. Shear walls are more effective when these are located along exterior perimeter of building.

To design a shear wall IS Code – 13920:1993 Indian Standard Ductile detailing of RC members are used. This code provides a ductile design to give adequate toughness and ductility to resist severe earthquakes.

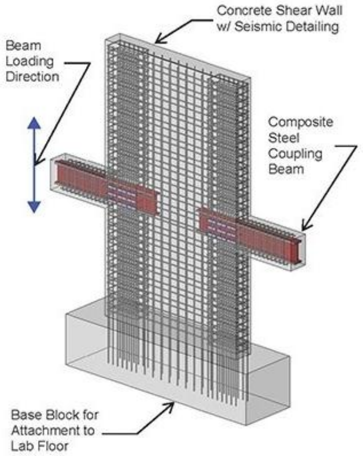


Fig. 1.3 Components of Shear wall

II. LITERATURE REVIEW

Manjeet Dua (2018) performed an analyses on a (G+15) storey building frame in II Seismic zone using STAAD Pro and compared the displacements observed in model once with shear wall and again without shear wall at different locations. It was observed that the best location of shear wall in multi storey building is near the core of the building. By providing shear wall, the structural seismic behaviour will be affected to a great extent and hence the strength and stiffness of building will be increased.

A Ravi Kumar et. al. (2017) conducted a thorough study for determining the solution for shear wall location in multi storey building based on its elastic and elasto - plastic behaviours. He analysed a 10 storey building,40m in height for earthquake load using ETABS.He decided that shear walls are one of the most successful building elements in resisting lateral forces during earthquake and for a developing nation like India shear wall construction is considered to be a foundation for construction industry.

Tanawade S. B. , Kore P. N. and Swami P.S. (2016) –In this paper elastic seismic response of reinforced concrete frames with reinforced concrete bracing member in K or A at different level braced pattern with G+11 building with 5 bay structures is analysed in both minor and major direction. This approach focuses on the planning of A-braces in a particular bay, level and its combination, which ultimately reduces lateral deflection so that the economy can eventually be achieved in comparison to the frame of the same moment.

Ziaulla Khan, B.R Narayana, Syed Ahmad Raza (2015)-By using advance software of structural design, ETABS, analysis of G+14 building in earthquake zone IV is done. By result it is concluded that when a building is subjected to lateral and torsional deflection under the application of earthquake loads As a result, a wider range of movement can be induced in the building. Result of stiffness and stability of structure are the most important in multi-storeys buildings. So bracing can be the more easy and economical and efficient to method to reduce the lateral deflection. As the result of this storeys shear and storeys displacement is considered.

Umesh .R .Braider, Shivraj Mangalgi (2014)- Different types of bracings were arranged in outer part of elevation of a multi-storeys building subject to earthquake load. Results of comparative study were shown in different graphs for different models. The building was analysed on parameters which induced such as time period and lateral displacement. A building of G+10 storeys of reinforced concrete structure with 25X20 m ground elevation in medium soil condition was examined. By checking the results from ETABS software in liner static, linear dynamic and pushover condition conclusion was made that results are same that is obtain by considering IS Code method. They found that value of base shear gets changed in different bracing arrangements. They concluded the value of base shear can be reduced by using X bracing or V bracing as compare to frame structure without bracing.

III. METHODOLOGY

In this study a building having regular plan is considered for analysis as shown in fig. All stories including ground storeys having 3.5m floor to floor height is considered for the analysis. Area of plan of building is 480m2. Structures are having 5-bay in X-direction and each bay is having a length of 6m and in Z-direction number of ways are 3 with different length two bays are having length of 6m and middle bay is having a length of 4m.Three types of columns are considered in this study. Some columns are rectangular and some columns are square as per structure requirement. Two types of beams having different cross sections are used. Sizes of beams are 300X600 and 300X450. Slabs with a thickness of 200mm are used. A floor finishing of 50mm is provided. Supports of the structure are made fix at the bottom. Three types of walls are used – main wall, partition wall and parapet wall. The thickness of wall varies as main wall is having a thickness of 230mm, partition wall and parapet walls are half of the main wall thickness. Height of main wall and partition wall is same as the height of stories. Parapet wall is considered with a height of 1m. Shear wall are provided in some models and the thickness of shear wall is taken 230mm. In some other models cross bracings are provided these bracings are having steel-I section ISMB-100. Building is located in two types of earthquake-zones. ZONE- III AND IN ZONE V. Soil condition are considered medium stiff and a damping ratio of 5% and importance factor is taken1. Dead loads and live loads are applied accordingly. Earthquake loads are applied as per IS 1893 (Part -1) 2002.

