Response of The Different Lateral Load Resisting System Used In Multi Storey Building Construction

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Abstract- *From the beginning of ancient period, we know the Earthquake is the transfer mechanism which influences the seismic performance of the structural elements of building due to unnecessary and intense lateral displacements of the building. Due to the lack of space, there is a new trend to construct the multi storey building in the high seismic area. For the construction of the multi storey buildings in the high earthquake prone area required effective lateral load resisting system which withstands against the seismic forces at the time of earthquake otherwise structure may be subjected to massive damage as well as collapse. After many experimental investigations it has shown that performance of the structure increased greatly because use of the lateral load resisting system in the building configuration. The choice of the particular lateral load resisting system depends on the two fundamental parameters like seismic risk of the zone and inexpensive for the construction. Due to advancement in the construction industry and efforts of the various researchers, a number of lateral load resting systems are available. In present work the comparative study is carried for the different lateral load resisting systems like moment resisting frame system, shear wall system and composite frame system. The parametric study is carried out with the help of parameters like fundamental natural time period, storey drift, storey displacement, storey stiffness, and base shear. The linear dynamic analysis is performed by response spectrum method using E-tabs software*

Keywords- Lateral load resiting system,moment resisting frame system,shear wall system,composite frame system, Response spectrum method.

I. INTRODUCTION

In major cities of the country, increase in the human population due to the lack of space the horizontal development gets constrained to overcome this problem there is a new trend to construct the multi storey building in the high seismic area. The earthquake is the natural calamity which influences the stability and performance of the structure. Now days in construction industry, structures are becoming more slender and slender which are more susceptible for lateral displacement in high seismicity area. Due to this more challenges for the structural engineers to cater both gravity loads as well as lateral loads. Outstanding advancement in the construction industry and efforts of the various researchers, structures are made earthquake resistant. After many experimental investigations it has shown that performance of the structure increased greatly because use of the lateral load resisting system in the building configuration. The choice of the particular lateral load resisting system depends on the two fundamental parameters like seismic risk of the zone and inexpensive for the construction. There are different lateral load resisting systems like moment resisting frame system; shear wall system and composite frame system are available. The moment resisting frames are the combination of the beams and columns which connected to each other by the rigid joint connection. Rigid frame action provides the stability against the lateral loads which develops moment and shear forces in the structural elements as well as connection between them. The capacity of the lateral load resisting system depends on the bending stiffness of the structural elements. This arrangement provides more open space which allows freedom for selection of the location for the door and windows. This system is economical up to 25 storey structures. Shear wall systems are most frequently used lateral load resisting system in multi storey building. It has very high in plane as well as out of plane stiffness which resist the gravity and lateral load simultaneously. When the centre of gravity of the structure and resultant of the forces coming on the structure differs by more than 30 percent at that shear wall system is used which reduce the eccentricity between the center of rigidity and center of the gravity. It is more effective in construction cost and damage of the structure at the time of earthquake. Shear wall system is efficient up to 35 storey structures. Composite frame system is a combination of the two heterogeneous materials which are bind together acts as a single element. The composite action between two different elements gives stiffness to the structure to resist the load coming on it. Composite frame system is a combination of the concrete slab is connected to steel beam using shear connector which acts as a solo unit. In case of the frame system due to various advantages like high stiffness and strength, high durability, rapid erection etc. the composite frame system become more popular all over world. In present work, comparative and parametric study is carried for the different lateral load system.

II. REASEARCH OBJECTIVES

The comparative and parametric study is carried out to investigate the effectiveness of various lateral load resisting systems like moment resisting frame system, shear wall system and composite frame system by performing Response spectrum method using E-Tabs Software

III. SCOPE OF WORK

The present study focuses on the analytical investigation of the response of the different lateral load resisting system on the seismic response of the structure.

To evaluate the performance of the different lateral load resisting system like moment resisting frame system, shear wall system and composite frame system subjected to seismic loads as per IS 1893:2016. To study the linear dynamic behaviour of the different framing systems are available by performing Response spectrum method using E-Tabs Software. The parametric study is carried out using different parameters like storey drift, storey displacement, storey stiffness, base shear and fundamental natural time period.

