REVIEW PAPER ON COMPARATIVE STUDY OF SEISMIC ANALYSIS OF G+15 RCC BUILDING FRAMES WITH AND WITHOUT MASONRY INFILL WALLS

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***ABSTRACT*: Reinforced concrete frames with masonry infill walls are a common practice in countries like India, where the region is prone to seismic activity. Generally the masonry infill walls are treated as nonstructural element in structural analysis and only the contribution of its mass is considered and it's structural properties like strength and stiffness is generally not considered. The structures in high seismic areas are greatly vulnerable to severe damages. Apart from the gravity load structure has to withstand to lateral load which may develop high stresses. Now day's reinforced concrete frames are most common in building construction practice around the globe. The vertical gap in reinforced concrete frames i.e. created by the columns and beams are generally filled in by brick or masonry and it is referred as brick infill wall or panels. In this study these infill walls will be replaced by diagonal strut and analysis will be performed. Comparing results obtained from the computerized model analysis for G+ 15 structures with and without infill. We check the results for base shear, lateral floor displacement, story drift by buildings for the comparison of results.**

***KEYWORDS:* G+15, Bare, Infill, Story drift, Base shear, Time period, Natural frequency.**

INTRODUCTION -

Reinforced concrete (RC) frame buildings with masonry infill walls have been widely constructed for commercial, industrial and multi-family residential uses in seismic-prone regions worldwide. Masonry infill typically consists of brick masonry or concrete block walls, constructed between columns and beams of a RC frame. These panels are generally not considered in the design process and treated as non-structural components. In country like India, Brick masonry infill panels have been widely used as interior and exterior partition walls for aesthetic reasons and functional needs. Though the brick masonry infill is considered to be a non-structural element, but it has its own strength and stiffness. Hence if the effect of brick masonry is considered in analysis and design, considerable increase in strength and stiffness of overall structure may be observed. Present code, IS 1893(Part-I): 2000 of practice does not include provision of taking into consideration the effect of infill. It can be understood that if the effect of infill is taken into account in the analysis and design of frame, the resulting structure may be significantly different.. Moreover, infill, if present in all stories gives a significant contribution to the energy dissipation capacity, decreasing significantly the maximum displacements. Therefore 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. When sudden change in stiffness takes place along the building height, the story at which this drastic change of stiffness occurs is called a soft story. According to IS 1893(Part-I): 2000, a soft story is the one in which the lateral stiffness is less than 50% of the story above or below. In this paper the strength and stiffness of the brick masonry infill is considered and the brick masonry infill is modeled using diagonal strut. The main parameters considered in the study to compare the seismic performance are time period, base shear, natural frequency and story drift.

OBJECTIVES –

The silent objectives of the present study have been identified as follows:

i. To study the effects of building analysis of G +15 story structure with and without infill walls.

ii. To study the effect of brick infill on the stiffness of the structure.

iii. To study the effects of three different models to find which will gives the good performance in analysis of structure w.r.t stiffness, base shear and story drift.

LITERATURE REVIEW –

Past studies also carried out on the behavior of RC frame with in-fills and the modeling, analysis of the RC frame with and without in-fills.

