Non-Linear Seismic Analysis of Rc Framed Structures With And Without Infills

Kanakamedala Meghana, B.J.N Satish, M. Shiva Rama Krishna, Mounika Jonnadhula

Abstract: ***Reinforced concrete Structures are very common type of construction in India. Analytically while modeling the structure, we design only beams, columns, slabs and footings, where walls are not considered while designing but wall loads are considered on the beams but in practical construction, the infills are placed in the structure. While designing, infills are not considered as structural elements and their influence on the structural response is neglected. Their impact is shown in the global behaviour of RC frames subjected to seismic loads. So it is very important to study the behaviour of infills on the RC bare frames. The presence of infills results in increase in the structural stiffness; it also increases natural frequency of vibration which depends on seismic spectrum. In addition to that, it also decreases the storey drift demands and increases the storey lateral forces. The presence of infills changes the behaviour of reinforced concrete bare frame along the height of the structure and changing the lateral load transfer mechanism. In this study, 3 and 6-storeyed reinforced frames without infill and with infill is considered and evaluated through non-linear analysis. The objective of this paper is to compare various parameters such as Time period, Base shear, Storey drifts, Displacements and to study the performance of the building. Taking the above parameters into consideration, we can compare performance of infill Structures with the structures without infill in seismic zone III.***

Index Terms**:** ***Reinforced concrete frames, Infill, Time period, Stiffness, Base shear, Overturning moments.***

I. INTRODUCTION

Reinforced concrete frames are the most commonly used the type of structures which are constructed in many moderate and high seismic regions around the world due to ease of construction and rapid progress of work. In analytical study, we consider bare frame RC structure i.e.., beams, columns, slabs and footings. In general construction practice, masonry is placed in between columns and beams which also act as partition walls in the structure; these partitions are also called Infills. The individual units which can be laid together and bound together by using mortar are called masonry and it can be of brick, concrete or stones. The use of masonry can increase the thermal mass of the building and it can also protect the same from fire. Infills have low tensile strength under vertical loads and it has high compressive strength. Reinforced concrete frame structures are generally designed without considering the structural action of infills. They are considered as the non-structural elements of the building. Infills provide the stiffness to the structure and its behavior is different from the bare frame structure. The presence of infill results in an increase in structural stiffness. It also increases the natural frequency of vibration which depends on the seismic spectrum. In addition to that, it also decreases the storey drift demand and increases the storey lateral forces. If the time period of the structure decreases then the stiffness of the structure will be more. Therefore it is important to study the impact of infill walls on Reinforced concrete bare frame. In some cases, the frames are designed to resist the earthquake loads but the infill is rarely included in the structural design as it is a nonstructural element and the layout of infill can have a negative effect on seismic performance. In the seismic zones, the effect of infill on the reinforced structure influences the seismic response of the structure. By using infill frames, the lateral deflection is reduced compared to the reinforced bare frame. Due to the increase in strength and stiffness of infill panels, there will be a decrease in storey drifts and an increase in lateral storey forces. Infill helps in the increase of ductility, stiffness and flexural strength of the members. The presence of infill in the RC structure is more significant in small structures compared to tall structures. As the height of structures increases the effect of infill wall reduces.

In this study, 3 and 6 storey irregular residential structure without infill and with infill is taken into consideration. In reinforced concrete bare frames, wall load is considered on the beams and on the reinforced concrete frame with infill; the infill is taken as the structural component. The objective of this study is to compare various parameters such as time period, base shear, storey drifts, storey displacements and study the performance of the building. Both the models with and without infill for G+2 and G+5 were analyzed using an equivalent static method and response spectrum method according to IS 1893:2002. Pushover analysis (non-linear static method) was also carried out. The pushover analysis gives a clear understanding about the structure, which shows the performance during earthquakes. It also provides data on the strength of a building.

II. DESCRIPTION OF THE MODEL

In this study 3 and 6 storey Reinforced concrete frame with infill and without infill residential structure is considered and modelled. AutoCAD plan of the structure is shown in Fig. 1. The grade of concrete is M25 and steel is Fe415. The length and width of the building are (17.66*14.46) m and the height of plinth and each floor is 1.2m and 3m respectively. The slab thickness is 0.15m. Sizes of Beams and columns

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are (0.23*0.3)m and (0.3*0.45) m. External and internal thickness of the wall is 230mm and 115mm respectively. The dead loads and live loads are taken from IS 875-Part 1&2.

