NON LINEAR STATIC ANALYSIS OF FRAME WITH AND WITHOUT INFILLS

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Abstract:- The general multi-storey construction in country which is constructed with reinforced concrete frames consists brick masonry Infill walls. Unreinforced masonry infill walls will not take part towards resisting gravity loads, but will have effect significantly, in terms of increased stiffness and strength for the loads like earthquake are acting on the structure. However, in real time analysis and design, the infill stiffness is generally neglected in structural analysis, resulting in an under-estimation of stiffness and natural frequency of the structure. To study the effect of the structure with the presence of Infill walls when lateral loads are acted on the structure here in this project, a typical building assumed in seismic zone-2 of India as per IS: 1893-2002. Features like plan irregularity and vertical irregularity (soft storey) are introduced in the building. Infill walls were modeled using the equivalent strut approach presented in FEMA 356. Static analysis (for gravity and lateral loads), Response spectrum analysis and non-linear pushover analysis (assigning the hinge properties to beams and column sections) were performed. In the present study, the non-linear response of Reinforced cement concrete structure by using SAP2000 software under the seismic loading has been carried out with the intention to investigate the relative importance of Infill walls when present in structure during the earthquake then the response factor depends on several factors in the non-linear analysis of RCC frames. This includes the altering in load displacement graph.

Keywords: SAP2000, FEMA 356, RCC FRAMES

I. INTRODUCTION

Earthquake is the main cause for the ground motion in random fashion in both horizontally and also in vertically, which starts its origin at the epicentre. Generally structures present on the ground they start vibrating when they are subjected to earthquake by inducing inertial forces on them. There are some high seismic areas where structures located at that will face severe damages. In addition to the gravity load these structures should also capable of resisting lateral loads which develops a high stresses in the members.

In the present scenario of reinforced concrete constructions the vertical space between the beams and columns is generally filled by brick Infill walls or panels, these are constructed only when the complete structure is constructed by using the material called as Bricks with cement mortar to have adequate bond between bricks and also to withstand. Generally the width or thickness of these will be in the range of 115mm to 230mm and they also have some openings for the purpose of general requirements.

The main reason to use the Infill wall in the structures because the material is locally available in bulk and also it can be handled easily, also it has good heat insulating properties which makes it greater comfort for the occupants of the building.

II. INFILL WALLS AND PUSHOVER ANALYSIS

A. *MASONARY INFILLS:*

The frames are infilled with stiff construction such as brick or concrete block masonry, primarily to close the structure or to cover the structure and not to expose out and also to provide safety for the users. Such masonry walls known as Infill walls.

B. *STIFFNESS OF INFILL WALLS (FEMA 356):*

For overall building analysis purposes, the compression struts which is replaced for infill stiffness of solid infill panels should be placed concentrically across the diagonals of the frame, effectively forming a concentrically braced frame system (Figure1). In this configuration, however, the forces imposed on columns (and beams) of the frame by the infill are not represented. To account for these effects, compression struts may be placed eccentrically within the frames as shown in Figure2. If the analytical model consists of eccentrically located compression struts, the results should have infill effects on columns directly.