IV. PROBLEM STATEMENT

To evaluate the seismic response of the multi storey building, we considered G+10 storied structure situated in the seismic zone V and medium soil condition. The following data is used for investigation

a) RC frame details:

- No. of stories: G+10
- Floor to floor Height: 3m
- Type of Building: Residential
- Size of Columns: 300 X 550 mm (MRF & SW)
- Size of Beams: 300 X 400 mm (MRF & SW)
- Size of Columns: ISMB 350 mm (CFS)
- Size of Beams: ISMB 450 mm (CFS)
- Thickness of shear wall: 200 mm
- Thickness of Slab: 150mm
- Thickness of External wall: 230 mm
- Thickness of Internal wall: 115 mm

b) Loading details

- Live load on floor: 3 KN/m^2
- Live load on roof: 1.5 KN/m^2
- Floor finish on floor: 1.5 KN/m^2
- Floor finish on roof: 2 KN/m^2

c) Seismic details

- Type of Frame: RC building with SMRF
- Earthquake zone: Zone V
- Type of soil: Hard [Type-I as per IS1893:2016]
- Importance factor: 1.2 [Table no. 8 IS1893:2016]
- Response reduction factor: 5
- Damping of structure: 5%
- Response spectra: As per IS1893:2016
- Time period: 0.075(H) 0.75 [MRF]

: 0.09H/d (1/2) [SW & CFS]