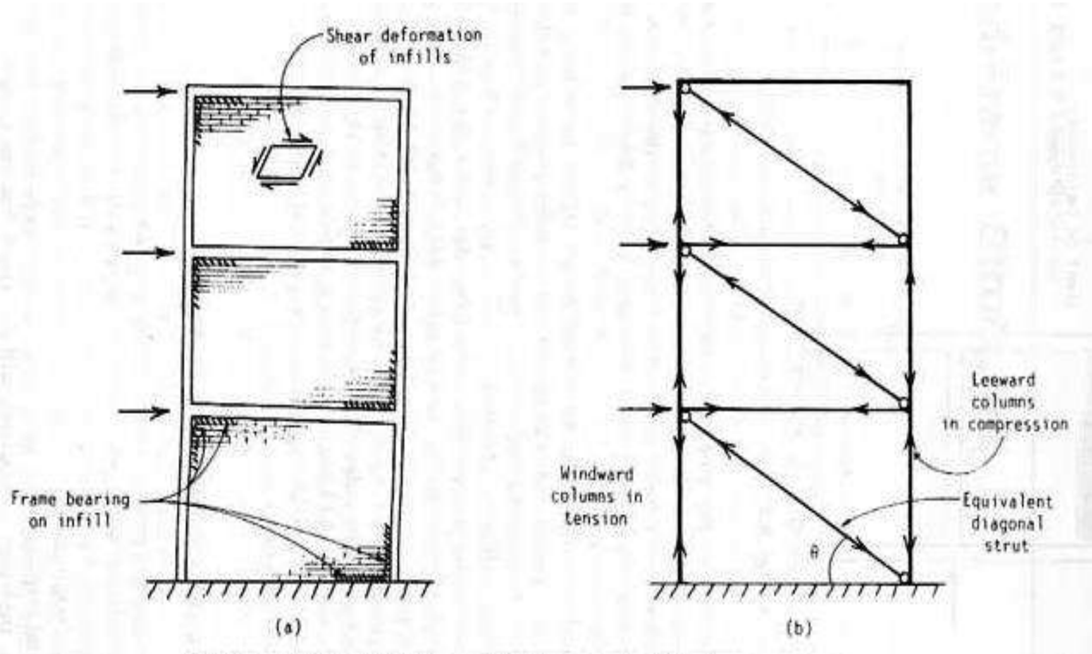
V.K.R.Kodur, M.A.Erki and J.H.P.Quenneville considered a three story RC frame building models for the analysis. These RC frames were analyzed for three cases i) Bare frame ii) Infilled frame iii) Infilled frame with openings. Based on the analysis results they found that Base shear of infilled frame is more than infilled frame with openings and bare frame. Time period of infilled frame is less as compare to infilled frame with openings and bare frame. The natural frequency of infilled frame is more as compare to infilled frame with openings and bare frame.
Mehmet Metin Kose studied the different RC frame models that were bare frame, frame without open first story and frame with open first story. Based on the results obtained from different computer models, it was found that the number of floors (height of building) was the primary parameter affecting the fundamental period of building. The fundamental period of frame without open first story is less than frame with open first story and bare frame.
Jaswant N.Arlekar, Sudhir K.Jain and C.V.R.Murty analyzed the different building models that include building with masonry infill walls in all the story and building with no walls in the first story and bare frame building model. Static and dynamic analysis of building models were performed using software ETABS. It was seen that the natural period of the building by ETABS analysis do not tally with the natural period obtained from the empirical expression of the code IS 1893-1984. The natural period of infilled frame is less as compare to soft first story frame and bare frame building models. Also from the analysis they concluded that RC frame building with soft story perform poorly during strong earthquake shaking. The drift and the strength demands in the first story column are very large for building with soft first story.
P.M. Pardhan, P.L. Pardhan, and R.K. Maske highlighted the need of knowledge on partial infilled frames and the composite action and also summarize the findings till date done by various researches on the behavior of partial infilled frames under lateral load. The infill contributes in the stiffening of the frame and it was reported that the infills can increase the stiffness of the frame 4 to 20 times (referring to number of literature).
Homes studied experimentally on steel frames infilled with brick masonry and reinforced Concrete walls and developed semi-empirical design method for laterally loaded infilled Frames based on equivalent strut concept. His tests suggested that reinforced concrete walls increase the strength of frame by 400% whereas the brick masonry infills increase around 100%. He indicated that the presence of vertical load increased the strength by about 15% and that openings in walls might reduce strength up to 40% based on the composite behavior. The infill was considered to fail in compression. The load carried by infill at failure was calculated by multiplying the compressive strength of material by the area of equivalent strut. He states that the width of equivalent strut to be one third of the diagonal length of infill, which resulted in the infill strength being independent of frame stiffness. The load carried by the frame was then calculated by assuming that the strut was shortened by an amount which was its length multiplied by the strain at failure in the infill material. Subsequently, many investigators developed the strut width value related to the length of contact between wall and the columns and between the wall and the beams.
In 1961 **Holmes** stated that width of diagonal is given by,
$w = dz/3$
Where, dz = Diagonal length of infill panel
Das and C.V.R. Murty (2004) carried out non-linear pushover analysis on five RC frame buildings with brick masonry in-fills, designed for the same seismic hazard as per Euro-code, Nepal Building Code and Indian and the equivalent braced frame method given in literature. In-fills are found to increase the strength and stiffness of the structure, and reduce the drift capacity and structural damage. In-fills reduce the overall structure ductility, but increase the overall strength. Building designed by the equivalent braced frame method showed better overall performance.

