IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 60-65

Effect of Infill on Seismic Response of High Rise Symmetric and Unsymmetric RC Frame Structure

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Abstract: *These brick masonry or concrete block walls are generally not considered in the design process and treated as non-structural components. In this paper seismic analysis has been performed using Equivalent static analysis, Response spectrum analysis and wind analysis on four types of structures symmetric plan with symmetric elevation, symmetric plan with two types of unsymmetric elevations and unsymmetric plan with symmetric elevation for G+15, G+35 and G+ 55 story bare frame and infill frame panel. The results are discussed and conclusion were made for bare frame and infill panel frame. In modelling the masonry infill panels the Equivalent diagonal Strut method is used and the software ETABS is used for the analysis of all the frame models.*

Keywords: *Bare, equivalent static analysis, Infill, RC frame, Response spectrum analysis, Wind analysis*

I. Introduction

General

Earthquake is responsible for ground motion in haphazard manner in horizontally as well as vertically, in all directions radiating from the epicentre. Structures founded in ground vibrate, inducing inertial forces on them. Reinforced concrete (RC) frame buildings with masonry infill walls have been extensively constructed for residential and commercial uses in seismic-prone regions in whole world.

Rc Bare Frame

It is the most frequent model of structural analysis for the building all around the world. In frame, the beam and columns are treated and designed as a frame member. Fig. 2.1.1 shows bare frame model. The contradiction may occur in the analysis and seismic response of the structure because the strength and stiffness characteristic of the infill is not considered. Although this model is still used in the most parts of the world even in seismic prone areas

Fig.1.1 Bare frame model

Infill Panel Frame

The contribution of masonry is of great importance, even though strongly depending on the characteristics of the ground motion, especially for frames which has been designed without considering the seismic forces. In this analysis the strength and stiffness of the brick masonry infill is consideredand it is modelled using diagonal strut.

Fig.1.2 Infill panel frame model

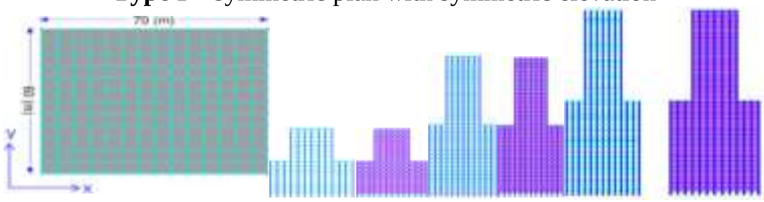
II. Objectives

1. The primary aim of the present study is to analyse the symmetric and unsymmetric plan as well as elevation of RC frame structures with and without masonry infill wall under seismic condition.
2. To analyse G+15, G+35, G+55 storey reinforced concrete bare framed and masonry infill wall structures with symmetric plan and symmetric elevation, symmetric plan and unsymmetric elevation unsymmetric plan and symmetric elevation, under seismic condition.
3. To compare response of RC frame with and without masonry infill wall with respect to time period, base shear, story shear, story displacement and story drift.

III. Structures And Design Data

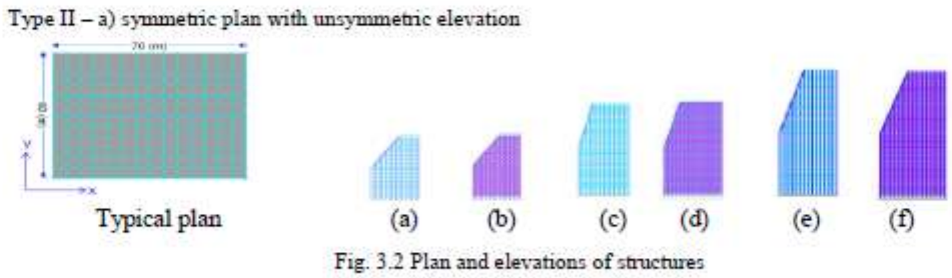
Following types of structure analyzed

Type I – symmetric plan with symmetric elevation



Typical plan (a) (b) (c) (d) (e) (f)

Fig. 3.1 Plan and elevations of structures Type II – a) symmetric plan with unsymmetric elevation