Figure1: Plan of the Moment resisting frame system

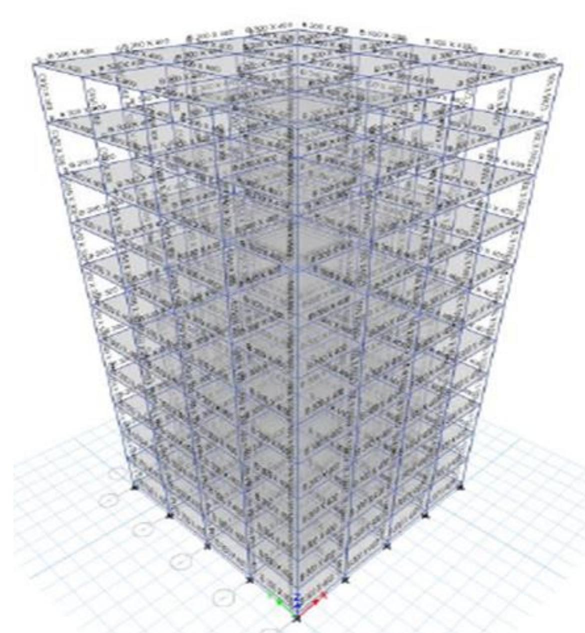

Figure2: 3D view of the MRF system

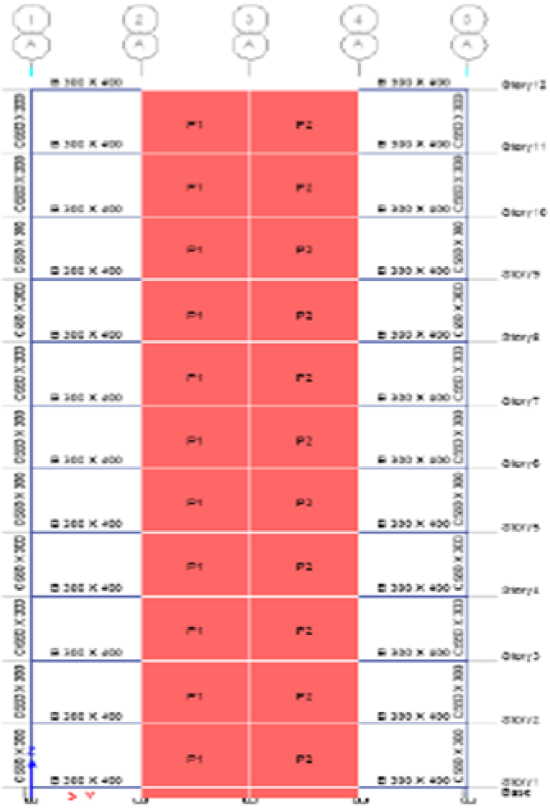

Figure3: Elevation for SW system

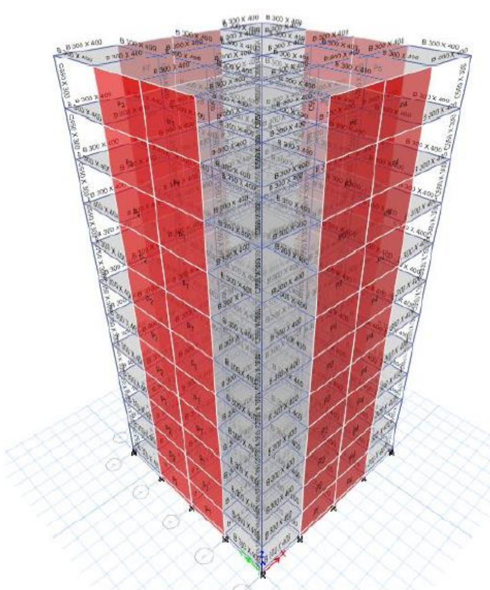

Figure4: 3D of the SW system

Figure5: Plan view of the CF system

V. METHOD OF ANALYSIS

To know the linear dynamic behaviour of the different framing system response spectrum method is used.

Response spectrum method:

To know the topmost response of the building during the earthquake is obtained from the response spectrum method. This method gives earthquake response spectrum based on the type of soil condition. This method provides an approximate response but it is very beneficial for the structural design aspect. This method reflects the distribution of the forces up to the elastic range efficiently and also shows the effect of the higher modes of vibration. This method is applicable for the regular and irregular building without any height restrictions.

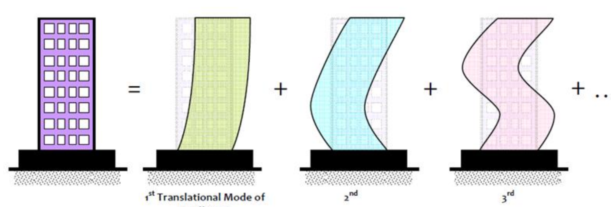

Figure6: Idealisation of Response spectrum method

VI. RESULTS AND DISCUSSION

The results obtained from the response spectrum method for the different framing systems like moment resisting frame system, shear wall system and composite frame system are as follows

1. STOREY DISPLACEMENT:

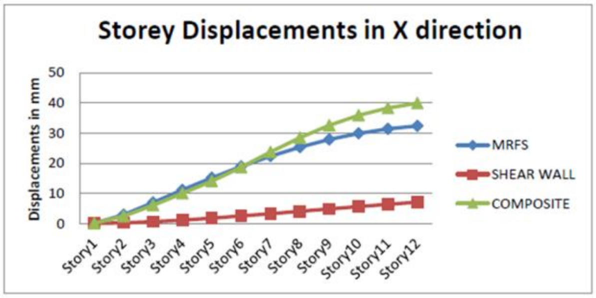

Figure7: Storey displacement in X direction

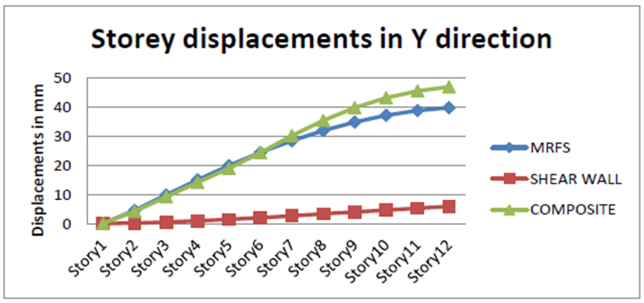

Figure8: Storey displacement in Y direction

In all the systems, lateral displacement of the building is within the permissible limit as per codal provisions. The displacements of the MRF and shear wall structure is less than composite structure but are in permissible limit as prescribed by the codal provision. It is due to the flexibility of composite structure when compared to RCC structures. There is 23.46% increase in the lateral displacement of composite system in X direction and 17.94% increase in Y direction as compared to MRFS and 463.88% increase in X direction and 696.17% increase in Y direction as compared to shear wall system. Hence introduction of shear wall considerably reduces the lateral displacement of the building.