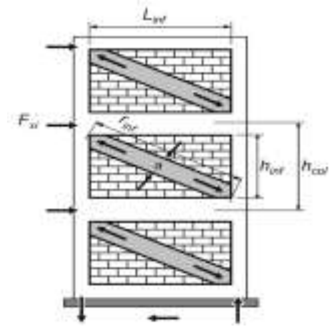


Figure 1: Concentric Struts

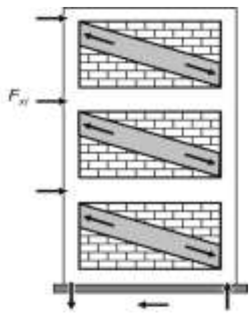


Figure 2: Eccentric Struts

C. PUSHOVER ANALYSIS:

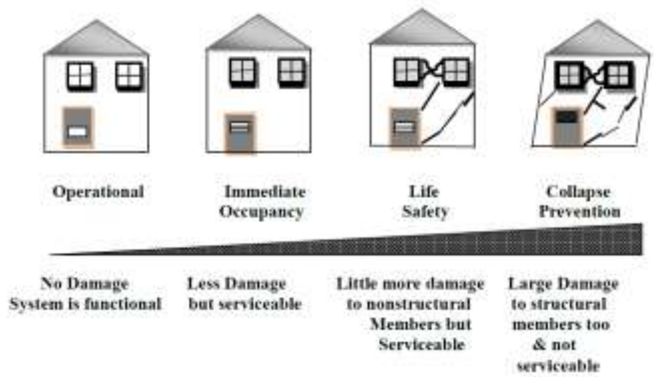


Figure 3: Performance levels and damage functions

Pushover Analysis option will allow engineers to perform pushover analysis as per FEMA -356 and ATC-40. Pushover analysis is a static, nonlinear procedure using simplified nonlinear technique to estimate seismic structural deformations. It is an incremental static analysis used to determine the force-displacement relationship, or the capacity curve, for a structure or structural element. The analysis involves applying horizontal loads, in a prescribed pattern, to the structure incrementally, i.e. pushing the structure and plotting the total applied shear force and associated lateral displacement at each increment, until the structure or collapse condition.

Pushover analysis is a method by which a computer model of the building is subjected to a lateral load of a certain shape (i.e., inverted triangular or uniform). The intensity of the lateral load is slowly enhanced and the stages of cracking, yielding, plastic hinge formation, and failure of different structural members are noted. Pushover analysis will provide important in depth knowledge of the weak zones in seismic performance of a structure.

D. PLASTIC HINGE ZONES:

In lateral load analysis system of the structure, dissipate energy under server imposed deformations through critical regions of the members, often termed as "plastic hinges".

Types of Plastic Hinges:

- Negative Plastic Hinges.
- Positive Plastic Hinges.

III. MODELLING AND ANALYSIS

The major objectives of this work was to test a RCC G+4 frames which has vertical irregularity with Infill wall considered in one model and without infill wall under pushover loads. Thus the structure tested in this work is a prototype. The model was deliberately selected so that it had certain eccentricities and was un-symmetric in plan

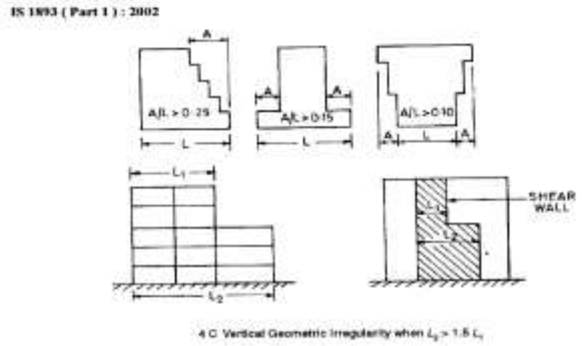


Figure 4: Vertical Geometric Irregularity

PLAN OF BUILDING:

