IJIRSET

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, JANUARY 2014

Behaviour of RCC Multistorey Structure With and Without Infill Walls

Mohammed Nauman[1], Nazrul Islam[2]

Structure Engineer, Department of Civil Engineering, Faculty of Engineering and Technology, Jamia Millia Islamia, New Delhi, India [1]

Professor, Civil Engineering Department, Islamic University, Medinah Munawwarah, Kingdom of Saudi Arabia[2]

Abstract: Framed reinforced concrete structures are most commonly types of structures constructed all over the world due to ease of construction and rapid progress of work. Generally brick or block work masonry is done in these frames which act as an infill panels in the framed structure. Infill walls provide the lateral stiffness to the structure. Its behaviour is very different from the bare frame structure.

Keywords: Reinforced concrete, Brick masonry, infill panels, Bare frame

I. INTRODUCTION

Behaviour of masonry infilled concrete frames under the lateral load is studied. Investigations showed that, one of the most appropriate ways of analyzing the masonry infilled concrete frames is to use the diagonally braced frame analogy. RCC buildings are generally analyzed and designed as bare frame. But after the provision of infill walls, mass of the building increases and this will result in the increase of the stiffness of the structure. During the seismic activities, response of the structure with infill walls is quite different for the structure without infill walls. Infill walls changes the dynamic behaviour of the structure. In this study two G+11 storeyed structure models are generated. In one structure, brick infill walls are modelled as strut element. These struts act as a compression members. In the other structure, only bare frame structure is modelled. All the parameters i.e. beam sizes, column sizes, floor height; load parameters etc are same for both the structures

II. RELATED WORK

Paulay & Priestley proposed a theory about the seismic behaviour of masonry infilled frame and a design method for infilled frames. Authors said that although masonry infill may increase the overall lateral load capacity, it can result in altering structural response and attracting forces to different or undesired part of structure with asymmetric arrangement. This means that masonry infill may cause structural deficiencies. Infilled frames behave differently with respect to lateral load level. At low levels, both concrete frame and infill act in a fully composite manner.

Smith & Coull presented a design method for infilled frame based on diagonally braced frame criteria. The developed method considered three possible modes of failure of infill: shear along the masonry, diagonal cracking through masonry and crushing of a corner of infill. They assumed effective width of diagonal compression strut as equal to one-tenth of the diagonal length of the infill panel. At the initial design stage, frame must be designed on the basis of the gravity loading.

Smith & Carter examined multi-story infilled frames for the case of lateral loading. In the light of experimental results, authors proposed design graphs and design method based on an equivalent strut concept. First, they focused on the composite behavior of infilled frame and failure modes. Then, the factors that affect the effective width of diagonal compression strut were determined. Finally, with known factors and behaviour, the design curves to estimate equivalent strut width, cracking and crushing strength of infill panel were presented.

III.MODELLING & ANALYSIS OF BUILDING

The analysis of G+11 storeyed RCC structure is carried out using STAAD V8i software for special moment resisting frame situated in zone 4.These RCC G+11 storeyed structures are analysed for infill panels and without infill . Bending moments, shear forces, storey shears, and axial forces are compared for both type of structural systems.

Structure	SMRF
No. of Stories	G+11
Type of Building	Residential
Young's Modulus for Concrete	$21.7\text{x}10^6$ kN/m^2
Young's Modulus for Brick Masonry	$3.85\text{x}10^6$ kN/m^2
Grade of Concrete	M25
Density of RCC	25 kN/m^3
Beam Size	0.3x0.45m
Column Size	0.3x0.75m
Dead Load Intensity	5 kN/m^2
Live Load Intensity	2.0 kN/m^2
Seismic Zone, Z	IV
Importance Factor, I	1
Height of the Structure	39 m
Response Reduction Factor, R_F	5
Time Period for Bare Frame in X Direction	1.17 sec
Time Period for Bare Frame in Z Direction	1.17 sec
Time Period for Infill frame in X Direction	0.66 sec
Time Period for Infill frame in Z Direction	1.08 sec

