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"Analysis of RCC Building with Different Types of Wall Materials Using Infill, Without Infill and Diagonal Strut Conditions"

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Abstract— *Infill walls are integral parts of any building including residential, commercial & industrial as well. These infill walls mostly serve purpose of room separators. For residential buildings these infill walls are required to maintain privacy of different rooms. The safety against fire is also one of the prime requirements of infill walls. In addition to these the infill walls also beneficial for thermal comfort, sound insulations, weather resistance, and durability & water-proofing. The thermal comfort is a requirement that the enclosure walls must comply. The infill walls should be durable, sound resistant, weatherproofed and waterproofed considering surrounding environment.*

There are large varieties of infills walls available in the market like brick infill walls, thin concrete infill walls, light weight AAC block infill walls. Timber infill walls, light weight still infill walls, glass infill walls (mostly used in commercial buildings) etc. However commonly used infill wall types are Brick, thin concrete and light weight AAC block infill walls.

However various past studies have shown that the infill walls contribute majorly to the stiffness of building. This study is intended to understand the effect of various types of infill walls on structural behavior of the same building. The structural effects compared for the study includes modal behavior, deflections, drift, base shear etc. These results are also compared with building model without infill walls. Earthquake analysis method considered for this study is static coefficient method & Response Spectrum (dynamic analysis) method.

IS 1893:2016 clause no. 7.9 gives provisions for RC framed Buildings with Unreinforced Masonry Infill walls; these provisions are also studied & applied in the dissertation. Results of actual infill models & without infill models are compared with infill walls modeled by using equivalent diagonal strut as per provisions of IS 1893:2016.

Key words: *ETABS, Earthquake load, wind load, dumbbell shaped shear wall, response spectrum analysis.*

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I. INTRODUCTION

General Introduction

The presence of masonry infill walls in reinforced concrete (RC) buildings is very common; however, and even today, during the design process of new buildings and in the assessment of existing ones, infills are usually considered to be non-structural elements, and their influence on the structural response is ignored. Their influence is recognized in the global behavior of RC frames subjected to earthquake loadings.

Over the last years, many authors have studied the effects of the infill panels on the response of RC structures and the need of inclusion of these non-structural elements on the structural seismic assessment and design process is recognized. Observations made by technicians and experts to damaged buildings caused by seismic actions proved that the presence of masonry infill walls can have beneficial or negative effects to the structure. The presence of the infills is commonly associated with the significant increase in the overall structural stiffness implied by the infills, and then, a higher natural frequency of vibration, which depends on the relevant seismic spectrum, can lead to an increase in seismic forces.

When constructed in buildings with steel or RC moment frames, infill walls are traditionally not considered as a part of the lateral load resisting system. An argument for ignoring the effect of these infill walls is that such walls typically do not offer much displacement capacity and in an event of significant lateral demands, the infill wall would disintegrate and the original lateral load resisting system acts as intended in the design assumptions and processes. The problem, however, is that on one hand such simplified design approach does not predict the level at which the damage in the URM infill wall occurs -this can be significant in terms of nonstructural damages- and on the other hand it does not consider the global and local effects of having these stiff and brittle elements coupled with the primary lateral load resisting system, e.g. shift in natural frequency of the structure, overall change of structural behavior, and increases in shear demand on the columns, in diaphragm demands, and in collector element forces.

Reinforced concrete (RC) frames with unreinforced masonry (URM) infill walls constitute a significant portion of the building stock throughout the world. Infill walls in these buildings are generally considered as non-structural elements. Observations after several earthquakes revealed that infill walls may significantly alter the response of adjacent columns. Studies point out that infill walls increase lateral stiffness and strength of a frame subjected to seismic excitations under low to moderate seismic demands. Under strong seismic excitations, sudden failure of masonry infill walls may accelerate the damage in the structural elements.

