A study of effectiveness of In-Fill panels in RCC frame for seismic zone V

Mr.Zahid Usmani[1], Prof.Vaishali Girge[2]
[1, 2] ICOER, PUNE

Abstract-*the presence of infill wall in the building gives better behavior under lateral loads. For multistoried structures, the con-sideration of effect of bottom storey under seismic forces would be an important parameter. As per IS 1893 (Part-I) :2002the columns and beams of the softstorey are to be designed for 2.5 times the storey shear and moments calculat-ed under the seismic load of a bare frame (i.e. without considering infill effect). In this paper, model is studied to inves-tigate the magnification factor for variousload combinations considering peripheral masonry infill wall only for zone V, peripheral masonry infill wall along with tie beams and RCC X braings underseismiceffect.TheR.C.C. Building model (P+4) has been preparedusing STAAD-Prosoftware. The Seismic Coefficient Method has been performed for the analy-sis of various models. The results of investigations and their conclusions are discussed below*

Keywords-In fill Walls, RCC frames, IS 1893:2002, FEMA, STAAD-Pro,Zone V

I. INTRODUCTION

In RC frame brick walls is just architectural point of view and to make partition and other aspect. In multistory buildings, the ordinarily occurring vertical loads i.e. dead or alive, do not cause much of a effects, but the lateral loads due to wind or earthquake tremors are a matter of great concern and need special consideration in the design of buildings. These lateral forces can produce the critical stress in a structure, set up undesirable vibrations, and in addition, cause lateral sway of the structure which can reach a stage of discomfort to the occupants. In many countries situated in seismic regions, reinforced concrete frames are infilled fully or partially by brick masonry panels with or without openings. Although the infill panels significantly enhance both the stiffness and strength of the frame, their contribution is often not taken into account because of the lack of knowledge of the composite behavior of the frame and the infill. During the elastic response phase, the presence of brick infill walls increases in plane lateral stiffness of the structure and reduced its fundamental period , and as a result leads to larger shear forces.n residential building RC frame structure are infill by brick panels on all four sides and resisting the lateral earthquake loads on building. By experimentally it has been shown that brick walls have high initial lateral stiffness (Moghaddam and Dowling 1987, Drysdale et al. 1999, Paulay and Priestley 1992,). Hence masonry infills in RC frames differentlateral load transfer mechanism of the structure from predominant frame action to predominant truss action(Murty and Jain 2000). Shown in Figure 1 below. Thus it is responsible for increase in axial forces in the RC frame.

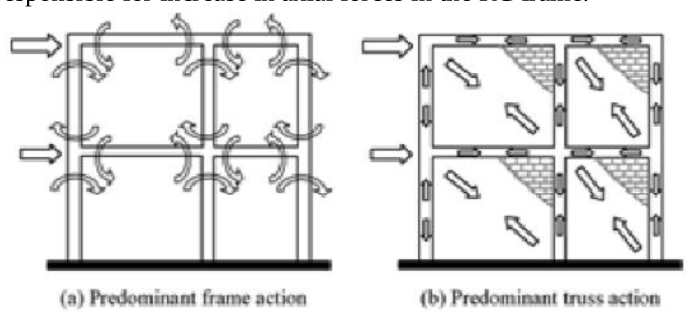


Fig.1 Schematic Representation of Infill Walls

1.1 Objectives of Present study

Following are objectives of present study to analyze the structure.

1. To study the literature available regarding infill walls and understanding the effects on structural performance.
2. To study RCC frame structure subjected to seismeic load as per IS 18932:2002 ZONE V
3. To study the structure considering In-fill panels
4. To study the performance of RCC infilled frame structure

II. CODAL PROVISION (IS 1893:2002 Part-I)

Seismic Analysis using IS 1893 (Part1):2002In this approach the earthquake force is applied on the structure using seismic coefficient method. In this method the design horizontal seismic coefficient Ah for the structure is given as

$$Ah=(Z/2)*(Sa/g)*(I/R)$$

Where, Z= zone factor as per different zones. IS 1893 (Part1):2002 has classified India in to four zones II to V. In zone II seismic intensity is low and very severe for zone v, I= importance factor, depending upon the functional use of the structures, R= Response reduction factor, depending on the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations. However, the ratio I/R shall not be greater than 1.0 and Sa/g = Average response acceleration coefficient for rock or soil sites. This ratio depends upon the time period and site condition. For the calculation of the earthquake force soils are grouped into three groups as shows in table 3.2 below.

Figure 2 of IS 1893-2002(I) shows the proposed 5 percent spectra for rocky and soils sites and Table 3 of IS 1893-2002(I) gives the multiplying factors for obtaining spectral values for various other damping.