METHODOLOGY–

The methodology worked out to achieve the above-mentioned objectives is as follows:

- Review the existing literature and Indian design code provision for analysis and design the earthquake resistance building.
- Considering G+15 building with and without infill for the modeling.
- Model the selected building without infill walls considering infill strength/stiffness.
- Model the selected buildings with infill walls as diagonal strut considering infill strength/stiffness. Model the infill wall as diagonal strut with end conditions as pinned supports.
- Also design the building manually for earthquake load analysis results obtained.
- Observations of results of time period, story drift, lateral displacement and other parameters of models with and without infill.

In the present work it is proposed to carry out seismic analysis of multi-storey RCC buildings using Response spectrum analysis method considering bare and infill frames with the help of STAAD PRO software.



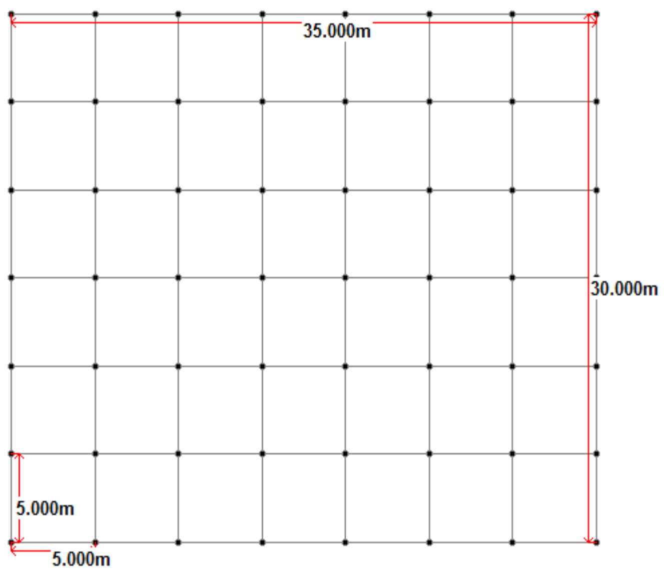
MODELING –

A study is undertaken which involves seismic analysis of RC frame buildings with different models that include bare frame and infilled frame. The parameters such as base shear, time period, natural frequency, story drift and lateral displacement are studied. The software STAAD PRO is used for the analysis of the entire frame models.

Analyzing the data

Following data is used in the analysis of the RC frame building models

- Type of frame: Special RC moment resisting frame fixed at the base
- Seismic zone: Three (3)
- Number of story: 10
- Floor Height: 3.5 m
- Plinth Height: 1.5 m
- Depth of slab: 150 mm
- Spacing between frames: 5 m
- Live load on floor level: 3 kN/m^2
- Live load on roof level: 1.5 kN/m^2
- Floor Finish: 0.6 kN/m^2
- Material: M40 concrete, Fe 500 steel and Brick infill
- Thickness of infill wall: 230 mm
- Density of concrete: 25 kN/m^3
- Density of infill: 20 kN/m^3
- Type of soil: Medium
- Response spectra: As per IS 1893(Part-1):2002
- Damping of structure: 5%



Building Plan

Modeling of Infill Wall

Equivalent Diagonal Strut Method is used for modeling the infill wall. In this method the infill wall is idealized as diagonal strut and the frame is modeled as beam or truss element. Frame analysis techniques are used for the elastic analysis. The idealization is based on the assumption that there is no bond between frame and infill.
The width of the diagonal strut is given as

$$\propto hx = \frac{\pi}{2}\sqrt[4]{\frac{4Ef.Ic.h}{Em.t.sin2\theta}}$$

$$\propto l = \frac{\pi}{2}\sqrt[4]{\frac{4Ef.Ib.l}{Em.t.sin2\theta}}$$

Where,

E_m and E_f = Elastic modulus of the masonry wall and frame material (i.e.,

concrete), respectively

L, h, t = Length, height and thickness of the infill wall, respectively

I_c, I_b = Moment of inertial of column and the beam of structure, respectively

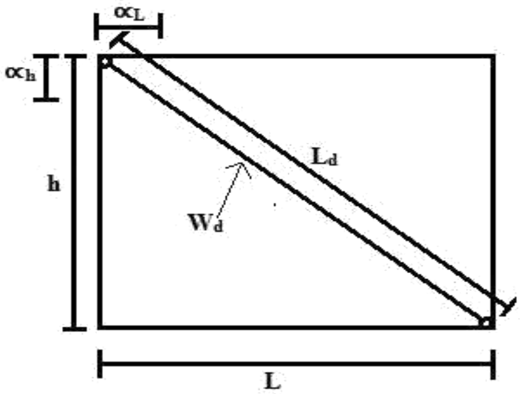
$\theta = \tan^{-1}\frac{h}{l}$ = angle of inclination of diagonal strut

