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Time Period Analysis of Reinforced Concrete Building with and without the Influence of Masonry Infills

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Abstract—Strength and stiffness are the most important characteristics of any structure. Due to the architectural efficiency of masonry-infilled reinforced concrete frames, the frames are highly common structural forms for buildings. But in the current practice, stiff masonry walls are neglected and only bare frames are considered in design calculations. However, the infills can significantly modify the structural behavior of these frames, which can be detrimental to the seismic performance of buildings. The fundamental period of vibration, dependent on mass and stiffness, is a key parameter in assessing seismic demand. Through this study, the fundamental periods of vibration of RC framed buildings are studied using 3D FE modeling including the effects of infill.

Index Terms—Natural period, Frames, Infill, Mode shape, Base shear, Stiffness, Span

1 INTRODUCTION

All objects have a natural or fundamental period; this is the rate at which they will move back and forth if they are given a horizontal push. As per IS 1893 (Part1):2002, the approximate fundamental natural period of vibration (Ta), in seconds, of a moment-resisting frame building without brick infill depends only on the height of the building and for all other buildings, including moment-resisting frame buildings with brick infill panels are depend on base dimension beside height. But the actual seismic failure modes and performances of infilled RC frames typically differ from those anticipated based on the original structural analyses performed by design engineers. At present, engineers' neglect the influence of infills on overall structural performance because infills are normally considered non-structural components.

2 OBJECTIVES

The objectives of the present study are first to find out the natural period of building with and without infill and to make a comparison between the IS 1893(Part 1):2002 code value and then to conduct a parametric study for finding out the factors influencing the time period of building and to find out a method to in cooperate that parameters in the equation for time period.

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3 ELEMENT DISCRIPTION

3.1 SOLID 65

The element used for modeling the brick units and concrete is Solid 65. Solid 65 is used for the 3-D modeling of solids with or without reinforcing bars Fig. 3.1. The solid is capable of cracking in compression. The element is defined by eight nodes with degrees of freedom at each node: translations in the nodal x, y and z directions.

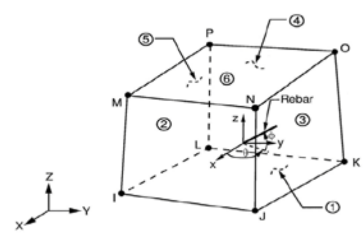


Fig 1. SOLID65 Geometry

3.2 Material Property

The properties of materials used through this study is shown in the Table 1.

TABLE 1. MATERIAL PROPERTIES

Description	Young's Modulus (kN/mm2)	Poisson's Ratio	Density (kg/m3)
Concrete	7	0.2	2400
Infill wall	4	0.17	1800

3.3 Modelling of masonry structure

The following modeling strategies can be adopted depending on the level of accuracy, simplicity desired and application field (1) Detailed micro modeling (2)Simplified Micro modeling (3) Macro-modeling. The present work uses detailed macro modeling. The main advantage of detailed macro modeling is that, it is convenient for the modeling of whole structure, because the number of elements required can be huge, and consequently the cost of calculation time can be reduced tremendously.

4 Model Analysis

Modal analysis is used to determine the vibration modes of a structure. These modes are useful to understand the behavior of the structure. The modal analysis also conducted to attain the frequencies and mode shapes of the frames under study.

5 Building Parameters under Study

The parameter considered for the study is listed in Table 2.

Table 2. Parameters Used

Sl. no.	Parameters	Studied values
1	Number of storey	1,2,4,6,8,10
2	Number of spans	1,2,3,4,5
3	Span Length	4,5,7,9,11m
4	Amount of infill	20,40,60,80%
5	Height of each storey	2.5, 3,3.5, 4, 4.5m
6	Size of col-umn	300x300,400x400, 500x500, 600x600,700x700mm

6 Models

6.1 Base Models

A 10 storied bare frame is modeled using ANSYS software. It is a regular frame with five bays, each having length 3m. Each storey having 3m height. The size of column and beam are adopted as 300x300mm. M30 concrete is used. The infilled frame is modeled by using 100mm thick walls as infills.