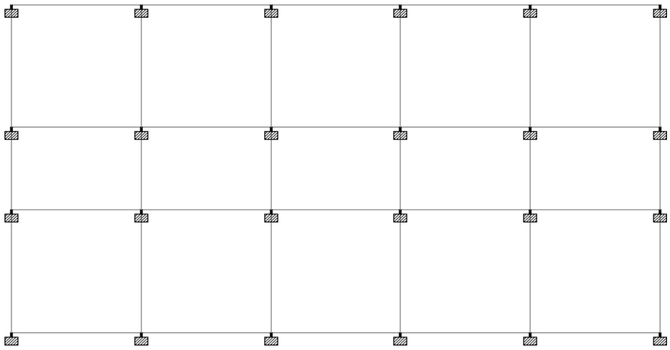


Fig. 3.1 Structural Plan

A. *Models Considered for Analysis*

1) *5 Storey Structure:-*

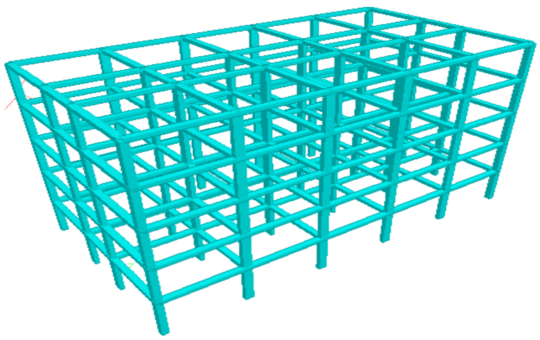


Fig. 3.2 G+5RC Frame System

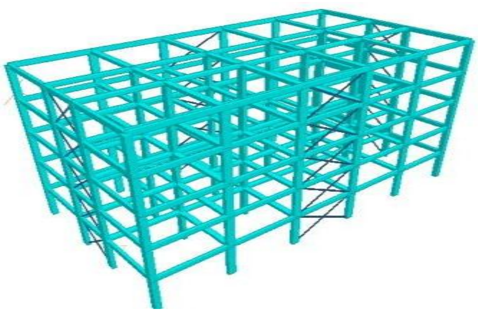


Fig. 3.3 G+5 with Bracing

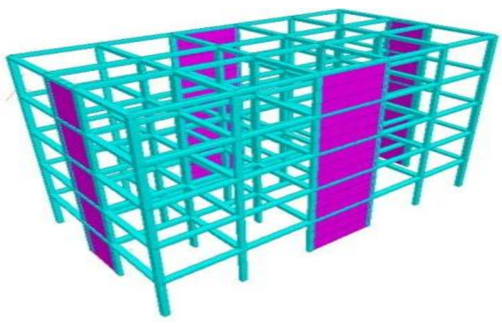


Fig. 3.4 G+5 with Shear Wall

2) *10 & 20 Storey Structure:-*

Similarly models are considered for G+10 and G+20 building

- They are analysed for both the zones i.e. zone 3 and zone 5
- In totality 18 models are taken into consideration
- Concrete grade M-30 with steel reinforcement of Fe-500 are used in all models
- Bracings which are used in models are made of steel.

B. Load Case Details:

1) Dead load:-

Dead loads are calculated with the help of the unit weight of the materials assigned to the framing members. Indian code IS 875 (part I) -1987 is used for the design loads other than earthquake loads for building & structures.

2) Live load:-

A live load of 4KN/m^2 is applied on the structure.

3) Earthquake load:-

The earthquake load based on the Indian Standard IS 1893 (Part 1): 2002, Criteria for Earthquake Resistant design of Structure, Part 1: General Provisions and Buildings (fifth revision) is used.