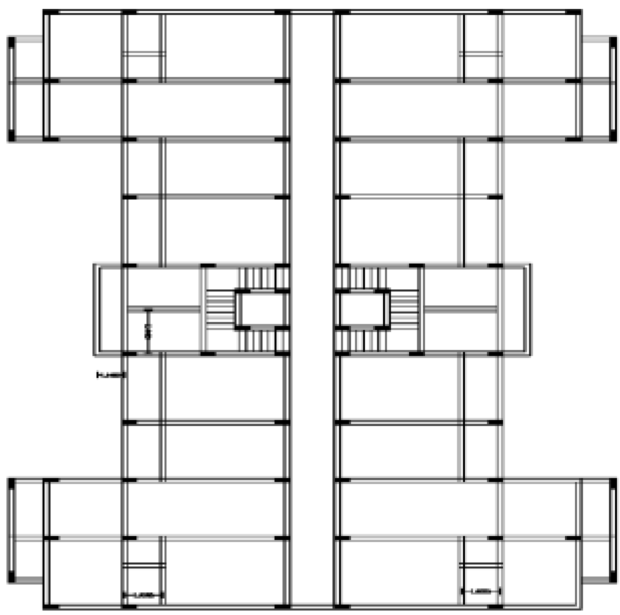


Figure 5: Plan of Building

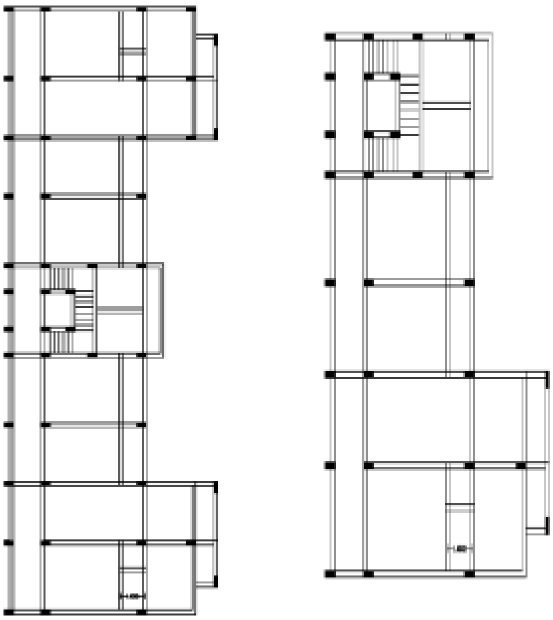


Figure 6: Framing Plans of all the floors

Building Type	**RC frame with masonry brick infill**
Number of stories	Ground + 4 Storey
Plan dimensions	37 m X 27 m
Building height	12 m above plinth level

Table 1: Summary of Building

ANALYSIS IN SAP2000:

