"EARTHQUAKE VIBRATION CONTROL USING FRAME SHEAR WALL"

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Abstract: 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. As day by day seismic zones are changing the buildings which are earlier not prone to Earthquake, now came in severe zones, so for them this method of strengthening can be done easily. And for those buildings which was not constructed as per modern code procedure, by inspecting them according to their importance value mentioned in code (IS 1893 part1:2002) we can in advance provide sufficient stiffness to those building to resist the lateral loads significantly by constructing exterior shear wall of adequate strength as per Code provisions. In this study a symmetrical in plan, building model of (G+10) storey is created in E-tabs software and is subjected to lateral load (earthquake load only).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 dia. 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

1. Introduction

Adding Concrete walls to the RC frame bays with reinforced concrete is useful and effective in countering seismic forces by seismic retrofitting but is effective only if the connection of old concrete to the new concrete obeys as monolithic behavior. It is a simple and also cost effective way of adding or retrofitting shear walls to existing RC frame bays. Even after this method is widely applied, there are still certain aspects and issues regarding seismic design and retrofitting. There is neither codes or standards nor rules for designing and detailing the connection between the added RC wall and existing frame. They provide no guidance for modeling of frame bays converted into RC frame bays. The only feasible way in which one can achieve code conforming design for seismic retrofitting is to aim at the composite wall which acts as fully monolithic and will be designed as such.

Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) forces. These forces can literally tear (shear) a building apart. Reinforcing a frame by attaching or placing a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints. Shear walls are especially important in high-rise buildings subjected to lateral wind and seismic forces. Shear wall buildings are usually regular in plan and in elevation. However, in some buildings, lower floors are used for commercial purposes and the buildings are characterized with larger plan dimensions at those floors. In other cases, there are setbacks at higher floor levels. Shear wall buildings are commonly used for residential purposes and can house from 100 to 500 inhabitants per building.

Retrofitting of the buildings by adding RC walls improves base shear capacity of existing frame and also increases their lateral rigidity which will lead to decrease displacement and deformation. The whole process should be carried in such a way that the new walls are much stronger that is necessary for retrofitting of the building. Footings provided for the new wall should be kept large enough to counter the moment produced. As the strengthening of existing structure with RC wall will be costly with the foundation work to counter moment, the wall footing size should be kept limited by limiting the moment resistance at the base by adding new web between existing columns. Reasonably, for cost and accessibility, footing is kept small and weakly connected for thin shear walls will uplift to seismic response. This problem is very less in new buildings because their designers fixes the base of large wall at box type foundation consisting perimeter walls connected at top and bottom. In Practical terms, RC-infilled frame specimens failed in shear having low ductility and ultimate deformation.

If the aim is to have a composite wall which conforms to codes for concrete structures and may conveniently be considered in the analysis and the verification as monolithic, each bar of the two way reinforcement in the new web which terminates at the interface with an existing frame member should be fully anchored into the member past that interface. There may be any type like, the web bars can be spliced one to one with starter bars, epoxy grouted at mid width of the interface and all along the perimeter of the new web. This process can be labour intensive and costly, owing to the very large number of bars to be epoxy grouted in the frame members.

Fig.1.1. Concrete crushing and reinforcement buckling

Shear walls can be of aspect ratio 0.5,1 and 2 based on the height of the wall to the length of the wall. The minimum 1% shear wall ratio is recommended to obtain the control in lateral story drift. Also the strategy for designing the shear walls is to resist the total designed base shear, to place equal amounts of shear wall in both orthoganal directions with or without opening. Seismic action can be occurred in any direction so there is need to provide equal amounts of shear walls in both orthogonal directions.

