Earthquake Vibration Control using Modified Framed Shear Wall

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Abstract— The building is subjected to different load combinations as per the code recommends and base shear, displacement, drift values, time period, forces in columns and beams were obtained at different storey level. Later on, the same building model is strengthened by providing external shear wall in parallel direction of building plan and connecting the external shear wall with the beams and columns of existing building using links of (25 mm Diameter steel Bars of Fe415) and again the building is subjected to the different load combination, now it is found that displacement, drift value have been decreased to a reasonable extent which is within the permissible limit. Also this time those members which was found to be weak in carrying the lateral forces due to less stiffness earlier, are now strong enough in carrying lateral load. Then finally the outcomes and results are stated, comparisons are made and different graphs have been plotted and their relations have also discussed in detail.

Keywords- Earthquake vibration, reinforced concrete building collapse, displacement, shear wall

I. INTRODUCTION

In past earthquakes, many buildings (Reinforced Concrete) have experienced either different types of damage or collapsed. On buildings which were collapsed by earthquakes various investigations have been carried out. In today's era, global strengthening schemes are mostly used as strengthening strategies according to which structures are made more ductile for limiting lateral displacement. In these schemes, global behavior of the system is transformed. Another method is element strengthening method in which ductility of deficient elements is increased, so that it will be safer under design load condition. Limit state conditions shell not be achieved when subjected to design loads.

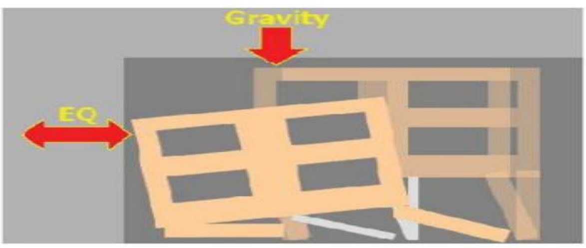

Fig. 1: Collapse Mechanism of Structure during Earthquake [Setia et. al., (2012)].

Global strengthening methods are more popular than element strengthening method because it is less expensive and easy to implement in case of many deficient elements.

Fig. 2: Building Collapsed in 2001 Bhuj Earthquake

II. EFFECTS OF EARTHQUAKE ON STRUCTURE

1. Inertia Forces in Structures

The generation of inertia forces in a structure is one of the seismic influences that detrimentally affect the structure. When an earthquake causes ground shaking, the base of the building would move but the roof would be at rest. However, since the walls and columns are attached to it, the roof is dragged with the base of the building.

The tendency of the roof structure to remain at its original position is called inertia. The inertia forces can cause shearing of the structure which can concentrate stresses on the weak walls or joints in the structure resulting in failure or perhaps total collapse. Finally, more mass means higher inertia force that is why lighter buildings sustain the earthquake shaking better.

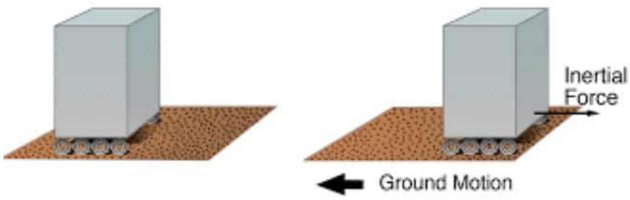

Fig. 3: Direction of Inertia Forces

2. Effect of Deformations in Structures

When a building experiences earthquake and ground shaking occurs, the base of the building moves with the ground shaking. However, the roof movement would be different from that of the base of the structure. This difference in the movement creates internal forces in columns which tend to return the column to its original position.

These internal forces are termed stiffness forces. The stiffness forces would be higher as the size of columns gets higher. The stiffness force in a column is the column stiffness times the relative displacement between its ends.

