Effect of Contact between Infill and Frame on the Behaviour of infilled Multistorey Frames

Dr.H. ACHYUTHA
Assistant Professor, Structural Engineering Laboratory
Indian Institute of Technology, Madras, India.

R.JAGADISH
Lecturer, Faculty of Engineering - Civil
Bangalore University, Bangalore.
(Formerly Research Scholar, Structural Engineering Laboratory, Indian Institute of Technology, Madras)

S.S. RAHMAN
Formerly Post-graduate student,
Structural Engineering Laboratory
Indian Institute of Technology, Madras, India.

Summary - The composite action between infill and frame is a function of the degree of tight-fit or the length of contact at the interface of infill and frame. The effect of type of contact between infill and frame on the behaviour of multistorey infilled frames is studied. Four different types of contacts are considered. For the analysis, 'simplified frame work method' is used. It is concluded that if there has to be composite action between the infill and the frame there has to be good contact atleast between the infill and the beam portions of the frame.

1. INTRODUCTION

With the present knowledge of infilled frames, it is well established that the addition of walls as infills improve considerably the strength and stiffness of a frame building [1-3]. This is due to the composite action between the infill and the frame. This composite action is a function of the degree of tight fit or the length of contact between the infill and the frame. Some construction procedures like providing shear connectors at the interface of frame and infill or casting of concrete members directly on brickwork have been suggested by some earlier investigators.

In an infilled frame, there are four interfaces between the infill and the frame. The behaviour of infilled frame will be influenced by whether good contact has been provided at all the four interfaces or at few interfaces only. This paper reports the salient results of a study made on infilled frames with different types of contact between the infill and the frame [4]. Four categories of contact have been considered in the present study.

2. TYPES OF CONTACT

Four categories of contacts along the interfaces of frame and infill are considered as shown in Fig.1.

1. Contact on all the four interfaces of infill and frame.
2. Contact along the supporting beam and two column interfaces.
3. Contact along the top and the supporting beam interfaces only, and
4. Contact along the supporting beam interface only.

3. TYPES OF FRAMES

For the analysis, three different types of frames are considered, namely:

1. Single storey single bay
2. Two storey single bay
3. Three storey single bay

The dimensions of the frames selected for the analysis are shown in Fig.2.

4. TYPES OF LOADS

Behaviour of all the types of infilled frames with the four types of contact are studied for the following two types of loading:

1. lateral loads and
2. vertical loads. (Fig.3)

5. METHOD OF ANALYSIS

Infilled frames are analysed making use of 'simplified frame work method' proposed by Ganesan et al [5]. In this method, the elastic continuum is considered as an assemblage of rectangular plate elements rigidly connected with each other at the mid-point of their sides. Each element is then replaced by the plane framework model consisting of two bar elements intersecting at right angles and rigidly connected with the adjoining elements. The forces on the elastic continuum are replaced by statically equivalent nodal loads. Using any standard plane frame computer programme, the equivalent plane frame-work is then analysed for deformations, forces and moments at various joints. From these results the stresses in the members of the plane framework and the stresses in the elastic continuum (infill panel) are interpreted.

6. RESULTS AND CONCLUSIONS

The results obtained from the theoretical analysis is presented and discussed in detail under three groups depending on the number of storey and forms part of a thesis [4]. The results in the form of axial force, shear force and bending moment in the members of the frame, stresses in the infill and the lateral deflection of infilled frame have been studied and for brevity the salient results are discussed and conclusions drawn therefrom are presented below:

a) In one storey frames, if there has to be composite action between the infill and the frame, there has to be good contact atleast between the infill and the beam portion of the frame, of course, in such a case the infill should have regular foundation as provided in load bearing constructions.

b) There exists certain similarities in the distribution of forces, moments, etc in the top and bottom-most storeys of two and three storey infilled frames.

c) Of the four cases of contact considered, the reduction in forces, moments, deflections, etc. is highest in the case of four side contact and decreases in the order of four, two, three and one side contact. For example, the influence on maximum deflections in the frame for each case of load is given in Table 1.

d) In most of the cases, the order of influence on the moments, forces, deflections, etc of the frame is almost same in both the cases of four and two sides contact. But the infill is severely stressed in the case of two sides contact.

e) In usual multistorey frame constructions, walls are built on beams as partitions making no provisions for good bonding or connections with the side columns and top beam. Even in such cases, as observed from the cases of frames with infills having contact on one side (i.e. on the supporting beam), there is reduction in horizontal sway, in moments, forces, vertical deflections of the supporting beam, in all cases of loads.

f) When there is good interaction between the infill and the frame, there are tensile stresses (in the infill) of the order that will cause cracking and hence this calls for reinforcing the infill to take up the tensile stresses.