Fig. 1 Modelling Data

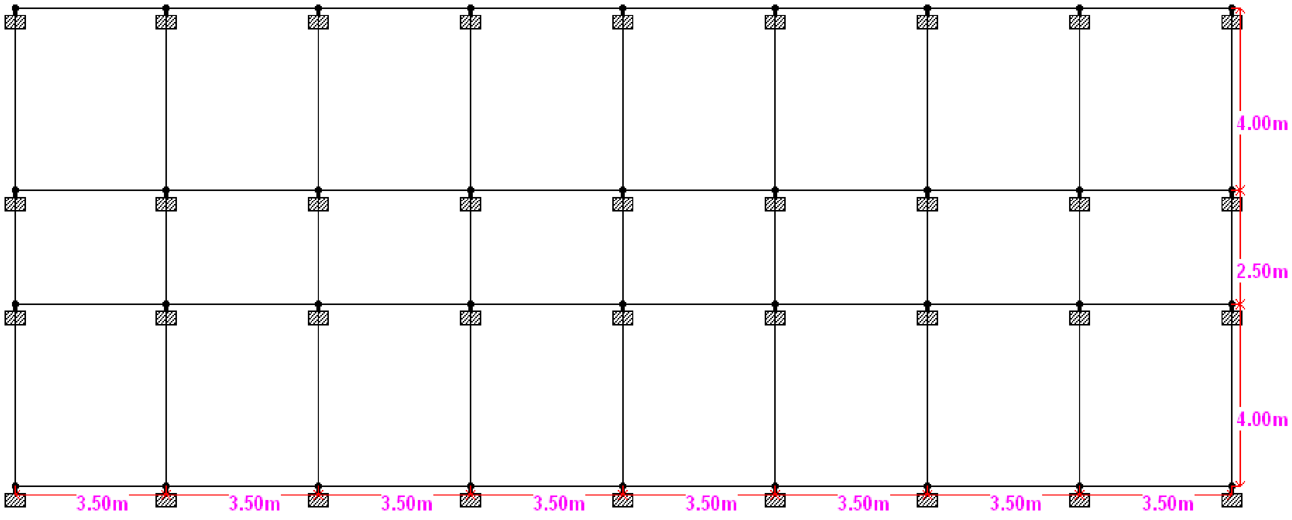

Fig. 2 Plan of Structure

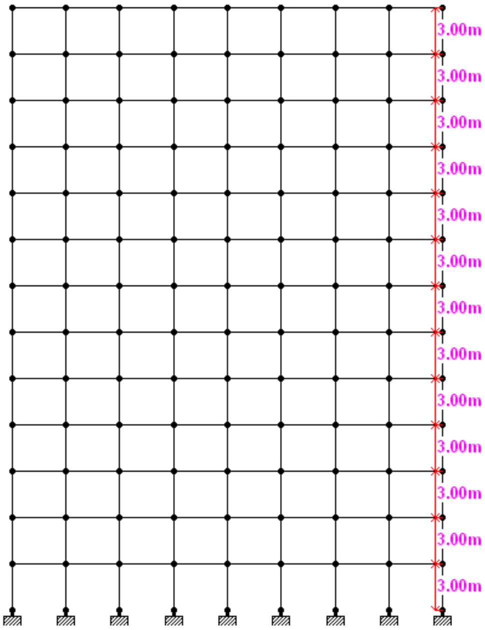

Fig. 3 Elevation of Without Infill (Bare Frame) Structure

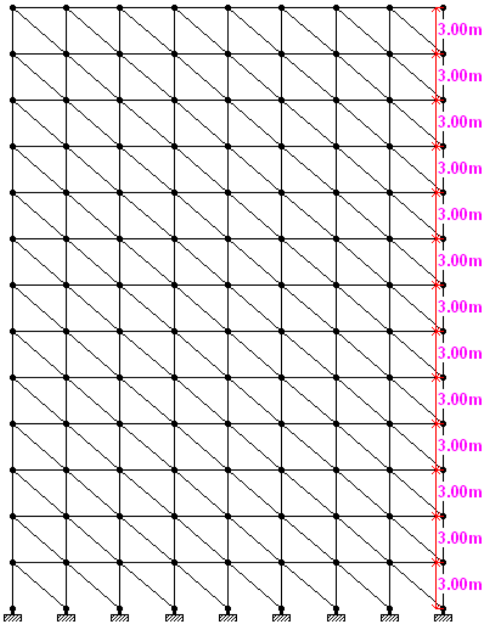

Fig. 4 Elevation of Infill Framed Structure

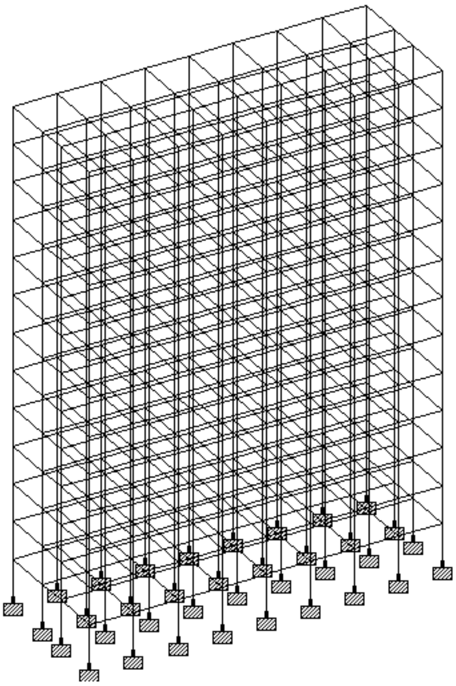

Fig. 5 Isometric View of Without Infill (Bare Frame) Structure

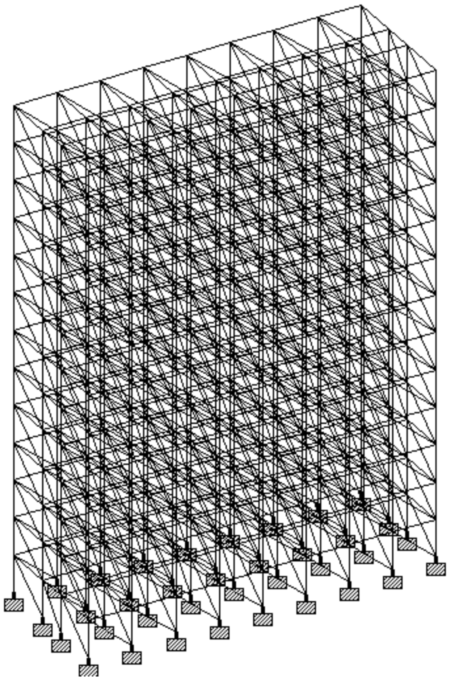

Fig. 6 Isometric View of Infill Framed Structure

IV. RESULTS

Level	Without Infill	With Infill	Percentage Reduction
Base	0	0	0.00
Ground Floor	1.355	0.529	60.96
1st Floor	3.525	1.2	65.96
2nd Floor	5.89	1.917	67.45
3rd Floor	8.301	2.671	67.82
4thFloor	10.697	3.446	67.79
5th Floor	13.036	4.228	67.57
6th Floor	15.279	5.002	67.26
7th Floor	17.383	5.754	66.90
8th Floor	19.299	6.466	66.50
9th Floor	20.977	7.121	66.05
10th Floor	22.36	7.703	65.55
11th Floor	23.393	8.195	64.97
Terrace Floor	24.05	8.583	64.31

Table. 1 Maximum Lateral Deflection (mm) in X- Direction

Level	Without Infill	With Infill	Percentage Reduction
Base	0	0	0.00
Ground Floor	1.569	0.46	70.68
1st Floor	4.502	1.161	74.21
2nd Floor	7.841	1.991	74.61
3rd Floor	11.3	2.931	74.06
4thFloor	14.77	3.96	73.19
5th Floor	18.196	5.057	72.21
6th Floor	21.508	6.198	71.18
7th Floor	24.646	7.362	70.13
8th Floor	27.542	8.526	69.04
9th Floor	30.121	9.668	67.90
10th Floor	32.305	10.765	66.68
11th Floor	34.033	11.797	65.34
Terrace Floor	35.318	12.751	63.90

