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Effect of Masonary Wall on Reinforced Concrete Frames under Earthquake Demands

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Abstract:- **Infill walls are considered to non-bearing structural members but affect not only structure masses also lateral rigidities which may cause free vibration behavior of the buildings. Although infill walls are not considered structural members, they are acting together with the frame when subjected to seismic loads. Analyze and calculation models including infill wall contribution are difficult and complex especially on major construction projects. Behavior of masonry infilled R.C. frames under seismic loads should be modeled to consider the effect of the infill walls on the seismic performance of the structure. In this study an overview of the modelling methods of infill walls in reinforced concrete frames is presented. The advantages or disadvantages of the presented methods are discussed and an easy and effective procedure is suggested for using in practice design. Present paper describe the nature of RC frame building with G + 11 storey with masonry infill materials of brick masonry. Completely fill, bare frame, soft storey, multiple opening frame models are studied. Effect on various parameters like base shear, displacement, storey drift etc are taking into account. Infill walls are modelled as pin-jointed single equivalent diagonal strut. All analysis was carried on software Etabs. Result from study conducted have shown that infill walls increases base shear, stiffness while displacement, time period and drift have been reduced.**

Index Terms—infill wall, masonry, infilled frame, modeling

I. INTRODUCTION

Reinforced concrete frames with masonry infill walls are widespread systems in many earthquake-prone regions of the world. The infill walls are used for insulation and partition purposes rather than structural purposes and generally considered as non-structural elements in structural design. The inherent uncertainties of the infill walls
introduce difficulty to regard them as structural members. These uncertainties are associated to both the infill wall and the surrounding frame. The variability in the material properties of the constituent elements and high non-linearity of the masonry panels make it difficult to predict/calculate the behavior of the infill walls. Moreover, the properties of the infill walls highly depend on the quality of the bricks, mortar and the workmanship. Typically, quality control of these factors is poor in most applications. In addition, the properties of the frames, i.e. reinforcement detailing, member capacities, number of bays and stories are the factors that influence the behaviour of the infilled frames. In many studies, it is proven that infill walls affect the behaviour of structures
Significantly. If separation joints between infills and bounding frame are not provided,
interaction of the frame and the infill wall reveals a different behaviour than what is expected. This interaction can be advantageous, if the infill walls are located appropriately throughout the structure and taken into account in the analysis process, if
possible. It is known that presence of infill walls lead to considerable increases in lateral
strength and stiffness of the frames compared to those of the bare frames while decreasing the average drifts.

2. BUILDING DISCRIPTION:

Detailing of residential Building with square shape plan of G+11 storey.

2.1. GEOMETRICAL PROPERTIES:

S.No.	Structural Part	Dimension
1.	Length in X-direction	24 m @ 6m
2.	Length in Y-direction	24 m @ 6m
3.	Floor to floor height	3 m
4.	Total height of building	33.5 m
5.	Slab thickness	150 mm

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6.	Column size	550×550 mm
7.	Beam size	300×450 mm
8.	Width of infill	0.23m

2.2. MATERIAL PROPERTIES:

S.No	Material	Grade
1.	Concrete(Beam, column)	M30
2.	Concrete(Slab)	M25
3.	Rebar	HYSD-415
4.	Grade of concrete	MM 7.5 OPC mortar
5.	Density of infill wall	18kN/m^3
6.	Compressive strength of masonry infill	6.5Kn/m^2
7.	Modulus of elasticity of concrete (Ec)	27.39 G Pa
8.	Poision's ratio of concrete	0.2
9.	Poision's ratio of masonry infill	0.16

2.3. SEISMIC DATA:

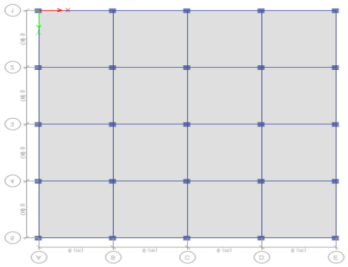
1.	Earthquake Zone	IV
2.	Damping Ratio	5%
3.	Importance Factor	1.5
4.	Type of soil	Soft soil
5.	Response Reduction factor	5
6.	Time Period	Program calculated