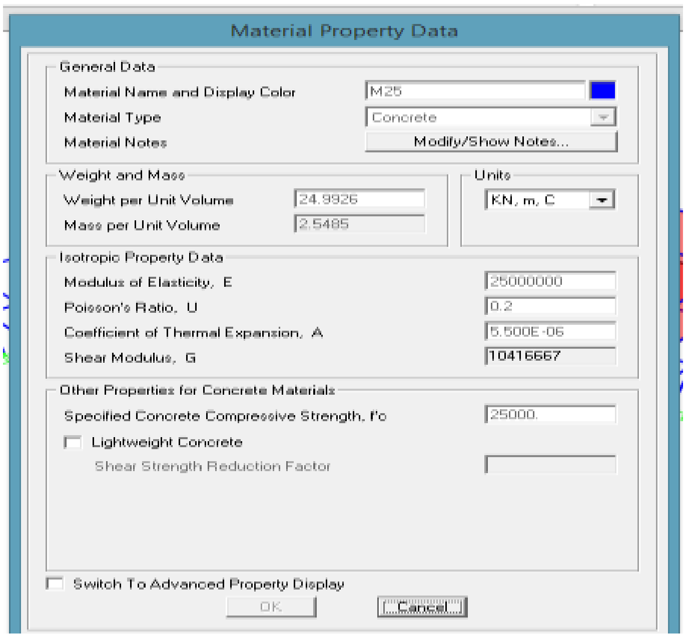


Figure 7:The material specifications for concrete grade M25

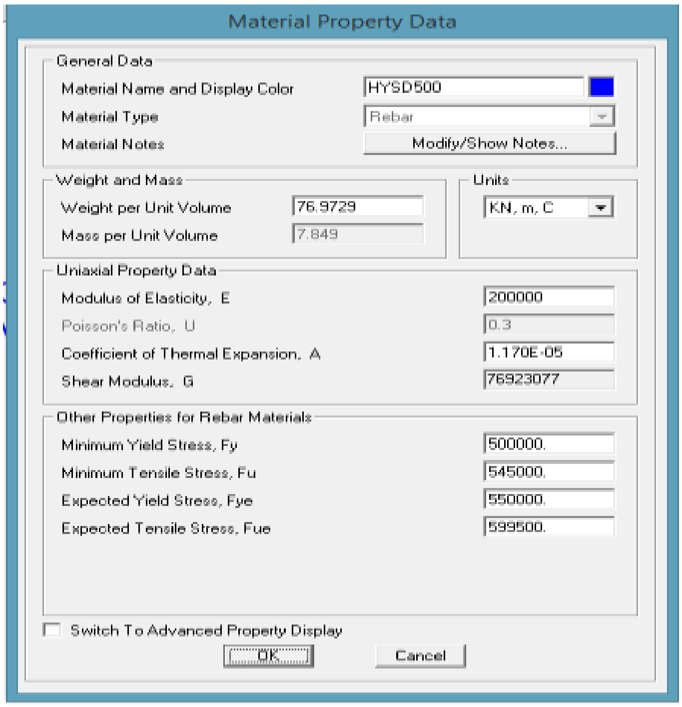


Figure 8: The Reinforcement grade specifications for HYSD 500

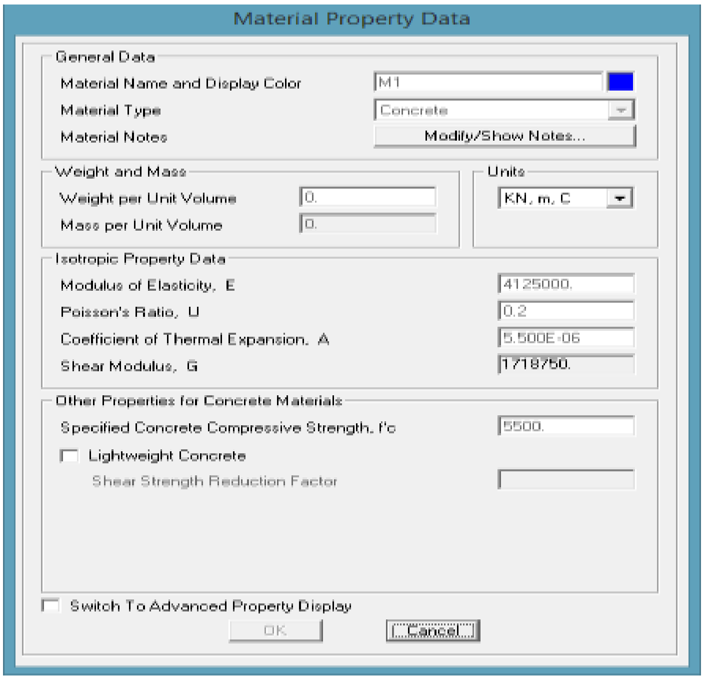


Figure 9: The masonry infill wall material properties

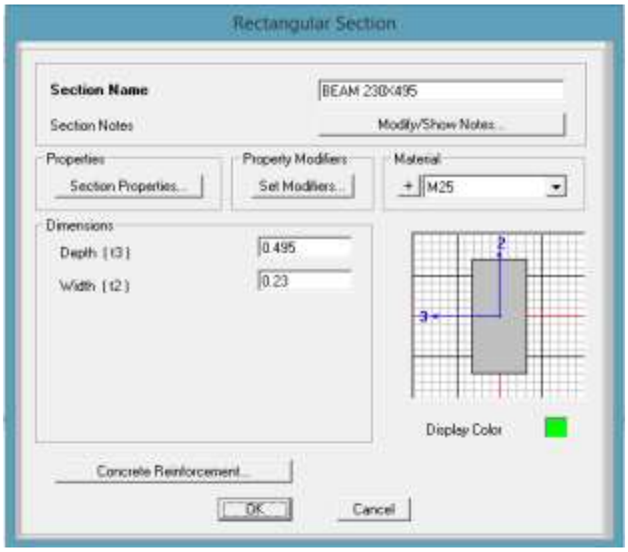


Figure 10: The Floor beams section details in the structure

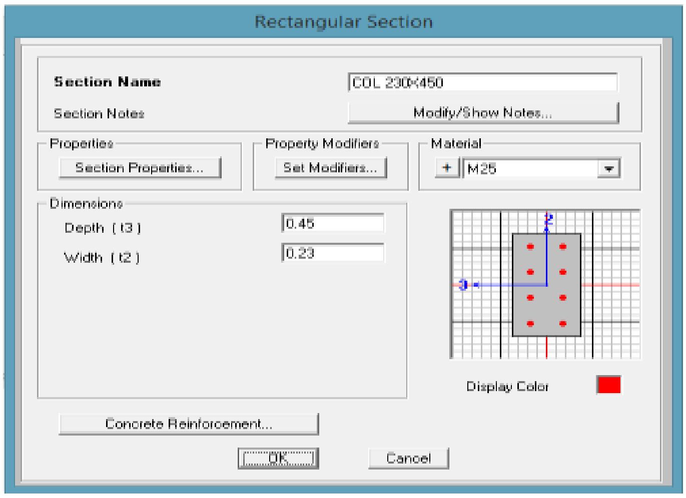


Figure 11: Column section details for all the columns in the structure