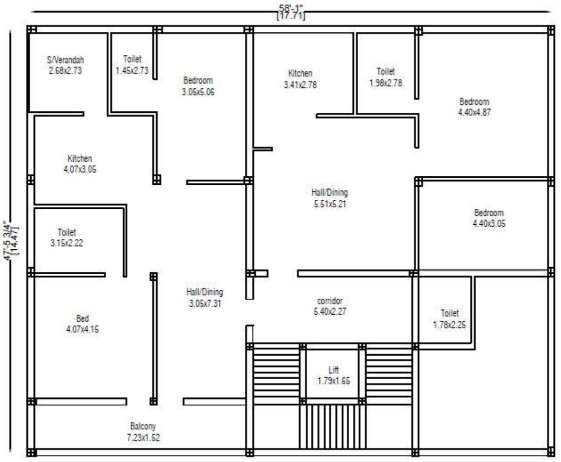

Fig: 1 Architectural Plan of the Structure

The earthquake loads are taken from IS 1893-2002 and linear static and non-linear static analyses are carried on the structure. Both the structures are design by using the above design values. The modeling of the RC bare frame and infill structure for 3 and 6 storeys are shown in the figures 2 & 3. The natural time period of the RC frames with and without infill are calculated by using IS 1893 codebook and the members are designed by using IS 456 codebook.

Fig 2a: G+2 RC Structure without Infill

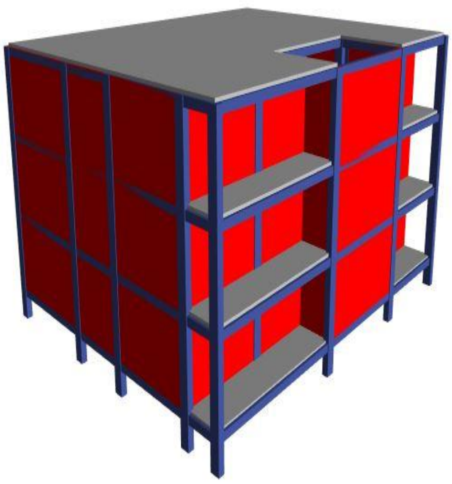

Fig 2b: G+2 RC Structure with Infill

Fig 3a: G+5 RC Structure without Infill

Fig 3b: G+5 RC Structure with Infill

III. RESULTS AND DISCUSSIONS

The fundamental time period is the first time period of the structure and the results are shown in table 1. It is observed that the time period in RC frame with infill is less compared to the RC frame without infill. Considering the infill in the RC frame decreases the time period, increases the stiffness of the structure and increase in the base shear also as shown in table 2. The modes shapes with respective to time period are shown as bar graph in figures 4a &4b.

I: Base Shear (kN) for G+2 and G+5 structures with and without Infill.

	G+2 Structure		**G+5 Structure**	
	Without Infill	**With Infill**	**Without Infill**	**With Infill**
Base Shear (kN)	315.57	484.5	1014.82	1625.9

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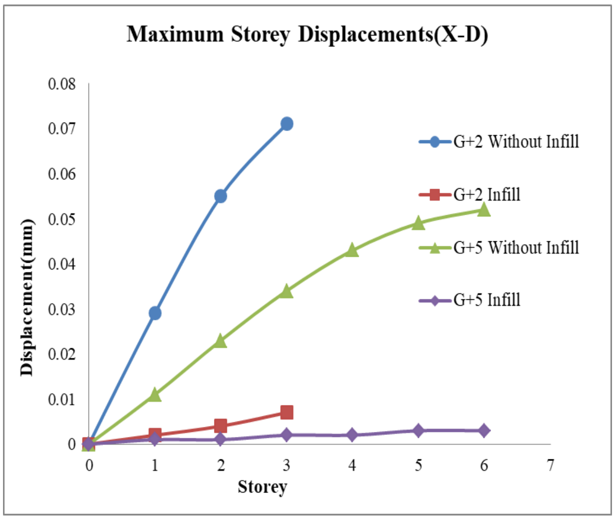

Fig 4a: Maximum storey displacement for G+2 & G+5 Storeys.

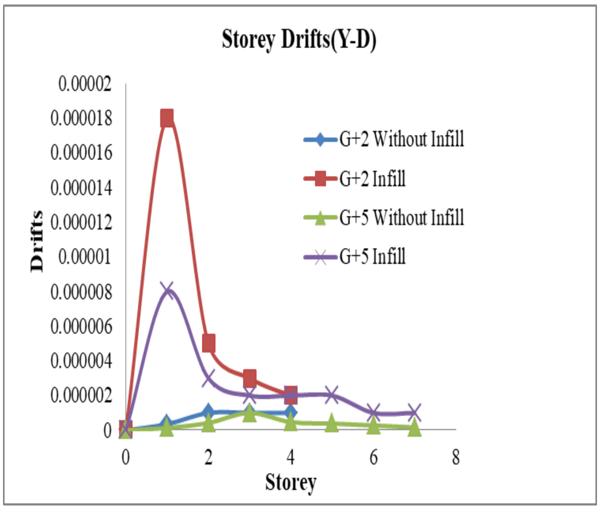

Fig 5b: Maximum Storey Drifts for G+2 &G+5 Storeys.