2. STOREY DRIFT:

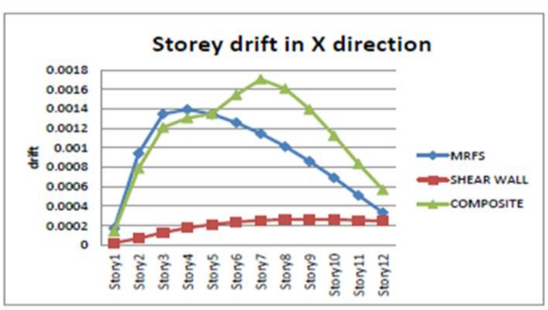

Figure9: Storey drift in X direction

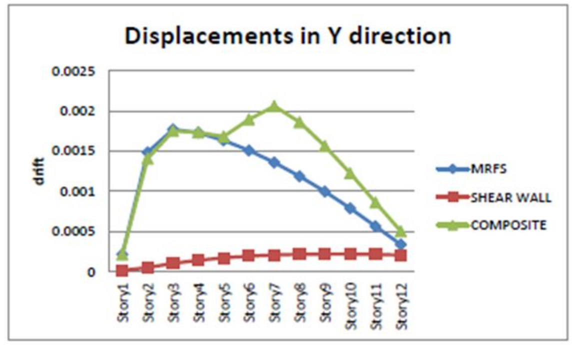

Figure10: Storey drift in Y direction

The drift of the MRF and shear wall structure is less than composite structure but are in permissible limit as prescribed by the codal provision. It is again due to the flexibility of composite structure when compared to RCC structures. There is 22.31% increase in drift of composite structure in X direction and 16.31% increase in Y direction compared to MRFS and 593.08% increase in X direction and 832.12% increase in Y direction compared to shear wall system. Hence introduction of shear wall also reduces the drift of the building.

3. STOREY STIFFNESS:

The stiffness of the shear wall system is found greater when compared with other two systems. Provision of shear wall generally results in reducing the displacement because the shear wall increases the stiffness of building and sustains the lateral forces. There is 536.62% increase in stiffness of shear wall system in X direction and 865.01% increase in Y direction compared to MRFS and 550.51% increase in X direction and 965.97% increase in Y direction compared to composite system**.**