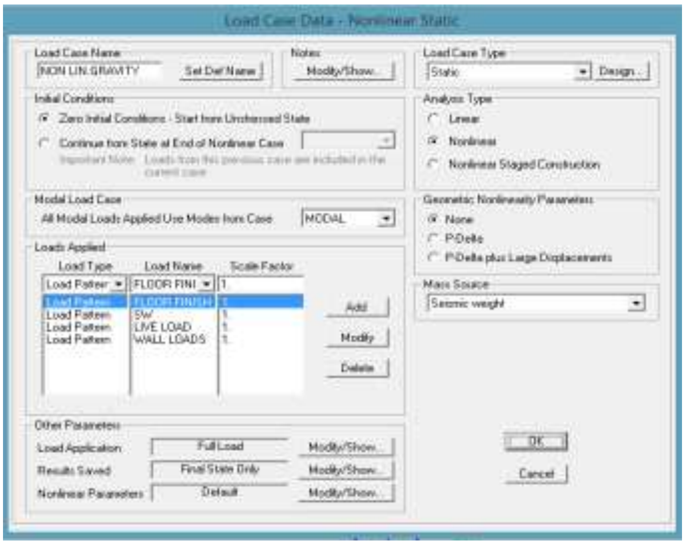


Figure 12: Non Linear Static load case for Gravity loads

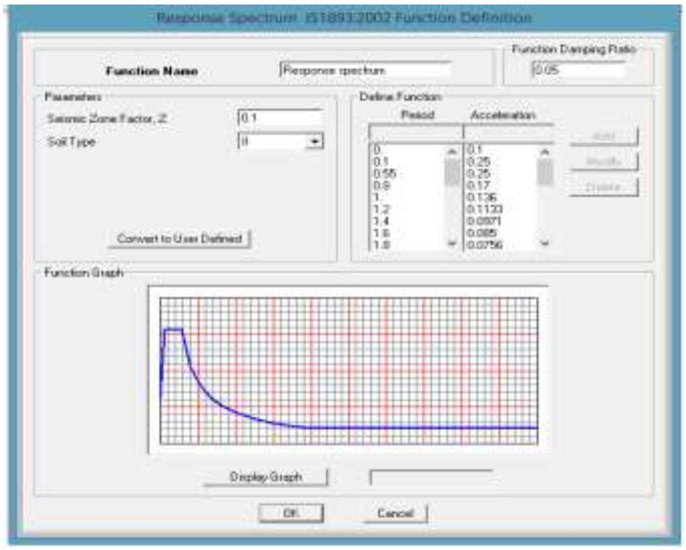


Figure 13: Response spectrum Function definition as per IS 1893-2002

IV. RESULTS AND DISCUSSIONS

The results of Analysis of RCC frame. Analysis of RCC frame under the static loads has been performed using SAP2000 software. This is followed by load deflection curve.

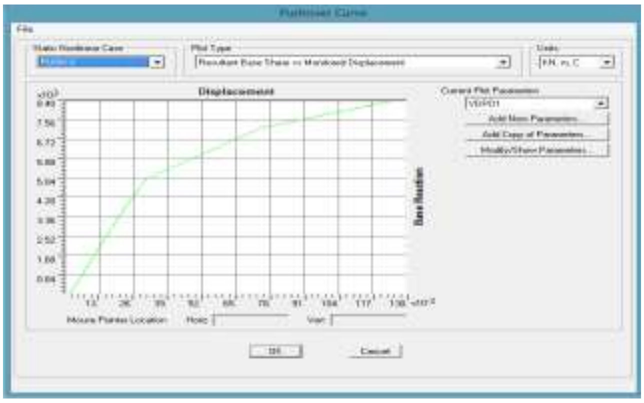


Figure 14: Base shear Vs Roof Displacement for the structure with Infill wall for Push-x direction