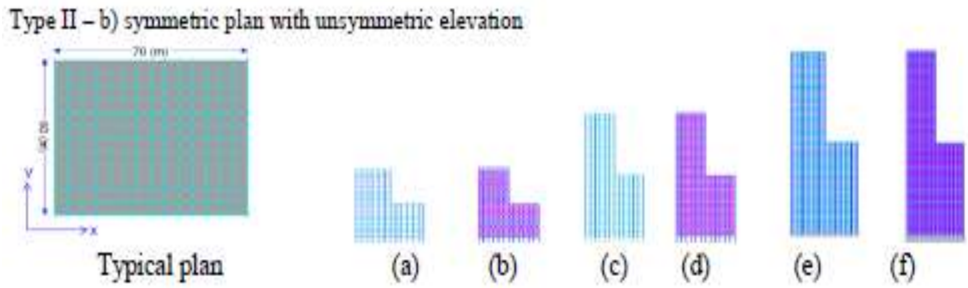
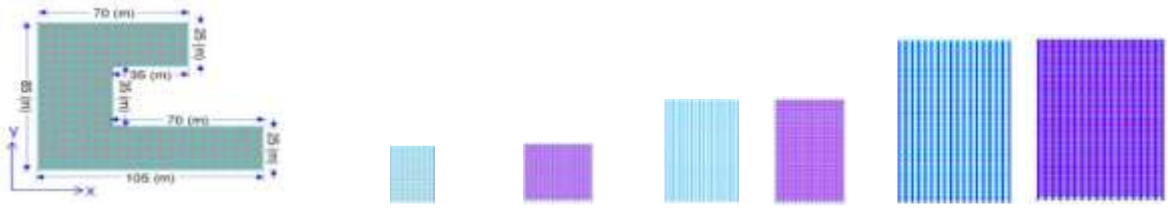


Fig. 3.3 Plan and elevations of structures

Type III – unsymmetric plan with symmetric elevation



Typical plan (a) (b) (c) (d) (e) (f)

Fig. 3.4 Plan and elevations of structures

Table 3.1: Input data for modelling the RC frame structure in ETAB

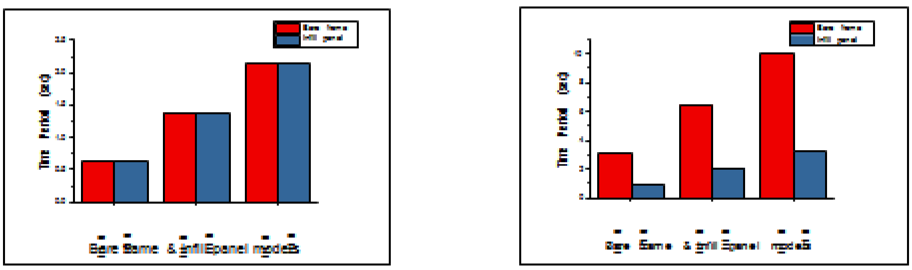
Type of Building	Commercial
Storey	15, 35, 55
Types of frame	SMRF
Grade of concrete	M 40
Grade of steel	Fe 415
Seismic zone	III
Zone factor (Z)	0.16
R factor	5
Damping ratio	5%
Soil type	Medium soil

IV. Results And Discussions

Present research is based on the analysis of G+15, G+35 and G+55 bare frame and infill panel models under seismic condition. The analysis is carried out on the structures with symmetric plan with symmetric elevation, symmetric plan with unsymmetric elevation and unsymmetric plan with symmetric elevation. The responses based on the results obtained are presented in terms of time period, base shear, story shear, story drift and story displacement. The structural responses for the bare frame and infill panel frame are compared and results are presented in graphical form for G+15, G+35 and G+55 for the case of symmetric plan with unsymmetric elevation.

