Effect of Brick Infill Wall and Shear Wall in the Design of RC Framed Regular Building and Mass Irregular Building

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Abstract –*Earthquake is one of the most devastating natural hazards that cause great loss of life and livelihood. Passed research works based on an experimental and analytical investigations shows that the contribution of infill wall and shear wall cannot be simply neglected towards adding strength and stiffness to the RC framed regular and irregular buildings. The structure is said to be irregular as a building that lacks symmetry and discontinuity in geometry, mass or load resisting elements. This project work is concerned about analyzing the behaviour of regular and mass irregular building of G+14 storeys provided with shear wall and infill wall. The analysis is done by using ETABS 2015 software by considering equivalent lateral force for regular and response spectrum method for mass irregular building by considering zone 5. Brick infill walls were modelled using equivalent strut approach. The results of parameters like time period and storey displacement are obtained and graphs are plotted. From the results it can be concluded that the time period and storey displacement is decreases as compared that of bare frame, with the addition of shear wall and infill wall and it can also be observed that regular structure possess better seismic performance as compared to mass irregular structure.*

Key Words: Mass irregular building, Shear wall, Brick infill wall, Equivalent static method, Response spectrum method, ETABS 2015.

1.INTRODUCTION

Developments in the design of multistorey frames have emphasized the importance of limiting the sideway under the action lateral loads. Some of the lateral load resistant structures used in practice were given in Fig 1. Diagonal bracing may be conveniently adopted in steel frames as shown in Fig 1(a). In reinforced concrete frames such diagonal bracing is impracticable, however in such buildings lateral sway restricted by providing rigid joints make it virtually impossible to achieve economy in the design of columns. Provisions of reinforced concrete shear walls in the plane of the load at selected positions of tall buildings, is shown in Fig 1(c) is the modern trend of construction in order to limit the lateral sway and achieve economy in the designs.

However, the ever increasing cost of steel and cement make such structures quite expensive. This lead one to think of alternative means and one such is the possibility of utilizing the generally not considered structural stiffness and strength of masonry walls which have to be provided for functional reasons in a building along with reinforced concrete frames is shown in Fig 1(d).

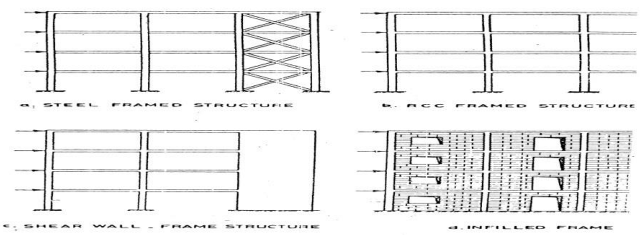

Fig-1: Lateral Load Resistant Structures

1.1 OBJECTIVES OF STUDY

The main objective of the proposed work is

- To study the regular and mass irregular building along with the effect of brick infill wall and shear wall panels.
- The frame is analysed by finite element method of analysis using the software ETABS.
- Various models thus generated parametrically are compared and suitable conclusions are drawn.

2. MODEL DESCRIPTION

In this project, ETABS 2015 software package was used for the analysis of building model by considering parameters shown in table 1. The structural models considered for the study is of G+14 storey. The plan dimensions taken for the study is 10x10 m. The height of the building taken to be 3m. For the study totally two models are considered out of which one is regular and other one is mass irregular building. Each model is analysed for different cases such as with shear wall and infill wall.

Masonry walls are modelled as equivalent diagonal strut method. The key to this approach lies in determination of effective width of the equivalent diagonal strut.

The effective width is given by

$$W_{ef} = 0.175 (\lambda_h H)^{-0.4} \sqrt{H^2+L^2}$$

Where:

$\lambda_h = [(E_i\, t \sin 2\theta)/(4\, E_c I_c H_i)]^{1/4}$ and $\theta = \tan^{-1}(H_i/L)$

Thickness of infill wall (t) is 0.23 m, height of infill wall (H_i) is 2.55 m and length of infill wall (L_i) is 2.40 m, where H and L are the height and length of the frame, E_c and E_i are the elastic moduli of column and infill wall panel, θ is the angle of defining the diagonal strut, I_c is the modulus inertia of the column and H_i is the height of infill wall.