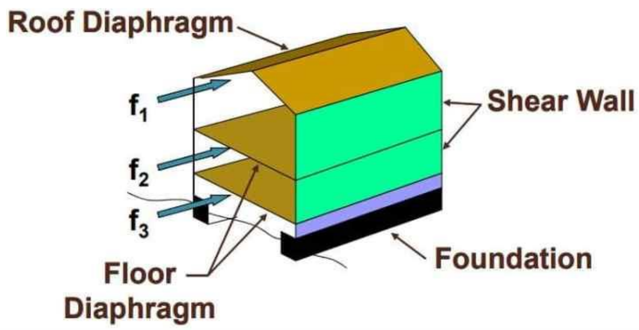

Fig. 4: Lateral Force Resisting System in a House

III. MATERIALS USED

The material properties used in creating the model were as follows: -

1. Grade of Concrete – M 25 (For Columns) and M 20 (For Beams)
2. Grade of Reinforcement – Fe 415
3. Poisson Ratio of Concrete – 0.2
4. Poisson Ratio of Reinforcement – 0.3
5. Density of Concrete – 25KN/m3
6. Density of Reinforcement – 8.5KN/m3
7. Young’s Modulus of concrete – 2.5 × 104 MPa (M25) & 2.2 × 104MPa (M20)
8. Young’s Modulus of reinforcement – 2.1×105MPa
9. Damping Factor – 0.05 (As per Clause 7.8.2.1 of IS 1893(Part 1):2002

Geometric Properties

The geometrical properties measured and used to create model were as follows:

1. The slab thickness – 125 mm
2. Beam cross sections on all floors – 0.30 m × 0.50 m
3. Column cross section on all floors – 0.30 m × 0.75 m
4. Storey Height – 3.5 m on the lower most storey – 3.0 m on all the above stories.
5. Spans – 5.0 m × 5.0 m
6. Link1 of steel bars = 25 mm
7. Wall thickness = 200 mm

IV. MODELLING AND METHODOLOGY

Problem 1: Details of Model - 1 and Analysis

A model of (G+8) storey reinforced concrete framed building is located in the seismic zone-IV and on medium soil. The building measures 25m, each way in plan at all floor levels. Storey heights are about 3m at all elevations and bottom storey is 3.5m in height. The roof and floors are of concrete slabs consisting of a 125mm slab thickness. beams the in the building are of (0.3 m × 0.5 m) and columns in the building are (0.3m × 0.75m). The material properties are fck = 20 MPa, fck = 25 MPa and fy = 415 MPa.