And the approximate fundamental natural period of vibration in seconds for other types of buildings including moment resisting building with infill can be estimated as-
For other buildings

$$T_a = 0.09h/\sqrt{d}$$

Where, h = Height of building in meters. This excludes the basement storeys where basement walls are connected with ground floor deck or fitted with building columns, however, it includes the basement when they are not connected.

d = base dimension of the building at the plinth level in meters along considered direction of the lateral force.

The total design lateral force (design seismic base shear) along any principal direction shall be calculated by using following expression

VB = Ah x W

Where,

VB = design seismic base shear

Ah = design horizontal seismic coefficient for structures as explained in section 3.10.1 of IS 1893-2002.

W = seismic weight of building as full dead load and appropriate amount of imposed load.

2.1 Equivalent Diagonal Strut Method

The frames with unreinforced masonry can be modeled as equivalent braced frames by replacing infills with equivalent diagonal strut. Many investigators proposed various approximations for the width of equivalent diagonal strut. The width of diagonal strut depends on length of contact between the wall & the columns (αh) and between wall & beams (αL). The formulation for αh & αLon the basis of beam on an elastic foundation was given by Stafford Smith (1966). Hendry (1998) proposed the following equation to determine effective strut width w, where the strut is assumed to be subjected to uniform compressive stress.

$$\alpha_h = \frac{\pi}{2} \sqrt[4]{\frac{4E_f I_c h}{E_m t \sin 2\theta}}$$

$$\alpha_L = \pi \sqrt[4]{\frac{4E_f I_b L}{E_m t \sin 2\theta}}$$

$$w = \sqrt{\alpha_h^2 + \alpha_L^2}$$

Where, Em is Elastic Modulus of masonry wall, Ef is Elastic Modulus of masonry of frame material, t is Thickness of the in-fill wall, h is Height of the in-fill wall, L is Length of the in-fill wall, Ic is Moment of Inertia of the column of the frame, Ib is Moment of Inertia of the beam of the frame, θ is tan-1 (h/L) and w is Width of the Equivalent Strut

III.PROBLEM STATEMENT

Consider a four-storey reinforced concrete office bu ilding shown in Fig. 1.2. The building is located in Shillong (seismic zone V). The soil conditions are medium stiff and the entire building is supported on a raft foundation. The R. C. frames are infilled with brick-masonry. The lumped weight due to dead loads is 12 kN/m2on floors and 10 kN/m2on the roof. The floors are to cater for a live load of 4 kN/m2on floors and 1.5 kN/m2on the roof.Beam Size 230 x450.Column Size 230 x600.Slab thickness 120 mm.Grade of concrete M20 and Grade of steel Fe415

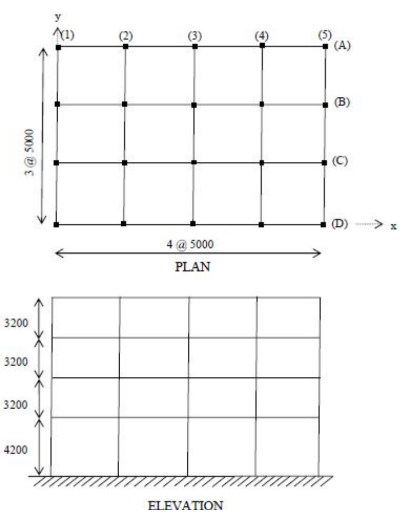


Fig.2 Plan and Elevation of RCC Frame

Seismic Weights:

The floor area is 15×20=300 sq. m. Since the liveload class is 4kN/sq.m, only 50% of the live loadis lumped at the floors. At roof, no live load is tobe lumped. Hence, the total seismic weight on the floors and the roof is:

Floors:
$W1=W2=W3=300\times(12+0.5\times4)$
= 4,200 KN

Roof:
$W4 = 300\times10$
= 3,000 KN
(clause7.3.1, Table 8 of IS: 1893 Part 1)
Total Seismic weight of the structure,
$W = \Sigma Wi = 3\times4{,}200 + 3{,}000$
= 15,600 KN

Fundamental Period:

Lateral load resistance is provided by momentresisting frames infilled with brick masonrypanels. Hence, approximate

Fundamental natural period:

(Clause 7.6.2. of IS: 1893 Part 1)
EL in X-Direction:
$T = 0.09h / d$
= 0.09(13.8) / 20
= 0.28 sec
The building is located on Type II (medium soil).
From Fig. 2 of IS: 1893, for T=0.28 sec,
$Sa/g=2.5$
Ah= 0.09(Clause 6.4.2 of IS: 1893 Part 1)

Design base shear
Vb=Ah X W
$= 0.09\times15{,}600$
= 1,440 kN
(Clause 7.5.3 of IS: 1893 Part 1)

Force Distribution with Building Height:

The design base shear is to be distributed withheight as per clause 7.7.1. Table 1.1 gives thecalculations. Fig. 1.2(a) shows the design seismicforce in X-direction for the entire building.
EL in Y-Direction:

$T = 0.09h\ d$
= 0.09(13.8) / 15
= 0.32 sec
Sa/g = 2.5;
Ah = 0.09

Therefore, for this building the design seismic force in Y-direction is same as that in the Xdirection.

