SEISMIC ASSESSMENT OF SYMMETRICAL RC STRUCTURE WITH BRICK MASONRY INFILLS

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Abstract:-Masonry is one of the most widely used construction material in the world. Masonry wall are commonly used in reinforced concrete frame building as infills , primarily to protect the inside of the buildings from the environment and create partition insides. For the design and analysis of RC frame structure, infills are commonly treated asnon-structural element and hence ignored. Masonry infill is found in mostexisting concrete frame building system. This type of infill is common in our country where seismicity is of prime importance. Masonry infills do resist lateral forces with substantial structure action. In addition to this infills have a considerable strength and stiffness and they have significant effect onthe seismic response of the structural systems. There is general agreement among researcher that infills frame have greater strength as compared to frames without infills. In this paper the reinforced concrete frame with brick masonry infill for different configuration of infill walls in plan have been studied to observe it is influences on response of the frame. Non-linear timehistory analysis has been carried out using SAP2000 for ground motion record of El Centro earthquake. Maximum base shear, storey displacement, fundamental time period and maximum axial force are considered as responseparameter of the structure for comparison.

Keywords: **-Masonry infill, Equivalent diagonal strut, Non-linear time history analysis,RC frame.**

I. INTRODUCTION:

Reinforced concrete (RC) framed buildings with infill walls are usually analyzed and designed as bare frames, without considering the strength & stiffness contributions of the infills. However, during earthquakes, these infill walls contribute to the response of the structure and the behavior of infilled framed buildings is different from that predicted for bare frame structures. Therefore a study is undertaken which involve nonlinear time history seismic analysis of framed structure having different configuration of infill wall in plan. Infill walls are modeled as equivalent diagonal strut. The infill components increase the lateral stiffness and serve as transfer medium of horizontal inertia forces. In this study four different models of a G+5 storey building symmetrical in plan are considered. The building are modeled using 40.00% masonry infills & remaining portion of the masonry infill are meant for functional purpose such as door & window openings.

Previous research on the response of RC frame with masonry infill walls has been presented by Mulgund G.V.[1] in which he study the behavior of RC frames with various arrangement of masonry infill by non-linear push over analysis, P.G. Asteris [2]lateral stiffness of brick masonry infilled plane frame with various amount of opening in the reduction of the infilled frames stiffness has been investigated, Kasim Armagan kormaz[3] RC frame structure with different amount of masonry infill wall considered to investigate the affect of infill wall & diagonal strut approach is adopted for modeling masonry infill walls.

II. PARAMETER FOR MODELING OF INFILL WALL:-

In the present paper the contribution of the masonry infill wall to the response of reinforced concrete frame are to be analyzed by Non-linear time history analysis. Reinforced concrete frame building models was performed without and with infill masonry wall. The equivalent diagonal strut is calculated based on the equation and properties given in FEMA 356. The structural frame models were subjected to the El Centro.

III. Data Tabulation:-

Properties of the element used.

In modeling plane frame, the following material properties and geometrical properties have been used for beam, columnand masonry infill.

A.Material Properties: -The following material properties of normal weight concrete & masonry infill have been provided for non-linear time history analysis of building frames.

- Density of masonry = $20kN/m^3$
- Density of concrete = $25kN/m^3$
- Young's modulus = $22360.67N/mm^2$
- Poisson's ratio = 0.15
- Compressive Strength of concrete = $20N/mm^2$
- Compressive Strength of masonry = $4N/mm^2$

B.Geometrical properties: - The following sectional properties have been used for beams & columns.

Column = 300mmX300mm
Beam = 230mmX300mm

Non-Linear time history analysis is carried for El Centro. The analysis is carried out for four different configurations of infill panels as listed below.

1. Model – I (Figure No.1)
2. Model – II (Figure No.2)
3. Model – III (Figure No.3)

4. Model – IV (Figure No.4)

These four types of configuration one model are without equivalent strut (BF1, BF2, BF3 and BF4) and others are with equivalent diagonal strut (SF1, SF2, SF3 and SF4). Thus total eight models are analyzed and results are compared.