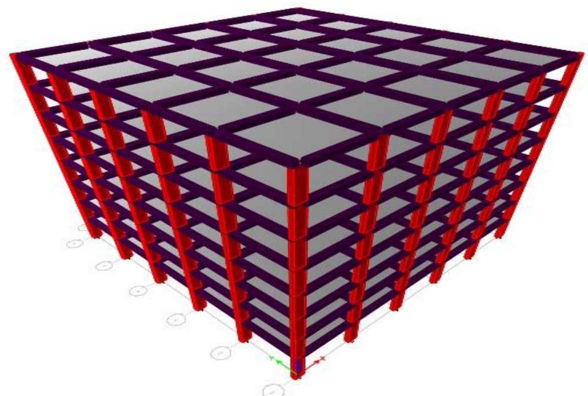

Fig. 5: View of Model-1

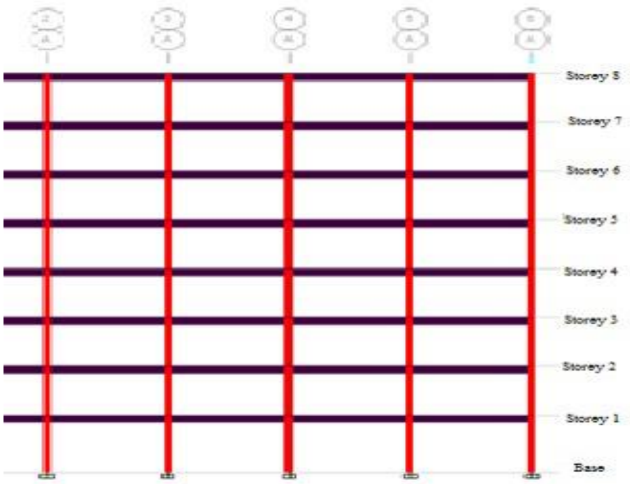

Fig. 6: Elevation View of Model-1

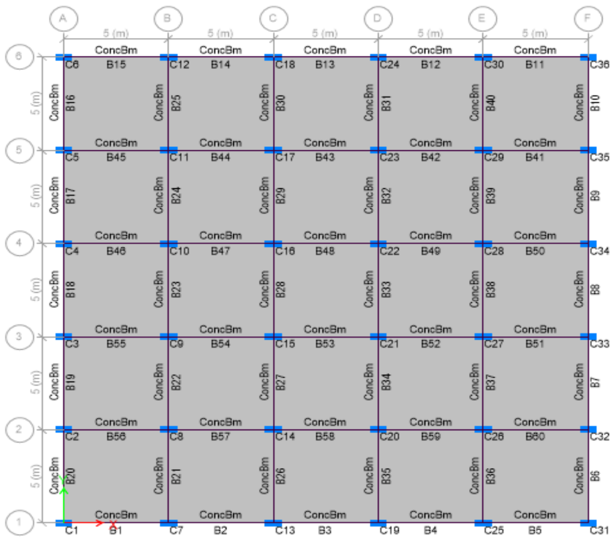

Fig.7: Plan View of Model-1

V. RESULTS

Lateral displacement results of all three models are compared and discussed:

A) Lateral Displacement in X - Direction due to EQX

Table 1:

Storey	Load	Lateral Displacement In X direction	
		Model-1	Model-2
Storey 1	EQX	2.42	0.63
Storey 2	EQX	5.93	1.66
Storey 3	EQX	9.7	3.02
Storey 4	EQX	13.33	4.59
Storey 5	EQX	16.63	6.27
Storey 6	EQX	19.38	8
Storey 7	EQX	21.44	9.69
Storey 8	EQX	22.79	11.16

Here we can say that by providing external shear wall to the existing building effectively and efficiently we can reduce the lateral displacement of a building up to a reasonable extent, which is in the permissible range which our Indian codes recommends. In above models by providing external shear wall lateral displacement has been reduced to more the 50% which ultimately makes building strong from excessive vibrations.

Table 2:

Storey	Load	Lateral Displacement In Y direction	
		Model-1	Model-2
Storey 1	EQY	5.15	0.65
Storey 2	EQY	10.08	1.69
Storey 3	EQY	14.83	3.09
Storey 4	EQY	19.29	4.71
Storey 5	EQY	23.28	6.455
Storey 6	EQY	26.6	8.244
Storey 7	EQY	29	10.01
Storey 8	EQY	30.3	11.66

From the above table we can say that by providing external shear wall to the existing building framed structure in both direction symmetrically, we have increased the mass or weight of the building as a whole to act as a monolithic structure during earthquake vibration, so we find that our base shear value at each floor level has been increased to a minor extent but this little increase in mass has reduced our displacement value to much lesser extent.

Table 3:

Storey	Load	Storey Shear in X direction (KN)	
		Model 1	Model 2
Storey8	EQX	538.292	1190.6054
Storey7	EQX	1070.69	2513.9244
Storey6	EQX	1464.88	3494.2976
Storey5	EQX	1741.59	4182.9095
Storey4	EQX	1921.56	4630.8779
Storey3	EQX	2025.5	4889.2552
Storey2	EQX	2074.16	5009.0858
Storey1	EQX	2088.4	5041.4648

VI. CONCLUSION

By performing above study and results obtained as conclude that building which were built before the advent of modern codes by performing above study and results obtained as conclude that building which were constructed/ built before the advent of modern codes but are valuable such as hospital, fire station, schools & power station etc. such buildings can't bear the transverse load (earthquake load), efficiently as these were not designed for these loads. As now seismic zones changes day to day & now these old buildings/ monuments exist in severe to very severe zones, we can't leave these buildings vacant for long time period during renovation work, which require rehabilitation of living life.

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