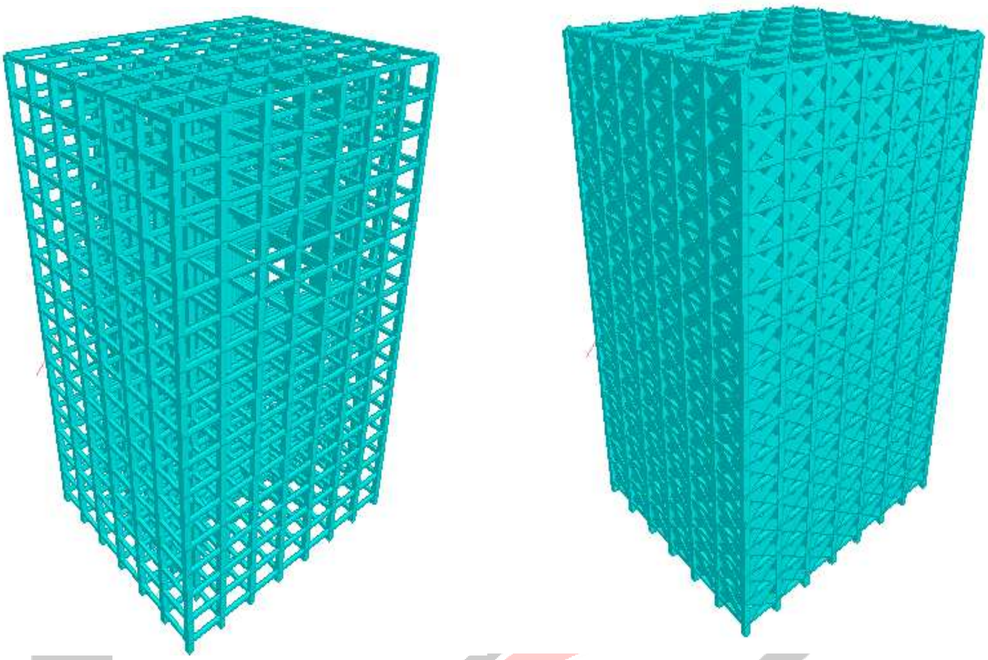
The equation to determine the equivalent or effective strut width (w_d), length (L_d) and area of strut (A_d), where the strut is assumed to be subjected to uniform compressive stress.

$$Wd = \frac{1}{2}\sqrt{\propto h^2 + \propto l^2}$$

$$Ld = \sqrt{h^2 + l^2}$$

$$Ad = t.Wd$$





3-D View of G+15 With and Without Infill Strut building

RESULTS AND DISCUSSION –

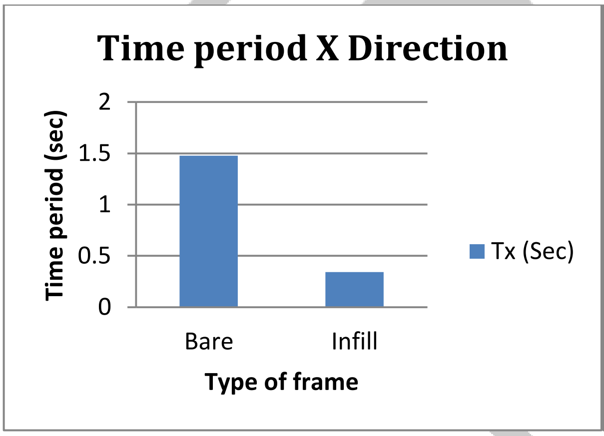
The seismic analysis of the entire frame models that includes bare frame, infilled frame and open first story frame has been done by using software STAAD PRO and the results are shown below. The parameters which are to be studied are time period, natural frequency, base shear and story drift.