REFERENCES

[1] J.R.BENJAMIN and H.A. WILLIAMS: The Behaviour of One-storey Reinforced Concrete Shear Walls - Proc. of A.S.C.E., Vol.83, May 1957.

[2] A.COULL: The Influence of Concrete Infilling on the Strength and Stiffness of Steel Frames - Cement and Concrete, Oct-Dec.1966, pp 162-169.

[3] D.V.MALLICK and R.P.GARG: Effect of Openings on the Lateral Stiffness of Infilled Frames - Proc. of The Institution of Civil Engineers, Vol.49, 1971, pp 193-209.

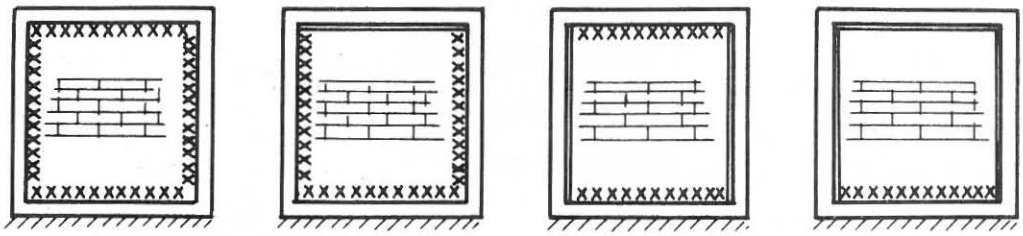
[4] S.S.RAHMAN: Effect of Contact between Infill and Frame on the Behaviour of Infilled Multistorey Frames - M.Tech Thesis, Indian Institute of Technology, Madras, July 1979.

[5] T.P.GANESAN, P.C. VARGHESE and H.ACHYUTHA: Simplified Framework Method for certain Plane Stress Problems - Journal of Institution of Engineers, Vol.57, Part CI-5, pp 250-254, 1977.

TABLE 1

Number of Storeys	Load case	Absolute value in simple frame without infill	Number of sides of contact*			
			Four	Three	Two	One
One	LC1	5.1	1.2	62.6	1.2	99.6
	LC2	0.2	48.0	62.0	63.8	99.8
	LC3	51.8	0.7	1.0	0.9	92.0
Two	LC1	5.5	2.1	60.3	2.1	98.0
	LC2	0.3	39.4	63.8	49.1	99.9
	LC3	295.3	0.9	1.1	1.0	68.0
	LC4	4.1	1.3	3.9	1.4	9.2
Three	LC1	5.7	2.9	60.4	3.0	97.7
	LC2	0.5	36.4	65.4	43.0	99.7
	LC3	83.5	1.2	1.5	1.2	38.3
	LC4	4.3	2.4	6.4	2.6	12.4
	LC5	3.8	1.4	4.2	1.5	9.7

* The deflections in these cases are expressed as a percentage of the absolute maximum value of the deflections in a simple frame without any infill.