2. Litrature Survey

Fardis *et al*,(2013) stated that seismic retrofitting by adding concrete RC walls in column beam frame bay is common where it performs as monolithic element. This method of retrofitting is cost effective and feasible. Dahesh *et al*, (2015) this study states that RC walls prove to be relevant in controlling the lateral stiffness and story drift of the RC buildings against earthquake. This parametric study gives idea about orientation and optimuum arrangement of RC walls. Anna Birely *et al*,(2008) this study on reinforced concrete walls stated that it is primarily used lateral load resisting element in building. This study also researched in developing tools to enable Performance based Earthquake Engineering (PBEE) of RC walls. Dahesh *et al*, (2015) stated that Shear walls are known for their contribution in improving the lateral stiffness and thus controlling the story drift of the Reinforced Concrete (RC) buildings against earthquake loading. Mohammad J. Fadaee and Donald E. Grierson (1998) discussed a computer-based method for the optimal design of three-dimensional Reinforced Concrete (RC) structures having beams subjected to shear force and bending moment, columns subjected to biaxial moments, biaxial shears and axial loads, and shear walls subjected to pure shear. Regarding the beams and columns, the design variables are the width, depth and area of longitudinal reinforcement of member sections. Fardis *et al*, (2013) stated that replacingconcrete walls by infilling certain frame bays with reinforced concrete is popular for seismic retrofitting, but is covered by codes only if the connection of the old concrete to the new ensures monolithic behavior. Ali Kaveh and Pooya Zakian (2014) states thatSeismic design of Reinforced Concrete (RC) dual systems is performed as an optimization problem for which the charged system search algorithm is utilized as an optimizer. Can Balkaya and Erol Kalkan (2003) stated that Shear-wall dominant buildings are the prevailing multi-story RC buildings type particularly in the regions prone to high seismic risk. To identify their most essential design parameters, dynamic and inelastic static pushover analyses were conducted on the backbone of performance based design methodology. Many reinforced concrete (RC) buildings have either collapsed or experienced different levels of damage during past earthquakes.

Many investigations have been carried out on buildings that were damaged or ruined by different earthquake. They usually cannot provide the required ductility, lateral stiffness and strength, which are definitely lower than the limits imposed by the modern building codes. Due to low lateral stiffness and strength, vulnerable structures are subjected to large displacement demands, which cannot be met adequately as they have low ductility. Many old strutures or buildings that lie in earthquake prone areas are dangerous during the ourene of earthquake. These old strutures are built without onsidering the earthquake resistant norms. These strutures does not obey any eartquake resistant odes or norms. So there is need to provide shear wall in the olumn beam frame bay to gain the dutility, stiffness and strength.

3. Methodology

3.1. Modelling 3D earthquake resisting building of l-shape and c-shape with provision and non-provision of shear wall :

Initially, modelling of 10 storey buildings of L and C shape was performed on ETABs. On this software, Earthquake deficient building is to be modelled and parameters like maximum story displacement and maximum story drift is found out. After the displacement and story drift is checked, the shear wall is to be provided on corners and sidewalls to reduce the displacement and story drift. Then, displacement and story drift is checked for shear wall provided on corner and sidewall, and whichever has minimum displacement and drift is to be provided finally. Usually, provision of corner sidewall gives minimum displacement and drift.

3.2. Specification of modelled building :

Columns-	1) 300mm x 600mm
Beams-	1) 300mm x 600mm
	2) 300mm x 550mm
	3) 230mm x 450mm
Shear walls -	1) 150mm thick
	2) 200mm thick
Slab Thickness -	125 mm
Storey Height-	3 m

DEAD LOAD

It is taken as according to IS -875 (Part 1): 1987

Dead load for slab = Density of concrete x Slab thickness

Dead load for beam = Density of concrete x Beam depth

LIVE LOAD

It is calculated as per IS-875 (Part 2):1987

Live Load on floors= 1.5 KN/m^2

WIND LOAD:

It is calculated as per IS-875 (Part 3): 1987

EARTHQUAKE LOAD:

It is calculated as per IS-1893 (Part 1):2002

Earthquake zone-III (Z=0.16)

Response Reduction Factor- 5

Importance Factor- 1.5 (Very Important Building)

Rock and Soil Site Factor- 1 (Medium Soil Building)

Type of Structure- 1

Damping- 5%

Soil type- Medium Soil

- All the above loads are applied to the C and L shape structures viz. structures with and without provision of shear walls.
- Each shape structure is designed with 5 types- structure without shear wall, structure with shear wall at both of its corner, structure with shear walls at one side of its corner, shear walls at its adjacent side and shear walls with opening at both sides of its corners.

