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Numerical Study of Scaled 3D Infilled RC Frame Tested on 6 DOF Shake

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Abstract: Reinforced concrete frame with masonry infill are construction typology mostly used around the world. The masonry infill has some desirable effect, i.e., increase in energy dissipation, lowering the top displacement and some undesirable effect i.e., short column effect, soft story effect. During analysis the effect of infill are usually ignored, due to which this effect the overall resulting behavior of structure. Various researchers have made researches to understand the behavior. Here in this study, three different types of models were considered with different number of bays, for both bare and infill. Models were analyzed with static modal analysis and non-linear pushover analysis. Modal analysis shows the fundamental period and comparison was made for all structures, which shows how the time period of structures changes with introduction of infill. Pushover curves are plotted for all the structures, and comparison has been made for infill and bare structures.

I. INTRODUCTION

Large number of building are constructed with masonry infill now a days for functional and architectural purposes. These infill are considered as nonstructural element and usually their stiffness contributions are normally ignored in analysis and design. This infill typically consists of masonry bricks and blocks. However, when the structure is subjected to some lateral or earthquake loading, infill wall interacts with the frame, and also exhibit energy dissipation during loading conditions. The infill panel may be integral and non-integral depending on the connectivity of infill to frame. various researchers have worked on infill to frame interaction. Present codes, IS 1893: 2000 practice does not include provision of taking into consideration the effect of infill. While considering the infill in analysis, the result of structure may differ. Significant experimental and analytical researches have been made, which attempts to explain the behavior of infilled frames. This infills gives a significant contribution to energy dissipation and decreasing significant maximum displacement of structures. Therefore, the contributions of infill have a significant effect on RC frame, especially in seismic forces.

II. DESCRIPTION OF STRUCTURAL MODEL

The available model for determining the infill within reinforced concrete frame can be grouped into micro model and macro model. Micro model captures the interaction of infill with RC frame in much more detail, and require high computational efforts and time. While macro model use, when there is need of only capturing the global and over all behavior of structure. This approach is computationally efficient and require less time. Various researchers have used various methods for the macro model. FEMA 356 explained the use of equivalent diagonal strut, which acts as a compression member within RC frame. Diagonal strut model can be single diagonal strut, double diagonal strut or three diagonal struts. The infill wall has been modelled by double diagonal strut here in this study. This behaves like compression strut between columns and beams, which transferred compression forces form one node to another node. Various researchers have derived various mathematical equations for the width of struts. Based on FEMA 356, the following relation were used for determining the width of strut,

$$a = 0.175\,((\lambda_1.h_{col})\text{-}0.4) \times r_{inf}$$

Where, λ_1 is coefficient used to determine equivalent width of infill strut can be calculated by using the following relation.

$$\lambda_1 = ((E_m.t_{inf}.\sin 2\theta)/\,(4.E_f.I_{col}.h_{inf}))^{\mathbf{0.25}}$$

Where, E_m = modulus of elasticity for infill, i.e., $550xf_m$
E_f = expected modulus of elasticity for frame material,
t_{inf} = the thickness of the infill wall,
h_{col} = Column height
I_{col} = moment of inertia of the section of the column of the surrounding frame,
h_{inf} = height of the infill wall panel
r_{inf} = the length of the diagonal strut.

III. DESCRIPTION OF PROPOSED STRUCTURE

In this study, three different models 4 four story, 8 story and 12 story were considered for both bare and infill model. each model having different no of bays i.e., 3, 4 and 5 bays in X-direction and 3 bays in Y-direction. Story height were considered as 12 feet and bay to bay dimensions were considered as 10 feet. Size of the beams and size of the columns were considered as 600 x 600 mm. depth of the slab is considered as 120 mm. the columns are assumed to be fixed at the ground level.

M20 grade for concrete is used with modulus of elasticity 22360 MPA. Grade 60 steel were used with modulus of elasticity 200 GPA within RC member. Unit weight for brick masonry 20 KN/m^2 were considered with modulus of elasticity 2035 MPA. Seismic zone 4 is considered.

To observe the effect of infill and no of bays on the model response, the following different models were considered for both Bare and Infill.