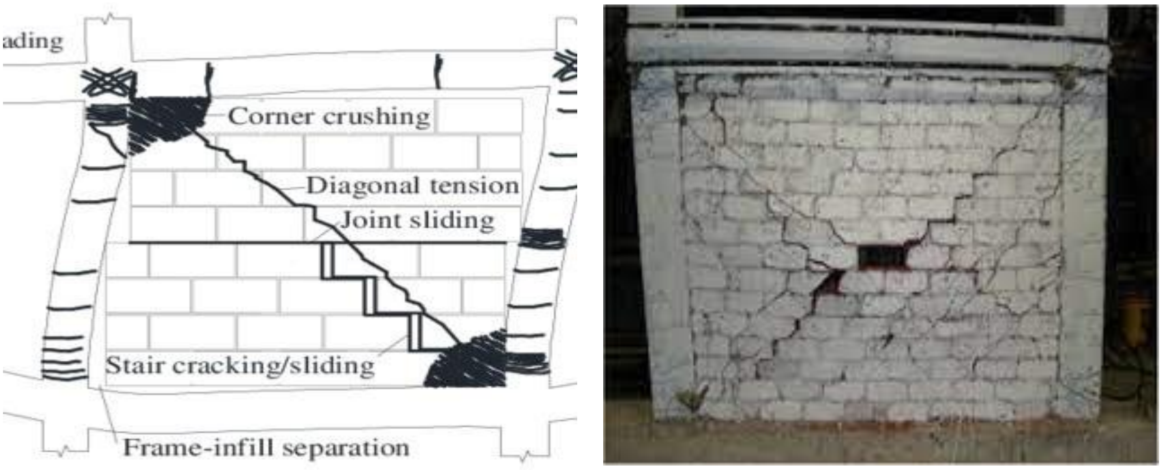


Fig. 1 Various Failure Patterns Of Infill Walls

The need for including infill panels in the analysis of RC frames has been recognized for a long time. The behavior of empty frames and infilled frames is very different. Researchers claims that the contribution of masonry infills to the global capacity of the structure constitutes the structural strength to the 80% and stiffness to the 85%. The main reason of their beneficial behavior is that the amount of increase in earthquake inertia force appears to be relatively small, comparatively with the increase in the strength of masonry infills. Although there is no general acceptance of the contribution of infill walls in the earthquake resistant design, many researches point out that negative effects are often associated with irregularities in the distribution of infills in plan and/or in the evaluation.

II. RESEARCH OBJECTIVE

The Present work consists of comparison of structural behaviors of seven different models of same building as listed below:
Model 1 – Building without infill walls
Model 2 - Building with brick infill walls (actual modeling of brick infill)
Model 3 - Building with brick infill walls (equivalent diagonal strut modeling method as per IS1893:2016)
Model 4 - Building with RCC infill walls (actual modeling of RCC infill)
Model 5 - Building with Fly Ash infill walls (actual modeling of Fly Ash infill)
Model 6 - Building with Fly Ash infill walls (equivalent diagonal strut modeling method as per IS1893:2016)

III. PROJECT STATEMENT

The study will give more knowledge which result into benefits for future implementation with the help of RCC building actual Analysis and design. To study the effect of infill wall and without infill wall building.

i) Response Spectrum Method

A response spectrum is simply a plot or steady-state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency that are forced into motion by same base vibration. The resulting plot

can then be used to pick off the response of any linear system, given its natural frequency of oscillation. One such use is in assessing the peak response of building to earthquake. The science of strong ground motion may use some values from the ground response spectrum for correlation with seismic damage.
In technical terms it can be said that it is the representation of the maximum response of idealized single degree of freedom having certain period and damping during earthquake ground motion. The maximum response is plotted against the undammed natural period and for various damping values can be expressed in terms of maximum relative velocity or maximum relative displacement. The characteristics of seismic ground vibrations expected at any location depends upon the magnitude of earthquake, its depth of focus, distance from the epicenter, characteristics of the path through which the seismic waves travel, and soil strata on which the structure stands. The random earthquake ground motions, which cause the structure to vibrate, can be resolved in any three mutually perpendicular directions.

IV. PROBLEM FORMULATION

Multi-storied Reinforced concrete building, moment resisting space frame have been analyzed using professional software. Model of Multistoried building frame is analyzed by response spectrum Method. The plan dimensions of buildings are shown in table below. The plan view of building, elevation of different frames is shown in figures below. 1.3

Table 1. Detailed Features of Building

Sr. No.	Parameters	Values
1	Material used	Concrete- M30, M35, & M40
		Reinforcement Fe-415&500Mpa
3	Height of each Story	3.0m
4	Height of ground Story	2m
5	Density of concrete	25KN/m^3
6	Poisson ratio	0.2-concrete and 0.15-steel
7	Density of brick	20KN/m^3
9	Code of Practice adopted	IS456:2007, IS1893:2016
10	Seismic zone for IS1893:2002	III
12	Importance factor	1.2
13	Response reduction factor	5
14	Foundation soil	Medium
15	Slab thickness	150mm
16	Wall thickness	230mm
17	Floor Finish	1KN/m2
18	Live load	2.5 KN/m2
19	Earthquake load	As per IS 1893-2016
20	Wind load	As per IS 875- 2015
24	Model to be design	G+20
25	Ductility class	IS1893:2016 SMRF
27	Basic wind speed (Vb)	39 m/sec
28	Terrain category	2
29	Risk coefficient	1
30	Topography factor	1
31	Parapet wall ht.	0.9m

Load case and load combination

Unless otherwise specified, all loads listed, shall be considered in design for the Indian Code following load combinations shall be considered,