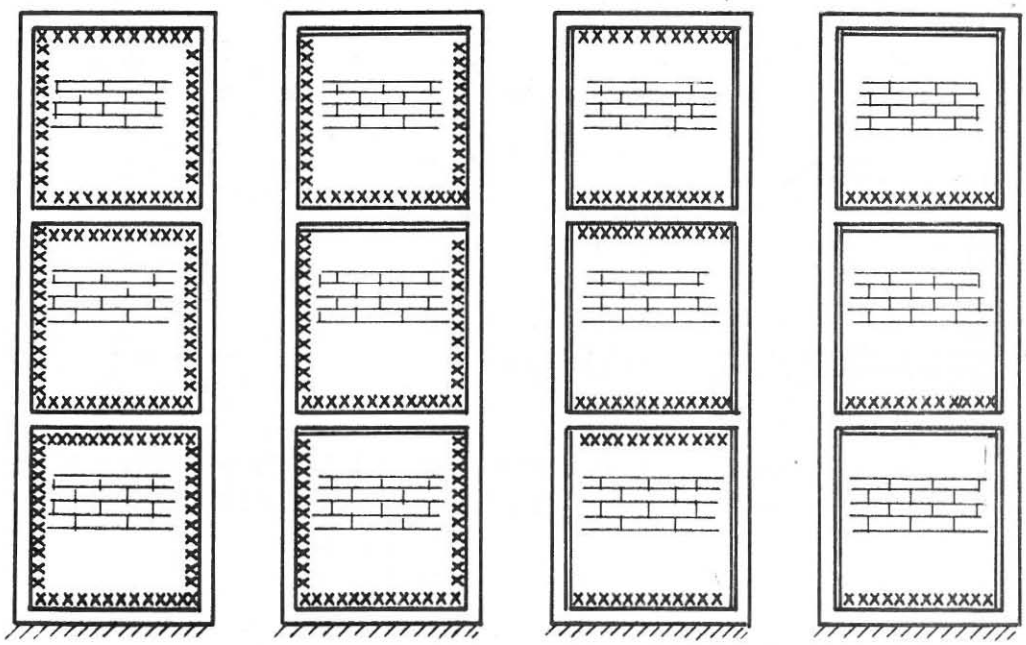
a. Full contact

b. Three sides contact

c. Two sides contact

d. One side contact

ONE STOREYED INFILLED FRAME



a. Full contact

b. Three sides contact

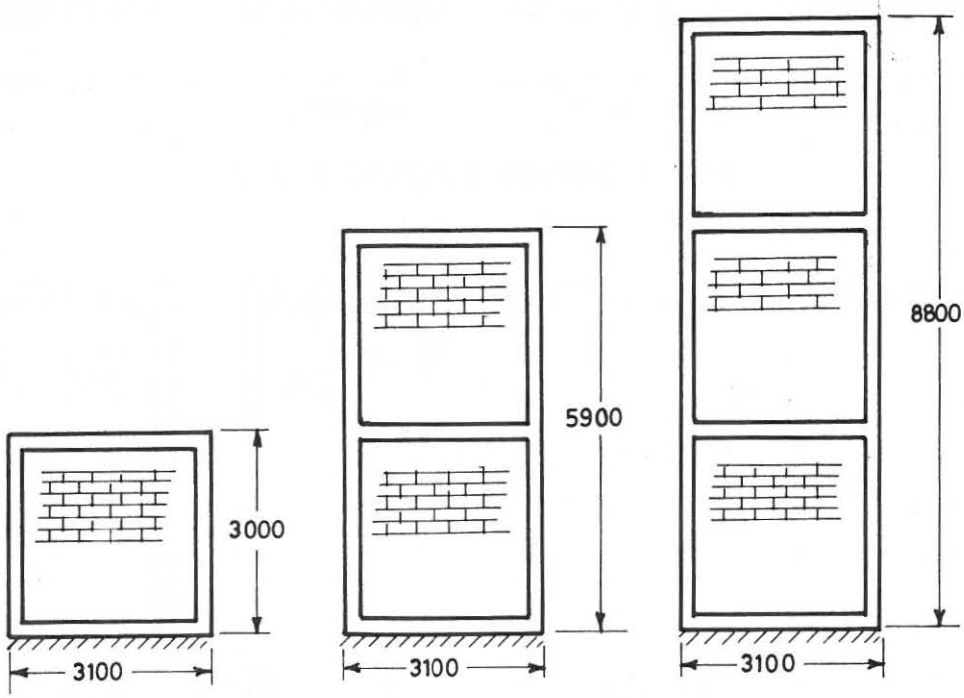
c. Two sides contact

d. One side contact

THREE STOREYED INFILLED FRAME

FIG. 1. TYPES OF CONTACT.