Time Period

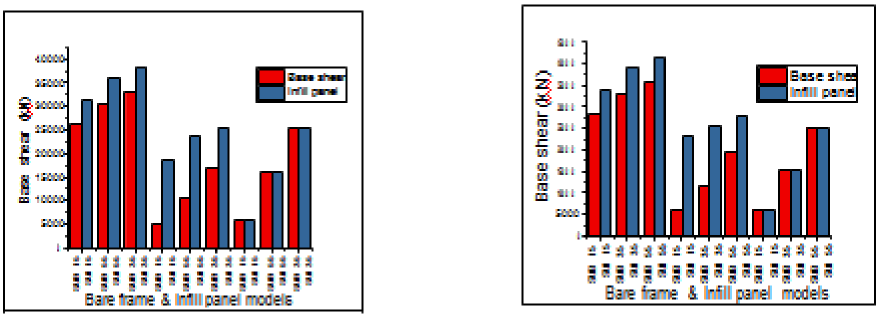
Fig.4.1. (a) shows that time period calculated by ESA is same for bare frame and infill panel frame. Fig. 4.1 (b) shows time period calculated by modal analysis and it is observed that time period for infill panel structure is reduced by 29.57%, 31.45% and 32.92% for G+15, G+35 and G+55 stories as compared to bare frame structure bare frame structure.



(a) (b)

Fig. 4.1: Time period (a) Equivalent static analysis (b) Modal analysis

Base Shear



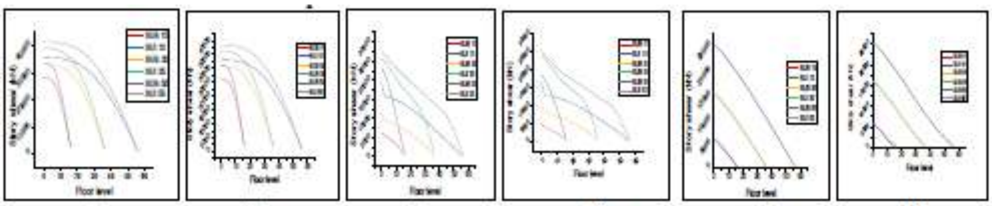
(a) (b)

Fig. 4.2: Base shear (a) in X-direction (b) in Y-direction

Fig. 4.2 shows base shear in X and Y direction of G+15, G+35 and G+55 structures for bare frame and infill panel structures. From Fig. 4.2 (a) and Fig. 4.2 (b) it is observed that base shear of infill panel frame is significantly more as compared to bare frame structure. Base shear obtained by ESA for G+15, G+35 and G+55 is increased by 11.88%, 11.79% and 11.60% in the case of infilled wall panel as compared with results of bare frame respectively. Base shear obtained by RSA for G+15, G+35 and G+55 is increased by 37.55%, 22.19% and 14.48% in case of infilled wall panel as compared with results of bare frame respectively. But base shear obtained by wind analysis is same in both cases. These increases in stiffness may cause an increase of the base shear, depending on both the frame analysed and the characteristics of the ground motion. The addition of the infills decreases the corresponding periods which can produce an increase in the strength demand.

Story Shear

Fig. 4.3 (a), (b), (c), (d), (e) and (f) shows story shear in X and Y direction of G+15, G+35 and G+55 structures for bare frame and infill panel structures using ESA, RSA and wind analysis respectively. From Fig. 4.3 it is observed that overall story shear calculated by ESA for G+15, G+35 and G+55 infill panel frame is 12%, 11.79% and 11.70% more as compared to bare frame respectively. Whereas overall story shear calculated by RSA for G+15, G+35 and G+55 for infill panel frame is 32.09%, 34.02% and 33.64% more than bare frame respectively. In the case of wind analysis story shear is same for bare frame and infill panel frame.



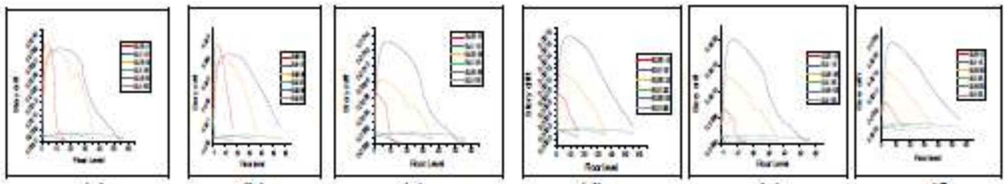
(a) (b) (c) (d) (e) (f)

Fig. 4.3: Story shear (a) in X direction by ESA (b) in Y-direction by ESA (c) in X-direction by RSA (d) in Y-direction by RSA (e) in X-direction by wind analysis (f) in Y-direction by wind analysis