Table -1: Parameters considered in the present study

Structure Type	Ordinary moment resisting frame
No. of storey	G+14
Typical storey height	3.0m
Seismic zone	V
Type of soil	Hard soil
Material properties	
Grade of concrete in slabs	M_{25}
Grade of concrete in columns	M_{40}
Grade of concrete in beams	M_{30}
Grade of concrete in walls	M_{20}
Grade of steel	Fe415
Density of concrete	25 kN /m^3
Member properties	
Slab thickness	0.150m
Beam size	0.30m x 0.45 m
Column size	0.30m x 0.90m
Shear Wall size	0.30m
Dead load intensities	
Roof finishes	2 kN/m^2
Floor finishes	1 kN/m^2
Live load intensities	
Roof	1.5 kN/m^2
Floor	3.0 kN/m^2
Earthquake live load on slab as per clause 7.3.1 and 7.3.2 of IS: 1893(Part-1) 2002	
Roof	0.25 x 1.5 = 0.375 kN/m^2
Floor	0.25 x 3.0kN/m^2 = 0.75 kN/m^2

Mass Irregularity:

In this irregularity the changes made with respect to regular building is that live load is increased more than 200% that of a regular building. Live load considered is 3 kN/m^2 where as in irregular building it is considered s 7 kN/m^2 in 4^{th} and 8^{th} floor as per IS 1893-2002 part 1.

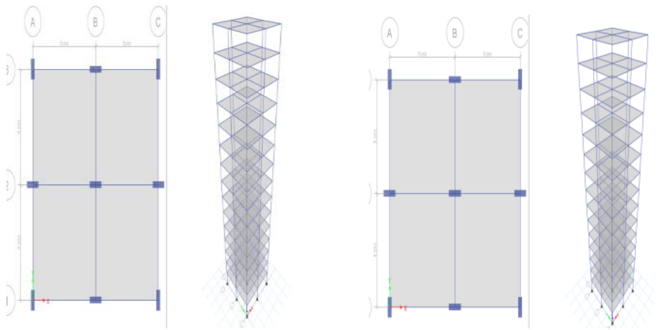

Fig-2: plan and 3D view of regular and mass irregular building respectively

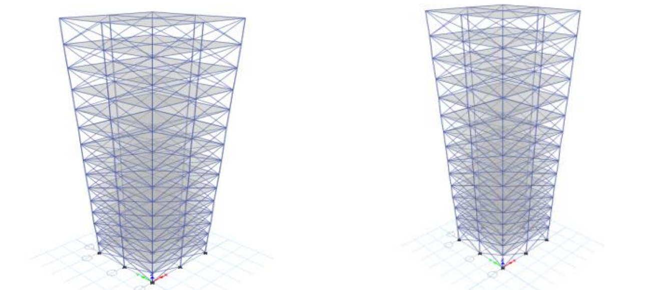

Fig-3: 3D view of regular and mass irregular building with infill wall respectively

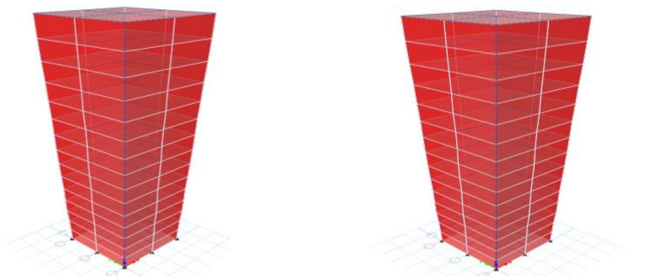

Fig-4: 3D view of regular and mass irregular building with shear wall respectively

3. Results and Discussions

The notations used are as follows
RB= Regular building
MI= Mass irregularity
RB IN= Regular building with infill wall
MI IN= Mass irregularity with infill wall
RB SW= Regular building with shear wall
MI SW= Mass irregularity with shear wall

3.1 Time period

From the graphs seen in the Fig 5 for 15 storey regular and mass irregular building for fundamental time period respectively. The time period considerably reduces with the use of infill wall and shear wall which can be seen in graphs. Time period for hard soil in 15 storey mass irregular building with infill wall and shear wall is decreased by 57.25 and 78.25% (from table3) as compare with mass irregular building respectively. Time period in regular building will be less compared to irregular buildings can be seen in below tables.

Table-2: Time period for 15 storey.

Soil type	Study parameter	Type of building		
		RB	RB IN	RB SW
Hard	Time period	1.816	0.817	0.418

Table-3: Time period for 15 storey.