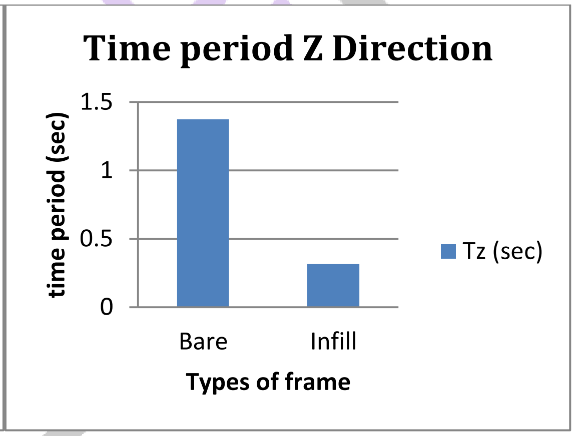
Parameters	Bare	Infill
Tx (Sec)	1.478	0.341
Tz (sec)	1.375	0.316
ωx (Hz)	0.677	2.933
ωz (Hz)	0.727	3.168
Vbx (kN)	5017.85	11713.74
Vby (kN)	4646.66	13127.94

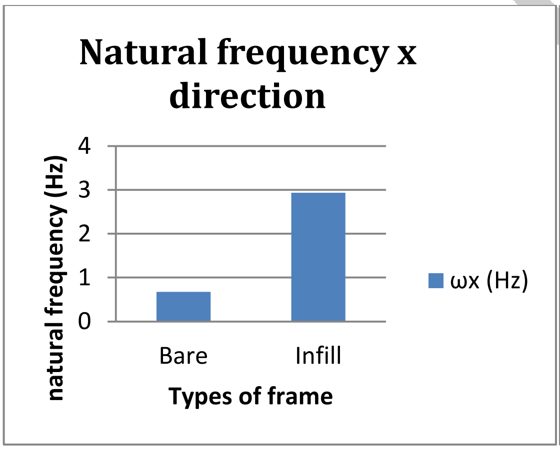
Where
Tx – Time period in X direction in seconds
Tz – Time period in z direction in seconds
ωx – Natural frequency in X direction in Hz
ωz – Natural frequency in z direction in Hz
VBx – Base shear in X direction in KN
VBz – Base shear in z direction in KN

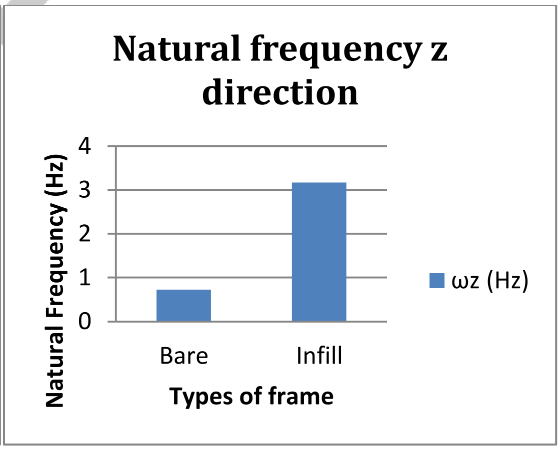
Absolute story drift

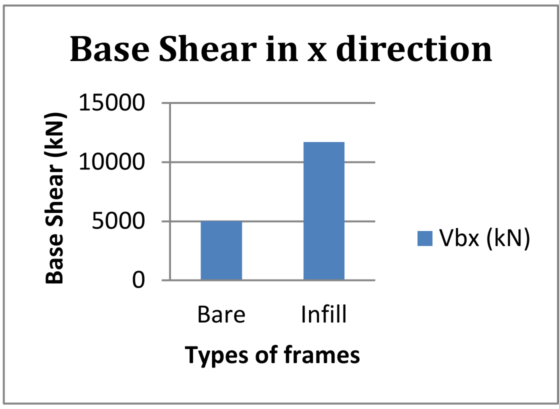
Floor Ht	Bare	Infill
-1.5	0	0
0	0.621	0.277
3.5	4.616	0.339
7	6.292	0.35
10.5	6.696	0.385
14	6.641	0.41
17.5	6.399	0.428
21	6.067	0.442
24.5	5.689	0.449
28	5.284	0.453
31.5	4.86	0.45
35	4.413	0.443
38.5	3.937	0.44
42	3.42	0.427
45.5	2.857	0.419
49	2.25	0.396
52.5	1.628	0.381
56	1.079	0.355