TABLE: Pushover Curve - PUSH X											
Step	Displacement	BaseForce	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
	m	KN									
0	0.001542	0	1965	0	0	0	0	0	0	0	1965
1	0.022537	3767.751	1964	1	0	0	0	0	0	0	1965
2	0.030943	5010.481	1897	68	0	0	0	0	0	0	1965
3	0.074935	7224.974	1781	86	98	0	0	0	0	0	1965
4	0.123602	8385.475	1713	55	176	20	0	1	0	0	1965
5	0.123533	8381.266	1713	55	176	21	0	0	0	0	1965

Table 2: Base Shear V_s Roof Displacement with Infill wall

TABLE: Pushover Curve - PUSH X											
Step	Displacement	BaseForce	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
	m	KN									
0	0.00064	0	1802	0	0	0	0	0	0	0	1802
1	0.028874	3287.971	1801	1	0	0	0	0	0	0	1802
2	0.045038	4965.766	1728	74	0	0	0	0	0	0	1802
3	0.095553	7118.864	1548	155	99	0	0	0	0	0	1802
4	0.166743	8445.675	1393	183	177	38	2	9	0	0	1802
5	0.184867	8634.539	1369	195	171	30	2	35	0	0	1802
6	0.185301	8637.444	1369	195	169	32	2	35	0	0	1802