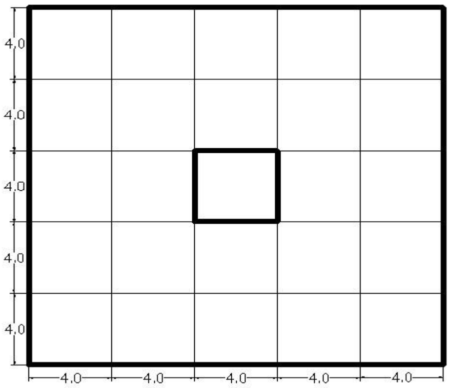


Figure 1: Model – I

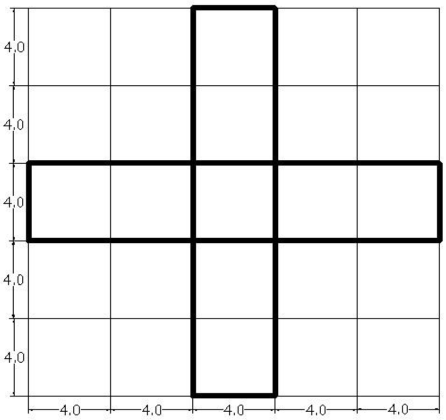


Figure 2: Model– II

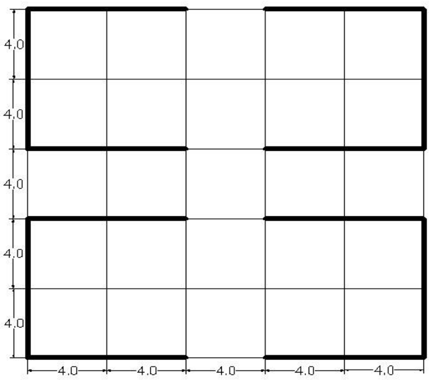


Figure 3: Model – III

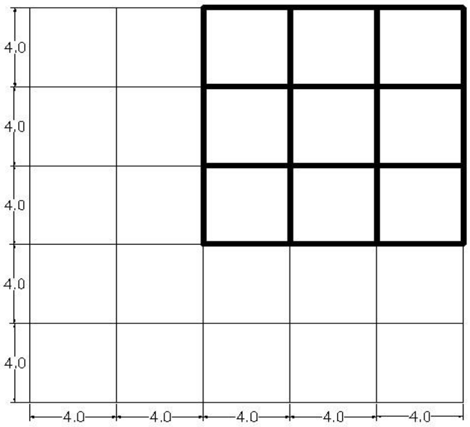
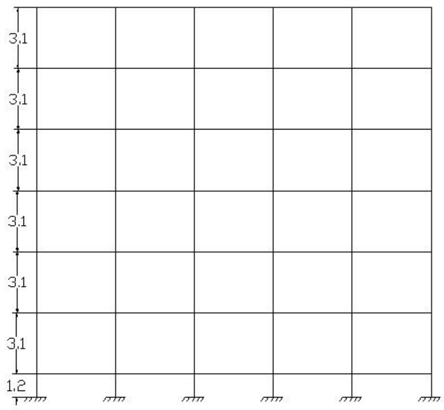
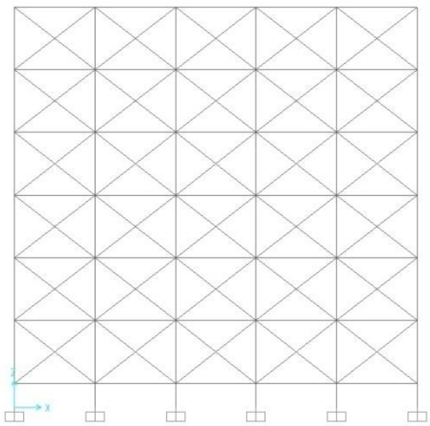


Figure 4: Model – IV





IV. Modeling of masonry Infill wall:-

Inanalysis of infilled frame system, the masonry infill wall is modeled using equivalent diagonal strut model. The equivalent diagonal strut modeling of masonry infills in frames gained popularity because of its simplicity and limited number of input parameter required in modeling. In equivalent diagonal strut method the tensile strength of masonry is negligible and only compression diagonal strut is liable to resist the lateral load properties of brick masonry infill is taken from IS1905-1998 (code of practice for structural use of unreinforced masonry). The equivalent strut shall have the same thickness and modulus of elasticity as the infill panels it represents as per FEMA 356 various parameters are given below for finding out strut of width.