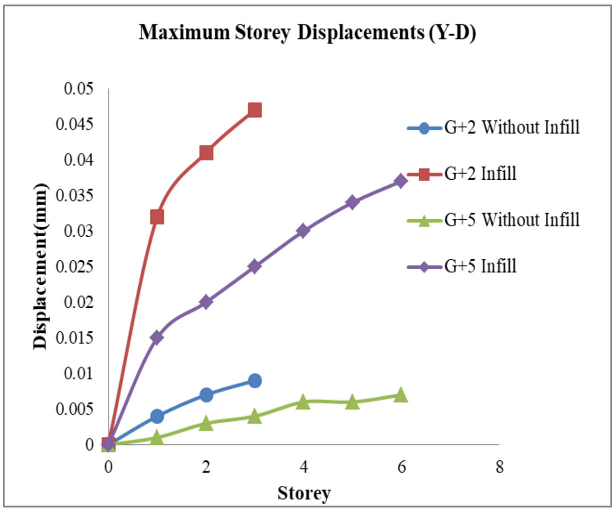

Fig 4b: Maximum storey displacement for G+2 & G+5 Storeys

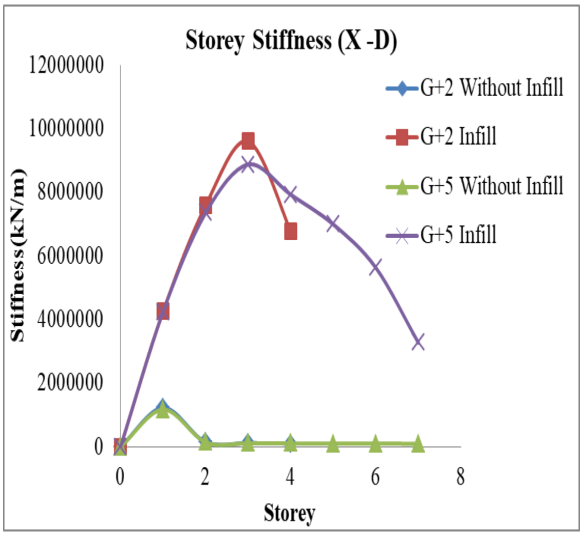

Fig 6a: Maximum Storey Stiffness for G+2& G+5 in X-Direction.

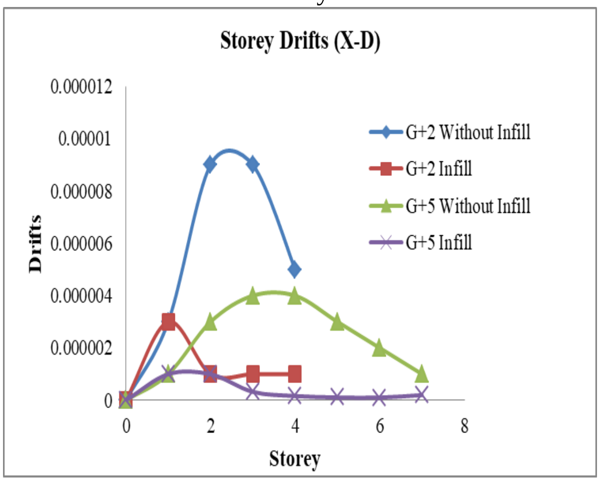

Fig 5a: Maximum Storey Drifts for G+2 &G+5 Storeys

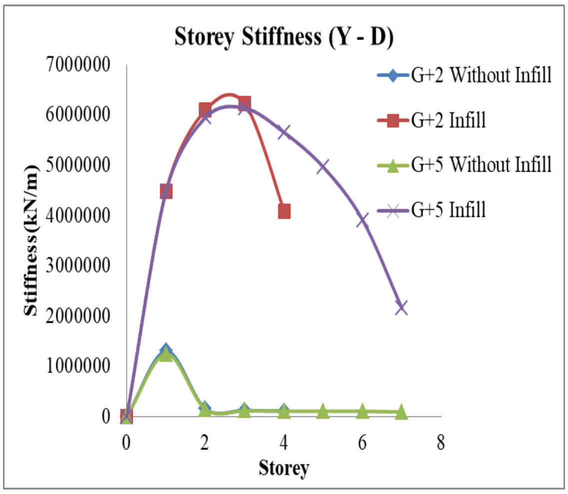

Fig 6b: Maximum Storey Stiffness for G+2& G+5 in Y- Direction

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II: Dynamic characteristics of G+2 Structure

