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Behavioural Study of RC Flat Plate Multi-Storey Building Persuaded By Stiffness of Masonry Infill Wall

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ABSTRACT
With a very swift development in urban areas the framed structures which are infilled by brick masonry or concrete blocks are widely used as partition walls and also exterior walls. Masonry infill walls are common element in structural system which modifies the conduction of building under the lateral load. These structures resist the moderate earthquakes and accomplish well in such a prime manner that even if they have no load bearing function. Evidently, during the time of resolution of such a multi-storey structure, the infilled frame is considered as bare frame, because IS codes do not provide any guide lines for the analysis and design of RC frames with infill wall. This paper addresses the numerical study of G+10 RC flat plate framed building with different cases i.e, soft story at ground level (Basement), with soft story at 5th floor level, without soft storey and bare frame building by using ETABS as soft computing tool. All these cases are analyzed for equivalent static method and Response spectrum method. By this, dynamic properties are evaluated and according to the results obtained conclusions are drawn.
Keywords –Masonry, soft story, infilled, dynamic, partition.

I. INTRODUCTION

Reinforced concrete structure is incorporated with infill walls, which are most extensively used in construction of multi-storey flat plate building in developing countries. During the process of structural design of the flat plate building, the effect of infill walls are collectively discarded due to the complexities involved in modelling of infill wall and its influence with connected RC frames. However, Masonry infill walls has been deserved to be considered that its presence will affect strength, seismic behaviour and stiffness of building Due to augmentation of population leads to utilize basement of the building itself for parking. Even though building with parking floor (soft story) are susceptible to failure due to seismic load, their construction is still widely extended. Literally, soft story means vertical discontinuity of stiffness in the structure. Infill walls are to be pondered as non-structural element. Since, in earthquake action RC frames clearly behave as moment resisting frame.

II. CONCEPT OF INFILL WALL

Previously, many authors have closely examined the influence of infill walls on the response of RC structures and the exigency of incorporation of these non-structural seismic valuation and design process is acknowledged. The material of the masonry infill wall is the main distinct, ranging from natural stones to man-made brick and blocks. It is anticipated that system will continues to be used in many countries because masonry infill walls are cost effective and suitable for temperature. In India, masonry infill panels are negotiated as non-structural element and their strength and stiffness contributions are disregarded. These infill walls behave like diagonal struts and increase the stiffness of a RC frame building and its presence reduces the ability of frame to bend and deform. The conduction of infilled frame is affected by property of infill material, workmanship and property of frame.

III. DETAILED DATA FOR ANALYSIS

- Type of Structure : Multi Storeyed RC Rigid Jointed Flat Plate Frame (Special Moment Resisting Frame)
- Number of Stories: Eleven (G+10) ; 35m X 25m
- Seismic Zone : V (Table 2, IS 1893 (Part-1):2002)
- Floor Height: 4m for Ground Floor, 4m for other Floors & 3m below plinth.
- Grade of Concrete: M40 for Ground, First & Second Floors Columns.
- M35 for Other Floors Columns
- M25 for Beams and Slabs
- Size of Columns : 600mmX600mm
- Size of Beams : 600mmX300mm
- Depth of Slab : 200mm thick
- Thickness of Wall : 200mm
- Imposed Load : 3.0KN/m2
- Floor Finish & Partitions : 2.0 KN/m^2
- Specific Weight of RCC : 25 KN/m^3
- Density of brick:18KN/m^3

- Type of Soil : III
- Response Spectra : As per IS 1893 (Part- 1) 2002
- Damping : 5%
- Importance Factor : 1.5
- Response reduction Factor : 5.0
- Structural Software : ETABS Version ultimate 15.0

Elevations of analytical model with infill walls with and without soft story at different levels are given in below Fig.1 to Fig. 4

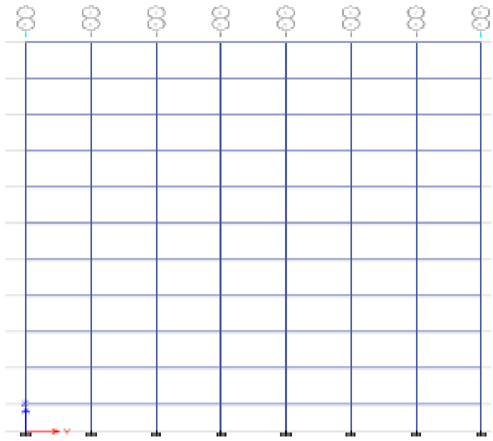

Figure.1: Model 1(Bare Frame building)