$$W = 0.175d\,(\lambda h)^{-0.4} \qquad -1$$

Where

$$\lambda = \left[\frac{t \sin 2\theta E_{me}}{4 h E_{fe} I_{col}}\right]^{\frac{1}{4}} \qquad -2$$

$$\theta = \tan^{-1}(h/l) \qquad -3$$

h - Height of brick infill panel
l - Length of brick infill panel
h' - Height of the frame, measured between the

centerlines of the beams & columns (Fig.7),
l'- length of the frame, measured between the
Centerlines of the beams & columns.
d - Diagonal length of infill,
λ - Coefficient depending on properties on Infill,
t- Thickness of the infill,
E_{me}-Young's modulus of the infill material,
E_{fe}-Young's modulus of the material Constituting the frame,
f_{me} – Compressive strength of infill wall,

TABLE. I VALUES OFDIFFERENT PARAMETERS FOR EQUIVALENT STRUT CALCULATION

t	230	mm
l'	4000	mm
l	3700	mm
h'	3100	mm
h	2800	mm
d	4640.04	mm
I_{col}	1.35×10^9	mm^4
f_{me}	4	N/mm^2
E_{me}	2200	N/mm^2
E_{fe}	22360.679	N/mm^2
λ	1.097×10^{-3}	
w	498	mm

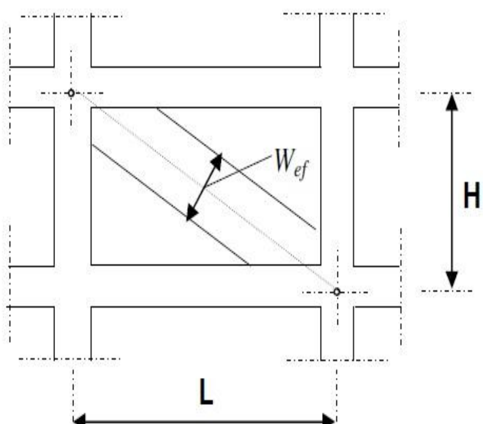


Figure 7 : Diagonal Model of the infiil wall

V.Results & Discussion :-

Using SAP2000 vs. 14 a analysis were carried outand the comparison was done for different parameters such as maximum base shear, joint displacement, maximum axial force & fundamental time period.

The maximum shear force in X direction for bare frame & strut frame for different model are as shown in Fig. 8. It can be seen that maximum base shear increases with the inclusion of strut. The percentage increase in base shear is 14.99%, 36.96%, 35.46% & 14.10% for models I, model II, model III & model IV in case of strut frame when compared to bare frame respectively.

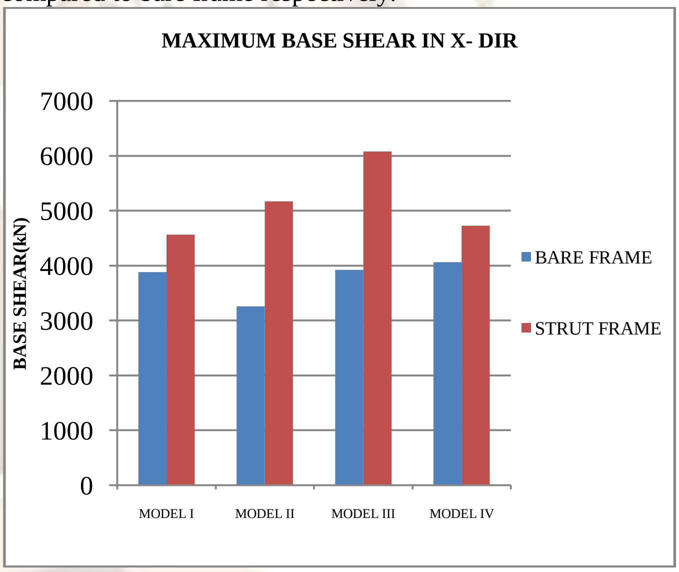


Figure 8 : Maximum base shear in X- direction

The displacement in X direction for different model's are as shown in Fig 9. The figure shows that joint displacement decreases by the modeling of infill walls as a strut. The percentage decrease is 37.82%, 19.43%, 31.67% & 37.01% for models I, model II, model III & model IV in case of strut frame when compored to bare frame respectively. The reduction in the displacement of stories is due to the increase in stiffness of the structure.