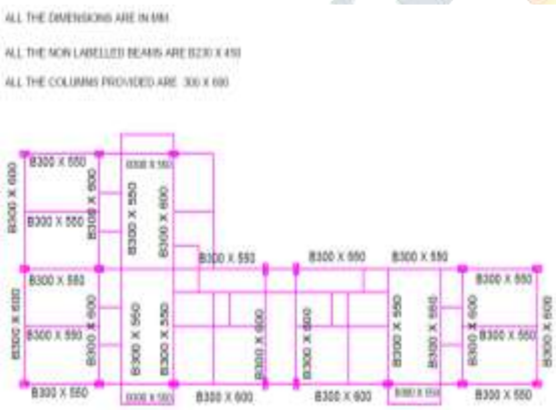


Fig 3.1. L-Type building grid

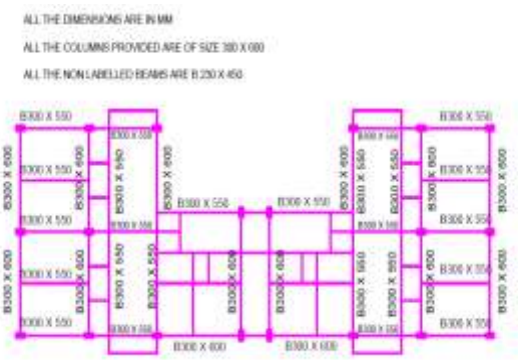


Fig 3.2. C-Type building grid

4. Results

4.1.. Results of maximum displacement and storey drift :

L SHAPE BUILDING (mm)

Table.4.1. Normal L shape building

NORMAL L SHAPE BUILDING	
Maximum story displacement	129.91
Maximum story drift	0.005168

Table.4.2. With both side corner shear walls

WITH BOTH SIDE CORNERS SHEAR WALLS	
Maximum story displacement	32.30
Maximum story drift	0.001538

Table.4.3: With adjacent shear walls

WITH ADJACENT SHEAR WALLS	
Maximum story displacement	91.51
Maximum story drift	0.004052

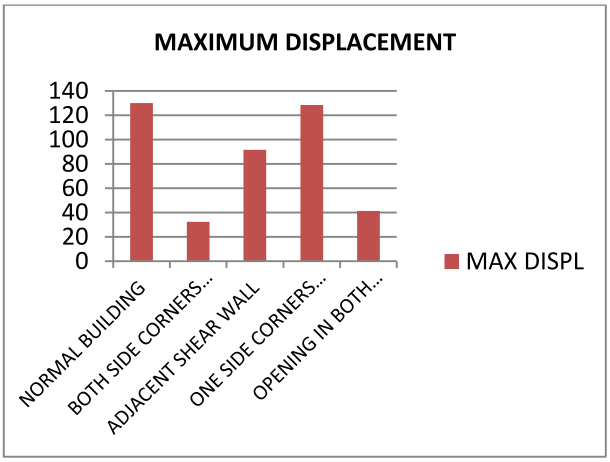
Table.4.4: With one side corner shear walls

WITH ONE SIDE CORNERS SHEAR WALLS	
Maximum story displacement	128.50
Maximum story drift	0.005561

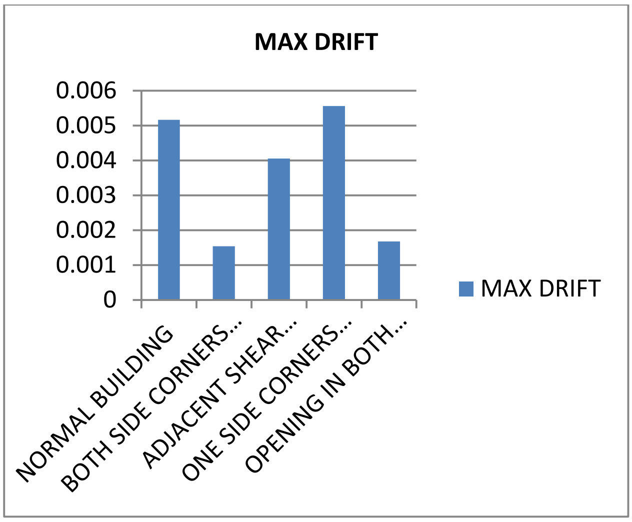
Table.4.5: With opening in both side corners shear walls