Table 1: Detail of proposed Structures

Model	No of Storey	X-Direction	Y-Direction	
Model 1	4 Story	3 Bays	3 Bays	Both bare and infill
Model 2	4 Story	4 Bays	3 Bays	Both bare and infill
Model 3	4 Story	5 Bays	3 Bays	Both bare and infill
Model 4	8 Story	3 Bays	3 Bays	Both bare and infill
Model 5	8 Story	4 Bays	3 Bays	Both bare and infill
Model 6	8 Story	5 Bays	3 Bays	Both bare and infill
Model 7	12 Story	3 Bays	3 Bays	Both bare and infill
Model 8	12 story	4 Bays	3 Bays	Both bare and infill
Model 9	12 Story	5 Bays	3 Bays	Both bare and infill

IV. NON-LINEAR ANALYSIS

In this study, two types analysis were performed, i.e., Static Modal analysis and non-linear Push over analysis in Nonlinear Finite Element Software SAP2000 v 21. Modal analysis was conducted to determine the frequencies and time period for different models. In this the model was analyzed under gravity load and no lateral load was applied. Push over analysis were performed to determine the seismic response of the structural system. This procedure also helps to demonstrate, how building work by identifying mode of failure and the total potential for progressive collapse. Under the nonlinear static procedure, the model is subjected to gravity analysis (60 % of dead load and 20 % of live load), and simultaneously displaced using preselected lateral load pattern, until the top floor displacement reaches to the target displacement. And resulting internal deformation and forces are determined.

Columns and beams were modelled as frame element and slabs were modelled as shell element. Default M-3 hinges were assigned to beams and interacting hinges P-M2-M3 hinges were assigned to columns as defined by FEMA 356. Infill within RC frame were modelled by double diagonal strut element, with both ends pinned and active in compression only. Push over analysis were carried out by displacement control method. The displacement was targeted as 4 % of the total height of the model. the resulting base shear and top floor displacement were considered to define the push over curve.

V. RESULT AND DISCUSSIONS

Both the buildings (infilled and bare) were analyzed with static modal analysis. Push over analysis were also carried out, which provides an insight into the structural aspects, and deals with the ductility and strength of the structure.

The periods of vibrations were determined using Eigen value analysis in SAP 2000. As the infill introduce, the stiffness of the structure increased and hence the fundamental period of model reduces, due to which the structure attracts more base shear. Figure 1 (a to c) shows the comparison between the fundamental periods for infilled and bare model. Figure 1 (d) shows, as the number of stories increases the fundamental periods also increase.

Base shear and top floor displacement curve are drawn in Fig. 2 and Fig. 3 for both infilled and bare structure. This shows with the introduction of diagonal structs, the structure becomes more stiffens and gives more base shear capacity. With the increment of number of bays, the base shear increased by 80 %. Similarly, by introducing the diagonal strut, base shear increased and hence the top floor displacement decreased by 85%. Diagonal strut also increased the energy dissipation capacity, and no plastic hinges were observed as compared to bare frame.

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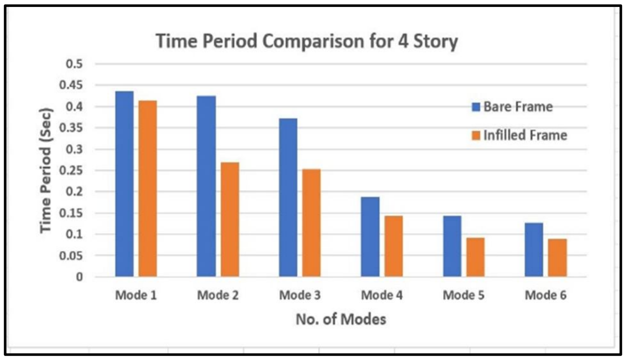
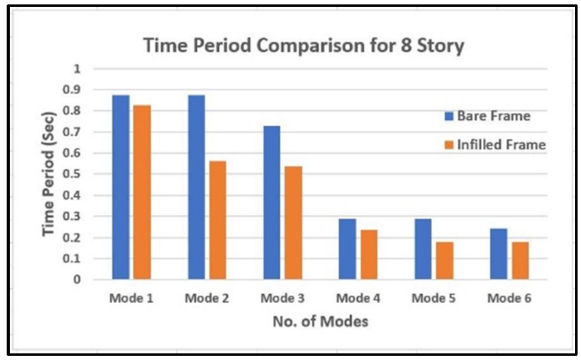


(a)