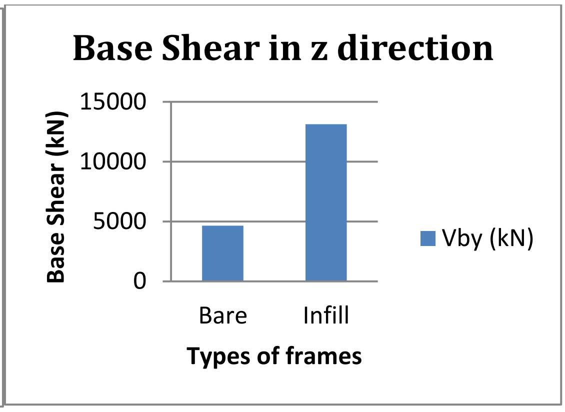


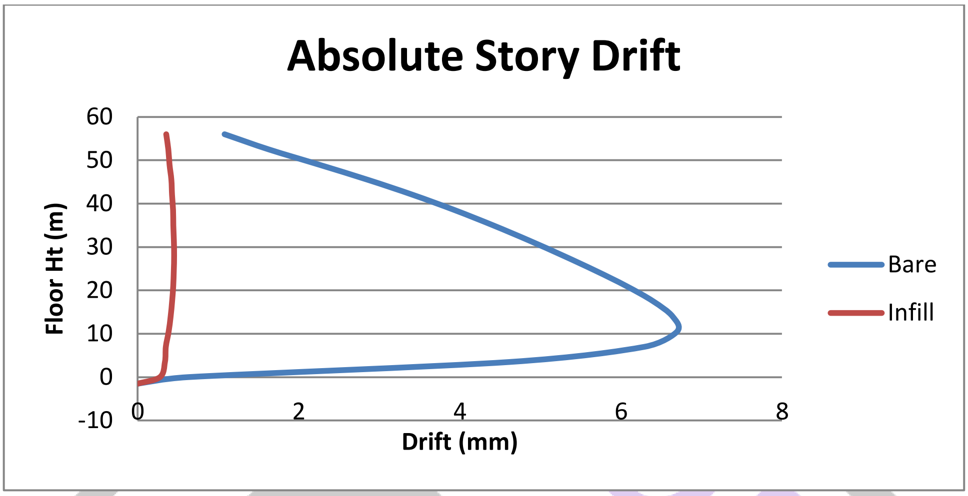












CONCLUSION

From the analysis seismic performance of RC framed buildings with and with-out infill wall observed the results of change in time period, base shear and story drift of the buildings for all the structures of G+15 models. When compared the bare-frame model and equivalent diagonal strut models results for seismic load analysis observed that without considering the stiffness of infill frame in bare model stiffness of the building is very less where are the strut models which considered the stiffness of infill as strut has more stiffness of the building and also economical in section area of steel. Therefore, strut model gives the accurate performance of building during the seismic analysis of buildings.

REFERENCES

[1] **P.M.Pradhan**, **P.L.Pradhan**, **R.K.Maskey** "Kathmandu University Journal of Sciences, Engineering and Technology, Vol.8 No I, February 2012, Pp 142-152.

[2] **B.Srinavas** and **B.K.Raghu** Prasad "The Influence of Masonry in RC Multistory Buildings to Near- Fault Ground Motions" Journal of International Association for Bridge and Structural Engineering (IABSE) 2009, PP 240-248.

[3] **Mulgund G.V** "Seismic Assessments of RC Frame Buildings with Brick Masonry Infills" International Journal of Advanced Engineering and Technologies, Vol No.2 Issue No.2, 140-147(2011).

[4] **P.G.Asteris** "Lateral Stiffness of Brick Masonry Infilled Plane Frames" Journal of Structural Engineering" ASCE (2003).

[5] **Diptesh Das** and **C.V.R.Murty** "Brick masonry infills in seismic design of RC framed buildings" Part 1- Cost implifications, The Indian Concrete Journal (2004).

[6] **Siamak Sattar and Abbic B.Liel** "Seismic Performance of Reinforced Concrete Frame Structures With and Without Masonry Infill Walls" University of Colorado, Boulder.

[7] **V.K.R.Kodur, M.A.Erki and J.H.P.Quenneville** "Seismic analysis of infilled frames" Journal of Structural Engineering Vol.25, No.2, July 1998 PP 95-102.

[8] **P. G. Asteris, 2003**, M.ASCE, Lateral Stiffness of Brick Masonry In filled Plane Frames, Journal of Structural Engineering, Vol.129, No.8, August1, 2003.ASCE, ISSN0733-9445/2003/8-1071±1079.

[9] **Mehmet Metin Kose** "Parameters affecting the fundamental period of RC buildings with infill walls" Engineering Structures 31 (2009), 93-102.

[10] **Jaswant N.Arlekar**, **Sudhir K.Jain**, and **C.V.R.Murty** "Seismic Response of Frame Buildings with Soft First Storeys" Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997 New Delhi.