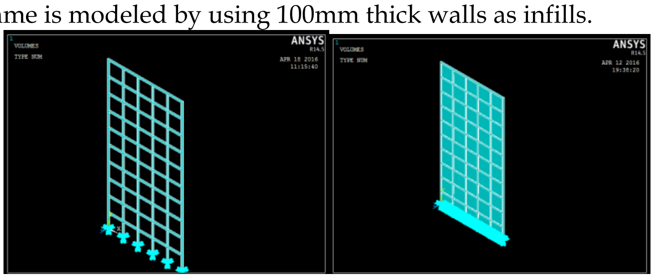
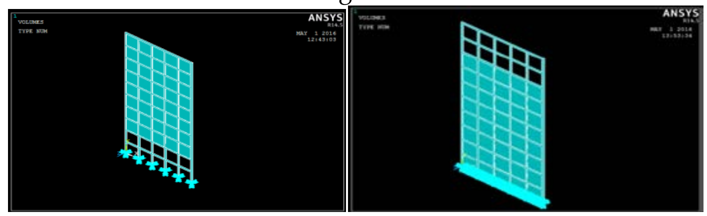


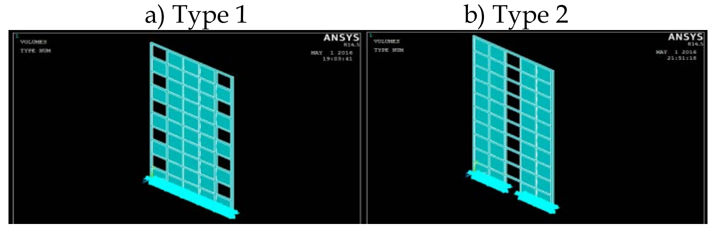
Fig 2.Model of 10 Storey Bare Frame and infill frame

6.2 Models for Parametric study

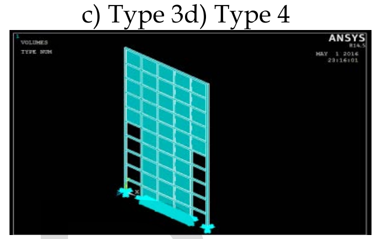
For studying the effect of parameters mentioned in the Table 2, different modals are created. In addition to that for finding the effect of distribution of the infill, additional five models are created and is shown in Fig.3.



a) Type 1 b) Type 2



c) Type 3d) Type 4

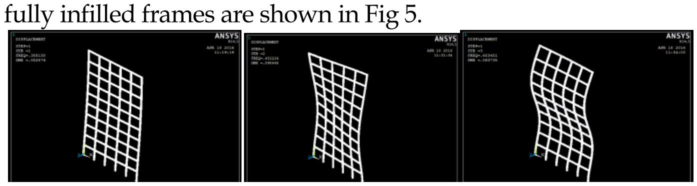


e) Type 5

Fig 3. Different Infill Configuration

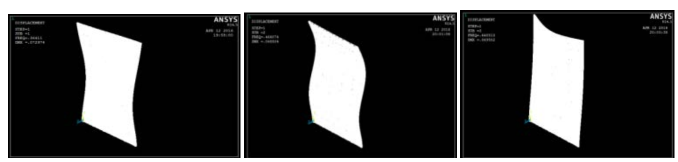
7 Result and Discussion

The mode shapes of the bare frames are shown in Fig.4 and for fully infilled frames are shown in Fig 5.



a) First b) Secondc) Third

Fig 4. Mode shapes of Bare Frame



a) First b) Secondc) Third

Fig 5. Mode shapes of Infill Frame

7.1 Parametric study Result

7.1.1 Effect of Number of Storey on Time Period

The time period increase with increase in number of storey.

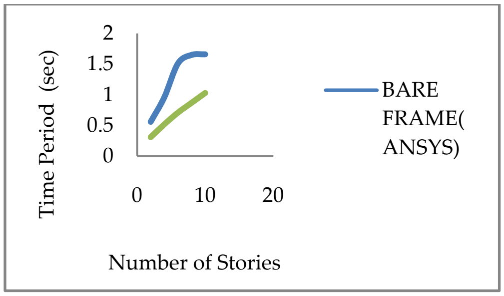


Fig 6. For Bare frames

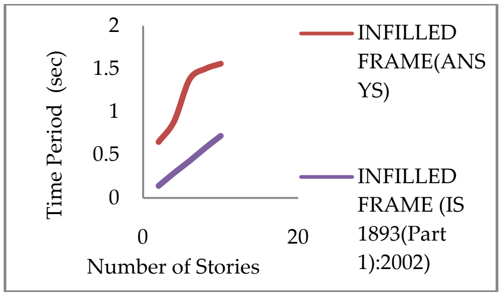


Fig 7. For Infilled frames

7.1.2 Effect of Number of Span on Time Period

The time period decreases with increase in the number of span.