Soil type	Study parameter	Type of building		
		MI	MI IN	MI SW
Hard	Time period	1.968	0.836	0.428

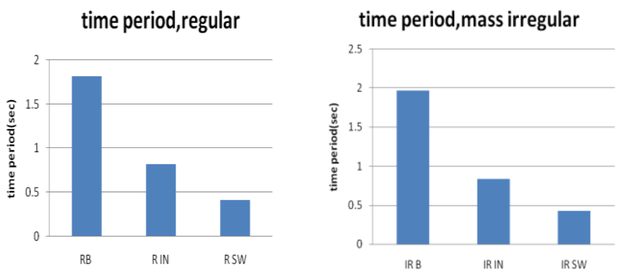

Fig-5: Time period for regular and mass irregular Building with infill wall and shear wall

3.2: Storey displacement

From the graphs seen in the Fig 6 for 15 storey regular and mass irregular building for storey displacement respectively. The storey displacement is increasing as the number of storey have been increased and storey displacement reduces considerably with the use of infill wall and shear wall which can be seen in below graphs. The storey displacement for hard soil in 15 storey mass irregular building with infill wall and shear wall is decreased by 46.49% and 70.7% (from table 5) as compared with 15 storey mass irregular building respectively. Storey displacement in regular building will be less compared to mass irregular building can be seen below graphs.

Table-4: Storey displacement.

Soil type	Study parameter	Storey No.	Type of building		
			RB	RB IN	RB SW
Hard	Displacement (mm)	15	29	16.4	8.9
		14	28.1	15.3	8.2
		13	26.9	14.1	7.4
		12	25.5	12.9	6.7
		11	23.8	11.6	5.9
		10	21.8	10.3	5.2
		9	19.7	9.0	4.5
		8	17.4	7.7	3.7
		7	15	6.4	3.1
		6	12.5	5.2	2.4
		5	10	4.0	1.8
		4	7.5	3.0	1.3
		3	5.1	2.0	0.8
		2	2.8	1.2	0.5
		1	0.9	0.5	0.2

Table-5: Storey displacement

Soil type	Study parameter	Storey No.	Type of building		
			MI	MI IN	MI SW
Hard	Displacement (mm)	15	31.4	16.8	9.2
		14	30.4	15.7	8.3
		13	29.2	14.5	7.6
		12	27.7	13.2	6.8
		11	25.8	11.9	6.1
		10	23.7	10.6	5.3
		9	21.4	9.2	4.6
		8	18.9	7.9	3.8
		7	16.3	6.6	3.1
		6	13.7	5.3	2.5
		5	10.9	4.2	1.9
		4	8.2	3.1	1.3
		3	5.6	2.1	0.9
		2	3.1	1.2	0.5
		1	1.0	0.5	0.2

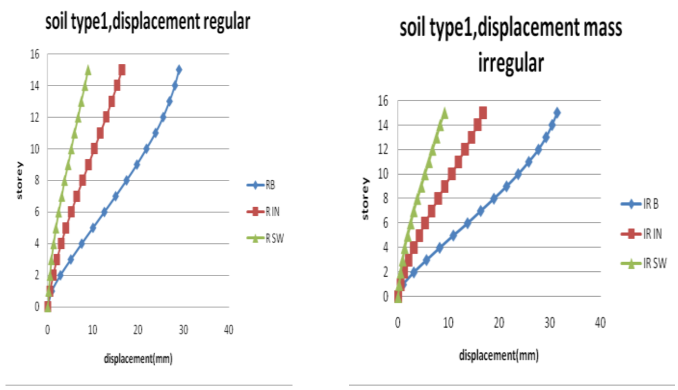

Fig-6: Storey displacement of regular and mass irregular building with infill wall and shear wall.

4. CONCLUSIONS

The study presented compares the difference between regular building and mass irregular building. The following conclusions were drawn based on the investigation.

- The time period and storey displacement was found to be reduced as compared to that of bare frame, with infill wall and shear wall.
- Regular building gives the best results, because the time period and storey displacement is less in regular building compared to mass irregular

building. The seismic response of regular structure gives better in comparison with that of irregular structure, because of the discontinuities along the height of the building.

- It is thus concluded that seismic response of a building is influenced greatly by brick infill wall and shear walls, soil supporting the base. Ignoring any one of them, can significantly affect the performance of the structure during earthquake and lead to devastating effects.

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