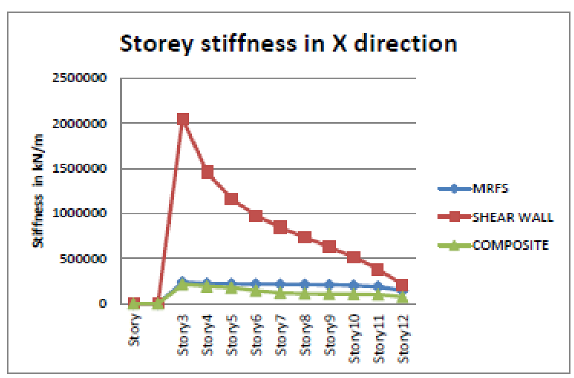

Figure11: Storey stiffness in X direction

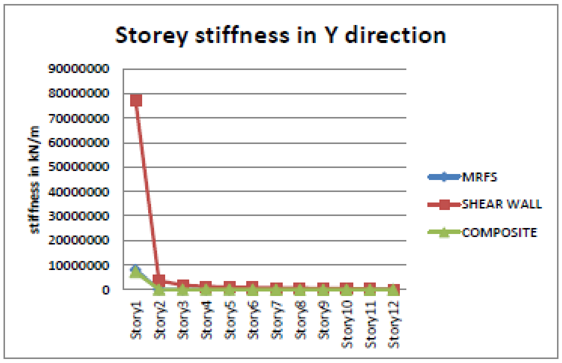

Figure12: Storey stiffness in Y direction

4. STOREY SHEAR:

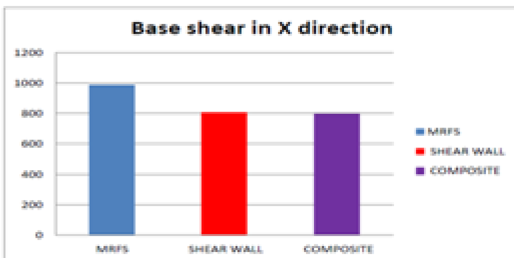

Figure13: Base shear in X direction

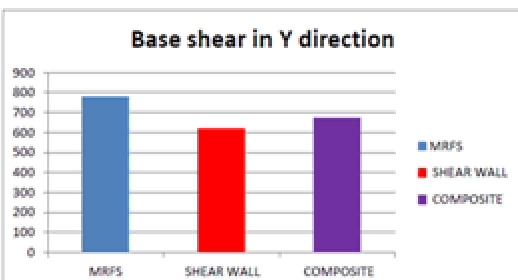

Figure14: Base shear in Y direction

Base shear in composite system is found less as compared to MRFS and shear wall system. There is 19.29% reduction in base shear of composite system in X direction compared to MRFS and 1.13% reduction in X direction compared to shear wall system.

5. FUNDAMENTAL NATURAL TIME PERIOD:

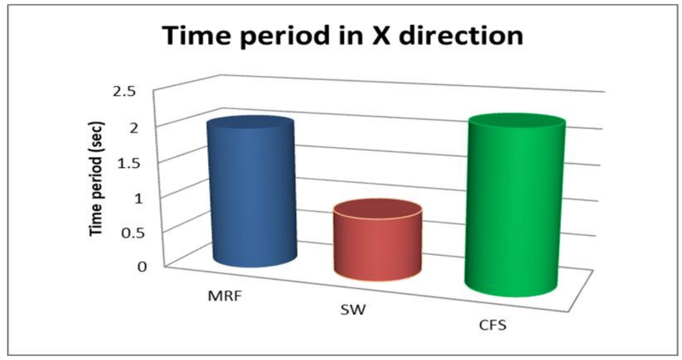

Figure15: Time period in X direction

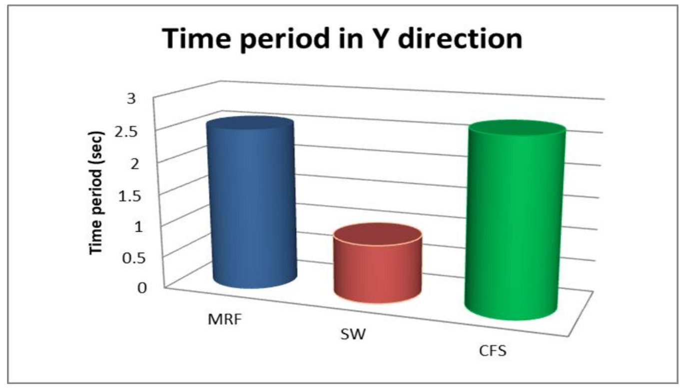

Figure16: Time period in Y direction

Time period of the shear wall system is found very less as compared to the MRF system and composite system. This is because of the stiffness provided by the shear wall to the structure. The time period of the composite system is greater than other two systems because it provides flexibility to the structure but it is within permissible limit as per codal provisions.

VII. CONCLUSION

1) Storey displacement and drifts are reduced considerably in case of shear wall system than moment resisting frame system then followed by composite frame system in both directions. In all the case storey displacement and drifts are within permissible limit as per codal provision.
2) From the linear dynamic analysis, the storey stiffness for shear wall system is much higher as compared to moment resisting system and composite frame system.
3) The base shear is much greater in moment resisting frame system than composite frame system then followed by shear wall system for all models in both x and y-direction.
4) The natural time period of the shear wall system is much less as compared to the composite frame system and moment resisting frame system. The time period obtained from the analysis is in comparison with the empirical expression given by the code.

5) From the linear dynamic analysis for multi storey structures, shear wall system and composite frame systems are found to be better mode of construction than moment resisting frame system.

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