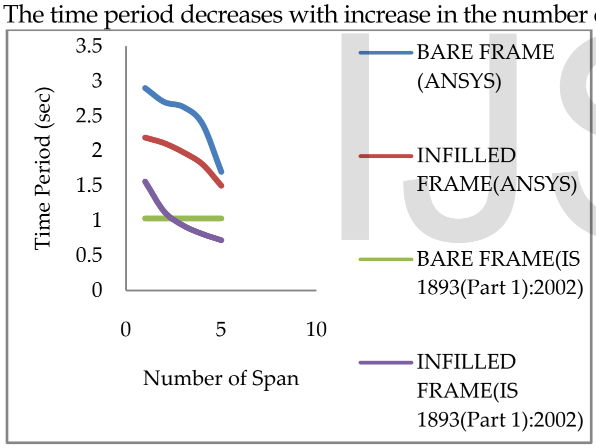


Fig 8. Period vs. Number of Span

7.1.3 Effect of Span Length on Time Period

The time period increases with increase in the span length.

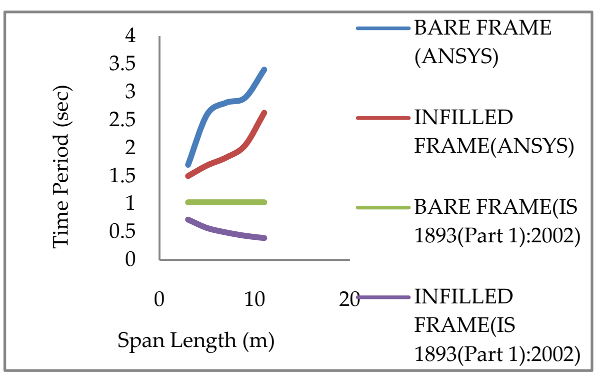


Fig 9. Period vs. Span Length in m

7.1.4 Effect of Column Stiffness on Time Period

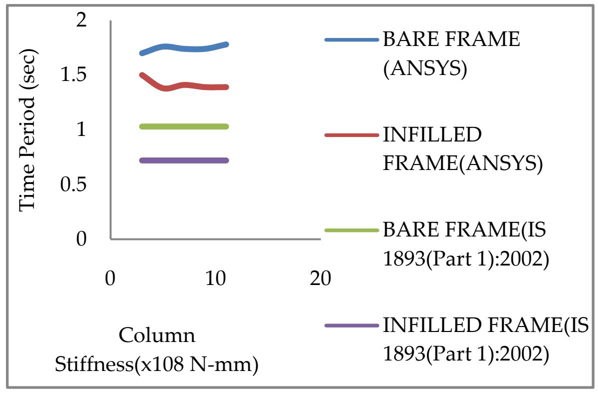


Fig 10. Period vs. Column Stiffness

7.1.5 Effect of Area of Infill on Time Period

When infill is incorporated in the FE analysis, the period becomes shortened with the increase in number of infilled panels due to added stiffness from the equivalent diagonal struts.

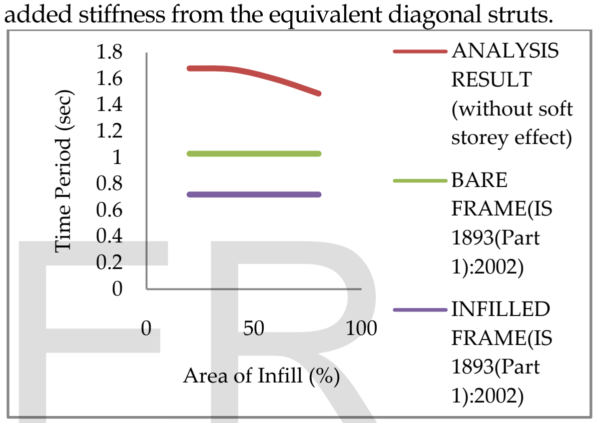


Fig 11. Period vs. Area of infill in %

7.1.6 Effect of Different Infill Distribution

Among the five type of distribution, four of them have less influence on the time period. But the Type1 shows a great variation with high time period. Here the Type 1 is the bottom soft storey structure. So from this it is clear that the bottom soft storey structure time period is entirely different than the common structural forms.