IV. FEM MODELS IN STAAD-PRO

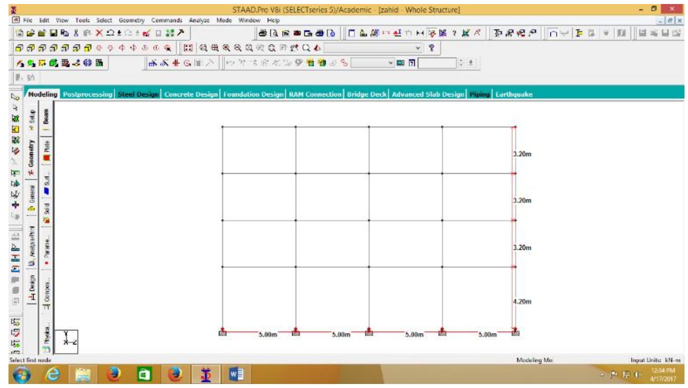


Fig.4FEM model in STAAD-Pro

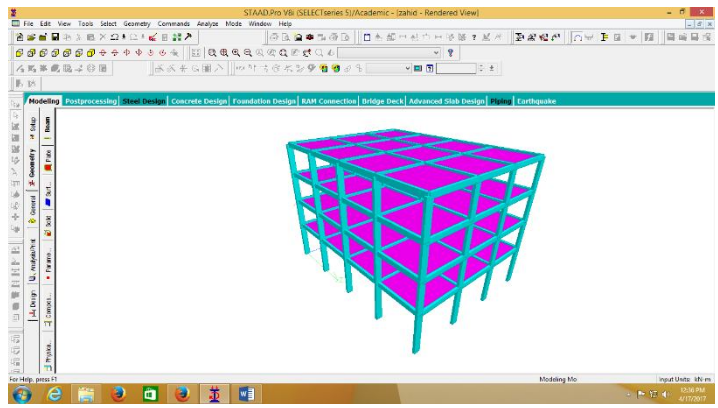


Fig.5 RENDERED VIEW STAAD-Pro

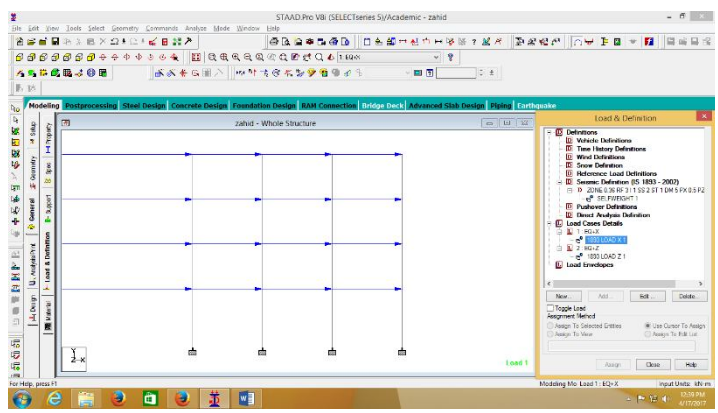


Fig.3 Base Shear Aloang X direction

The frame is modeled as per the parameters as given in

Table 1. Two types of models are considered for the analysis as given below:

Model 1: Bare frame model, however masses of the infill walls are included in the model.

Model 2: Full infill masonry model. Building has one full brick masonry infill wall in all storeys except the ground floor.