Table. 2 Maximum Lateral Deflection (mm) in Z- Direction

Level	Without Infill	With Infill	Percentage Reduction
Base	0	0	0.00
Ground Floor	1.355	0.529	60.96
1st Floor	2.17	0.67	69.12
2nd Floor	2.365	0.718	69.64
3rd Floor	2.411	0.754	68.73
4thFloor	2.396	0.775	67.65
5th Floor	2.339	0.782	66.57
6th Floor	2.243	0.774	65.49
7th Floor	2.104	0.751	64.31
8th Floor	1.917	0.712	62.86
9th Floor	1.678	0.656	60.91
10th Floor	1.383	0.582	57.92
11th Floor	1.034	0.492	52.42
Terrace Floor	0.657	0.394	40.03

Table. 3 Drift(mm) in X- Direction

Level	Without Infill	With Infill	Percentage Reduction
Base	0	0	0.00
Ground Floor	1.569	0.46	70.68
1st Floor	2.933	0.701	76.10
2nd Floor	3.339	0.83	75.14
3rd Floor	3.459	0.94	72.82
4thFloor	3.473	1.029	70.37
5th Floor	3.422	1.096	67.97
6th Floor	3.312	1.141	65.55
7th Floor	3.139	1.164	62.92
8th Floor	2.896	1.164	59.81
9th Floor	2.578	1.141	55.74
10th Floor	2.184	1.097	49.77
11th Floor	1.728	1.032	40.28
Terrace Floor	1.285	0.954	25.76

Table. 4 Drift (mm) in Z- Direction

Level	With Infill	Without Infill	Percentage Reduction
Base	3044.27	1059.05	65.21
Ground Floor	3044.27	1059.05	65.21
1st Floor	2996.56	1038.54	65.34
2nd Floor	2916.84	999.68	65.73
3rd Floor	2800.56	949.59	66.09
4thFloor	2652.48	894	66.30
5th Floor	2474.46	835.57	66.23
6th Floor	2266.41	774.82	65.81
7th Floor	2028.18	709.8	65.00
8th Floor	1759.62	636.93	63.80
9th Floor	1458.96	551.27	62.21
10th Floor	1122.29	447.66	60.11
11th Floor	746.1	320.01	57.11
Terrace Floor	331.56	163.04	50.83

Table. 5 Storey Shear (kN) in X- Direction

Level	With Infill	Without Infill	Percentage Reduction
Base	1860.33	1059.08	43.07
Ground Floor	1860.33	1059.08	43.07
1st Floor	1824.44	1036.43	43.19
2nd Floor	1765.7	991.55	43.84
3rd Floor	1685.91	935.66	44.50
4thFloor	1593.83	876.36	45.02
5th Floor	1493.33	819.2	45.14
6th Floor	1384.03	766.25	44.64
7th Floor	1263.71	713.05	43.57
8th Floor	1128.38	653.55	42.08
9th Floor	970.29	578.97	40.33
10th Floor	777.69	480.96	38.16
11th Floor	539.2	353.94	34.36
Terrace Floor	249.97	188.28	24.68

Table. 6 Storey Shear (kN) in Z- Direction

Floor	With Infill	Without Infill	Percentage Reduction
Base to Ground	503.695	272.06	45.99
Ground to 1st	469.07	245.251	47.72
1st to 2nd	418.96	212.826	49.20
2nd to 3rd	367.53	180.407	50.91
3rd to 4th	315.76	149.353	52.70
4th to 5th	267.35	120.069	55.09
5th to 6th	219.76	92.84	57.75
6th to 7th	173.50	68.029	60.79
7th to 8th	129.45	46.118	64.37
8th to 9th	97.45	27.709	71.57
9th to 10th	72.36	15	79.27
10th to 11th	46.47	9.065	80.49
11th to Terrace	25.39	4.162	83.61