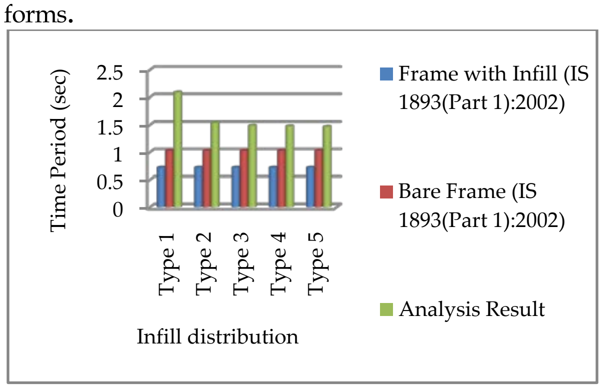


Fig 12. Period Vs. Type of infill distribution

7.2 Proposing Solution

From the study presented here we can identify the following three parameters which influences the period: (a) span length, (b) number of spans and (c) amount of infilled panels. Considering these parameters the period can be refined as Ta = (C1/C2C3)0.075 h 0.75 Here, C1 is the modification factor for span length, C2 is the modification factor for number of spans and C3 is the modification factor for amount of infill. Where, C1 = 0.004 X3 – 0.072 X2 + 0.475X + 0.562, C2 = - 0.035 Y2 + 0.047 Y + 2.1 and C3 = - 7x10-5Z2 + 0.003 Z + 1.577 Where, X is the span length, Y is the number of span and Z is the percentage of amount of infill. For bare frames the C3 value is zero.

7.3 Effect of Proposed Solution on Base shear

The IS1893(Part 1):2002 equation for calculating base shear (VB) is VB= Ah W.where, W = Seismic weight of the building and Ah = The design horizontal seismic coefficient for a structure and is determined by the following expression: Ah = (ZISa)/(2Rg) Where, Z is the seismic zone factor, I is importance factor, R is response reduction factor and (Sa/g) is the average response acceleration coefficients. Sa/g in turn depends on the natural period of the structure and are inversely proportional. So the base shear is also inversely proportional to the time period.

Let consider an example building having 7 floors and each floor 3.5m height, a panel span of 8 m and there are 6 such type of panels and 80% infilled panels are also present. For this building, the period given by the code equation is 0.83sec. The time period obtained from the new formulae is 1.11 sec. As a result the base shear is reduced by 25%.This means that the building design can be significantly economized if this 25% reduction in base shear is accounted.

8 CONCLUSION

The study reveals that the main parameters influence the time period are besides height number of span, span length and area of infill. So a modification is proposed in the equation given in IS 1893(Part 1):2002 by including the effects of these parameters. Also the natural period of building obtained from the model analysis is always upper bound than the code values. So the increased time period decrease the base shear. This will reduce the reinforcement requirement. There by make an economical design of construction. The time period of bottom soft storey model shows a large variation from other distribution pattern. So it takes more care for such type of building design in earthquake point of view. Otherwise the changes in the time period make an unexpected resonance condition. This will leads to the entire collapse of the structure.

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REFERENCES

[1] Y.P. Yuen, J.S. Kuang., Nonlinear seismic responses and lateral force transfer mechanisms of RC frames with different infill configurations, Engineering Structures 91, 125–140, 2015.
[2] Naveen Kumar B.Set al., Time Period Analysis of Reinforced Concrete Building with and Without Influence of Steel Bracings , International Journal of Modern Chemistry and Applied Science, 2015.
[3] Made Sukrawa, Earthquake response of RC infilled frame with wall openings in low-rise hotel buildings, Procedia Engineering 125 , 933 – 939, 2015.
[4] Cinitha.A, Umesha.P.K., A rational approach for fundamental period of low and medium rise steel building frames, International Journal of Modern Engineering Research (IJMER), Vol. 2, Issue. 5, Sep.- Oct. 2012.
[5] G. Uva et al., Appraisal of masonry infill walls effect in the seismic response of RC framed buildings: A case study, Engineering Structures 34, 514–526, 2012.
[6] Jaime Andrés Campbell Barraza., Numerical model for nonlinear analysis of masonry walls, RWTH, July 2012.
[7] Sirajuddin M, Narayanan Sambu Potty and Sunil J., Non Linear Seismic Analysis of Masonry Structures, Journal of Design and Built Environment, Vol. 9, pp. 1–16, December 2011.
[8] IS 1893 (Part1) : 2002.