Table 3: Base Shear V_s Roof Displacement without Infill walls

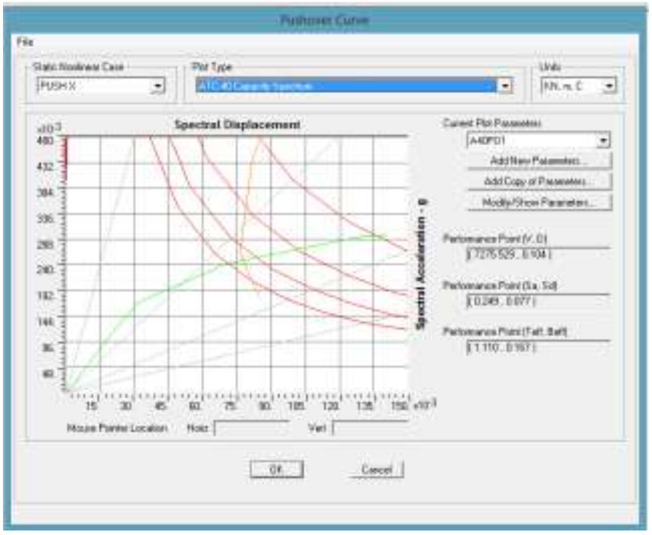


Figure 15: Capacity curve & Demand curve also Performance point

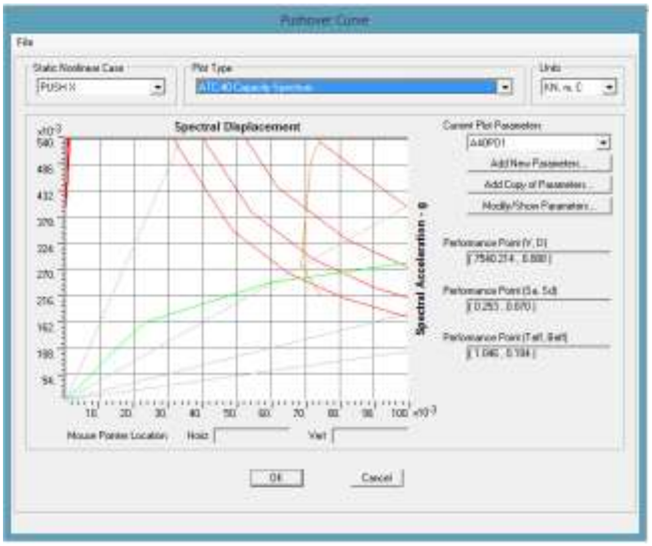
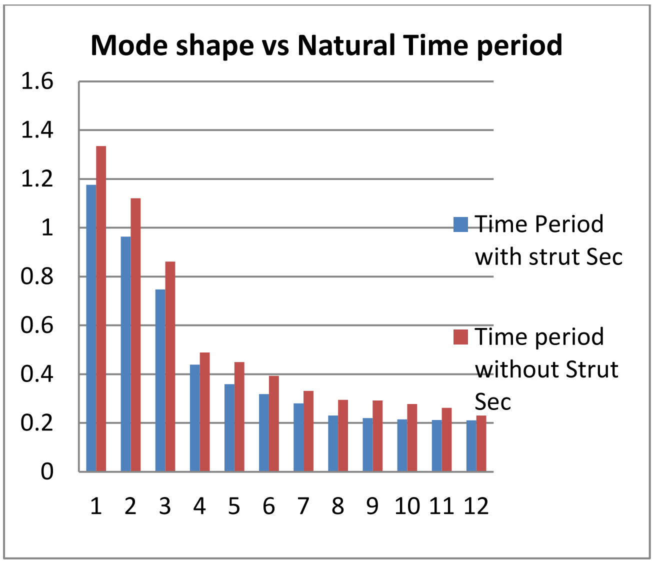
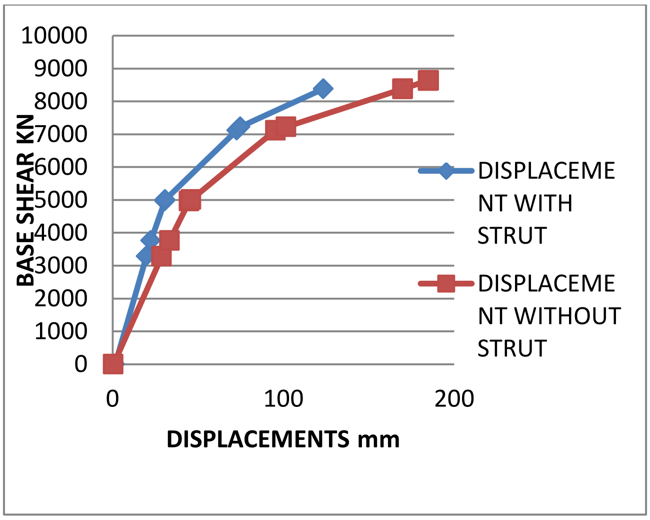


Figure 16: Capacity Spectrum & Demand Spectrum with Infill wall

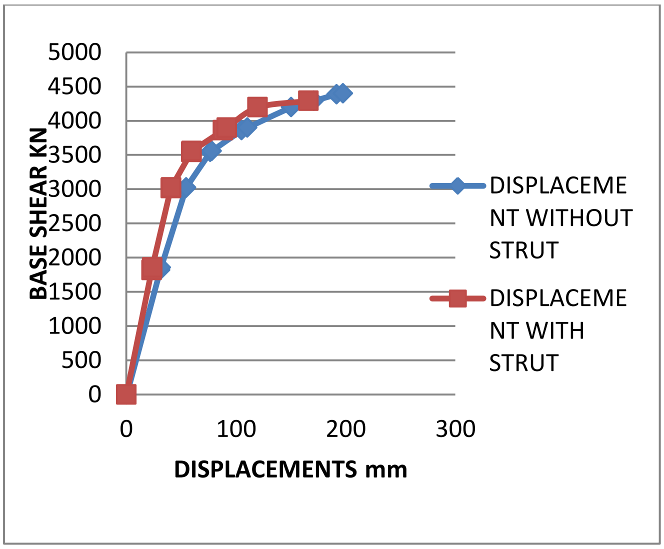
COMPARISION RESULTS:



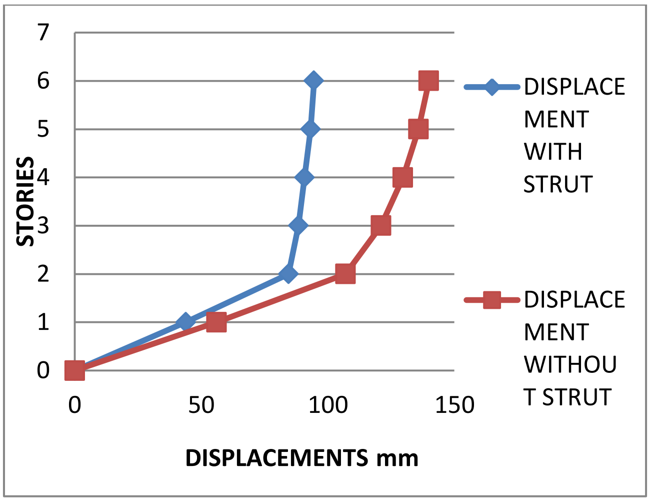
Graph 1: Mode shape Vs Natural Time period