Table. 7 Axial Force (kN) for Earthquake in X Direction

Floor	With Infill	Without Infill	Percentage Reduction
Base to Ground	562.353	288.689	48.66
Ground to 1st	522.286	266.68	48.94
1st to 2nd	466.058	238.373	48.85
2nd to 3rd	408.62	208.528	48.97
3rd to 4th	352.68	178.614	49.35
4th to 5th	298.95	149.287	50.06
5th to 6th	246.08	121.041	50.81
6th to 7th	195.40	94.381	51.70
7th to 8th	147.76	69.868	52.71
8th to 9th	104.06	48.127	53.75
9th to 10th	65.69	29.833	54.58
10th to 11th	36.24	15.642	56.84
11th to Terrace	14.37	5.841	59.35

Table.8 Axial Force (kN) for Earthquake in Z Direction

Floor	Without Infill	With Infill	Percentage Reduction
Base to Ground	43.253	34.756	19.64
Ground to 1st	43.849	21.483	51.01
1st to 2nd	43.702	22.086	49.46
2nd to 3rd	43.094	22.14	48.63
3rd to 4th	42.256	22.09	47.72
4th to 5th	41.038	21.77	46.96
5th to 6th	39.272	21.02	46.48
6th to 7th	36.819	19.84	46.12
7th to 8th	33.559	18.19	45.79
8th to 9th	29.378	16.07	45.31
9th to 10th	24.149	13.51	44.04
10th to 11th	18.017	10.60	41.19
11th to Terrace	11.475	5.97	48.00

Table. 9 Shear Force (kN) for Earthquake in X Direction

Floor	Without Infill	With Infill	Percentage Reduction
Base to Ground	39.413	24.493	37.86
Ground to 1st	27.291	8.062	70.46
1st to 2nd	24.465	8.775	64.13
2nd to 3rd	23.556	8.64	63.34
3rd to 4th	23.013	8.50	63.05
4th to 5th	22.35	8.28	62.97
5th to 6th	21.396	7.92	62.98
6th to 7th	20.06	7.42	63.02
7th to 8th	18.274	6.75	63.07
8th to 9th	15.961	5.89	63.07
9th to 10th	13.005	4.83	62.85
10th to 11th	9.253	3.57	61.43
11th to Terrace	2.868	1.43	50.00

Table. 10 Shear Force (kN) for Earthquake in Z Direction

Floor	Without Infill	With Infill	Percentage Reduction
Base to Ground	109.997	73.03	33.61
Ground to 1st	77.379	32.695	57.75
1st to 2nd	68.028	34.081	49.90
2nd to 3rd	64.855	33.83	47.84
3rd to 4th	64.662	33.56	48.09
4th to 5th	63.645	32.78	48.49
5th to 6th	61.891	31.71	48.77
6th to 7th	59.254	30.27	48.91
7th to 8th	55.549	28.16	49.30
8th to 9th	50.567	25.35	49.87
9th to 10th	43.931	21.94	50.07
10th to 11th	35.533	18.20	48.79
11th to Terrace	25.804	11.21	56.55

Table. 11 Moment (kN-m) for Earthquake in X Direction

Floor	Without Infill	With Infill	Percentage Reduction
Base to Ground	34.389	10.324	69.98
Ground to 1st	49.644	10.54	78.77
1st to 2nd	52.317	11.059	78.86
2nd to 3rd	52.398	10.44	80.08
3rd to 4th	51.36	9.96	80.61
4th to 5th	49.574	9.40	81.04
5th to 6th	47.285	8.74	81.51
6th to 7th	44.128	7.95	81.98
7th to 8th	39.973	7.16	82.09
8th to 9th	34.687	6.18	82.19
9th to 10th	28.188	5.07	82.01
10th to 11th	19.704	3.75	80.97
11th to Terrace	14.058	2.21	84.29