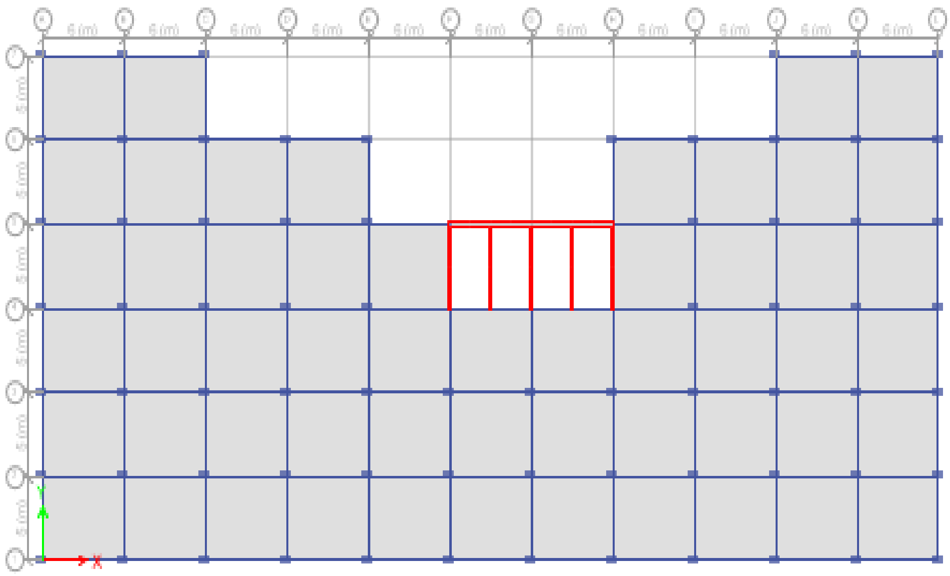
Load case

1) DL: Dead load
2) LL: Live load
3) EQ: Earthquake load
4) W: Wind Load

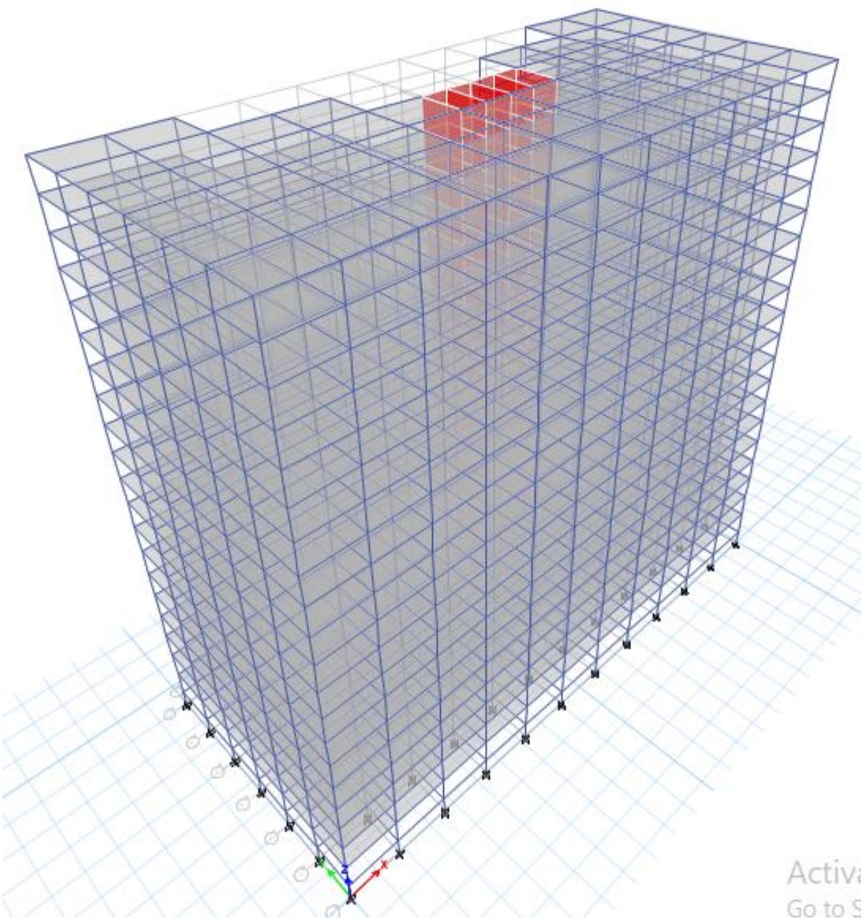
Load combination

1) 1.5DL+1.5LL
2) 1.2DL+1.2LL + 1.2EX
3) 1.2DL+1.2LL- 1.2EX
4) 1.2DL+1.2LL+ 1.2EY
5) 1.2DL+1.2LL - 1.2EY
6) 1.2DL+1.2LL+1.2WLX
7) 1.2DL+1.2LL-1.2WLX
8) 1.2DL+1.2LL+1.2WLY
9) 1.2DL+1.2LL-1.2WL