S.No	Time period		Direction		Mode mass participation factor	
	Without Infill	With Infill	Without Infill	With Infill	Without Infill	With Infill
1	0.457	0.114	Longitudinal	Transverse	69.78%	92.07%
2	0.445	0.108	Transverse	Longitudinal	70.4%	95.33%
3	0.386	0.084	Torsion	Torsion	70.27%	98.41%

III: Dynamic characteristics of G+5 Structure

S.No	Time period		Direction		Mode mass participation factor	
	Without Infill	With Infill	Without Infill	With Infill	Without Infill	With Infill
1	1.3	0.255	Longitudinal	Transverse	72.92%	87.45%
2	1.267	0.234	Transverse	Longitudinal	72.82%	91.32%
3	1.184	0.17	Torsion	Torsion	73.34%	96.78%

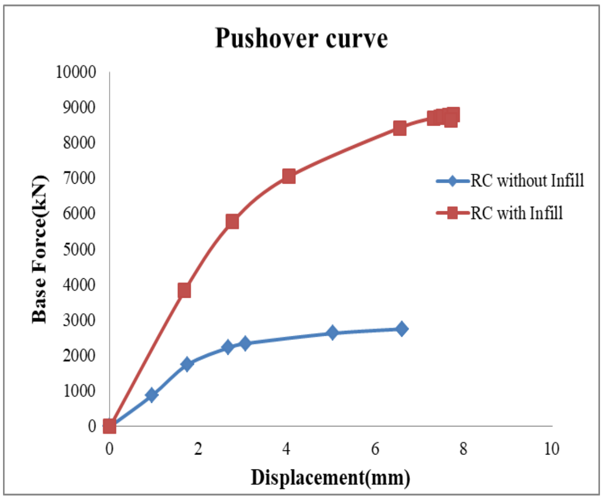

Fig 7: Pushover curve for G+2 Structure

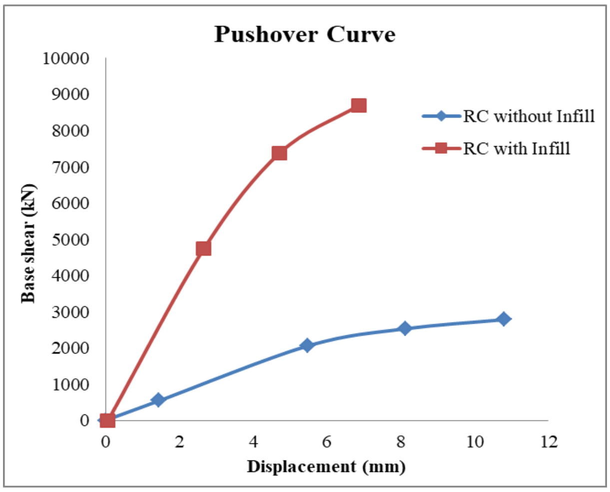

Fig 8: Pushover curve for G+5 Structure.

The discussions G+2 and G+5 storeys are as follows,

- The Base shear is more for RC structure when compared to RC without Infill as it is shown in Table I.
- The Time period of the RC structure with Infill is less than the RC structure without infill. Table II & III represents the Dynamic characteristics of G+2 & G+5.
- In RC structure without Infill, the storey displacement in X-direction and Y-direction is more when compared to RC structure with infill as shown in Fig 4a & 4b.
- In X-direction and Y-direction, the storey drift is less for RC without Infill structure than RC structure with infill as shown in figure 5a & 5b.
- For G+2 structure, the storey stiffness for RC with infill is more compared to RC without infill. Similarly, for G+5 structure as shown in the figure 6a & 6b.
- Compared to both the structures G+2 is good than G+5 for providing infill. Because, stiffness of infill will get decreased with increase in number of storeys, simultaneously stiffness of infill will get increase within minimum number of stories.
- In the presence of infills, the stiffness of the structure and base shear increases.
- The lateral load resisting mechanism of infill frames differs from bare frames.

- Figure 7 and 8 shows the Base shear versus Displacement curve for the structure with and without infill as obtained from pushover analysis. The curve shows that consideration of infill stiffness gives more base shear capacity.

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