Story Drift

Fig. 4.4 (a), (b), (c), (d), (e) and (f) shows story drift in X and Y direction of G+15, G+35 and G+55 structures for bare frame and infill panel structures respectively. The principal information derived from these investigations has indicated that story drift for G+15, G+35 and G+55 is minimum for infill panel frame as compared to bare frame model. From Fig. 4.4 (a) and (b) it is observed from results of ESA for G+15, G+35 and G+55 infill panel model story drift is decrease by 14.32%, 29.32% and 29.70% as compared to bare frame respectively. From Fig. 4.4 (c) and (d) it is observed from results of RSA that for G+15, G+35 and G+55 infill panel model, story drift is decrease by 41.50%, 66.92% and 44.87% as compared to bare frame respectively. Wind analysis results shows that for G+15, G+35 and G+55 infill panel model story drift are decrease by 15.49%, 30.82% and

30.93% as compared to bare frame respectively. Introduction of infill panels in the analysis of RC frame decreases story drift.

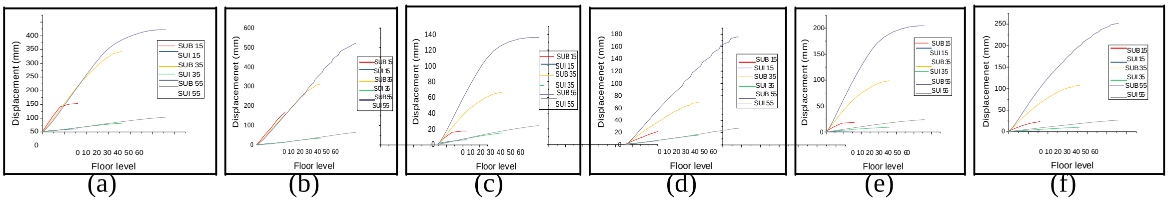


(a) (b) (c) (d) (e) (f)

Fig. 4.4: Story drift (a) in X direction by ESA (b) in Y-direction by ESA (c) in X-direction by RSA (d) in Y-direction by RSA (e) in X-direction by wind analysis (f) in Y-direction by wind analysis

4.5 Story Displacement

Fig. 4.5 shows story displacement of G+15, G+35 and G+55 story RC bare frame and infill panel frame in X and Y direction using ESA, RSA and wind analysis respectively. Based on the results obtained story displacement is less for infill panel frame as compared with bare frame. Story displacement calculated by ESA for infill panel is 12% less as compared to bare frame model, by RSA it is 32% less as compared to bare frame models. Story displacement calculated by wind analysis for infill panel frame is 10% less as compared to bare frame models this is due to additional stiffness added by infill panel. Results shows that, displacement is very large in case of bare frame as compare to that of infill frame. If the effect of infill wall is considered then the displacement has reduced. Displacement is more at last storey because earthquake force acting on it more effectively.



(a) (b) (c) (d) (e) (f)

Fig. 4.5: Story displacement (a) in X direction by ESA (b) in Y-direction by ESA (c) in X-direction by RSA (d) in Y-direction by RSA (e) in X-direction by wind analysis (f) in Y-direction by wind analysis.

V. Conclusion

The results obtained from analysis for G+15, G+35 and G+55 with and without infill walls by equivalent static analysis, response spectrum analysis and wind analysis in terms of time period, base shear, story shear, story drift and story displacements. The main objective of this study is to analyse and calculate response of high rise RC bare frame and infill wall frame with symmetric plan with symmetric elevation, symmetric plan with unsymmetric elevation and unsymmetric plan with symmetric elevation under seismic loading.

1. Result shows that an introduction of infill panels in the analysis of RC frame reduces the time period of bare frames and it enhances the stiffness of the structure.
2. It has been observed that introduction of infill panel, controls the lateral displacement and storey drift. Story displacement is maximum when infill panel are absent and difference is significant if compared with infill wall structure.
3. There is a considerable difference in the base shear and the lateral forces of bare frame and infilled frame. The base shear of infilled frame is 40 % more than bare frame.
4. Overall result shows that stiffness of RC frame is more as compared with the results of RC bare frame.
5. Overall results show that story drift is reduced as compared with results of bare frame due to addition of infill panel increases the stiffness of RC frame.
6. Results revealed that RC frame with infill panel model are having more stiffness and rigidity as compared to bare frame model. Whereas symmetric plan with symmetric elevation RC structure with and without infilled wall panel gives better performance under seismic condition.

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