Table. 12 Moment (kN-m) for Earthquake in Z Direction

V. DISCUSSION

As the structure is modelled in staad pro, figure 1 shows the modelling data of the structure. Figure 2,3,4,5& 6 show the different views of the infilled and bare frame structure. Table 1 and table 2 show the comparison of maximum lateral deflection for infilled and bare framed structure under the earthquake load in X and Z direction respectively. Table 3 and table 4 show the storey drift for infilled and bare frame structure for earthquake load in X and Z direction respectively. Table 5 and table 6 show the storey shears for different storeys for infilled and bare frame structure for earthquake load in X and Z direction respectively. Table 7 and table 8 show comparison of axial forces due to earthquake load in X and Z direction for infilled and bare frame structure. Similar comparison has been shown in table 9, 10, 11 and 12 for shear forces and bending moments for infilled and bare frame structure.

VI. CONCLUSION

Lateral deflection in both the direction decreases considerably with the introduction of in fill walls. It indicates that the stiffness of the structure is increased. Remarkable reduction in the storey drift has also been observed. Maximum reduction in the storey drifts in X and Z direction is 69.64% and 76.1% respectively.

Drastic reduction in the storey shears has been observed in both the structures. Storey shears increases considerably after the addition of infill walls. After the addition of infill walls the building become stiff as compared to the bare frame structure, it will attract large amount of lateral forces as compared to the bare frame structure.

Notable reduction in axial force for the columns has been observed for the seismic forces in both the direction after the application of the infill walls.. Maximum share of the axial force has been taken by the infill walls. Shear forces and bending moments in the columns has also been reduced considerably after the addition of infill walls in the structure. The results show that the infill framed structure always enhances the seismic performance of the building. Also it increases the stiffness of the structure hence it will have the lesser deflection as compared to the bare frame structure .

REFERENCES

[1] Holmes H, “Steel frames with Brickwork and Concrete Infilling”, Proceedings of the Institute of Civil Engineers pp 473- 478 1961.

[2] Stafford Smith, “Behaviour of the Square Infilled Frames”, Journal of Structural Div. ASCE pp 381-403 1966.

[3] Klingner R E, Bertero V V. “Earthquake Resistance of Infilled Frames”, Journal of Structural Engineering, ASCE pp:973-989 1978.

[4] Valiasis T N, Stylianidis K C, Penelis G G, “Hysteresis Model for Weak Brick Masonry Infills in R/C Frames Under Lateral Reversals”, European Earthquake Engineering 1993.

[5] Nauman Mohammed, Islam Nazrul. “Behaviour of Multistorey RCC Structure with Different Type of Bracing System (A Software Approach)” International journal of innovative research in science, engineering and technology, pp 7465 -7478,dec 2013

[6] IS 1893(part 1) – 2002, “Criteria for earthquake resistant design of structures, part 1-general provisions and buildings”, fifth revision, Bureau of Indian Standards, New Delhi, India.

\

BIOGRAPHY

Mohammed Nauman received his B.Tech. degree in Civil Engineering from Jamia Millia Islamia, New Delhi, India, in 2008 and the M.Tech degree in Earthquake Engineering from Jamia Millia Islamia, New Delhi, India, in 2013. Currently, he is a practicing structural engineer. His areas of designing are design of multistorey RCC and steel structures. His main area of interest is the retrofitting of the existing RCC and steel structures.

Dr. Nazrul Islam received has published more than 55 research papers in International journals and conferences along with the degrees like obtained his Bachelor's Degree in Civil Engineering from AMU Aligarh, India in the year 1984, Master's degree in Structures from IIT Roorkee, India (then known as University of Roorkee) in the year 1990. He has obtained his Ph.D. degree in Structures from IIT Delhi, India in the year 1998. He served as teaching faculty in Jamia Millia Islamia for more than 28 years presently working as Professor and Head of the Civil Engineering Department in Islamic university, Medinah Munawwarah, Kingdom of Saudi Arabia.