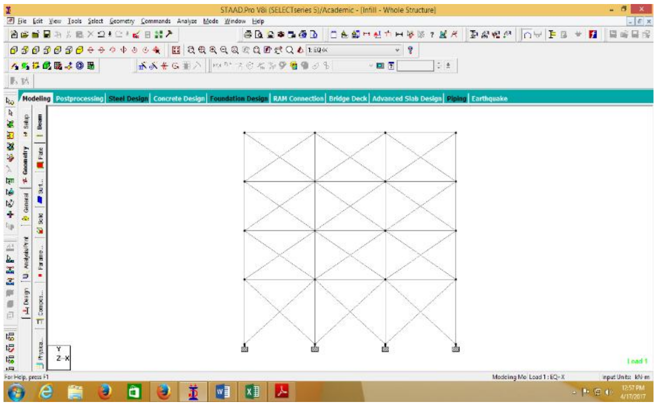


Fig.6 FEM model in STAAD-Pro of Infill Walls

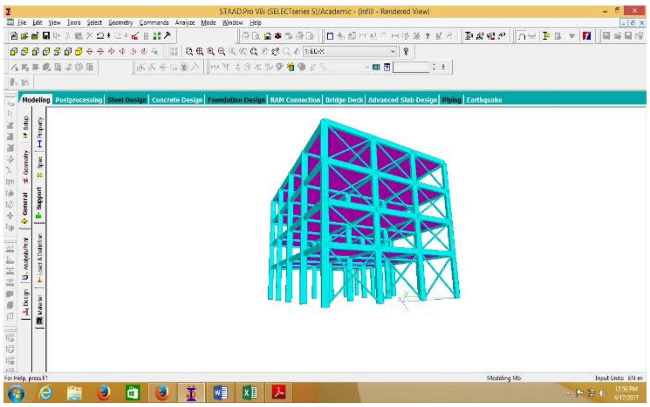


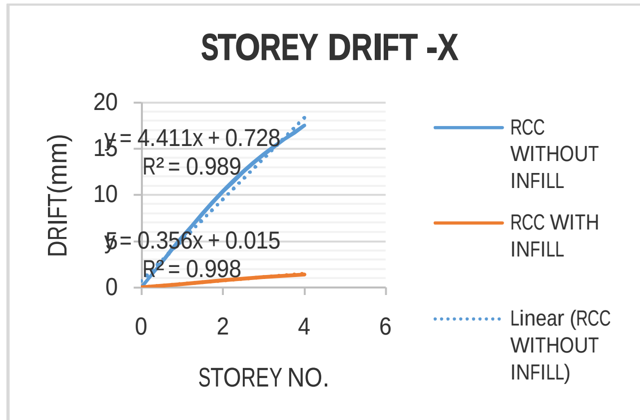
Fig.7 FEM model in STAAD-Proof Infill Walls

V. RESULTS AND DISCUSSION

5.1Storey Shear

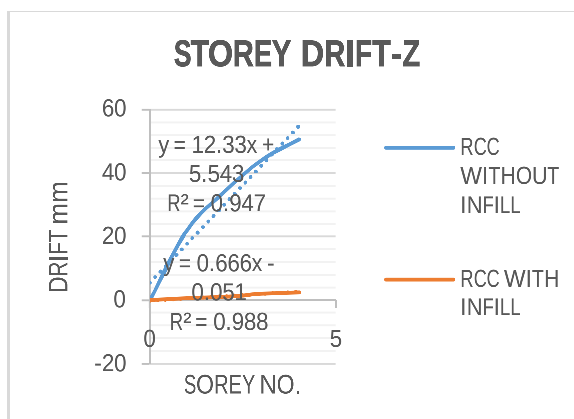
Storey shear is the distribution of design base shear along height of the structure. The storey shear is more for RC frame with masonry infill and least for bare frame. Storey shear depends upon the stiffness in the frame. The struts resist the lateral seismic forces through axial compression along the strut. The contribution of infill increases the stiffness of the frame, resulting increase in seimic force than bare frame. Table 3shows the values for storey shear in X-direction.Shear obtained from Response Spectrum method comes out to be more that Equivalent Static method which shows that IS: 1893 -2002 (Part 1) method gives conservative value and that Response Spectrum value is more actual response. Fig. 3(a & b) showsthe graphical representation of base shear for both method and the corresponding trends of increase in base shear value for RC frame with infill

STOREY DRIFT X	RCC WITHOUT INFILL	RCC WITH INFILL	% REDUCTION
0	0	0	0
1	3.4	0.375	88.97058824
2	8.4	0.742	91.16666667
3	11.4	1.109	90.27192982
4	14.4	1.413	90.1875



Graph No.1 Storey drift X

STOREY DRIFT Z	RCC WITHOUT INFILL	RCC WITH INFILL	% REDUCTION
0	0	0	0
1	22.1	0.613	97.22624434
2	34.14	1.11	96.7486819
3	44.15	2.089	95.26840317
4	50.623	2.592	94.87979772



Graph No.2 Storey drift X

VI. CONCLUSIONS

Present study makes an effort to access the effect of dual system on natural period, story Displacement, base shear, axial load and design moment of column.

1. The values of natural period are reduces for dual system with as compare to bare and infill frame, hence Provisions of dual system will reduces the natural period of R.C.C. building.
2. Strory Drift along X and Z direction significantly reduces up to 80% as from graph no.1 and graph no.2.
3. Top story displacement of bare frame, infill frame and dual system are increases according to soil strata and different seismic zonesIt also concludes that provisions of infill struct and shear wall will reduce the value of story displacement in bare frame.
4. Axial forces of column are increase according to seismic zone i.e. higher seismic zone shows higher value of axial load. In comparison of bare frame and infill frame with dual system, the values of axial loads and design moments are reduce.

FUTURE SCOPE

The same comparison can be made with In-fill walls to RCC shear wall for seismic coefficient method

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