IV. RESULT & DISCUSSION

In this research analysis is done for different 18 models, with different heights, in different earthquake zones and with different types of arrangements. In this paper, the analysis and design of only 5 storey structures is done. Main focus of this is study is to control the cost of construction in high rise buildings and make them safe against lateral forces. Cost is controlled by decreasing the columns sizes and by providing shear wall or bracings at the place of columns.

A) Comparison between Materials:

As shown in the following table when bracings and shear walls are used at the place of simple framed structure then quantity of material get reduced. It can be seen from the following results that when we talk about zone-5 quantity of material used changes more as compare to zone-3. We can say that bracings and shear are more effective in high rise buildings and critical earthquake zones.

Table 4.1 Material Quantity used in 5 Story Structure in ZONE-3

Storey	Material used	RC Frames	Braced Frame	Shear Wall
5	Concrete(m^3)	227	227	307
	Steel(Kg)	31751	24965	26576

Table 4.2 Material Quantity used in 5 Story Structure in ZONE-5

Storey	Material used	RC Frames	Braced Frame	Shear Wall
5	Concrete(m3)	292	292	372
	Steel(Kg)	59564	37787	29103

B) Comparison between Cost:

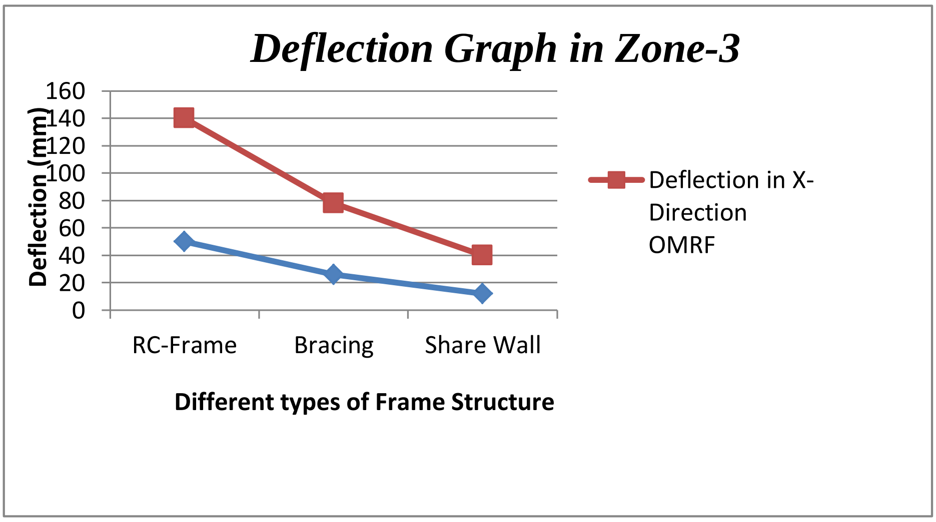
Table 4.3 Cost Comparison in 5 Story Structure in ZONE-3

Storey	Material used	RC Frames (RS)	Braced Frame (RS)	Shear Wall (RS)
5	Concrete	1135000	1135000	1535000
	Steel	1587550	1248250	1344150
	Total Material cost	2722550	2383250	2879150

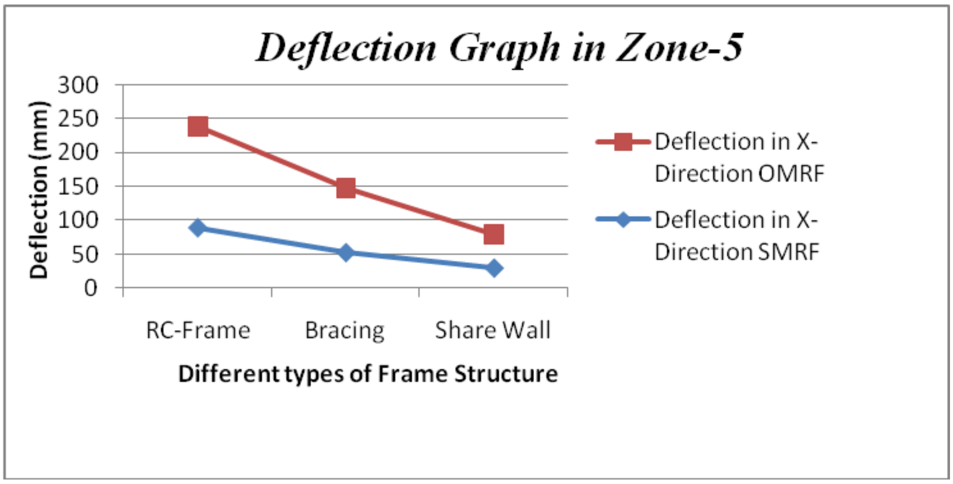
Table 4.3 Cost Comparison in 5 Story Structure in ZONE-5