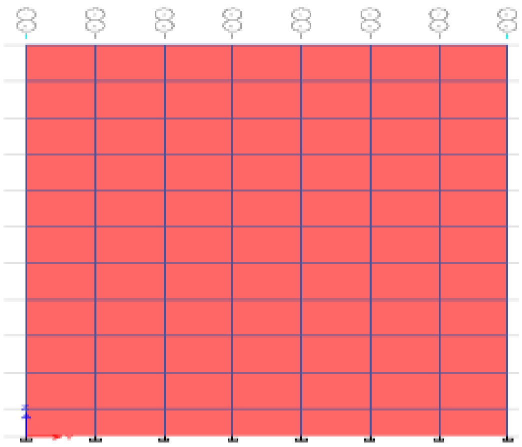

Figure.2: Model 2(without soft story)

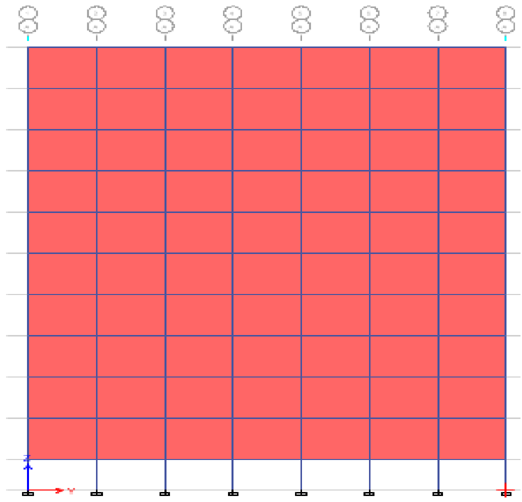

Figure.3: Model 3(with soft story at ground floor or basement)

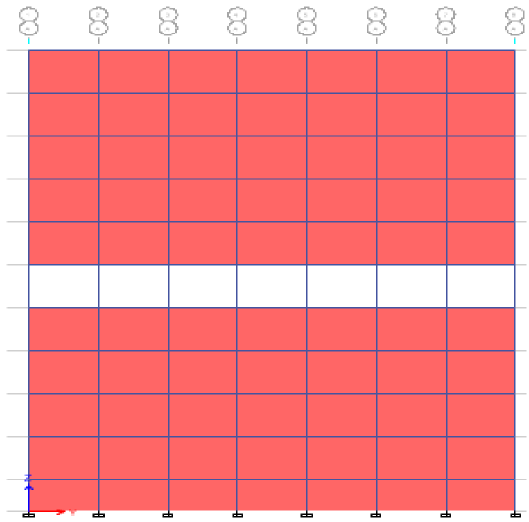

Figure.4: Model 4(with soft story at 5th floor level)

IV. Results and Discussions

The seismic behaviour of RC flat plate building with infill wall is still not mastered and guidelines for their modelling and analysis are lacking in design codes. So for each model described in the problem statement is analysed and designed with the help of structural analysis software "ETABS". The following are the results obtained as shown in Table 1, 2, 3 and 4 shows the tabulation of base shear; time period, scale-up factor and storey drift values for all the models. From the results obtained, the following graphs can be drawn. Figure-5, 6, 7, 8 and 9 shows the graphs of base shear, time period, maximum story displacements and maximum story drifts versus different models.

Table 1: Base shear and scale up factor for all the models

Base shear							
Model No.	Story type	Base Shear in KN				Scale up	Scale up
		Equivalent Static Method		Response Spectrum Method			
		X	Y	X	Y	X	Y
1	G+10	9053.649	9053.649	3360.7098	3664.8198	3.9641758	3.635225
2	G+10	10096.307	10096.307	18674.201	18887.238	0.7955744	0.7866007
3	G+10	10058.508	10058.508	18953.311	21579.563	0.7809239	0.6858848
4	G+10	9995.5092	9995.5092	15248.777	16045.78	0.9645621	0.9166517

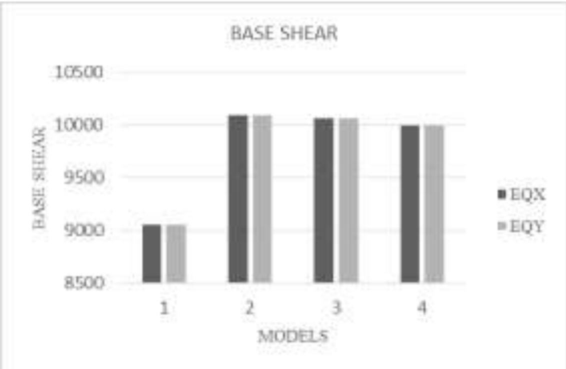

Figure 5: Base shear versus different models (Equivalent static method)