A. Building Plan



B. G+20 Story 3D Model



V. RESULTS

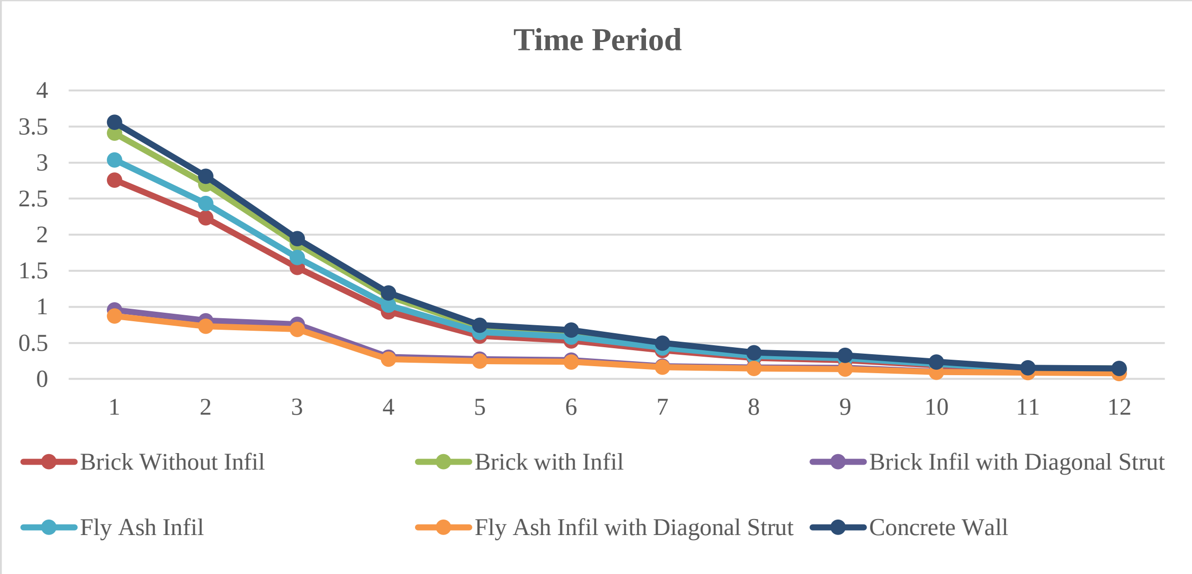
In the present study, Relative Analysis of RCC structure with different types of wall materials and conditions i. e Brick without infill wall, brick infill wall, brick infill with diagonal strut, fly ash infill wall, fly ash infill wall with diagonal strut and concrete wall building with G+20 story building.

Table 2. Time Period Results In Different Types of Wall Material and Conditions

	Without Infill Brick Wall	With Infill Brick Wall	Infill Brick Wall With Diagonal Bracing	Fly Ash Infill Wall	Fly Ash Infill Wall With Diagonal Bracing	Concrete Infill Wall
Mode	**Period**	**Period**	**Period**	**Period**	**Period**	**Period**
	sec	sec	sec	sec	sec	sec
1	2.761	3.409	0.959	3.039	0.874	3.56
2	2.236	2.702	0.81	2.435	0.732	2.812
3	1.547	1.873	0.759	1.686	0.691	1.948
4	0.933	1.146	0.304	1.025	0.276	1.196
5	0.598	0.719	0.276	0.65	0.25	0.747
6	0.531	0.651	0.263	0.583	0.239	0.679
7	0.397	0.48	0.179	0.433	0.164	0.499
8	0.294	0.352	0.161	0.319	0.148	0.366
9	0.263	0.316	0.153	0.286	0.139	0.329
10	0.19	0.23	0.102	0.207	0.096	0.239

11	0.13	0.151	0.094	0.138	0.089	0.157
12	0.127	0.145	0.084	0.136	0.079	0.148

Graph 1. Modal Time Period vs. Different Types of Wall Materials



VI. CONCLUSIONS

In the present study, Relative Analysis of RCC structure with different types of wall materials in building i. e. Brick without infill wall, brick with infill wall, Brick infill with diagonal bracing, fly ash wall, fly ash with diagonal bracing and concrete wall building with G+20 story building in earthquake zone III with medium soil. The structures are analyses for earthquake zone III with medium soil and Results Compare. It has been made on different structural parameters viz. base shear, Earthquake displacement, Wind displacement, story force and modal mass participations etc. Grounded on the analysis results following conclusions are drawn.

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