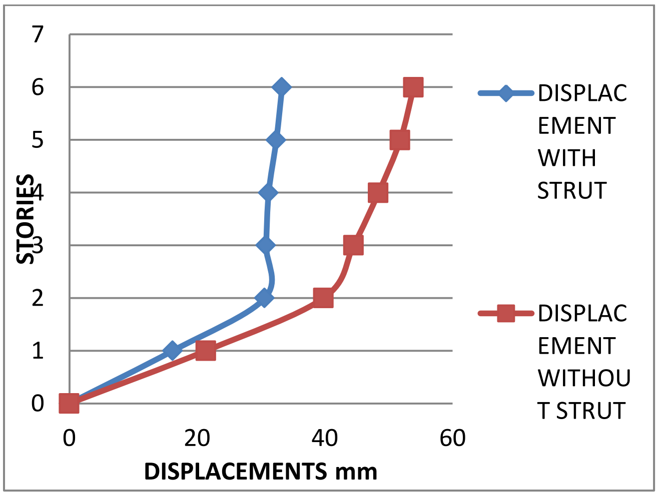
Graph 2: Base shear Vs Roof displacement curve for Building in X direction



Graph 3: Base shear Vs Roof displacement curve for Building in Y direction



Graph 4: Displacement profile of Building at the formation of mechanism in X direction



Graph 5: Displacement profile of Building at the formation of mechanism in Y direction

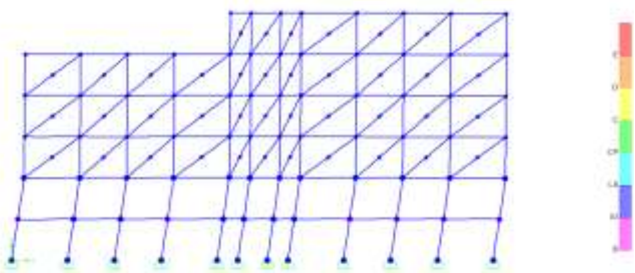


Figure 17: Load Resisting Mechanism for a typical frame of Building with Infill panels

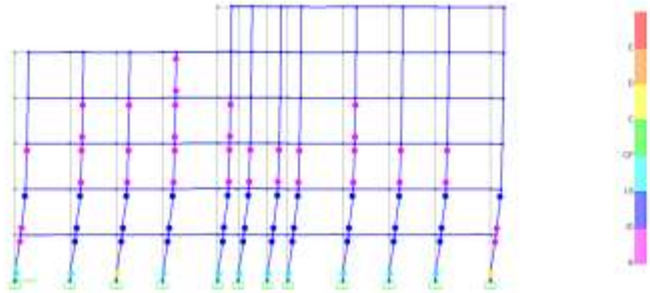


Figure 18: Load Resisting Mechanism for a typical frame of Building for Bare Frame

V. CONCLUSIONS

The influence of masonry infill on the response of multi-storied building under seismic loading is shown through typical examples.

- The presence of masonry infill panels modifies the structural force distribution significantly.
- The total storey shear force increases considerably as the stiffness of the building increases in the presence of masonry infill.
- Also, the bending moments in the ground floor columns increase, and the mode of failure is by soft storey mechanism (formation of hinges in ground floor columns).

The lateral load resisting mechanism of the masonry in filled frame is mainly different from the bare frame. The bare frame acts primarily as a moment resisting frame with the formation of plastic hinges at the joints under lateral loads. In contrast, the infill frame behaves like a braced frame resisted by a truss mechanism formed by the compression in the masonry infill panel and tension in the column. The plastic hinges are confined with the joint in contact with the infill panel. It is seen that the existing buildings with open ground storey are deficient and in need have retrofit.

SCOPE OF THE PROJECT:

In the present study, the 4 storey frame has been studied under monotonic loads. This may be further studied for more storeys and the frame can be studied under cyclic-loading to monitor the variation in load-deflection curves at given time history

VI. REFERENCES

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