2.4. LOADING:

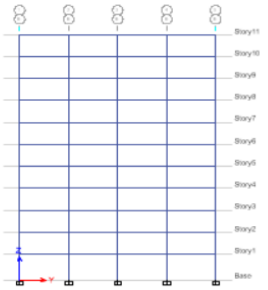
a. Live load 3.5 kN/m^2

b. Earthquake load as per IS 1893 part-I

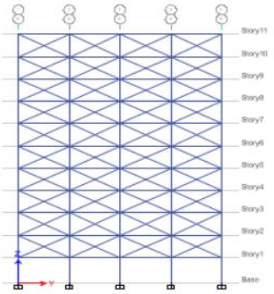
3. PLAN DETAIL



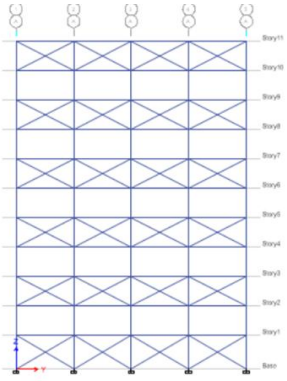
Plan view of building



Elevation view of bare frame



Elevation view of open story frame



Elevation view of multiple opening frame

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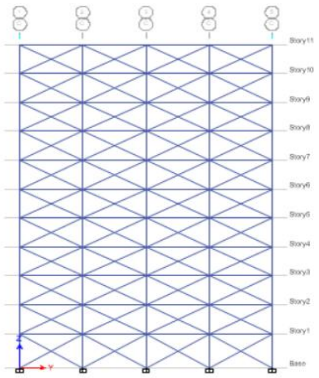

Elevation view of fully infilled frame

4. METHOD OF ANALYSIS:

The plan shape used for analysis is square shape regular Multi story building. Response spectrum method is suitable in case of regular and medium high rise building. In response spectrum analysis. In this approach, the multiple modes of response of building to an earthquake are taken in account. Thus the peak response of structure during an earthquake is obtain directly from the earthquake response spectrum. This procedure gives an approximate peak response, but this is quite accurate for structural design applications. . So we have adopted this method for analysis.

5. ANALYSIS RESULT:

The analysis of all the models has been done by using software ETABS and results are shown below. The parameters which are to be studies are storey displacement, storey drift and torsion.

5.1 Story stiffness:

As per IS 1893-2016, soft story is a story whose lateral stiffness is less than that of story above.

As per IS 1893-2002, soft story is one in which the lateral stiffness is less than 70 percent of that in the story above or less than 80 percent of average lateral stiffness of the three story.

Table: Story stiffness in X direction (kN/m)

	Bare frame	Multiple opening frame	Fully infilled frame	Open story frame
Story 11	277628.238	1235836.377	1452811.281	1448086.022
Story 10	334850.447	751642.718	2112495.564	2107649.956
Story 9	344443.03	1696451.601	2394327.196	2389930.479
Story 8	346703.622	801166.275	2562187.184	2558093.561
Story 7	347568.888	1827577.576	2679408.599	2675496.231
Story 6	348247.833	822263.945	2774779.389	2770855.593
Story 5	349240.791	1911663.097	2863608.716	2860233.935
Story 4	351508.524	839576.18	2955850.358	2946213.376
Story 3	358668.491	1989280.766	3063891.204	3126752.522
Story 2	386727.389	822750.349	3153236.575	2510578.845
Story 1	533885.391	2534471.539	3331942.759	870195.131

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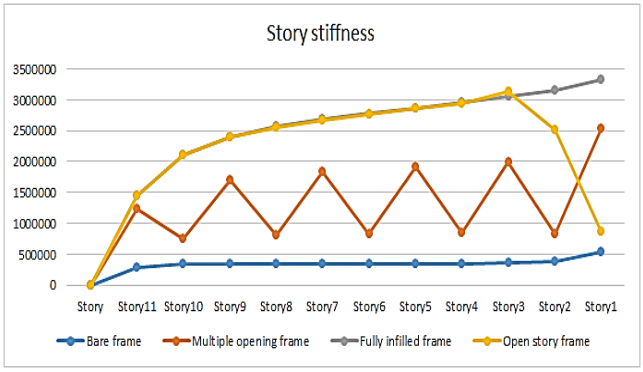