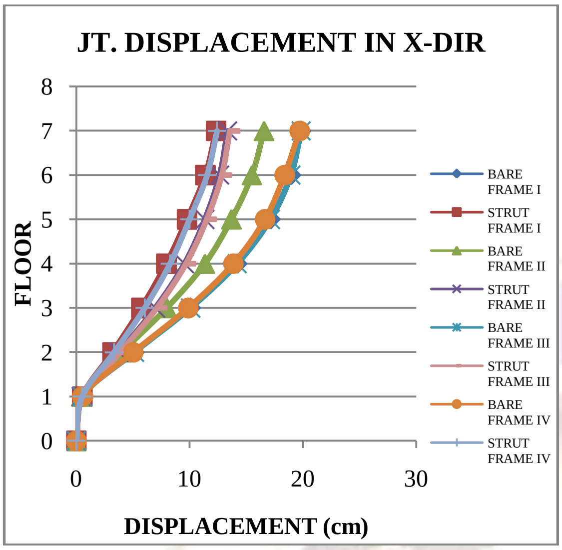


Figure 9 : Storey Displacement in X-direction

The maximum axial force in the column are as shown in Fig 10. It shows that axial forces increases by46.34%, 60.06%,51.52%, & 43.98% for models I, model II,model III, model IV. In case of struct frame when compare to bare frame respectively.

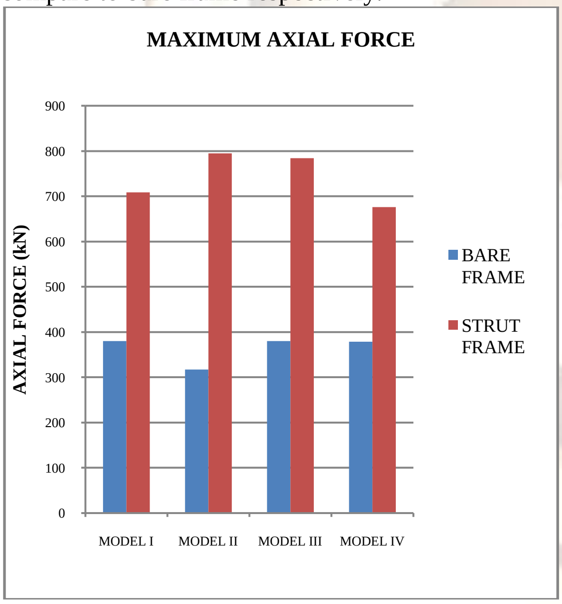


Figure 10: Maximum axial force

Following Graph shows the fundamental time period of different models.

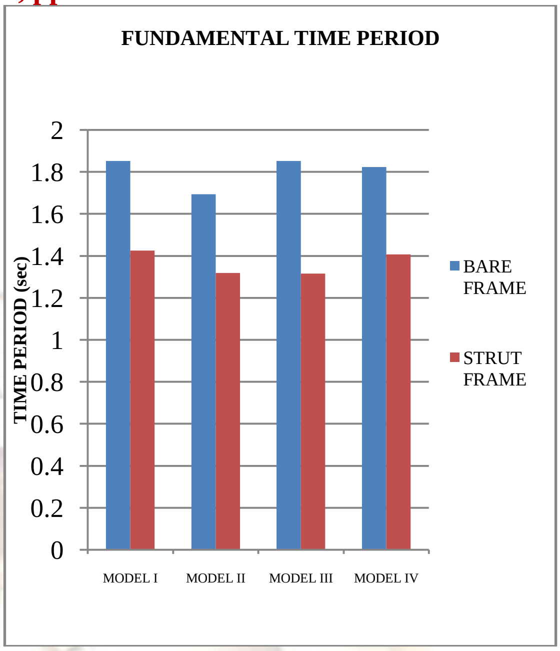


Figure 11 : Fundamental Time Period

It can be seen that the fundamental time period reduces by 23.04%, 22.18%, 29.01% and 22.86% for model I, Model II, Model III, Model IV. Modeling of infill panels as strut member reduces the time period of bare frame and enhance stiffness of the structure.

V
I.Conclusion :-

In this paper comparison of bare frame structure & strut frame structure for different configuration of infill panel is carried out. From this study it is clear that modeling of masonry infill panel is equivalent to diagonal strut which inflluences the seismic performance of building. As the stiffness of building increases due to inclusion of struts, the maximum base shear & maximum axial force increases while story displacement decreases.Also the fundamental time period of the structure decreases in strut frame as compare to bare frame.

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