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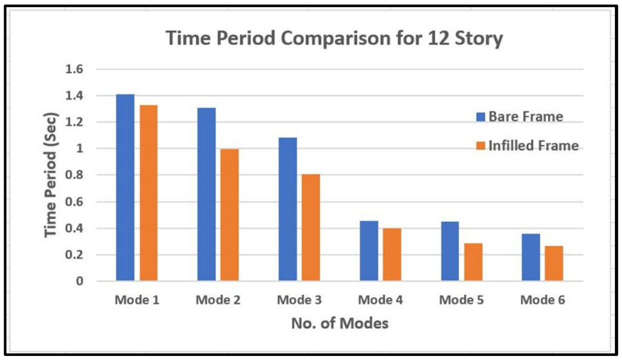

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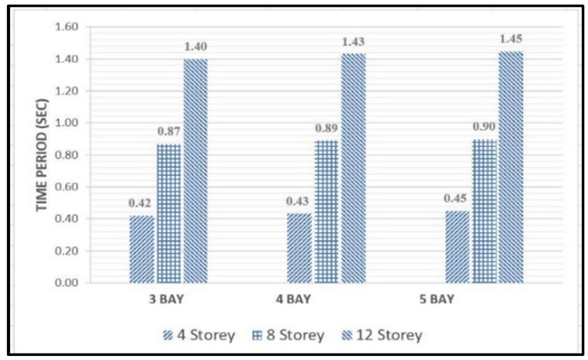
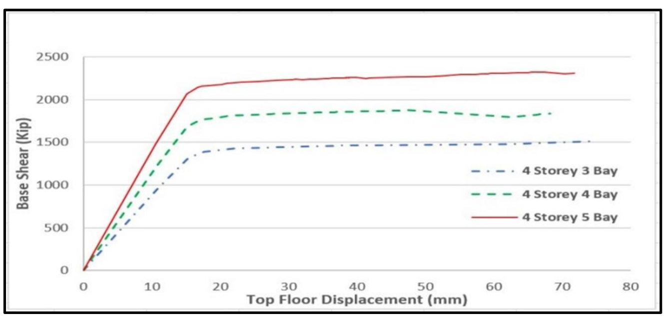
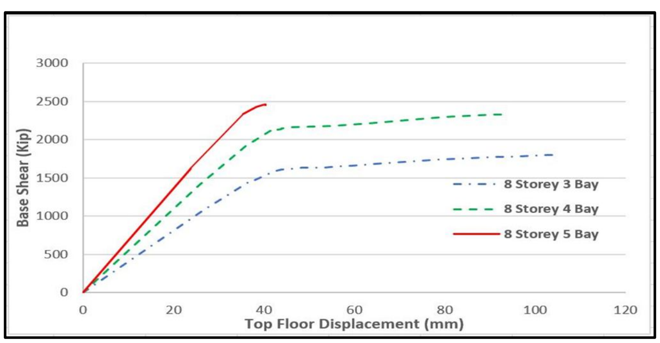


(d)

Figure no 1: Time Periods Comparison for Bare frame and infilled frame



(a)



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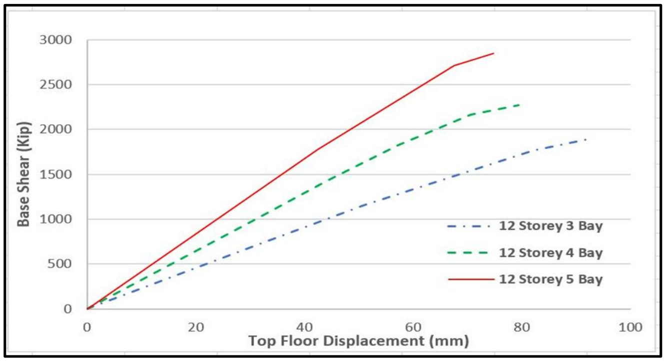
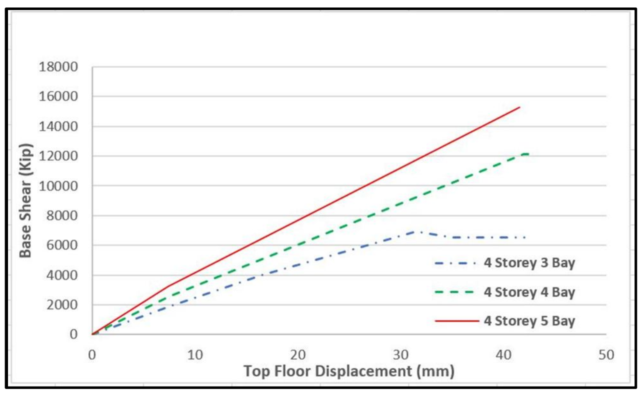