Figure 5.1(a): Comparison of Story stiffness in X Direction

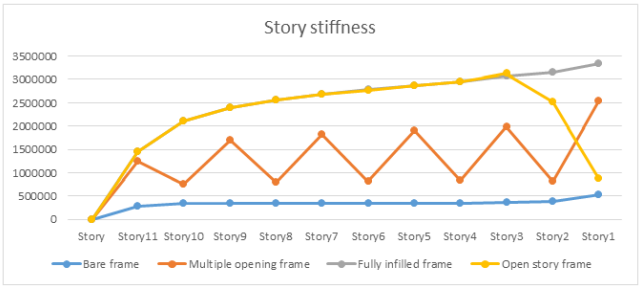

Figure 5.1(b) : Comparison of Story stiffness in Y Direction

5.2 Story drift:

It is the displacement of one level relative to the other level above or below. According to IS 1893:2002 the maximum value for story drift must not exceed 0.004 times the height of building. Here it's value is 12mm.

Table 5.2: Maximum story drift in X direction (mm)

Story	Bare frame	Multiple opening frame	Fully infilled frame	Open story frame
Story4	7.51	6.302	2.77	8.62
Story3	7.509	2.706	2.735	2.969
Story5	7.296	2.656	2.751	2.437
Story2	7.029	6.632	2.691	2.415
Story6	6.911	5.864	2.671	2.35
Story7	6.347	2.401	2.521	2.345
Story8	5.583	4.84	2.293	2.214
Story1	5.103	2.157	2.563	2.014
Story9	4.599	1.853	1.979	1.738
Story10	3.411	3.048	1.569	1.379
Story11	2.158	0.959	1.088	0.957

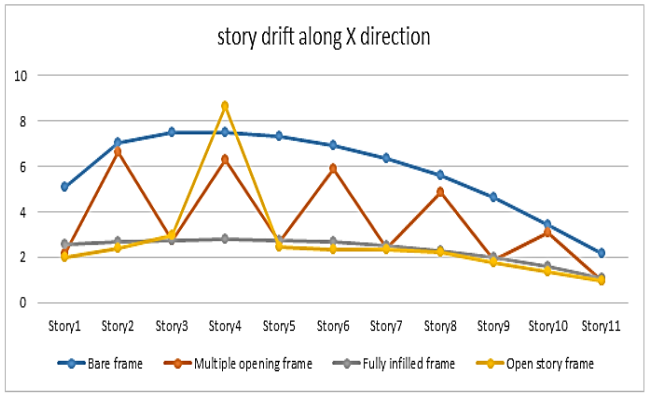

Figure 5.2(a): Comparison of Drift in X Direction

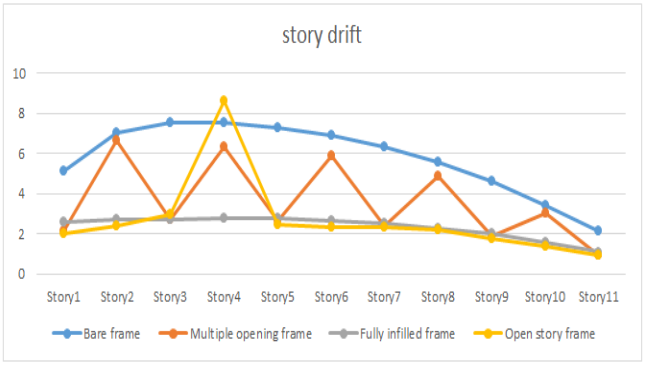

Figure 5.2(b): Comparison of maximum Displacement in Y Direction

5.3 Max/avg. story drift ratio (Torsion): As per IS 1893:2002 Code describe that the torsional irregularity will be occur when max story drift/ average story drift is more than 1.2.