Frame members : 200 x 200
Infill : 2700 x 2700 x 200
$E_{concrete}$: 0.206 N/mm^2
E_{infill} : 0.069 N/mm^2



a. One storeyed infilled frame

b. Two storeyed infilled frame

c. Three storeyed infilled frame

FIG. 2. DETAILS OF FRAMES.

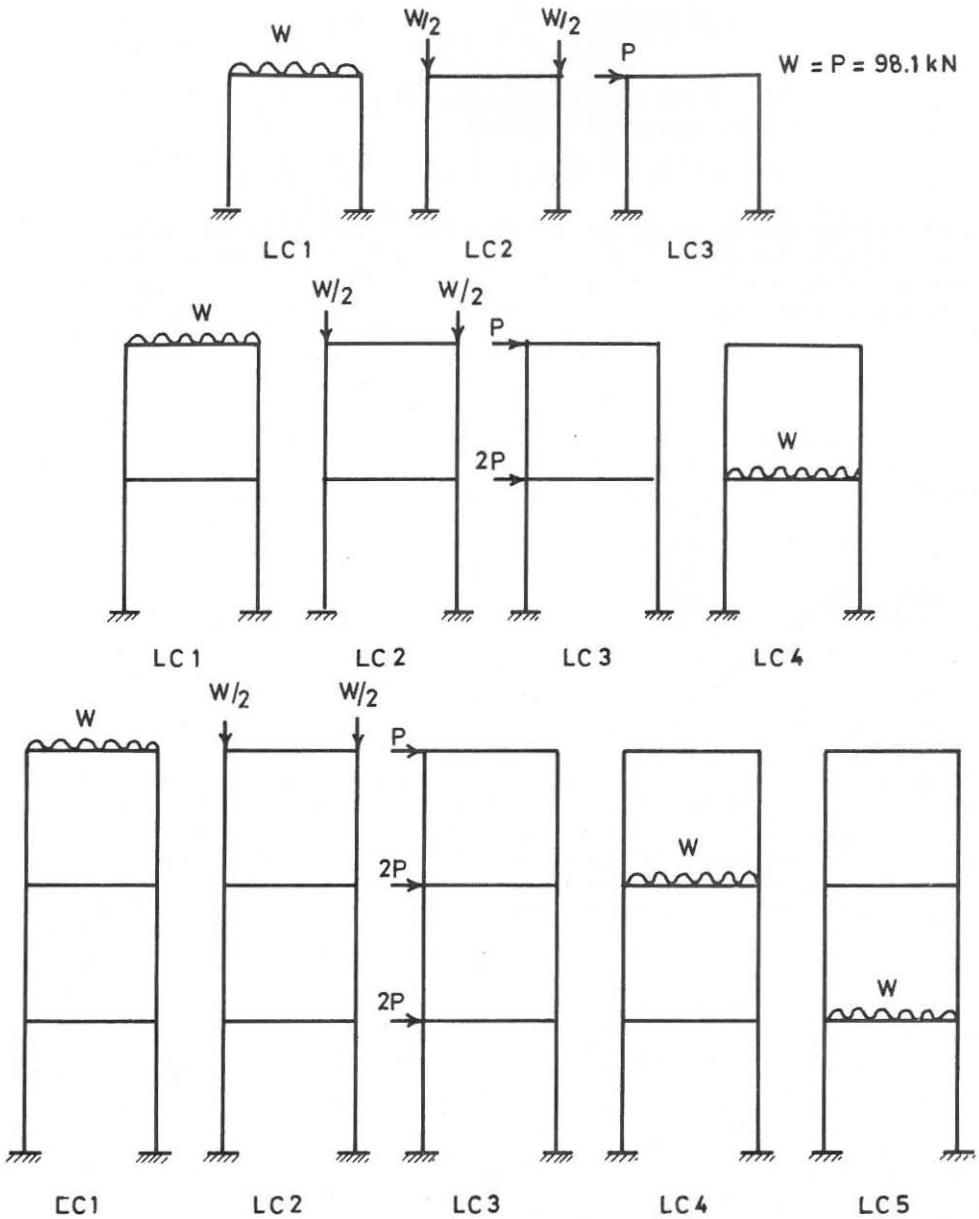


FIG. 3. LOADING CASES.