(c)

Figure no 2: Pushover curves for Bare frames

(a)



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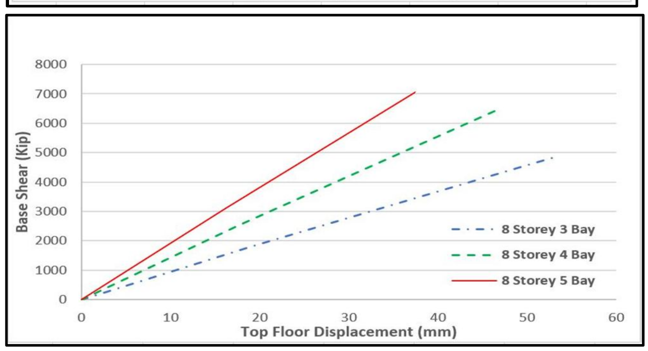

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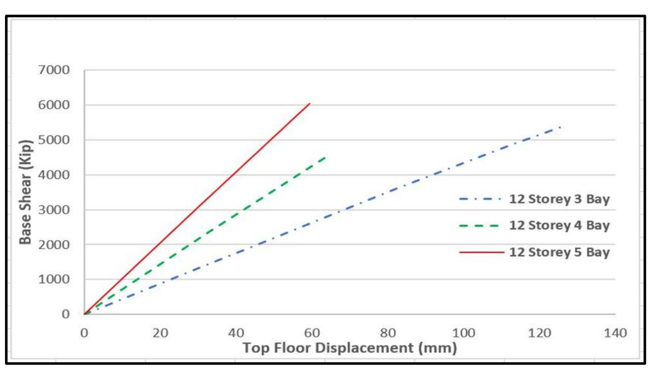

Figure no 3: Pushver curves for Infilled frames

VI. CONCLUSIONS

The effect of masonry infill wall on multi story RC building are illustrated under seismic loading through typical example. The infill wall modifies the strength of RC frame and structural force distribution significantly. It can be seen here, that total shear force increases significantly and the structure stiffens due to the presence of infill. The bare frame act as moment resisting frame and plastic hinges were created under lateral loading. As the bending moment increases at the bottom, plastic hinges were created at the lower portions of structures, which leads to short story effect. In contrast, the infilled frame behaves like a braced frame resisted by truss mechanism which is formed by compression in masonry infill. It can also be concluded here, as the stiffness for a structure increases, the fundamental periods of vibration decreases, this will show better results under seismic loading.

REFERENCES

[1] Swarnkar, S., & Datta, D. (2015). Analysis of Building with Infill Walls, *2*(9), 71–76.
[2] Viswanathan, S., Ravi, S., Nagarajan, T., & Srinivas, V. (2014). Numerical Simulation of Compression and Shear Behaviour of Unreinforced Brick Masonry, 72–77.
[3] Analysis, P. (n.d.). CHAPTER 2, 14–41.
[4] Davis, R., Krishnan, P., Menon, D., & Prasad, A. M. (2004). 13 th World Conference on Earthquake Engineering MULTI-STOREY RC FRAMED BUILDINGS IN INDIA, (1198), 1–9.
[5] Paul, G., & Agarwal, P. (2012). EXPERIMENTAL VERIFICATION OF SEISMIC EVALUATION OF RC FRAME BUILDING DESIGNED AS PER PREVIOUS IS CODES BEFORE AND AFTER RETROFITTING BY USING STEEL, *13*(2), 165–179.
[6] Mazzotta, V., Brunesi, E., & Nascimbene, R. (2017). Numerical Modeling and Seismic Analysis of Tall Steel Buildings with Braced Frame Systems.
[7] Pradesh, A. (2017). A STUDY ON SEISMIC RESPONSE OF REINFORCED CONCRETE FRAMED BUILDINGS WITH AND WITHOUT INFILL WALLS, 1250–1263.
[8] Mazzotta, V., Brunesi, E., & Nascimbene, R. (2017). Numerical Modeling and Seismic Analysis of Tall Steel Buildings with Braced Frame Systems.