Table 5.3 Max/avg story drift in X direction

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Mode	Bare frame	Multiple opening frame	Fully infilled frame	Open story frame
1	1.411	0.881	0.613	0.75
2	1.411	0.881	0.613	0.75
3	1.237	0.763	0.511	0.644
4	0.455	0.293	0.202	0.24
5	0.455	0.293	0.202	0.24
6	0.4	0.256	0.171	0.199
7	0.257	0.175	0.116	0.128
8	0.257	0.175	0.116	0.128
9	0.227	0.155	0.103	0.112
10	0.171	0.129	0.083	0.088
11	0.171	0.129	0.083	0.088

Story	Bare frame	Multiple opening frame	Fully infilled frame	Open story frame
Story5	1.101	1.099	1.097	1.099
Story4	1.101	1.098	1.095	1.098
Story3	1.101	1.097	1.093	1.096
Story2	1.101	1.095	1.091	1.095
Story1	1.101	1.094	1.09	1.094
Story11	1.1	1.093	1.089	1.092
Story10	1.1	1.09	1.087	1.091
Story9	1.1	1.088	1.086	1.09
Story8	1.1	1.086	1.085	1.089
Story7	1.1	1.08	1.083	1.087
Story6	1.1	1.06	1.082	1.086

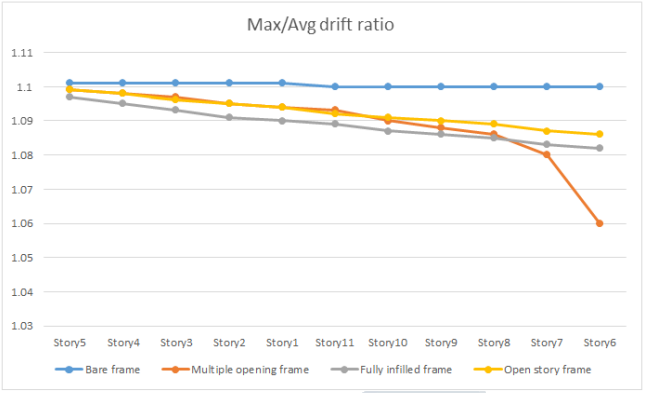

Figure 5.3(a): Comparison of Max/Avg Drift Ratio in X Direction

Natural Time Period:
All the objects of structure have a tendency to vibrate. The rate at which it wants to vibrate is its fundamental time period(natural time period) or un-damped free vibration of a structure. The natural time period of vibration(Tn) in sec are given below.

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Where,
K= Stiffness
M= Mass of the structure.

Table: Natural time period

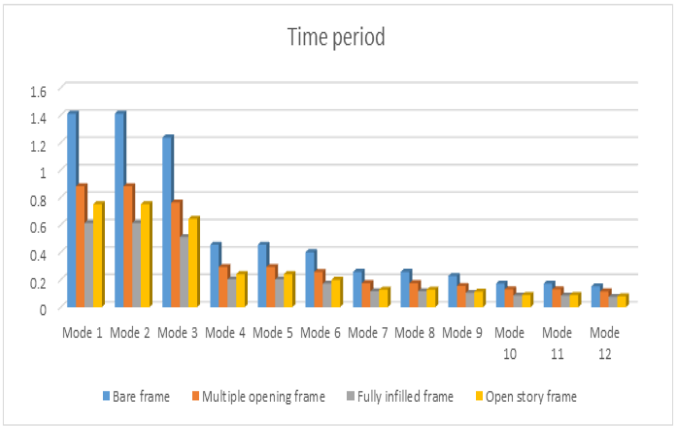

Figure 5.4(a): Bar graph showing time period

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CONCLUSIONS:

Response spectrum analysis was performed and results were found in terms of story drift, story displacement and max. drift/avg. drift ratio. From the results of analysis of the models following conclusions can be drawn.

The comparative study of storey drift in X and Y direction for four models are represented in table 5.2, in figure 5.2(a) and figure 5.2(b). The story drift value of open story model was 8.62 which highest of all model followed by bare frame followed by multiple opening frame. Multiple opening frame and bare frame had failed in stiffness criteria. Means it could prove dangerous if there is no infill panel on any storey.

The comparative study of storey stiffness in X and Y direction for four model are given in table 5.1, in figure 5.1(a) and figure 5.1(b). The storey stiffness value of bare frame has the lowest value i.e 5.23 times less than fully infilled frame. This means that infill panel increases story stiffness considerably.

From the table 5.3 and figure 5.3(a) and figure 5.3(b), the value of Torsion in X direction the maximum value of torsion is for bare frame i.e. 1.084 at story 5, which is greater than those of all other models.. The minimum value of torsion is observed in fully infilled frame.

Time period for the bare frame has the highest value while time period for fully infilled frame has the lowest value.

From the above study we can conclude that fully infilled frame shows better performance among the other models.

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