Table-2: Codal and analytical fundamental time period of building models

Time period in seconds					
Model No.	Story type	As Per ETABS Analysis			As Per IS 1893-2002
		Mode-1	Mode-2	Mode-3	
1	G+10	2.907	2.696	2.086	1.26
2	G+10	0.365	0.293	0.175	0.774
3	G+10	0.664	0.58	0.411	0.774
4	G+10	0.612	0.517	0.437	0.774

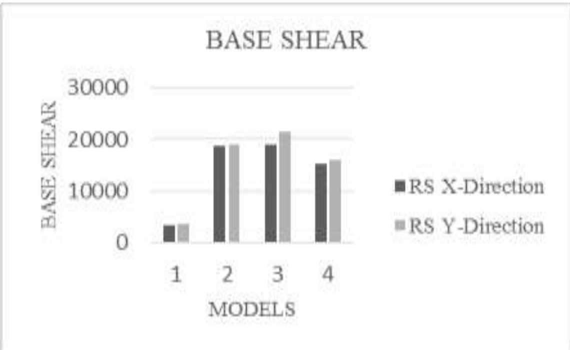

Figure 6: Base shear versus different models (Response spectrum method)

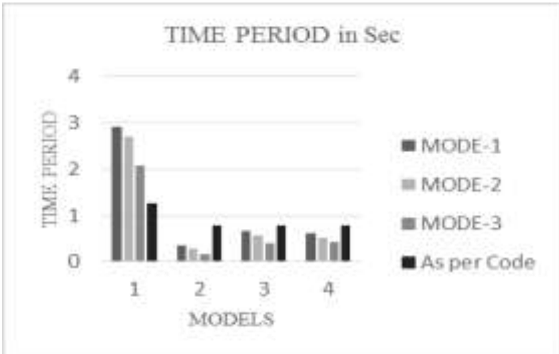

Figure 7: Time period versus different models

Table-3: Lateral displacement of flat plate building with infill wall models for seismic analysis

Modal No.	Story type	Max. story displacement of 10^{th},5^{th} and ground floor in mm					
		X			Y		
		10th floor	5th floor	GFL	10th floor	5th floor	GFL
1	G+10	352.5	214.9	8.9	240.3	148.5	6.5
2	G+10	5.9	3.3	0.33	3	1.1	0.7
3	G+10	14	10.8	6.8	8.1	6.5	4.4
4	G+10	15.1	12	0.2	9.7	8.2	0.1

Table-4: Inter story drift of flat plate building with infill wall models for seismic analysis

Modal No.	Story type	Max. story drift of 10^{th},5^{th} and ground floor in mm					
		X			Y		
		10th floor	5th floor	GFL	10th floor	5th floor	GFL
1	G+10	3.339	10.969	3.004	2.115	7.423	2.217
2	G+10	0.094	0.161	0.138	0.043	0.081	0.087
3	G+10	0.127	0.195	2.375	0.059	0.097	1.554
4	G+10	0.114	2.314	0.136	0.052	1.688	0.085

Figure 8: Maximum story displacements versus different models

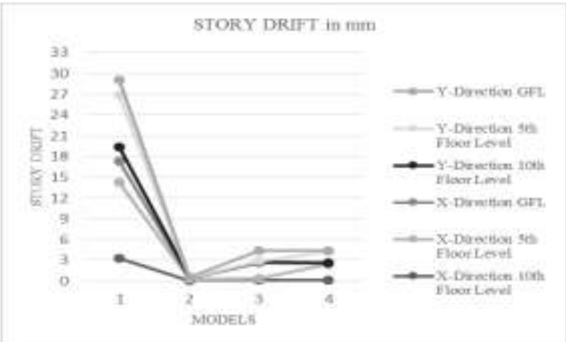

Figure 9: Maximum story drifts versus different models

V. CONCLUSION

a. The acquired analytical values of Natural period do not acquiesce with the Fundamental time periods obtained from the empirical expressions of the code for building with infill walls. Therefore to design such flat plate building with infill wall dynamic analysis should be required.
b. Fundamental time period in Model 2 drastically decreases compared to other models due to the increase in storage stiffness by introducing infill wall.
c. The performance of masonry infill wall is evidently better compared to that of other models.
d. Base shear increase with increase in mass and stiffness of the building. Hence, flate plate building with infill wall is more than bare frame.
e. Contemplating, the stiffness of infill in the flat plate building during the analysis will result in rapid reduction of lateral displacement of building which in turn assures the safely of structure.
f. Flat plate building without soft storey is having very minimum lateral displacement than compared to others.
g. Base shear due to response spectrum analysis is more than compared to equivalent static method in flat plate building with infill walls. Since, infill walls are stiffer than beams and slabs.
h. The inter story drift of models with infill wall are very minute than compared to bare frame.

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