WITH OPENING IN BOTH SIDE CORNERS SHEAR WALLS	
Maximum story displacement	41.37
Maximum story drift	0.00168

Comparision of maximum displacement for all position in l shape building (mm)



Comparision of maximum drift for all position in l shape building (mm)



C SHAPE BUILDING (mm)

Table.4.6. Normal C shape building

NORMAL C SHAPE BUILDING	
Maximum story displacement	115.33
Maximum story drift	0.005149

Table.4.7. With both side corner shear walls

WITH BOTH SIDE CORNERS SHEAR WALLS	
Maximum story displacement	44.56
Maximum story drift	0.001722

Table.4.8. With adjacent shear walls

WITH ADJACENT SHEAR WALLS	
Maximum story displacement	102.52
Maximum story drift	0.004421

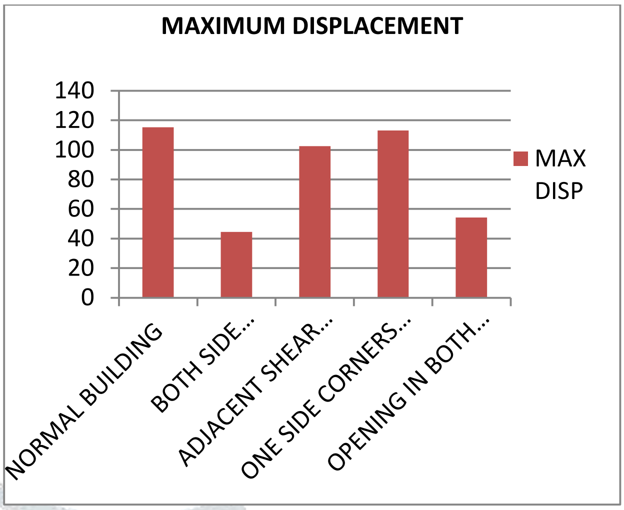
Table.4.9. With one side corner shear walls

WITH ONE SIDE CORNERS SHEAR WALLS	
Maximum story displacement	113.22
Maximum story drift	0.005115

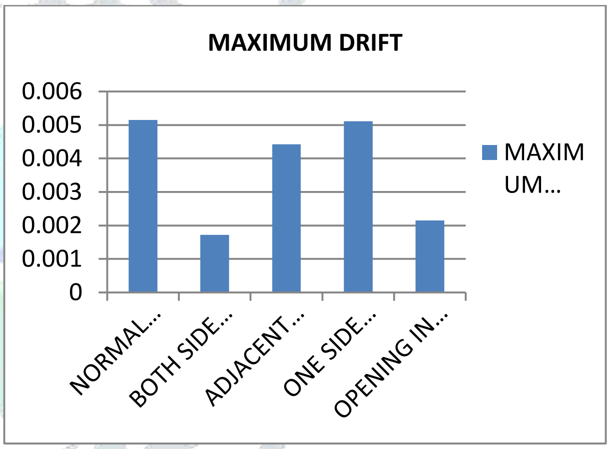
Table 4.10. With opening in both side corners shear walls

WITH OPENING IN BOTH SIDE CORNERS SHEAR WALLS	
Maximum story displacement	54.21
Maximum story drift	0.00215

Comparaison of maximum displacement for all position in c shape building (mm)



Comparision of maximum drift for all position in c shape building (mm)



5. Conclusion

- Shear wall provision proves more efficient minimizing the deflection, displacement and storey drift.
- Building with no shear wall provision has no lateral load resistance and undergoes deflection under earthquake load.
- Shear wall cannot be provided to overall building, so it is added in proper location that with minimum shear walls maximum lateral load is resisted.
- Shear wall provided at the one side corners, adjacent sides and both side corners, maximum lateral load is resisted.
- From all this locations of shear wall, orientation of shear wall at both corners prove more efficient having minimum deflection.
- For both corners shear wall, parameter is used by providing opening in shear walls and is analyzed for it, it gives more deflection than previous one.
- It is concluded that shear wall oriented at both corners of structure is more earthquake resistant.
- The shear walls at both corners has minimum displacement and storey drift.

- These parameters prove that it is more durable and lateral load resisting.

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