Storey	Material used	RC Frames (RS)	Braced Frame (RS)	Shear Wall (RS)
5	Concrete	1460000	1460000	1860000
	Steel	2978200	1889350	1455150
	Total Material cost	4438200	3349350	3315150

C) ***Deflection Analysis in Different Frame structure:***

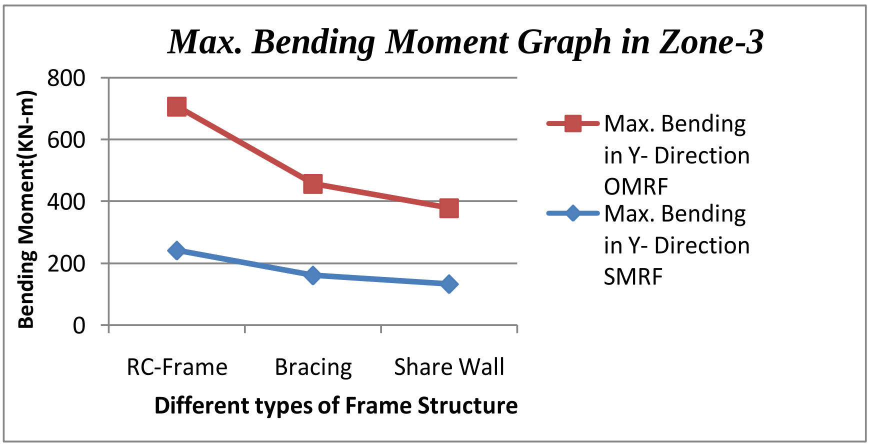


Graph 4.1 Deflection Comparisons in Zone 3

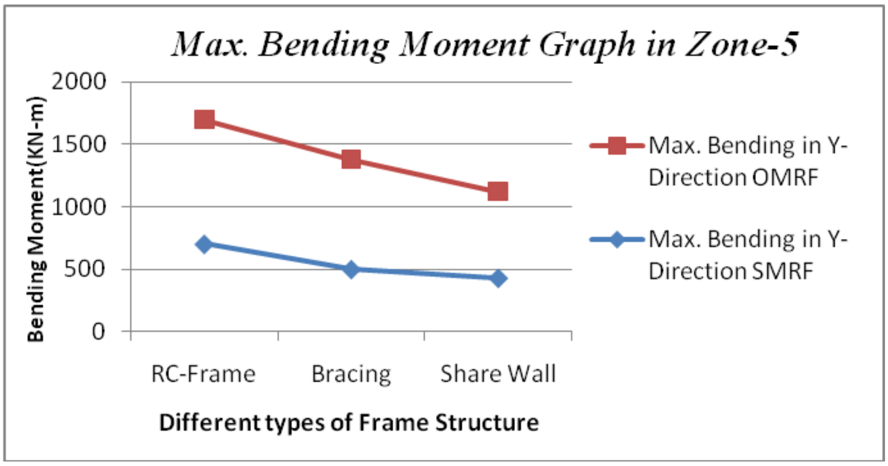


Graph 4.2 Deflection Comparisons in Zone 5

D) ***Maximum Bending Moment Analysis in Different Frame structure:***



Graph 4.3 Max. Bending Moment Comparison in Zone 3



Graph 4.4 Max. Bending Moment Comparison in Zone 5

V. CONCLUSION

After analysing and comparing we have observed that:

- The amount of concrete used in case of Shear wall structure is more than that of bracing and RC frames.
- The amount of steel used in shear wall is less in a 5-storey building of zone 3.
- Inclusion of shear wall and bracing systems in the structure is more resilient in the event of the earthquake.
- Deflection and bending moment in case of shear wall are very less as compared to its counterpart.
- Thus, structurally shear wall structure is more suitable.
- If we consider both the factors (economy and structure), then bracing frames is suitable option.

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